ELECTRONIC WASTE RECOVERY STUDY

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DISCLAIMER

This document has been prepared in consultation with stakeholders at the federal, provincial and municipal government levels in Canada, and in consultation with electronics product, recycling and other private sector and non-profit stakeholders in Canada. Consultations have also been undertaken with public and private stakeholders in the U.S., Europe and elsewhere. While the views and perspectives of stakeholders are reflected throughout the document all analyses, findings and recommendations are solely those of the consultant.

Recycling and other facilities identified in this document are provided for information purposes only. Additional relevant facilities may exist and those that are identified may not necessarily accept materials from a specific source. The identification of a facility in this document does not carry any implication concerning the status of the facility or its performance. Identification of appropriate facilities is the responsibility of the user of this document.

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Best Management Practice	Management that best meets established policy objectives under the assumption that available systems and technologies are employed to the range of end-of-life electronic products in all regions of the country
Brands	The trade name given by producers to their products
Current Management Practice	Existing practices for managing end-of-life electronic products
Design for Environment	Product design that results in lessening the impact of a product n the environment over the course of the product lifecycle
Disassembly	The taking apart of a product for the purpose of separating components and/or materials for reutilisation
Electronic Product	Products that contain an electrical circuit. For the purpose of the document, these products are limited to: rechargeable batteries, telephones, stereos, cell phones, computers, computer peripherals, monitors and televisions
Electronic Waste	An unwanted electronic product or component that is that is discarded or which is surplus to the needs of its owner
End of Life Product	A product that is no longer required by its owner
End Use Market	Markets that resell end-of-life products or that incorporate end-of-life products or their materials in the manufacture of a new product
Greenhouse Gas	A gas that absorbs and re-emits infrared radiation, warming the earth's surface and contributing to climate change
Intermediate Processor	An organisation that prepares products or materials for sale to end use markets
Producer	The manufacturer, brand-owner or first importer of a product who sells or offers for sale the product in a jurisdiction
Recycle	The reutilisation of materials in the manufacture of new products
Recovery	The reutilisation of materials for purposes not related to their original purpose, including the recovery of energy
Reuse	The reutilisation of a product without changing the make-up or form of the product
Waste Management Hierarchy	A preferred order of waste management approaches comprising, in descending order of preference, reduce, reuse, recycle, recovery (of energy or materials) and disposal (including incineration)
Waste Reduction	Action to reduce the quantity or toxicity of wastes, and including the redesign of products for improved reusability or recyclability

LIST OF ACRONYMS AND ABBREVIATIONS

ABS	Acrylonitrile Butadiene Styrene
BFR	Brominated Flame Retardants
BMP	Best Management Practice
CCME	Canadian Council of Ministers of the Environment
CD	Compact Disc
CMP	Current Management Practice
CPRA	Canadian Polystyrene Recycling Association
CRT	Cathode Ray Tube
C-WPEPS	Canada-Wide Principles for Electronic Product Stewardship
DfE	Design for Environment
DfRe	Design for Reutilisation
DfTR	Design for Toxics Reduction
EOL	End of Life
EPSC	Electronic Product Stewardship Canada
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HARL	Home Appliance Recycling Law
HH	Household
HHW	Household Hazardous Waste
HIPS	High Impact Polystyrene
IAER	International Association of Electronics Recyclers
IC&I	Industrial, Commercial and Institutional
ISRI	Iron and Steel Recycling Institute
JEITA	Japanese Electronic and Information Technology Association
LCD	Liquid Crystal Display
MSW	Municipal Solid Waste
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Cooperation and Development
OEM	Original Equipment Manufacturer
OH&S	Occupational Health and Safety
PBB	Polybrominated Biphenyls
PBDE	Polybrominated Dimethyl Ether
PC	Polycarbonate
PCB	Printed Circuit Board
PP	Polypropylene
PPO	Polyphenylene Oxide
PEUR	Promotion of Effective Resource Utilisation (Law)
PRB	Portable Rechargeable Battery
PRO	Producer Responsibility Organisation
PWB	Populated Wiring Board
RBRC	Rechargeable Battery Recycling Corporation
RLS	Reverse Logistics System
RoHS	Restriction on Hazardous Substance
WEEE	Waste Electric and Electronic Equipment

EXECUTIVE SUMMARY

Background

Electronic products play a key role in Canadian society. Across the country, businesses and households rely on electronic products as an integral component of maintaining the quality of life that Canadians have come to expect. However, when electronic products reach the end of their life consumers typically have no choice but to discard the products as waste destined for disposal. This has several consequences:

- Recyclable materials are lost, with consequences of increased virgin resource extraction and the environmental implications of these extraction activities.
- Opportunities to reduce greenhouse gas (GHG) emissions through use of recyclable materials are lost (use of recyclable materials in manufacturing processes typically carries significantly lower net GHG impacts than use of similar levels of virgin resources).
- Increased pressure on landfills, a common destination for used electronics.
- Materials that are toxic to human health and ecosystems can be released into the environment.
- Municipalities, and the taxpayers, bear ever-increasing waste disposal costs.
- Exports of EOL electronic products to developing countries with poorly developed or enforced environmental regulations may cause significant negative human and environmental impacts.

Well-developed technologies and infrastructures for enhanced management of EOL electronic products can lead to preventing the negative consequences associated with these products. A wide range of benefits can also be realized such as reduced GHG emissions, elimination of harmful leachate, less pressure on landfills, creation of business opportunities and increased employment.

Objectives

The objectives of this document are to:

- Identify current fate and national infrastructure for reusing and recycling EOL electronic products.
- Identify the “state-of-the-art” of EOL electronic product management in other countries.
- Detail “Best Management Practice” (BMP) for managing EOL electronic products in Canada.
- Present a feasibility analysis and recommendations for the application of the BMP in Atlantic Canada provinces (New Brunswick, Newfoundland and Labrador, Nova Scotia and Prince Edward Island).

Scope

The scope of this document is to address enhanced EOL management of the following electronic products: computers, monitors, computer peripherals (including keyboards, printers and scanners), televisions, telephones, cell phones, stereos and rechargeable batteries.

Methodology

This document has been prepared by a consultant guided by a committee including federal representation from Natural Resources Canada’s *Action Plan 2000 on Climate Change* and Industry Canada, provincial representation from Nova Scotia Environment and Labour and the Resource Recovery Fund Board Inc. (RRFB Nova Scotia), Newfoundland and Labrador Department of Environment and Conservation and the Multi-Materials Stewardship Board (MMSB), New Brunswick Department of the Environment and Local Government and Prince Edward Island Department of Environment, Energy and Forestry, as well as the private industry sector represented by Electronics Product Stewardship Canada (EPSC). The preparation of the document has included the following main activities: (i) literature review; (ii) discussions and meetings with public and private sector stakeholders across Canada and internationally; (iii) visits to electronic product processing facilities; (iv) identification of technology and infrastructure options for management of EOL electronic products in Canada; (v) identification of costs and cost recovery options for enhanced management of EOL electronic products in Canada; (vi) identification of a BMP for Canada; (vii) development of options and identification of a recommended option for application of the BMP in each of the Atlantic Canada provinces.

Key External Factors

The following events occurred during the preparation of this document and have particularly influenced its content and recommendations:

- The Canadian Council of Ministers of the Environment adopted "Canada-Wide Principles for Electronics Product Stewardship". These provide a policy context for identifying stakeholders with responsibilities for enhanced management of EOL products in Canada and the actions they should take to achieve enhanced management of EOL electronic products.
- Significant change in the EOL electronics product management sector in Canada and internationally in preparation for what is widely perceived to be a significant business opportunity for EOL electronic product management service providers.
- Significant change in the electronics product sector in Canada and some other countries in response to evolving industry responsibilities for EOL management of its products.

Key Findings

The following represent the key findings of this document:

Current Fate And National Infrastructure For Reusing And Recycling EOL Electronic Products

- An estimated 19.458 million electronic products that are the focus of this document are expected to reach their end-of-life in 2005 (excluding rechargeable batteries, of which an estimated 6.15 million may be discarded in 2005), representing 165,429 tonnes of waste. These amounts are projected to grow by 8 percent and 11 percent respectively by 2010.

- Discarded consumer electronics typically have little residual value. There is widespread consensus that over 90 percent of EOL electronic products generated by consumers in jurisdictions without formal EOL electronic product recovery programs goes to disposal. EOL electronic products generated by the industrial, commercial and institutional (IC&I) sector often has residual value either through reuse of a device or through reuse of its components.

- National and international infrastructures have been developed by the private sector to take advantage of this value. There were over 60 organisations in Canada engaged in some aspect of processing EOL electronic products for reuse or recycling purposes in December 2004. Some of these organisations have multiple facilities; however, the sector is characterised by a few large facilities and many small facilities. The number of organisations and facilities in the sector grew in 2005, although data are not available regarding the extent of this growth.

- There is an extensive, but unquantified, reuse market in Canada for computer and computer-related products. This market is supplied by late-model products from the IC&I sector that are sold into both the IC&I and consumer sectors. Where markets do not exist for whole devices, their components may be removed for sale on the reuse market. There is also an extensive, but unquantified and poorly regulated, export market for reusable Canadian computer and computer-related products

- Markets for recyclable materials in EOL electronic products exist in Canada and the US. Selected facilities that may accept materials from EOL electronic products for recycling are identified in Annex I, Maps 2 through 5. Based on these facilities, and subject to facility-specific specifications and requirements:

    - Ferrous metals may be recycled at facilities in Alberta (1), Saskatchewan (1), Manitoba (1), Ontario (8), Quebec (3) and at least 30 additional facilities in the US.
    - Copper is recycled at a facility in QC, while aluminum may be recycled at facilities in Ontario (8), Quebec (5) and at least 25 additional facilities the US.
    - Leaded glass may be utilised in smelter applications in British Columbia (1), New Brunswick (1) and at least 3 additional facilities in the US.
    - Lead may be recycled at smelters in British Columbia (1), New Brunswick (1) and at least 1 other facility in the US.

  - Plastics may be recycled at facilities in British Columbia (2), Alberta (3), Ontario (2), Quebec (1) and at least 6 additional facilities in the US.
  - Printed circuit boards may be recycled at facilities in Ontario (1), Quebec (1) and at least 15 additional facilities in the US, while rechargeable batteries may be recycled at a facility in BC and at least one other facility in the US.

- Recyclable materials markets are global in scope and materials flow is financially-driven through international networks. Thus, materials from EOL electronics may be exported despite the availability of markets in North America.

- New markets are emerging for materials found in EOL electronics. Major markets have been developed for leaded glass (including cathode ray tubes) since 2003 in New Brunswick and British Columbia. Several new markets for separated plastics have emerged in recent years. There is significant opportunity to apply mixed plastics sorting and recycling technology in Canada if minimum quantities of plastics can be assured.

- Regulatory frameworks have been insufficient to prevent the export of EOL electronic products and their materials from Canada to countries where management of these items does not meet Canadian occupational health or environmental standards.

- Alberta has had a program to recover EOL electronics since 2004. British Columbia and Saskatchewan have introduced regulations for programs in their respective provinces since that time.

The "State-Of-The-Art" Of EOL Electronic Product Management In Other Countries

- All OECD countries and several non-OECD countries are developing programs to provide for enhanced management of EOL electronic products. In each country, the focus of current initiatives is on the recovery and recycling/reuse of EOL electronics.

- Actions in other countries to achieve enhanced EOL management of electronic products are generally based on the concept of "producer responsibility", such that producers are responsible for the EOL management of their products.

- The most effective EOL electronic product management programs provide for separate collection of EOL electronic products; consumers have easy access to the collection infrastructure. EOL electronic products collected through this infrastructure may be streamed for reuse of the whole device or its components, and/or may be processed for recycling of their materials. Approximately 80 percent of EOL electronic products in Norway are recovered for recycling and/or reuse.

- Countries are increasingly adopting EOL electronic product management legal frameworks that govern how such products must be managed. Members of the European Union are now implementing the EU Waste Electronic and Electrical Equipment (WEEE) Directive which establishes, among other things, (i) methods for collecting EOL electronic products; (ii) numeric requirements for how collected products are managed; (iii) the way in which management will be paid for; and (iv) the responsibilities of public and private sector stakeholders. Members of the EU are also implementing requirements of the Restriction on Hazardous Substances (RoHS) Directive, which prohibits or limits the use of certain materials in designated electronic equipment. Japan has implemented a series of legal requirements for the management of EOL electronic equipment, and has also detailed stakeholder responsibilities. In the U.S., cathode ray tubes (CRTs) are considered the most significant EOL electronic product management challenge, and some states now have legal frameworks that address these specifically.

Best Management Practice For Managing EOL Electronic Products In Canada

- The creation of an effective infrastructure for the separate collection of EOL electronic products will result in collection of an estimated 95 percent of such products. An estimated 92 percent of the materials in EOL electronic products can be recycled using existing technology. At least a small percentage by weight of collected EOL electronic products may have reuse application.

- Achieving the BMP in Canada requires the following key actions, among others: (i) provinces to adopt legal frameworks that give effect to producer responsibility for management of EOL electronics and which include a prohibition on the disposal of EOL electronic products and their materials unless they have first passed through a licensed recycling processing facility; (ii) establishment of a separate collection system for EOL electronics that is convenient for consumers, and which can be used without payment of a fee at the point of collection; (iii) the tracking of EOL electronic product management costs on at least a brand basis, and the internalisation of these costs by the producer in the cost of new products; (iv) adoption of standards for processing EOL electronic products that are not less stringent than the "Recycling Vendor Qualification Standard" prepared by EPSC.

- Implementation of actions to achieve the BMP to recycle EOL electronic products is estimated to cost an average of less than $1.00 per kilogram of EOL electronic product. It is estimated this would achieve, among other things, a reduction of over 193,000 tonnes per year in carbon dioxide emissions, a reduction of over 5 million tonnes per year of mining wastes and revenues from the sale of recyclable materials of $25 million per year.

Feasibility Analysis And Recommendations For The Application Of The BMP In Atlantic Canada Provinces

This report recommends the application of the best management practice in Atlantic Canada, as detailed in Section 8 and in Annex J. The key recommendations are as follows, with references to Section 8 where further detail can be found:

- Provincial collection point networks should be established for the separate collection of EOL electronics (see section 8.3.1).

- Collected EOL electronic products should be transported to disassembly facilities located in each province. This will result in local disassembly of over 90 percent by weight of EOL electronics in each province (see section 8.3.2 and section 8.3.3).

- Materials recovered from disassembly should be shipped to end use markets (see section 8.3.2).

- Stakeholder responsibilities should be implemented according to new legal frameworks in each province (see Section 8.4.7). Provinces should consider delegating implementation of the EOL electronics recovery program to a joint public/private entity, and providing the option for producers to establish separate recovery systems if they meet provincial criteria (see section 8.4.1). Provincial responsibilities under this legal framework should include a prohibition on the disposal of electronic products unless they have first passed through a licensed processing facility (see section 8.4.7). Producers should be required to pay the costs of EOL management of their products through the internalisation of those costs. However, visible fees may be charged to consumers at program launch with a clearly stated commitment by the producers to sunset visible fees according to a schedule negotiated with the regulatory body or its agent and reflected in the legal framework (see section 8.4.3); this may be considered permissible within the context of the C-WPEPS (see section 8.4.3).

- The core cost of the application of implementing the recommended EOL electronic products recovery and processing system in Atlantic Canada would be equivalent to: $0.76/kg of EOL electronic product in New Brunswick, $0.89/kg of EOL electronic product in Newfoundland and Labrador, $0.75/kg of EOL electronic product in Nova Scotia and $0.91/kg of EOL electronic product in Prince Edward Island (see section 8.3.3).

1.0 INTRODUCTION

1.1 Background

The electronic products sector is important to Canada. Electro-Federation Canada, the umbrella association that represents the electronic products industry, identifies that its over 250 corporate members contribute over $50 billion to the Canadian economy and employ over 130,000 workers in more than 1400 facilities in Canada.

Traditionally, electronic products have been considered durable items; owners have retained them over many years, even decades. As real costs for electronic products decreased, and as the economy has grown, however, electronic products have been replaced with increasing frequency. The consequence is a burgeoning quantity of electronic product waste that poses a significant, and expensive, management challenge that is characterised by the following:

- Difficulty in managing many electronic products in municipal waste management programs. The bulky nature of many electronic products makes them unsuitable for regular collection.
- Human and environmental hazards associated with electronic wastes. Some products present a potential human hazard in their management (e.g. through potential breakage of cathode ray tubes (CRTs)), and many products contain materials that may pose an occupational health and safety (OH&S) risk in management of the product as a waste, and which may pose an environmental threat if they are released into the environment in, for example, a landfill or from an incinerator.
- Loss of material and energy resources. Electronic product components and materials may have reutilisation value that can contribute to economic development, but these are lost in the absence of adequate mechanisms to achieve component and materials reutilisation.
- Rapidly increasing volumes of discarded electronic product occupying landfill space.

In response to these issues, jurisdictions around the world are beginning to address the issue of how best to manage electronic wastes. This document provides data and analysis concerning the current and future generation and management of electronic wastes in Canada, with a specific focus and feasibility analysis on the Atlantic provinces.

1.2 Scope

The scope of this document is defined in terms of geographic boundaries and in terms of the range of end-of-life (EOL) electronic products considered.

The scope of EOL electronic product generation data and analysis, and of current and potential future e-waste management systems, is national. However, EOL electronic products generated in Canada may be managed elsewhere, and EOL electronic products generated elsewhere may be managed in Canadian facilities. This international dimension to the management of EOL electronic products requires that although the focus of analysis is national, it is necessary to consider activities elsewhere that are relevant to the Canadian context. Accordingly, data and management systems in other countries are also considered where they have relevance to Canada.

Within the Canadian context, particular focus is placed throughout this document on Atlantic Canada: New Brunswick, Newfoundland and Labrador, Nova Scotia and Prince Edward Island. The extent of feasibility analysis and recommendations regarding actions to be taken to address EOL electronic products will be specific to Atlantic Canada.

The scope of EOL electronic products considered by this document extends to the following products when discarded, together with their materials and their components: televisions, computers, monitors, computer peripherals, telephones, cell phones, stereo systems and rechargeable batteries.

1.3 Objectives

This document has two broad objectives:

1. To identify, on a macro-scale, the current national infrastructure for reusing and recycling end-of-life electronics.
2. To identify options and feasibility for establishing systems in Atlantic Canada for the collection, reuse and recycling of end-of-life electronics.

1.4 Report Format

Section 2 of this document presents estimates of EOL electronic product generation and estimates of the quantity of materials that are found in EOL electronic products. In Section 3, systems for collecting and processing EOL electronic products in Canada and elsewhere are presented, together with processing systems for EOL electronic products and end-use markets for electronic products that are reutilised. Current stewardship programs for EOL electronic products are reviewed in Section 4. In Section 5, current management practices are addressed, and best management practices are presented in Section 6; benefits associated with best management practice are presented in Section 7. A feasibility assessment for recovery of EOL electronic products in the Atlantic Canada is detailed in Section 8. Section 9 presents the key finding and recommendations of the document. Supporting data for all aspects of this document are found in the annexes.

2.0 EOL ELECTRONIC PRODUCT GENERATION IN NORTH AMERICA

2.1 Current and Future Quantities of EOL Electronic Products

2.1.1 Methodologies For Estimating Waste Generation

The type of waste generated, the generators of the waste and the purpose for which waste generation estimates are developed all influence the selection of a methodology for estimating waste generation.

EOL electronic products discarded by either a business or household may end up in the municipal solid waste (MSW) stream. Methodologies for estimating MSW generation are well established and are based on analysing samples taken at particular points during the year that are considered to be representative of periods of typical waste generation. Depending on the scale and scope of the sampling and analysis program, adjustments can then be made as necessary to reflect seasonal influences and social factors.

This methodology works well for wastes that are discarded on a regular basis. Some MSW products and materials, however, are discarded infrequently or may only be permitted to be discarded on an occasional basis . These types of waste fall broadly into what are often referred to as "bulky wastes". Methodologies for estimating MSW may or may not include estimates of these "bulky wastes", and generally do not include detailed analysis of the percentages of different types of product found in bulky wastes. Consequently, methodologies for estimating MSW generation are not well suited to the estimation of EOL electronic product generation.

There are additional difficulties in estimating EOL electronic product generation based on MSW data. As discussed elsewhere in this document:

- Considerable amounts of EOL electronic product are believed to be in storage and will one day be discarded.
- Significant quantities of EOL electronic product are transferred from the point of generation to a distant location for processing. However, significant quantities of waste may arise from these processing operations that must then be managed. This can result in underestimation of EOL electronic product generation at the local level, and overestimation at locations where e-waste is processed.
- The generation of most materials in MSW remains relatively stable or may change gradually on a year-on-year basis. The type and quantity of EOL electronic product that is generated, however, may vary greatly over time frames of only a few years, but this may not be captured - and is not predictable - using methodologies for generally estimating MSW generation.

As discussed in Section 3 of this document, many municipalities have implemented collections for EOL electronic products. Data from these initiatives is also problematic in estimating EOL electronic product generation, since the range of products that are collected varies and the amount that is collected may be subject to a number of external influences (e.g. publicity and the weather).

Alternative approaches for estimating EOL electronic product generation have therefore been developed in response to the difficulties inherent in using MSW estimation methodologies. These approaches include "sales based" methodologies and involve estimating the quantity of electronic products that enter the marketplace and then estimating the fate of those products over time.

2.1.2 EOL Electronic Product Generation

The data identified in Tables 1, 2, 3 and 4 have been developed for the purpose of this document. Except for data on portable rechargeable batteries (PRBs), the data in Table 1 for "Subtotal Canada" are developed from *Baseline Study of End-of-Life Electrical and Electronic Equipment in Canada* and *Information Technology (IT) and Telecommunication (Telecom) Waste in Canada - 2003 Update*; the

development of data in these documents has been undertaken with industry participation. Industry data have been used to identify household EOL electronic discards separately from industrial, commercial and institutional (IC&I) sector EOL electronics discards at a national level and to then identify the quantity of household EOL electronic products discarded on a provincial basis. Estimated IC&I EOL product discards have been developed by attributing a quantity of EOL electronic products to each province in proportion to its contribution to national 2003 gross domestic product (GDP).

Estimates for Canadian PRBs have been extrapolated from data in *Fiche d'Information: Les Piles Domestiques - Quantité de Piles Mises en Marché au Québec*, published by Recyc-Québec in 2003[1]. Data has not been available to separately identify PRBs generated in the IC&I and household sectors. Accordingly, all PRBs are attributed to households.

Estimates of EOL electronic product discards in the US have been prepared on the basis of: (i) the application of methodologies identified in the above reports to US sales data reported in *IAER Electronics Recycling Industry Report: 2003*, International Association of Electronics Recyclers, Albany, New York, 2003 (for computers, monitors and televisions); and (ii) extrapolation of Canadian data to the US for remaining equipment.

Table 1 presents estimated e-waste generation in *units* of discarded e-waste in Canada for 2005 by province and territory for each of the products that are the focus of this document. Table 2 presents estimated e-waste generation in *tonnes* of discarded e-waste in Canada for 2005 by province and territory for each of the products that are the focus of this document; the conversion of units of EOL electronic products to tonnes has been undertaken in the basis of the data in Annex A. In both Table 1 and Table 2 projections have been made for e-waste anticipated to be generated in 2010. The estimates in Table 1 and Table 2 relate to e-wastes that are no longer required by the owner of the product and which are anticipated to be discarded by the owner of the product into an external management system for their disposition. The tables should therefore be understood in the context that:

- Products that enter a second or subsequent life are excluded from the data in Table 1 and Table 2.
- EOL electronic products that are in storage are excluded from Table 1 and Table 2.

Several important characteristics are evident from the data in Table 1 and Table 2:

- EOL electronics that are generated in the greatest numbers (Table 1) are not generated in the greatest tonnages (Table 2). For example, the 2.762 million cell phones projected to be discarded in Canada in 2005 will amount to 442 tonnes of waste by weight, while the 2.216 million TV that are projected to be discarded in 2005 in Canada will total 81,702 tonnes of waste.
- Generation of EOL electronics by province broadly corresponds to centres of population and levels of economic activity. Highest levels of EOL electronics generation in Canada therefore occur in Ontario and Quebec. However the methodology used to develop the estimates shown Table 1 and Table 2 suggest that EOL electronics discards may not precisely mirror provincial populations. This is discussed further in connection with Table 3 and Table 4, below.

Generally, the weights and units of EOL electronics that are discarded are projected to increase in the 2005 - 2010 period. In the case of cell phones, however, a decrease is projected. This occurs because convergence of technologies is anticipated to result in new products by 2010 that will have begun to replace what are currently

[1] The Rechargeable Battery Recycling Corporation has been approached for data concerning PRBs, but has declined to provide data on sales of PRBs or rates of recovery of PRBs. The United States Geological Survey (Plachy, J., *Cadmium Recycling in the United States in 2000*, US Geological Survey Circular 1196-0*)* estimates that 3.5 billion consumer batteries were sold in the US in 2000, of which approximately 10 percent were nickel-cadmium and that 80 percent of rechargeable batteries are sold within a consumer product and not separately.

Table 1:
Estimated Generation of Selected EOL Electronic Products in North America (Thousands of Units)

Total Estimated EOL Product Discards (000's Units/year)								Jurisdiction	Total Estimated EOL Product Discards (000's Units/year)							
Cell Phones		Telephones		Stereos		Rechargeable Batteries[1, 2]			Computers		Monitors		Computer Peripherals		TVs	
2005	2010	2005	2010	2005	2010	2005	2010		2005	2010	2005	2010	2005	2010	2005	2010
182	***115***	***133***	***189***	***157***	***265***	***454***	***ND***	***Region: Atlantic Canada***	***169***	***199***	***192***	***154***	***321***	***343***	***160***	***164***
57	37	42	59	50	84	*145*	*ND*	New Brunswick	53	62	60	48	100	107	51	52
43	27	31	44	35	59	*101*	*ND*	Newfoundland and Labrador	40	47	45	36	76	81	36	37
72	45	53	75	63	106	*181*	*ND*	Nova Scotia	67	79	76	61	127	136	64	65
10	6	7	11	9	16	*27*	*ND*	Prince Edward Island	9	11	11	9	18	19	9	10
608	***383***	***447***	***634***	***507***	***849***	***1455***	***ND***	***Region: Quebec***	***568***	***672***	***646***	***517***	***1078***	***1150***	***518***	***528***
608	383	447	634	507	849	*1,455*	*ND*	Quebec	568	672	646	517	1,078	1,150	518	528
1,101	***694***	***810***	***1,149***	***836***	***1,401***	***2,381***	***ND***	***Region: Ontario***	***1,030***	***1,218***	***1,170***	***937***	***1,955***	***2,086***	***862***	***878***
1,101	694	810	1,149	836	1,401	*2,381*	*ND*	Ontario	1,030	1,218	1,170	937	1,955	2,086	862	878
860	***543***	***632***	***895***	***646***	***1085***	***1840***	***ND***	***Region: Western Canada***	***804***	***951***	***914***	***732***	***1527***	***1629***	***666***	***680***
344	217	253	359	219	368	*614*	*ND*	Alberta	322	381	366	293	611	652	230	234
339	214	249	353	281	472	*807*	*ND*	British Columbia	317	374	360	288	601	641	287	293
92	58	68	96	79	132	*226*	*ND*	Manitoba	86	102	98	79	164	175	80	82
85	54	62	87	67	113	*193*	*ND*	Saskatchewan	79	94	90	72	151	161	69	71
11	***7***	***8***	***11***	***7***	***12***	***20***	***ND***	***Region: Territories***	***11***	***12***	***11***	***9***	***20***	***21***	***7***	***7***
6	4	4	6	3	5	*8*	*ND*	Northwest Territories	6	7	6	5	11	11	3	3
2	1	2	2	2	3	*6*	*ND*	Nunavut	2	2	2	2	4	4	2	2
3	2	2	3	2	4	*6*	*ND*	Yukon	3	3	3	2	5	6	2	2
2,762	***1,741***	***2,031***	***2,882***	***2,051***	***3,439***	***6,150***	***ND***	***Subtotal Canada***	***2,582***	***3,053***	***2,935***	***2,349***	***4,901***	***5,230***	***2,216***	***2,258***
55,000	34,669	24,665	35,000	18,966	31,801	*56,869*	*ND*	USA	48,000	75,000	55,000	44,019	45,320	48,362	24,318	27,774
57,762	**36,410**	**26,696**	**37,882**	**21,017**	**35,240**	**63,019**	**ND**	**Total**	**50,582**	**78,053**	**57,935**	**46,368**	**50,221**	**53,592**	**26,534**	**30,032**

Notes: 1. Rechargeable battery data are preliminary estimates
2. "ND" indicates "no data"
All data rounded to nearest whole number.

Sources: RIS International Ltd., Five Winds International, Electro-Federation Canada, *Baseline Study of End-of-Life Electrical and Electronic Equipment in Canada*, Environment Canada, Hull, 2003
RIS International Ltd.., *Information Technology (IT) and Telecommunication (Telecom) Waste in Canada - 2003 Update*, Environment Canada, Hull 2003.
Fiche d'Information: Les Piles Domestiques, Recyc-Québec, Montréal, 2003
IAER Electronics Recycling Industry Report: 2003, International Association of Electronics Recyclers, Albany, New York, 2003
Confidential industry sources.

Table 2
Estimated Generation of Selected EOL Electronic Products in North America (Tonnes)

Total Estimated EOL Product Discards (tonnes/year)								Jurisdiction	Total Estimated EOL Product Discards (tonnes/year)							
Cell Phones		Telephones		Stereos		Rechargeable Batteries[1,2]			Computers		Monitors		Computer Peripherals		TVs	
2005	2010	2005	2010	2005	2010	2005	2010		2005	2010	2005	2010	2005	2010	2005	2010
29	***18***	***133***	***189***	***455***	***871***	***18***	***ND***	***Region: Atlantic Canada***	***1,934***	***2,232***	***2,602***	***1,674***	***1,683***	***1,757***	***4,427***	***5,940***
9	6	42	59	145	278	6	ND	New Brunswick	601	694	812	523	524	547	1,411	1,894
7	4	31	44	101	194	4	ND	Newfoundland and Labrador	460	531	613	394	399	417	991	1,329
11	7	53	75	182	348	7	ND	Nova Scotia	766	884	1,032	664	667	696	1,766	2,370
2	1	7	11	27	51	1	ND	Prince Edward Island	107	123	145	93	93	97	259	347
97	***61***	***446.8***	***634***	***1,461***	***2,803***	***60***	***ND***	***Region: Quebec***	***6,546***	***7,555***	***8,734***	***5,619***	***5,683***	***5,934***	***14,246***	***19,117***
97	61	446.8	634	1,461	2,803	60	ND	Quebec	6,546	7,555	8,734	5,619	5,683	5,934	14,246	19,117
176	***111***	***810***	***1,149***	***2,411***	***4,626***	***98***	***ND***	***Region: Ontario***	***12,060***	***13,922***	***15,834***	***10,187***	***10,420***	***10,890***	***23,676***	***31,771***
176	111	810	1,149	2,411	4,626	98	ND	Ontario	12,060	13,922	15,834	10,187	10,420	10,890	23,676	31,771
138	***87***	***632***	***897***	***1,864***	***3,579***	***75***	***ND***	***Region: Western Canada***	***9,508***	***10,895***	***12,371***	***7,958***	***8,150***	***8,518***	***18,331***	***24,597***
55	35	253	359	633	1,215	25	ND	Alberta	3,869	4,467	4,951	3,185	3,317	3,472	6,319	8,479
54	34	249	353	811	1,556	33	ND	British Columbia	3,654	4,217	4,870	3,133	3,171	3,311	7,898	10,598
15	9	68	96	226	435	9	ND	Manitoba	993	1,146	1,329	855	863	901	2,206	2,960
14	9	62	89	194	373	8	ND	Saskatchewan	922	1,065	1,221	785	799	834	1,908	2,560
1.8	***1.1***	***8***	***11***	***21***	***40***	***0.8***	***ND***	***Region: Territories***	***124***	***144***	***159***	***102***	***107***	***112***	***205***	***275***
1.0	0.6	4	6	9	17	0.3	ND	Northwest Territories	69	80	86	55	59	62	89	120
0.3	0.2	2	2	6	11	0.2	ND	Nunavut	23	27	31	20	20	21	55	74
0.5	0.3	2	3	6	12	0.3	ND	Yukon	32	37	42	27	28	29	61	81
442	***278***	***2,031***	***2,882***	***6,213***	***11,920***	***254***	***ND***	***Subtotal Canada***	***30,106***	***34,752***	***39,705***	***25,544***	***26,046***	***27,213***	***60,886***	***81,702***
8,802	5,536	24,665	35,000	57,452	110,225	2,346	ND	USA	559,678	853,718	744,046	478,678	240,847	251,641	668,144	1,004,951
9,244	**5,814**	**26,696**	**37,882**	**63,665**	**122,145**	**2,600**	**ND**	**Total**	**589,784**	**888,470**	**783,751**	**504,222**	**266,893**	**278,855**	**729,030**	**1,086,653**

Notes: 1. **Rechargeable battery data are preliminary and are to be verified**
2. "ND" indicates "no data"
All data values of 1 or greater rounded to nearest whole number; data values less than 1 rounded to nearest tenth.

Sources: RIS International Ltd., Five Winds International, Electro-Federation Canada, *Baseline Study of End-of-Life Electrical and Electronic Equipment in Canada*, Environment Canada, Hull, 2003
RIS International Ltd.., *Information Technology (IT) and Telecommunication (Telecom) Waste in Canada - 2003 Update*, Environment Canada, Hull 2003.
Fiche d'Information: Les Piles Domestiques, Recyc-Québec, Montréal, 2003
IAER Electronics Recycling Industry Report: 2003, International Association of Electronics Recyclers, Albany, New York, 2003
Confidential industry sources.

referred to as cell phones; this technology convergence has already begun, with the increasingly widespread use of cell phones for written (e.g. text messaging) and visual (e,g, photographic) communication in addition to traditional voice communication.

A decrease in the quantity (units and tonnes) of EOL monitors generated is also projected. Lower unit generation results from current flat sales and lower rates of monitor replacement than have occurred in the past. However, a decrease of 20 percent in terms of units is projected to translate to a decrease of 35 percent by weight as early flat screen technology begins to be seen in discarded monitors by 2010, particularly as part of the scheduled replacement cycle of technology by the IC&I sector.

- Flat screen technology will also have important implications for TVs. Discard of TVs over approximately the 1995-2004 period was dominated by mid-size TV sets as consumers upgraded to large format TVs. Flat screen TV technology that is now available will increasingly be the choice of consumers in coming years. While the number of TVs discarded annually is projected to remain fairly constant, the weight of TVs that will be discarded by 2010 is estimated to be over 30 percent greater in 2010 than in 2005 because the TVs being discarded in 2010 will increasingly be the large format TVs that have been purchased over the past decade.

- In percentage terms, discarded tonnages and units of stereos are projected to grow more rapidly (by 91 percent and 69 percent respectively) in the 2005 - 2010 period than other products identified in this document as a function of rapid technology change and the discard of old technology by consumers.

- Generation of EOL electronic products in the US is generally projected to parallel the generation of similar products in Canada. However, recent estimates in the US suggest much greater relative generation of computers and monitors in that country than would be anticipated on the basis of population or economy. The reasons for this are not clear.

The definition of management options for EOL electronic product begins with the identification of the generator of waste. Two categories of EOL electronic products generators are important, which between them capture the universe of generators: (i) IC&I generators; and, (ii) household generators. IC&I generators are those in the business sector (including government and government institutions). Household generators are those who generate EOL electronic products from their homes.

Tables 3 and 4 present estimates of EOL electronic product generation in the IC&I sector by province and territory, and for the U.S. Direct estimates of IC&I EOL electronic product generation by province and territory have not been available to the preparation of this document. Accordingly, the data in Table 3 and Table 4 have been developed as follows:

- Household EOL electronic product generation at the national level has been subtracted from the total amount of EOL electronic product generation at the national level, resulting in an estimate of national IC&I EOL electronic product generation.
- The resulting estimate of IC&I e-waste generation at the national level has been attributed to each province and territory based on the contribution of each to the national economy as measured by GDP.

Table 3 and Table 4 identify that EOL electronic products in the IC&I sector are not generated in an equitable pattern across Canada. Levels of IC&I electronic product use (and therefore EOL generation) are assumed to be linked to GDP - the higher the level of GDP, the higher level of both electronic product use and the rate of EOL electronic product generation. However, natural resources contribute disproportionately to GDP in some provinces and it cannot be assumed that a link necessarily exists between the value of a natural resource and the use of electronic products. Notwithstanding this limitation to the methodology, it is believed that the data provide important insights into the distribution of EOL electronic product generation between households and the IC&I sector.

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Table 3
Estimated Units of Selected EOL Electronic Products Generated by the Industrial, Commercial and Institutional (IC&I) Sector and by the Household (HH) Sector in North America: 2005 (000's)

Total Estimated EOL Product Discards (000's)								Jurisdiction	Total Estimated EOL Product Discards (000's)							
Cell Phones		Telephones		Stereos		Rechargeable Batteries[1,2]			Computers		Monitors		Computer Peripherals		TVs	
IC&I	HH	IC&I	HH	IC&I	HH	IC&I	HH		IC&I	HH	IC&I	HH	IC&I	HH	IC&I	HH
101	***80***	***74***	***57***	***6.3***	***152***	***454***		***Region: Atlantic Canada***	***94***	***74***	***109***	***85***	***180***	***141***	***13***	***148***
31	25	23	18	2	48	145		New Brunswick	29	24	33	27	55	45	4	47
25	18	18	13	2	34	101		Newfoundland and Labrador	23	16	27	19	44	32	3	33
40	32	29	23	2	61	181		Nova Scotia	37	30	43	34	71	56	5	59
5	5	4	3	0.3	9	27		Prince Edward Island	5	4	6	5	10	8	1	9
354	***253***	***261***	***186***	***21***	***485***	***1,455***		***Region: Quebec***	***331***	***237***	***377***	***269***	***629***	***449***	***47***	***472***
354	253	261	186	21	485	1,455		Quebec	331	237	377	269	629	449	47	472
688	***414***	***506***	***304***	***41***	***794***	***2,381***		***Region: Ontario***	***643***	***387***	***731***	***440***	***1,220***	***734***	***90***	***771***
688	414	506	304	41	794	2,381		Ontario	643	387	731	440	1,220	734	90	771
541	***320***	***398***	***235***	***32***	***613***	***1,840***		***Region: Western Canada***	***506***	***299***	***576***	***340***	***960***	***568***	***71***	***596***
238	107	175	78	14	205	614		Alberta	222	100	253	113	422	189	31	199
199	140	146	103	12	269	807		British Columbia	186	131	211	149	353	249	26	261
53	39	39	29	3	75	226		Manitoba	50	37	57	42	94	70	7	73
51	34	38	25	3	64	193		Saskatchewan	48	31	55	36	91	60	7	63
8	***3***	***5***	***3***	***0.5***	***7***	***20***		***Region: Territories***	***7***	***3***	***8***	***4***	***13***	***7***	***1.4***	***7***
5	1	3	1	0.3	3	8		Northwest Territories	4	1	5	2	8	3	1	3
1	1	1	1	0.1	2	6		Nunavut	1	1	1	1	2	2	0.2	2
2	1	1	1	0.1	2	6		Yukon	2	1	2	1	3	2	0.2	2
1,692	***1,070***	***1,245***	***786***	***103***	***1,948***	***6,150***		***Subtotal Canada***	***1,582***	***1,000***	***1,799***	***1,136***	***3,003***	***1,898***	***223***	***1,993***
29,460	25,540	5,884	18,781	948	18,017	56,869		USA	32,000	16,000	39,000	16,000	27,773	17,547	2,443	21,875
31,152	**26,610**	**7,129**	**19,567**	**1,051**	**19,966**	**63,019**		**Total**	**33,582**	**17,000**	**40,799**	**17,136**	**30,776**	**19,444**	**2,665**	**23,868**

Note: 1. It has not been possible to distinguish between rechargeable batteries used in the IC&I sector separately from those use in the household sector. Rechargeable batteries are therefore shown for the IC&I and household sectors combined.

2. **Rechargeable battery data are preliminary and are to be verified**

All data values of 1 or greater rounded to nearest whole number; data values less than 1 rounded to nearest tenth.

Sources: RIS International Ltd., Five Winds International, Electro-Federation Canada, *Baseline Study of End-of-Life Electrical and Electronic Equipment in Canada*, Environment Canada, Hull, 2003

RIS International Ltd.., *Information Technology (IT) and Telecommunication (Telecom) Waste in Canada - 2003 Update*, Environment Canada, Hull 2003.

Fiche d'Information: Les Piles Domestiques, Recyc-Québec, Montréal, 2003

IAER Electronics Recycling Industry Report: 2003, International Association of Electronics Recyclers, Albany, New York, 2003

Gross Domestic Product, Expenditure-Based By Provinces and Territories, Statistics Canada, Ottawa, 2004.

Confidential industry sources.

Table 4
Estimated Tonnage of Selected EOL Electronic Products Generated by the Industrial, Commercial and Institutional (IC&I) Sector and by the Household (HH) Sector in North America: 2005

Total Estimated EOL Product Discards (Tonnes)								Jurisdiction	Total Estimated EOL Product Discards (Tonnes)							
Cell Phones		Telephones		Stereos		Rechargeable Batteries[1]			Computers		Monitors		Computer Peripherals		TVs	
IC&I	HH	IC&I	HH	IC&I	HH	IC&I	HH		IC&I	HH	IC&I	HH	IC&I	HH	IC&I	HH
16	***13***	***74***	***58***	***19***	***436***	***18***		***Region: Atlantic Canada***	***1,278***	***657***	***1,463***	***1,140***	***1,060***	***622***	***365***	***4,061***
5	4	23	19	6	139	6		New Brunswick	391	210	448	365	325	199	112	1,299
4	3	18	13	5	97	4		Newfoundland and Labrador	315	146	360	253	261	138	90	901
6	5	29	23	7	174	7		Nova Scotia	504	262	577	455	418	248	144	1,622
1	0.7	4	3	1	26	1		Prince Edward Island	68	39	78	67	56	37	19	239
57	***41***	***261***	***186***	***65***	***1,396***			***Region: Quebec***	***4,450***	***2,096***	***5,095***	***3,639***	***3,696***	***1,988***	***1,275***	***12,971***
57	41	261	186	65	1,396	60		Quebec	4,450	2,096	5,095	3,639	3,696	1,988	1,275	12,971
110	***66***	***506***	***304***	***126***	***2,285***	***98***		***Region: Ontario***	***8,634***	***3,426***	***9,886***	***5,948***	***7,171***	***3,249***	***2,474***	***21,202***
110	66	506	304	126	2,285	98		Ontario	8,634	3,426	9,886	5,948	7,171	3,249	2,474	21,202
87	***50***	***398***	***235***	***99***	***1,767***	***75***		***Region: Western Canada***	***6,790***	***2,649***	***7,774***	***4,596***	***5,639***	***2,511***	***1,946***	***16,385***
38	17	175	78	44	590	25		Alberta	2,986	883	3,419	1,533	2,480	837	856	5,464
32	22	146	103	36	775	33		British Columbia	2,493	1,161	2,854	2,015	2,070	1,101	714	7,184
9	6	39	29	10	217	9		Manitoba	667	326	764	565	554	309	191	2,014
8	5	38	25	9	185	8		Saskatchewan	644	279	737	483	535	264	185	1,723
1	***0.6***	***5***	***3***	***2***	***19***	***1***		***Region: Territories***	***95***	***29***	***110***	***49***	***79***	***20***	***27***	***178***
0.7	0.2	3	1.0	1	8	0.3		Northwest Territories	57	12	66	20	48	11	16	73
0.2	0.2	0.9	0.7	0.2	5	0.2		Nunavut	15	8	17	14	12	8	4	51
0.3	0.2	1.4	0.8	0.3	6	0.3		Yukon	23	9	27	15	19	8	7	54
271	***171***	***1,245***	***786***	***311***	***5,902***	***254***		***Subtotal Canada***	***21,251***	***8,855***	***24,332***	***15,373***	***17,649***	***8,397***	***6,089***	***54,797***
4,714	4,087	5,884	18,781	2,873	54,579	2,346		USA	373,119	186,559	527,596	216,450	147,596	93,251	67,115	601,029
4,985	**4,258**	**7,129**	**19,567**	**3,183**	**60,482**	**2,600**		**Total**	**394,369**	**195,415**	**551,928**	**231,823**	**165,245**	**101,648**	**73,204**	**655,826**

Note: 1. It has not been possible to distinguish between rechargeable batteries used in the IC&I sector separately from those use in the household sector. Rechargeable batteries are therefore shown for the IC&I and household sectors combined.

2. **Rechargeable battery data are preliminary and are to be verified**

All data values of 1 or greater rounded to nearest whole number; data values less than 1 rounded to nearest tenth.

Sources: RIS International Ltd., Five Winds International, Electro-Federation Canada, *Baseline Study of End-of-Life Electrical and Electronic Equipment in Canada*, Environment Canada, Hull, 2003
RIS International Ltd.., *Information Technology (IT) and Telecommunication (Telecom) Waste in Canada - 2003 Update*, Environment Canada, Hull 2003.
Fiche d'Information: Les Piles Domestiques, Recyc-Québec, Montréal, 2003
IAER Electronics Recycling Industry Report: 2003, International Association of Electronics Recyclers, Albany, New York, 2003
Gross Domestic Product, Expenditure-Based By Provinces and Territories, Statistics Canada, Ottawa, 2004.
Confidential industry sources.

Within the EOL electronic products identified in Table 3 and Table 4, it is estimated that households will account for the generation of an estimated 51 percent of the units of EOL electronic products considered in this document, and 57 percent of the tonnage; the IC&I sector will account for the remaining units and tonnages. Within these data, however, some products will be generated primarily by one sector or the other. Households, for example, will generate over 90 percent of stereos and TVs. The IC&I sector will generate the majority of the computer and computer-related EOL products and most of the phones.

Over the 2005 - 2010 period, the proportion of EOL electronics product units generated by households and by the IC&I sector is likely to remain generally unchanged. However, the anticipated increase in the tonnage of televisions that are projected to be discarded by 2010 implies that households will discard an increased proportion of EOL electronic products by weight as compared to 2005.

2.2 Materials in EOL Electronics Products

Different products are manufactured from different materials - stereos, for example, contain many materials that are different to those found in cell phones. Within products, however, there is often a high level of similarity in the materials used by different manufacturers.

Broadly, electronic products are manufactured from glass, metals and plastics, each of which is further sub-divided into more specific material types. Table 5 identifies the tonnages of different materials found in electronic products. Annex B identifies typical materials composition associated with each of the products considered in this document.

2.3 Trends in EOL Electronic Product Quantities and Materials Composition

Several important trends are apparent with respect to the quantities and materials in the e-wastes that are the focus of this document.

2.3.1 Trends in EOL Electronic Product Materials Quantities

The quantity of e-waste generated in Canada is growing rapidly. In total, the generation of the EOL products considered in this document is projected to be 11.4 percent higher in 2010 than in 2005. Growth in EOL electronic products is a function of the following factors:

- Growth in population.
- Economic growth.
- Increasing market penetration. High levels of market penetration stimulates new product development.
- Technology upgrading/obsolescence.

2.3.2 Trends in EOL Electronic Product Materials Composition

Because there is a time lag between the time of manufacture of an electronic product and its discard as a waste (the time lag being defined as the period of use of the product) , the materials composition of EOL electronic products may not reflect that of new products.

The consequence of this situation is that trends in the materials composition of EOL electronics follows trends in the use of materials to manufacture electronic products, but at a later date. Two general trends in the manufacture of electronic products have occurred over the past several years that have had, and will continue to have, an impact on EOL electronics materials composition:

Table 5
Estimated Materials Composition of EOL Electronic Products[1]: 2005 (Tonnes)

Jurisdiction	Glass		Metals					Plastics			Other[6]
	Glass[2]	PWB Glass/ Silica Oxide	Aluminum	Copper	Ferrous	Misc. Metal Fraction[3]	Other PWB Metals[4]	PWB Epoxy Resin	Wire Insulation	Other Plastics[5]	
Sub-Total: Atlantic Canada	***3,147***	***207***	***292***	***389***	***3,177***	***939***	***55***	***226***	***20***	***2,404***	***408***
New Brunswick	996	65	91	123	993	299	17	71	6	755	128
Newfoundland and Labrador	717	48	69	89	746	211	13	52	5	558	95
Nova Scotia	1,253	82	116	155	1,260	374	22	90	8	955	162
Prince Edward Island	181	12	16	22	178	55	3	13	1	136	23
Sub-Total: Quebec	***10,273***	***685***	***983***	***1,280***	***10,635***	***3,038***	***184***	***747***	***68***	***7,975***	***1,357***
Quebec	10,273	685	983	1,280	10,635	3,038	184	747	68	7,975	1,357
Sub-Total: Ontario	***17,604***	***1,212***	***1,789***	***2,218***	***19,169***	***5,105***	***325***	***1,322***	***123***	***14,121***	***2,408***
Ontario	17,604	1,212	1,789	2,218	19,169	5,105	325	1,322	123	14,121	2,408
Sub-Total: Western Canada	***13,674***	***945***	***1,398***	***1,725***	***14,968***	***3,957***	***253***	***1,030***	***96***	***11,006***	***1,878***
Alberta	4,991	364	563	642	5,938	1,394	98	397	39	4,245	727
British Columbia	5,706	381	548	711	5,928	1,685	102	416	38	4,440	756
Manitoba	1,581	105	149	197	1,620	469	28	114	10	1,220	207
Saskatchewan	1,396	95	138	175	1,482	409	25	103	9	1,101	188
Sub-Total: Territories	***162***	***12***	***19***	***21***	***191***	***45***	***4***	***13***	***1***	***137***	***23***
Northwest Territories	77	6	10	10	102	20	2	7	1	71	12
Nunavut	39	3	4	5	38	12	1	3	<1	29	5
Yukon	46	3	5	6	51	13	1	3	<1	37	6
Subtotal Canada	***44,861***	***3,060***	***4,481***	***5,633***	***48,146***	***13,085***	***822***	***3,337***	***308***	***35,645***	***6,076***
USA	611,758	45,893	75,350	77,012	746,676	157,064	12,324	50,054	5,104	438,618	82,669
Total	**656,619**	**48,953**	**79,830**	**82,645**	**794,822**	**170,149**	**13,146**	**53,392**	**5,412**	**474,263**	**88,745**

Notes:
1. The materials composition shown in this table is specific to the products that are the focus of this document, and to the quantities in which they are estimated to be generated as shown in Table 1. Table 5 is based on data presented in Annex B, which identifies the sources of data used to derive the figures shown in Table 5.
2. "Glass" includes leaded and unleaded glass from CRTs in TVs and monitors; amounts of lead within the glass of CRTs is identified in Annex B.
3. "Miscellaneous Metal Fraction" includes small amounts of metals in close association that are believed to be aluminum, copper and ferrous, but for which individual data are not available.
4. "Other PWB Metals" refers to metals found in PWBs other than aluminum, copper and ferrous (which are included in the columns of those names). PWB metals composition is identified in Annex B.
5. "Other plastics" include the array of plastics found in EOL electronic components other than PWBs and wiring insulation (e.g. housing). These plastics include HIPS, ABS, PC, PPO, PP and other plastics in smaller proportions.
6 "Other" materials are comprised of materials associated with components or assemblies within products for which materials composition data was unavailable.

- The use of high value metals in electronic products has been reduced. As shown in Annex B, there is a wide range of high value metals used in the manufacture of electronics products, and particularly in circuit boards. It has been possible to reduce the quantity of these materials while still retaining required product quality standards. While this has reduced production costs it also reduces the value of EOL electronics products, and particularly circuit boards, and thereby reduces the economic attractiveness of recycling those products.
- Concerns around the environmental impact of materials have resulted in regulatory initiatives that are leading to change in materials composition of a broad range of electronics products. This is discussed further in Section 3.3.2.

The following are among the trends associated with the specific EOL electronic products that are the focus of this document:

Televisions CRT technology is being replaced with LCD technology. This will decrease the amounts of lead found in TVs significantly, but increase the amounts of mercury (in the fluorescent tubes used in the back lighting of LCD screens). The weights of comparably sized TVs have been dropping since 1980, and are expected to continue dropping. Lightweight plastics have replaced some of the wood and metal. The transistors and tubes have been replaced by compact integrated circuits.[2]

Computers The component technology of computers is changing rapidly. Disc drives have been replaced by, or complemented with, CD drives and more recently DVD drives. Circuit boards and chips are being developed for more powerful applications. New alloys are being developed to replace traditionally used materials; Apple Computer Ltd., for example, has introduced a magnesium-based material for internal computer applications.

Monitors CRTs are being replaced with LCD technology. This will decrease the amounts of lead found in monitors significantly, but increase the amounts of mercury (in the florescent tubes used in the back lighting of LCD screens).

Peripherals Scanners are becoming integrated with printers into "multi-function" printers resulting in a new type of product.

Cellular/Mobile Phones These are becoming smaller and lighter, and with a rapidly increasing range of functionality that necessarily entails changes in materials composition.

Telephones Corded phones are being replaced with cordless phones that reduce cords associated with the telephone, but which increases battery use.

Portable Rechargeable Batteries The increasing popularity of lithium-polymer batteries is resulting in increased levels of both lithium and polymer in EOL electronic products.

Stereo Equipment The use of wood in the manufacture of stereo receivers has been reduced. Product convergence between CD and DVD players will also impact waste composition.

Around the world, particular focus is currently being placed on reducing the use of hazardous substances in the manufacture of electronic products, and on materials issues associated with the management of plastics. Recent and on-going initiatives that impact materials composition representative of wider activity include, among others:

[2] RIS International. “Baseline Study of End-of-Life Electrical and Electronic Equipment in Canada.” Pg 6-1 to 6-4, June 2003.

- Matsushita Electric Industrial Co., best known for its Panasonic brand, announced in June 2003 that all of its group companies will halt the use of lead, mercury, hexavalent chromium, cadmium, and specified bromine-based flame retardants (PBBs and PBDEs) beginning with new products shipped in April 2005.
- NEC Corporation of Japan announced in January 2004 that it has successfully developed a highly flame resistant vegetable-based plastic, or bioplastic, without the use of flame retardants composed of chemicals such as halogen and phosphorus. The new bioplastic has reportedly attained the highest level of flame resistance in Underwriters Laboratories (UL) Standards, the standards most commonly used in North America for flame resistance. NEC aims to use the new bioplastic in electronic equipment by 2006.

2.4 Data Quality

The data that has been presented in this section builds on, is developed from and adds to previous data on EOL electronics generation and composition. Accordingly, it is believed that the data represents the best that is available. At the same time, however, it is the case that the data are developed from estimates of differing quality, small sample sizes, limited research bases, and industry and government sources whose willingness to supply data is conditioned by individual agendas, confidentiality requirements and selective disclosure. These problems pervade the literature. Data quality concerning EOL electronics generation and composition is therefore generally poor and uncertain. Specifically:

- *Direct measurement of electronic waste generation has not been made in Canada*. Estimates of EOL electronics generation developed in Canada have been prepared on the basis of assumed sales, life spans of electronic equipment and similar techniques that have not necessarily been corroborated either methodologically or empirically.

- *Information that is available is not collated.* Although data have not been empirically collected regarding EOL electronics generation, there are many organisations engaged in receiving and managing discarded electronic products. The extent to which these data might corroborate aspects of estimated EOL electronic product generation and materials composition (and subsequent management) is unknown because mechanisms are not in place through which such data might be gathered.

- *Materials composition data is based on small samples that are not properly representative of electronic waste generation*. Data on materials composition is derived in many cases from a limited number of individual devices that have been extensively analysed. While the data from such analyses provide important insights into electronic wastes materials composition, the extrapolation of limited data to different products within even the same product category can lead to erroneous conclusions.

- *Rapid change in electronic product development.* The electronics industry is characterised by rapid change in short periods of time. Estimates of future waste composition in the electronics waste stream that are based solely on composition in past years will be erroneous, as discussed elsewhere in this document.

- *New product composition data is largely unavailable.* Data on electronics product composition is closely held within original equipment and component manufacturers. Mechanisms for profiling electronics waste composition based on actual materials use data have not been developed and in the absence of appropriate mechanisms manufacturers are unlikely to share sensitive and product-specific information.

The following actions will address this issue:

1. Notwithstanding weaknesses and uncertainties associated with the existing database, it is clear that large and growing quantities of EOL wastes are being generated across Canada. Equally, it is clear that trends in this regard in Canada are substantively similar in the US, and elsewhere in the world. Weaknesses and uncertainties associated with current data should not deter action within the public and private sectors to address needs for enhanced management of EOL electronics.

2. A mechanism is required to collate data regarding EOL electronic waste generation and composition. An appropriate mechanism should be structured around the following:

    - Recognition that industry, government and consumers will play key roles in enhanced management frameworks for EOL electronics and that it is reasonable that each requires adequate information on which to base informed decision making. The consequence of inadequate information will be lack of consensus over appropriate actions, and actions that are significantly less than optimal in terms of the impact of the actions on EOL electronics, and which involve unnecessary cost to industry, government and consumers.

    - Acceptance that company-specific and product-specific details around the design of, and materials used in, new electronic products is competitive and this places reasonable constraints as to who has access to such data. At the same time, recognition that mechanisms are available through which necessary data can be collated from within industry and made available to other stakeholders in ways that protect proprietary company and product information.

3. Within the context of a national stakeholder group, key annual baseline data requirements in support of EOL management of electronics should be identified and a template for its presentation should be developed. This should address actual and forecast sales of electronic products, and data on materials composition. EPSC should gather this data from its membership, with the objective of growing that membership and the breadth of the data. Data may be presented in aggregate formats without prejudice to individual brands or companies[3].

Precedents for industry disclosure of these types of data are well established. Materials Safety Data Sheets and Transportation of Dangerous Goods records routinely record what had at one time been considered proprietary product and company data, without ill-effect to industry. Both voluntary and regulatory initiatives requiring disclosure of product data have been undertaken in Canada and the US as part of regulatory programs to ensure the reduction of toxic materials entering the environment. Within the context of EOL management of products, various industry groups are engaged in the collation of production and materials data in support of stewardship-based and other types of EOL management systems. The Canadian Polystyrene Recycling Association has addressed this issue through retention of a legal firm to collate required data under strict non-disclosure terms agreed by all companies in the Association whose data was requested; other approaches may also be feasible and preferred.

[3] Disclosure along these lines is required in California, effective May 2004, under that state's *Electronic Waste Recycling Act, 2003.*

3.0 CURRENT MANAGEMENT OF EOL ELECTRONIC PRODUCTS

This section reviews current management of EOL electronic products in North America. First, an overview of the life cycle of electronic products and stakeholders is provided; this provides the overall context in which the management of EOL electronics takes place. Collection systems for EOL electronics are then discussed and assessed. The infrastructure available for managing end-of-life electronics in Canada and the US is then presented.

3.1 Overview of Management of Electronic Products

Figure 1 presents the range of major functions and stakeholders associated with management of electronic products. Each step in the chain from materials extraction adds value to what was received from the previous function; maximum value is received at the point that the consumer obtains the product. The purchaser discards the product following its use. EOL management involves collection of the discarded product, which may then be managed through different combinations of reuse, recycling, or disposal. Reuse and recycling conserve value by returning components and materials back to the production/ consumption chain. Disposal results in materials loss together with the investments in their creation.

The EOL management of electronic products through disposal raises the following key concerns:

- *Contamination of the environment*. Electronic products contain a wide variety of materials that pose a high risk to environmental quality. Chief among these, metals in electronics products may be liberated from the products either by the method of disposal itself or by environmental processes following disposal (e.g. leaching).
- *Use of landfilling capacity*. Electronic equipment that is disposed of in a landfill occupies space that is difficult to replace. For public sector disposal organisations, keeping materials out of landfill is a priority.
- *Loss of resources and energy investments.* Disposal of electronic wastes results in the loss of resources from the economy and the loss of energy invested in those resources. Energy associated with manufacture of products from secondary (recycled) resources within EOL electronics typically requires fewer energy inputs as compared to manufacture from virgin materials: recycled copper saves 85 percent of the energy need to manufacture copper from raw materials, and energy savings associated with the use of secondary iron and steel, aluminum and plastic are 74 percent, 95 percent and 80 percent respectively[4].
- *Elevated levels of greenhouse gas (GHG) emissions*. Products manufactured from secondary materials typically generate reduced GHG emissions as compared with manufacture from virgin materials. Preliminary data indicate that use of 1 tonne of secondary aluminum in products as compared to the use of aluminum manufactured from virgin materials results in a GHG reduction of 10.1 tonnes of carbon dioxide equivalent; the corresponding reductions in GHG emissions associated with the use of secondary steel, copper, lead, glass and plastic are 1.16 tonnes, 3.66 tonnes, 1.27 tonnes, 0.11 tonnes and 1.77 tonnes respectively[5].

The extent to which EOL electronics contribute to the above problems is a function of the extent to which they are disposed of rather than reused or recycled.

3.2 EOL Electronics Collection

3.2.1 Options and Practices in Canada

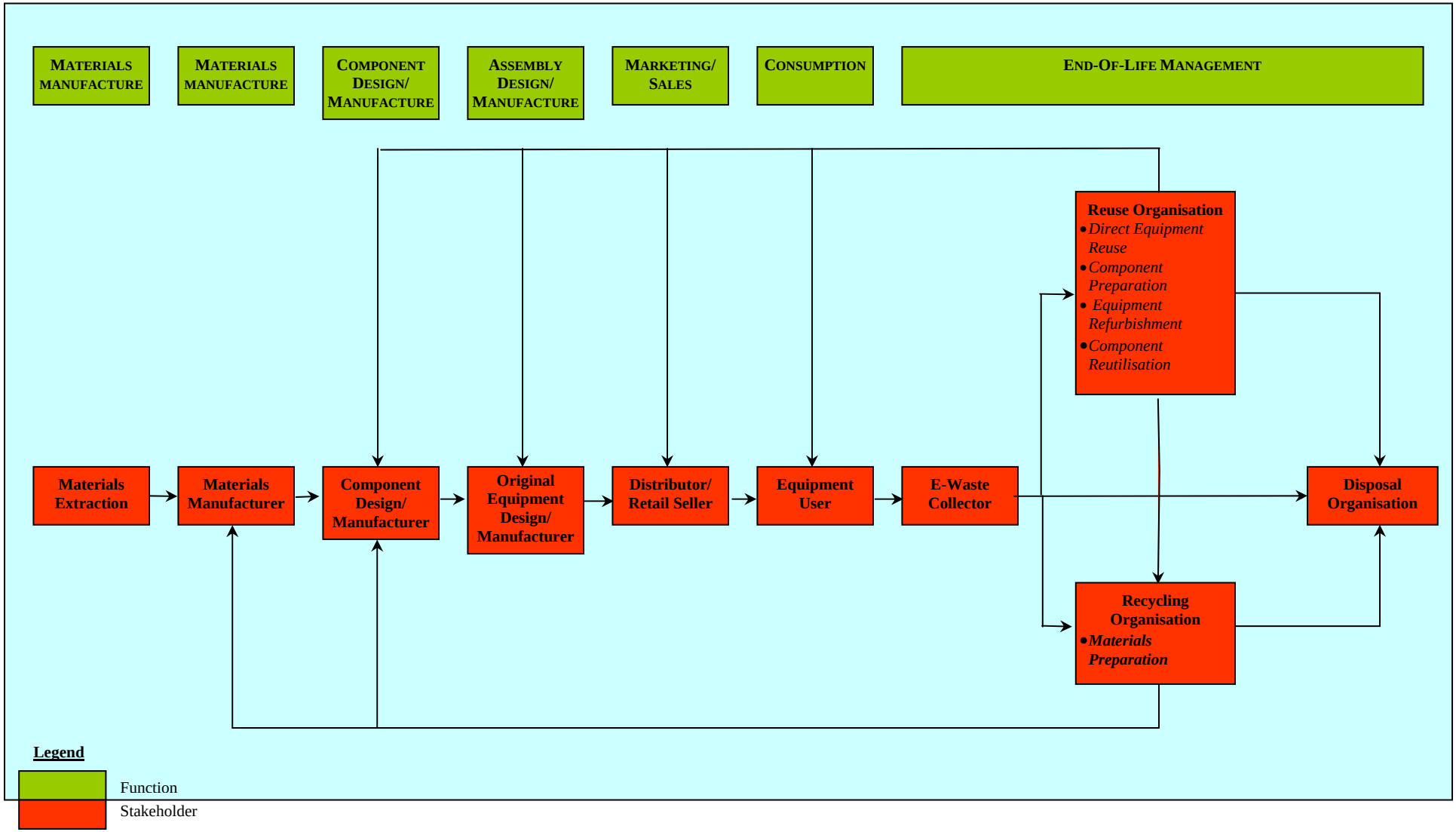
3.2.1.1 Collection Options

Collection of EOL electronic products can be undertaken by municipalities (including public or private entities acting on behalf of municipalities), the electronics product sector or the independent private

[4] US Environmental Protection Agency data quoted by Institute for Scrap Recycling Industries, *Comments on the Petition for the Imposition of Monitoring and Controls with Respect to Exports from the United States of Copper Scrap and Copper Alloy Scrap*, Washington D.C. May 2004

[5] Preliminary data supplied by Natural Resources Canada, 29 June 2004

Figure 1:
Functions and Stakeholders In Electronics Product Management



Arrows indicate direction of product/materials flow

sector. Table 6 identifies the range of collection options available, highlighting the advantages, disadvantages and effectiveness of each, as well as the suitability of each option for EOL electronics, indicating the types of EOL products that should be collected under each option and the relative cost.

3.2.1.2 Current Initiatives Three initiatives have been undertaken in Canada over approximately the past year that bear directly on collection of EOL electronics products:

- The Canadian Council of Ministers of the Environment has adopted Canada-Wide Principles For Electronics Product Stewardship (C-WPEPS), see Annex C**.** These Principles establish a policy framework for a harmonised approach to the management of EOL electronic products in Canada. Among other items, the Principles are clear that producers are responsible for their products at end-of-life, and that provinces will "undertake specific measures at their discretion" to provide for management of EOL electronic products.
- The Government of Alberta is the first Canadian jurisdiction to adopt a legal framework through which to provide for the management of EOL electronic products. This framework requires that, effective 1 October 2004: (i) Alberta Recycling Management Authority, a non-profit multi-stakeholder organisation accountable to the Government of Alberta, will manage a province wide program for the recycling of EOL televisions, computers, keyboards, mice, monitors and printers; (ii) environmental fees ranging from $5.00 - 45.00 will be applied to these items to provide for their EOL management and including education, collection, transportation and processing of the EOL products.
- Electronics Product Stewardship Canada (EPSC), an industry association representing major electronics product manufacturers[6] selling into the Canadian marketplace, has proposed a national EOL electronics management program based on producer take back financed through fees at the point of sale. The program would initially target computers, monitors, printers and televisions and would target households and small businesses.

Although these initiatives target primarily EOL electronic product collection, they have significant implications on subsequent processing.

3.2.3 Collection of EOL Electronics in Other Countries

3.2.3.1 United States of America

As in Canada, household EOL electronics are collected by municipalities without financial or other support from OEMs or others in the industry.[7] A national survey[8] undertaken by the Northeast Recycling Council (NERC) in 2001 identified that over 90 percent of municipal EOL electronic product collections by municipalities were based on either depots or drop-off systems; other collections of EOL electronics were through bulky waste collections. Overall, it was found that on-going collection programs recovered over 50 percent more material than special events and that bulky waste collection recovered the most material (average of 63 tonnes per year as compared to 21 tonnes per year for special event collections) at the lowest cost ($US 334/tonne versus an average of $US 501/tonne for other methods).

NERC updated the survey in 2003[9]. Among its findings regarding changes in the intervening time period:

[6] EPSC membership includes: Apple Canada Inc., Brother International Corporation (Canada) Ltd., Canon, Canada Inc., Dell Canada, Epson Canada Ltd., Hewlett-Packard (Canada) Co., Hitachi Canada, Ltd., IBM Canada Ltd., Lexmark Canada Inc., LG Electronics Canada, Panasonic Canada Inc., Sanyo Canada Inc., Sharp Electronics of Canada Ltd., Sony of Canada Ltd., Thomson Multimedia Ltd. and Toshiba of Canada Ltd.

[7] OEMs and industry participation in collection is occurring on a project-specific basis, however, in a similar way as has occurred in Canada (e.g. Calgary's E-Cycle Round Up)

[8] *National Survey of Government Operated Electronics Collection Programs and Training Manual for Setting-Up and Operating Collection programs*, Northeast Recycling Council, Brattleboro, 2001; www.nerc.org

[9] *National Electronics Recycling Program Data Update*, Northeast Recycling Council, Brattleboro, 2003; www.nerc.org

Table 6
Collection Options for EOL Electronics

Collection Option	Advantages	Disadvantages	Effectiveness	Suitability for EOL Electronics	Appropriate EOL Electronics	Relative Cost To Collect[2]
Municipal Collection[1]						
Drop-off Bin at Landfill Transfer Station or Materials Recovery Facility	Can be piggy-backed onto other resource/waste management services Training of staff and management can be integrated with existing waste management services	Landfills and transfer stations may not be conveniently located for users Availability of collection not easily communicated OH&S concerns associated with product breakage High levels of product breakage incompatible with reuse strategies Full time monitoring required to ensure proper use	May attract high levels of household and small business participation in municipalities where waste generators are accustomed to delivering secondary materials and wastes to management facilities Effectiveness increased if linked to a ban on disposal	Appropriate for small EOL electronic products intended to be recycled and where breakage will not result in OH&S concerns.	Cell phones Telephones Rechargeable batteries	$
Curbside Collection	EOL electronic products may be piggy-backed onto curbside collection of other materials Training of staff and management can be integrated with existing waste management services Availability of collection easily communicated	Addition of EOL electronics products may not be easily achieved operationally (e.g. capacity of collection vehicles, MRF handling) OH&S concerns associated with product breakage High levels of product breakage incompatible with reuse strategies	Attracts high levels of participation from households. Effectiveness increased if linked to ban on disposal	Appropriate for small EOL electronic products intended to be recycled and where breakage will not result in OH&S concerns.	Cell phones Telephones Rechargeable batteries	$$$
HHW Component	Piggy-backs onto other resource/waste management services Training of staff and management can be integrated with existing waste management services Availability of collection easily integrated with other HHW communications	HHW collections may be infrequent Management within a HHW collection may incur unnecessary costs Quantities may overwhelm handling capacity if focus is HHW collection, not EOL electronics collection	Can attract high levels of participation from households Effectiveness increased if linked to ban on disposal	Suitable for collection of all EOL electronic products	All EOL electronic products	$$ - $$$$
Bulky Waste Collection	Piggy-backs onto other resource/waste management services Training of staff and management can be integrated with existing waste management services Availability of collection easily integrated with other resource/waste management communications	Addition of EOL electronics products may not be easily achieved operationally (e.g. capacity of collection vehicles) OH&S concerns associated with product breakage High levels of product breakage incompatible with reuse strategies	Attracts high levels of participation from households Effectiveness increased if linked to ban on disposal	Suitable for bulky EOL electronic products destined for recycling or disposal that do not pose an OH&S concern if they break	Computers Computer peripherals Stereos	$$$

Table 6 Cont.
Collection Options for EOL Electronics

Collection Option	Advantages	Disadvantages	Effectiveness	Suitability for EOL Electronics	Appropriate EOL Electronics	Relative Cost To Collect
Producer/Retailer Collection						
Return to Retailer	Reflects product stewardship principles May encourage DfE Convenient to consumer Easy to communicate collection service at point of sale Handling EOL electronics provides new retailer business/marketing opportunities Provides opportunity for return to OEM using reverse distribution channels	Likely to be retailer resistance Training of retailer staff and management required Likely to require separate storage space at retailer Internet/mail order purchases do not have a retail point of sale Retailers will incur additional costs	Would attract high levels of participation from households and business Effectiveness increased if linked to ban on disposal and deposit/refund or used product payment	Suitable for all EOL electronic products	All EOL electronic products	$
Return to OEM[3]	Consistent with product stewardship principles Promotes DfE Places accountability for managing EOL electronics on the OEM	Likely to be OEM resistance OEM training of staff and management required OEMs will incur additional costs	Would attract high levels of participation from households and business if implemented at no visible cost to the consumer	Suitable for all EOL electronic products	All EOL electronic products	$ - $$
Independent Collection						
Asset Management/ Non-Profit Collection	Links to existing collection infrastructure Professional expertise already functioning as a business Competitive industry maximises cost-effectiveness Availability of collection service easily communicated to consumers	Applied only to EOL electronics with sufficient intrinsic reuse value	Attracts high levels of participation from business; may not be appropriate for household EOL electronics except cell phones Ban on disposal and deposit/ refund or used product fee increases effectiveness	Suitable for all EOL electronic products	All EOL electronic products	$$ - $$$
Collection Site Network	Can be piggy-backed onto other resource/waste management services Training of staff/management can be integrated with existing waste services Siting may be linked to existing collection sites Easily communicated particularly where consumers are accustomed to collection sites.	Existing resource recovery collection sites likely to be inappropriate for managing many EOL electronic products Full time monitoring required to ensure proper use Consumers and resource managers in some provinces not accustomed to collection sites.	Attract high levels of participation from households and small businesses when conveniently located, properly managed. Effectiveness increased if linked to deposit/refund system and ban on disposal	If properly design and operated, appropriate for larger EOL electronic products intended for reuse or recycle or which pose an OH&S concern if they break	Existing sites: Cell phones Telephones Rechargeable batteries Appropriately designed/ operated sites: All EOL electronic products	$ - $$$$

Notes
1. Municipal collection may be performed by municipality directly, or a public or private entity on behalf of the municipality
2. The symbol "$" indicates relatively low cost; the symbol "$$$$" indicates relatively high cost. In some cases, a collection option may incur a wide range of costd depending on the specific design of the collection option; where this is the case, the range of relative cost is shown.
3. This includes return to the OEM itself, or return to an entity designated by the OEM.

Sources
LURA Consulting, *A National Consultation on the Management of Discarded Electronics*, Federation of Canadian Municipalities, 2003
National Survey of Government Operated Electronics Collection Programs and Training Manual for Setting-Up and Operating Collection programs, Northeast Recycling Council, Brattleboro, 2001; www.nerc.org
National municipal, industry and non-profit sector interviews, June-August 2003

- The number of household EOL electronics programs at the municipal level had doubled.
- Special event programs had increased by 15 percent, bulky waste collections by 100 percent (but from a low base in 2001) and other forms of on-going collection had declined by 20 percent.
- Over 50 percent of programs charge participants a fee for the collection service.
- Operating costs of on-going depots and drop-off centres had declined 74 percent to $US 133/tonne while materials received increased by 4 percent, making these systems more cost-effective than bulky waste curbside collection.

Management of EOL electronic products in the U.S. has been driven by toxicity concerns at the state level. Massachusetts banned CRTs from land disposal in 1999 and Maine, California and Minnesota have since followed suit, as have some municipalities. California legislation also prohibits the sale of CRTs and monitors in the state that fail to meet EU RoHS requirements according to the implementation timing of RoHS established by the EU, see Section 3.3.1.

At the national level, the federally-funded National Electronic Product Stewardship Initiative has not resulted in tangible change in the way that EOL electronic products are managed. Major efforts to develop improved management and processing of EOL electronics materials (particularly plastics) have been undertaken through large scale projects, for example, the Polymer Recycling Zone initiative to recycle EOL electronics plastics and the related Mid-Atlantic Recycling Centre for End-of-Life Electronics, intended as a prototype "demanufacturing" initiative. A key problem that has emerged from these initiatives is that the lack of collection infrastructure for EOL electronics is the single largest barrier to the recycling of EOL electronics plastics; technologies for recycling mixed EOL electronics plastics exist and the industry is confident that programs that require the collection of EOL electronic products would be rapidly met with investment in plastics recycling infrastructure.

In 2003 California adopted an *Electronic Waste Recycling Act.* Key elements of this Act include:

- Collection of EOL fees on electronic products at the point of sale, to be paid to state-authorised recyclers. This component will be implemented on 1 November 2004 and will initially be limited to CRT-containing televisions and monitors, and to LCD computer monitors, and to laptop computers with LCD screens.
- Requirements on OEMs to disclose sales volumes of, and hazardous substances used in, regulated products.
- Requirements on OEMs to inform consumers regarding EOL electronic product recycling opportunities.
- Requirements for recyclers to be located in the US or, if not, to provide documentary evidence that they meet California standards in order to receive recycling payments from fees collected at point of purchase.

3.2.3.2 European Union (EU) and Europe

Within the EU, the EU itself has the power to issue Directives that its member states are bound to comply with; compliance is achieved by the member states "transposing" the EU Directive into their national legal frameworks and then giving effect to the requirements of the Directive (now national law) through their national institutions. In February 2003, the EU passed the Waste Electronic and Electrical Equipment (WEEE) Directive which member states are required to have transposed into national law by 13 August 2004[10] and which they were required to implement not later than 13 August 2005. Collection

[10] Only Greece has met the deadline for transposing the WEEE Directive into national law. While other EU member states may be subject to a fine for not achieving compliance, they continue to move towards national enactment of the Directive.

of EOL electronic goods in the European Union (EU) will be a function of the requirements of the WEEE Directive.

The WEEE Directive covers products that use electricity or batteries as a power source. These are classified under 10 categories, as shown in Annex D. The Directive has set a minimum separate collection target of 4 kg per head of population per annum. EOL electronic products that are separately collected it must be treated according to the Directive's requirements:

- The producer is responsible for the costs associated with the transportation, treatment, recovery and recycling of WEEE, starting from a central collection point. The producer is defined in terms of brand name of the electrical product, which means that retailers who sell electrical equipment under their own brand are also defined as producers. If the producer is an offshore company then responsibility passes to the company (or person) that first imports the electrical product.

- The retailer is responsible for the costs associated with the free take back of EOL electrical products and delivery to a central collection point. Private households must be given the opportunity to return EOL electrical products without charge, whether or not they replace it with a new product. Businesses must be offered the return of EOL electrical products without charge when they are replaced with a new product on a like-for-like basis; the costs of managing EOL electrical products that are not covered by free take back rules falls upon the product user.

- The WEEE Directive does not place obligations on the consumer regarding what they must do with their EOL electronic products.

The requirement for retailers to accept the take back of EOL electronics from householders or businesses can be achieved in a variety of ways, for example:

- The consumer can bring back the old item to the point of sale if a delivery service is not offered.
- The consumer could expect the retailer to arrange the take back the old item from their premises upon delivery of a new item.
- Retailers may arrange an alternative method of take back, through a third party agreement, but this method must not make it harder for the consumer to return the product. For example, the consumer may mail (at retailer expense) the old item to a third party.

Box 1
Collection of EOL Electronics Under The WEEE Directive: The Case of the UK

Consumers are encouraged to return their EOL electronics for separate management, but will not be required to do so. Retailers that sell electrical goods are encouraged to communicate the take back system and will establish a take back system. The UK Government is allowing a flexible approach where retailers can either have an in-store take back scheme or join a municipally-operated, but industry-financed compliance scheme.
The central collection points to which retailers must deliver EOL electronics are currently undefined, but may include existing waste management facilities and depots as well as non-profit groups engaged in electronics reuse activities.

If retailers choose to take back in store, then there will be requirements to register for storage or exemption licenses for the areas where the EOL electronic products are kept. There may also be a requirement for those who transport WEEE to hold waste carriers license and for the drivers to have training in the transportation of hazardous waste.

Retailers will be liable for the cost of delivery of EOL electronics to a central collection point and must ensure that all separately collected EOL electrical products enter a logistical chain whereby the end result is reuse or recycling. Separately collected WEEE must be treated using "best available treatment, recovery and recycling techniques", where the term recovery is defined to mean the range of opportunities for the recovery of value from a waste (including, but not necessarily limited to, energy recovery and

recycling) and where "recycling" is defined as "the re-processing in a production process of the waste materials for the original purpose or for other purposes, but excluding energy recovery".[11] The collection site marks the point in the logistical chain where producers take over the financial burden for WEEE, so are responsible for transport away from the site and to a treatment facility.

Producers, or their agents, are required to provide for the management of separately collected WEEE according to the requirements summarised in Table 7, where "recycling" has a meaning akin to the meaning of recycling in this document, and "recovery" includes, among other items, both the use of a material as fuel and the long term storage of EOL electronic products. Although much work has been undertaken to prepare for the implementation of the WEEE Directive, important gaps remain in the infrastructure that will be necessary to begin collecting and reprocessing the large quantities of EOL electronic products that are addressed by the Directive.

Although the WEEE Directive requires new action at a national level in EU Member States, legislative action has been taken in Europe to manage EOL electronic products for several years. Norway has had a national EOL electronics management program since 1999 through which 80 percent of EOL electronic products are managed. Regulations were passed in the Netherlands in 1997 to provide for the management of EOL electronic products, and several characteristics of that legislation are reflected in the WEEE Directive. Flanders in Belgium (since 1999) and Switzerland (since 1998) have had regulatory programs through which producers and retailers have had EOL management responsibilities for electronic products. In Sweden, collection of EOL electronics amounted to the equivalent of 8 kgs/person in 2002.

3.2.3.3 Japan and Asia

EOL electronics products are managed in Japan under two pieces of legislation: the Home Appliances Recycling Law and the Promotion of Effective Utilization of Resources Law.

The Home Appliance Recycle Law (HARL) was published on June 5th 1998 and enforced on April 1st 2001. The products covered are:

- Washing machines
- CRT televisions (LCD televisions to be covered at a later date)
- Refrigeration units
- Air conditioning units

The HARL stipulates that the above items must be collected by designated electrical appliance shops and be recycled by the OEM. All retailers are required to accept and send for recycling designated old appliances received from citizens when the consumer purchases a new replacement item. Citizens are asked to bear the cost for disposal of used appliances, including the recycling charges and the transportation fee, upon transferring items to the designated electrical shops (if not replacing it with new) or the retailer of the new appliance if using the retailer take back system. Received items are be transferred to the OEM (or their approved recycling facility) along with the recycling fees. The landfilling of end of life home appliances is banned. OEMs have formed 2 collection organisations that manage 380 collection points and 39 recycling plants across the country.

The Promotion of Effective Utilization of Resources (PEUR) Law was enacted in 1991 and revised in May 2000 to address personal computers. As of April 2001, the law required recycling of PCs discarded

[11] *Directive 2002/96/EC Of The European Parliament And Of The Council of 27 January 2003 on waste electrical and electronic equipment (WEEE)*, Office for Official Publications of the European Communities, 2003; http://europa.eu.int/eur-lex/en/consleg

Table 7
European Union WEEE Directive Requirements

PRODUCT CATEGORY	RECOVERY RATE (TO BE ACHIEVED BY 31 DECEMBER 2006)	RECYCLING RATE (TO BE ACHIEVED BY 31 DECEMBER 2006)
Large Household Appliances	80%	75%
Small Household Appliances	70%	50%
IT and Communications Equipment	75%	65%
Consumer Equipment	75%	65%
Lighting Equipment	70%	50%
Electric and Electronic Tools	70%	50%
Toys, Leisure and Sports Equipment	70%	50%
Monitoring and Control Instruments	70%	50%
Automatic Dispensers	80%	75%

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by businesses. Often referred to as the Recycling Promotion Law, it was designed to more broadly aid the creation of a recycling oriented society, and was innovative in two regards:

- It includes a focus on reducing waste requiring disposal by targeting reuse and recycling and also by addressing the reduction of resources used in product manufacture. Waste within 69 product categories are no longer allowed to go to landfill.

- It addresses the entire product life span including design, end of life management and reutilisation of secondary materials by manufacturers. Electronic product design is regulated through requirements of manufacturers to meet design guidelines established by the Ministry of Economics and Industry, although the guidelines that have so far been established largely accord with industry practice. Landfilled materials must be treated and even then may only be landfilled in the absence of other options.

EOL electronics are among the products targeted by this law, which includes provision for OEM responsibilities for collection and treatment of EOL electronics, but leaves the generator of the EOL electronic product with responsibility for paying for the cost of collection and management. Initial implementation of the law with respect to EOL electronics focussed on the IC&I sector; in October 2003, implementation was extended to households. Both household and IC&I generators have to separate their regulated EOL electronics into categories. Co-disposal is an offence; householders and IC&I generators can be fined if it is proved that they have not separated waste.

EOL electronics may be returned in a number of ways, including through the retailer, at collection centres and direct to the OEM through any of the post offices in the country. The OEMs have themselves developed innovative ways through which to meet their obligations.

- IBM Japan Ltd. and Hitachi Ltd. have established a joint recycling service in November 2002 through which used PCs are gathered at 15 collection centers across the country. Bodies and parts are sorted and are then provided to businesses who have been contracted to do the intermediate recycling. Reusable parts are recycled at reuse centers.

- IBM, Hitachi, NEC and others have developed management systems to monitor acceptance of orders, tracking, transporting, collecting, and handling of EOL electronics manifests. Through this system, a client can use the internet to check the status of any particular EOL electronics product accepted into the collection system.

- Following the application of PEUR to households in 2003, electronics manufacturers identify recyclable products with a recycling logo that has been created by the Japan Electronics and Information Technology Industries Association (JEITA).

After 3 months of implementation, JEITA reported that over 33 percent of discarded computers during that period had been collected.

Elsewhere in Asia, Taiwan and South Korea have implemented EOL electronic product management programs. In Taiwan, government mandated collection of EOL electronic products has driven the development of processing infrastructure. In South Korea, producers are required to take back EOL computers. monitors, computer peripherals and appliances, and will be required to take back cameras and cell phones in 2005. In both countries, materials are processed through disassembly and materials recycling. A voluntary cell phone recycling initiative by Nokia in Malaysia that included a 20 percent discount on new Nokia purchases upon the return of an old cell phone achieved the recovery of an estimated 5 percent of cell phones sold after 2 years of implementation in 2003.

3.2.3.4 Australia

The Australian Mobile Telecommunications Association established a voluntary program to recover used cell phones across Australia in 1999. The industry estimates that 14 million people in Australia own a cell phone, and that cell phones are discarded every 18-24 months; annual sales of cell phones are in excess of 5 million and in excess of 10 million cell phones are estimated to be stored in offices and homes.

Issues related to toxic materials in cell phones and their impact on the environment if the cell phones are discarded to landfills led the industry to develop a take back initiative. Consumers are requested to drop off unwanted cell phones at one of 1800 retail drop off points in high traffic locations around the country such as supermarkets, shopping malls, banks and post offices. Communications initiatives include advertising campaigns, media coverage and in-store promotions for phone collections.

Collected handsets are transported to a processor for sorting and dismantling, following which batteries, handsets and chargers/miscellaneous materials are sent for recycling. Since program initiation over 400,000 handsets have been collected through the program.

The program is funded by industry. Manufacturers pay $A 0.30 per handset they sell into the marketplace. Carriers pay according to the overall market aggregate of handsets sold, and currently pay $A 0.12 per handset. The levies are collected monthly on a self-disclosure basis.

3.3 Electronics Design and EOL Management

Preferred approaches to the management of electronics products in Canada are set out in the C-WPEPS, as follows:

Principle 3: Environmental and human health impacts are minimized throughout the product life-cycle, from design to end-of-life management.

Principle 4: Management of e-waste is environmentally sound and consistent with the 4R waste management hierarchy:

a. Reduce, including reduction in toxicity and redesign of products for improved reusability or recyclability

b. Reuse
c. Recycle
d. Recovery, of materials and/or energy from the mixed e-waste stream

These principles taken together identify that the life cycle of electronic products should be considered in the management of electronic products and, in this context, that product design has an important role to play in both the impact of electronic products on human health and the environment, and in the management of electronic products at the end of their life. In addition, initiatives for managing electronic products should give effect to a hierarchy of approaches in which the first-identified are the preferred approaches and the later approaches are less preferred approaches.

Electronics product design to reduce toxicity and improve reusability and recyclability fall within an aspect of product design that has become known as "design for environment" (DfE). DfE encompasses all aspects of product design that target improved environmental product performance. Accordingly, DfE addresses both toxicity reduction and improved reusability/recyclability, as well as other environmental priorities that are not directly spoken to in the CCME C-WPEPS, such as energy consumption. Within DfE, there are different design groupings that address specific aspects of DfE. For the purpose of this document, two sub-groupings are important: design for toxics reduction (DfTR), addressing the CCME goal of reducing toxicity in electronics products, and design for reutilisation (DfRe), addressing CCME goals of reusing, recycling and recovering EOL electronics[12].

As identified in Figure 1, electronics product design takes place at the point of both the component manufacturer and original equipment manufacturer (OEM). A close and dynamic relationship exists between these stakeholders in which component characteristics are considered by OEMs in the design of their products, and in which OEM requirements spur innovation in component manufacture. The assembly of electronic equipment typically requires components supplied from a variety of component suppliers, including suppliers of such diverse items as plastic housing, metal frames, populated wiring boards and circuitry, and many other items. The diversity of components within electronic products presents one set of challenges to design to reduce toxicity and improve reusability and recyclability; the range, diversity and relationships between and among component suppliers and OEMs represents another set of challenges.

3.3.1 Design For Toxics Reduction

Design for reduction of the use of materials known to be toxic at low concentrations to human health and the environment has become a priority in the electronics industry. The toxic nature of materials used by the industry has been known for many years, and over the past decade and more the use of these materials in the electronics industry has declined on a unit basis. Until the late 1990's, reductions in the use of these materials was driven by economic considerations: many materials known to be toxic at low concentrations (particularly metals) are very costly and there has therefore been an intrinsic incentive to reduce the use of these materials. However, the continued presence of these materials in electronic products is increasingly considered to cause/pose unacceptable impacts and risks to human health and the environment. Accordingly, direct regulation of specific materials commonly used in the electronics industry is now being undertaken and is now driving DfTR actions in many countries.

[12] DfRe should not be confused with design for recycling (DfR), a widely used term internationally that is often ambiguous because definitions of "recycling" vary significantly. The term "recycling" has specific meaning in Canada that is narrower than in some other jurisdictions, such that DfR is a subset of DfRe.

The most important such initiative is in Europe where in 2003 the EU adopted the Restriction on the use of Hazardous Substances (RoHS) Directive. This Directive requires that EU Member States ensure that no new electronic products are put on the market that contain the metals lead, mercury, cadmium or hexavalent chromium, or the flame retardants polybrominated biphenyls (PBB) and polybrominated dimethyl ethers (PBDE), all of which have been commonly used in electronics manufacture[13]. The RoHS Directive does not represent a complete list of materials that are toxic to human health and the environment at low concentrations; other materials used in electronics, such as beryllium, are also of concern. Accordingly, it is likely that the 2003 RoHS Directive is only the beginning of a continuing EU initiative to reduce the toxicity of electronic materials.

Awareness of the RoHS initiative has sparked considerable research around the world. Much of this research remains in the corporate proprietary domain, but the information that is available identifies not only the seriousness of this type of regulatory initiative to the industry, but also the creativity of responses that can be obtained when regulatory programs establish specific criteria and firm timeframes:

- Canon Inc. has instructed 200 of its suppliers of materials to investigate the chemicals contained in the materials they use as a first step in reducing the toxicity of its products.[14]
- Matsushita Electric Industrial Co., owner of Panasonic brand, announced in June 2003 that all of its group companies will halt the use of RoHS-mandated substances beginning with new products shipped in April 2005. This commitment extends to its products worldwide, and not simply those manufactured or sold in EU countries, in response to its perspective that other countries will also adopt RoHS-like requirements. To achieve its goals, the Matsushita group made it a company-wide project to create operating procedures to avoid the use of the hazardous substances, develop alternatives, and share expertise. The company will also revise its procurement standards to enhance the "green" procurement of parts and materials.[15]
- NEC Corporation of Japan announced on January 2004 that it has developed a flame resistant vegetable-based plastic, or bioplastic, without the use of flame retardants composed of environmentally harmful chemicals such as halogens and phosphorus. The newly developed bioplastic has attained the highest level of flame resistance in Underwriters Laboratories (UL) Standards, the standards most commonly used in the United States for flame resistance. This plastic reportedly has other important properties for resin used for electronic equipment cases, such as moldability and strength, comparable to the fiber-reinforced polycarbonate used in desktop office equipment. NEC aims to use the new bioplastic in electronic equipment by 2006.[16]
- Lead free solder has been developed and is now commonly used in the industry, at least by Asian manufacturers[17].

Issues around materials impacts can be complex, however, and the reduction of one "toxic material" can result in its replacement with a material that may be less toxic, but which may be used in greater quantities. The application of lead-free solders identified above, for example, has come at the cost of solders that contain higher levels of tin, silver and copper each of which can also have toxic effects on human health and the environment. In addition, life cycle analysis highlights that while overall toxic impacts associated with lead-free solder may be reduced as compared to leaded solder, this may have negative consequences in terms of other considerations, such as resource depletion[21]. LCD technology that is rapidly replacing CRTs in monitors and TVs results in reduced use of lead, but increased use of mercury.

Although Canadian jurisdictions have not targeted the use of specific materials in electronics product manufacture, policy in Canada is aligned with international concerns over the use of toxic materials in

[13] The RoHS Directive contains exemptions for the use of some specific materials in some specific applications.
[14] Japan for Sustainability Newsletter, 15 July 2002
[15] Japan for Sustainability Newsletter, 26 June 2003
[16] Japan for Sustainability newsletter, 6 February 2004.
[17] Huisman, J., *The QWERTY/EE Concept*, Delft University of Technology, 2003, Section 6.3.2

electronic product manufacture. The CWPEPS, identified above, prioritise the need to reduce EOL electronic product toxicity. In addition, the Government of Canada has adopted the Brundtland Commission's definition of sustainable development and the Minerals and Metals Policy of Canada applies this definition by identifying the key elements of sustainable development in the context of minerals and metals.

3.3.2 Design for Reutlisation

The term "reutilisation" includes, in descending order of environmental preference within the CCME C-WPEPS, reuse, recycling and recovery. DfRe initiatives are therefore those that focus on designing electronic equipment to facilitate the repair/reuse of whole equipment or its parts, the recycling of its materials and the recovery of, particularly, energy value from its materials[18].

The ability of EOL managers to integrate EOL electronics products into reutilisation systems is constrained by several aspects of the way in which the products are designed:

- Components are not necessarily designed to be easily removed at the end of product life.
- Multiple materials are used that are not identified and which cannot be easily separated.
- Product assembly uses various types of fastening and locking devices that are difficult to access and to undo/unlock.
- Components may contain toxic substances and materials that pose an OH&S or environmental hazard during reutilisation.

OEMs have identified opportunities for addressing these issues. Hewlett Packard, for example, has undertaken the following with respect to its products[19]:

- Snap-in features for eliminating glues and adhesives from product construction where feasible.
- Marking of plastic parts weighing more than 25g, according to ISO 11469 for easier sorting.
- Reducing the number and types of materials used in HP products.
- Increasing the use of single plastic polymers.
- Increased use of moulded-in colours and finishes instead of paint, coatings or plating.
- Designing plastic and metal to be easily separable for dismantling and recycling.

Box 2
DfRe Applied to a Laptop Computer

Hewlett Packard estimates that the optimisation of DfRe can have a profound impact on the economic as well as the technical feasibility of EOL product reutilisation. In the case of a laptop computer, for example, DfRe initiatives could reduce dismantling time from an average of 7.1 minutes to 0.7 minutes resulting in a reduction in the dismantling/EOL management cost of $4.32 - 7.74 per unit. However, achieving this benefit would result in an additional manufacturing cost of $1.70.

Other electronics product OEMs are also undertaking DfRe initiatives. For example, Philips is undertaking DfRe research and assessment at its Consumer Electronics Environmental Competence Centre (Holland), and LG Electronics is pursuing similar work at its facilities in Korea and in Europe.

Notwithstanding this activity, product design support for the reutilisation of EOL electronics continues to be primarily an after-the-fact issue. Not only are limited numbers of opportunities for DfRe acted upon, new products do not generally incorporate DfRe considerations. Sony Corporation, for example, announced in 2004 the development of optical discs

[18] "Recovery" of energy involves the destruction of the material from which energy is recovered. In product management terms, therefore, "recovery" of energy is a method of disposal.
[19] Edmonds, F., *The HP Design for Environment Program*, Hewlett Packard Canada, 2004 (unpublished)

made of a composite material that is 51 percent paper, a development whose consistency with DfRe management principles is not clear regardless of other advantages the product may have.

DfRe opportunities are product-specific, and it is therefore difficult for regulatory agencies to directly require DfRe actions without infringing on internal and proprietary corporate decision-making. However, regulatory actions on aspects of EOL management of electronics can indirectly encourage DfRe actions and are responsible for driving many of the DfRe actions identified above:

- In Japan, the HARL and the PEUR law require OEMs to manage EOL electronics, creating an incentive for DfRe to contribute to minimising EOL management costs for the OEMs, and the PEUR law includes provision for OEMs to meet design guidelines;
- In Europe, the EU WEEE Directive places EOL management responsibilities on producers and is also expected to result in DfRe initiatives[20]. Among other things, the WEEE Directive also requires that the following be removed from separately collected EOL products, and it is anticipated that DfRe initiatives will particularly be focussed on minimising costs and maximising opportunities for reutilising the following:
  - Batteries
  - PCBs in cell phones generally, and of other devices if the surface area of the PCBs is greater than 10 cm^2.
  - Plastics containing brominated flame retardants (e.g. PBB and PBDE)
  - CRTs
  - LCDs (together with their casings where appropriate) of a surface greater than 100 cm^2 and all those back-lighted with gas discharge lamps.
  - External electric cables.

While these and other DfRe initiatives are important, their impacts will not become evident in the EOL management of products for a number of years since it will take time for: (i) DfRe recommendations to actually be incorporated into the manufacture of new products; (ii) new products to be discarded and for their DfRe benefits to be realised.

3.3.3 Achieving Enhanced DfTR and DfRe

From the perspective of minimising regulatory interventions and maximising voluntary corporate social and environmental responsibility it would be desirable for industry to take maximum initiative in identifying and acting on DfTR and DfRe opportunities. Attractive technical opportunities for application of DfTR and DfRe have been identified by designers and manufacturers, but these have not been widely adopted without direct economic advantage or specific regulatory requirements. Designers and manufacturers are now addressing DfTR and DfRe as a consequence of regulatory action that both directly targets electronic equipment design (e.g. RoHS-type regulation, which specifically prohibits specified materials in product design/manufacture) and which indirectly targets design as a result of impositions made on other parts of the product management chain (e.g. EU and Japanese-type regulation that requires reutilisation of EOL products and, in doing so, stimulates DfRe activities).

Experience to date with both DfTR and DfRe stimulated by regulatory initiatives is that both can have a profound impact on EOL management of electronics if they are pursued in a systematic manner with defined objectives. The continuing and evolving regulatory emphasis on both design and EOL aspects of electronics product management has created conditions in which the consequences to designers and

[20] Other relevant and related activities are also being undertaken as a consequence of the WEEE Directive related to the development of new recycling technologies and creation by OEMs of new organisations to recycle EOL electronics materials

manufacturers of prioritising DfTR and DfRe are positive in terms of the acceptability of their products in the market place, and the costs of their products to consumers. Regulatory frameworks that provide incentive or direct requirement for DfTR and DfRe will, however, play a critical role in the rate of uptake of opportunities. This has key implications on both "best management practices" (BMPs) for EOL electronics and, specifically, on the cost of achieving those BMPs.

Table 8 identifies opportunities for DfTR and DfRe and technical approaches that industry can pursue in accordance with the guidelines. Acting on opportunities such as these can have pragmatic impact. For example, research undertaken by OEMs on DfTR and DfRe guidelines has resulted in, among many other results:

- The identification in 2003 of 25 recommendations for DVD player design improvements that addressed reduction in quantities of materials used (including reduction in the amount of heavy metals and other materials that are toxic at low concentrations), materials substitution, repositioning of components within the device and optimising the fasteners used in the device[21].
- 17 recommendations for improved CRT design.
- 150 design improvements for 10 cell phones[22].

The costs of acting on opportunities identified for design improvements are specific to the product and the nature of the improvements, and require evaluation in all cases. Although action has not kept pace with the identification of opportunity, methodologies are available for estimating the environmental and other benefits associated with individual design improvements such that the most cost effective initiatives can be selected from among a larger number if it is not feasible to act on all opportunities.

Activity to enhance design of electronic products is undertaken at the individual company level. However, industry associations can play key roles in optimising design of electronic products, as well as in other aspects of the environmental performance of electronic products. Various associations within the plastics industry may be models in this regard, having undertaken a range of initiatives related to the environmental performance of their products of common interest to their members. Also, standards for DfTR and DfRe might be developed through the International Standards Organisation (ISO) or other appropriate entity, and it may be feasible to develop an international system of electronically coding components to facilitate their reutilisation.

Although electronics products sold in Canada are largely manufactured in other countries (see Annex B), the global marketplace for electronics companies provides significant economic opportunities for development of design improvements at company and industry-wide levels in this country; for example, C-Vision in Nova Scotia now manufactures RoHS-compliant electronic products components. These opportunities need not be limited strictly to electronics products that are the focus of this document, since opportunities for environmentally-enhanced design exist broadly across the spectrum of electronic products.

Canada is obtaining environmental benefits from the global marketplace for electronic products. As indicated above, companies may be driven to improve design as a result of regulatory pressure in specific regions of the world, but this may result in change in their products marketed in all regions of the world. Global electronics companies are marketing products in Canada that have been modified to comply with the EU WEEE and RoHS Directives. As consumers become more educated regarding environmental

[21] Huisman, J., *The QWERTY/EE Concept*, Delft University of Technology, 2003 - Appendix 6.
[22] Personal Communication, P. Koepfgen Electronics Design Consultant, 6 July, 2004

Table 8
Opportunities for Design for Toxics Reduction and Design for Reutilisation

Opportunities for Design for Toxics Reduction

Choose materials with low tensile strength and notch reserve impact strength for the largest parts
Determine key heavy metal parts
Reduce the weight of materials with little value
Replace materials with negative environmental impact with materials with alternatives less negative, neutral or positive environmental impact
Avoid specifications that require key heavy metal items
Avoid the use of heavy metal coatings
Reduce the toxicity of waste by reducing the amount of toxic materials
Establish tracking systems for toxic materials from supply to EOL fate of materials.

Opportunities for Design for Reutilisation

Determine whether the product has positive, negative or neutral recycling value
Replace components with low reutilisation value with alternatives with higher reutilisation value
Determine the desired end-of-life management approach for a product and design it to meet that purpose.
Develop power supplies and motors with improved unlocking performance of the copper winding and iron core
Do not use metal inserts in large plastic parts
Concentrate material groups in easily separable or separate assemblies of the product
Use materials that can be separated using established materials separation technologies, such as magnetism and electrical conductivity
Use magnetic metal fixtures when parts of different plastics (e.g. housing) are connected
If plastic screws are used, ensure they are made of the same type of plastic
If different plastics are used for large parts, the difference in specific density of the plastics should be larger than 0.1 kg/dm^3, e.g. PP with ABS
Use different colours for different plastics
Look for specific physical properties in materials that make them easy to separate
Use the same material for buttons, doors and windows etc. on the housing of a product
Use solid wiring instead of threaded wiring
Use the same plastic for housing, front and brackets
Use form enclosures rather than screws
Make enclosures for parts that have to be unscrewed at least 10 mm in size
Do not attach parts made of a material mix (e.g. PCBs) to parts made of a mono material larger that 50 g.
Avoid connections between heavy metals and steel or plastic; if they are required make them large
Limit the amount of copper in steel to be recycled
Use materials coding to facilitate disassembly
Use recyclable materials
Design components as easily disassemblable modules
Place modules/components that need to be disassembled (e.g. mercury switches) in the outer areas of the product and make them easy to remove.
Select easy-to-loosen or easy-to-break fastening techniques
Code dangerous/toxic substances and materials and make them easy to remove
Minimise the number of materials
Design sub-assemblies which can be easily separated into fractions with different end-of-life treatment
Use only materials that can be cleanly separated by low cost separation techniques
Use materials that can be melted
If using smeltable materials or if materials with different separation properties cannot be used, move critical parts to other positions or make them suitable for manual disassembly
Make target materials easy to unlock from non-target materials

issues associated with electronic products, marketing efforts can be expected to incorporate information about environmental design aspects of the products.

3.4 Electronics Product Reuse and Recycling

Processes for undertaking EOL electronics reuse, recycling and recovery are described in this section. Markets for components and materials are identified, together with the linkages between different aspects in the reuse/recycle/recovery chain. The different stakeholders in these activities are identified, together with identification of the type and scope of their activities and an overview of the costs and revenues involved. The types of public and private sector interventions that might be considered to support reuse/recycling/recovery activities are identified.

Generally, EOL electronic products collected through systems identified in Section 3.2 are managed through processes identified in this section. However, municipalities in particular may arrange for EOL electronic products to be managed through iron and steel scrap yards.

As identified in Figure 2, EOL electronic product reuse and recycle involve a complex series of interactions in which an EOL product may pass through each of these steps and ultimately to disposal. The more steps that an EOL electronic product passes through the less the amount that remains for final disposal.

3.4.1 EOL Electronics Product Reuse

Reuse is the reutilisation of a product or component without changing the makeup of the product or component; it is therefore a non-destructive form of reutilisation in that the items to be reused are retained in their original form. There are two levels of reuse of EOL electronic products:

- Direct reuse of the product
- Indirect reuse of the product

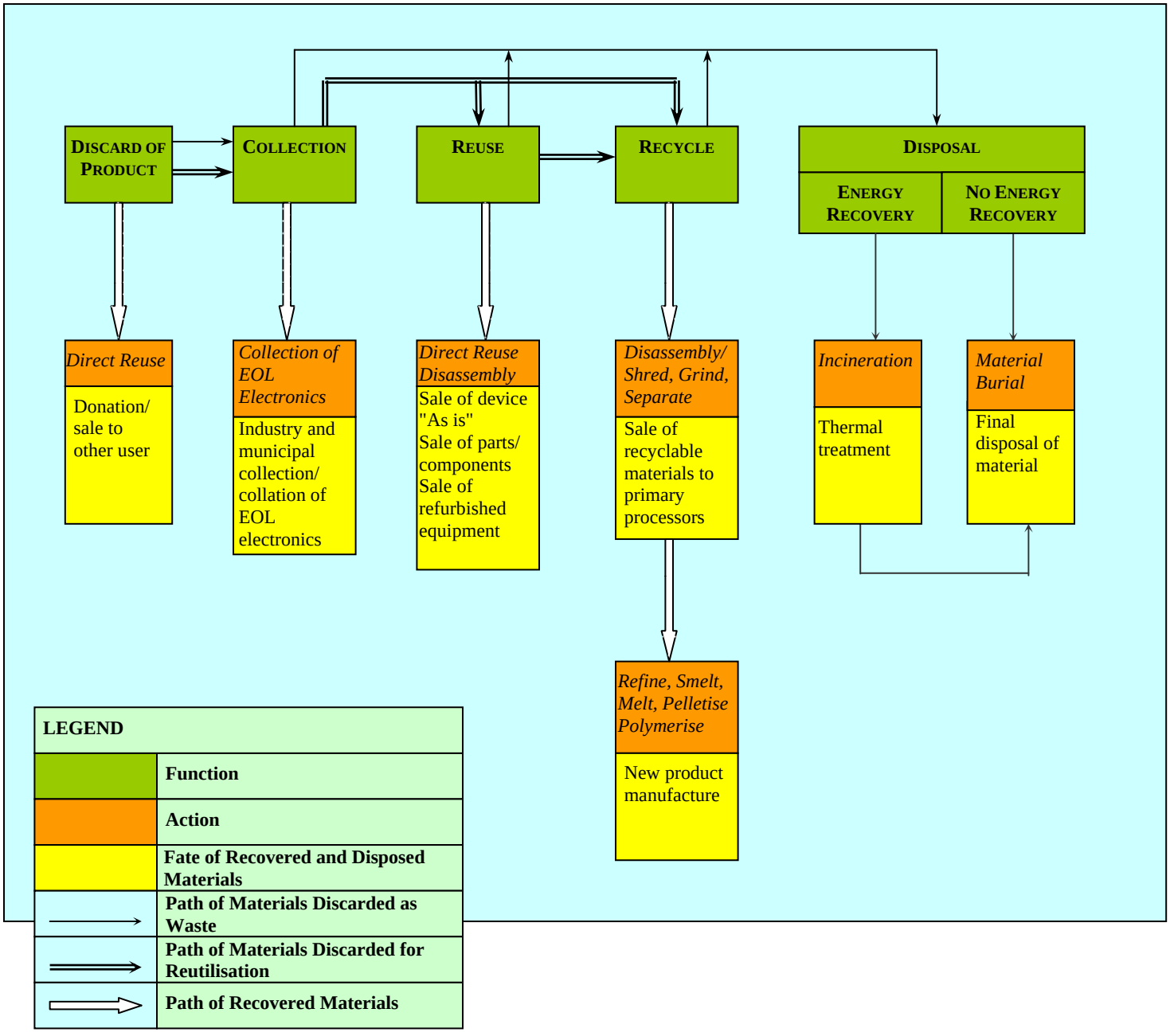
3.4.1.1 Direct Reuse

Direct reuse of EOL electronic products involves the reuse of products without any - or with minimal - repair or other work to prepare the product for use by a new user. Direct reuse may take place either before or following collection.

Direct reuse is an important element of EOL management for a number of products. Surveys have shown that at the household level between 50 and 60 percent of residents give away "first use" computers, printers, computer peripherals and televisions rather than discard them. The recipients of these actions are other individuals and community and other non-profit organisations[23]. Municipalities have also sought to provide direct reuse opportunities for household electronic equipment collected as part of EOL electronic product collection initiatives. The effectiveness of direct reuse initiatives at this level may be limited, however; in Winnipeg, of the 5,535 EOL electronic products that were collected in October 2003, 154 (2.8%) were sold for direct reuse at an average price of $12.09 each.

[23] *Technology Disposal Research*, Confidential source, 2003.

Figure 2
Processes For End-Of-Life Management Of Electronic Products



At the IC&I level, direct reuse may occur pre-collection in terms of making used electronic equipment available to, for example, employees. More commonly, direct reuse occurs post-collection. OEMs and equipment suppliers that operate lease programs, for example, may make electronic equipment available for reuse at the end of a lease term. In the case of computer equipment, it may first be necessary to clean the hard drive of information, and in the case of telephone or cell phone equipment it may be necessary to first clean the product; one major supplier of telecommunications services in Canada donated about 5,000 cell phones for direct reuse in 2003[24]. Computer OEMs with take back or lease programs also donate end-of-first-life products in this way, but data on the number of units involved is not available.

Figure 3 identifies the steps involved in direct reuse at the commercial level. Following evaluation to ensure that products meet basic acceptance criteria (e.g. the product is an acceptable type of device in an apparently acceptable state of repair), products are sorted according to technical specification and tested and graded. In direct reuse, products that meet testing and grading requirements are offered for sale.

3.4.1.2 Indirect Reuse

Indirect reuse includes both the reuse of parts and components of EOL electronic equipment, and the reuse of the equipment itself after repair and/or refurbishment. The term "indirect reuse" is used to indicate that work ("repair") is done on an EOL electronic product in order to achieve a reuse result, see Figure 3. Thus, some components may be removed and others added, but the product or component serves the same basic purpose as it was initially intended to serve.

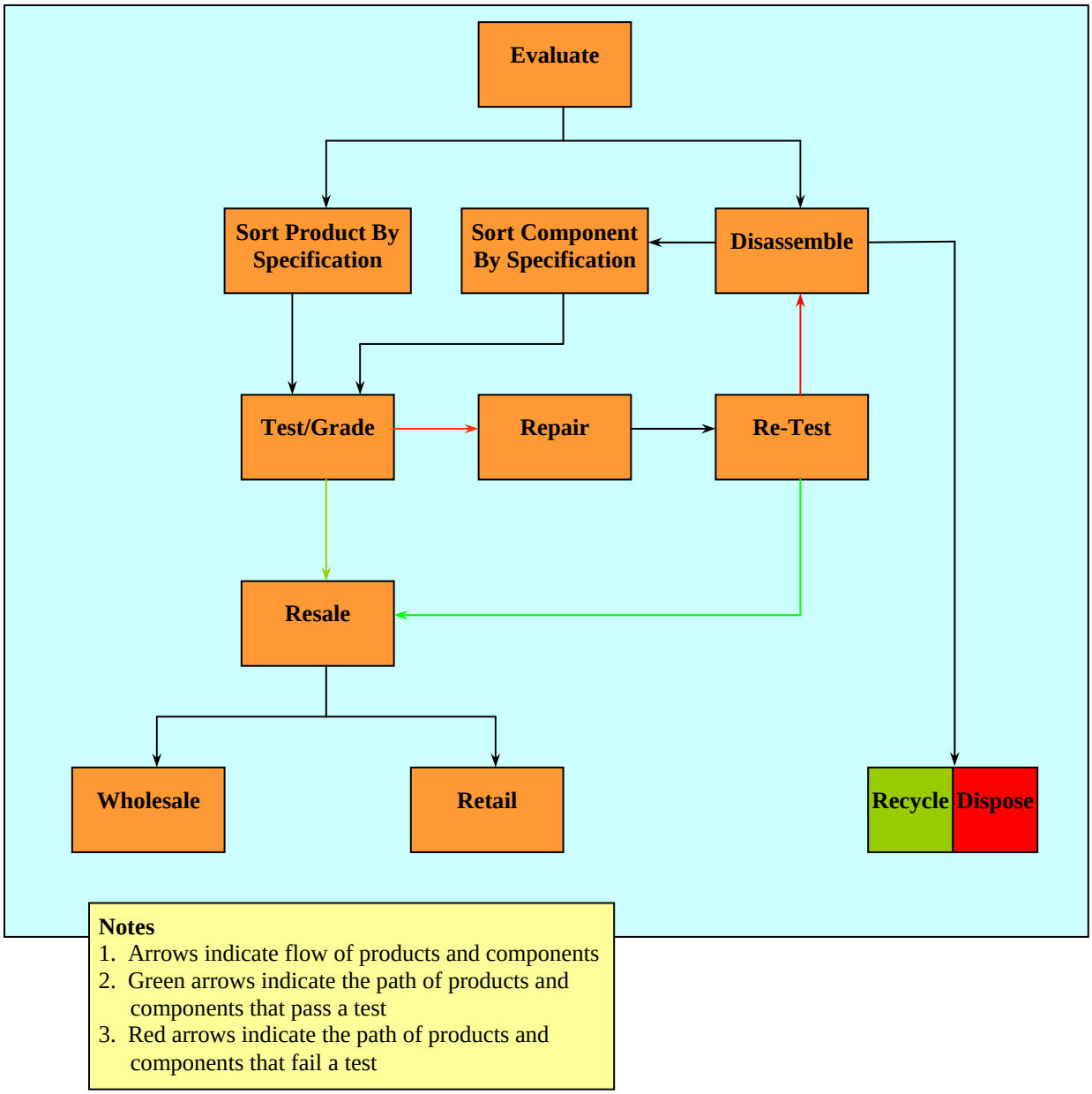
Indirect reuse involves the partial or complete disassembly (also referred to as "demanufacturing") of the EOL product in order to achieve the reuse of parts/components for its repair/refurbishment. Disassembly is undertaken by hand; research and pilot initiatives on automated disassembly have been undertaken, but commercial application of automated disassembly has not been implemented.

Some disassembly operations focus only on the removal of parts and components for resale. These operations remove the items in which they are interested, and discard the remainder of device, either for recycling or disposal. Other disassembly operations undertake both the salvage of parts/components and the refurbishing of used computers. The level of refurbishment that is undertaken is dictated by both the requirements of the markets that are being served and by the characteristics of the equipment that is targeted for refurbishment.

The extent to which disassembly and refurbishing are undertaken is a function of the value of the disassembled or refurbished items. In order to achieve cost-effective disassembly or refurbishment operations it is necessary to establish the time required to undertake different individual tasks, benchmark these and look for opportunities to improve on the benchmarks. Table 9 identifies benchmark times associated with a variety of disassembly operations. Hewlett Packard has estimated that the time required to dismantle one of its "standard" laptop computers is 7.1 minutes, but that the application of DfR to create an "optimised" product could reduce dismantling time to 0.7 minutes (see Box 2). The high cost of labour in Canada relative to the value of the saleable products from the disassembly operation has generally limited commercial disassembly operations in a reuse context to the removal of high value parts/components. Clearly, a reduction of 90 percent in the time required to dismantle a computer, as indicated to be technically feasible by Hewlett Packard, holds significant potential to enhance the financial viability of disassembly.

[24] Industry source, 27 July 2004

Figure 3
Generalised Steps In Commercial EOL Electronics Reuse Operations



Initiatives to refurbish electronic equipment are being undertaken by, particularly, the non-profit sector across the country. Also, electronic equipment returned to OEMs at the end of a lease program has higher residual value than the generally older electronic equipment available from households, and the higher value attached to this equipment may make refurbishment of this equipment justifiable and attractive to the OEMs themselves. This is particularly the case with computers, where brand name refurbished computers are available for sale direct from OEMs and through retailers at lower cost than the price of equivalent brand new equipment.

Table 9
Examples of Times for Disassembly Operations[25]

DISASSEMBLY OPERATION	BENCHMARK TIME
Screw (easily accessible)	6.5 seconds
Screw (obstructed access)	10.5 seconds
Glued joint	12.0 seconds
Nut/bolt combination	11.5 seconds
Welded joint (per point)	7.5 seconds
Welded joint (per surface)	18.5 seconds
Slide	3.0 seconds

Salvaged parts/components and refurbished electronic equipment may be:

- Sold directly to end-users;
- Sold to brokers, wholesalers or manufacturers; or
- Inventoried for future sale.

The market for some categories of refurbished electronic equipment in Canada is significant, particularly for computers. Within the household sector, 3.6 percent of Canadian households bought used computer equipment in 2002, spending an average of $18/household for total national expenditure of $210 million, representing approximately 5 percent of total household expenditures on computers in that year.[26] Data on the sale of refurbished equipment to the IC&I sector is unavailable, but is also estimated to be significant; the non-profit Computers for Schools organisation , for example, donated 86,000 computers with a commercial value of $43 million (assuming an average value of $500/computer) to schools across the country in 2003. Refurbished computers are also available to the IC&I sector from some OEMs and through retail outlets. Commercial markets for other reused electronic products are not as significant and may be negligible in some cases (e.g. stereos).

International markets - and specifically those in developing countries - for salvaged parts/components and refurbished electronic equipment have not been quantified, but are certainly highly significant. The cost-revenue equation for reused electronic products in developing countries is different to OECD countries.

Although household and corporate incomes/revenues are lower in those countries than in OECD countries, lower labour rates and lower cost working conditions for electronic products results in commercial opportunities to resell and refurbish electronic equipment that has limited market or commercial value in OECD countries. These conditions are coupled with strong demand for electronic products, and revenue/income streams that can support the purchase of refurbished electronic equipment but not necessarily new equipment. These circumstances support not only the refurbishing of equipment in one country for domestic sale in that country, but also trade in refurbished electronic products between countries.

[25] Boks, C. *The Relative Importance of Uncertainty Factors in Product End-of-Life Scenarios*, Delft University of Technology, 2002; Section 2.3.4
[26] Calculated from data contained in: *Survey of Household Expenditures: 2002,* Statistics Canada, Ottawa, 2003

Table 10
Sample of Quotes for Purchase of Used Electronic Components and Equipment (July 2004)

ITEM	QUOTED PRICE ($US)	NOTES
Pentium 2 and Pentium 3 Computers	$20 – 50	500/month required
Laptop computers, any model	$50 – 250	Price depends on age and capacity of computer
Used Monitors	$5 - 10 each	40,000/week required
Cell phones	$2 - 25 each	Quantities in the hundreds/month required
DVD drives	$24 each	800/month required
Hard Drives	$12 – 25	Price depends on gigabyte capacity
RAM	$4 - 8/each	Price depends on capacity
Processors	$Cdn 3.00 each	Quantities in the hundreds/month required
Routers	$0.25 each	10,000/week required
Pentium 233 Processors	$Cdn 3.00 each	Single batch of 400 required
In addition, markets are quoted the following subject to price and other arrangements: printers, keyboards, televisions, modems, floppy drives, CRTs (15,000 month)		

Table 10 identifies quoted dealer purchase prices for mid-2004 in the international market place for a variety of electronic components and used products; the table represents only a small sample of opportunities for trade in EOL equipment and components, and international markets certainly exist for many more items than are listed in the table. International transactions of EOL electronic products and materials continue to be debated, and these issues are discussed in Section 3.7. Annex E identifies quoted prices for EOL electronic equipment available from a commercial Canadian reuse/refurbish organisation.

3.4.2 EOL Electronic Product Recycling

The term "recycling" is often used ambiguously to mean different things by different stakeholders and is defined in different ways by different jurisdictions worldwide. Across Canada, however, jurisdictions have defined recycling as having to do with the act of incorporating materials that have been previously used in the manufacture of a product in the manufacture of a new product, i.e. the reutilisation of materials for their material value and not for other values they may have (e.g. energy).

For the purpose of this document, the following definition of recycling is therefore adopted:

"The series of activities by which discarded materials are collected, sorted, and processed, as required, into raw materials and used in the production of new products."

In contrast to reuse, recycling involves the reutilisation of items for the value of their materials rather than for their value as parts/components or products. Recycling is therefore a destructive process since the original material is physically altered between the point of discard and the point that it emerges as a constituent of a new product.

As illustrated in Figure 2, materials that are recycled are those that are either: (i) destined directly for recycling following collection; or (ii) EOL products that are transferred to a recycling system as rejects from a reuse stage. Recycling of EOL electronics involves two steps following collection:

- Processing must be undertaken to prepare materials in a form that they can be incorporated by an end user in a manufacturing process.
- Materials must be incorporated into a manufacturing process.

Materials can only be said to be recycled if the second of these steps is achieved. There are many organisations that refer to themselves as "recyclers" that undertake the first of these steps only. Materials may be processed as part of a recycling system, but until they have been incorporated into a manufacturing process they cannot be considered to have been "recycled".

Processing materials as part of a recycling system typically involves disassembly and processes that shred, grind and separate materials; the extent to which each is undertaken and the range of specific actions within each activity is a function of the EOL products that are handled, the materials that are targeted for recycling and the quality and other criteria that must be achieved in order to sell processed materials to their intended markets.

Figure 4 identifies generalised steps in the processing of EOL electronics for recycling. A pre-sort separates products with a reuse value from products and materials to be recycled; products to be reused are typically handled according to the steps shown in Figure 3. Materials to be recycled are typically first subjected to disassembly of the products to remove components whose materials may be hazardous in subsequent operations or which may escape into the environment; for example, mercury switches, PCBs and CRTs may be removed as part of disassembly at this stage. Hazardous and specialised materials must typically be processed at off-site facilities, but some EOL electronics processors have on-site capacity to process some of these materials. Disassembly may also include the removal and separation of some components from others for their recyclable materials value; at least one Canadian processor recovers plastic housing in this way from TVs to be recycled.

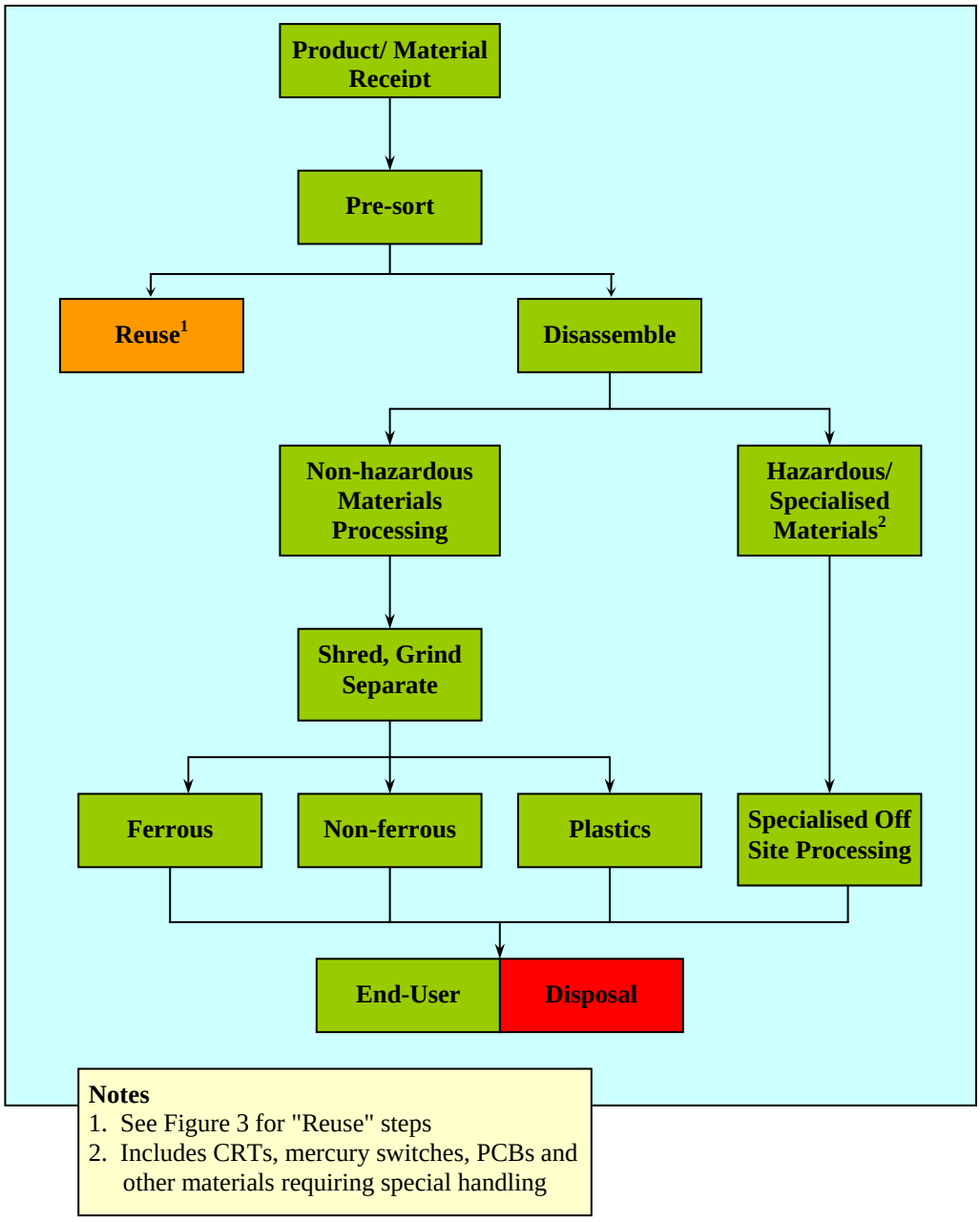
A variety of technologies may be applied to both separated materials and those remaining to be separated. Separated materials may be ground or shredded to facilitate both their transportation to an end-user and their incorporation into a manufacturing process. Remaining materials may be shredded and ground following which magnetic separation may be applied to separate ferrous from non-ferrous metals, eddy current technologies may be applied to separate non-ferrous metals from each other and air classifiers may be used to separate light and heavy fractions (e.g. metals from plastics). In some cases, only some of these processes may be carried out at one facility; e.g. magnetic separation may be undertaken by an EOL electronics processor, but separation of ferrous from non-ferrous metals may be undertaken elsewhere.

The separation of EOL electronics materials for recycling is imperfect. For example, a simple ferrous-non-ferrous separation through application of a magnet (commonly effective in other recycling contexts) fails when non-ferrous and ferrous metals are attached. Mechanised technologies currently in application in North America and Europe also fail to separate different types of plastics; about 12 thermoplastics are commonly found in EOL electronics and all could be recycled if they are separated from each other but recycling opportunities continue to be highly limited if any of them are mixed with any others. Air classifiers are less than 100 percent effective in achieving desired materials separations.

Many of these issues can be resolved in materials separation for recycling is undertaken through manual disassembly and without mechanised processing; e.g. for computer and related devices and televisions. However, this cannot resolve all issues (e.g. not all plastics can be separated from each other unless they are marked).

Completion of disassembly/shred/grind/separate operations results in product streams that may typically be sold to the following end-users for incorporation into a manufacturing process:

Figure 4
Generalised Steps In EOL Electronics Processing For Recycle



- PCBs may be sold to precious metals refiners. One of the largest markets in North America for PCBs is Noranda, which includes PCBs in the feed for its Horne smelter in Quebec and then recovers individual metals through a refining process at a facility in Montreal.
- Limited quantities of plastics are currently recycled. Small amounts of hand-separated plastics may be recycled, and small amounts (relative to the quantities available) are recycled as mixed plastics. Other plastics are destined for recovery and disposal.

- Ferrous metals may be sold to steel mills (primary or secondary).
- Copper may be sold to copper smelters.
- Aluminum may be sold to secondary aluminum smelters.
- Glass may be sold to lead smelters (for recovery of lead in CRTs), manufacturers of CRTs, light bulb manufacturers, others who used leaded glass (e.g. in cathedral glass and architectural glass applications) or to glass manufacturers (non-leaded glass only).

3.4.3 Current Status Of EOL Electronics Reuse and Recycling In Canada

An infrastructure is developing across Canada to reuse and recycle EOL electronic products, components and materials. Work has been undertaken in the preparation of this study to identify organisations involved in the reutilisation of EOL electronics products and materials generated in Canada. Annex F identifies organisations in Canada that receive EOL electronic equipment for the purpose of reusing and recycling[27]. Map I-1 (see Annex I) identifies selected intermediate processors of EOL electronic products in Canada and the US. Although some organisations are very small, the number of organisations is larger than has been previously identified[28]; some of this increase reflects improved understanding of the sector, and some of the increase reflects new activity. By comparison, a 2003 US study identified 432 organisations that receive EOL electronic products and materials in that country[29].

Table 11 identifies the number of organisations that receive EOL electronics organisations in each province in mid 2004. In terms of the number of organisations that process EOL electronics, British Columbia and Ontario are heavily represented and other provinces less so; organisations that have more than one location have additional facilities in Alberta, British Columbia, Ontario and Quebec, which has the effect of further concentrating processing capacity in British Columbia and Ontario. In addition to the data shown in the Table, Computers for Schools is represented in all provinces, although in some their operations are more modest than in others. Also, organisations based in central and western Canada are known to be collecting EOL electronic equipment from the Maritime provinces and from the Prairie provinces.

Data on the processing capacity for EOL electronics is incomplete. Survey and research undertaken in the preparation of this document has identified an EOL electronics product processing capacity of 55,740 tonnes per year from 22 organisations willing to share these data. However, the following factors need to be taken into account in understanding this figure:

- Many organisations that have been contacted have declined to make capacity or current operational data available.
- Some organisations process a different range of products than are covered by this document, and capacity and operational data reflect the range of products they process rather than necessarily the smaller range products of interest to this document.
- Iron and steel scrap yards may also accept EOL electronic products, but it has not been possible to estimate the quantity of EOL electronics items these facilities may handle.
- Available data involves a certain amount of double counting as organisations that engage in recovering components for reuse and in refurbishment may forward materials they cannot use to other EOL electronics processors.

[27] An additional number of general iron and steel scrap yards also handle EOL electronics.
[28] For example, 38 organisations that receive EOL electronics are identified in *Baseline Study of End-of-Life Electronics and Electronic Equipment in Canada*, Environment Canada, June 2003
[29] *IAER Electronics Recycling Industry Report*, International Association of Electronics Recyclers, Albany, New York, 2003

Table 11
Distribution of EOL Electronic Processing Companies In Canada By Province[1,2]

PROVINCE	NO. OF EOL ELECTRONIC PROCESSING ORGANISATIONS	EOL ELECTRONIC PRODUCTS MANAGED[3]
Alberta	7	All
British Columbia	18	All
Manitoba	8	Computers, telephones. No data on other products
Newfoundland and Labrador	1	Computers, monitors and peripherals
New Brunswick	2	Computers, cell phones, telephones, monitors, peripherals
Nova Scotia	1	Computers, monitors, peripherals
Ontario	21	All
Prince Edward Island	0	None
Quebec	3	All
Saskatchewan	2	Computers, peripherals, monitors, TVs, stereos.

Note: 1 The table reflects provinces where organisations are based. Some organisations have facilities in additional provinces, and these are not shown in the Table. In particular, Computers for Schools has at least 1 facility in each province and territory.
2. This table excludes scrap yards and organisations whose activities are believed to only include shipment of EOL electronics, see text.
3. With respect to the products that are covered by this document.

Notwithstanding these issues, it is believed that the available data includes capacity data for the major EOL electronics product processors in Canada, as well as for many other smaller processors. Research in the US has suggested that in that country the EOL electronics product processing capacity of the largest five organisations exceeds the combined processing capacity of all other EOL electronic processors in the country.[30] Available data suggests that although there is a growing number of companies receiving EOL electronic products and materials, the sector in Canada is dominated by a few larger players that account for the majority of activity. Recent reports and data suggest that a total of 12,374 tonnes of the EOL electronics products that are the focus of this report will be reutilised in 2005[31]. While firm data are not available, it seems likely that this figure may significantly underestimate the quantity of EOL products and materials that are the focus of this report that will be received by the infrastructure currently in place.

The EOL electronics management sector in Canada is new. It operates in a largely unregulated environment and is driven to a significant extent by both corporate policy that requires electronic equipment to be managed in accordance with corporate environmental policies regarding waste reduction and recycling, and because companies wish to destroy electronic data records. As a result, the sector is narrowly - but not exclusively - focused on computer and computer-related EOL products. Except for the recovery of PCBs for recycling, the cost of recycling EOL electronics exceeds the value of recovered materials and a service fee must therefore be charged to recover costs.

[30] USEPA Factsheet, 2004 at www.epa.gov/epaoswer/hazwaste/recycle/ecycling/trends.htm
[31] *Baseline Study of End-of-Life Electrical and Electronic Equipment in Canada*, Environment Canada 2003; *Information Technology (IT) and Telecommunication (Telecom) Waste in Canada - 2003 Update*, Environment Canada, October 2003.

The actual quantity of EOL electronic products that are recovered for reutilisation by EOL electronic waste handlers in Canada is significantly lower than the amount of EOL electronics products they receive. As detailed above, EOL electronics processors achieve commercial success by maximising the revenues they receive from the products and materials they handle. The highest returns are associated with reuse of products. However:

- In some cases the only markets for reuse are overseas (e.g. markets claimed as reuse for whole televisions and monitors, and CRTs)
- In other cases, overseas reuse markets are much larger and/or more lucrative than North American markets (e.g. cell phones and computers).

EPSC has taken steps to address issues associated with the processing of EOL electronic products through the preparation of criteria for Vendor Qualification approval by EPSC. "Vendors" are those selling a "recycling" service for EOL electronic products. Approved vendors are required to "fully" recycle EOL electronic products, either themselves or through sub-vendors. Additionally, approved vendors are required to:

- Accept full responsibility for EOL electronics once delivered.
- Certify that both they and their sub-vendors meet the environmental and health and safety standards of their jurisdiction.
- Ensure that no waste is shipped to developing and non-OECD countries.
- "Maximize" the use of recycling and ensure that electronic hardware is not landfilled.

Certified vendors are required to provide reports and documentation regarding their operations in support of their on-going compliance with the standard.

Provinces have not yet taken steps to address regulatory aspects of EOL electronics reprocessing. One consequence of this is that EOL electronics reprocessors may be subject to uneven regulatory requirements. In Ontario, for example, scrap metal yards are exempt from various regulatory and administrative procedures to which other receivers and managers of waste are subject. These exemptions are made on the basis of encouraging recycling through minimising administrative and related costs. Processors of EOL electronics products who are not scrap metal yards are not exempt from these administrative and regulatory requirements and incur time and effort that related businesses do not. Companies may therefore manage the same EOL products, but be subject to differing regulatory regimes[32].

Many aspects of EOL electronic product reuse and recycling can be strongly influenced through consumer demand. "Green procurement" initiatives by IC&I sector organisations, including government, can specify aspects of environmental performance that electronic products must meet. In principle, these can address any aspect of electronic product design and EOL management. The industry will respond provided that lead times are adequate and orders warrant the level of effort that may be specified in a procurement initiative. Electronic product energy consumption criteria are often cited in procurement initiatives. Organisations could establish criteria for recycled content in electronic equipment, disassembly benchmarks, end-of-life management requirements and other aspects of the environmental performance of electronic products. Likewise, individual consumers could significantly influence the environmental design and management of EOL electronics through purchasing choices. To date, there has been little activity in these regards in Canada, although some companies are now requiring assurance from EOL electronic product processors that materials will not be exported.

[32] Personal communications 10 August 2004 with industry representative and A. Ciulini, Ontario Ministry of Environment.

3.5 Markets for EOL Electronics Scrap Materials

3.5.1 Markets Overview

Market prices for materials recovered from EOL electronic products are global and are subject to a wide range of factors. Technical criteria for scrap materials have been established in the US by the Institute of Scrap Recycling Industries (ISRI)[33]; these criteria are used across North America and internationally for classifying scrap materials. Any given scrap product may be sold by a processor under one of many possible classifications that reflect the technical characteristics of the scrap products produced; the same scrap materials may therefore be sold as different products depending on the quality of scrap produced by the processor.

Levels of contamination (i.e. the quantities of materials other than the primary material being sold) impact market prices. In some cases (e.g. plastics), reprocessing sensitivity establishes very low levels of tolerance for contaminants (e.g. in plastics, contaminants must typically comprise less than 2 percent of total weight). In other cases higher levels of contaminants can be tolerated, but the range of products into which recovered materials can be recycled may be lower; in the recycling of metals, for example, alloys found in EOL electronics are recyclable, but often only in either lower grade applications (e.g. casting processes) or through smelting processes that remove/recover the impurities. Market price is also influenced by the quantity of material being sold, the frequency of its availability and the duration of the contract. Transportation costs may be excluded from the sale price, or may be fully or partially included. While these factors influence market prices in any specific circumstance, prices for materials recovered from EOL electronic products in mid -2004 generally fell within the following range, quoted in $US as the international trading currency for scrap materials (bracketed values are negative):

- Ferrous metals: $US 190 - 220/tonne
- Copper: $US 550 - 600/tonne
- Aluminum: $US 0.90 - 1.10/kg
- Leaded glass: ($US 0.08 - 0.15/kg)
- Unleaded glass: $US 35-45/tonne
- Mixed plastics: $US 40 - 200/tonne

The extent to which any market may accept scrap materials from EOL electronics is a function of scrap quality, market demand and price; a successful negotiation between sellers and buyers of scrap is therefore required in order for potential end use markets to become actual end-use markets. However, the way in which materials reach Canadian and US or other international markets is complex. Brokers and intermediaries may often be used to gain maximum value from scrap materials, and joint marketing and cooperative initiatives can achieve higher values for scrap materials than might otherwise be possible.

Specific markets data is identified below. Additional information is provided in Annex I, particularly related to market development. Maps are provided in Annex I that identify selected materials markets in North America.

3.5.2 Ferrous and Non-Ferrous Metals

Markets for scrap materials have traditionally been volatile, and this has been particularly the case since mid 2003 for scrap metals recovered from EOL electronic (and other) products. Grades of scrap copper that sold for $US 1.30 - 1.50/kg in mid 2003 were being sold for up to 50 percent more in mid 2004; other

[33] These are available on-line at http://www.isri.org/specs/

scrap metals have seen similar increases of value over the same time period. These markets are being driven by overseas demand for metals scrap, particularly from Asia and more specifically China. As prices rise, so the economic incentive to export scrap to high-paying markets increases, placing pressure on domestic North American end-users of scrap. In some cases, this pressure is only the latest in a series of pressures that have led to decline in North American capacity to utilise scrap. In the case of copper, for example, the US had 450,000 tonnes of secondary copper smelting capacity in the early 1980's; the last secondary copper smelter closed in 2001 and it appears that the only facility in North America now capable of processing copper from EOL electronics is Noranda's Horne smelter in Quebec. Secondary aluminum smelters accept aluminum recovered from EOL electronics. Steel mills can accept ferrous metals from EOL electronics.

3.5.3 Plastics

All plastics are either "thermosets" or "thermoplastics". Thermoset plastics - which include the plastics used to manufacture circuit boards - are not recyclable using current technology. By contrast, all thermoplastics are inherently recyclable and comprise over 90 percent of the plastics used in electronic products. There are three markets for these recovered plastics:

- Mixed plastics may be sold to markets for direct manufacture into new products in which polymer-specific criteria are not important. These markets include the manufacture of plastic wood, including fence posts, decking, and furniture frames.
- Separated plastics may be sold to markets for direct manufacture into new products in which polymer-specific criteria are important. Plastics recycling is routinely undertaken at this level with industrial scrap and post-consumer packaging scrap that has been separated according to polymer type.
- Separated plastics may be sold for reduction to their chemical basis from which new plastics may be manufactured. Technologies have been demonstrated for this level of recycling, but it is not known to be undertaken in North America with respect EOL plastics.

Plastics used in electronics manufacture may include flame retardants. As discussed in connection with DfTR and DfRe initiatives, the future of these additives is uncertain as a function of RoHS initiatives in Europe and the development of bioplastics that meet industry standards for flame resistance. Over the next several years, however, EOL products will continue to contain these additives. Industry estimates suggest that approximately 50 percent of plastics traditionally used in electronic products may contain flame retardants. In a recycling context, flame retardants may limit the applications in which recycled plastics may be used, but they do not inherently prevent the recycling of plastics.

The greatest immediate opportunity for recycling plastics used in electronic products is to achieve separate streams of plastic that can then be sold to product manufacturers. Until recently, this has meant hand separation of plastics according to polymer type. Table 12 identifies typical plastics composition in three EOL electronics products. As indicated in the Table, although there are a wide variety of plastics used in the products, and although the types of plastic used in each product vary, by far the majority of plastics are comprised of only one or two types. The main constraints to the recovery of recyclable plastics from these and other EOL electronic products has been: (i) the cost of hand separation followed by materials preparation and transportation to an end use market in comparison with the cost and performance predictability of virgin plastics; (ii) the lack of adequate means of identifying/separating individual plastics; and (iii) the availability of other options, specifically recovery of energy and disposal.

Work over the past decade to develop mechanised recovery of plastics from EOL electronics has recently had two important results.

- US-based MBA Polymers has developed a process to separate ground, mixed plastics from a variety of EOL sources, including electronics. The company has constructed a 40,000 tonne/year facility in China to

prepare recovered plastics for the Chinese plastics manufacturing market. Supply is projected to come primarily from Japan. Plans are being developed for similar facilities in Europe. No plans are presently being made for a facility in North America because of uncertainty of supply.
- Sony Corporation has developed technology that can detect fire retardant materials in recovered plastics, thereby providing a basis for managing plastics on the basis of the presence of these materials.

These developments mark important steps in developing commercially viable plastics recycling initiatives. In Canada the Canadian Polystyrene Recycling Association (CPRA) has indicated it believes it has the ability to recycle HIPS at its facility in Mississauga, and would have interest in doing so subject to completion of test runs of available materials, but has cited the presence of fire retardant materials as a key commercial constraint to doing so[34].

3.5.4 Glass

Glass contained in EOL electronics is contained very largely in televisions and monitors, the core component of which has traditionally been the CRT. Markets for glass in EOL electronic products fall into two categories:

- "Glass-to-glass" recycling applications
- Lead smelters

In the context of managing EOL electronics, "glass-to-glass" recycling refers to the practice of recovering CRT glass and recycling it directly into a process for the manufacture of new CRT glass or other glass products for which cullet[35] derived from CRTs is appropriate. The processing of CRTs in glass-to-glass recycling is a specialised task that general processors of EOL electronic products are generally not equipped to manage, and which involves the separation of CRT components - including panels, frit and funnels - according to the demands of end use markets.

Two companies dominate the processing of CRTs for glass-to-glass recycling in North America; both are located in the US. Of these companies, one (Dlubak Glass) claimed in 2004 to handle 90 percent (41,000 tonnes per year) of CRT-derived cullet from two processing plants in Ohio and Arizona. Demand for CRT cullet from CRT manufacturers is currently high; demand exceeds supply to the extent that Dlubak Glass believes that it could sell many thousands of tonnes of CRT-derived cullet beyond its current activities. Dlubak Glass charges $US 0.22/kg to process whole monitors and CRTs, and $US 0.33/kg to process whole TV's. In Canada, Accu-Shred in Mississauga processes CRTs for glass-to-glass recycling for $0.75 - 0.85/kg.

The primary glass-to-glass end users are manufacturers of new CRTs for TVs and monitors. Canada is not a producer of CRTs, but the US has been a CRT producer for many years. Over the past several years, however, CRT production in the US has moved offshore. Accordingly, glass-to-glass recycling into CRTs has increasingly become - and is now, effectively, entirely - an industry engaged in export of recovered and processed cullet. Glass-to-glass recycling markets also exist for CRT cullet in the manufacture of fibreglass and bottles, but the supply of cullet to these markets is restricted to lead-free panel glass. Leaded glass can be recycled into glass used in lighting products.

Two smelters in North America accept CRT glass: Noranda's lead smelter in Belledune (New Brunswick) and the Doe Run lead smelter in Boss (Missouri) - both are primary lead smelters. The Belledune facility

[34] Personal communication with CPRA 10 June 2004.
[35] "Cullet" refers to glass that is recovered for recycling.

Table 12.
Plastics Composition of TVs, Computers and Cell Phones[36]

PLASTIC	TELEVISIONS	COMPUTERS	CELL PHONES
HIPS	75%	5%	0%
ABS	8%	57%	0%
PPO	12%	36%	0%
PP	3%	0%	0%
PC/ABS	0%	2%	81%
Other	2%	1%	19%

Note: Percentages may sum to more than 100% due to rounding.

processes approximately 1,000 tonnes of CRTs per year, and the Doe Run facility processes approximately 25,000 tonnes of CRTs per year. In addition, Teck-Cominco in Trail (British Columbia) has completed the pilot testing of processing EOL electronics including CRT's and anticipates processing up to 15,000 tonnes per year of EOL electronics material. Ultimately, the company has additional capacity to process a further 30,000 tonnes of CRTs per year if two furnaces that are presently closed were restarted in the future[37]. Large quantities of glass to supply this capacity are anticipated to be available in the short-to-medium term as a result of continuing discard of TVs and monitors, and as a result of change to flat screen (non-CRT) technologies. Over the longer term, availability of CRTs will decline.

Although CRTs contain important percentages of lead, which are recovered, the interest of both the Doe Run and Belledune lead smelters in processing CRTs lies in the glass as well as in the lead that is recovered. Silica is a critical fluxing agent in the smelting process, and CRTs offer an effective substitute. The quantity of CRTs that can be processed through a primary lead smelter is a function of the maximum proportion of silica/glass that can be included in the mix; excess quantities result in larger volumes of slag that must be disposed of[38]. The Doe Run facility charges between $US 80 - 150/tonne for the CRTs it processes, depending on the volume of CRTs and other factors. The Belledune facility has considered establishing a processing fee of $250/tonne.

3.5.5 Printed Circuit Boards

PCBs contain recoverable quantities of a wide variety of precious and other metals that occur in trace amounts in EOL electronic products. The quantity of these metals in electronic products has been reduced over time, and this has resulted in declining potential value of PCBs to the recycling industry. Within the industry, "high grade" electronic scrap therefore refers to older PCBs, and "low grade" electronic scrap refers to more recent PCBs. Actual value of PCBs depends on the price of recovered metals as well as the quantity of those metals in the PCB; as with other secondary metals, these values can change greatly over short periods of time.

[36] Glenn Brown, Australian Mobile Telecommunications Association, *We're Talking Recycling: Mobile Phone Industry Recycling Program*, Third National Workshop of Extended Producer Responsibility, Halifax, Nova Scotia, March 2003
[37] Personal communications, 22 June and 23 August 2004.
[38] Slag itself may be processed for incorporation into construction materials (e.g. cement)

Recovery of metals from PCBs is undertaken by companies engaged in wider reclaim of precious and trace metals. PCBs may typically be shipped whole in gaylord containers or drums to a reprocessor. Metals are recovered through a smelting and refining process that may be undertaken within one facility (typical of specialty operations) or in different facilities (e.g. Noranda, where facilities in Rhode Island sample and assay PCBs, smelting is undertaken at the Horne copper smelter in Quebec and refining of precious and trace metals from copper anodes produced at the Horne smelter is performed at a facility in Montreal). Currently, smelting and refining are typically undertaken on a toll basis in which the reprocessor charges a fee and the value of the recovered metals is credited to the supplier of the PCBs. The tolling fee is based on the volume of PCBs to be processed, and the value credited to the supplier of the PCBs is a function of the mix of PCBs supplied and the types, quantities and values of the metals they contain. In mid-2004, a typical pricing structure might be as follows:

Administrative handling fee	$US 350.00 (flat rate)
Smelting/refining charge	$US 1.10 - 2.75/kg. Lower rates apply to large amounts to be processed (e.g. over 4,500 kgs) and higher rates apply to smaller amounts to be processed (e.g. less than 1,000 kgs). In addition, the processor may typically charge between 2 - 3% of the value of the metals recovered.
Credit to supplier	In mid-2004, a supplier of PCBs could expect to receive a credit generally in the range of $US 2.00 - 4.00/kg of PCB supplied, depending on market prices and metals composition of the PCBs.

Some North American processors of EOL electronic products send PCBs to Europe for recovery of metals, and some overseas suppliers and processors send PCBs to North America for metals recovery.

3.5.6 Rechargeable Batteries

Unlike other products considered in this document, rechargeable batteries are not processed prior to being sent to an end-user. Following their collection, rechargeable batteries are bulked for transportation and sent for management at one of two facilities: INMETCO, located in Pennsylvania, receives nickel cadmium, nickel metal hydride, lithium on and sealed lead batteries; and TOXCO, located in Trail (British Columbia) receives lithium ion batteries.

The major source of rechargeable batteries destined for INMETCO is the Rechargeable Battery Recycling Corp. (RBRC) program for recovering rechargeable batteries. All rechargeable batteries collected by. RBRC in Canada and in the US are sent to INMETCO for processing[39]. RBRC does not provide data on the percentage of rechargeable batteries sold in Canada and the US that are recycled through its program. However, in 2001 RBRC established a target to recycle 70 percent of portable rechargeable batteries[40]. Based on industry discussions and available data, it appears that the percentage of rechargeable batteries that are sold in Canada and that are recycled may be in the range of 35 percent, although some sources place recovery and recycling rates at closer to 10 percent[41]. The TOXCO facility receives lithium ion batteries from industrial generators including, in particular, the US military and the oil sector. Costs for recycling rechargeable batteries are paid by RBRC for batteries collected under its program or by the generator of the waste battery

[39] Rechargeable batteries collected through the RBRC program in the western US are sent to a facility in California for consolidation/shipment to INMETCO. The facility is owned by Kinbursky Brothers, owners of TOXCO.
[40] *Waste in the Wireless World: The Challenge of Cell Phones*, INFORM Inc, Hew York, 2002
[41] *Electronics Recycling: What To Expect From Global Mandates*, Raymond Communications, 2003.

TOXCO is currently implementing its "Big Green Box" program across Canada. Under this initiative, TOXCO will supply a box that can hold 20 kgs of batteries together with the cost of courier return to TOXCO of the full box for $105. Consumers will be able to place any type of battery (rechargeable or not) in the box together with small e-waste items (e.g. hand held devices) for recycling of those batteries and devices by TOXCO. This initiative is a consumer application of a program implemented earlier by INMETCO in which the company provides, for a fee, a box to companies in which they can place spent batteries and arrange for courier return to INMETCO when the box is full.

INMETCO accepts all rechargeable batteries, as well as alkaline (non-rechargeable) batteries. Approximately 30-35 percent of the rechargeable batteries it receives are nickel-cadmium, 25-30 percent alkaline, 10-15 percent nickel metal hydride, 10-15 percent sealed lead, and 1 percent lithium ion. Sealed lead batteries are shipped to Nova Pb, secondary lead smelter in Quebec, and lithium ion batteries are shipped to British Columbia, where they are believed to be processed by TOXCO. Remaining batteries are processed at the INMETCO plant and the resulting products are sold to the stainless steel industry. As rechargeable (and other) battery use has grown in recent years, together with the introduction of the RBRC program, so the quantities of batteries received by INMETCO has grown. Implementation of RoHS requirements in Europe will result in change in the composition of batteries in North America to the extent that the removal of cadmium from the European marketplace results in its removal from the North American marketplace as well.

INMETCO has supplemented the supply of batteries from the RBRC program with its own initiatives targeted at the industrial sector. In addition to the provision of boxes to companies (see above), the company has provided prepaid envelopes to small businesses for the mail back of batteries, and has coordinated milk-run pickups in which collection of drums of batteries is coordinated among several generators in order to reduce transportation costs for each generator. INMETCO's recycling process has been estimated to be 50% more energy efficient than production of metals from virgin ore.[42]

3.6 EOL Electronic Products Disposal

As indicated in Figure 2, EOL electronic products and materials that are not reused or recycled are managed through disposal. Disposal may first involve incineration (with or without energy recovery) and necessarily involves land disposal. The only combustible materials of significance used in the electronics products considered by this document are plastics. Therefore, the use of incineration as a management strategy for the EOL products considered in this document is limited to plastics.

Some industrial facilities operate at temperatures in which wastes are effectively incinerated, even though the facilities are not considered "incinerators". Chief among these in Canada are smelters and cement kilns. Cement kilns are not known to have been used for managing EOL electronics materials. However, Noranda's Horne copper smelter in Quebec receives plastics containing metal scrap from across North America. While the primary objective at this facility is to smelt metals, the energy value in the plastics in the electronics scrap offsets energy that would otherwise need to be purchased. The facility has been found to burn at a high enough temperature and with a long enough residence time in the smelter that atmospheric emissions often associated with the incineration of plastics are within emission requirements. Plastics are also consumed in the recovery of metals from PCBs, also achieved through a smelting process. The inclusion of plastics as part of the EOL electronic product mix accepted at Teck Cominco's lead smelter in British Columbia is intended, in part, to offset energy costs.

[42] Plachy, Jozef, *Cadmium Recycling in the United States in 2000*, US Geological Service Circular 1196-O, 2002

EOL electronic products and materials that are not reutilised are subject to land disposal. These products and materials include:

- Products that are collected but which do not enter a reuse or recycling stream.
- Materials that are discarded from reuse and/or recycling streams for disposal.
- Materials that are discarded from smelting processes.

Notwithstanding the desire of public and private agencies to maximise the reutilisation of waste materials, land disposal is accepted around the world as a necessary component of solid waste management systems.

The legal framework in Canada (and elsewhere) for land disposal facilities has been conceived around the following:

- Some solid wastes pose a higher risk to human health and the environment than other wastes. Around the world, these are usually defined as "hazardous wastes", although in some jurisdictions different terminology may be used to refer to the same waste materials.
- Hazardous solid wastes may be generated by IC&I activities as a consequence, primarily, of the manufacture of products.
- Non-hazardous ("municipal") solid wastes are generated by households, and wastes of a similar nature are also generated by IC&I activities.

It has become apparent that the distinctions that form the basis for the legal framework governing solid waste management are not adequate for a variety of EOL electronic products and materials. Several electronic products meet the criteria for definition of "hazardous waste" by virtue of their leachate toxicity characteristics - i.e. the concentrations in which regulated materials (generally heavy metals) may be liberated to the environment when the materials are discarded to land disposal facilities. Among other research:

- CRTs have been found meet criteria for leachate toxicity[43].
- Generators should assume that "[EOL electronic] devices that contain a colour CRT or printed wiring board with lead-bearing solder ….should be considered hazardous waste".[44]
- Cell phones have been found to leach metals at levels that exceed "hazardous waste" criteria.
- Nickel cadmium batteries meet criteria for leachate toxicity.

The disposition of electronic products in municipal landfills creates reservoirs of materials that may pose an environmental threat in both the short and long term.

EOL electronic products that are discarded to land disposal following processing in a smelter are believed to be tightly bound in the smelter slag and are typically disposed on land as non-hazardous solid waste, or may be further processed for application as a fill material or in cement manufacture.

3.7 International Issues

In addition to the organisations that receive EOL electronic products for processing in Canada, there are other organisations that receive EOL electronic products for shipment overseas. The extent of this activity is not clear; neither Canadian Border Services Agency not Statistics Canada track these data. However, anecdotal information from throughout the industry suggests that the quantity of Canadian EOL

[43] Musson, Stephen E., *Management of Discarded Cathode Ray Tubes*, University of Florida, 2000; http://www.louisville.edu/admin/dehs/confer/PresentationMusson.ppt

[44] Townsend, Timothy et al., *RCRA Toxicity of Computer CPUs and Other Discarded Electronic Devices*, University of Florida, July 2004; www.ees.ufl.edu/homepp/townsend/research/Electronic leaching

electronics shipped overseas for reutilisation likely significantly exceeds the quantity reutilised in Canada and the US. One company operating in Canada, the US and in other OECD countries in 2004 claimed to have the capacity to ship 500,000 tonnes of EOL electronic equipment to Asian markets annually. In this instance, monitors and TVs are destined for a plant in the Philippines and computers are sent to a plant in China.[45] It was estimated in 2002 that "50 - 80% of e-waste collected [in the US] for recycling is shipped overseas"[46]. It is not clear that the situation in Canada is substantially different.

Materials recovered from EOL electronic products in Canada may be marketed through a complex system of intermediaries. In some cases, processors market materials directly to an end-user in Canada, or to an intermediate organisation for further processing before being sold to an end user. In other cases, materials may sold through a broker. In either case, materials may be exported; as discussed elsewhere in this document, prices for scrap materials overseas are causing materials recovered from EOL electronics to be sold to overseas markets even when domestic markets may exist. Major destinations for materials recovered from Canadian EOL electronics include east Asia and South America, but demand exists from a wide range of developing countries. PCBs recovered from Canadian EOL electronics are being processed in western Europe as well as in North America.

Concerns have been raised in recent years regarding the export of EOL electronics products and materials to overseas markets in developing countries. These countries frequently lack the environmental or occupational health and safety legal frameworks to provide for proper management of these products and materials, and even when adequate legal frameworks exist the application and enforcement of the frameworks may be weak or absent. Concerns over the export of EOL electronic products have therefore focussed on:

- The environmental damage caused by EOL electronic products and materials that are improperly managed in developing countries.
- Occupational health risks associated with absent or inadequate systems for preventing exposure of workers to toxic materials contained in EOL electronics products and materials.
- The use of child labour to process wastes from richer, developed countries.

Additionally, concerns have been raised that used electronic equipment - even if it has been, or is to be, refurbished - has a relatively short life and that therefore the export of used electronics products to developing countries amounts to the export of waste to these countries. China, for example, has responded to issues such as these by tightening controls on EOL electronics that were allowed into the country in 2001, but these have been unevenly enforced and EOL electronic products and materials have been reported to continue to enter the country from OECD nations[47].

These issues are complex and extend across the OECD countries and have led to calls for regulations to limit or ban the export of used electronic products and materials to developing countries. On the other hand, demand for electronic products is high in developing countries and for many people the only affordable products are used equipment imported from OECD countries. Priority in developing countries is often placed in meeting immediate needs, and the consumption of discarded goods and materials from OECD countries has become an important economic activity for many developing countries in terms of satisfying their own populations and in terms of the manufacture of exports to developing countries. In the context of EOL electronics specifically, for example, secondary copper refineries in the US had the capacity to smelt 340,000 tonnes of copper scrap (including copper now recovered from EOL electronics)

[45] Personal communication, 6 July 2004
[46] *Exporting Harm: The High Tech Trashing of Asia*, Silicon Valley Toxics Coalition, 2002.
[47] Confidential source, 12 August 2004.

in the early 1980's; today, there are no secondary copper facilities in the US able to accept scrap grades equivalent to those associated with copper recovered from EOL electronics, although 511,000 tonnes of copper scrap were exported from the country in 2002 rising to 2.075 million tonnes of scrap in the first 7 months of 2004. The US Commerce Department turned down a request from copper scrap processors in 2004 to place controls on the export of scrap copper.

These issues continue to be debated at international forums including the Basel Convention on the Transboundary Movement of Hazardous Wastes and Their Management, the OECD and World Trade Organisation. The Basel Convention largely exempts (Annex IX, List B Paragraph 1110 of the Convention) electronics from the requirements of the Convention.

Developing countries may view well intended environmentally-motivated initiatives to restrict trade in used goods as an economic measure intended to thwart economic competitiveness. On the other hand, there are documented instances of widespread practices associated with the management of EOL electronics from Canada and other countries that clearly impact the health of workers and the environment in developing countries.

Development of Canadian responses to these issues is framed by policy statements at the level of CCME and the Canadian International Development Agency (CIDA). CCME has spoken to this issue in its Canada-Wide Principles For Electronics Product Stewardship, Principle 12:

> *E-waste is exported from Canada for recycling only at facilities with a documented commitment to environmentally sound management and fair labour practices.*

CIDA has established a Sustainable Development Strategy: 2004 - 2006 in which the Agency sets out Canada's commitment to fostering development in developing countries that is:

> *"…equitable and environmentally sustainable and that strengthens the economic, social, environmental, and governance capacity of women and men, girls and boys."*[48]

Government agencies have clearly established a basis through which actions can be taken to address issues associated with the management of EOL electronics in developing countries, and both CCME (through Environment Canada) and CIDA as well as other federal agencies are in a position to strengthen EOL electronic products and materials trade regimes.

3.8 Gaps and Opportunities in Canada

Table 13 summarises key gaps and opportunities for enhanced reutilisation of EOL electronic products in Canada. The table first identifies "gaps" in the legal framework, and with respect to each of collection, processing for reuse and processing for recycling; gaps are also noted in relation to markets for recyclable materials. The "consequence" of each gap is identified, together with "actions underway" relevant to the gaps and their consequences. "Barriers" are then identified that constrain action, followed by "opportunities" for action to address barriers and fill gaps. The "opportunities" identified constitute the range of key actions that should be taken primarily by government at all levels, as appropriate, but also by the private sector to achieve cost effective reutilisation of EOL electronic products and materials.

[48] Sustainable Development Strategy: 2004–2006, Enabling Change, Canadian International Development Agency,

Table 13
EOL Electronics Product Reutilisation Gaps and Opportunities

	GAP	CONSEQUENCE	ACTIONS UNDERWAY	BARRIERS	OPPORTUNITIES
Legal Framework	1. Absence of link between entities responsible for managing EOL electronics and designers/manufacturers 2. Inadequate legal frameworks governing disposal of EOL electronics 3. Inadequate legal frameworks governing environmental consequences of export of EOL electronics	1. Unfunded EOL management mandate placed on local government; failure to maximse DfRe options 2. Entry of toxic materials into the environment; landfills used for recyclable materials 3. Environmental impacts of EOL products exported to developing countries	▪ CCME has adopted EOL electronics policy statement ▪ Alberta legal framework to finance recovery of EOL electronics (effective 1 October)	▪ Provincial legal frames vary regarding institutional responsibilities ▪ Uncertainty of how best to regulate OEMs active in Canada through internet only ▪ Political will to strengthen EOL electronics legal frames varies across Canada ▪ No indication of willingness of federal government to act on trade in EOL electronics or materials ▪ No indication of coordinated international action to regulate EOL electronics/materials trade	▪ Creation of provincial legal frames to give effect to CCME policy principles according to defined timing schedules ▪ Creation of legal frame to integrate trade in EOL electronic products and materials into global trading system in ways compatible with sustainable development principles
Collection	1. Systems to collect household EOL electronic products are inconvenient, low-impact and expensive 2. Systems for collection of IC&I EOL electronics narrowly focussed and uncertain	1. Low levels of household EOL electronics collected; collected products not adequately stored/handled to facilitate reutilisation 2. IC&I collections focus on computers/IT equipment from large companies	▪ New collection systems being designed in Alberta ▪ EPSC proposing collection systems at national level ▪ Increasing number of municipalities maintaining limited collection of household EOL electronics ▪ Commercial opportunities to collect/reutilise EOL electronic products being exploited	▪ High cost of municipal collection ▪ Inadequate participation by producer and EOL electronics reuse/recycle sector in household EOL electronics collection system design ▪ Low levels of value in most EOL electronics do not attract commercial interest	▪ Application of producer responsibility for separate collection of EOL electronic products that reflects that costs are not borne by the taxpayer and which provides incentives, and no disincentives, to consumer participation ▪ Prohibit landfill disposal of EOL electronic products ▪ Require reutilization of separately collected EOL electronic products
Processing for Reuse	1. Inadequate capacity to maximise reuse opportunities 2. Reuse infrastructure inequitably distributed across the country 3. Reuse infrastructure narrowly focussed on cell phones and IC&I EOL computers/telephones, and uncertain	1. Failure to maximise existing reuse opportunities 2. Particular failure to maximise existing reuse opportunities in regions poorly served by infrastructure 3. Functional electronic products prematurely enter EOL phase	▪ Commercial "cherry-picking" of financially attractive opportunities ▪ Government financing non-profit processing for reuse. ▪ OEMs/others directing computers to processing for reuse ▪ NGO interest in processing for reuse ▪ OEM interest in leased item reuse	▪ Inherent constraints to reuse associated with old, outdated products. ▪ Non-optimised design makes processing for reuse in Canada expensive ▪ Commercial implications of reuse may lead to OEM resistance ▪ Issues associated with licensing/ ownership of hardware and software	▪ Establish quality criteria and symbol for refurbished products ▪ Build on existing domestic and overseas market for refurbished electronic equipment
Processing for Recycling	1. Inadequate processing capacity 2. Un-coordinated provincial legal frameworks in support of recycling facilities that require regional inputs 3. Technologies used by some processors may fail to maximise value of recyclable materials 4. Processing technologies ill-matched to plastics markets	1/2.Inadequate collection and inadequately regulated EOL electronics export results in processing facilities operating below capacity in spite of large volumes of EOL products/ materials available 3 Processing costs not optimised 4. Limited ability to meet plastics market demands	▪ EPSC promoting Canadian processing for recycling through vendor qualification standards	▪ Low value of recyclable materials requires "tipping fee" to financially justify facilities ▪ Inadequate legal frameworks allow other management options that are environmentally less desirable, uncertain or damaging ▪ Legal frameworks fail to provide an attractive investment climate	▪ Create environment supportive of new investment: (i) close option of disposal without treatment; (ii) regulate exports of EOL electronic products/materials ▪ Consider opportunity for Canada to import EOL electronics for environmentally-sound processing
Markets	1. Plastics markets unable to absorb all plastics from EOL electronics 2. Leaded glass markets incur net negative revenue 3. Many markets are overseas	1. Large quantities of plastics believed destined for disposal 2. Processing costs need to reflect negative market value 3. Declining domestic markets for EOL recyclable materials	▪ New technologies available to recycle EOL electronics plastics ▪ New North American markets for leaded glass ▪ OEMs incorporating recyclable materials in new products	▪ Recyclable materials markets are global, limiting the impact of Canada-specific actions ▪ Continuing trend of traditional North American users of secondary materials relocating overseas	▪ Canadian primary smelters provide large opportunity as "recyclers of last resort" ▪ Global markets financially and technically accessible from Canada

4.0 REVIEW OF CURRENT STEWARDSHIP PROGRAMS AND INITIATIVES

The C-WPEPS identify that "producers" are primarily responsible for the management of EOL electronic products in Canada. The policy frame for management of EOL electronic products is therefore one of "producer responsibility". This section reviews the experience of producer responsibility in Canada and elsewhere in terms of public (regulatory) and private (voluntary) "producer responsibility" activities.

In this section, the C-WPEPS "principles" are identified in *italics* followed by discussion of how these principles are being applied in other stewardship programs, and more specifically, stewardship programs for EOL electronic products where possible. It is noted, however, that provincial and state stewardship programs for EOL electronics in North America have only recently commenced, and European and Asian programs have been operating for no more than six years. With limited case studies in place from which to draw definite “lessons learned”, the following section also draws from the experience with Canadian stewardship programs for other end-of-life products. Details of stewardship programs for EOL electronic products are included in Annex H, and provide the basis from which the analysis in this section is drawn

4.1 Defining Stewardship for Electronics

The first of the CCME’s guiding principles refers to the responsible steward in an electronics stewardship program. It states:

1. *Responsibilities associated with management of e-waste are primarily borne by producers of the products, where “producer(s)” means the manufacturer, brand-owner or first importer of the product who sells or offers for sale the product in each jurisdiction.*

In Canada, several provincially mandated crown agencies or multi-stakeholder not-for-profit Boards manage “stewardship” programs. While producers may have some say in program development and operations (e.g. by way of pre-program consultations, a seat on the board, or an industry committee of the Board), the producer’s responsibility with the program is limited.

However, this principle is consistent with many operating stewardship programs in Europe. For the most part, producers with a common set of interests in managing a form of e-waste develop a “collective” with one operating agency to manage the legal obligation and responsibilities of that group of stewards/producers. Consistently, these responsibilities include partial collection, transportation, and coordination of recycling in an environmentally appropriate manner.

Collective partnerships usually develop when producers gain economic efficiencies through managing their waste with competing companies with similar waste products. The formation of a collective may be prescribed through legislation, or permitted in lieu of individual producer responsibility. In Canada legislation/regulation varies in this respect.

In British Columbia and Quebec for example, the stewardship legislation requires producers and first importers to prepare stewardship plans individually, but allows for collectives in lieu of individual responsibility. Alternatively, in Ontario, legislation calls for a collective (called an Industry Funding Organization or IFO), but allows for individual producers or groups of producers to “opt-out” of collectives through industry stewardship plans, if that plan meets the program goals set out by the collective.

In general, existing stewardship programs are in place for “like” materials (for example, beverage containers, paint, lubricating oil, packaging) where collectives make economic sense because the recycling process and costs are fairly equal irrespective of the brand.

However, in the case of electronic products, variables such as product size, toxic components, metal content, recyclability and other factors can determine a wide range of management options and costs. For this reason, program designs should allow flexibility in how producers organise themselves to address their responsibilities. This is consistent with the WEEE directive in Europe, for example, where several collectives have been formed representing different product types and/or brands.

Producer stewardship responsibilities are being addressed through "voluntary" or "non-voluntary" approaches. Voluntary approaches have two critical deficiencies:

- They do not provide a level playing field. Without an appropriate regulatory framework, companies that are willing to invest in stewardship initiatives have no assurance that other companies with whom they compete will make similar investments. Where there are uncertain returns or net costs, this is likely to place companies that are otherwise willing to take actions at a competitive disadvantage - and they are unable to act. Legislation is critical to establishing an equitable investment and operations climate for stewardship activities.
- Typically, they lack accountability. Voluntary mobile phone collection, brand-based computer return programs, ink jet and toner cartridge programs, and rechargeable battery collection programs (all voluntary) only provide a quantification on the amount of material recovered, not the recovery rate (i.e. the percentage of product sold that is in fact recovered). As documented Section 3, recovery rates under these programs appear to be low.

Industry argues that non-voluntary (regulated) approaches can be onerous and inefficient when legislation/regulation is too prescriptive. In an effort to mitigate these concerns, simple legislation can be drafted which offers industry flexibility to design and operate a recovery program (including the option of participating with a provincial agency, where appropriate), but which requires that binding targets and mandatory reporting obligations be met and that penalties are spelled out if they are not. In addition, legislation may require producers to demonstrate the environmental effectiveness of their program. Also, basic environmental management guidelines should be set for materials management (e.g. following the waste management hierarchy).

This approach, which is being used in Europe today, is successful in that it allows government to set the rules, while providing industry with flexibility to meet those rules in a cost effective and less onerous manner. In addition, this flexibility provides companies with opportunities to attain competitive gains through innovation.

4.2 Financing EOL Electronic Product Stewardship

CCME's second principle refers to the financing of e-waste programs. It reads:

2. *Costs of program management are not borne by general taxpayers.*

In most regulated stewardship programs, the costs associated with transportation from consolidation points and recycling treatment processes are not borne by taxpayers. Consistent with most programs is that producers and first importers are the original funders of the program. Generally, they pay a set fee per unit sold to the management agency or Board. The program is simple once all producers and first importers are registered - normally a requirement to sell in the province.

What typically occurs however is that the producer recoups these stewardship costs from the retailer who then passes it on to consumers through a visible fee. Therefore, in most Canadian regulated programs, costs are borne directly by consumers through visible fees at the point of purchase.

For example, in British Columbia, Saskatchewan, Alberta and Manitoba beverage containers and used oil materials are financed through visible consumer fees. British Columbia's household special waste program charges front-end "eco-fees" on products like paint, gasoline, and flammable liquids. Every tire program in Canada is also financed through a visible fee charged at the point of purchase.

Not all programs in Canada have visible consumer fees. For example, Ontario's new Blue Box 50% share funding model forces brand owners and first importers to pay levies. Obligated stewards are unable to recoup the levies directly from consumers, because for the most part they are too small to charge on a per item basis. Through Quebec's Consumer Protection Act, the new paint program forbids retailers from charging a visible fee on paint.

Some industries argue in favour of visible fee because consumers will eventually pay stewardship costs anyway in the price of the product. However, experience in Canada and European jurisdictions show us that by externalizing the fee directly on consumers individual companies do not have the ability to reduce the fee charged on their product through product innovation. In addition, companies have little to no interest in reducing these costs through product or packaging redesign, as the externalization of these new environmental costs has shifted the responsibility from taxpayers to consumers directly. These points are discussed further in Section 5.3.

In addition, stewardships fees - fees charged for the service of managing a producer's waste product - will vary year to year based on regularly fluctuating costs. Stewards/producers have the ability of paying exact yearly or quarterly costs based on what the forecasted costs are for that year or quarter, or if charged after the fact, on what the actual cost were for that period. When fees are made visible and passed down throughout the distribution chain to the final consumer, it is less likely that the fees charged will reflect the exact costs. More often than not, visible fees remain fixed year after year, misrepresenting the actual system costs. Fixed fees, and therefore fixed spending budgets for services rendered are also not competitive.

As indicated in Annex H, in Europe programs vary by country and product type relating to funding through visible or non-visible fees. Of the seven separately funded EOL electronic product management programs (five countries, with two programs in each of the Netherlands and Norway), three have visible consumer fees (Switzerland, Belgium and the Netherlands - white and brown goods). These fees are collected at retail and remitted to the managing collective agencies.

Of the remaining four programs the industry collective charges its members directly based on market share, or in the case of Sweden, El-Kretsen (the industry collective) has a series of fees based on a variety of factors including a standard recycling fee, the real cost of collection and treatment of WEEE charged each month to producers based on market share, and fixed annual fees for some products. Funds are used to finance the various partners in the system.

The rationalization for these existing funding structures varies depending on whether visible fees are prohibited, what products are covered, and what costs industry is required to fund. Most collective agencies defend their existing funding mechanisms as the most appropriate system for their program. Agencies with non-visible fees charged directly based on true costs argue that the program has less administration and is therefore cheaper for industry.

This may explain why in some European jurisdictions where visible fees are not prohibited, industry has chosen to internalize the program costs based on existing market share. For example, in Norway and the Netherlands, El-Retur and ICT Milieu (respectively), represent the IT industry and charge their members non-visible fees based on market share.

Transitioning visible fees to non-visible fees is a concept that has been accepted by the European WEEE Directive. The Directive sets a visible fee phase-out by 2011 (over seven years) for most WEEE categories and by 2013 (over nine years) for large household appliances. The rationale for allowing visible fees for seven and nine years respectively, is to finance historic and orphan waste (these are discussed further in Section 5.3). It was deemed unfair and potentially untenable to burden small businesses with costs incurred for WEEE produced prior to the coming into effect of the WEEE Directive. Regulators can term these temporary fees as "historical waste charges" which may be optionally internalized immediately, or phased-out over time after which program funding will be internalized.

In the Netherlands for example, where two separate collectives exist, different fee structures for revenue collection have emerged. Manufacturers of "grey goods" (i.e. information technology products) have chosen to internalize their costs of managing existing, historical and orphan waste based on their current market share. ICT Milieu (their collective organization) receives the bill for processing and transportation that has already occurred and invoices stewards quarterly based on their current market share. Manufacturers of white and brown goods have, on the other hand, chosen to charge their customers a visible fee at the point of purchase for these products. These fees cover retail handling, transport and recycling.

4.3 Design for Reutilisation (DfRe) and Design for Toxics Reduction (DfTR)

CCME's third principle refers to design for environment. It reads:

> *3. Environmental and human health impacts are minimized throughout the product life-cycle, from design to end-of-life management.*

Addressing DfRe and DfTR in stewardship programs is relatively untried and untested. In Canada, the only example of provincially mandated DfRe exists in most regulations for beverage container packaging programs. These regulations prohibit non-recyclable packaging, or in the case of Prince Edward Island, non-refillable beer and soft-drink packaging.

The European Union is addressing DfTR for electric and electronic equipment, as described in Section 3. Specifically, the *Restriction of Hazardous Substances in Electrical and Electronic Equipment Directive (RoHS Directive*) restricts the use of lead, mercury, cadmium, hexavalent chromium and certain brominated flame retardants (polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs) in the manufacture of new electrical and electronic equipment as of July 1st, 2006. The Directive also contains a list of exemptions for some applications (where no current replacement for the restricted substance is available) and sets out a committee procedure for reviewing that list.

The RoHS Directive will mainly affect the manufacturers of electrical and electronic equipment, but it will also have an impact upon those who import these goods into the European Union, those who export to other Member States, and those who re-brand other manufacturers' equipment as their own and relevant parts of the manufacturing supply chain.

Canadian provinces could harmonise with the RoHS directive. Adopting these standards through regulation and in a harmonized manner with the European Union will alleviate a potential risk that some manufacturers would "dump" non-RoHS compliant products into Canada after July 1, 2006, the date the RoHS takes effect in Europe. California for example, has directed the California Integrated Waste Management Board to track the evolution of the RoHS directive and adopt regulations consistent with RoHS.

4.4 End-of-Life Management Guidelines

CCME's fourth, eleventh, and twelfth principles refer to end-of-life management of EOL electronic products. They read:

4. Management of e-waste is environmentally sound and consistent with the 4R waste management hierarchy:

- *a. Reduce, including reduction in toxicity and redesign of products for improved reusability or recyclability*
- *b. Reuse*
- *c. Recycle*
- *d. Recovery, of materials and/or energy from the mixed e-waste stream*

11. E-waste is managed in the most economically and logistically feasible manner, while striving to maximize local economic and social benefits.

12. E-waste is exported from Canada for recycling only at facilities with a documented commitment to environmentally sound management and fair labour practices.

All stakeholders agree that there needs to be a set of guidelines around how EOL electronic products should be managed. Guidelines should seek to realize a common set of performance, reporting and auditable standards and practices that are acceptable to both industry and government by ensuring a high benchmark of environmental responsibility. EPSC has developed Recycling Vendor Selection and Qualification Program Standards. These standards form the basis of guidelines developed for Alberta's EOL electronic products management program and can be considered as a basis for harmonizing aspects of provincial programs. Effective monitoring and tracking programs and credible penalties are centrally important to ensuring compliance with environmental standards.

4.5 Free and Easy Access for Recycling

CCME's fifth principle refers to the importance of offering consumers free and easy recycling. It reads:

5. Consumers have reasonable access to collection systems without charge.

Existing voluntary electronics management programs (excluding voluntary mobile phone, ink cartridge and battery programs) use back-end user fees to help offset manufacturers' recycling costs. Any form of a back-end fee charged to consumers for recycling serves as a disincentive for proper end-of-life management, especially where prohibitions on landfill disposal do not exist.

In Europe, the WEEE Directive calls for mandatory take-back to the distributor or seller on (in principle) a buy-one take-one back basis. Several countries mandate municipal responsibility for EOL electronic product. As a result, various schemes have been developed where collection sites include municipal depots, private depots, retail locations, repair centres, and special event days.

In California's EOL CRT management program, collection points are not prescribed but left to the market place to be determined using an economic collection incentive (about 20-cents/lb of material collected) as the primary driver. Unless otherwise prescribed, programs elsewhere generally maintain a variety of collection points based on the various characteristics of each country, region or city.

As stewardship policy evolves, so too may the options related to collection, which go beyond traditional municipal collection centres. In some cases for example, retailers have voluntarily extended their service to their customers to take-back waste products. For example, in Montreal, there are over 30 RONA stores

that offer a take-back service for old paint and paint cans. Only one Canadian Tire offers the same service and most other paint stores do not. As a customer buying new paint, the offer to take-back old paint is a value added service that differentiates RONA stores from all the others. The impact is so great that other paint retailers such as Coop Fédérée and Matériaux à Bas Prix have also stepped up their service by offering in-store take-back.

In western Canada, one of British Columbia's largest grocery chains - Save-on-Foods - invested in a highly automated, clean, and easy-to-use interface for the collection of empty beverage containers, other non-beverage packaging and other products such as old ink jet cartridges. Save-on-Foods' investment has paid off with increased market share and customer loyalty.

Several provinces have established depot systems at which a variety of materials are accepted for recycling. Similar to the return of recyclable materials to point-of-purchase locations, depots have been effective where they provide consumers with adequate levels of convenience for the return of their recyclable materials. This implies not only a sufficient number of depots to provide convenience to a population, but also that they be sited in locations that are convenient and easy for consumers to reach, such as in - or adjacent to - shopping areas.

Prescribing one type of collection system for a whole province may not be suitable in all cases based on the varying regional, rural and urban features. Allowing flexibility with the collection system provides program operators (stewards, steward collectives, governments or not-for-profit agencies) with the ability to keep program costs down by stimulating competition with the collection service providers, whether public or private.

4.6 Education and Awareness

CCME's sixth principle refers to the importance of education and awareness in a stewardship program. It reads:

> 6. *Education and awareness programs ensure that consumers, retailers and other stakeholders have sufficient information on program design and knowledge of their roles.*

While this principle seems straightforward, in terms of informing consumers what do with products at the end-of-life, it is often overlooked with retailers and stewards. This is especially true in Canada where collectives manage programs using visible fees.

As discussed in Section 5.3, when visible fees are implemented the economic impetus to striving for program efficiency is lost. Stewards, usually brandowners and retailers, no longer have an interest is working to make the programs more efficient through product or packaging, re-design or reformulation. Over time, affected stewards are less and less engaged in the program as their obligation (both financial and operational) is passed on.

Where fees are fully internalized by stewards, the collective agency still maintains a responsibility to regularly inform stewards on methods (in terms of design and materials usage, for example) that can assist in decreasing program costs and increasing overall program efficiency. This feedback is a critical component of promoting continuous improvement.

4.7 Provincial, Inter-Provincial, and Product Harmonization

CCME's seventh, eighth and ninth principles refer to the importance of provincial, inter-provincial and product harmonization. They read:

7. *Program design and implementation will strive for equity and consistency for consumers, particularly between those who live in adjacent jurisdictions and between those who live in small, rural and remote communities and large urban centres*

8. *Adjacent jurisdictions will strive for consistency in e-waste products collected.*

9 *Programs will include residential, commercial, historic and orphan products.*

Lack of provincial program harmonization can create economic dislocations, unnecessary transborder shipments of waste products and increased costs. For example, some Canadian provinces have deposit return programs for beverage containers where neighbouring provinces either do not, or have programs that offer lower refund levels. Each of these programs experience shipment of non-eligible materials into their program, and subsequently have to finance their management.

Known as "bootlegging", this practice also exists in programs where different fixed funding structures exist for used oil products, tires and paint. While it is difficult to find official documentation on these practices, most program operators within provinces that pay higher collection and processing funds than neighbouring jurisdictions report that this does occur, and will naturally take place when the programs are not harmonised.

From a stewards' perspective, complying with very different provincial programs can be unnecessarily onerous and costly.

4.8 Reporting – Performance Accountability

CCME's tenth principle refers to accountability. It reads:

10. *Programs will report on performance, specify objectives and targets, and be transparent in financial management.*

Most Canadian stewardship programs release annual reports, which provide financial management statements and their performance in terms of material collected. Less common, however, is reporting on the fate of materials in terms of reuse, recycling, energy recovery and residual waste to landfill. In addition, some programs are unable - or unwilling - to quantify the amount of material available to collect, and are thereby unable to provide data on the effectiveness of the program in actually recovering materials for reutilisation. In terms of EOL electronic products that are the focus of this document, this has been a particular issue with respect to rechargeable batteries and the Rechargeable Battery Recycling Corporation (RBRC).

Accountability information is essential in determining the success of a program and can easily be a requirement set out in regulation.

4.9 Stewardship Trends In Europe

As identified in Annex H, programs for the management of EOL electronic products have been developed in several European countries over the past decade. These programs have been developed at the national level in response to regulatory frameworks requiring EOL electronics product management initiatives by industry. The EU WEEE Directive requires EOL electronics management programs in all EU countries. Those countries that have pre-existing programs will be required to ensure their programs meet the

requirements set out in the WEEE Directive. In addition, the WEEE Directive has led to some companies reviewing existing national arrangements and proposing alternatives.

Western European countries like Netherlands, Belgium, Switzerland, Norway and Sweden all regulated WEEE take-back programs prior to the European WEEE directive. What resulted from these national schemes was the implementation of a variety of industry "collectives" tasked with meeting the regulatory objectives on behalf of the electronics industry.

Where national programs have been established prior to the WEEE Directive, industry has met its obligations through establishment of a "Producer Responsibility Organisation" (PRO) or other type of "collective". At the onset of the program in most jurisdictions only one collective (for a group of product types) might exist. For example, Recupel in manages the program on behalf of industry in Belgium, El Kretsen in Sweden and SWICO in Switzerland. In the Netherlands NVMP is the collective for white goods and brown goods, and ICT Milieu for grey goods. In each case, these collectives were established to manage EOL electronics shortly after countries mandated EPR programs for WEEE.

For the most part the "collective" is a symptom of a new responsibility – extended producer responsibility for electronic products. At the time the collectives were formed there were few resources and a narrow knowledge base on which to build a program in compliance with the law. The drive towards the collective is a logical industry response to meeting a new challenge: in an effort to reduce risk, industries align, pool their resources and expeditiously implement the regulated requirements. As programs become more established, however, administrative systems develop, and the collection and processing infrastructures mature. At the same time, the stability of the collectives has begun to erode as the competitive spirit of the private sector questions whether a function (currently undertaken by the collective) can be done more cheaply or more effectively by another agency, or by the individual business itself.

A first step in this evolution in the electronics sector in Europe has been the creation of the European Recycling Platform (ERP), founded by HP, Sony Europe, Braun and Electrolux late in 2002. The impetus for this initiative was the WEEE Directive, which would see national programs in 25 different countries. The founders of ERP were concerned with the significantly differing cost data from the existing national programs, and the administrative burden that will result from 25 separate European programs. The idea behind the ERP is to act as a central clearinghouse interface between national take-back systems.

The ERP partnership has a common view on key elements of managing EOL electronics . It believes in the importance of individual producer responsibility, the need for competition in the EOL electronic services market and a desire for market-based systems which reward design for environment. These characteristics are not prioritised in existing national programs, where collective responsibility for managing EOL products reduces competition, and establishes a disincentive to corporate responsibility for the environmental performance of products.

ERP's mission is to ensure a cost-effective implementation of the WEEE Directive and it expects to benefit from economies of scale and increased competition. ERP will develop and operate a common waste management procurement platform that spans the EU, and which will open up opportunities for pan-European recycling services and cross-border competition within the waste management service market. ERP is not a closed partnership, but invites other companies to join and further build its own economies of scale.

The ERP initiative will result in greater competition and innovation in terms of regulatory compliance in the marketplace. Individual national collectives will be forced to work more cooperatively with other national agencies and be more competitive with their tendering. This is already occurring, with the "WEEE Forum", a group of collectives that share information to gain insight of more effective and cost

efficient operations. Collectives will also be forced to benchmark best practices, be more transparent and gain efficiencies within their own administrative system.

The critical element to efficient and effective industry programs for management of EOL electronics is the creation of competitive frameworks that allow for individual producer responsibility or multiple collectives/partnerships. In this way, companies can establish EOL product management programs in ways that are flexible and adaptable over time, and in which the environmental performance of products can become part of the competitive basis for product development and marketing. Many Canadian extended producer responsibility regulations are flawed in this respect, in that they prescribe one specific management agency, and prescribe an established collection infrastructure. These programs incorporate fixed funding of EOL product management services and regulated handling fees. The consequences of delinking EOL product management costs in this way are discussed further in Section 5.3.

5.0 CURRENT MANAGEMENT PRACTICE AND OPTIONS/ISSUES FOR ENHANCED EOL PRODUCT MANAGEMENT

The Government of Canada and the provinces and territories have clearly signalled through the C-WPEPS their intent that existing management practices for EOL electronics should be improved. The issue, therefore, is to determine what improvements are feasible, and how they can be achieved.

As presented in Section 3, EOL electronic products may be managed in the following ways:

- *Reduction*. This involves the generation of a reduced amount of EOL electronic products, or a reduction in the environmental burden of EOL electronic products when they are generated.
- *Reuse*. This involves the reutilisation of EOL electronic products after they have completed a first or subsequent life; i.e. after they have been discarded by a user of the product.
- *Recycling*. This involves the reutilisation of materials used in electronic products in the manufacture of new products.
- *Disposal.* This involves the final disposition of EOL electronic products, either through direct disposal or following treatment such as incineration.

This section assesses options and issues for enhanced management of EOL electronic products in Canada.

5.1 Current Management Practice

Figure 5 illustrates the current management practice (CMP) for EOL electronic products that are the focus of this document for 2005 under the assumption that the status quo for mid 2004 is applied to 2005.[49] The CMP is characterised by the following:

- An estimated 289,801 tonnes of electronic products that are the subject of this document will reach the end of their first life in 2005. Of this amount, 165,683 tonnes (the amount reported in Table 2) will require management through either recycling or disposal.[50]
- Discard direct to disposal is the fate of the largest amount (almost 149,165 tonnes) of the EOL electronic products considered in this document.
- The quantity of EOL electronics entering a recycling system under the CMP will be 16,518 tonnes. The amount actually recycled is 4,641 tonnes less than this as a result of materials that enter the recycling stream, but which are rejected; un-recycled plastics is the largest contributor to this amount.
- Over 100,000 tonnes of EOL electronics will be managed by the existing reuse infrastructure described in Section 3. Of this amount, approximately 40 percent is projected to come from information technology equipment (i.e. computers, printers and peripherals) of which over 90 percent will be generated by the IC&I sector. Approximately 59 percent of the CMP reuse estimate is accounted for by TVs, of which over 90[51] percent are estimated to be generated by the household sector. The balance of the 2005 CMP illustrated in Figure 5 will be from reuse of stereo equipment, mostly from the household sector. Ultimately, reused products will be discarded to a recycle or disposal stream for "final" management.

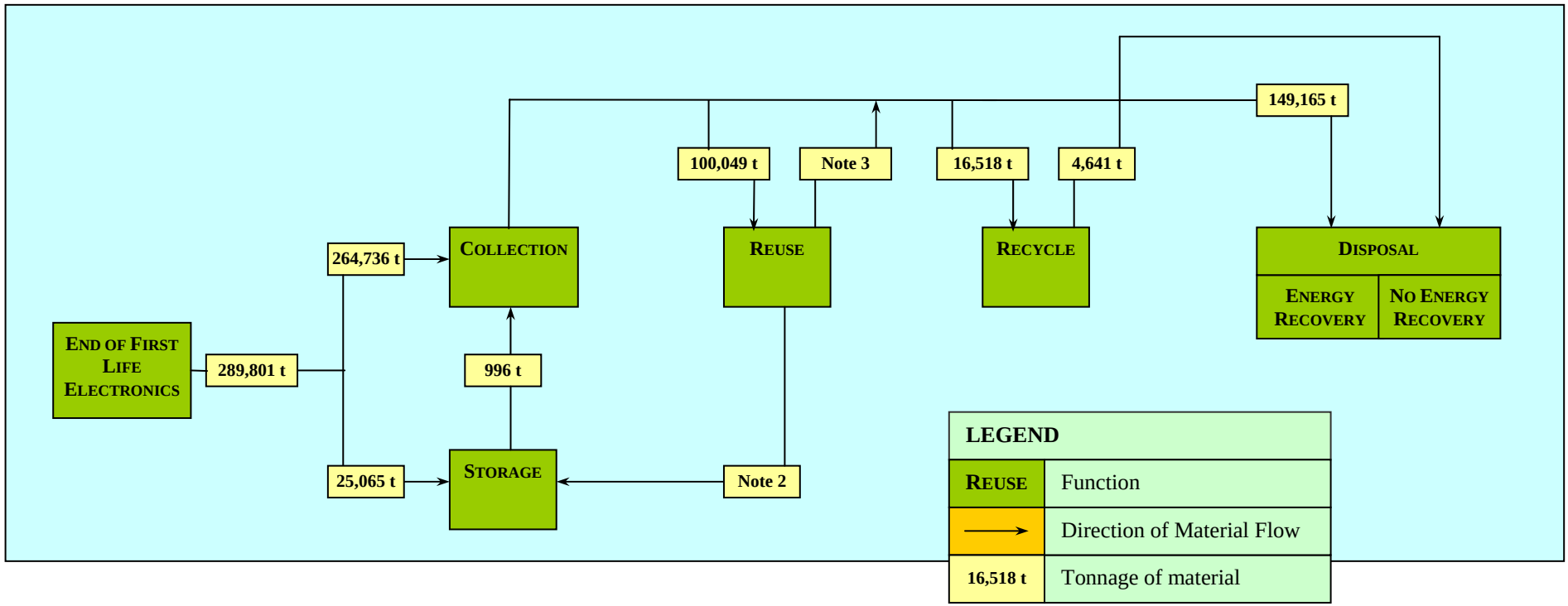
[49] This assumption is useful for analytical purposes. However, it is recognised that the reality of 2005 EOL electronic product management will be a function of actions that may be taken between mid 2004 and the end of 2005. At the time of preparation of this document, the introduction of an EOL electronics management program by the Government of Alberta in that province in October 2004 is particularly relevant in this context and will impact the CMP that is presented.

[50] RIS International Ltd., Five Winds International and Electro-Federation Canada, *Baseline Study of End-of-Life Electrical and Electronic Equipment in Canada*, Environment Canada, Hull, 2003.

RIS International Ltd., Information Technology (IT) and Telecommunication (Telecom) Waste In Canada - 2003 Update, Environment Canada, Hull, 2003.

[51] Ibid.

Figure 5
Base Case Materials Flows: 2005 (Estimated tonnes)[1]



Notes:

1. Anticipated materials flows under mid-2004 status quo scenario applied to 2005.
2. EOL electronics going to storage after second life; quantity included in quantity of EOL electronics going to storage after first life.
3. Includes discards to recycle and disposal from second and subsequent lives; quantity discarded from reuse to recycle/disposal not known.

Sources

RIS International Ltd., Five Winds International Ltd., Electro-Federation Canada Ltd., *Baseline Study of End-of-Life Electrical and Electronic Equipment in Canada*, Environment Canada, Hull, 2003

RIS International Ltd.,. *Information Technology (IT) and Telecommunication (Telecom) Waste in Canada - 2003 Update*, Environment Canada, Hull, 2003

Confidential industry information/data compiled in the course of preparing this document, June - September 2004.

- Significant quantities (approximately 25,000 tonnes) of EOL electronics are estimated to be placed in storage in the 2005 CMP scenario, and this amount is marginally offset by materials leaving storage for collection. Ultimately, EOL electronic products placed in storage will be discarded to a recycle or disposal stream for "final" management, although some may be reused first. Until separate collection systems are established, however, it is likely that the amounts of material leaving storage will continue to be small.

The CMP scenario has arisen in the context of industry and consumer actions that have stimulated the rapid development and implementation of technology in the absence of effective considerations of how that technology can or should be managed at the end of its life. Future EOL management of electronic products under the CMP scenario is underlain by both a continuation of this situation and a continuing absence of market or other forces to elicit substantive change in the way in which EOL electronic products are managed. Accordingly, the future under the CMP scenario will be characterized by:

- Continuing reuse of electronic products (particularly those generated in the IC&I sector) that have completed a first life, or, in some cases, subsequent lives. However, as technology continues to achieve more efficient electronic products, and particularly as technology convergence occurs among what are traditionally distinct products, it is not clear that reuse will play as important a role in the future as it does currently.
- Continuing low levels of recycling. Market-driven recycling of EOL electronic products is driven by the desire of companies to physically destroy equipment that may hold confidential information, "green" their image and, to a lesser degree, by the value of the materials in EOL electronic products. As OEMs reduce the quantities of high value materials in their products, so the financial attractiveness of recycling in the open market place will decline, and recycling levels are also likely to decline. Already, the market value of recyclable materials contained in electronic products is far below the cost of recycling those products.
- In the absence of recycling infrastructure, the current high level of reliance on disposal will continue.

5.2 Options and Issues For Enhanced Management Of EOL Electronic Products

There are three dimensions to considering options for enhanced management of EOL electronic products.

- *Strategies* Four strategies are possible: reduction, reuse, recycling and disposal (including recovery).
- *Components* Design and implementation of a strategy requires consideration of management components. In the context of strategies for enhanced management of EOL electronics, the management components associated with any strategy include one or more of product design, collection, transportation, processing and markets. For each of these there are implementation options, and for each option there are opportunities and constraints that may influence whether and how an option can be effectively implemented.
- *External Factors* External factors act on the components of a management system and impact the effectiveness of a component. Legal and institutional frameworks, public education/awareness actions, and financial considerations can all have a profound impact on the effectiveness of a management component, and can be decisive in the feasibility of any particular option.

For each strategy, the analysis in this section therefore considers the components that are inherent to each management strategy, together with the role that external factors can play in maximising the effectiveness of each component and, therefore, the strategy as a whole.

5.2.1 Options/Issues for Reduction

Options for "reduction" focus on actions that reduce either the quantity of discarded EOL electronics and/or the toxic materials that EOL electronics contain. Table 14 identifies options for "reduction". Key points identified in the table include:

Table 14
Options for Reduction
Objective: Reduce the quantity of EOL electronics and reduce the use of materials that are harmful to human health and the environment in the manufacture of electronic products

Management Component	Options	Opportunities/ Constraints to Implementation	External Factors To Facilitate Implementation Of Options		
			Legal/Institutional Frameworks	Public Education and Awareness	Financial Considerations
Design	Lengthen functionality period of electronic products	Rapid innovation is decreasing functionality period	Design criteria/ benchmarks could address environmental design issues	Increased awareness of "reduction" objectives and rationale by electronic product designers can facilitate achieving "reduction" objectives	Market mechanisms to link financial benefit to producers with products that met DfRe and DfTR objectives
	Restrict/phase out use of substances of concern	EU RoHS initiative driving global substance phase out	Failure to legally adopt RoHS requirements may result in local dumping of non-RoHS compliant products		Financial implications of RoHS largely absorbed by OEMs
	Manage health and environmental risks of substances of concern	Strict management criteria can encourage voluntary phase out of substances of concern	Management criteria can be included in legal frameworks for maximum impact		
Collection	←		Not Applicable	→	
Transportation	←		Not Applicable	→	
Processing	←		Not Applicable	→	
Markets	Promote "green" electronic products/materials	Consumers likely to choose "green" products where price and performance are equivalent Increased recyclability of some materials (e.g. plastics)	Legal frameworks can favour products/ materials that meet "reduction" objectives	Public education in support of longer product life times and reduced use of substances of concern is important to raise awareness, but unlikely to achieve "reduction" objectives by itself	Where "green" products/materials incur additional cost, level financial playing field required to attract consumer support

- Products could be designed to last longer, and so require less frequent replacement.
- Marketing of "greener" products could result in consumers choosing longer lasting or more environmentally desirable products.
- The EU RoHS directive has spurred innovation and is changing the global electronics market environment. The issue of application of the requirements of the RoHS Directive in Canada is no longer one of determining if costs to industry are balanced by benefits, but of maintaining a modern market environment.

5.2.2 Options/Issues For Reuse

Table 15 identifies options for "reuse" of EOL electronics. As indicated elsewhere in this document, reuse refers to the reutilisation of electronic products following their discard by a user at the end of a first or subsequent life. As shown in Figure 5, considerable quantities of EOL electronic products enter reuse management already. A percentage of the products that enter reuse, however, are rejected either because the product is unsuitable for reuse or because components do not have reuse value. Computers for Schools, for example, required a throughput of 146,000 computers to achieve the refurbishment of 86,000 computers in 2003.

Table 15
Options for Reuse

Objective: To maximize the extent to which electronic products and their components are reutilised

Management Component	Options	Opportunities/ Constraints to Implementation	External Factors To Facilitate Implementation Of Options		
			Legal/Institutional Frameworks	Public Education and Awareness	Financial Considerations
Design	Develop design criteria to maximise ease of disassembly	DfRe opportunities are significant DfRe seldom a design priority	Legal frameworks can encourage or require application of DfRe	Professional awareness and information exchange can encourage design innovation to facilitate reuse	Link DfRe to profit opportunity and/or regulatory requirement
Collection	Introduction of expanded collection systems in which EOL products are handled as new products	Absence of public sector EOL electronic collection infrastructure for reuse presents opportunity for its creation Asset managers have established collection systems for the richest EOL electronic product streams that limits impact of new initiatives	EOL electronic products can be banned from disposal Legal frameworks can establish collection systems compatible with reuse objectives	Communication of availability of infrastructure for collecting EOL electronics for reuse (and criteria for its use)can attract EOL electronic products with high reuse potential	Costs for reverse logistics systems (including collection, transportation and processing) to be included in cost structures for EOL electronics management at brand level
Transportation	Packaging and transport of EOL products as for new products Introduction of mechanisms to ensure that EOL electronic products are received only be approved facilities	Transportation can be organised based on "reverse distribution" concept, or on an "as needed" basis National and international shipments of EOL electronics are unregulated.	Tracking systems can be introduced to ensure that EOL electronics are delivered to appropriate processors nationally and internationally	Training in EOL electronics handling, packaging and transportation will ensure effective transportation for reuse	
Processing	Introduction of systems to identify EOL products with high reuse potential Creation of enhanced disassembly capacity	Initial network of facilities that process for reuse established; processing technology demonstrated Electronic scanning of devices combined with visual inspection can rapidly identify EOL products with high reuse potential Labour-intensive disassembly can result in high cost Regulatory requirements for processing EOL electronics vary across Canada, and within provinces	Occupational health and safety, and other legislation, already in place to regulate processing for reuse Harmonised regulatory frameworks will support "level playing field" for industry actions Establish legal basis for industry-developed Vendor Qualification Standard	Training in disassembly and processing for reuse can create a new and professional workforce	
Markets	Identification of domestic markets for "pre-owned" electronics Identification of international markets for "pre-owned" electronics	Markets for "pre-owned" electronics and components established in Canada and internationally Market opportunities extend largely to IT equipment.	Creation of consumer standards for EOL electronics in second and subsequent lives	Marketing of "pre-owned" electronics can create rising demand for pre-owned electronic products	"Pre-owned" electronics products sell at a discount to new products. Major opportunities for, in particular, export of high quality "pre-owned" IT equipment Extensive markets for IT equipment components.

Establishment of reuse systems requires the design and implementation of "reverse logistics systems" (RLS). These are already in place in some contexts; for example, computers returned to OEM's through lease return systems. Some companies have extended this concept to a broader consumer application. In North America, Black and Decker implements a refurbishment program with respect to electronic products returned by consumers. In Europe, Xerox has implemented a RLS program framed around the categorization of returned products according to numeric grades, as follows:

Category 1	"Dust off" product and repair of product
Category 2 and 3	Product in good condition, suitable for either "remanufacture" or "parts remanufacture"
Category 4	Product not suitable for reuse and to be recycled to extent feasible

Of 116,308 units managed in 2003, 2 percent were repaired, 7 percent remanufactured, 12 percent stripped for parts and 79 percent sent for materials recycling/disposal.[52]

Options for collection, transportation and processing of EOL electronics for reuse should consider that:

- Asset managers and others have established collection, transportation and processing infrastructure for recovering high value EOL electronic products (primarily computers and related equipment) for reuse; these are sourced from large IC&I facilities.
- The potential for reusing EOL electronic products from the household sector is low. Products from this sector are generally older that those from the IC&I sector, and may not be sellable at any price. Estimates suggest that less than 5 percent of EOL household computers have reuse value, for example.[53]
- RLS need to provide handling of EOL products destined for reuse as if the products were new in order to ensure that the products are not damaged.

Annex H identifies opportunities for reuse according to the products considered in this document.

Financial frameworks in support of enhanced levels of EOL electronic product reuse should provide that:

- In accordance with the C-WPEPS, collection of reusable EOL electronics incurs no cost to consumers
- Costs associated with reuse are internalised within the cost of the product to the consumer.
- Individual companies benefit financially from the environmental performance of their products.

Financial considerations are addressed in conjunction with "recycling", see Table 16.

5.2.3 Options/Issues For Recycling

Table 16 identifies options for "recycling" of EOL electronics. As indicated elsewhere in this document, recycling refers to the reutilisation of materials used in electronic products following their discard by a user. As shown in Figure 5, an estimated 16,518 tonnes of EOL electronics material enters a recycling process under the CMP, and of this 4,641 tonnes (28 percent) is rejected and is disposed of.

Enhanced recycling of EOL electronics will be facilitated by:

- Incorporating recyclability considerations in the design of electronic products
- Using recyclable materials in the manufacture of new electronic products.

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[52] Rahman, S., *Reverse Logistics*, Institute of Transport Studies, School of Business, University of Sydney: Presentation to Logistics Association of Australia, April 2004.
www.laa.asn.au/_data/page/210/PresentationApr04.pdf

[53] Industry estimates obtained June - November 2004.

Table 16
Options for Recycling

Objective: For EOL electronic products where reuse is not undertaken, to maximize the extent to which materials used in electronic products are reutilised

Management Component	Options	Opportunities/ Constraints to Implementation	External Factors To Facilitate Implementation Of Options		
			Legal/Institutional Frameworks	Public Education and Awareness	Financial Considerations
Design	Develop design criteria to maximise ease materials identification and separation Include recyclability of materials in design of new products	DfRe opportunities are significant DfRe seldom a design priority	Legal frameworks can encourage or require application of DfRe	Professional awareness and information exchange can encourage design innovation to facilitate recycling	Link DfRe to profit opportunity and/or regulatory requirements
Collection	Introduction of expanded collection systems in which EOL products are separately recovered for recycling Collection should be convenient and at no cost to consumers	Absence in most of Canada of public sector EOL electronic collection infrastructure for recycling presents opportunity for its creation.	EOL electronic products can be banned from disposal Legal frameworks can establish collection systems compatible with recycling objectives	Communication of availability of infrastructure for collecting EOL electronics for recycling can attract high levels of public participation	s Costs for reverse logistics systems (including collection, transportation and processing) to be included in cost structures for EOL electronics management at rand level
Transportation	Introduction of transportation systems to processing centres. Introduction of mechanisms to ensure that EOL electronic products are received only be approved facilities	National and international shipments of EOL electronics are unregulated.	Tracking systems can be introduced to ensure that EOL electronics are delivered to appropriate processors nationally and internationally	Training in EOL electronics handling, packaging and transportation will ensure effective transportation for recycling	
Processing	Maximise use of existing recycling capacity Invest in enhanced recycling capacity Focus on EOL products of highest environmental concern	Initial network of facilities that process for recycling established; processing technology demonstrated Regulatory requirements for processing EOL electronics vary across Canada, and within provinces	Occupational health and safety, and other legislation, already in place to regulate processing for reuse Harmonised regulatory frameworks will support "level playing field" for industry actions Establish legal basis for industry-developed Vendor Qualification Standard	Training in processing for recycling can create a new and professional workforce	
Markets	Establish targets for use of recycled materials in new products Include recyclable market considerations in design of new electronic products	Markets for recyclable materials that meet secondary materials specifications are well-established. Major opportunities for recycling plastics	Legal frameworks can establish minimum content requirements for use of secondary materials in electronic products	Information clearing house can ensure wide distribution of knowledge regarding available markets	Financial frameworks should take account of global markets/market prices for secondary materials

5.2.4 Disposal

As shown in Figure 5, an estimated 149,165 tonnes of EOL electronics are disposed under the CMP.

Enhanced management of EOL electronic wastes consistent with the C-WPEPS requires strategies that move EOL electronic products and materials out of disposal strategies through application of reduction, reuse and recycling strategies (C-WPEPS Principle 4). Four options are available for disposal of remaining EOL electronics after the implementation of options identified above:

- *Status Quo* Under this option, EOL electronic products that were not reused or recycled would continue to be disposed of under existing regulatory frameworks.

- *Implement Discriminatory Disposal Fees* The concept of discriminatory disposal fees has been widely used by municipalities in Canada to discourage the use of municipal landfills for the disposal of materials that may legally be disposed of in those landfills but which are either unwelcome (e.g. because of their bulkiness) or because they are recyclable or compostable.

  Discriminatory disposal fees could be applied on the disposal of EOL electronic products as a mechanism to encourage recycling. Discriminatory disposal fees would need to be at a similar level to, or greater than, the cost of alternative management options to serve as an effective deterrent to disposal. This approach could be readily applied at public sector disposal sites. However, its effective application would also require its extension to the private sector, which is a major avenue for the disposal of EOL electronic waste, primarily through the incineration of materials included in feedstock from which metals are extracted for recycling.

- *Apply Hazardous Waste/Waste Dangerous Goods (HW/WDG) Criteria* HW/WDG are defined, among other ways, according to criteria concerning the amount of potentially toxic material that may be released by the waste. Methodologies for testing wastes to determine whether these criteria are met are set out in legal frameworks. As identified in Section 3, tests have shown that at least several types of EOL electronic products meet hazardous waste criteria. This has resulted in some EOL electronic products (notably CRTs) being banned from disposal in municipal landfills in some US jurisdictions, but similar actions have not yet been taken in Canada.

  Disposal of EOL electronic products that meet criteria as hazardous wastes would both raise the cost of their management and provide a powerful message to both consumers and industry regarding the potential environmental impact of the products. The primary cause of EOL electronic products meeting hazardous waste criteria has to do with the rate at which metals leach from the products under prescribed test conditions. Over time, some EOL products that currently meet hazardous waste criteria will cease to do so as the amounts of these metals in the product are reduced, either through efficiency measures taken by the industry or as a consequence of the implementation of the RoHS Directive in the EU and similar initiatives elsewhere (e.g. California).

- *Ban EOL Electronics from Disposal*. Some jurisdictions have banned materials from disposal where recycling opportunities exist. The effect of this type of action is to drive materials into recycling infrastructures, thereby ensuring maximum levels of recycling and the operation of recycling infrastructures at maximum levels of efficiency.

  As indicated in Section 3, the identification that an EOL electronic product is "recyclable" does not necessarily mean that it is currently feasible to recycle all materials in the product. Implementation of bans on the disposal of EOL electronics would therefore need to distinguish between recyclable and non-recyclable materials, and would need updating over time as non-recyclable materials became recyclable. Bans on disposal can play an important role in creating the transition from what it is technically possible to recycle/reuse to what is commercially feasible. Bans on disposal have the effect of ensuring minimum levels of supply of materials, and also achieve closure of lower cost (but environmentally less preferred) disposal options, thereby creating conditions in which private sector investment becomes viable if such

investment was not previously viable as a consequence of materials being sent to lower cost disposal facilities.

From the perspective of achieving sustainable development objectives and maximising environmental benefits, disposal should be considered a measure of last resort. Accordingly, materials for which recycling or reuse opportunities exist can, at a minimum, be banned from disposal facilities where no recovery of value takes place. Likewise, EOL electronics products that meet criteria for management as hazardous waste should be managed as such, since the environmental consequences of hazardous wastes depend on the nature of the material and not on where it was generated or whether or not it was a product.

5.3 Options For Paying For EOL Electronic Product Management

The way in which costs are allocated has important implications for industry, consumers and the future management of EOL electronics. Clarity can be brought to this issue by establishing principles that any financing and cost recovery framework should meet. The following are relevant:

- *Costs should be internalised in the price of the product.* Internalising costs ensures that those who benefit from a product should pay the full costs associated with that product. Internalising costs provides a direct incentive to producers to improve performance within existing regulatory frameworks and cost structures.
- *Competition should prevail*. Competition leads to innovation. This applies equally to the environmental performance of electronic products as it does to other aspects of electronic product performance. Those who compete most effectively in the environmental domain should receive commensurate benefits.
- *Within any cost recovery framework, free-riders should be addressed.* Free-riders are those who benefit from a management system, but who do not contribute to the costs of that system. Stakeholders that do not respect cost allocations for management systems place unreasonable financial burdens on others and may threaten the viability of the management system.
- *Financing historic problems may require special considerations*. As identified in Figure 5, significant quantities of EOL electronics are believed to be in storage. Clearly, the costs of managing these products cannot be internalised in the cost of the product, and it is too late for competition to impact how these products are managed. A transitional mechanism may therefore be required through which to address historic problems.

In addition, the C-WPEPS identify that “producers of electrical and electronic products are responsible for their products at end-of-life” (C-WPEPS Preamble, and also reflected in Principle 1), and that “costs of program management are not borne by general taxpayers” (Principle 2), and that “consumers have reasonable access to collection systems without charge”. Principle 11 identifies that local economic and social benefits should be maximised within the context of economic and logistical feasibility.

There are, in principal, three options for who should pay the costs of enhanced management of EOL electronic products: the consumer, government and industry. Table 17 evaluates these options against the above criteria, and integrates this technical evaluation with relevant Principles in the C-WPEPS.

The “Overall Evaluation” identifies several advantages of Industry Fees (“Producers Pay”) over other options:

- Competition is promoted, since products with lower EOL costs will result in benefits for the brand owner.
- Environmentally preferred products will be developed over time as a result of competition.
- Overall EOL management costs will be driven down by competition and the appearance in the market of products that are environmentally preferred.

Attaining these benefits is a function not simply of “producers pay”, but the way in which producers pay. There are two issues:

- Internalising the costs of management of EOL electronics.
- Whether fees to cover the costs of EOL electronics management should be "visible" or "non-visible".

The benefits identified above associated with the "producers pay" option requires that industry is able to internalise the costs of EOL management of electronics products. This does not imply an absence of cost to the consumer. Instead, it means that industry pays costs that it then passes on to the consumer. The benefits identified above arise because of the way in which industry accounts for its costs under a cost internalisation model as compared to the way industry accounts for its costs through the other mechanisms identified in Table 17.

The internalisation of costs associated with EOL management of electronic products requires that producers/importers are able to isolate the EOL management costs associated with their specific brands. If the costs associated with EOL electronic products are not isolated in this way, producers cannot properly incorporate the EOL costs of their brands into the costs of those brands. The consequence of failing to isolate costs is therefore that any effort to internalize EOL management costs into the cost structure of a brand results in incorporation of costs incurred in the EOL management of other competing brands. The effect is to discourage competition among brand owners and to discourage improved environmental performance of products:

- *Competition* is discouraged because brand owners that either have invested, or might in future invest, in products that carry improved EOL management characteristics (e.g. lower costs for meeting environmental objectives) will not see an adequate return on their investment. The benefits (e.g. financial returns) of lower cost EOL management that these brand owners seek with improved environmental performance are diluted by the higher costs of EOL management of competitors' products. Worse, competing brand owners who have not invested in improved EOL management characteristics will benefit from the efforts of their competitors whose products have improved environmental management characteristics and which lower the overall costs of EOL management across the entire product category. Under this scenario, the best interests of individual brand owners are served by doing nothing: they will receive little benefit for their investment, and what benefits they receive will also be received by their competitors, who will not have made similar investments.

- *Improved environmental performance* is discouraged as a consequence of lack of competition. Since brand owners cannot, under aggregated cost accounting systems, obtain financial returns commensurate with their investment in the EOL performance of their products they will simply seek to meet regulatory requirements within the context of their existing business models – which externalize EOL management costs. But the continued externalization of costs from producer-specific brands to a collective-product category will continue to discourage improved environmental product performance for the same reasons as identified above: those who invest in improved product performance do not have the opportunity to receive commensurate return from their investment, while competitors who have not made similar investments also share in any resulting cost reductions. This approach is therefore not conducive to meeting C-WPEPS Principle 4.

Achieving the benefits of cost internalisation therefore requires tracking the cost of EOL electronic products management by brand, at a minimum. Where the costs of EOL management of individual brands can be identified, costs can be internalised by the brand owner and the benefits identified above will be achieved. However, the industry in Canada is not currently structured to be able to track EOL product management costs on this basis, although it has moved in this direction in other countries (e.g. Japan). Isolating the EOL management costs of different brands therefore presents a series of practical management issues to the electronics industry.

The first issue is to determine where in the EOL product management chain the costs of managing one brand should be isolated from the costs of managing other brands. For reasons identified in Section 3, the

Table 17
Paying for Enhanced Management of EOL Products: Evaluation Matrix

COST RECOVERY DESIGN CRITERION	EVALUATION OF STAKEHOLDER FEE OPTIONS TO MEET DESIGN CRITERION		
	ADVANCE DISPOSAL FEES ("CONSUMER PAYS")	PAYMENT FROM TAX REVENUES ("GOVERNMENT PAYS")	INDUSTRY FEES ("PRODUCERS PAY")
Costs should be internalised in the price of the product	"Advance disposal fees" may be paid by consumers. These are typically visible fees that cannot be easily adjusted to reflect management costs of specific products Advance disposal fees recognise the cost of management of EOL products, but tend to discourage improved environmental performance of products and establish artificial EOL management costs	Government payment of externalised environmental costs removes financial incentives for improved product performance and is inconsistent with internalisation of costs.	Industry is best placed to precisely determine the environmental cost of compliance with regulatory requirements and responds to the opportunity to improve aspects of product performance when there is financial benefit to be gained
Competition should prevail	Separate consumer fees for managing EOL electronic products delink environmental performance from the basket of performance attributes associated with products, and reduce competition to enhance environmental performance	Tax-based mechanisms for paying for enhanced environmental product performance removes competition. However, tax mechanisms can be effectively used to stimulate or reward environmentally-preferred behaviour where market forces are insufficient to drive change	Costs attributable to specific products will drive change to reduce those costs while maintaining or enhancing performance.
Within any cost recovery framework, free-riders should be addressed.	Advance disposal fees paid at the point of purchase within a jurisdiction eliminate free riders since every sale is accompanied by application of the advance disposal fee. However, advance disposal fees on internet sales may result in variable collection of the fees	Free-riders are associated with tax-based mechanisms for enhanced management of EOL electronic products to the extent that individuals avoid paying taxes they are responsible for.	Industry free-riders may try to gain financial advantage by not paying their allocation of industry fees for enhanced management of EOL electronic products, particularly with respect to internet sales. Government regulation/enforcement and industry compliance actions can address industry free-riders
Financing historic problems may require special considerations	Consumer fees to address historic problems may be viewed as arbitrary. Those paying the fees may not have benefited from products now considered a "historic problem".	Taxes may fund the correction of "historic problems" to the extent that these problems have resulted in a change in social expectations/requirements rather than "fault" on the part of individual consumers or industry.	Industry fees may fund the correction of "historic problems" to the extent that these problems have resulted from industry failure to address the consequences of its products on the environment rather than a change in social expectations/ requirements on the part of consumers or government.
Relevant C-WPEPS Principles	Consumers have reasonable access to collection systems without charge (Principle 5)	Costs of program management are not borne by general taxpayers (Principle 2)	Responsibilities associated with management of e-waste are primarily borne by producers of the products, where "producer(s) " means the manufacturer, brand owner or first importer of the product who sells or offers for sale the product in each jurisdiction (Principle 1)
Overall Evaluation	Direct consumer fees may be easily collected and remitted and provide dedicated funds for managing EOL electronic products. However, they do not internalise environmental costs in the price of a product, do not promote competition to improve environmental performance, and artificially establish EOL management costs. As such, they are likely to promote the environmental status quo in products and unnecessarily high EOL management costs	Tax-based mechanisms may be useful in stimulating environmental improvement in products and product management where market forces are insufficient. Although they do not internalise costs, they may promote competition. The use of general tax revenues to manage EOL products has failed to provide adequate management systems, does not internalise cost and does not promote competition, but may be appropriate to finance correction of historic problems	Industry fees for new management frameworks can be designed to internalise cost and promote competition, both of which will act to drive down the costs of EOL management frameworks over time. Although these costs will be passed onto the consumer, the costs involved will be reduced over time as compared to other cost recovery options and EOL management options will be enhanced. Industry fees may be appropriate to finance correction of historic problems

preferred collection mechanism is for the EOL electronics that are the subject of this document to be brought by consumers to a collection point. EOL electronic brands – and the costs for their management - might therefore be tracked from the point of collection:

- Tracking of brands – and their related EOL management costs - at the point of collection would require the first receiver of EOL electronic products to identify different brands (and, possibly, different models within a brand) in order that each brand (and, possibly different brand models) can be tracked through the EOL product management chain. The EOL management costs associated with each brand can then be tracked by the brand owner from the point of collection, and costs can be incorporated into product pricing. If brands were returned to a retailer dealing in a company's products, tracking by brand would be straightforward since the range of brands returned to a retailer would be limited to only the brands carried by the retailer. If brands were returned to some other form of collection point that received all brands, tracking by brand would be required within the collection point.

Alternatively, if the costs of collection and transport for multiple brands is similar, there may be no advantages to tracking costs at the point of collection. Tracking by brand may therefore be undertaken at a later point in the EOL management chain, such as the point of reutilisation[54].

- Tracking of brands – and their related EOL management costs - at the point of reprocessing provides for all brands to be aggregated for upstream collection and transportation. Where the overall management system results in collection/transportation cost differences between brands, then isolating EOL management costs between brands from the point of processing for reutilisation will fail to capture the benefits of one product over another with respect to collection/transportation. The extent to which this has practical consequences depends on the extent to which different brands might incur different handling and transportation costs. However, tracking of brands at the point of processing provides for the costs of EOL management to be tracked by brand owners from that point on.

From the perspective of maximising the environmental performance of electronic products, it would be desirable for tracking to be undertaken as early in the EOL product management chain as possible. This maximises the extent to which brand owners are accountable for the EOL management costs associated with their products.

In order for the tracking of EOL management costs to be implemented, techniques are required to ensure that EOL electronic product brands are tracked at each step of the EOL management process. At least two technologies are available that could provide for this to be undertaken: (i) scannable bar codes; and (ii) installation of a chip that would allow tracking. Some EOL electronic products returned for reutilisation in Japan are tracked to the point that generators of individual pieces of EOL electronics product are able to follow where in the EOL handling and management system their specific piece of equipment is. At each step of the handling and management process the EOL product is electronically registered as having been received until the product is finally processed. In other sectors in Canada, tracking systems are used for tracking movements of hazardous waste and for tracking items shipped by courier. While the specifics of a tracking system associated with EOL electronic products would evidently vary as compared with these types of tracking system, the principles would be similar and these models could be adapted to the EOL electronic products context.

The remaining logistical question related to establishing an infrastructure through which electronic products could be tracked in order to isolate the costs associated with their management is who the collection agents should be. Appropriate agents should satisfy the following criteria:

[54] There may also be intermediate points between the point of collection and processing for reutlisation at which brands and associated costs would be segregated, such as transfer depots where similar brands from a wide geographic area are bulked into large loads for transportation to a processor.

- Agents should provide ease of access for those generating EOL electronic products (i.e. the consumer).
- Agents should be existing entities, if possible, in order to reduce costs that would otherwise be incurred through establishing a parallel structure.
- Agents through whom administrative simplicity can be achieved would be preferred.

A number of agents are possible that meet these criteria:

- Retail stores. Stores that sell electronic brands can be responsible for receiving either: (i) all brands of a particular product category (and for segregating different brands within the product categories); or (ii) only EOL products of the producers whose brands they sell.
- Drop-off facilities. Several provinces have already established networks for the receipt of reusable or recyclable EOL products. The scope of these facilities can be extended to EOL electronics and brands can be segregated as they are received by the facility.
- Municipal facilities, including landfills and transfer stations. These may not always be conducive to ease of access by consumers of electronics products to the extent that reaching these facilities requires a dedicated trip by the consumer to a place they would not normally go.

Following collection, EOL products can be transported for processing to facilities that best meet the requirements of the brand owner.

The following conclusions are drawn from the above analysis:

- There are benefits associated with "producer pay" mechanisms for financing EOL electronics product management that cannot be achieved with other mechanisms for financing EOL electronics product management. These benefits include promotion of competition among producers, development of environmentally-improved electronic products by producers, progressively lower EOL management costs charged by entities in the EOL product management chain, and lower costs to the consumer over time.
- Attaining these benefits requires that brand owners are able to internalise the EOL management costs of their product brands. "Producer pay" frameworks that do not provide for internalisation of costs will not achieve the above benefits.
- Internalising the costs of product brands requires that EOL electronics are segregated and subsequently managed according to brand in order that producers can internalise brand-specific costs.

As identified in Section 4, many programs to provide for the management of EOL electronic and other products are structured around collectives. These collectives are established in different ways and with differing levels of legislative support. However, their functions are similar: to remove products from waste disposal streams and direct these products to reutilisation streams.

Typically, industry sectors that have established a collective to address EOL management of their products have accepted the principle that as producers they also have a responsibility for addressing the end-of-life management of their products. Two approaches have most commonly been taken to financing the activities of collectives established for this purpose:

- *Partial internalization of EOL management costs* In this approach, EOL management costs may be charged back to participating companies on the basis of an agreed formula, such as percent of market share. This allows companies to reflect the cost of EOL management in their brand cost structures. However, it does not provide a basis for the benefits of full cost internalisation because individual companies do not see appropriate benefit (i.e. profit opportunity) when all members of a collective benefit from the initiative of a single company. "Fees" in this instance are "non-visible" and may, in fact, be confidential even within the collective if they are charged to members on the basis of market share, for example. As indicated in Section 4, this is also the approach taken by some EOL electronics collectives in Europe.

- *Externalization of EOL management costs* In this approach, consumers are charged for EOL management of products. EOL management costs are not reflected in brand cost structures. "Fees" charged to consumers in this instance may be "visible" because:

    - The collective wants the public to understand the costs associated with EOL management of products.
    - It is reasonable (or may be legally required) for the cost of the service provided by the collective to be made visible to the public.
    - The alternative of the fee charged by the collective being included in brand-specific prices is too complex to administer.
    - In some instances, legislation requires visible fees as a protection that the costs of EOL product management by a collective are transparent.

Approaches that externalise EOL management costs have been used for the EOL management of electronic products in several jurisdictions, as identified in Section 4. They have also been used for EOL management of products in other sectors, also as identified in Section 4. In many respects cost externalisation provides the simplest short term arrangement for EOL management: normal production and marketing of products is unaffected since none of the EOL management costs are related to the environmental performance of any brand, and EOL management of products is provided for through an industry (or sometimes government) organisation which may have administrative linkage to the industry sector (e.g. companies may have a share or director position), but which is financially independent. While the relative simplicity of the arrangement is attractive, over time it leads to lack of competition, reduced opportunity for profit, higher consumer costs and discourages improved environmental performance of products.

Under the cost internalisation approach identified above, the costs of EOL management of electronics product brands becomes internalised within the overall cost of the brand. Accordingly, the issue of a visible or non-visible fee for EOL management of the brand does not arise. Because costs are internalised, they are part of the cost of the product; costs are specific to brand and enhancements in the EOL performance of the brand accrue to the brand owner and not to others.

Internalising the costs of EOL management of electronic products represents a departure for the electronics industry (producers, importers, distributors and retailers) in Canada. The sector traditionally supplies products, and its responsibility for managing those products ends at the point of sale. The internalisation of EOL management costs carries with it a change in the traditional business model.

Views in the electronics industry regarding EOL product management diverge, not only in Canada but also in the U.S. and elsewhere. The divergence of views is at several levels: the role of collectives, visible or non-visible fees, reuse versus recycling of EOL electronics, collection mechanisms, scope of appropriate EOL electronics programs and other issues. The voluntary NEPSI initiative in the U.S. attempted to bridge these issues, and in Europe the European Recycling Platform presents different perspectives on these issues as compared to the WEEE Forum.

Moving towards the internalisation of costs for managing EOL electronic products is complicated by two factors: an inadequacy of collection infrastructure, and the question of how to address "historic" and "orphan" waste. Clearly, infrastructures need to be in place to provide for the segregation of EOL electronics by brand if costs are to be internalised. Two types of infrastructure are required:

- Physical infrastructure (i.e. places to collect EOL electronics) needs to be determined across the country. This will vary according to existing recycling and other infrastructures already in place. The willingness of the retail sector to view the handling of returned EOL electronics as a profit opportunity is also relevant in this context. As identified in Section 4, some retailers have already recognised this opportunity in the context of other sectors.

- Management infrastructure. Implementation of tracking systems is required that allow companies to identify brand-specific costs associated with EOL management of electronic goods. Tracking systems will be related to the management systems used to recover EOL electronics; different organisations with different EOL management systems will use different tracking systems appropriate to their circumstances.

Some stakeholders have argued that no product should be subject to stewardship EOL management requirements unless the cost of EOL management for that product has been paid to the steward. This leads to the concept of "historic" waste; that is, EOL electronic products that are in use but for which no money has been paid to provide for EOL management. Some jurisdictions have introduced stewardship obligations on producers, but provided a grace period during which some products (i.e. those already in use) are exempt from stewardship obligations while other products (i.e. those sold after the introduction of stewardship obligations and on which an EOL fee has been paid) are subject to the new regime.

There are practical shortcomings with this approach, however. In reality, money paid for EOL management at the time of sale of a new device is unlikely to be placed in an account to await a day in the undefined future when the product is discarded; such an eventuality may be measured in decades for some electronic products. In practice, therefore, it is reasonable to assign the cost of EOL management of products currently in use to the purchasers of new products and to finance current EOL management requirements from current sales.

"Orphan" wastes, however, require integration into an EOL management system. Orphan wastes are electronic products for which no responsible producer exists. In some cases, an original producer may have been taken over by another producer; in this case, the liabilities as well as the assets of the brands owned by the original producer would be assumed by the new owner, and consequently the new owner should assume EOL stewardship responsibilities for those products. However, it may not be possible to identify a producer with EOL management responsibilities if a brand owner ceases business without passing responsibility for assets and liabilities to others (e.g. in the case of a bankruptcy). In this case, EOL management costs for those products may either be shared by the industry as a whole (e.g. on the basis of current market share in the relevant market segment) or may be assumed as a public liability.

First Steps The following points are relevant to achieving the internalisation of EOL management costs:

- Significant change in the way in which costs are accounted for in industry is required.
- Physical and management infrastructures will need to be established that provide for management of EOL electronic products in ways consistent with cost internalisation. Different options are available in different parts of Canada for achieving this; however, technology exists to provide for EOL product management in ways supportive of cost internalisation.
- Appropriate legal frameworks to support EOL management that achieves cost internalisation.

Based on these points, the following first steps should be considered:

- Enactment of a legal framework. This should be structured to establish goals and to promote competition within the industry. Companies can therefore be allowed to meet EOL management goals through a collective, but should be allowed to "go it alone" if they choose. Visible fees may be permitted – but not required – initially, but these should be rapidly phased out as internalised cost structures are defined.
- Industry should consider how the relationships it has already established for the distribution of electronic products into the market place may be leveraged to achieve EOL product management objectives, and the business opportunity that this provides for those relationships.
- Mechanisms for achieving collection of EOL products should be considered by all stakeholders, based on consumers bringing electronic products to depots or other collection points, as well as extension of asset management activities identified in Section 3.

Legal frameworks should provide reasonable time for the establishment of EOL electronic product management systems and should clearly assign stakeholder accountability for their implantation, see Section 6.2.1.

The retail sector in Canada has traditionally been opposed to accepting EOL products of any description, arguing their role is the selling of products, and not the facilitation of the collection of EOL products. Individual retailers, however, have recognised opportunity in accepting EOL products, as identified in Section 4. Wider acceptance will require wider understanding of a business model in which profit is gained from handling of EOL products as well as from the handling of new products. Regulatory influence can be exerted to define the retail role in EOL electronics management through the same logic that underlies stewardship arrangements: those who profit from the sales of a product should participate in the EOL management of that product. The responsibility of retailers to accept EOL electronic products is established in Japan, Europe and other countries, and is clearly articulated in the WEEE Directive.

6.0 BEST MANAGEMENT PRACTICE AND IMPLEMENTATION FRAMEWORK

6.1 Best Management Practice

The Best Management Practice (BMP) is defined as:

> *Management that best meets established policy objectives under the assumption that available systems and technologies are employed to the range of EOL electronic products in all regions of the country.*

Based on the assessment of options in Section 5, Table 18 presents the BMP for the management of the EOL electronic products that are the focus of this document. The table identifies:

- Each management component for electronic products, from design to disposal.
- For each management component, the CMP is summarised as the baseline from which initiatives to enhance management of EOL electronic products must begin.
- The objective of the BMP for each management component.
- The basis for each objective.
- Stakeholder actions to achieve the BMP.

Application of the BMP will result in:

- The application of DfRe and DfTR in support of enhanced management of EOL electronics.
- A network of drop-off depots and drop-off points that are convenient for consumers to use and which receive EOL electronics at no cost to the consumer.
- Continuing recovery of EOL electronics by asset managers and others through their existing and future networks.
- The collection of EOL electronics that are presently in storage.
- Increased reuse of EOL electronics to the extent that is feasible under market demand conditions.
- Increased recycling of EOL electronics and the sale of recovered materials in the domestic and international marketplaces.
- The disposal of EOL electronic products only following processing for recycling.

The application of the BMP is estimated to have the potential to achieve the separate collection of 95 percent of the EOL products that are the subject of this document. Once EOL products enter the separate collection system, there will be opportunity to increase the level of reuse and recycling of EOL electronic products. It is estimated that the BMP has the potential to achieve the reuse of an additional 10,005 tonnes of EOL electronic products and the recycling of 92 percent of the materials that are sent to final disposal; materials that are not recycled under the BMP are those for which recycling technologies are not known to be in application anywhere in the world. Materials flows under the application of the BMP identified in Table 18 are identified in Figure 6.

6.2 Implementation of the Best Management Practice

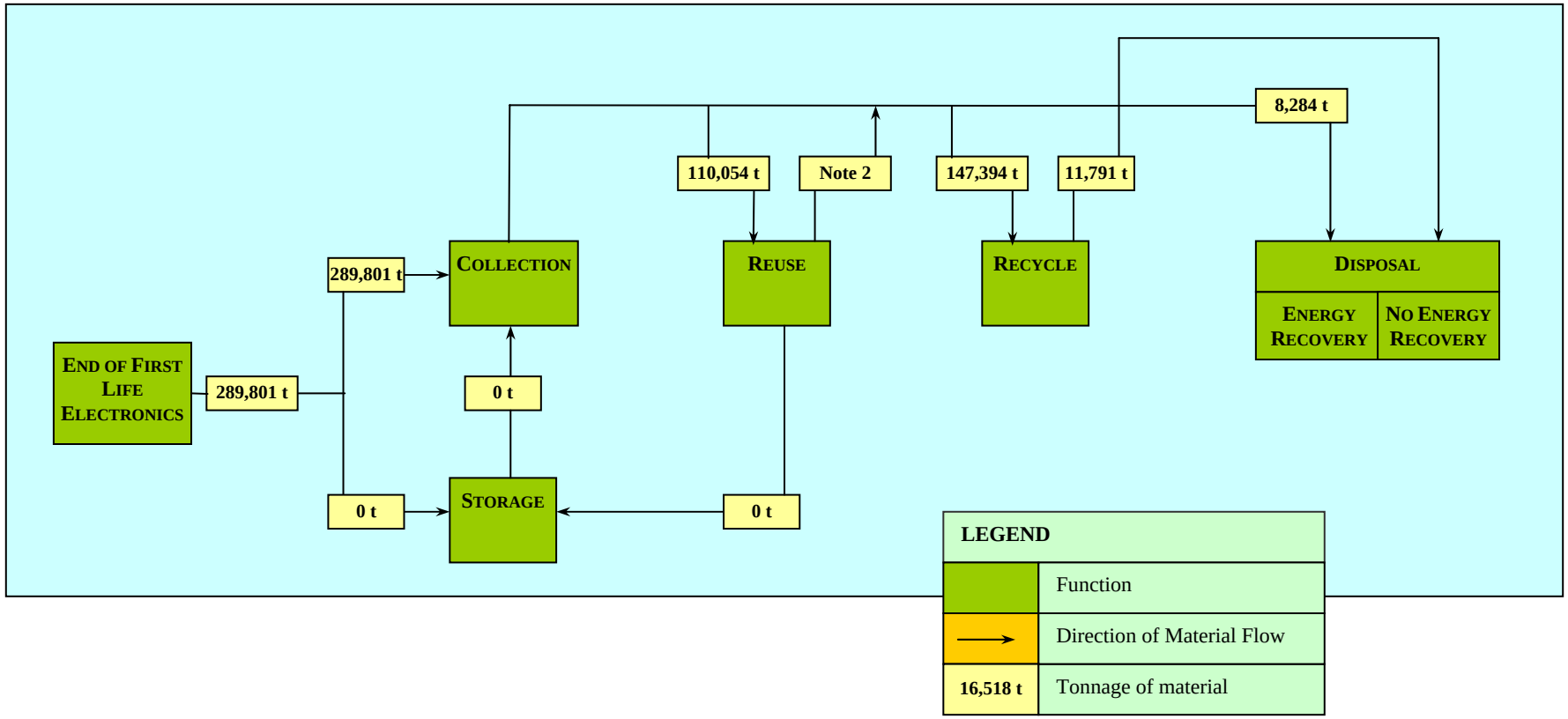
The BMP represents the "best" management practice in terms of what is achievable in managing EOL electronic products today in accordance with the waste management hierarchy.

The way in which this result is achieved - and the extent to which it is achieved - are functions of the implementation frameworks that are developed. Jurisdiction for waste management is provincial; federal jurisdiction in the sector applies only in the context of the transboundary (inter-provincial or international) movement of wastes. Specific implementation of initiatives to manage EOL electronic products are

Table 18
Best Management Practice

Management Component	Current Management Practice (2005)	Best Management Practice Objective	Basis for Best Management Practice	Stakeholder Actions To Achieve Best Management Practice
Design	Design driven by market demand and internal design criteria; little incentive/reason for OEM's to consider EOL management or environmental priorities	Design of electronic products of that reflects EOL management and environmental priorities	Application of established opportunities to reflect EOL and environmental priorities in electronic product design	*Government* Establish DfRe criteria through regulatory measures; take measures to ensure parity with EU RoHS requirements; require producers to internalise EOL product management costs *Producers* Internalise EOL product management costs
Storage	Estimated 25,065 t of EOL electronics placed in storage	No EOL electronic products managed through storage	Appropriate EOL management systems will remove incentive to manage EOL electronic products through storage	*Government* Establish in regulation producer responsibility for collection and management of EOL electronic products consistent with C-WPEPS. Ban disposal of EOL electronics and materials, unless they have passed through a licensed recycling processing facility *Producers* Establish drop-off depots/points for convenient separate collection of EOL electronics at no charge to consumers, including "historic" EOL electronics *Consumers* Bring EOL electronics to drop-off depots/point
Collection	Skeleton network of depots/drop off centres for separate EOL electronics Asset management system serves IC&I sector	Separate collection of at least 95 percent of EOL electronic products discarded for final management	Demonstrated effectiveness in Canada of mechanisms for separate collection of recyclable materials	*Government* Establish in regulation producer responsibility for collection and management of EOL electronic products consistent with C-WPEPS. Ban disposal of EOL electronics and materials, unless they have passed through a licensed recycling processing facility *Producers* Establish drop-off depots/points for convenient separate collection of EOL electronics at no charge to consumers, including "historic" EOL electronics *Consumers* Bring EOL electronics to drop-off depots/point
Reuse	Estimated 100,049 t of EOL electronics reused as a result of informal activity at the household level and commercial activity by asset managers, OEMs and others at the IC&I level	Short term increase of 10 percent in quantity of EOL electronic products reused. Further increases in reuse of EOL electronic products according to market demand	Current domestic and international market opportunity for "pre-owned" electronic products and components. Potential future reuse opportunities according to market conditions	*Government* Regulate requirements for labelling electronic products to permit rapid identification of EOL products with high reuse potential; approve disassembly/reuse facilities; establish DfRe criteria through regulatory measures to facilitate disassembly/reuse; establish quality criteria with other stakeholders for reused products *Producers* Ensure access of third parties to electronics with potential for reuse. *Consumers* Consider purchase of "pre-owned" electronic products
Recycle	16,518 t of EOL electronics enter recycling process, but 4,641 t rejected as waste	Recycling of 92 percent of separately collected materials contained in EOL electronic products destined for final management	Proven technologies and market opportunities for recycling 92 percent of materials in EOL products that are the focus of this document 80 percent of EOL electronics discarded to final management already recycled elsewhere in the absence of state-of-the art plastics recycling	*Government*: Approve recycling facilities (including disassembly, mechanised processing and scrap metal facilities); support development of new processing technologies and new markets for recyclable materials; adopt "buy recycled" procurement. *Producers:* Establish new infrastructure for processing in support of recycling; establish transportation from collection point to processing facilities *Consumers*: Consider purchase of electronic products containing recycled materials
Disposal	Disposal of 90 percent of EOL electronic products discarded to final management.	Disposal of 12 percent (and subsequently declining percent) of EOL electronic products/ materials discarded for final management	Disposal of EOL electronic materials as management option of last resort	*Government:* Prohibit disposal of EOL electronic products and materials unless they have first been processed through recycling processing facilities

Figure 6
Best Management Practice Materials Flows: 2005 (Estimated tonnes)[1]



Note 1: Anticipated material flows (2005) resulting from application of Best Management Practice.
Note 2. Includes discards to recycle and disposal from second and subsequent lives

therefore subject to provincial implementation frameworks and priorities. While the C-WPEPS have harmonised policy objectives across the country together with some aspects of implementation, other aspects of implementation have not been harmonised and it is not clear that provinces will necessarily choose to act in the same ways in these cases. This section outlines key implementation perspectives for the consideration of provinces and the private sector as they develop EOL electronic product management programs.

Implementation of EOL electronics management in support of achieving the BMP will need to include the following components:

- Legal frameworks
- Investment in new infrastructure
- Public awareness/education
- Research and development
- Institutional frameworks

Timing of implementation and costs of implementation will also need to be considered.

6.2.1 Legal Frameworks

Legal frameworks are required to give effect to the principles set out in the C-WPEPS, see Annex C. The legal mechanism through which provinces should establish EOL electronics programs is regulation. Regulations should ensure consistency with the C-WPEPS. Within this overall context, regulatory frameworks should be framed to:

- Separate the role of the regulator and the operator. Provincial regulatory entities should not directly operate EOL electronics management programs.
- Establish timing and target products. All stakeholders require time to prepare for the initiation of a major EOL electronics management program. The specific products that are subject to management under the EOL electronics management program should be identified, but more general language should also be used to capture future products that may be developed or which may arise from technology convergence. Initially, legal frameworks should address, at a minimum, all the EOL products that are the focus of this document and should consider, in particular, additional products that may be readily added to those addressed by this document (for example, non-rechargeable batteries might be addressed in addition to rechargeable batteries)
- Provide flexibility regarding how EOL electronics management programs are managed and implemented. The responsibility of producers to manage EOL electronics should be stated. However, producers should be given the choice of meeting their responsibilities through managing their own EOL products, participating through a collective or managing/implementing programs with agencies that have been established by government for the purpose of managing end of life products.
- EOL electronics management systems should be financed by producers through industry fees that are invisible to the consumer; this will permit producers to integrate the cost of EOL management into their price structures and to achieve financial benefit to the extent that their products can be managed increasingly competitively at end-of-life. EOL management costs will be driven down and the environmental performance of products will increase.
- Notwithstanding the above point, visible fees may be permitted (but not required) through which to support establishment of initial EOL product management infrastructure and administrative frameworks. Regulatory frameworks should specify the phasing out of visible fees as consumers discard “historic” products and as core management infrastructure is established.
- Establish minimum design objectives and criteria relating to DfRe together with financial penalties for failure to meet the objectives/criteria.
- Ensure consistency with standards related to DfTR that are at least equal to those generally applied in OECD countries and consistent with relevant policy at a national and provincial level.

- Require reporting against regulatory requirements and other criteria that provinces may define in regulation, including the type and quantity of product each puts on the market and quantity of each type that has entered a reuse/recycling process, and the amount of each type of product that has been sent for disposal, including incineration.
- Require producers to register with the regulatory authority as an official record of their responsibility to participate in EOL management.
- Establish that EOL products that meet HW/WDG test criteria (whether in a whole, crushed or other state) are classified as HW/WDG.
- Establish similar regulatory requirements for all receivers/processors of EOL electronics products.
- Ban the disposal of EOL electronic products and materials unless they have been through a process in support of their recycling.
- Assign responsibility to producers for public education and awareness in support of the EOL electronics program.
- Establish a fund under the direction of the province and jointly managed with producers to address local research and development (including market development) priorities associated with EOL electronics product management and to be financed by producers.
- Establish numeric requirements for the quantity of EOL electronic products reused or recycled on an annual basis, expressed as a percentage of the total quantity of EOL electronics discarded, and including in the definition of "discard" the electronic products that are managed through all receivers of such products as well as leased electronic products that are returned to the lessor.
- Provide for the tracking, in partnership with Environment Canada and Transport Canada, as necessary, of transboundary movement of EOL electronics using harmonised definitions and protocols.
- Adopt the standards and related provisions of the Recycling Vendor Qualification Standard developed by EPSC as requirements that must be met by all processors of EOL electronic products, and provide for monitoring/ tracking systems to ensure compliance.

The regulatory framework should establish that the supply of regulated products is contingent on compliance with the regulatory framework, and should establish the accountability of producers to ensure that: (i) they are registered; (ii) their products are in regulatory compliance; and (iii) the EOL management of their products – including financial considerations - is consistent with regulatory requirements. Penalty provisions should include the ability of the regulator to prohibit both the entry into the jurisdiction, and the distribution, of products: (i) for which the producer is not registered; (ii) which are not in regulatory compliance; or (iii) which are not managed in ways that are consistent with regulatory requirements. This approach will ensure that all electronic products entering the jurisdiction, and the management systems for those products, are in compliance with regulatory requirements whether or not the producer has a physical presence in the jurisdiction. Regulatory frameworks should be reviewed and updated periodically to reflect changing opportunities and requirements. Aspects of regulatory frameworks will best be coordinated through CCME.

New regulatory frameworks for management of EOL electronic products require time to be implemented since EOL product management structures need to be designed and implemented at several levels (e.g. administration, physical infrastructure, logistics, financing and other structures). Table 19 identifies the time provided by different EOL electronics management frameworks between the date of enactment of regulatory requirements and the date by which compliance with those requirements must be achieved.

As identified in the table, the European WEEE Directive provides a graduated timeline depending on the requirement. As a start, the Directive provides national governments with 18 months in which to transpose the directive into national legislation and 20 months to establish dedicated WEEE collection. The RoHS Directive provides almost 3.5 years for industry to phase out regulated substances and almost 4 years are provided by the WEEE Directive for industry to meet initial recycling targets. In addition, the WEEE Directive allows for 7 years of a visible consumer fee to finance the collection and recycling of historic and orphan waste, following which non-visible fees are required.

Table 19
Implementation Periods For EOL Electronic Management Regulatory Frameworks

JURISDICTION	LAW	DATE OF LEGISLATION	PROGRAM DATE	IMPLEMENTATION TIME
European Union	WEEE Directive - Transposition of Directive into national legislations	Feb-03	Aug-04	18 months
European Union	WEEE Directive – Separate collection of WEEE	Feb-03	Aug-05	20 months
European Union	RoHS Directive - Phasing out of substances banned.	Feb-03	Jul-06	3 years, 5 months
European Union	WEEE Directive – State collection minimum of 4kg per capita from households	Feb-03	Dec-06	3 years, 10 months
European Union	WEEE Directive - recycling and Recovery targets to be achieved by producers	Feb-03	Dec-06	3 years, 10 months
European Union	WEEE Directive - no more visible fees on most EEE products.	Feb-03	Feb-11	7 years
European Union	WEEE Directive - no more visible fees on large household appliances.	Feb-03	Feb-13	9 years
Austria	White Goods Ordinance	Mar-93	Mar-95	24 months
Belgium - Flemish Government	Waste Prevention and Management Ordinance (tires, white goods, brown goods, IT equipment, batteries, end-of-life vehicles)	Jun-98	Jul-99	13 months
Belgium	Inter-Regional Cooperation Agreement (white goods, small appliances, TVs, monitors, AV equipment)	Jul-01	Jul-04	24 months
Belgium	Inter-Regional Cooperation Agreement (lighting, toys, measuring equipment)	Jul-02	Jul-04	24 months
Netherlands	Decree (take-back of brown and white goods)	Apr-98	Jan-99	8 months
Netherlands	Decree (small household appliances)	Apr-98	Jan-00	20 months
Switzerland	Ordinance (electronics, household appliances, IT equipment)	Jan-98	Jul-98	6 months[1]
Norway	Trade agreement between Government and trade organizations	Mar-98	Jul-99	16 months
Sweden	Ordinance for Producer Responsibility of Electrical Electronic Products (AV, Appliances, IT, Telecom)	Jul-00	Jul-01	12 months
Japan	Household Appliance Law (TVs, Air conditioners, refrigerators, washing machines)	Jun-98	Apr-01	30 months
Japan	Promotion of Effective Reutilization of Resources Law (commercial computers, laptops)	May-00	Apr-01	10 months
Japan	Promotion Law (Personal computers)	May-00	Oct-03	3 years, 5 months
Alberta	Electronics Designation Regulation - municipal collection of e-waste	May-04	Oct-05	5 months
Alberta	Electronics Designation Regulation - collection of visible fee	May-04	Feb-05	9 months
California	SB 20	Oct-03	Jan-05	15 months

Note 1: A voluntary group represented by 36 member companies "SWICO" was in operation since 1994.

In European countries where electronics programs were regulated prior to the WEEE Directive, regulators usually gave at least 18 months for implementation. While the Swiss implementation period was only six months, it is important to note that since 1994 a voluntary program represented by 36 member companies - "SWICO" - was in operation, making expansion simply a matter of building on existing administrative systems, as well as collection and processing infrastructure.

The shortest implementation period reported in the table is in Alberta, Canada. This short turn around was facilitated by a number of factors. First, the Alberta program is administered by an existing government body (Alberta Tire Recycling Board, renamed the Alberta Recycling Management Authority (ARMA), which had existing resources and funding to undertake all the preliminary work. In addition, the Alberta program has little industry involvement, with revenue being collected through visible fees at the point of

purchase and collection systems piggy-backing on existing municipal depot programs. It should also be noted that the revenue-raising element of the program was originally set for October 2004, five months after the date of the regulation, but was delayed an additional four months to February 2005.

The California program, which is similar to Alberta in terms of government administration and revenue raising was also delayed several times, for a final implementation period of 15 months.

Industry has consistently requested that regulators consider program factors such as industry involvement, existing infrastructure and/or program and other provincial initiatives before setting implementation timelines. In general, initial elements of a program (e.g. registration of regulated companies or products) may be implemented over a six month period, but full implementation may require periods of up to – in some instances – a number of years depending on program requirements. The effective dates of different components of regulatory requirements should therefore be phased in over time.

6.2.2 Investment in Infrastructure

New infrastructure will be required to manage EOL electronic wastes in the quantities identified in the BMP. Annex I identifies existing infrastructure in North America on a regional basis and provides maps that locate major infrastructure relevant to EOL electronic product management, together with a discussion of issues associated with new infrastructure and market and business development. Necessary infrastructure will need to address:

- Collection
- Transportation
- Processing and disassembly

This section identifies feasible combinations of collection, transportation and processing/disassembly on the basis of the assumptions identified in the analysis. Actual implementation will vary as a function of local opportunity and proponent priority.

Collection The C-WPEPS identify that consumers should "have reasonable access to collection systems without charge." Achieving the BMP - or any level of increased EOL electronic products or materials reutilisation - requires separate collection of EOL electronics, and this should be undertaken through consumers bringing their EOL electronic products to identified drop-off locations. These locations may be retail stores (for either collection of brands sold by the dealer, EOL products that are replaced by a new purchase at the store or for all brands within a product category) or collection facilities established for the purpose. If collection is to be undertaken through established facilities, a density of at least one per 15,000 people in urban areas and 1 per 10,000 people in rural areas may be employed.[55]

The total amount of EOL electronic products that will be collected under the BMP is shown in Table 20.

[55] This corresponds to the density of collection sites in Nova Scotia used for recovering beverage containers and other materials for recycling, and has been found to provide an effective level of consumer convenience.

Table 20
Estimated Tonnes of EOL Electronics Collected Under The BMP (2005)

	CELL PHONES	TELEPHONES	STEREOS	RECHARGEABLE BATTERIES1	COMPUTERS	MONITORS	PERIPHERALS	TVS
Region: Atlantic Canada								
New Brunswick	9	40	138	6	571	772	498.	1,340
Newfoundland and Labrador	7	29	97	4	438	582	379	941
Nova Scotia	10.5	49	172	7	728	980	633	1,678
Prince Edward Island	1	7	26	1	102	138	88	245
Region: Quebec	93	425	1,388	57	6,219	8,298	5,401	13,534
Quebec	93	425	1,388	57	6,219	8,298	5,401	13,534
Region: Ontario	167	770	2,290	94	11,458	15,044	9,900	22,493
Ontario	167	770	2,290	94	11,458	15,044	9,900	22,493
Region: Western Canada								
Alberta	52	240	602	24	3,676	4,705	3,152	6,004
British Columbia	51	237	770	32	3,471	4,626	3,013	7,503
Manitoba	14	65	216	9	944	1,263	820	2,095
Saskatchewan	12	60	184	8	877	1,159	759	1,813
Region: Territories								
Northwest Territories	<1	4	8	<1	66	82	56	85
Nunavut	<1	1	5	<1	22	29	19	53
Yukon	<1	2	6	<1	30	40	26	58

Transportation and Processing/Disassembly Two types of transportation require consideration for the management of EOL electronic products:

- *Primary transportation.* This includes the pick-up of EOL electronic products from collection sites and the transport of these products to either a point of disassembly/mechanised processing, or a transfer point. Primary transportation is undertaken using a vehicle (truck) that is manoeuvrable in urban areas.
- *Secondary transportation.* This includes the transportation of EOL electronics from a transfer point to a point of disassembly/mechanised processing. Secondary transportation is undertaken when the distance between the point of generation of EOL electronic products is sufficiently remote from the point of disassembly/mechanised processing that while primary collection can be achieved as described above, it is more economical to use a long haul transport vehicle (truck) to transport EOL electronic products to the point of disassembly/mechanised processing than the vehicle used for primary collection.

The capacity of drop-off points to accept EOL electronic products is a function of not only the size of the drop-off points but also the frequency of primary collection. Optimisation of the balance between the two is case specific and requires analysis in the context of specific program designs.

Specific transportation requirements depend on defining the point of origin and the point of destination for materials to be processed/disassembled. For the purpose of this analysis, the following is assumed:

- The point of origin is the drop-off point to which people bring their EOL electronics.
- The destination is the facility at which EOL electronics are disassembled/processed for reutilisation.

Drop-off collection points are assumed to be located at the minimum density identified above.

Table 21
EOL Electronic Product Processing Requirements: BMP Scenario

REGION	QUANTITY OF EOL ELECTRONICS	SHIFTS REQUIRED TO PROCESS[1]	PROCESSING FACILITIES[2]
Atlantic Canada	10,724	1.5	1
Quebec	35,415	4.9	2
Ontario	62,217	8.6	3
Manitoba/Saskatchewan	10,296	1.4	1
Alberta	18,455	2.6	1
British Columbia	19,704	2.7	1

Notes
1. Based on 3 tones/hour x 8 hour shift x 6 days/week operations x 50 weeks/year

The location of disassembly/mechanised processing facilities will be a function of the quantities of EOL electronics that are available for disassembly/mechanised processing. Mechanised processing facilities are capital intensive facilities whose financial attractiveness depends on the availability of large quantities of materials. Processing rates vary according to the scale of technology employed. However, a processing rate of at least 3 tonnes/hour is achievable with technology with a rated processing capacity of up to 4 tonnes/hour[56]. Based on the data in Table 20, the number of processing facilities that might be implemented to process EOL electronics under the BMP scenario is identified in Table 21; Annex I includes discussion of issues associated with the actual number of facilities that may be appropriate.

This scenario of mechanised processing would accommodate all the EOL electronic products identified in Table 20 except for rechargeable batteries, which are assumed to continue to be managed under the current RBRC program, expanded as appropriate. The specific locations of facilities may vary as compared to what is identified in Table 21 based on local factors and priorities.

Disassembly, by contrast, is a labour intensive process where smaller quantities of EOL electronic products may be processed locally. Disassembly facilities can be established in large or small centres according to need. However, disassembly is slow and the numbers of individuals required to disassemble the EOL products generated in a major urban centre can become very large[57].

The question of whether disassembly or mechanised processing facilities should be preferred in any specific context may be considered according to the following:

- The most effective use of mechanised processing will be in major urban centres where large quantities of EOL electronic products are locally available and where transportation costs to the facilities can be minimised.
- Where lower quantities of EOL electronic products are generated, the transportation of these products to a centralised mechanised processing facility may be justified from a financial perspective if the costs of

[56] Actual processing capacity may be as little as 80 percent of nominal processing capacity, depending on the efficiency of facility and technology operations.
[57] The rate of disassembly varies according to the extent of disassembly undertaken. Time and motion studies indicate that the disassembly of a typical mix of computers, monitors, peripherals and TVs based on the composition of EOL electronics products identified in Table 1 and Table 2 will be 18 kgs per hour in support of maximizing materials recycling. Disassembly in support of component/equipment reuse will be more rapid.

local disassembly are greater than the cost of mechanised processing plus the cost of transportation to the mechanised processing facility.

- The shipment of EOL electronic products to a mechanised processing facility amounts to the transfer of economic benefits associated with EOL electronics management to the area in which the processing facility is located.

Based on these considerations and the cost estimates presented in Table 22, the following is assumed:

- EOL electronic products (except for rechargeable batteries) generated in Alberta, British Columbia, Ontario and Quebec will be managed in mechanised processing facilities as presented in Table 21. Rechargeable batteries will be processed at existing recycling facilities in the US.
- Computers, monitors, peripherals and TVs generated in Manitoba, Newfoundland and Labrador, New Brunswick, Nova Scotia, Prince Edward Island and Saskatchewan will be managed through disassembly facilities located in those provinces. Telephones, cell phones and stereos will be transported for recycling at the closest mechanised processing facilities.[58] Rechargeable batteries will be processed at existing facilities in the US.

This disassembly/mechanised processing framework implies the following transportation system:

- All EOL products identified in Table 20 will be picked up by primary transportation. An average of 1.89 tonnes of EOL electronics product will be collected per primary collection vehicle per day, at a density of 1 tonne to 4.30 m^3.
- All EOL products picked up through primary collection and destined for disassembly will be delivered directly to the disassembly facility. This includes all computers, monitors, peripherals and TVs in Manitoba, Newfoundland and Labrador, New Brunswick, Nova Scotia, Prince Edward Island and Saskatchewan. Telephones, cell phones and stereos will be transported by secondary transportation for recycling at the closest mechanised processing facilities. The average haul distance is assumed to be 1,000 kms at a density of 1.69 tonnes/m^3. Rechargeable batteries will be managed in the US.
- All EOL electronic products (except rechargeable batteries) generated in Alberta, British Columbia, Ontario and Quebec will be managed in mechanised processing facilities. The geography of these provinces will allow for the majority of EOL electronic products to be directly delivered to mechanised processing facilities through the primary transportation network. However, it will be cost effective to use secondary transportation to deliver an estimated:

    - 33 percent of EOL electronics generated in Alberta
    - 45 percent of EOL electronics generated in British Columbia
    - 10 percent of EOL electronics generated in Ontario
    - 10 percent of EOL electronics generated in Quebec.

- The use of secondary transportation will require transfer points at which loads are bulked up from the primary to the secondary transportation vehicles.

6.2.3 Public Awareness/Education

Public education and awareness will be required to support implementation of the BMP. Public education and awareness initiatives should focus on communicating the following:

- How the program works
- How households and the IC&I sector should participate in the program
- What the benefits of the program are

[58] Provinces may elect to also disassemble these products. However, they are generated at high volume, imposing significant organisational challenges regarding the number of people required to disassemble, and can be transported at relatively high density (and therefore lower cost) to mechanised processing facilities.

- How the program is paid for
- Results and benefits that are achieved over time.

Public education and awareness should be initiated in advance of actions to implement the BMP in any jurisdiction and should continue over the long term.

As the program to implement the BMP evolves over time, changes in how the program operates should be considered from the perspective of the user of the program. Changes that impact how people use the program should be clearly communicated; major changes should be implemented in stages to facilitate the users adaptation to new ways of doing things.

Public education and awareness can use the range of media available. Point of purchase communications and printed instructional materials that are included with new products are effective in reaching specific purchasers but, because products are used over extended periods of time, broader communications are also required so that users know how their product should be managed at the end of its life.

6.2.4 Research and Development

The management of EOL electronic products according to the BMP will be a major new activity for all stakeholders. In both the short term and over time it is clear that there will be opportunity to enhance management of EOL electronic products to reduce costs, improve recyclable materials markets and respond to local priorities. Research and development in support of these and other actions will therefore be appropriate. Initial priorities include:

- Developing/commercialising markets for recyclable materials, with specific focus on plastics.
- Refining aspects of BMP implementation to reduce costs and increase benefits.

6.2.5 Institutional Frameworks

The C-WPEPS identify that:

- Provinces will establish their own EOL electronics programs
- Responsibilities associated with the management of EOL electronic products are primarily borne by producers.

Institutional frameworks should therefore reflect that:

- Entities responsible for regulating EOL electronic management systems (i.e. provincial regulatory entities) do not operate those systems.
- Producers finance and organise the EOL electronics management system in ways that maximise use of existing infrastructure, and that balance economies of scale necessary for efficient operations with levels of competition necessary to ensure reasonable costs.
- Producers bear the cost of establishing and operating the EOL electronics management program based on the use of non-visible fees that provide opportunity for producers whose EOL products incur lower costs to benefit proportionately; those who perform best should benefit most.
- Adequate management and communications structures are established between regulated parties, the regulator and other stakeholders that provide for dialogue and informed decision-making.

Mechanisms should be established for collaboration between the public and private sectors on market development for recyclable materials, particularly for leaded glass and for plastics (see Section 6.3.2). Focus in both these cases should be on Canadian commercialisation of technologies used elsewhere in the world.

6.2.6 Timing

Actions to implement enhanced EOL electronics management have already been undertaken in some provinces. Alberta has implemented a program since October 2004. Other provinces have prepared or adopted legislation and have taken other actions. How - and whether - the BMP is achieved will depend on actions at the provincial level, and the timing associated with actions will vary according to the constraints, priorities and opportunities in each province.

The first priority in implementing the BMP is for provinces to establish the necessary legal framework through regulation or other appropriate legal instrument.

Implementation of EOL electronics management responsibilities under the legal framework should commence not sooner than 6 months following the enactment of the governing legal instrument in order that those who are given legal responsibilities have the opportunity to prepare for program implementation.

Initial focus should be on creation of the collection and recycling system. All provinces have immediate opportunity to establish collection systems (e.g. through the electronic product network), but some provinces may have opportunities that others do not have (e.g. an established drop-off site network). Some provinces have an established capacity to recycle EOL electronic products, and this capacity is growing. In other provinces (e.g. Quebec), new private sector investment in processing capacity is highly likely as a consequence of regulations that would establish separate collection and recycling requirements under the BMP. Where disassembly is to be undertaken, the establishment of a disassembly infrastructure will be an initial priority together with training of staff.

6.2.7 Estimated Costs

The costs of the implementation of the BMP are estimated in Table 22. Necessarily, the cost estimates are based on assumptions regarding the implementation of the BMP in any province. The estimates are therefore a guide only and should be considered only in the context of the assumptions on which they are based. Generally, these include the following:

- The cost estimates pertain to the application of the BMP to projected 2005 EOL electronics.
- The collection, transportation and processing of EOL electronics will be as set out in Section 6.2.2.
- Existing infrastructure will be used wherever possible.
- Costs are based on quoted market rates and practices wherever possible, but in the case of mechanised processing assume a processing cost of $0.70/kg across the country[59].

Specific assumptions included in Table 22 are as follows:

- It will be the responsibility of the consumer to bring EOL electronic products to *collection* points. Accordingly, there will be no program cost to collect EOL electronic products. Costs associated with *storage* of collected EOL electronic products include management, labour, equipment, building amortisation and operating costs, insurance and supplies. The precise number of storage points cannot be estimated, although a minimum density is identified in Section 6.2.2**.** In addition, EOL electronic product storage will be one of a number of activities that may be undertaken at the locations where the EOL electronic products are stored. In the absence of specific provincial collection/storage frameworks for EOL

[59] This rate pertains in some regions of Canada; other rates may pertain in specific locations or with respect to specific circumstances.

Table 22
Summary of Estimated EOL Electronics Management Costs To Achieve BMP In Canada[60]

BUDGET ITEM	COST PER YEAR[1]	COST PER KILOGRAM	REMARKS
COLLECTION/PRIMARY TRANSPORTATION/DELIVERY TO TRANSFER POINT OR PROCESSING FACILITY			
Collection	000	000	Cost of collection borne by consumer
Storage	$13,498,000	$0.13	Includes handling fee and amortised gaylord container costs; estimates based on industry sources
Primary Transportation	$20,820,000	$0.13	Includes transportation from collection point to transfer point/processing facility; estimates from industry sources
DISASSEMBLY AT TRANSFER POINT/PROCESSING FACILITY			
Disassembly	$16,578,000	0.73	Calculated estimate based on industry sources. Includes cost of transportation to end-use markets and revenue
TRANSFER/SECONDARY TRANSPORTATION/DELIVERY TO PROCESSING FACILITY			
Transfer Cost	$477,000	0.02	Includes transfer to long-haul truck. Range in cost results from whether or not disassembly is undertaken. Data from market study (Western Canada)
Secondary Transportation	$1,319,000	0.05	Includes haulage to processing facility. Range in cost results from whether or not disassembly is undertaken. Based on average haul distance of 400 km; estimates from industry sources
Mechanised Processing	$96,260,000	$0.70	Mechanised processing for recycling. Estimate based on assumed initial BMP market price.
PUBLIC EDUCATION AND AWARENESS/RESEARCH			
Public Education/Awareness	$2,851,000	$0.017	Allocation based on $0.10/unit sold
Research and Development Fund	$2,851,000	$0.017	Allocation based on $0.10/unit sold
Total	$154,654,000	$0.98	

Notes
1. Costs are commercial costs quoted on the basis of amortised capital and market prices.

electronics it is assumed that net collection/storage costs will be equal to $0.50 per electronic item handled. The "storage cost" estimate in Table 22 is based on a handling fee of $0.50 per item of EOL electronics returned through separate collection under the BMP; the amount shown in Table 22 therefore represents the sum of collection and storage of EOL electronics prior to transportation. In addition, the amortised cost of gaylord containers required for EOL electronics storage is included in the storage cost.

- The *primary transportation* cost estimates are based on the collection system and assumptions identified in Section 6.2.2. Rates are based on quoted rates provided by industry.
- *Disassembly* costs are based on the results of time and motion studies undertaken by industry in 2003, and include labour, management, operations, revenue from recyclable materials and transportation to end-use markets for recyclable materials. While the net cost of disassembly shown in Table 22 is higher than the assumed cost of processing (see below), the disassembly cost is below costs quoted by some mechanised processing operations and is sufficiently close to the estimated cost of mechanised processing presented in

[60] These estimated costs will require validation and adjustment, as appropriate, in each province to reflect local priorities and conditions at the time of implementation.

Table 22, together with the benefits of both reducing secondary transportation cost and achieving localsocio-economic gains, that the option of disassembly may be preferred in some provinces identified above. As indicated below, it is also likely that existing costs can be further reduced to bring the cost of disassembly below that of current mechanical processing charges.

- *Transfer* cost estimates (i.e. the process of bulking loads up from small vehicles to large vehicles) are based on costs incurred by an organisation in western Canada in 2003.
- *Secondary transportation* costs are estimated based on current industry line haul rates and include a fuel surcharge and allowance for pick up of EOL electronic products along line haul routes. An average secondary transport distance of 400 kms is collectively assumed in British Columbia, Alberta, Ontario and Quebec; an average 1,000 km haul distance is assumed for other provinces.
- *Processing* costs reflect rates under a competitive industry scenario. Processing costs include revenues from the sale of recyclable materials, which accrue to the processor. Accordingly, revenue from the sale of recyclable materials does not accrue to the EOL electronic products management program.
- *Public education and awareness* and *research and development fund* costs are both estimated based on the assumption that $0.10 per EOL electronic item discarded is both sufficient to meet the requirements of these activities, and within the range of what is affordable.

Management and overhead costs are included in the costs identified in Table 22.

Total cost for the implementation of the BMP under the above assumptions is estimated at $154,211,000 million per year based on the BMP for 2005. Based on the average weights of EOL electronic products identified in Annex A, this is equivalent to $0.98/kg of EOL electronics product managed, and $0.93/kg of EOL electronics product estimated to be discarded to final disposal in 2005 under the BMP presented in Figure 6. Different EOL electronics products have different management requirements, and the cost of managing individual products will vary on a per kilogram basis as compared to the average cost identified in Table 22[61]. Under the C-WPEPS, producers will be responsible for paying these costs.

Potentially significant cost savings are achievable at the level of processing for recycling. The creation of an advance disposal fee in Alberta has resulted in a government-defined processing rate - in effect, a regulated rate.

Other cost reductions may be associated with:

- Storage, if lower handling charges are negotiated with collection facilities; it is possible that return through retail outlets, for example, becomes a cost of retail business and that no handling fee would apply in that instance.
- Transportation (particularly primary transportation), where jurisdiction-specific implementation plans identify more efficient transportation arrangements than are assumed in this analysis.

The most significant stimulant to cost reduction over time may be the application of DfRe initiatives. Regulatory action that achieves DfRe objectives will facilitate the disassembly of EOL electronic equipment, thereby reducing the costs of disassembly. The impact on the cost of EOL electronic product management cannot be precisely gauged at this time, but the possible significance of DfRe can be estimated at a first level of approximation:

A reduction of 20 percent in the time required to disassemble EOL electronic products is widely considered feasible. The impact of this on the implementation of the BMP would be to:

- Reduce disassembly costs by $2.21 million/year at the level of disassembly identified in this section, equivalent to $0.11/kg of material disassembled.

[61] Section 8 refines these costs with respect to Atlantic Canada.

- Drive down per kilogram mechanised processing costs commensurately to ensure that processing remains cost-competitive. A reduction of $0.11/kg across the 137,515 tonnes of material assumed to be managed through mechanised processing would represent a savings of $15.12 million/year at the level of mechanised processing identified in this section.
- In the event that DfRe initiatives included the labelling of major plastics in computers, monitors, peripherals and TVs, the increase the value of recovered plastics in the marketplace from approximately $0.10/kg for mixed plastic to an average of at least $0.40/kg for separated plastics. This would increase revenues associated with the sale of plastic to approximately $12 million/year in the event the benefit was accrued across the country, or to approximately $1.5 million per year in the event that benefits accrued only in those provinces where disassembly takes place.

The direct benefit of DfRe applied at this level would therefore be in the range of $18.83 - 29.33 million per year, or 12.2 percent - 19.0 percent of the costs identified in Table 22.

In light of these considerations, it appears that net costs identified in Table 22 could be reduced by 20 - 30 percent through the application of known appropriate EOL electronic management administrative arrangements, operational efficiencies and technically feasible design change. Additional reductions in cost could be achieved through appropriately structured legal frameworks that provide all stakeholders with incentive to maximise both the environmental performance of electronic products and the operations of EOL electronics product management systems.

6.3 Import/Export of EOL Electronic Products and Market Development

6.3.1 Import/Export of EOL Electronic Products

The creation of an environmentally sound EOL electronic products management program in Canada will result in infrastructures that can serve EOL management requirements elsewhere. Opportunities include:

- Processing EOL electronics generated in the United States. Opportunities may extend across the country but may be greatest in southern Ontario because of its proximity to major centres of US population. Existing capacity in the US to process EOL electronics generally exceeds supply, and many US processors are anxious to see legislation introduced that will drive EOL electronics into reutilisation streams. If this happens, supply may exceed current capacity and there may be opportunities for Canadian processors to accept US EOL electronics to the extent that they have excess capacity. Also, Canadian-based processors are considering the establishment of US operations, and some have already established facilities there.
- To process EOL electronics generated overseas, particularly in Europe. There is considerable concern in several countries that there will not be sufficient capacity to accommodate the quantity of EOL electronic products that will require processing as mandated by the WEEE Directive. This may present a specific opportunity to Atlantic Canada, but also to Quebec and Ontario via the St. Lawrence Seaway.

EOL electronic products imported into Canada for processing consistent with the BMP would provide economic and social benefits, and may stimulate investment in capacity to utilise processed materials. Importation would be undertaken consistent with the requirements of the *Export and Import of Hazardous Waste Regulations* administered by Environment Canada and other applicable requirements. Residual wastes at a level consistent with the BMP would be generated, but the quantity of these wastes would not substantially impact existing waste disposal capacity in most regions of the country unless the amounts imported were very great (e.g. in excess of about 50,000 tonnes/year at any facility).

Countries that have been receivers of EOL electronics destined for recycling from Canada in recent years are becoming increasing concerned about the impact of those products in their countries. The impact of those countries effectively closing their borders to the import of such products (except those that were legitimately intended for sale as product) would likely have significant consequences on the quantities of EOL electronics requiring management under the BMP.

6.3.2 Market Development

Markets for materials recovered from EOL electronics have been discussed in Section 3.5. Most materials in EOL electronics can be readily absorbed into world markets for those materials. Two materials, however, will particularly benefit from market development activity:

- Leaded glass
- Plastics

Export markets exist for leaded glass at a net cost. Niche markets also exist for leaded glass in architectural and specialist glass (e.g. crystal) applications. One Canadian CRT processor has developed a market in the lighting industry. Nova Pb, near Montreal, may accept small quantities of leaded glass in its secondary smelting process; however, the silica in glass has been found to damage its furnace refractory lining. The Noranda lead smelter in Belledune, New Brunswick, has accepted small quantities of leaded glass. Teck Cominco is expecting to receive an annual quantity of 15,000 tonnes of EOL electronic products (including leaded glass) that it will process at its facility in Trail, B.C.. Markets for leaded glass in Canada generally require a fee be paid to the end-user to accept the material; alternatives are required in which leaded glass provides value-added benefit that generates revenue to glass suppliers.

Countries around the world are attempting to develop markets for plastics recovered from EOL electronics. There is considerable misinformation on this subject. Technologies exist to recycle EOL electronic plastics. Regulatory DfRe requirements to oblige suppliers/producers to label plastics according to resin and major additives (e.g. presence of flame retardants, and what they are) would facilitate the recycling of these materials. Opportunity also exists to attract new plastics recycling technology to mechanically separate and process plastics for recycling; the key requirement in this regard is legislation that ensures a constant supply of plastic to justify the necessary investment.

One company in the UK (Encapsulated Waste Ltd.) has developed a process for combining glass from CRTs with mixed plastics to create a building material. Another company has developed a confidential process to separate brominated plastics from non-brominated plastics and to separately recover both plastics at the polymer level and the bromine. Elsewhere in Europe, focus is being placed on technologies for incorporation of plastics and glass into construction materials.

Box 3
Market Development in the UK - The Case of London Remade

London Remade is the largest of several "Remade" (Recycling Market Development) initiatives in the UK. The initiative is an economic development and "social regeneration" initiative of the London Development Agency that links business, community and government sectors in developing recycling initiatives. Focus is placed on market development, and within this particular focus is placed on developing markets for EOL electronics that will be processed following implementation of the WEEE Directive. A main activity of London Remade within EOL electronics market development has been to work with MBA Polymer to create a plastics recycling facility; this work is

Box 3 highlights market development actions in London, UK..

In Canada, social organisations have targeted the refurbishment of cell phones, office equipment and disassembly generally as an opportunity to employ socially disadvantaged people; SARCAN in Saskatchewan has advanced province-wide proposals in this regard, and recent initiatives have been taken in Chicoutimi-Sagenuay, Quebec. The Computers for Schools program sees opportunity to expand its activities across the country. Market development actions can facilitate maximising these opportunities, and possibly opening export markets for refurbished equipment processed by social organisations. The asset management sector continues to grow.

7.0 BENEFITS ANALYSIS

Achievement of the BMP will result in the following benefits:

- Resource conservation benefits, including energy savings, reduction in manufacturing greenhouse gas emissions, and reductions in resource depletion
- Economic benefits, including revenues from recyclable materials and job creation.

The extent of these benefits is estimated in this section.

7.1 Resource Conservation[62]

7.1.1 Energy Savings

Reuse and recycling saves energy. Saving energy is an important benefit of recycling, because using energy usually requires fossil-fuel consumption and involves air and water pollutant emissions. The energy required to manufacture plastics, glass and metal from recycled materials is generally less than the energy required to produce them from virgin materials. Additionally, providing recycled materials to industry (including collection, processing, and transportation) typically uses less energy than supplying virgin materials to industry (including extraction, refinement, transportation and processing). Energy savings calculations encompass “feedstock energy” (the energy content of the petroleum and coal raw materials converted to plastic and steel, respectively) and energy required to process and transport materials throughout the life cycle of the materials.

Recycled metals consume significantly less energy and water, and produce less air pollution, than manufacture of products from virgin materials. For example, it has been estimated that, compared to manufacture from virgin materials, recycled steel:

- Uses 74% less energy
- Uses 40% less water
- Reduces air pollution by 86%
- Reduces water pollution by 76%

For other metals, the energy savings are: aluminum - 95%; copper - 85%; lead - 65%; zinc - 60%. Under the BMP material flows diverted from disposal, energy savings resulting from the reuse and recycle of EOL electronic products material will total 7.99 million BTUs per year based on material flows for 2005. Table 23 summarises energy savings associated with implementation of the BMP.

7.1.2 Reduction In Manufacturing Greenhouse Gas Emissions

By diverting EOL electronic products, the recycled material replaces the need for an equivalent amount of virgin materials. This results in a significant decrease in greenhouse gases (GHG) in the manufacture of new products using secondary resources as compared to the use of virgin resources. Table 24 provides preliminary factors for reduction in GHG emissions for each of the relevant material streams found in recycled electronics products. All reduction factors are in tonnes of equivalent carbon dioxide saved by

[62] Throughout the analysis of resource conservation savings, it is assumed that all EOL electrical products that are separately collected are recycled. The impact of reuse is to increase benefits associated with energy conservation and reduced GHG emissions, and leave benefits unchanged with respect to resource depletion.

Table 23
Energy Savings and GHG Impacts From Recycled Materials Under BMP
(Relative to Energy Required for Virgin Production, Canada 2005)

MATERIALS	TONNES RECOVERED	BTUS SAVED (IN MILLIONS)	TONNES OF GHG REDUCED
Aluminum	3,860	1,512,117	38,991
Ferrous	41,474	1,852,751	48,109
Copper	4,853	683,992	17,762
Other Metals	11,979	585,875	15,214
Glass	41,285	152,966	4,541
Plastic	39,081	3,198,543	69,174
Total	142,533	7,986,244	193,791

Table 24
Average Tonnes of Equivalent CO_2 Emission Reductions Resulting from Materials Recycled

Recycled Materials	CO_2 Emissions Reduction Factors (Tonnes)
Aluminium	10.10
Steel	1.16
Copper	3.66
Other Metals	1.27
Glass	0.11
Plastic	1.77

using the recycled material versus the virgin material.[63] For example, for every tonne of aluminum recycled, a GHG emission reduction of 10.10 tonnes of equivalent CO_2 is achieved as compared with a tonne of virgin aluminum produced.

Table 23 identifies GHG emission reductions associated with achievement of the BMP attributable to each material. Table 25 attributes these on a provincial basis according to the quantities of materials recovered in each province under the BMP. This represents a yearly reduction in CO_2 emissions resulting from the flow of materials for reuse and recycle under the BMP as opposed to producing an equivalent amount of virgin materials. As can be seen in Table 25, if the potential amount of EOL electronic material under the BMP is diverted for reuse or recycle, 193.8 thousand tonnes of carbon dioxide emissions would be avoided.

7.1.3 Raw Resource Replacement Benefits

Recycling and reuse also conserves natural resources.. For example, by recycling more than 40,000 tonnes of steel, recycling efforts reduce the need for virgin materials by twice that amount, including 50,190 tonnes of iron ore, 28,000 tonnes of coal and 2,400 tonnes of limestone. In the case of aluminum, there are 4 tonnes of bauxite saved for every tonne of aluminum recycled. In the case of glass, every

[63] Preliminary factors for reductions in Green House Gas (GHG) emissions provided by Natural Resources Canada in tonnes of carbon dioxide emission reductions resulting per tonne of recycled material as compared to an equivalent amount of virgin materials produced.

Table 25
Reduction in CO_2 Emissions Resulting From Estimated Materials Flow Under BMP of EOL Electronic Products (Accounting for Waste Generated by Recycling): 2005 (Tonnes)

JURISDICTION	GLASS	ALUMINUM	COPPER	FERROUS	OTHER METALS	PLASTIC	BMP TOTAL
Alberta	507	4,899	2,024	5,934	1,632	8,247	23,244
British Columbia	577	4,768	2,242	5,924	1,955	8,616	24,082
Manitoba	160	1,297	621	1,619	544	2,365	6,605
New Brunswick	101	792	388	992	346	1,464	4,082
Newfoundland and Labrador	72	600	281	746	245	1,083	3,027
Northwest Territories	8	87	32	102	24	139	391
Nova Scotia	127	1,009	489	1,259	433	1,853	5,170
Nunavut	4	35	16	38	14	56	163
Ontario	1,783	15,567	6,994	19,157	5,941	27,408	76,850
Prince Edward Island	18	139	69	178	63	264	732
Quebec	1,038	8,553	4,036	10,628	3,525	15,473	43,255
Saskatchewan	141	1,201	552	1,481	475	2,136	5,986
Yukon	5	44	19	51	15	70	203
Total Canada	4,541	38,991	17,762	48,109	15,214	69,174	193,791

tonne of glass made from 50% recycled materials saves 250 pounds of mining waste. One ton of recycled plastic saves 16.3 barrels (685 gallons) of oil, 98 million Btu's of energy, and 30 cubic yards of landfill space.[64]

Table 26 shows the savings in raw material resources as a result of reuse and recycling under the BMP material flows for EOL electronics in 2005. These savings in raw material resources occur on an annual basis, resulting from the annual flow of materials generated through the material flows associated with BMP. As the material flows in 2010 increase, the savings in raw material resources increase annually, corresponding to the increases in recycled and reuse material flows diverted from disposal.

7.2 Revenues From Sale Of Recyclable Materials

Revenues from the sale of recyclable materials are estimated by applying the lower level of the market values identified in Section 3.5 to the materials that would be recovered under the BMP as shown in Table 20. Table 27 identifies the value of materials that would be recovered on this basis.

[64] Savings in raw materials and natural resources with recycled materials versus virgin materials taken from Environmental Protection Agency and University of Massachusetts, Office of waste Management, moving and Surplus Property, publication, *Environmental Benefits of Recycling,* 2005.

Table 26
Savings in Raw Material Resources As a Result of Reuse and Recycling under the BMP, 2005 (Tonnes)

Recycled Materials	Resource Savings					Mining Waste Averted
	Bauxite Saved	Iron ore	Coal	Limestone	Oil	
Total	15,442	73,174	40,989	3,557	68,787	5,160,571

Table 27
BMP Revenues from Recyclable Materials (2005)

Jurisdiction	Glass	Aluminum	Copper	Ferrous	Other Metals	Plastics	Printing Wiring Boards
Sub-Total: Atlantic Canada	(657,723)	249,660	203,253	573,449	89,205	253,308	927,200
New Brunswick	(208,164)	77,805	64,268	179,237	28,405	79,525	290,700
Newfoundland and Labrador	(149,853)	58,995	46,503	134,653	20,045	58,834	214,700
Nova Scotia	(261,877)	99,180	80,988	227,430	35,530	100,634	368,600
Prince Edward Island	(37,829)	13,680	11,495	32,129	5,225	14,317	53,200
Sub-Total: Quebec	(2,147,057)	840,465	668,800	1,919,618	288,610	840,494	3,070,400
Quebec	(2,147,057)	840,465	668,800	1,919,618	288,610	840,494	3,070,400
Sub-Total: Ontario	(3,679,236)	1,529,595	1,158,905	3,460,005	484,975	1,488,498	5,432,100
Ontario	(3,679,236)	1,529,595	1,158,905	3,460,005	484,975	1,488,498	5,432,100
Sub-Total: Western Canada	(2,857,866)	1,195,290	901,313	2,701,724	375,915	1,160,159	4,233,200
Alberta	(1,043,119)	481,365	335,445	1,071,809	132,430	447,678	1,632,100
British Columbia	(1,192,554)	468,540	371,498	1,070,004	160,075	467,951	1,708,100
Manitoba	(330,429)	127,395	102,933	292,410	44,555	128,535	469,300
Saskatchewan	(291,764)	117,990	91,438	267,501	38,855	115,995	423,700
Sub-Total: Territories	(33,858)	16,245	10,973	34,476	4,275	14,421	55,100
Northwest Territories	(16,093)	8,550	5,225	18,411	1,900	7,524	28,500
Nunavut	(8,151)	3,420	2,613	6,859	1,140	3,135	13,300
Yukon	(9,614)	4,275	3,135	9,206	1,235	3,971	13,300
Subtotal Canada	(9,375,949)	3,831,255	2,943,243	8,690,353	1,243,075	3,757,089	13,716,100

Notes
1. Revenues for glass assume processing of CRTs at a cost of $US 0.22/kg
2. Revenues for plastic calculated on the basis of mixed plastics at $US 0.11/kg. Application of technology to separate mixed plastics, or disassembly into separate plastics types would raise revenue to as much as $0.60/kg, depending on plastic type.
3. All material revenues identified in Table 27 are estimates.

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8.0 FEASIBILITY ASSESSMENT OF RECOVERY OF EOL ELECTRONICS PRODUCTS IN ATLANTIC CANADA

This chapter sets out a feasibility assessment for the recovery and reutilisation of EOL electronic products in the Atlantic provinces that will achieve the "Best Management Practice" (BMP) identified in Section 6. The objective of the feasibility assessment is identified together with assumptions that underpin the assessment, the quantities of EOL electronics generated in Atlantic Canada is summarised, options for the recovery and reutilisation of EOL electronic products are detailed and a preferred option is recommended, the stewardship model that should be applied to the management of EOL electronics is identified, key elements of the regulatory/institutional framework that should govern the recovery of EOL electronic products are identified and implementation is addressed.

8.1 Objective

The objective of the feasibility assessment is to identify the broad design of a system to provide for the end-of-life management of the electronic products that are the focus of this document in accordance with the C-WPEPS. Details of implementation in any province or the region as a whole may vary in order to address specific local circumstances, and these should be addressed in detailed design at the time a decision is made to proceed with implementation.

The feasibility assessment is based on two assumptions:

- Disposal of EOL electronic products or their materials will not be allowed without prior processing for recycling.
- Management systems and facilities will conform to the Recycling Vendor Qualification Standards developed by ESPC, or their equivalent.

Taken together, these assumptions provide for: (i) all EOL electronic products that are the focus of this document to enter a processing system that meets established environmental standards; and (ii) the disposal of EOL electronics or materials only if there are not economically viable markets after processing.

8.2 Estimated EOL Electronics Products Generated And Collected In Atlantic Canada

Table 28 summarises the quantities of EOL electronics products that are estimated to require end-of-life management in 2005 and 2010 in each of the Atlantic provinces. As identified in Section 6, it is assumed that under the BMP 95 percent of the EOL electronics that are identified in Table 28 will enter an EOL management system.[65]

8.3 Recovery of EOL Electronics Products in Atlantic Canada

The identification of a preferred system for the recovery and recycling of EOL electronic products in Atlantic Canada will require the following to be addressed:

[65] The quantities of EOL electronics identified in Table 28 are summarized from data presented in Section 2. As indicated in Section 2.1.2, these data exclude products that currently enter a second or subsequent life, and therefore exclude current private sector leasing and commercially-motivated asset management activities. Implementation of the BMP scenario therefore addresses EOL electronic products not currently captured by these private sector activities, which are assumed to continue separate from, but in parallel with, the actions identified in this Section.

Table 28
EOL Electronic Product Generation In Atlantic Canada (tonnes)

		New Brunswick	Newfoundland and Labrador	Nova Scotia	Prince Edward Island	**Atlantic Canada**
Cell Phones	2005	9	7	11	2	29
	2010	6	4	7	1	18
Telephones	2005	42	31	53	7	133
	2010	59	44	75	11	189
Stereos	2005	145	101	182	27	455
	2010	278	194	348	51	871
Rechargeable Batteries	2005	6	4	7	1	18
	2010	ND	ND	ND	ND	ND
Computers	2005	601	460	766	107	1,934
	2010	694	531	884	123	2,232
Monitors	2005	812	613	1,032	145	2,602
	2010	523	394	664	93	1,674
Computer Peripherals	2005	524	399	667	93	1,683
	2010	547	417	696	97	1,757
TV's	2005	1,411	991	1,766	259	4,427
	2010	1,894	1,329	2,370	347	5,940
Total	2005	3,550	2,606	4,484	641	11,281
	2010	4,001	2,913	5,044	723	12,681

- Collection of EOL electronic products;
- Determination of where and how recovered EOL electronic products will be managed;
- Identification of the logistics associated with the collection and management system.

It is assumed that all the products identified in the above table will be targeted for management through the system detailed in this section, except that rechargeable batteries will be managed through the stewardship system being established by the RBRC.

8.3.1 Collection

The design of a collection system for EOL electronics is guided by the following C-WPEPS Principles:

- *Principle 5: Consumers have reasonable access to collection systems without charge.*
- *Principle 7: Program design and implementation will strive for equity and consistency for consumers, particularly those who live in adjacent urban jurisdictions and between those who live in small, rural and remote communities and large urban centres.*

The design of a collection system consistent with Principle 5 requires an interpretation of “reasonable access”. Principle 7 recognises that within a principle of equity and consistency, some flexibility will be required to address the specific needs and constraints of small, rural and remote communities.

Analysis in Section 2 of this document identified that the most appropriate approach for collection of EOL electronics in Canada is for consumers to bring their EOL electronics to permanent collection points. Two approaches are possible: collection can be performed by retailers on a “sell one, take an old one back” or other basis, or a network of collection points can be established. Because a large and increasing

proportion of electronics are sold direct over the internet, however, and may not be captured through a retailer "sell one take an old one back" or similar system, it is necessary to establish a network of collection points.

In the context of consumers and others bringing EOL electronic products to a collection point, the term "reasonable access" used in C-WPEPS Principle 5, above, is understood to mean that consumers would have access to a collection point that is located in a place that is generally frequented by the consumer on a regular basis. This implies different things in different places; in large urban centres one or two collection points might provide "reasonable access" for large numbers of people, while in rural areas lower population densities imply that larger numbers of collection points per population served would be appropriate, and in remote areas the provision of "reasonable access" means addressing the needs of very small communities disbursed across large areas.

In Alberta, the province with the widest experience in EOL electronics management, over 100 collection points have been established – usually at municipal waste management sites - of which 6 serve Calgary and Edmonton (3 in each city) and 6 serve Lethbridge. The remaining 109 sites are generally located on the basis of 1 per town and serve an average of about 10,100 people each. In Saskatchewan, SARCAN has reviewed opportunities to establish a provincial program for the recovery of EOL electronic products based on its existing recycling depot network across the province. Saskatoon, Regina and Prince Albert have multiple depots; the 59 depots implemented elsewhere serve an average of about 16,500 people each.

In addition to population served by a collection point, it is also relevant to consider convenience of location to residents: no matter what the population served by a collection point, if it is not convenient for residents it will not be used. Recent work in Newfoundland and Labrador has determined that 95 percent of users of Green Depots live within a 30 minute drive of a depot[66]. Broadly similar distributions of travel time to recycling depots are believed to occur in New Brunswick, Nova Scotia and PEI. Newfoundland and Labrador has also established "satellites" (under the aegis of a collection depot) for recovery of recyclable materials from remote areas.

EOL electronic products are generated on a very infrequent basis. It may therefore be considered that a lower density of collection points is required for EOL electronic products as compared to the density of recycling depots that have been established in each of the Atlantic provinces for the primary purpose of recovering consumer items (e.g. beverage containers) that are generated on a very frequent basis. A reduced density of collection points may therefore be feasible for the recovery of EOL electronic products (as compared to the density of collection points/depots for other products) to the extent that collection points are located in places that people normally travel to. Thus, while collection points need not be located on the basis of one in "every neighbourhood" or "every town", they should be conveniently located within an area that people would normally travel over a period of several weeks.

Other factors are also important in identifying the number of collection points for EOL electronic products:

- Overall EOL electronic product recovery costs rise if large numbers of small drop-off sites require multiple trips to transport EOL electronic products from collection points to subsequent management points, and to the extent that multiple handling of EOL electronic products is required to make up full truck loads for transportation purposes.

[66] LURA Group, SNC Lavalin, EDM Group, *A Review of the Newfoundland and Labrador Green Depot Recycling System*, Multi-Materials Stewardship Board, St. John's, 2003 – unpublished.

Table 29
Site Locations for Collection of EOL Electronic Products
in Atlantic Canada

NEW BRUNSWICK	NEWFOUNDLAND AND LABRADOR	NOVA SCOTIA	PRINCE EDWARD ISLAND
Bathurst	Baie Verte	Amherst	Alberton
Buctouche	Bonavista	Annapolis Royal	Charlottetown
Campbellton	Carbonear	Antigonish	Montague
Caraquet	Channel-Port aux Basques	Baddeck	Summerside
Edmundston	Clarenville	Bridgewater	
Fredericton	Corner Brook	Cape Breton RM	
Grand Falls	Gander	Digby	
Miramichi City	Happy Valley-Goose Bay	Halifax (2)	
Moncton	Grand Falls-Windsor	Kentville	
Perth-Andover	Labrador City	Kingston	
St. John	Lewisporte	Liverpool	
St. Stephen	Marystown	Meteghan	
Sussex	Placentia	New Glasgow	
Tracadie	St. Anthony	Port Hawkesbury	
Woodstock	St. John's	Shelburne	
	Stephenville	Truro	
	Trepassey	Yarmouth	
		Windsor	

- Overall system efficiency and effectiveness depends on the capacity of collection point operators to properly handle collected items. Large numbers of collection points that each collect small quantities of EOL electronic products may result in business opportunities for individual operators that are insufficient to sustain the levels of training and investment in effective operations that are necessary for managing EOL electronic products.

For the purpose of this document, the location of collection points that provide “reasonable access” to consumers is defined as follows:

- One collection point for each city with a metropolitan population of 50,000 or more people; an additional collection point for a metropolitan population greater than 200,000. City collection points to also serve an area within 50 kms. of the city.
- One collection point for each town with a metropolitan population of 10,000 people; these collection points also serve an area generally within 50 kms of the town.
- Collection points to be strategically established in remaining “rural” areas to serve populations of 10,000 people within up to approximately a 50 km radius.
- “Satellite” collection points to serve remaining sparsely populated and remote areas.

EOL electronic product collection points should be located as identified in Table 29.

8.3.2 Management of Collected EOL Electronic Products

The management of collected EOL electronic products is guided by the following C-WPEPS principles:

- *Principle 4: Management of e-waste is environmentally sound and consistent with the 4R waste management hierarchy: a. Reduce, including reduction in toxicity and redesign of products for improved reusability or recyclability; b. Reuse; c. Recycle; d. Recovery, of materials and/or energy from the mixed e-waste stream*
- *Principle 11: E-waste is managed in the most economically and logistically feasible manner, while striving to maximize local economic and social benefits*

Analysis elsewhere in this document has identified that reuse of electronic products is already a well-established practice for late-model telephones, cell phones and computers and related IT devices. The BMP presented in Section 6 has identified that 10 percent of the EOL products identified in Table 28 may have reuse potential in addition to the quantity of devices currently being reused. In addition the BMP presented in Section 5 identified that 92 percent of the materials in the EOL electronics in Table 28 can be recycled. The separation of EOL electronic products into their component fractions may be undertaken through either local disassembly or through more highly centralised mechanised processes. Some management approaches may be suited to one or more of the products that are the focus of this document, but not necessarily to other products. Determining how best to proceed with management of EOL electronic products in Atlantic Canada following their collection therefore requires detailed analysis of options.

The following approaches can be considered in Atlantic Canada for management of EOL electronic products following their collection:

- Processing and recycling, where feasible, of materials through markets in the Atlantic Canada region and shipment of other products/materials for centralised processing and recycling outside the region.[67]
- Shipment of all materials to processing and recycling facilities outside the region. There are markets in central Canada and the north-eastern U.S. for EOL electronic product materials generated in Atlantic Canada, including "glass-to-glass" recycling opportunities that are not available in Atlantic Canada and which represent a better fit with Principle 4 of the C-WPEPS. Within this approach, the location of available "glass-to-glass" CRT recycling markets and their specifications for acceptance of CRTs allows consideration of this option both with and without local disassembly of EOL products that contain CRT's (i.e. monitors and televisions) so that this approach contains two options for consideration.
- Local disassembly of EOL products and shipment of recyclable materials to end-use markets.
- Installation of centralised systems for mechanised separation of materials and shipment of separated materials to end-use markets.

Recovery of EOL electronic products for reuse can be integrated into each of these approaches and is addressed in Section 8.3.5.

Five specific options are therefore considered for management of EOL electronics following their collection. Detailed technical and cost data including all calculations and technical and design assumptions are identified in Annex J. The options are:

- *Option 1:* Shipment of CRTs to Noranda's Belledune (New Brunswick) lead smelter, shipment of cell phones to ReCellular's Toronto facility for reuse and processing, and shipment of remaining materials to Noranda's processing facility in Brampton, Ontario for processing and management. This approach achieves high levels of materials processing, but the lowest quality of materials recovery. CRT's are primarily used for materials substitution and the glass is discarded in slag or used in slag in low-grade

[67] This approach is constrained by the availability of only a single market for a single material in the Atlantic Canada region. This is the use of CRTs at Noranda's Belledune lead smelter in New Brunswick, an approach that represents a relatively unattractive materials recovery policy option in that the major component of CRTs – glass – is used in a materials substitution context and is not in fact recycled, although it reduces other virgin material inputs that would otherwise be required.

construction applications. Plastics processed at Noranda's Brampton facility are burned at Noranda's Horne smelter, an approach considered as disposal notwithstanding the displacement of other forms of energy by the plastics.

Implementation of Option 1 would involve:

(i) The disassembly of monitors and TVs at collection depots. This would require a cadre of technicians to be trained in monitor and TV disassembly. The technicians could either be staff working at a collection point or individuals contracted on an "as needed" basis.
(ii) Shipment of cell phones to ReCellular's Toronto facility for reuse and processing
(iii) The transportation of trailer loads of CRTs from collection depots to the Noranda Belledune smelter.
(iv) The transportation of trailer loads of EOL telephones, stereos, computers, peripherals and non-CRT materials from monitors and TV's from collection points to Noranda's Brampton, Ontarion, facility for processing.

- *Option 2:* Shipment of TV's and monitors for "glass-to-glass" recycling at a US facility, shipment of cell phones to ReCellular's Toronto facility for reuse and processing, and shipment of remaining materials to Noranda's processing facility in Brampton, Ontario for processing and management. This results in significantly increased levels of materials recycling as a function of the "glass-to-glass" recycling approach, but the continued disposal of plastics at the Horne smelter.

  Implementation of Option 2 would involve:

  (i) The transportation of monitors and TVs (without disassembly) from collection points to EnviroCycle in Hallstead, Pennsylvania for processing and glass-to-glass recycling using overseas markets. EnviroCycle claims to send all other materials recovered from monitors and TVs to materials recycling markets.
  (ii) Shipment of cell phones to ReCellular's Toronto facility for reuse and processing.
  (iii) The transportation of trailer loads EOL telephones, stereos, computers, and peripherals from collection points to Noranda's Brampton, Ontario, facility for processing.

- *Option 3:* The same as Option 2, but with the processing of monitors and TVs prior to shipment in order to ship only whole CRTs, not whole monitor and TV units, to EnviroCycle in Hallstead, Pennsylvania. This option may hold financial attractiveness if lower costs associated with management of CRT's by the EnviroCycle more than offsets the cost of local disassembly of TV's and monitors and the cost of managing their non-CRT components.

  Implementation of Option 3 would be similar to Option 2, except that CRT's would be disassembled prior to shipment. This would option would involve:

  (i) The disassembly of monitors and TVs at collection points. This would require a cadre of technicians to be trained in monitor and TV disassembly. The technicians could either be staff working at a collection point or individuals contracted on an "as needed" basis.
  (ii) The transportation of trailer loads of CRTs from collection points to EnviroCycle in Hallstead, Pennsylvania for processing and glass-to-glass recycling using overseas markets.
  (iii) Shipment of cell phones to ReCellular's Toronto facility for reuse and processing.
  (iii) The transportation of trailer loads EOL telephones, stereos, computers, peripherals and non-CRT materials from monitors and TV's from collection points to Noranda's Brampton facility for processing.

Options 1, 2, and 3 all involve Noranda's Brampton facility for the processing of EOL electronics. Other processing facilities may also be feasible. However, Noranda's Brampton facility is the only processing facility in eastern Canada known to meet the requirements of the Recycler Vendor Qualification Standard established by EPSC and, in addition, is known to have sufficient capacity to accept the quantity of

materials available from Atlantic Canada. The identified "glass-to-glass" recycler in the US is the closest "glass-to-glass" CRT processing facility for recycling to Atlantic Canada.

- *Option 4:* Local disassembly of EOL electronic products and sale of recovered materials to end-use markets. This approach would maximise local materials recovery associated with EOL electronics management, and would maximise local socio-economic benefits. Current infrastructure for disassembly of EOL electronics is highly limited in Atlantic Canada and required infrastructure and facilities would therefore need to be created. The required infrastructure and facilities might be developed at the collection point, or on a more or less centralised basis in each province, or at the regional level. For the purpose of this assessment, it is assumed that disassembly facilities would be located in the major centres in each province; the advantages of this approach are that it would provide cost-efficiencies associated with larger operations (as compared to the option of disassembly being undertaken at individual collection points) and would incur reduced transportation costs and environmental impacts (as compared with the option of fully centralising disassembly in each province).

  The following operations are associated with disassembly:

  (i) Transportation of collected EOL electronic products from the collection points to the disassembly facilities.
  (ii) Disassembly of electronic products.
  (iii) Shipment of recovered materials to end-use markets.

  The disassembly of large quantities of EOL electronics would present a major logistics challenge during its initial implementation. It is therefore assumed that initial disassembly would address computers, monitors, printers and scanners, and TV's, and that cell phones would be shipped to Toronto-based markets for reuse and processing. Remaining EOL electronic products (keyboards, stereos and telephones) make up a small percentage of the weight of EOL electronics (about 8 percent) but a large proportion of EOL electronic items (about 47 percent). These items would therefore be considered for a second phase of products to be disassembled and that during the initial implementation phase they would be shipped to Noranda in Brampton, Ontario, for processing.

- *Option 5:* Undertake mechanical processing of materials in Atlantic Canada. Facilities do not currently exist in Atlantic Canada to undertake this activity and therefore new investment would be required.

  Implementation of Option 5 would require investment in mechanised processing facilities for processing computers, peripherals, TV's, monitors, telephones and stereos collected in Atlantic Canada; cell phones would be sent to Toronto-based markets for reuse and processing. High throughput levels are required at mechanized processing facilities to achieve operating efficiencies; accordingly, it is assumed that EOL electronic products from all of Atlantic Canada would feed one mechanised processing facility. This option would therefore involve:

  (i) The transportation of EOL electronic products to a single facility serving Atlantic Canada.
  (ii) The processing of EOL electronic products
  (iii) Shipment of recovered materials to end-use markets.

The management of rechargeable batteries can be integrated into each of these options. Infrastructure for the recovery of rechargeable batteries has been implemented through the RBRC. Rechargeable batteries can be recovered through the RBRC program at any facility in the Atlantic provinces and shipped for recycling using established RBRC shipping systems, at RBRC cost.

8.3.3 Costs of Recovery of EOL Electronic Products

Table 30 summarizes the costs of EOL electronic product management in Atlantic Canada. Annex J provides details for each province and for each option on the assumptions and calculations that underlie the data in this table. The table should be understood in the context of the following:

Table 30
Summary of Costs for Recovery of EOL Electronic Products in Atlantic Canada

Province	Quantity of EOL Electronics Collected (kgs)	Annual Collection Depot Cost ($)	Processing Option	Annual Processing Cost ($)	Cost ($)	
					Total Annual Cost	Cost/ Kilogram
New Brunswick	3,372,840	410,517	1. Ship to Noranda (Brampton) and Noranda (Belledune)	3,203,379	3,613,896	1.07
			2. Ship to Noranda (Brampton) and EnviroCycle (Pennsylvania) – no pre-processing	2,365,548	2,776,065	0.82
			3. Ship to Noranda (Brampton) and EnviroCycle (Pennsylvania) – with pre-processing	3,410,844	3,821,361	1.13
			4. Disassembly in province of generation	2,150,566	2,561,083	0.76
			5. Regional processing facilities (Provincial share of total cost)	2,467,970 - 3,538,414	2,878,487 – 3,948,931	0.85 – 1.17
Newfoundland and Labrador	2,475,200	366,974	1. Ship to Noranda (Brampton) and Noranda (Belledune)	2,595,991	2,962,965	1.20
			2. Ship to Noranda (Brampton) and EnviroCycle (Pennsylvania) – no pre-processing	2,050,689	2,417,663	0.98
			3. Ship to Noranda (Brampton) and EnviroCycle (Pennsylvania) – with pre-processing	2,768,442	3,135,416	1.26
			4. Disassembly in province of generation	1,834,861	2,201,835	0.89
			5. Regional processing facilities (Provincial share of total cost)	1,967,279-2,726,059	2,334,253 – 3,093,033	0.94 - 1.25
Nova Scotia	4,259,800	514,295	1. Ship to Noranda (Brampton) and Noranda (Belledune)	4,131,404	4,645,699	1.09
			2. Ship to Noranda (Brampton) and EnviroCycle (Pennsylvania) – no pre-processing	3,079,537	3,593,832	0.84
			3. Ship to Noranda (Brampton) and EnviroCycle (Pennsylvania) – with pre-processing	4,387,020	4,901,315	1.15
			4. Disassembly in province of generation	2,685,069	3,199,364	0.75
			5. Regional processing facilities (Provincial share of total cost)	3,102,988-4,498,845	3,617,283 – 5,013,140	0.85 - 1.18
Prince Edward Island	608,950	91,167	1. Ship to Noranda (Brampton) and Noranda (Belledune)	593,417	684,584	1.12
			2. Ship to Noranda (Brampton) and EnviroCycle (Pennsylvania) – no pre-processing	439,462	530,629	0.87
			3. Ship to Noranda (Brampton) and EnviroCycle (Pennsylvania) – with pre-processing	627,723	718,890	1.18
			4. Disassembly in province of generation	461,004	552,171	0.91
			5. Regional processing facilities (Provincial share of total cost)	445,466-644,320	536,633 – 735,487	0.88 – 1.21

- *Quantity of Electronics Collected* Under the BMP scenario presented in Section 6, it is assumed that 95 percent of EOL electronic products that are generated will be separately collected for processing.
- *Annual Collection Point Cost* Collection point costs are independent from processing options. Therefore the same cost pertains for each processing option.

  Costs are inclusive of all anticipated costs, except that in some instances it may be necessary to locate "satellite" collection sites that feed into a collection point. "Satellite" sites should be located, in particular, to serve remote communities on the south coast of Newfoundland, the Great Northern Peninsular of Newfoundland, communities in Labrador other than Labrador City and Happy Valley-Goose Bay, and northern Cape Breton island. "Satellite" sites might be most effectively implemented in these communities at local public works yards, and would feed into the closest collection point identified in Table 29. This would be coordinated between the collection point and "satellite" operators. Costs associated with "satellites" and related transportation would be high on a per kilogram basis, but the very small quantities of EOL products that are recoverable from these locations would have only a minor impact on overall provincial collection depot costs. These issues can be addressed as part of detailed program design/implementation.

  The extent to which new capital costs are incurred to implement collection points for EOL electronic products will depend on the extent to which these sites are co-located with existing businesses (either recycling depots or other businesses) and the extent to which these businesses may need to invest in additional equipment. However, it is anticipated that collection of EOL electronics will be integrated into the collection of other recyclable products and materials at elected existing recycling collection sites, or will be integrated with other existing businesses.

- *Annual Processing Cost* These costs include all anticipated costs for the management of EOL electronics from the point that they leave a collection point to the point of sale of recovered materials. For each province, Options 1 – 3 involve the use of existing processing facilities; capital costs associated with processing will not be required. For each province, Options 4 and 5 will require investment in new facilities; as identified in Annex J, capital costs have been depreciated in order to identify annual costs. Option 4 assumes that only materials that are generated within a province enter disassembly facilities in that province. Option 5 assumes that regional processing facilities would be used to process all EOL electronic products in Atlantic Canada, and that the cost to each province would be proportional to the percentage of total EOL electronic products they contribute. Option 5 is expressed as a range to reflect the significance on cost of the specific location of new processing facilities and the specific type of technology adopted and its related cost structures. The costs identified in Table 30 identify that disassembly is competitive with mechanised processing; this reflects high capital costs associated with mechanised processing equipment and the practice of commercial mechanised processing systems in Canada of partially disassembling some EOL electronic components (e.g. monitors and televisions) before mechanised processing for health, safety and/or environmental reasons.

- *Total Annual Cost* This is the sum of the "Annual Collection Point Cost" and the "Annual Processing Cost", including all transportation.

- *Cost/Kilogram* This is calculated as the total annual cost divided by the quantity of EOL electronics collected. The lowest cost option in each province is identified as Option 4: Disassembly in Province of Generation, except for PEI for which Option 2 involving shipment of EOL products out of province is marginally less costly than Option 4.

For Options 1 – 3, additional or lesser amounts of EOL electronic product as compared with quantities assumed in this document can be accommodated though increased or reduced frequency of transportation to processors and markets.

The costs identified for Option 4 and for Option 5, above, are based on single shift operations, 8 hours per day 5 days per week. Different operating assumptions (e.g. 2 shifts/day over 6 days/week) will result in

reduced costs. However, the operating assumptions provide scope for: (i) increased quantities of EOL electronic products (as compared with the quantities estimated in Table 28) that may occur either because of underestimation of EOL electronic product generation and collection, or because of growth over time in EOL electronic product generation and collection, or as a result of stored quantities requiring management; and (ii) for Option 4, the processing of EOL electronic products generated in a province different to the one in which they were generated. In both cases, additional amounts of EOL electronics could be accommodated through additional shifts or additional operating days per week.

Costs associated with transportation and processing of rechargeable batteries will be borne by the RBRC as part of their established rechargeable battery recycling program.

Cost estimates in Table 30 and in Annex J are subject to the following:

- Applicable taxes are not included.
- Fuel surcharges typically applied by transportation companies have not been included. These surcharges are in addition to quoted transportation rates to reflect changing fuel prices has not been included. The surcharge varies over time and by company; in October 2005 it was quoted at 11.9 percent over quoted baseline transportation costs.
- Specific markets, processing facilities and transportation rates have been assumed for recovered EOL electronic products and their materials. While all cost and revenue data are based on quoted sources, all costs and revenues are subject to final agreements with these or other processors and markets, which may result in higher or lower costs and revenues than those reflected in Table 30 or Annex J.

Investment costs for the implementation of EOL electronics product recovery vary very greatly among the options considered. Options 1, 2 and 3 have very low investment costs. These options assume that collection depots are associated with existing businesses and that EOL products and materials are shipped for processing out of province. Investment costs associated with these options are related to the procurement of gaylords.

Investment costs for Option 4 involve the establishment of disassembly facilities, and therefore require investment in land, building and equipment in addition to gaylord containers.

Investment costs associated with Option 5 involve the establishment of a regional processing facility and therefore involve investment in land, building and equipment.

Table 31 summarises investment costs associated with each of these options; additional details regarding the basis for estimated investment costs for Option 4 and Option 5 are included in Annex J.

The required investment can be met through the following approaches:

- Investment by electronics product producers (either directly, or through an entity they create or through a third party), who are responsible under the C-WPEPS for management of EOL electronic products.
- Investment by provinces.
- Investment by others under a design-build-operate or similar form of contract in which costs are paid for over time through service provision fees.

Responsibilities for meeting the investment cost associated with the recovery of EOL electronics products will require definition. However, the following programs may be considered for contributions to the investment:

- The Clean Technology Program of Sustainable Development Technology Canada, which invests in new technologies that contribute to sustainable development objectives.

Table 31
Estimated Investment Costs ($) Associated With Recovery Options

PROVINCE	PROCESSING CENTRE	OPTION					
		OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5 INVESTMENT COST	PROVINCIAL SHARE OF OPTION 5
New Brunswick	Moncton	267,300	267,300	267,300	1,878,837	12,030,100	3,786,167
	St. John				1,084,253		
	Fredericton				1,214,475		
	Total				4,177,566		
Newfoundland and Labrador	St. John's	302,940	302,940	302,940	1,785,485		2,778,533
	Corner Brook				1,386,558		
	Total				3,172,043		
Nova Scotia	Cape Breton RM	338,580	338,580	338,580	1,053,540		4,781,825
	Halifax				4,091,668		
	Total				5,145,208		
Prince Edward Island	Charlottetown	71,280	71,280	71,280	1,007,944		683,575
	Total				1,007,944		

Notes:
1. Estimated investment cost excludes land costs
2. Provincial share of Option 5 calculated on basis of proportion of total regional tonnes collected attributable to each province

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- Canada Strategic Infrastructure Fund, administered by Infrastructure and Communities Canada. This fund identifies environmental technologies as one of its priorities.
- Infrastructure Canada Program, administered by Infrastructure and Communities Canada. This fund facilitates the renewal of urban infrastructure in Canada, specifically including infrastructure for waste management.
- Municipal Rural Infrastructure Program, administered by Infrastructure and Communities Canada. This program addresses in particular the infrastructure needs of rural communities.
- Transformative Technologies Program, administered by Industry Canada. The creation of this program was announced in September 2005, and is expected to be implemented early in 2006 with a general mandate to foster the implementation of new, environmentally appropriate technologies.
- Technology Early Action Measures, administered by Natural Resources Canada, Industry Canada and Environment Canada. This program invests in clean technology projects
- Enhanced Recycling Program, administered by Natural Resources Canada. This program anticipated to be implemented in fiscal 2006/2007.
- Green Municipal Fund, administered by the Federation of Canadian Municipalities on behalf of the Government of Canada.
- Atlantic Innovation Fund, administered by Atlantic Canada Opportunities Agency (ACOA). The fund supports the application of innovative technologies.
- Business Development Program, administered by ACOA. This program supports the development of business opportunities in Atlantic Canada.

Other relevant programs may also exist at the federal, regional or provincial levels.

8.3.4 Job Creation

Job creation data are presented in Table 32**,** and are detailed in Annex J for each province.

Table 32
Employment Creation (person years/year)

	Collection	Option 1 Total	Option 2 Total	Option 3 Total	Option 4 Total	Option 5	
						Transport to Processing	Processing and Transport to Markets
New Brunswick	7.38	18.38	9.19	18.84	73.58	0.57	51.51
Newfoundland and Labrador	5.18	15.37	8.67	15.70	57.16	2.07	
Nova Scotia	9.18	23.62	12.04	24.20	92.08	0.71	
Prince Edward Island	1.36	3.39	1.73	3.47	14.00	0.10	

Collection points are required for all EOL electronic product management options. Job creation attributable solely to collection of EOL electronic products will be equivalent to an estimated 1.36 person years per year in Prince Edward Island ranging to an estimated 9.18 person years per year in Nova Scotia; New Brunswick and Newfoundland and Labrador will create 7.38 and 5.18 person years of employment per year respectively in collection points.

Additional employment would be created through implementation of Options 1, 2 and 3 as a result of the transportation of EOL electronics to processors; in Options 1 and 3 employment will also be created through the disassembly of TVs and monitors prior to transporting these items to processors. Data shown for these options include employment creation in collection points.

The most significant employment creation in each province is associated with the disassembly actions identified under Option 4. Lesser levels of employment creation are also associated with transportation of materials to and from disassembly facilities under this option. The data shown include employment creation associated with collection points.

Significant employment creation is also associated with Option 5. The major job creation benefit of this option, however, will accrue to the province that hosts the processing facilities under this option. Employment creation at collection points under this option is in addition to the employment creation shown for Option 5.

8.3.5 Reuse of EOL Electronic Products

There is high potential for some EOL electronic products to be reused. In some cases it is possible to reuse components, in other cases whole devices may be reused either directly or following refurbishment (this may vary from a simple cleaning of the devices to the upgrading of a device through replacement of some components).

EOL electronic products with reuse potential include IT equipment (i.e. computers, monitors and peripherals) and cell phones. Other items may have reuse potential, but this is likely to be highly limited. Within the options identified above, the opportunity for cell phone reuse is sufficiently high that all recovered cell phones can be sent to a reuse market. Within the IT sector, items with reuse potential will generally be those that are less than about 3 years old. The application of reuse to EOL IT devices

therefore depends on ability to separate potentially reusable items from other items that are recovered for recycling purposes. The proportion of all items recovered that have reuse potential is not known, but is likely to not exceed 10 percent.

IT items with reuse potential can be identified at either the collection point or at a processing facility (either disassembly or mechanised processing). The question of where best to identify items with reuse potential depends on the specific overall management option that is selected. Initially, it may not be feasible to identify all such items since information that permits the identification of their age or the technology they use may not be available. This is likely to change over time, however, as jurisdictions increasingly target "highest and best" EOL electronics product management. However, bar code scanning technology has been used for at least two years to track the management of EOL electronic products in Japan, and has been introduced to North America with respect to both cell phone and IT equipment management. This technology can also be used in the Atlantic provinces to facilitate the identification and separate management of items with reuse potential.

EOL electronic products that are recovered for reuse will need to pass through a process to ensure they meet minimum quality criteria and, as necessary, that they are refurbished or that their components are removed for reuse. This may be done at either the point of collection, or at the point of processing (either disassembly or mechanised processing), or by a specialised third party. However, capacity for managing EOL electronic products for reuse is highly limited in Atlantic Canada and will need to be developed. The application of reuse will therefore need to be introduced into the overall recovery of EOL electronic products in response to opportunities afforded by third parties and as local capacities develop.

Products that are recovered for reuse have commercial value. It is assumed that products recovered for reuse are revenue-neutral; i.e. that the cost of recovering and processing the products equals the commercial value of the products. The effect of EOL electronic product reuse will be to increase job creation and decrease the cost of processing for recycling through both removing materials from the recycling stream and, potentially, generating revenue if processing for reuse is revenue-positive.

8.3.6 Recommended System for Recovery of EOL Electronics

Option 4 is recommended as the preferred recovery system for EOL electronic products in Canada. This option brings employment and value added recycling benefits, retains flexibility to accommodate and promote reuse of EOL electronics over time and provides opportunity to support new industries that can utilise recycled materials. However, achieving Option 4 will require the development of infrastructure and capacity in each Atlantic Canada province. Management of EOL electronics according to one of Options 1, 2 or 3 may therefore be necessary in parallel with actions to achieve Option 4, and as these actions in support of Option 4 are taken it will be possible to progressively phase out other actions.

The cost of Option 4 applied to 2005 data is identified in Table 33 in terms of: (i) cost per EOL electronic item; and (ii) cost per new electronic item[68]. The "cost per EOL electronic item" identifies the average cost incurred to manage individual product items according to the Option 4; for example, the average cost of managing a monitor in New Brunswick would be $10.78. The "cost per new electronic item" identifies the average cost that would need to be added to new electronics in order to achieve cost recovery through internalisation of EOL management costs; for example, an average of $7.88 would need to be added to the cost of a new monitors sold in New Brunswick in 2005 in order to recover the costs of managing EOL monitors in 2005. The difference between these two numbers arises because the number of monitors sold

[68] Additional detail on these costs and costs per EOL electronic item associated with other options are identified in Annex J.

Table 33
Estimated Cost of Recommended EOL Electronic Product Management System (2005)

Product	New Brunswick				Newfoundland and Labrador				Nova Scotia				Prince Edward Island			
	Cost/ EOL Item	Cost/ Unit Sold			Cost/ EOL Item	Cost/ Unit Sold			Cost/ EOL Item	Cost/ Unit Sold			Cost/ EOL Item	Cost/ Unit Sold		
		2005	2006	2007		2005	2006	2007		2005	2006	2007		2005	2006	2007
Cell Phones	0.13	0.11	ND	ND	0.14	0.14	ND	ND	0.12	0.11	ND	ND	0.16	0.13	ND	ND
Telephones	0.79	1.00	ND	ND	0.92	1.25	ND	ND	0.78	1.00	ND	ND	1.02	1.17	ND	ND
Stereos	2.02	1.66	ND	ND	2.49	2.08	ND	ND	2.01	1.66	ND	ND	2.43	1.95	ND	ND
Computers	9.26	6.75	6.75	6.82	10.54	8.45	8.45	8.66	9.15	6.76	6.76	6.88	11.75	7.93	7.93	8.40
Monitors	10.78	7.88	7.87	8.18	12.36	9.87	9.87	10.32	10.64	7.89	7.89	8.22	12.41	9.25	9.25	9.36
Peripherals	4.24	3.55	3.54	3.63	4.80	4.44	4.43	4.55	4.18	3.55	3.54	3.22	5.08	4.17	4.16	4.20
TVs	19.46	16.18	ND	ND	23.70	20.27	ND	ND	19.37	16.20	ND	ND	23.77	19.01	ND	ND

Note: "ND" indicates no data available.

in 2005 is higher than the number of monitors requiring EOL management in that year.

The analysis in Table 33 has been extended to computers, peripherals and monitors for 2006 and 2007. It is estimated that both the number of these items requiring EOL management and new sales of these items will increase by 3.8 percent between 2005 and 2006; accordingly the "cost per new electronic item" required to pay for EOL management is the same for both years. However, sales of these items in 2007 are projected to fall, while there will be continued growth the number of items requiring EOL management and a small increase in the "cost per new electronic item" required to pay for EOL management is therefore projected.

These cost estimates are based on the outcomes of the model detailed in this document; costs will vary in response to variations in actual costs and revenues as compared to those in this model, and in response to implementation that results in variations as compared to the assumptions in this model. Costs can be reduced to the extent that EOL products are streamed for reuse and the extent to which such items generate income, disassembly times are reduced (through DfRe actions, for example), transportation costs are reduced or prices paid for recyclable materials increase.

The costs identified in this section relate to the direct management of EOL electronic products. In addition, costs for the implementation of the recommended option – or for any other option – will include:

- Management and administration costs for the stewardship entity (see next section).
- Training
- Public education and awareness
- Research and development

Key aspects of implementation of this EOL recovery and processing is presented in Section 8.5.

8.4 Stewardship Model

Principle 1 of the C-WPEPS identifies that

- *Responsibilities associated with management of e-waste are primarily borne by producers of the products, where "producers" means the manufacturer, brand owner or first importer of the product or who sells or offers for sale the product in each jurisdiction.*

This principle clearly establishes the basis for a stewardship approach to management of EOL electronic products. This chapter identifies the stewardship basis for the implementation of the recommended recovery of EOL electronic products. The following are addressed:

- The stewardship entity and its responsibilities.
- Disclosure and reporting.
- Financing of the recovery of EOL electronic products.
- "Green" procurement.
- Research and development and public awareness and education.
- Market development
- The legal framework to govern stewardship.

8.4.1 The Stewardship Entity And Its Responsibilities

The C-WPEPS identify the principle of producer responsibility for EOL electronic product management, but does not specify how producers should discharge this responsibility. In Atlantic Canada, each province has created a public sector "Public Stewardship Entity" which has responsibilities for stewardship programs in the province. In addition, each province has a policy-making entity ("Department of the Environment") with responsibilities for policy and regulation. The electronics sector has created Electronics Product Stewardship Canada, a "Private Stewardship Entity" at the national level that is working with provinces to develop electronics stewardship programs. Each province will therefore need to determine the role of both its "Public Stewardship Entity" and "Department of the Environment" with respect to the recovery and management of EOL electronic products, and the role of the "Private Stewardship Entity". Determination of roles and responsibilities of the different entities should ensure separation and clarity of the roles of the different entities.

The following options may be considered, and variations on these may also be possible:

1. Department of Environment sets EOL electronic products recovery policy and requires that "Public Stewardship Entity" implements the policy to achieve policy goals and bills the private sector on a cost recovery basis. The role of the "Private Stewardship Entity" in this option may be an advisory role.
2. Department of the Environment sets EOL electronic products recovery policy and places responsibility and accountability on "Public Stewardship Entity" to achieve goals, but allows "Public Stewardship Entity" flexibility to meet goals as it deems appropriate. "Public Stewardship Entity" may implement recovery programs itself or contract implementation to a third party (e.g. "Private Stewardship Entity") whose contractual obligations are monitored.
3. Department of the Environment sets EOL electronic products recovery policy and requires that producers participate in a joint public sector/producer organisation created and chaired by "Public Stewardship Entity" that will supervise the recovery of EOL electronic products on behalf of producers. Producers, however, will be individually accountable for the cost of EOL management of their products. Individual producers could opt out of the public sector/producer organisation if they establish recovery and management systems for their EOL products that meet the requirements of the Department of the Environment and were approved by it.
4. Department of the Environment sets EOL electronic products recovery policy and places responsibility and accountability on individual producers to meet policy goals and which allows them to meet their responsibilities either individually or through a third party (e.g. "Private Stewardship Entity"), and who would report (either directly or through a third party) to "Public Stewardship Entity", who may undertake audits as necessary to verify reported results and which would advise the "Department of the Environment" regarding status of policy achievement.

5. Department of the Environment requires that "Private Stewardship Entity" is responsible and accountable for meeting policy goals and for reporting progress to "Public Stewardship Entity", who may undertake audits as necessary to verify results.

Option 3 is considered the most appropriate of the above options for the following reasons:

- It provides for a single entity in each province that can both organise and coordinate a recovery and management system that can serve all producers and all consumers, and manage the allocation of brand-level costs to individual brand owners. There is therefore assurance that an adequate baseline service will be established.
- It allows for other recovery and management systems to be developed by producers (either individually or collectively) provided that those systems meet overall EOL recovery and management policy objectives.
- It ensures that producers participate in the organisation and management of the recovery and collection system, an appropriate arrangement given that producers will be paying for EOL product recovery and management.
- It allows producers flexibility to determine how they wish to participate in the joint public/private entity – either as individual companies or through an industry grouping such as EPSC.
- It provides a mechanism for coordinating activities that are in the direct interest of both the public sector and producers, including public awareness/education, research and development and other activities.
- It ensures long term implementation security as compared to options that place EOL product recovery and management implementation responsibility solely on producers, who change over time and whose long term interests are not necessarily consistent with public sector policy interests.
- It provides assurance to all parties of an open and transparent mechanism for achieving C-WPEPS objectives.

8.4.2 Disclosure and Reporting

Appropriate levels of disclosure and reporting will relate to the EOL electronic product recovery policies of provinces. The basis of provincial policy is the C-WPEPS. The following disclosure and reporting is therefore appropriate:

- A requirement that "producers", as defined in the C-WPEPS, whose products are sold in a province register annually with the province as a "producer" and that they register the brands of each their regulated electronic products sold in the province.
- Confidential disclosure of the number of regulated electronic products, by brand, sold in each province annually.
- Annual reports by the implementing entity of progress made towards achieving and maintaining policy goals, including numbers and weight of EOL electronic products collected and their fate.
- Identification by the implementing entity of actions to be taken in coming year to achieve or maintain policy goals.
- Audited statements submitted by the implementing entity of phase-in fees collected from consumers (see below) and their use for the management of EOL electronic products, and identifying surpluses of collected fees over expended fees that may accrue.
- Audited statements of the revenues and expenditures of the implementing entity.

8.4.3 Financing Recovery of EOL Electronic Products

The C-WPEPS identify that costs for EOL management of electronic products will not be borne by general taxpayers (Principle 2), and that consumers will have reasonable access to collection systems without charge (Principle 5).

A transitional period may be provided, however, to allow cost internalisation during the initial phase in and early implementation period of the EOL electronic product recovery program. During this period, producers may be allowed to add a visible fee to the price of a product, and these fees should be remitted

to the entity responsible for implementing the recovery program. The period of implementation of a visible fee over a transitional period will need to be negotiated on the basis that application of a visible fee during a transition period is a temporary measure whose application is not inconsistent with the C-WPEPS. The amounts of visible fees that may be collected and expended during the transitional period should be independently audited. Any accrued surpluses should be applied to research, development and/or public education in support of EOL electronic products recovery in the province.

Cost internalisation at the level of producers implies that individual devices of regulated products will be tracked through the management system and that costs for managing each brand will be paid for by the brand owner. This will require the new application in Atlantic Canada of technology (e.g. bar codes) used for tracking purposes in other sectors and also in the electronics sector.

8.4.4 Green Procurement

Public sector agencies should support the development of environmentally preferred electronic products through the application of "green procurement" practices. Environmental criteria should be established regarding what constitutes "green procurement" for each product category, and these should be reviewed periodically to ensure that they are current. In particular, public sector agencies should review the outputs of the Environmental Product Environmental Assessment Tool (EPEAT), currently under development in the US, and should implement these with respect to procurement.

The environmental performance of electronic products sold in Atlantic Canada should not be less than those sold in other OECD jurisdictions.

8.4.5 Research and Development, and Public Awareness and Education

A public/private sector committee should be established to guide the application of research and development and public awareness/education activities. Research and development should address aspects of DfRe/DfTR and the recovery and processing system that are relevant at the provincial level. Public awareness and education should ensure that all users of electronic equipment are aware of both the location of collection points and their responsibility for taking their EOL electronics to these sites. The committee should include, at a minimum, a representative of the provincial environmental regulator, the provincial "public stewardship entity", the "private stewardship entity", a relevant environmental NGO and a relevant consumer NGO.

8.4.6 Market Development

Market development is a priority in three contexts, in particular:

- *Development of markets for plastics* Large quantities of plastics will be generated through the disassembly of EOL electronic products that is recommended to be achieved in Atlantic Canada provinces. Markets exist for these plastics in central Canada. However, new markets can be created in Atlantic Canada for recovered plastics. Technology now exists to separate mixed plastics used in electronic product applications. Minimum throughputs of at least 10,000 tonnes per year are required to make application commercially attractive; Atlantic Canada can position itself for these quantities in part through imports from Europe and the US. Alternatively, it is possible that high quantities of mixed plastics would attract investment in plastic wood or other mixed plastic products.

- *Development of markets for CRTs* There are limited markets for EOL CRTs in North America, other than in smelting applications. It may be possible to identify new market opportunities for leaded glass. It may also be possible to attract leaded glass processors to Atlantic Canada and to obtain a value-added product for export to overseas recycling markets.

- *Development of reuse standards* Opportunities to market reused electronic products in Canada and overseas will be strengthened through the development of reuse standards that provide consumer confidence in the quality of reused items. In particular, this would address concerns overseas that the export of EOL electronics for reuse amounts to export of waste. Action on this market development opportunity can most appropriately be taken at a national level, but can be initiated at the Atlantic provinces level.

8.4.7 Legal Framework

A legal framework is required to give effect to the stewardship model; voluntary stewardship programs will not achieve the results articulated in the C-WPEPS. An effective legal framework establishes a "level playing field": a fair and transparent basis for EOL electronic products management that places equitable responsibilities on all regulated entities. The legal framework should be under the responsibility of the Minister responsible for Environment.

The purpose of the legal framework governing the recovery of EOL electronic products and the stewardship model through which recovery is implemented should be to:

- Establish the goals of the EOL electronic product recovery initiative.
- Establish EOL electronic product management actions that are permissible and not permissible
- Identify the entities (including the public) with responsibilities for recovery of EOL electronic products, their roles and implementation deadlines.
- Establish the basis of cost recovery.
- Establish the overall administrative framework through which the identified entities will meet their responsibilities
- Provide a basis for DfE and DfRe.
- Identify penalties for failure to comply with the legal framework.

The legal framework need not detail all the stewardship points identified in this section. Within the overall structure, the legal framework should provide for flexibility in implementation that creates incentive for regulated entities to benefit from improved environmental performance of their products. Specifically, the following should be established in the legal framework governing an EOL electronics recovery program:

- *Goal of the Program* The goal of the recovery program should be defined as the recovery of all designated EOL electronic products for reutilisation[69].

- *Scope of Program* The scope of the program should be defined to include the provision of reasonable access for all consumers to separate collection of regulated EOL electronic products, and to ensure that all separately collected EOL electronic products are processed for recycling and reuse, as appropriate. Each product should be defined for regulatory purposes since common understanding of what is meant by a particular type of product is becoming increasing unclear as a result of technology convergence (e.g. is a device that can be used for taking pictures or for talking to another person a camera or a cell phone, or something else?).

- *EOL Product Management Actions Permissible and not Permissible* The legal framework should identify that: (i) the disposal (including incineration) of any EOL product, or of materials from that product, is prohibited unless the product has first been separately collected and processed for recycling; (ii)

[69] Designated products should include the items that are the focus of this document, whether they are generated by residents or the IC&I sector, and specifically: computers, monitors, computer peripherals, telephones, cell phones, stereos, televisions and rechargeable batteries.

transportation of unprocessed EOL electronic products will only be permitted to facilities that meet the RVQS established by EPSC, or an equivalent established by the province.

- *Entities Responsible, Their Roles and Implementation Deadlines* Responsible entities and their roles should be defined in accordance with decisions addressed in Section 8.4.1, above; regardless of how these issues are resolved, the option should be provided for individual producers to opt out of an initially established collective collection/processing system (including both products/materials handling and financing/cost) and manage their own EOL products so long as they comply with all requirements of the recovery and processing program. The regulatory framework should establish a joint industry/public sector committee to oversee expenditures of money raised for public awareness/education and research and development (see below). In order to design and implement the recovery system, a period of 12 months should be allowed between the date of promulgation of the regulation and the implementation of the collection and processing system.

- *Cost Recovery* The regulatory framework should allow the option of visible fees associated with the sale of new electronic equipment to be collected for an agreed upon period of time from the effective date, so long as these fees are used in support of the recovery and processing system; the allowable time period should be short – perhaps 2 years – but should be sufficient for brand owners to determine their EOL management costs. Legal frameworks should require that product and brand-specific EOL costs be internalised within brand costs after the agreed upon time period has lapsed. For the purpose of cost recovery, brands of EOL electronic products of a brand that have been taken over by a new company should be deemed to be a brand of the new company. Allowance should be made for brand owners to pay an additional amount of money to provide for EOL management of "orphan" products (i.e. products whose brand owner has gone out of business and whose ownership has not been taken over by another brand owner)[70].

  In addition, provision should be included in the regulatory framework for up to $0.20 per regulated item to be collected by government from the sale of new electronic products to finance public awareness and education activities and research and development associated with the recovery and management of EOL electronic products. Provision should also be made for the implementing entity to attribute its administrative and other costs to individual producers in proportion to the percentage of total EOL costs incurred by each producer.

- *Frameworks for Meeting Obligations* The overall administrative frameworks for achieving EOL electronic product recovery goals will be need to be defined in accordance with the definition of stakeholder roles and responsibilities (see Section 8.4.1). This will need to address disclosure, reporting and auditing (see Section 8.4.2), and should ensure that industry brand and sales data are submitted on a confidential basis.

- *DfRe and DfTR* The regulatory framework governing the recovery program should specify that the environmental performance of EOL electronic products should not be less than that of similar products permitted to be sold into the most stringent OECD marketplace.

- *Penalties* Penalties for non-compliance with the requirements of the recovery program should be identified in the legal framework. These should include that companies that fail to fully participate in the recovery program will not be permitted to market or sell their products in the jurisdiction.

8.4.8 Monitoring and Compliance

Fair and equitable stewardship systems depend on all entities with defined stewardship responsibilities participating to the full extent of their obligations.

[70] The amount of money needed to address this issue can be determined from the results of recovery actions over the first 2 years of implementation (paid through visible fees on new consumer purchases) and can be attributed to individual brand owners on an annual basis according to market share.

Under the recommended stewardship framework, the key elements of monitoring can be readily achieved. All producers selling into a jurisdiction will be obliged to join a public/private entity to recover EOL electronic products, or to set up a parallel system under provincial approval; monitoring of compliance with these requirements will be straightforward. In addition, however, producers will be required to pay for the EOL management of their products; this can be monitored within the public/private entity and, through audit, in a parallel private system.

There are a range of compliance measures that provinces can take if monitoring identifies non-compliance with the stewardship model. Producers themselves may play an important role in bringing a non-compliant producer into compliance by explaining the consequences of non-compliance to the industry as a whole. However, this and other compliance measures short of direct enforcement will only be effective in the long run if it is clear that provinces can and will act to enforce penalties against non-compliant producers.

A range of enforcement measures are possible. One of the most effective may be to publish the names of non-compliant producers; this approach can immediately impact market share and sales and may produce swift results. Fines may also be levied at a level to provide for both management of a producer's EOL products and to impose a penalty; continued non-compliance may result in higher fines. Exclusion of a producer's product from the provincial marketplace should also be provided for within the legal framework, although the enforcement of this measure should be reserved as a measure of last resort. Provinces should be clear, however, regarding this tool and their willingness to apply it under appropriate circumstances.

8.4.9 Summary of Stewardship Model

Table 34 identifies the consistency of the stewardship model presented in this section with the C-WPEPS.

8.5 Implementation

The following steps should be taken to initiate the implementation of an EOL electronic products recovery program in each province:

- The entity through which recovery and management of EOL electronic products will be implemented should be defined together with the overall stewardship model; Section 8.4 may be used to facilitate this process.
- A legal instrument should be adopted to give effect to the implementation entity and the stewardship model. In order to ensure a partnership approach between government and producers, it may be appropriate for government to draft a proposed legal instrument that is then discussed with producers, among others that may be relevant.
- Producers should be registered and data should be collected consistent with regulatory requirements and confidentiality provisions.
- The implementation entity should develop a detailed implementation plan that addresses all aspects of the implementation of the stewardship model.

The implementation plan should address all aspects of the EOL electronic product recovery and management initiative including, but not necessarily limited to:

- Establishment of collection points.
- Creation of disassembly capacity and facilities.
- Financing and cost recovery, including mechanisms for recovering costs from producers that supply electronic products to the provincial marketplace and including those without a physical presence in either the province or Canada.

Table 34
Concordance of Recommended EOL Electronics Management System in Atlantic Canada with C-WPEPS

C-WPEPS PRINCIPLE	RECOMMENDED STEWARDSHIP ACTION
1. Responsibilities associated with management of e-waste are primarily borne by producers of the products, where "producer(s)" means the manufacturer, brand-owner or first importer of the product who sells or offers for sale the product in each jurisdiction.	Producer responsibility to be legally established in each province. Producers may manage their own products directly or through an industry collective, and may contract operations (but not producer responsibilities/liabilities) to a third party.
2. Costs of program management are not borne by general taxpayers	Costs for EOL electronics management should be internalised by producers, following a 2 year period in which visible fees may be applied
3. Environmental and human health impacts are minimized throughout the product life-cycle, from design to end-of-life management	Environmental performance of EOL electronic products to be not less than in other OECS jurisdictions. Cost internalisation will result in design enhancements. Relevant OH&S standards will be applied at processing facilities. RVQ standards/procedures or their equivalent will be adopted.
4. Management of e-waste is environmentally sound and consistent with the 4R waste management hierarchy: *a. Reduce, including reduction in toxicity and redesign of products for improved reusability or recyclability* *b. Reuse* *c. Recycle* *d. Recovery, of materials and/or energy from the mixed e-waste stream.*	Prohibit the disposal of EOL electronics, prior to treatment. Cost internalisation will result in design enhancements. Develop reuse standards. Establish separate collection/logistics infrastructure. Support market development for recyclable plastics and CRT's, in particular. "Green procurement" to support environmentally-preferred products; may use EPEAT outputs as benchmarks
5. Consumers have reasonable access to collection systems without charge	Collection depots/points established throughout Atlantic Canada based on catchment/convenience criteria. Retailers may accept EOL electronic products. No charge to consumers to use collection depots/points.
6. Education and awareness programs ensure that consumers, retailers and other stakeholders have sufficient information on program design and knowledge of their roles	Establish industry/government committee to coordinate public education/awareness; fee charged at retail to support public awareness actions.
7. Program design and implementation will strive for equity and consistency for consumers, particularly between those who live in adjacent jurisdictions and between those who live in small, rural and remote communities and large urban centres	Rural and urban areas integrated within management program. Similar EOL electronic management approaches recommended for all Atlantic provinces.
8. Adjacent jurisdictions will strive for consistency in e-waste products collected	Each Atlantic province to collect the range of EOL electronic products that are addressed by this document
9. Programs will include residential, commercial, historic and orphan products	Products to be accepted from from all sectors and time periods
10. Programs will report on performance, specify objectives and targets, and be transparent in financial management	Legal requirements for electronics producers to report by brand on: (i) sales; (ii) EOL products collected; (iii) the fate of EOL electronics; (iv) financial data prior to full cost internalisation
11. E-waste is managed in the most economically and logistically feasible manner, while striving to maximize local economic and social benefits	Implement a phased program based on (i) collection maximising, as appropriate, existing infrastructure; (ii) local intermediate processing based on disassembly/ refurbishment for reuse and/or recycle, where feasible; (iii) remote processing where local processing is not feasible
12. E-waste is exported from Canada for recycling only at facilities with a documented commitment to environmentally sound management and fair labour practices	Legal adoption of RVQ requirements, or their equivalent

- Detailed identification of the structure, staffing, location and costs of the implementing entity
- Training of management and technical staff, and collection point operators.
- Preparation of public awareness/education materials, and their dissemination.
- Establishment of EOL electronic product tracking capacity.

It is anticipated that 12 months will be required to prepare the implementation of the EOL electronics recovery program, and that recovery of EOL electronic products can begin following that time.

The promulgation of a legal instrument that prohibits the disposal of EOL electronic products or materials without their first entering a recovery process may change many of the assumptions on which this feasibility assessment is based. In particular, it is likely that suppliers of EOL electronic products services may express high levels of interest in participating in the new initiative. The quantities of EOL electronic products that will be available from Atlantic provinces may be sufficient to attract private sector investment in new facilities in the region, and will attract the business interest of local organisations. The implementation entity should therefore adopt a flexible approach that provides opportunities for service providers to participate in the recovery and management system. The implementation entity should therefore consider the advantages of the following actions:

- Request bids from "primary" service providers to establish and operate the necessary provincial disassembly processing facilities on the basis of payment calculated on the number or tonnage, as appropriate, of EOL electronic products managed.
- If "primary" service providers are selected who do not themselves process materials for reuse, request bids from organisations ("secondary" service providers) interested in EOL product reuse on a fee for service basis (at the level of either whole devices or components) and require that primary service providers make available EOL products that secondary service providers will market for reuse.

Contracts of this nature with the private sector should be over a sufficiently long time period that service providers have reasonable assurance that their capital costs can be amortised.

Costs associated with processing EOL electronic products should reflect market conditions for recovered materials, components and devices. Secondary market conditions change over time – sometimes very rapidly - and the implementation entity may therefore give consideration to the inclusion of contract language that provides flexibility on fee rates to reflect changes in market prices, either up or down.

As noted in Section 2, there is uncertainty regarding aspects of the database on which many of the analyses in this document are based. These uncertainties include the quantity of EOL electronic products in storage awaiting an environmentally appropriate management system, the quantity of electronic products in the IC&I sector that are not managed through existing private sector asset management and other EOL electronic product management infrastructures, and the quantities of EOL electronic product that consumers discard. In order to ensure that local processing facilities are appropriately sized, it may therefore be prudent over the initial 6 – 12 months of implementation to implement the collection and processing of EOL electronic products on the basis of transporting these items to existing processing facilities and markets located, for the most part, outside the Atlantic Canada region. This would allow assumptions on types and quantities of EOL electronic product in the Atlantic Canada region to be confirmed, and for data to be adjusted as appropriate so that longer term commitments to local processing capacity are appropriately dimensioned and budgeted.

During implementation, all cost and revenue assumptions and estimated costs and revenues identified in this document should be verified and adjusted, as appropriate, to reflect both prevailing conditions at that time and the implications on costs and revenues of new assumptions or program design criteria that may be adopted.

8.6 Risks and Risk Management

The main risks to the proposed program are:

- Achieving full participation by EOL electronic product generators.
- Achieving producer participation in the program.
- Ensuring overall financial viability of the program.

Surveys in recent years have consistently shown that consumers would support a program to recover EOL electronic products if they had convenient access to the program and if the consumer did not have to pay a cost for participating in the program. The proposed program is designed to ensure consumer convenience – collection points should be located in places that are easily accessible and which are in or immediately adjacent to areas that consumers frequent; public awareness and education messages should ensure that consumers are aware of these locations and that they understand the importance of their participation in the program. Levels of participation in the program should be monitored, as necessary to achieve and maintain high levels of participation. Public awareness programs should be tailored to ensure local relevance. As necessary, rewards or other incentives (e.g. a discount on electronics purchases) can be offered to consumers for returning their EOL electronics to a collection point; these do not have to carry a high value but can have a high impact on participation rates. As appropriate, retailers might be encouraged to participate as "satellites" for collection points.

Producer participation in the program should be coordinated through relevant industry groups, particularly including Electronics Product Stewardship Canada. The electronics industry has signalled its willingness to participate in an effective electronics recovery program. The major electronics producers already participate in EOL electronics recovery programs elsewhere in the world, and may bring lessons learned from those programs to Atlantic Canada. Nonetheless, governments should ensure they have the necessary monitoring and enforcement recourses in the event of non-compliance by a producer.

All cost and revenue estimates in this document have been confirmed in the Canadian and North American marketplace in 2004 and 2005. All costs and revenues, however, should be confirmed at the time of implementation. The implementation of the program as presented in this document allows for a phased and flexible implementation strategy that will confirm baseline data before major investment decisions are taken, and this will allow all cost and revenue data to be refined, as necessary, to ensure the financial sustainability of the program.

9.0 KEY FINDINGS AND RECOMMENDATIONS

9.1 Key Findings

This section presents the key findings of this document, and identifies the report sections that may be consulted for further detail.

EOL Electronics Product Generation and Sector Development in Canada

- An estimated 19.458 million electronic products that are the focus of this document are estimated to have required recycling or disposal in 2005 (excluding rechargeable batteries, of which an estimated 6.15 million may be discarded in 2005), representing 165,683 tonnes of waste (see Section 2.1). These amounts are projected to grow by 8 percent and 11 percent respectively by 2010 (see Section 2.3).
- Late model EOL electronic products - generated primarily by the industrial, commercial and institutional (IC&I) sector - often have residual value either through reuse of a device or through reuse of its components (see Section 3.2). National and international infrastructures have been developed by the private sector to take advantage of this value (see Section 3.2). There were over 60 organisations in Canada engaged in some aspect of processing EOL electronic – mostly computer and related - products in December 2004 (see Section 3.4).
- Older EOL electronic products - generated by households and the IC&I sector – do not have sufficient reuse value to attract commercial activity and must be managed through either recycling or disposal. However, materials values are generally insufficient to attract the development of a domestic EOL electronics recycling infrastructure (see Section 3.4).
- There is significant, but non-quantified, export of EOL electronics from Canada and other developed countries to developing countries for recycling and reuse purposes. Significant worker health and environmental problems have arisen from improper management of these EOL products in developing countries (see Section 3.7).
- Of the EOL electronic products requiring recycling or disposal in 2005, 90 percent are estimated to have been sent directly to disposal (see Section 5.1).

The "State-Of-The-Art" Of EOL Electronic Product Management In Other Countries

- Most OECD countries are developing programs for enhanced management of EOL electronic products. The focus of these initiatives is on recovery and recycling/reuse of EOL electronics (see Section 3.2).
- Actions in other countries to achieve enhanced EOL management of electronic products are generally based on the concept of "producer responsibility", such that producers are responsible for the EOL management of their products (see Section 4).
- The most effective EOL electronic product management programs provide for separate collection of EOL electronic products; consumers have easy access to the collection infrastructure (see section 3.2). Over 90 percent of EOL electronic products in Norway are recovered for reutilisation and residual waste from the reutilisation of this amount is less than 10 percent (see Section 4, and Annex G).
- Countries are increasingly adopting EOL electronic product management legal frameworks that require separate collection and reuse/recycling of EOL electronic products (see Section 4).

Best Management Practice For EOL Electronic Products In Canada

- Best management practice requires the creation of an effective infrastructure for the separate collection and processing of EOL electronic products. This can result in collection of an estimated 95 percent of such products (see Section 6.1). An estimated 92 percent of the materials in EOL electronic products can be recycled using existing technology and markets (see section 6.1 and section 3.5). At least a small percentage by weight of collected EOL electronic products may have reuse application (see Section 6.1).
- Achieving the best management practice in Canada requires the following key actions, among others: (i) adoption by provinces of legal frameworks that give effect to producer responsibility for management of EOL electronics and which include both a prohibition on the disposal of EOL electronic products and their materials unless they have first passed through a licensed recycling processing facility, and support for "design for reutilisation" and "design for toxics reduction" (see Section 6.2); (ii) establishment of a separate collection system for EOL electronics that is convenient for consumers, and which can be used without payment of a fee at the point of collection (see Section 6.2); (iii) the tracking of EOL electronic

product management costs on at least a brand basis, and internalisation of these costs by the producer (see Section 5.3) ; (iv) adoption of standards for processing EOL electronic products that are not less stringent than the "Recycling Vendor Qualification Standard" prepared by Electronic Product Stewardship Canada (see Section 3.4).

- Implementation of the best management practice is estimated to cost an average of less than $1.00 per kilogram of EOL electronic product (see Section 6.2).
- Implementation of the best management practice would achieve, among other things, a reduction of over 193,000 tonnes per year in carbon dioxide-equivalent emissions, a reduction of over 5 million tonnes per year of mining wastes and revenues from the sale of recyclable materials in excess of $30 million per year and the conservation of over 200,000 tonnes of natural resources (see Section 7).
- Implementation of the best management practice will create jobs (see Section 8.3) and stimulate development of new, environmentally-preferred technology (see Section 3.3).

9.2 Recommendations

This report recommends the application of the best management practice in Atlantic Canada, as detailed in Section 8 and in Annex J. The key recommendations are as follows, with references to Section 8 where further detail can be found:

- Provincial collection point networks should be established for the separate collection of EOL electronics (see section 8.3.1).

- Collected EOL electronic products should be transported to disassembly facilities located in each province. This will result in local disassembly of over 90 percent by weight of EOL electronics in each province (see section 8.3.2 and section 8.3.3).

- Materials recovered from disassembly should be shipped to end use markets (see section 8.3.2).

- Stakeholder responsibilities should be implemented according to new legal frameworks in each province (see Section 8.4.7). Provinces should consider delegating implementation of the EOL electronics recovery program to a joint public/private entity, and providing the option for producers to establish separate recovery systems if they meet provincial criteria (see section 8.4.1). Provincial responsibilities under this legal framework should include a prohibition on the disposal of electronic products unless they have first passed through a licensed processing facility (see section 8.4.7). Producers should be required to pay the costs of EOL management of their products through the internalisation of those costs. However, visible fees may be charged to consumers at program launch with a clearly stated commitment by the producers to sunset visible fees according to a schedule negotiated with the regulatory body or its agent and reflected in the legal framework (see section 8.4.3); this may be considered permissible within the context of the C-WPEPS (see section 8.4.3).

- The core cost of the application of implementing the recommended EOL electronic products recovery and processing system in Atlantic Canada would be equivalent to: $0.76/kg of EOL electronic product in New Brunswick, $0.89/kg of EOL electronic product in Newfoundland and Labrador, $0.75/kg of EOL electronic product in Nova Scotia and $0.91/kg of EOL electronic product in Prince Edward Island (see section 8.3.3). Estimated core costs on a product basis, investment costs and job creation as a result of implementation of the recommended system, are identified in Table 35 (see section 8.3.6).

Table 35
Estimated Cost and Job Creation of Recommended EOL Electronic Product Management System

PRODUCT	NEW BRUNSWICK				NEWFOUNDLAND AND LABRADOR				NOVA SCOTIA				PRINCE EDWARD ISLAND			
	Average Cost/Kg			**$0.76**	**Average Cost/Kg**			**$0.89**	**Average Cost/ Kg**			**$0.75**	**Average Cost/Kg**			**$0.91**
	AVERAGE COST/ EOL ITEM	AVERAGE COST/ UNIT SOLD			AVERAGE COST/ EOL ITEM	AVERAGE COST/ UNIT SOLD			AVERAGE COST/ EOL ITEM	AVERAGE COST/ UNIT SOLD			AVERAGE COST/ EOL ITEM	AVERAGE COST/ UNIT SOLD		
		2005	2006	2007		2005	2006	2007		2005	2006	2007		2005	2006	2007
Cell Phones	0.13	0.11	ND	ND	0.14	0.14	ND	ND	0.12	0.11	ND	ND	0.16	0.13	ND	ND
Telephones	0.79	1.00	ND	ND	0.92	1.25	ND	ND	0.78	1.00	ND	ND	1.02	1.17	ND	ND
Stereos	2.02	1.66	ND	ND	2.49	2.08	ND	ND	2.01	1.66	ND	ND	2.43	1.95	ND	ND
Computers	9.26	6.75	6.75	6.82	10.54	8.45	8.45	8.66	9.15	6.76	6.76	6.88	11.75	7.93	7.93	8.40
Monitors	10.78	7.88	7.87	8.18	12.36	9.87	9.87	10.32	10.64	7.89	7.89	8.22	12.41	9.25	9.25	9.36
Peripherals	4.24	3.55	3.54	3.63	4.80	4.44	4.43	4.55	4.18	3.55	3.54	3.22	5.08	4.17	4.16	4.20
TVs	19.46	16.18	ND	ND	23.70	20.27	ND	ND	19.37	16.20	ND	ND	23.77	19.01	ND	ND
Investment Cost ($ millions)	4.177				3.172				5.145				1.007			
Job Creation (full time person years/yr)	73				57				92				14			

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Recycler's World; www.recycle.net/computer; on-line trading network for EOL electronics.
Statistics Canada, www.statcan.ca; data on socio-economic characteristics and conditions in Canada, household computer purchasing trends in 2002, and imports of electronic equipment into Canada.
Dr. Timothy Townsend, www.ees.ufl.edu/homepp/townsend/research/electronic_leaching; research into extent to which electronic products meet leachate toxicity criteria for classification as "hazardous waste" in the U.S.
U.S. Environmental Protection Agency, www.epa.gov; data on EOL electronic product management activities by US EPA.
Waste Diversion Ontario, www.wdo.ca; Datacall on municipal EOL electronic product recycling activities.

See Annex F of this document for internet addresses for processors of EOL electronic products in Canada.

ANNEX A

AVERAGE WEIGHTS USED TO ESTIMATE TONNAGES OF EOL ELECTRONICS

ANNEX A
Average Weights Used To Estimates Tonnages of EOL Electronics

PRODUCT	AVERAGE WEIGHT/UNIT (KG)	
	2005	2010
Computers		
Desktop PCs	13.60	13.60
Laptops	4.50	4.50
All Computers	*11.66*	*11.38*
Monitors		
CRT Monitors	13.60	13.60
LCD Monitors	6.88	7.00
All Monitors	*13.53*	*10.87*
Computer Peripherals		
Printers	8.80	8.80
Keyboards	0.90	0.90
Scanners	7.00	7.00
Computer Peripherals	*5.31*	*5.20*
Televisions		
Colour TVs <23"	12.99	13.01
Colour TVs 23" to 29"	49.99	50.00
Colour TVs >29"	57.13	57.07
TV with VCR	34.98	34.96
TV - Rear	98.52	99.36
TVs	27.48	36.18
Telephones		
Mobile Phones	0.16	0.16
Telephone Handsets	1.00	1.00
Stereos		
Stereo Receivers	5.97	5.98
Cassette Decks	5.95	5.90
CD Players	4.01	4.01
DVD Players	4.02	4.00
Mini/Mid Size Hi-Fi Systems	7.01	6.99
Portable CD Players	0.50	0.50
All Stereo Equipment	*3.03*	*3.47*
Portable Rechargeable Batteries		
Portable Rechargeable Batteries	0.04	0.04

Sources:

Average weights for all types of computers, monitors, computer peripherals (except keyboards) and telephones: RIS International Ltd., *Information Technology (IT) and Telecommunication (Telecom) Waste in Canada - 2003 Update*, Environment Canada, Ottawa, 2003

Average weights for all types of televisions and stereo equipment: RIS International Ltd., Five Winds International and Electro-Federation Canada, *Baseline Study of End-of-Life Electrical and Electronic Equipment in Canada*, Environment Canada, Ottawa, 2003

Average weights for keyboards and portable rechargeable batteries: PHA Consulting Associates based on focussed survey of items currently in use.

ANNEX B

Electronics Product Import Data
And Materials Composition

Annex B
Electronics Product Materials Composition And Import Data

For each device category, there are respective detailed material fraction information, Canadian import data, and associated material fractions for each device. The detailed material fraction information below is not meant to be exhaustive.

The material categories, Aluminum, Copper, and Ferrous includes those respective metals found in populated printed wiring boards. Copper includes copper from copper wires, except the copper wires found in power cords. Other PWB Metals does not include aluminum, copper, or ferrous from populated printed wiring boards. Materials from PWB (PWB Glass/Silica Oxide, PWB Epoxy Resin, Other PWB Metals, and contributions to Aluminum, Copper, and Ferrous come from average material fractions found in populated printed wiring boards (See detailed material fractions on printed wiring boards) and amounts of populated PWBs found in the devices. Unidentified Metals includes any materials that were not identified or materials that were not put into the other metal categories (Aluminum, Copper, Ferrous, Other PWB Metals) or Other. The copper wire contribution to the Copper category was calculated by assuming that smaller diameter copper wire (found in these devices) typically are made of 55% to 65% copper by weight[71].

The plastic from PWBs (epoxy resin used with a glass fiber to form a composite in the board) was not included in the Plastic category because epoxy resin is a thermoset. All epoxies are thermosets which mean they can't be recycled (at a material level). Normal plastic recycling processes increase the plastic temperature until the plastic melts. However for a thermoset, a temperature will be reached where it will chemically break down (combustion). This combustion occurs before a melting temperature is reached which destroys the plastic.

All materials listed in tonnes, used the average material fraction data and e-waste generation data in IC&I and consumer/domestic estimated for 2005, except for portable rechargeable batteries, where the e-waste generation data comes from consumer/domestic markets only.

[71] Personal communication, July 2004

Televisions

Origin of Canadian Imports (2003)

Origin of Products	% Total Value of Imports
Mexico	45.82%
United States	24.17%
Thailand	9.39%
China	5.82%
Taiwan (Taipei)	5.07%
Malaysia	3.65%
Japan	3.26%
Other	2.82%
Total	**100.00%**

The origin of the device is where the product was imported from, which is not necessarily where it was manufactured. Data from Statistics Canada https://strategis.ic.gc.ca/secure/sc_mrkti/tdst/tdo/tdo.php#tag and US Dept. of Commerce.

Materials in EOL Televisions By Province

	Glass	PWB Glass/Silica Oxide	Aluminum	Copper	Ferrous	Unidentified Metals	Other PWB Metals[1]	PWB Epoxy Resin	Plastics[2]	Other
Materials Composition	47.5%	1.8%	0.5%	4.7%	9.0%	18.3%	0.5%	1.9%	13.6%	2.1%
Alberta	3,002	111	32	296	571	1,156	30	121	859	133
British Columbia	3,752	139	40	370	714	1,445	37	151	1,074	166
Manitoba	1,048	39	11	103	199	404	10	42	300	46
New Brunswick	670	25	7	66	128	258	7	27	192	30
Newfoundland and Labrador	471	17	5	46	90	181	5	19	135	21
Northwest Territories	42	2	0	4	8	16	0	2	12	2
Nova Scotia	839	31	9	83	160	323	8	34	240	37
Nunavut	26	1	0	3	5	10	0	1	7	1
Ontario	11,246	416	121	1,109	2,141	4,333	112	453	3,220	497
Prince Edward Island	123	5	1	12	23	47	1	5	35	5
Quebec	6,767	250	73	667	1,288	2,607	67	273	1,937	299
Saskatchewan	906	34	10	89	173	349	9	37	259	40
Yukon Territory	29	1	0	3	5	11	0	1	8	1
Subtotal Canada	28,921	1,069	312	2,852	5,505	11,142	287	1,166	8,280	1,279
USA	317,369	11,732	3,425	31,299	60,416	122,270	3,151	12,796	90,868	14,031
Total	346,289	12,801	3,737	34,151	65,921	133,413	3,438	13,962	99,148	15,310

Notes
1. Aluminum, copper and ferrous in PWB's included in columns bearing those captions; "Other PWB Metals" therefore excludes those metals.
2. Excludes epoxy resin in PWBs

Source: Composition data from: *IAER Electronics Recycling Industry Report*, International Association of Electronics Recyclers, Brattleboro, 2003: Figure 45, adjusted to reflect materials content of PWB's.

Computers (CPUs)

Origin of Canadian Imports (2003)

Origin of Products	% Total Value of Imports
United States	35.84%
China	19.86%
Malaysia	10.74%
Taiwan	8.36%
Mexico	7.47%
Philippines	5.92%
Korea, South	5.49%
Japan	3.22%
Other	3.1%
Total	100.00%

The origin of the device is where the product was imported from, which is not necessarily where it was manufactured. Data from Statistics Canada https://strategis.ic.gc.ca/secure/sc_mrkti/tdst/tdo/tdo.php#tag and US Dept. of Commerce.

Materials in EOL Computers (CPUs) By Province (estimated tonnes in 2005)

	PWB Glass/ Silica Oxide	Aluminum	Copper	Ferrous	Other PWB Metals[1]	PWB Epoxy Resin	Wire Insulation	Plastics[2]	Other
Composition	5.5%	9.1%	4.2%	62.4%	1.5%	6.0%	0.8%	9.8%	0.4%
Alberta	212	353	164	2,412	57	231	30	378	16
British Columbia	200	334	155	2,278	54	218	28	357	15
Manitoba	54	91	42	619	15	59	8	97	4
New Brunswick	33	55	25	375	9	36	5	59	2
Newfoundland and Labrador	25	42	19	287	7	27	4	45	2
Northwest Territories	4	6	3	43	1	4	1	7	0
Nova Scotia	42	70	32	477	11	46	6	75	3
Nunavut	1	2	1	14	0	1	0	2	0
Ontario	661	1,101	510	7,520	177	721	92	1,177	49
Prince Edward Island	6	10	5	67	2	6	1	10	0
Quebec	359	598	277	4,082	96	391	50	639	26
Saskatchewan	51	84	39	575	14	55	7	90	4
Yukon Territory	2	3	1	20	0	2	0	3	0
Subtotal Canada	1,649	2,748	1,274	18,772	443	1,799	230	2,938	121
USA	30,663	51,093	23,678	348,974	8,234	33,443	4,272	54,616	2,254
Total	32,312	53,842	24,952	367,746	8,677	35,242	4,502	57,554	2,375

Notes
1. Aluminum, copper and ferrous in PWB's included in columns bearing those captions; "Other PWB Metals" therefore excludes those metals.
2. Excludes epoxy resin in PWBs

In addition to the materials identified CPUs contain lead, chromium (including hexavalent form), antimony (estimated at 0.1%), cadmium (variously estimated at *<0.01% to >25g)* and beryllium (0.08g); Five Winds International, *Toxic and Hazardous Materials in IT and Telecom Products*, Environment Canada, Hull, 2001

Source Except as noted, composition data provide by confidential sources, modified to reflect PWB materials.

Monitors (CRT type)

Origin of Canadian Imports (2003)

Origin of Products	% Total Value of Imports
Japan	42.72%
Mexico	16.58%
United States (U.S.)	15.80%
Taiwan (Taipei)	7.52%
China	6.26%
Korea, South	5.61%
Malaysia	2.42%
Other	3.09
Total	**100.00%**

The origin of the device is where the product was imported from, which is not necessarily where it was manufactured. Data from Statistics Canada https://strategis.ic.gc.ca/secure/sc_mrkti/tdst/tdo/tdo.php#tag and US Dept. of Commerce.

Materials in EOL Monitors - CRT Type - By Province (estimated tonnes, 2005)

	Glass	Aluminum	Copper	Ferrous	Unidentified Metals	Plastics	Other
Composition	39.0%	2.0%	2.0%	30.0%	4.0%	17.0%	6%
Alberta	1,931	99	99	1,485	198	842	297
British Columbia	1,899	97	97	1,461	195	828	292
Manitoba	518	27	27	399	53	226	80
New Brunswick	317	16	16	244	32	138	49
Newfoundland and Labrador	239	12	12	184	25	104	37
Northwest Territories	34	2	2	26	3	15	5
Nova Scotia	402	21	21	309	41	175	62
Nunavut	12	1	1	9	1	5	2
Ontario	6,175	317	317	4,750	633	2,692	950
Prince Edward Island	57	3	3	43	6	25	9
Quebec	3,406	175	175	2,620	349	1,485	524
Saskatchewan	476	24	24	366	49	208	73
Yukon Territory	16	1	1	13	2	7	3
Subtotal Canada	15,485	794	794	11,912	1,588	6,750	2,382
Recovered in Canada	1,858	95	95	1,429	191	810	286
USA	290,178	14,881	14,881	223,214	29,762	126,488	44,643
Total	305,663	15,675	15,675	235,125	31,350	133,238	47,025

Source: Maria Leet Socolof; Overly, Jonathan G.; Kincaid, Lori E.; and Geibig, Jack R. "Desktop Computer Displays: A Life-Cycle Assessment Volume 1." University of Tennessee Center for Clean Products and Clean Technologies. Pg. 2-8, Dec. 2001. http://www.epa.gov/oppt/dfe/pubs/comp-dic/lca/Ch2.pdf

Monitors (LCD type)

Origin of Canadian Imports (2003)

Origin of Products	% Total Value of Imports
Japan	42.72%
Mexico	16.58%
United States (U.S.)	15.80%
Taiwan (Taipei)	7.52%
China	6.26%
Korea, South	5.61%
Malaysia	2.42%
Other	3.09%
Total	**100.00%**

The origin of the device is where the product was imported from, which is not necessarily where it was manufactured. Data from Statistics Canada https://strategis.ic.gc.ca/secure/sc_mrkti/tdst/tdo/tdo.php#tag and US Dept. of Commerce.

Composition Of LCD Monitors

Metals		Glass	Plastics						Miscellaneous Materials		
Aluminum	Steel	Glass	PC	PMMA	Styrene-butadiene copolymer	PEE	Triphely phosphate	PET	Printed Wiring Board (populated)	Cables/ Wires	Other
2.34%	44.12%	10.31%	9.00%	7.80%	6.31%	5.23%	1.61%	1.03%	6.52%	4.08%	5.73%

Mercury is present in amounts between 0.12 - 50 mg

Source: Maria Leet Socolof; Overly, Jonathan G.; Kincaid, Lori E.; and Geibig, Jack R. "Desktop Computer Displays: A Life-Cycle Assessment Volume 1." University of Tennessee Center for Clean Products and Clean Technologies. Pg. 2-8, Dec. 2001; http://www.epa.gov/oppt/dfe/pubs/comp-dic/lca/Ch2.pdf (except for mercury)
Five Winds International. "Toxic and Hazardous Materials in IT and Telecom Products.", Environment Canada, Hull,. 2001. (for mercury)

Data on the quantity of LCD monitors likely to be discarded in 2005 are unavailable and it has therefore not been possible to estimate materials generated on a provincial basis

Computer Peripherals

Origin of Canadian Imports (2003)

Origin of Products	% Total Value of Imports
China	35.05%
United States	16.92%
Japan	9.52%
Korea, South	6.51%
Thailand	6.14%
Malaysia	5.77%
Mexico	4.05%
Taiwan	4.04%
Singapore	2.95%
Netherlands	1.51%
Other	7.54%
Total	**100.00%**

The data cover keyboards, scanners and printers.
The origin of the devices is where the product was imported from, which is not necessarily where it was manufactured. Data from Statistics Canada, *HS 847160: Input or Output Units for Computers and Other Data Processing Machines for 2003*, and US Dept. of Commerce.

Materials In EOL Computer Peripherals by Province (estimated tonnes, 2005)

	Glass	PWB Glass/Silica Oxide	Aluminum	Copper	Ferrous	Unidentified Metals	Other PWB Metals	PWB Epoxy Resin	Wire Insulation	Plastics	Other
Composition	1.7%	0.8%	2.1%	1.0%	33.7%	0.0%	0.2%	0.9%	0.0%	52.5%	7.0%
Alberta	58	26	69	34	1,117	0	7	28	1	1,741	232
British Columbia	55	25	66	33	1,067	0	7	27	1	1,664	222
Manitoba	15	7	18	9	290	0	2	7	0	453	60
New Brunswick	9	4	11	5	176	0	1	4	0	275	37
Newfoundland and Labrador	7	3	8	4	134	0	1	3	0	209	28
Northwest Territories	1	0	1	1	20	0	0	1	0	31	4
Nova Scotia	12	5	14	7	224	0	1	6	0	350	47
Nunavut	0	0	0	0	7	0	0	0	0	11	1
Ontario	182	82	216	107	3,508	0	22	90	4	5,468	728
Prince Edward Island	2	1	2	1	31	0	0	1	0	49	7
Quebec	99	45	118	59	1,913	0	12	49	2	2,982	397
Saskatchewan	14	6	17	8	269	0	2	7	0	419	56
Yukon Territory	0	0	1	0	9	0	0	0	0	15	2
Subtotal Canada	455	205	541	268	8,768	0	55	224	10	13,668	1,819
USA	4,212	1,897	5,002	2,479	81,075	0	509	2,069	91	126,384	16,824
Total	4,667	2,102	5,543	2,748	89,843	0	564	2,293	100	140,051	18,644

Source: Composition data developed through sampling and analysis by project team of 1 scanner, 1 inkjet printer and 3 keyboards, June 2004.

In addition to the materials identified, lead may present in lead solders in all peripherals, and beryllium is reported to be present in printers (EACEM; EECA; EICTA; EUROMETAUX. "Guidance Document on the Appliance of Substances under Special Attention in Electric & Electronic - Products." Ver. 02, Nov. 2000)

Cellular (Mobile) Phones

Origin of Canadian Imports (2003)

Origin of Products	% Total Value of Imports
Korea, South	37.25%
United States (U.S.)	21.31%
China	18.03%
Mexico	4.65%
Malaysia	4.31%
Germany	2.13%
Sweden	1.93%
Singapore	1.85%
Re-Imports (Canada)	1.65%
France	1.45%
Other	5.44%
Total	**100,00%**

The origin of the devices is where the product was imported from, which is not necessarily where it was manufactured. Data from Statistics Canada https://strategis.ic.gc.ca/secure/sc_mrkti/tdst/engdoc/tr_homep.html and US Dept. of Commerce.

Materials In EOL Cell Phones by Province (estimated tonnes, 2005)

	PWB Glass/Silica Oxide	Aluminum	Copper	Ferrous	Unidentified Metals	Other PWB Metals	PWB Epoxy Resin	Plastics	Other
Composition Estimates	7.2%	0.9%	3.2%	2.2%	37.2%	1.9%	7.9%	29.4%	10.4%
Alberta	4.0	0.5	1.8	1.2	20.5	1.1	4.3	16.2	5.7
British Columbia	3.9	0.5	1.8	1.2	20.2	1.1	4.3	16.0	5.6
Manitoba	1.1	0.1	0.5	0.3	5.5	0.3	1.2	4.4	1.5
New Brunswick	0.7	0.1	0.3	0.2	3.4	0.2	0.7	2.7	0.9
Newfoundland and Labrador	0.5	0.1	0.2	0.2	2.5	0.1	0.5	2.0	0.7
Northwest Territories	0.1	0.0	0.0	0.0	0.4	0.0	0.1	0.3	0.1
Nova Scotia	0.8	0.1	0.4	0.3	4.3	0.2	0.9	3.4	1.2
Nunavut	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Ontario	12.7	1.5	5.7	3.9	65.5	3.4	13.9	51.9	18.3
Prince Edward Island	0.1	0.0	0.1	0.0	0.6	0.0	0.1	0.5	0.2
Quebec	7.0	0.9	3.1	2.2	36.2	1.9	7.7	28.6	10.1
Saskatchewan	1.0	0.1	0.4	0.3	5.1	0.3	1.1	4.0	1.4
Yukon Territory	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.0
Subtotal Canada	31.9	3.9	14.3	9.9	164.3	8.6	34.8	130.1	45.8
USA	636	77	284	196	3,273	171	694	2,591	913
Total	668	81	298	206	3,437	179	729	2,722	959

Source: Composition estimates developed through sampling undertaken by the project team, June 2004

In addition to the materials identified, the following metals are used in cell phones: Antimony, Arsenic, Beryllium, Cadmium, Copper, Gold, Lead, Nickel, Palladium, Silver, Tantalum, Zinc and Battery Related Materials (See data ion this Annex for Battery Related Materials) (Five Winds International, *Toxic and Hazardous Materials in Electronics*, Environment Canada, Hull, 2001).

Telephones

Origin of Canadian Imports (2003)

Origin of Products	% Total Value of Imports
China	44.54%
Mexico	27.59%
Malaysia	10.69%
United States (U.S.)	4.38%
Taiwan (Taipei)	3.71%
Other	9.09%
Total	**100.00%**

The origin of the device is where the product was imported from, which is not necessarily where it was manufactured. Data from Statistics Canada https://strategis.ic.gc.ca/secure/sc_mrkti/tdst/tdo/tdo.php#tag and US Dept. of Commerce.

Materials In EOL Telephones by Province (estimated tonnes, 2005)

	Aluminum	Copper	Ferrous	PWB Boards	Plastics
Estimated Composition	2.1%	6.9%	21%	50%	30.6%
Alberta	5	18	53	125	77
British Columbia	5	17	52	123	76
Manitoba	1	5	14	35	21
New Brunswick	1	3	9	20	13
Newfoundland and Labrador	1	2	7	18	10
Northwest Territories	0	0	1	<1	1
Nova Scotia	1	4	11	25	16
Nunavut	0	0	<1	<1	0
Ontario	17	56	167	405	248
Prince Edward Island	0	1	1	2	2
Quebec	9	31	97	222	137
Saskatchewan	1	4	13	30	19
Yukon Territory	0	0	<1	<1	1
Subtotal Canada	42	140	426	1,012	621
USA	506	1,705	5,172	12,010	7,538
Total	548	1,846	5,597	13,395	8,159

Source: Composition data from: Envirosis, *Information Technology(IT) and Telecommunication (Telecom) Waste in Canada*, Environment Canada, Hull, 2000 adjusted by project team.

Portable Rechargeable Batteries

(Small sealed lead (SSL), nickel-cadmium(Ni0Cd), Lithium-ion (Li-Ion) and Nickel meatl-hydride (Ni-MH))

Origin of Canadian Imports - 2003

Origin of Products	% Total Value of Imports
Japan	*largest*
China	*2nd largest*
Korea	*3rd largest*

Information on imports or rechargeable batteries into Canada is not available from government or industry sources. The above information was provided by Norm England, Recyclable Battery Recycling Corporation through personal communication, July 2004.

Detailed Material Fractions (in percent)

	Small Sealed Lead	Nickel Cadmium	Lithium-Ion	Nickel Metal-Hydride
Aluminum	ND	NDd	0.6	3.0
Cadmium	ND	16.0	ND	ND
Cobalt	ND	1.5	ND	7.5
Copper	ND	ND	0.6	ND
Lead	70.0	ND	ND	ND
Manganese	ND	ND	ND	3.0
Nickel	ND	20.5	ND	62.5
Steel	ND	17.5	ND	ND
Lithium Hydroxide	ND	0.5	ND	ND
Lithium Cobalt Oxide	ND	ND	30.0	ND
Lithium Salts	ND	ND	3.0	ND
Carbon	ND	ND	20.0	ND
Organic Carbonates	ND	ND	12.5	ND
Polymer	ND	ND	0.6	ND
Potassium Hydroxide	ND	2.5	ND	3.0
Sodium Hydroxide	ND	ND	ND	3.0
Biphenol	ND	ND	0.2	ND
Other metals and non-metals	30.0	41.5	32.7	18.0

Note: "ND" indicates "no data"

Sources:

1. For all material fractions for Small Sealed Lead batteries: Rebecca Lankey; McMichael, Francis, *Rechargeable Battery Management and Recycling: A Green Design Educational Module.* Pg 5, Feb. 1999 http://www.ce.cmu.edu/GreenDesign/gd/education/Battery.pdf
2. For all material fractions for Nickel Cadmium types: Power*Rite *Material Safety Data Sheet (MSDS) - NiCd Rechargeable Battery – Cylindrical Type*. Retrieved June 2004; http://www.chiefsupply.com/JA%20Powerrite%20NiCd%20Flashlight%20Batteries.pdf
3. For all material fractions for Lithium Ion types: Ultralife Batteries Inc., *Material Safety Data Sheet (MSDS)." Ultralife Li-Ion Battery or Battery Packs*. Retrieved June 2004; http://www.ulbi.com/msdsheets/MSDS032-Li-ion.pdf
4. For all material fractions for Nickel Metal Hydride types: Gillette Environment Health and Safety. *Material Safety Data Sheet (MSDS) - Duracell Nickel Metal Hydride Batteries.* Retrieved June 2004; http://www.duracell.com/oem/safety/pdf/2030_3.pdf

Stereo Equipment

Origin of Canadian Imports

Origin of Products	% Total Value of Imports
China	47.44%
United States (U.S.)	21.24%
Malaysia	13.16%
Japan	8.13%
Korea, South	3.09%
Austria	1.39%
United Kingdom	1.02%
Other	4.53%
Total	**100.00%**

The origin of the device is where the product was imported from, which is not necessarily where it was manufactured. Data from Statistics Canada https://strategis.ic.gc.ca/secure/sc_mrkti/tdst/tdo/tdo.php#tag and US Dept. of Commerce.

Materials In EOL Stereos by Province (estimated tonnes, 2005)

	PWB Glass/Silica Oxide	Aluminum	Copper	Ferrous	Other PWB Metals	PWB Epoxy Resin	Wire Insulation	Plastics	Other
Estimated Composition	1.7%	0.6%	4.7%	32.3%	0.5%	1.8%	0.5%	52.4%	5.6%
Alberta	11	4	30	205	3	12	3	332	36
British Columbia	14	5	38	262	4	15	4	425	46
Manitoba	4	1	11	73	1	4	1	119	13
New Brunswick	2	1	7	47	1	3	1	76	8
Newfoundland and Labrador	2	1	5	33	<1	2	<1	53	6
Northwest Territories	<1	<1	<1	3	<1	<1	<1	5	<1
Nova Scotia	3	1	8	59	1	3	1	95	10
Nunavut	<1	<1	<1	2	<1	<1	<1	3	<1
Ontario	40	15	113	779	11	44	12	1,265	136
Prince Edward Island	<1	<1	1	9	<1	<1	<1	14	2
Quebec	25	9	68	472	7	27	7	766	82
Saskatchewan	3	1	9	63	1	4	1	102	11
Yukon Territory	<1	<1	<1	2	<1	<1	<1	3	<1
Subtotal Canada	104	40	290	2,006	28	114	30	3,259	350
USA	965	366	2,685	18,553	259	1,052	279	30,133	3,236
Total	1,069	405	2,975	20,560	287	1,166	310	33,392	3,586

Source: Composition data from sampling and analysis of 1 stereo receiver and 2 hi-fi systems (mini and mid-sized) undertaken by the project team in June/July 2004.

In addition to the materials identified, mercury is known to be present in stereo equipment in trace amounts (RIS International, *Baseline Study of End-of-Life Electrical and Electronic Equipment in Canada*, Environment Canada, Hull, 2003) and lead may be present in solder.

Printed Wiring Boards
(Populated and Unpopulated)

Composition of Printed Wiring Boards (Percent)

	Printed Wiring Board (Unpopulated)	Printed Wiring Board (Populated					Average
		1992	1993	1997(a)	1997(b)	1997(c)	
Aluminum	2.80	7.30	2.80	0.56	ND	ND	3.67
Beryllium	0.01	ND	0.01	ND	ND	4.00	0.01
Cadmium	0.00	ND	0.0004	0.01	ND	ND	0.01
Chromium	0.04	ND	0.04	0.04	ND	ND	0.04
Copper	14.30	ND	14.30	12.80	7.00	20.00	13.53
Gold	0.06	ND	0.06	0.02	ND	0.01	0.03
Iron	4.50	ND	4.50	3.90	6.00	23.00	9.35
Lead	2.20	0.80	2.20	2.90	ND	5.00	2.73
Nickel	1.10	1.50	1.10	1.30	3.00	ND	1.73
Palladium	0.01	ND	0.01	ND	ND	ND	0.01
Silver	0.06	ND	0.06	0.02	ND	0.10	0.06
Tin	2.00	ND	2.00	6.00	1.00	1.00	2.50
Zinc	0.40	0.70	0.40	1.00	2.00	ND	1.03
Epoxy Resin	24.80	24.30	24.80	70.00	23.00	23.00	33.02
Glass/Silica Oxide	47.60	ND	47.60	1.50	49.00	23.00	30.28
Other	0.12	65.40	0.12	0.00	9.00	0.89	2.03
Total	**100.00**	**100.00**	**100.00**	**100.05**	**100.00**	**100.00**	**100.00**

Sources:

Printed Wiring Board - Unpopulated: Atlantic Consulting; IPU. *LCA Study (Version 1.2) of the Product Group Personal Computers in the EU Ecolabel Scheme*, Pg. 84, March 1998. Originally from Pedersen 1993. Elektronik affald (Electronic waste), Masters Thesis, Department of Chemistry, Technical University of Denmark, (in Danish).

Printing Wiring Board - Populated, 1992: Atlantic Consulting; IPU. *LCA Study (Version 1.2) of the Product Group Personal Computers in the EU Ecolabel Scheme,* Pg. 84, March 1998. Originally from Nordi H. (1992): Projekt Elektronikavfall, Miljøkompassen AB, Sverige

Printing Wiring Board - Populated, 1993: Atlantic Consulting; IPU. *LCA Study (Version 1.2) of the Product Group Personal Computers in the EU Ecolabel Scheme*, Pg. 84, March 1998. Originally from Pedersen 1993. Elektronik affald (Electronic waste), Masters Thesis, Department of Chemistry, Technical University of Denmark, (in Danish).

Printing Wiring Board - Populated, 1997 (a): Atlantic Consulting; IPU. "LCA Study (Version 1.2) of the Product Group Personal Computers in the EU Ecolabel Scheme." Pg. 84, March 1998.

Printing Wiring Board - Populated, 1997(b): Atlantic Consulting; IPU. "LCA Study (Version 1.2) of the Product Group Personal Computers in the EU Ecolabel Scheme." Pg. 84, March 1998.

Printing Wiring Board - Populated, 1997(c): Atlantic Consulting; IPU. "LCA Study (Version 1.2) of the Product Group Personal Computers in the EU Ecolabel Scheme." Pg. 84, March 1998.

Notes

1. "ND" means "No Data"
2. Un-populated printed wiring boards are also known as “printed circuit boards” or “PCBs” (not to be confused with the family of chemicals called “polychlorinated biphenyls” (see the detailed material fractions of PVC Cabling in the Annex)). Populated circuit wiring Boards are also known as “Printed Wiring Assemblies.” These are printed wiring boards with the electrical components soldered to them (e.g., resistors, diodes, capacitors, etc.).

ANNEX C

Canadian Council of Ministers of the Environment
Canada-Wide Principles For Electronics Product Stewardship

(adopted June 2004)

ANNEX C
Canada-Wide Principles For Electronics Product Stewardship

Preamble

The management of used electrical and electronics equipment (e-waste) is rapidly becoming a major public policy issue in Canada and elsewhere around the world. Environmental concerns relate to the potentially hazardous nature of some of the materials these products contain and the increasingly large quantity of these products that require disposal in waste management systems. E-waste may contain lead, cadmium, mercury, and other potentially hazardous materials.

In accordance with CCME principles for pollution prevention, producers of electrical and electronic products are responsible for their products at end-of-life. It is widely recognized that legislative/regulatory initiatives are required to establish a level playing field for industry in the management of e-waste. The objective of these Canada-wide principles is to assist and support jurisdictions in the development of e-waste programs. While recognizing differences in the legislative/regulatory framework and existing programs among jurisdictions, CCME encourages regional or national cooperation in the development of e-waste programs. Specific measures undertaken by each jurisdiction will be at their discretion, with the goal of effective, efficient, and harmonized implementation.
To promote harmonization of approaches to the greatest extent possible, and to prevent market distortions among jurisdictions, the Canadian Council of Ministers of the Environment (CCME) endorses the following Canada-wide principles for electronics product stewardship:

Principles

1. Responsibilities associated with management of e-waste are primarily borne by producers of the products, where "producer(s)" means the manufacturer, brand-owner or first importer of the product who sells or offers for sale the product in each jurisdiction.

2. Costs of program management are not borne by general taxpayers

3. Environmental and human health impacts are minimized throughout the product life-cycle, from design to end-of-life management

4. Management of e-waste is environmentally sound and consistent with the 4**R** waste management hierarchy

a. **R**educe, including reduction in toxicity and redesign of products for improved reusability or recyclability
b. **R**euse
c. **R**ecycle
d. **R**ecovery, of materials and/or energy from the mixed e-waste stream.

5. Consumers have reasonable access to collection systems without charge.

6. Education and awareness programs ensure that consumers, retailers and other stakeholders have sufficient information on program design and knowledge of their roles.

7. Program design and implementation will strive for equity and consistency for consumers, particularly between those who live in adjacent jurisdictions and between those who live in small, rural and remote communities and large urban centres

8. Adjacent jurisdictions will strive for consistency in e-waste products collected

9. Programs will include residential, commercial, historic and orphan products

10. Programs will report on performance, specify objectives and targets, and be transparent in financial management

11. E-waste is managed in the most economically and logistically feasible manner, while striving to maximize local economic and social benefits

12. E-waste is exported from Canada for recycling only at facilities with a documented commitment to environmentally sound management and fair labour practices.

ANNEX D

EOL Electronic Products Regulated Under EU WEEE Directive

ANNEX D
EOL Electronic Products Regulated Under EU WEEE Directive

Annex D.1

The EU WEEE Directive applies to EOL electronic products within 10 product groups, identified in **bold**.

1. Large household appliances
Large cooling appliances
Refrigerators
Freezers
Other large appliances used for refrigeration, conservation and storage of food
Washing machines
Clothes dryers
Dish washing machines
Cooking
Electric stoves
Electric hot plates
Microwaves
Other large appliances used for cooking and other processing of food
Electric heating appliances
Electric radiators
Other large appliances for heating rooms, beds, seating furniture
Electric fans
Air conditioner appliances
Other fanning, exhaust ventilation and conditioning equipment

2. Small household appliances
Vacuum cleaners
Carpet sweepers
Other appliances for cleaning
Appliances used for sewing, knitting, weaving and other processing for textiles
Irons and other appliances for ironing, mangling and other care of clothing
Toasters
Fryers
Grinders, coffee machines and equipment for opening or sealing containers or packages
Electric knives
Appliances for hair cutting, hair drying, tooth brushing, shaving, massage and other body care appliances
Clocks, watches and equipment for the purpose of measuring, indicating or registering time
Scales

3. IT and telecommunications equipment
Centralised data processing:
Mainframes
Minicomputers
Printer units
Personal computing:
Personal computers (CPU, mouse, screen and keyboard included)
Laptop computers (CPU, mouse, screen and keyboard included)
Notebook computers

3. IT and telecommunications equipment Cont.
Notepad computers
Printers
Copying equipment
Electrical and electronic typewriters

Pocket and desk calculators
and other products and equipment for the collection, storage, processing, presentation or communication of information
by electronic means
User terminals and systems
Facsimile
Telex
Telephones
Pay telephones
Cordless telephones
Cellular telephones
Answering systems
Other products or equipment of transmitting sound, images or other information by telecommunications

4. Consumer equipment
Radio sets
Television sets
Video cameras
Video recorders
Hi-fi recorders
Audio amplifiers
Musical instruments
And other products or equipment for the purpose of recording or reproducing sound or images, including signals or other technologies for the distribution of sound and image than by telecommunications

5. Lighting equipment
Luminaries for fluorescent lamps with the exception of luminaries in households
Straight fluorescent lamps
Compact fluorescent lamps
High intensity discharge lamps, including pressure sodium lamps and metal halide lamps
Low-pressure sodium lamps
Other lighting or equipment for the purpose of spreading or controlling light with the exception of filament bulbs

6. Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
Drills
Saws
Sewing machines
Equipment for turning, milling, sanding, grinding, sawing, cutting, shearing, drilling, making holes, punching, folding, bending or similar processing of wood, metal and other materials
Tools for riveting, nailing or screwing or removing rivets, nails, screws or similar uses
Tools for welding, soldering or similar use
Equipment for spraying, spreading, dispersing or other treatment of liquid or gaseous substances by other means
Tools for mowing or other gardening activities

7. Toys, leisure and sports equipment
Electric trains or car racing sets
Hand-held video game consoles
Video games
Computers for biking, diving, running, rowing, etc.
Sports equipment with electric or electronic components
Coin slot machines

8. Medical devices (with the exception of all implanted and infected products)
Radiotherapy equipment
Cardiology
Dialysis
Pulmonary ventilators
Nuclear medicine

Laboratory equipment for *in-vitro* diagnosis
Analysers
Freezers
Fertilization tests
Other appliances for detecting, preventing, monitoring, treating, alleviating illness, injury or disability

9. Monitoring and control instruments
Smoke detector
Heating regulators
Thermostats
Measuring, weighing or adjusting appliances for household or as laboratory equipment
Other monitoring and control instruments used in industrial installations (e.g. in control panels)

10. Automatic dispensers
Automatic dispensers for hot drinks
Automatic dispensers for hot or cold bottles or cans
Automatic dispensers for solid products
Automatic dispensers for money
All appliances, which deliver automatically all kind of products

Annex D.2

The EU WEEE Directive requires that the following substances, preparations and components have to be removed from any separately collected EOL electronic products. These substances, preparations and components shall be disposed of or recovered in compliance with Council Directive 75/442/EEC:

Polychlorinated biphenyls (PCB) containing capacitors
Mercury containing components, such as switches or backlighting lamps
Batteries
Printed circuit boards of mobile phones generally, and of other devices if the surface of the printed circuit board is greater than 10 square centimeters
Toner cartridges, liquid and pasty, as well as colour toner
Plastic containing brominated flame retardants
Asbestos waste
Cathode ray tubes
Chlorofluorocarbons (CFC), Hydro chlorofluorocarbons (HCFC) or Hydro fluorocarbons (HFC)
Hydrocarbons (HC) of a GWP of 15 and over
Gas discharge lamps
Liquid crystal displays (together with their casing) of a surface area greater than 100 square centimeters and all those back-lighted with gas discharge
lamps
External electric cables
Components containing Refractory Ceramic Fibres as described in Directive 97/69
Components containing radioactive substances
Electrolyte capacitors containing substances of concern (Height or diameter more than 25 mm)

The following components of separately collected EOL electronic products has to be treated as indicated:

Cathode ray tubes: The fluorescent coating has to be removed
Equipment containing CFC, HCFC, HFC or HC: The CFC, HCFC present in the foam and the refrigerating circuit must be properly dealt with according to Regulation (EC) N°2037/2000 on substances that deplete the ozone layer. The HFC and HC present in the foam and the refrigerating circuit must be extracted and properly treated.
Gas discharge lamps: The mercury shall be removed.
All fluids must be removed.

ANNEX E

Used EOL Computer, Computer Peripheral and Monitor Prices

ANNEX E
Ecosys Canada Inc. Used Electronic Components and Equipment

This Annex identifies market prices for various electronic products on the reuse market. Information in this Annex is taken from price lists published by Ecosys Canada Inc. on 15 August 2004 at www.ecosys.ca

Used Electronics Components List

TYPE	DESCRIPTION	QUANTITY	PRICE
PIÈCES / PARTS	CARTE VIDÉO / VIDEO CARD 4MB AGP	95	9 $
PIÈCES / PARTS	CARTE VIDÉO / VIDEO CARD 4MB PCI	65	12 $
PIÈCES / PARTS	CARTE VIDEO / VIDEO CARD 8 MB AGP	127	15 $
PIÈCES / PARTS	CARTE VIDÉO / VIDEO CARD 8 MB PCI PREDATOR LT2 DUAL	37	25 $
PIÈCES / PARTS	CARTE VIDÉO / VIDEO CARD 8 MB PCI EVOLUTION 2 DUAL	11	25 $
PIÈCES / PARTS	CARTE VIDÉO / VIDEO CARD 16 MB PCI PREDATOR LT4	17	35 $
PIÈCES / PARTS	CARTE VIDÉO / VIDEO CARD 16 MB AGP	3	29 $
PIÈCES / PARTS	CARTE VIDÉO / VIDEO CARD 32MB AGP	11	35 $
PIÈCES / PARTS	CARTE SCSI PCI ADAPTEC AHA-2940 SCSI CONTROLLER CARD	21	15 $
PIÈCES / PARTS	MEMORY 64MB ECC EDO DIMM 168-PIN COMPAQ (228469-001)	107	30 $
PIÈCES / PARTS	MEMORY 128MB ECC EDO DIMM 168-PIN COMPAQ (228470-001)	17	50 $
PIÈCES / PARTS	MEMORY 128MB KIT EDO DIMM 168-PIN COMPAQ (149025-B21)	34	50 $
PIÈCES / PARTS	MEMORY 64MB PC100 SDRAM 168-PIN HP (1818-7321)	25	30 $
PIÈCES / PARTS	MEMORY 64MB PC133 SDRAM 168-PIN HP (1818-8149)	16	30 $
PIÈCES / PARTS	MEMORY 128MB SODIMM KINGSTON FOR LAPTOP (KTT500/128)	16	65 $
PIÈCES / PARTS	MEMORY 256MB EDO SDRAM 168-PIN (KTC2719/256)	16	90 $
PIÈCES / PARTS	LOT DE 70 CARTES RÉSEAU 10BT ISA/PCI NETWORK CARDS	1	70 $
PIÈCES / PARTS	IOMEGA ZIP DRIVE EXTERNE 100MB	19	15 $
PIÈCES / PARTS	IOMEGA JAZ DRIVE 1GB SCSI (AVEC AC ADAPTOR)	1	65 $
PIÈCES / PARTS	LOT DE 45 IMATION SLR5 8GB CARTRIDGE	1	400 $
PIÈCES / PARTS	PAPER SORTER C3764A POUR IMPRIMANTE HP	4	25 $
PIÈCES / PARTS	LECTEUR DVD INTERNE SCSI 10X TOSHIBA	2	25 $
PIÈCES / PARTS	TAPE DRIVE EXTERNE MODEL TH4BA-ES 10/20GB	1	90 $
PIÈCES / PARTS	COMPAQ DLT TAPE DRIVE 15/30GB	1	100 $
PIÈCES / PARTS	PROJECTEUR ACÉTATE (AVEC LE PROJECTEUR LCD)	2	149 $
PIÈCES / PARTS	DISQUE DUR 9.1G SCSI HARD DRIVE	7	55 $

Used Electronic Equipment List

TYPE	*DESCRIPTION*	*QUANTITY*	*PRICE*
ORDINATEURS / COMPUTERS	LOT DE 60 P200-233/32M-128M/2G-4G/ (48 CD) HP, COMPAQ, IBM	1	29 $
ORDINATEURS / COMPUTERS	PII-300/64M-128M/3.2G/NO CD COMPAQ	65	35 $
ORDINATEURS / COMPUTERS	CELERON 333/128M-160M/4G/NO CD COMPAQ	30	49 $
ORDINATEURS / COMPUTERS	PII-350/64M-128M/4.3G/NO CD COMPAQ	21	50 $
ORDINATEURS / COMPUTERS	PII-350/64M-128M/4G-6G/CD COMPAQ, HP	25	69 $
ORDINATEURS / COMPUTERS	PII-450/128M/10G/CD COMPAQ	2	90 $
ORDINATEURS / COMPUTERS	CELERON 500/128M-192M/6.4G/NO CD COMPAQ	35	100 $
ORDINATEURS / COMPUTERS	PIII-500/128M/6.4G/NO CD COMPAQ	5	119 $
ORDINATEURS / COMPUTERS	AMD K6-III 550 /128M/3.2G/NO CD TOWER CLONE	1	99 $
ORDINATEURS / COMPUTERS	PIII-550/64M/6.4G/CD HP	1	139 $
ORDINATEURS / COMPUTERS	PIII-600/256M/20G/CD DELL SFF	2	159 $
ORDINATEURS / COMPUTERS	PIII-650/64M/8.4G/CD HP	1	169 $
ORDINATEURS / COMPUTERS	PIII-866/128M/6G-15G/CD COMPAQ, IBM	3	259 $
SERVEURS / SERVERS	PPRO-200/256M/2X4.3G/CD COMPAQ PROLIANT 2500FT	60	99 $
SERVEURS / SERVERS	PII-233/256M-384M/2X4.3G/CD COMPAQ PROLIANT 1200	30	150 $
SERVEURS / SERVERS	DUAL PII-400/576M/2X9G/CD COMPAQ PROLIANT 1600	15	280 $
SERVEURS / SERVERS	DUAL PII-400/256M-512M/2X9G IBM NETFINITY 5000	60	280 $
MONITEURS / MONITORS	MONITEUR 15" GRADE A COMPAQ, HP, NEC, IBM 1996+	17	15 $
MONITEURS / MONITORS	MONITEUR 17" GRADE A APPLE	20	59 $
MONITEURS / MONITORS	MONITEUR 17" GRADE B (PALETTE/SKID)	25	35 $
MONITEURS / MONITORS	MONITEUR 20" GRADE A APPLE M1823	22	69 $
MONITEURS / MONITORS	MONITEUR 20" GRADE A SUN GDM-20D10 (SUN COMPATIBLE)	20	99 $
MONITEURS / MONITORS	MONITEUR 21" GRADE A VIEWSONIC	1	165 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE APPLE M2680 LASERWRITER 16/600 PS PRINTER	3	75 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP BUSINESS INKJET 2280TN PRINTER (NO POWER CORD)	1	300 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP OFFICEJET 5110 PRINTER	1	250 $

Used Electronic Equipment List

TYPE	*DESCRIPTION*	*QUANTITY*	*PRICE*
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP INKJET 1600C PRINTER	2	69 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP INKJET 2500CM PRINTER	5	109 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP LASERJET 4SI PRINTER	6	50 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP LASERJET 4 PRINTER	2	129 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP LASERJET 4M PLUS PRINTER	2	175 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP LASERJET 5 PRINTER (DÉCOLORÉ)	2	179 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP LASERJET 5 PRINTER	2	199 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP LASERJET 5N PRINTER (DÉCOLORÉ)	2	150 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP LASERJET 5SI PRINTER C3166A	6	299 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP LASERJET 5SIMX PRINTER	3	379 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP LASERJET 6MP PRINTER	1	225 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP LASERJET 1100 PRINTER (NO TONER)	1	175 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP LASERJET 2100SE PRINTER (NO TONER)	1	325 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP LASERJET 5000N PRINTER	4	599 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP LASERJET 8000DN PRINTER	7	729 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP COLOR LASERJET 4500N PRINTER	2	699 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE HP COLOR LASERJET 4550N PRINTER	1	799 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE LEXMARK 404910R PRINTER	1	99 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE LEXMARK 404912R PRINTER (AVEC PAPER TRAY)	3	50 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE LEXMARK OPTRA L 404912L PRINTER	1	89 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE LEXMARK OPTRA LX 4049-16L PRINTER	1	119 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE LEXMARK OPTRA LXN+ 4049-LF0 PRINTER	1	129 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE LEXMARK OPTRA S 1855 PRINTER (TRAY+DUPLEXER)	10	299 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE TEKTRONIX PHASER 350 PRINTER	1	195 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE TEKTRONIX PHASER 440 PRINTER	1	325 $
IMPRIMANTES-FAX / PRINTERS	IMPRIMANTE TEKTRONIX PHASER 850 PRINTER	1	650 $

ANNEX F

Processors of EOL Electronic Products

ANNEX F
Processors of EOL Electronic Products

This Annex identifies processors of EOL electronic products in Canada.

The organisations identified in this Annex undertake a variety of activities. Most organisations are engaged in processing computers for reuse/refurbishment. Other activities undertaken by some of these organisations include reuse/refurbishment of telephones, cell phones, monitors and peripherals. Some organisations undertake the processing of some or all EOL electronic products for the recycling of their materials. The listing is for guidance only and is not intended to be authoritative.

In addition to the organisatons identified below, the Computers For Schools organisation, based in Ottawa, operates refurbishment centres in each province and territory.

Organisation, Contact[1]	Phone, E-Mail, Web Coordinates[1]
ALBERTA	
Ecycle Solutions Inc. Contact: Gary Powers, President	Phone: (403) 945-2611; Fax: (403) 945-1241; E-mail: gpowers@ecyclesolutions.com Website: www.ecyclesolutions.com
Electronic Recycling Association Contact: Bojan Paduh (Calgary- reBOOT AB) (ERA also in BC and ON) (reBOOT also in SK,ON,QC,NB,NS,PE&NL)	Toll-free: 1-877-9EWASTE; Website: www.era.ca Calgary Phone: (403) 262-4488; Fax: (403) 234-9818; E-mail: calgary@era.ca Edmonton Phone/Fax: (780) 455-2088; Email: Edmonton@era.ca
HMI Industries Contact: Dave Laplante, Operations	Phone: (403) 346-4185; Fax: 346-3953; E-mail: info@hmiindustries.com Website: www.hmiindustries.com
Rainville Electronic Recycling Contact: Don Victor	Phone: (780) 951-1994; E-mail: don_victor2000@yahoo.ca
Recycle-Logic Inc. Contact: Laurie Parsons, Operations Director	Phone: (403) 348-0770; Fax: (403) 348-0760; E-mail: lparsons@recycle-logic.com Website: www.recycle-logic.com
RetroSystems	Phone: (403) 255-3353; Website: www.retrosystems.com
Shanked Metals	Phone: (780) 914-0412; Fax: (780) 486-7837; E-mail: lhaasbro@tbwifi.ca
Technotrash Alberta Contact: Chase De Schover	Phone: (403) 265-2332; Fax: (403) 265-2331; E-mail: Chase@Technotrash.ca Website: www.technotrash.ca
BRITISH COLUMBIA	
AAA Environmental, Inc.	Phone:1-847-526-5754; E-mail: nadine@aaaei.com; Web Page: www.aaaei.com
Advanced Industrial Manufacturing.	Phone: (604) 961-3432
Breakdown Recycling	Phone: (250) 381-2373; E-mail: breakdown@telus.net
BTR Recycling	Phone:(604) 273-7889
Camdow Computer Enterprises Inc	Phone: (604) 850-7600; E-mail: camdow@telus.net
Compucycle: Contact: Richard Drake	Phone: 250-336-8136; E-mail: compucycle@iscn.ca
Core Computer Recycling Society	Phone: (604) 649-8033; E-mail: blilam@axion.net
Electronic Recycling Association (also in AB and ON)	Toll-free: 1-877-9EWASTE; Website: www.era.ca Vancouver Phone/Fax: (604) 215-4483; E-mail: vancouver@era.ca
Electronics Recycling Global Co. Ltd. (also in ON)	Phone:+(604) 582-8087; Fax: (604) 589-8211; E-mail: info@electronics-recycling.com Website: www.electronics-recycling.com
Fraser Valley Metal Exchange	Toll-free: 1-877-303-5053; Phone:(604) 467-7878; E-mail: fvme33@aol.com Web Page: www.fvme.com
Genesis Recycling; Contact: Bert Monesmith	Phone: (604) 594-9989; E-mail: bertm@rider.com Website: www.rider.com
Monitor King	Phone: (604) 270-2677; E-mail: monitor@monitorking.bc.ca Website: www.monitorking.bc.ca
Okanagan Computer Products Recycling	Phone:+(250) 869-8877; E-mail: printers@okanaganprinters.com
P.G. Laser	Phone:1(250) 562-9643; E-mail: pg_laser@shaw.ca
Penticton and Area Cooperative Enterprises (PACE)	Phone: (250) 770-2284; E-mail: pace-e-waste@shaw.ca Website: www.voc-rehab-centre.info/e_waste_program.htm
Stop Computer Land Fill Contact: Ray Carling	Phone: (250) 503-5593; E-Mail: Ray@sclf.ca
Techno Trash Global	Toll-free: 1-877-771-7744; Phone: +(250) 717-0050; E-mail: rjhazel@technotrashglobal.com Website: www.technotrashglobal.com

ORGANISATION, CONTACT[1]	PHONE, E-MAIL, WEB COORDINATES[1]
Toxco Waste Management Ltd. Contact: Kathy Bruce	Toll-free: 1-877-GO-TOXCO; Phone: (250) 367-9882; E-mail: toxcokat@netidea.com Website: www.toxco.com
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Note 1: Contact names, phone numbers, e-mail addresses and websites are provided to the extent this information has been easily available to the researchers.

ANNEX G
EOL Electronic Product Producer Responsibility
Program Summaries

This Annex comprises:

- A description of Canadian and US EOL electronic product stewardship programs, and
- Two tables that summarise established EOL electronic product stewardship programs. Table G-1: Program Scope addresses the products that fall within each program, a summary of the program, targets established by programs, the collection model adopted by programs, recycling rates associated with programs and the financing model adopted by each program.

  Table G-2: Fees, Guidelines and Operations addresses - for the same programs as in Table G-1: Program Scope - the consumer fees, EOL management guidelines, oversight body, the program operating organisation(s) and contact information for additional information

Electronic Products Stewardship Canada
Recyclage des Produits Electroniques Canada

Electronic Product Stewardship Canada (EPS Canada) is a not-for-profit organization representing companies from the information technology sector, and manufactures and distributors of electrical products. EPS Canada's mission is to ensure the most efficient economic and environmental management of selected end-of-life electronics and information technology equipment required under government legislation. Their mandate is to create a national electronics end-of-life program for Canada allowing for maximum provincial and municipal flexibility.

Recognizing that stewardship for WEEE is a provincial jurisdiction, EPSC proposes to create a national program office responsible for the establishment of a fee structure, negotiations with industry and governments, collection of fees, standardization of activities, and reporting on national performance.

EPSC would delegate responsibilities and provide funding to provincial/territorial officers or to local organizations and allow them the maximum flexibility to manage their region.

Visible Fees Financing
The system would be funded through an environmental handling charge (also called an eco-fee), which would be placed on each major category of technology product. The revenue raised from fees will be adequate to cover the costs of environmentally responsible disposal, and reviewed on a regular basis to avoid deficits or surpluses. The charge would be initiated by the original equipment manufacturers and passed along to the consumer (with an explanatory flyer) and no mark up. The fee will be shown as a separate charge on the consumers receipt. Preliminary analysis indicates that the charges could be: Monitor: $12; CPU: $8; Laptop: $2; Printer: $7; Television: $25. There has been discussion of a fee phase-out over time once the historic and orphan WEEE is eliminated.

Funding
Raised revenues would be used to fund contracts with waste management companies for the pick up and disposal of product (either with national, regional, or local contracts) from a defined number of drop-off depots and consolidation sites (which may be located
at existing landfills or transfer stations) in each province, to pay for the national
and local administrative management of the program.

A consumer awareness and education program will be implemented to promote widespread understanding and support for the program. This would include education material at point of sale.

Funding will not be provided for collection (i.e.: handling fees).

Collection
EPS Canada anticipates that most WEEE will be collected in all areas of provinces through the use of existing rural and municipal landfill sites or through waste depots. In addition, if retailers are interested in collecting items, they too will be supported when they choose to run special drop-off events to maximize product recovery.

Recycling Vendor Qualification Standard
One of EPS Canada's guiding principles is that end-of-life products must only be managed in locations that have environmental and health protection laws acceptable to Canada. With this principle in mind, EPS Canada has developed a Vendor Qualification Standard, which covers environmental management, occupational health and safety, operations, sub-vendors, and transportation.

To date, the only existing Canadian provincial regulation (Alberta) is not consistent with the EPS Canada's program approach in several respects. Ontario however, where regulation will be passed this year, may allow for a similar program to be operated by a designated agent of EPS Canada.

National Electronics Product Stewardship Initiative (NEPSI)

In the United States, the National Electronics Product Stewardship Initiative (NEPSI) was created in 2001 to bring stakeholders together to develop solutions on issues related to electronic products end-of-life management. NEPSI's primary goal is

> "*the development of a system, which includes a viable financing mechanism, to maximize the collection, reuse, and recycling of used electronics, while considering appropriate incentives to design products that facilitate source reduction, reuse and recycling; reduce toxicity; and increase recycled content."*

Industry, state governments, the federal government, environmental non-governmental organisations and other interested stakeholders met for two years in an attempt to come to consensus on a national program, which would mitigate costs, and administration associated with state-by-state legislated programs.
Stakeholder consensus was achieved on several key program elements, which would be further defined as the program developed. They include:

- The scope of products for a program: TV/TV Monitors (CRTs & flat panels); Computer CRT & flat panel monitors larger than 9 inches; CPUs; Laptop/notebook computers; Small peripherals (mice, keyboards, cables, speakers); Consumer desktop devices (printers & multifunction devicesA base level of service, which assures public convenience, diversity of collectors, and competitive contracting. More specifically elements of the base level of service include:
- Convenient, permanent drop-off sites strategically located, that balance convenience;
- A role for retailers in which they would be strongly encouraged to participate in the collection system;
- Proper handling standards of e-waste in an effort to preserve material integrity for reuse or recycling;
- A basic level convenience which includes travel distance to the nearest drop-off site, hours/days of operation of the facility which will be determined locally, and level of consumer service which relates to the ability of the drop-off facility to handle the flow of products and traffic in an efficient and timely fashion. This would include both a rural and urban standard based on population density.
- Activities to be financed, which include: assistance with direct collection costs; transportation from collection sites to processing facilities, recycling centres; and recycling/processing;
- A collection incentive payment - a financial incentive paid per pound collected, which would be passed through to fund local government, charitable organizations, and other collection agencies (public or private). This financial incentive would be adequate to effectively draw a large percent of e-waste into the recovery infrastructure.
- Contracting/tendering would pay for transportation, consolidation and processing; End-of-life management guidelines: proper management of hazardous waste; maintain tracking records and monitor downstream processors; comply with minimum wage laws; complete certified training; export only whole products for reuse or processed materials for recycling; and
- The need for a national coordinating entity to jump-start the system between the agreement phase and ultimate potential enabling legislation being passed.

The main area of disagreement was on the financing mechanism. In June 2003, NEPSI stakeholders agreed to concentrate on a hybrid-financing model that would begin with an advanced recovery fee (ARF) and evolve into a partial cost internalization system (after about 7-10 years); talks broke down over this financing mechanism. The basic disagreement amongst industry stakeholders was over the ARF. The majority of consumer electronics stakeholders wanted the ARF, while key computer manufacturers wanted to run their own recycling programs without a visible fee. Since then, consumer electronics manufacturers have been meeting to come to agreement on a national financing mechanism. NEPSI's final report will be available in January 2005.

In the meantime several states have banned municipal landfill disposal of CRT waste, and two states - California and Maine - have passed EOL electronic product related stewardship laws. In addition, many states have draft laws for the state legislators, including: Minnesota, Massachusetts, Wisconsin, Oregon, Washington, and Florida. In response to these new laws the US Department of Commerce is looking at these developments in terms of inter-state issues that arise from state by state programs.

Federally, the Environmental Protection Agency (EPA) runs its *Plug into eCycling* – a voluntary program launched in January 2003. This program challenges stakeholders to invite different participants to develop electronics recycling. The program facilitates increased relationships for electronics recycling. Specifically, *Plug into eCycling* focuses on:

- Providing the public with information about electronics recycling and increasing opportunities to safely recycle old electronics;
- Facilitating partnerships with communities, electronics manufacturers, and retailers to promote shared responsibility for safe electronics recycling; and
- Establishing pilot projects to test innovative approaches to safe electronics recycling.

In addition, many computer manufactures maintain voluntary programs whereby ink and toner cartridges are taken back for free (usually using postage paid mailing labels), while CPUs, laptops and monitors are sent back to manufacturers for recycling for a back-end fee charged to the customer at the end of the EE's life.

Summary of Public and Private Sector EOL Electronics Product Stewardship Programs

Table G-1 and Table G-2 summarise public and private sector EOL electronic product stewardship management programs around the world.

Table G-1a: EOL Electronic Product Producer Responsibility Program Summaries – Regulatory Programs

Jurisdiction	Product Scope	Program Summary	Targets	Collection Model	Recycling Rates	Financing Model
EUROPE						
European Union Waste Electrical and Electronic Equipment (WEEE) Directive	Directive covers most products with a plug or battery. Specifically: large household appliances; small household appliances; IT and telecommunications equipment (grey goods); consumer equipment (brown goods); and others: lighting equipment; electrical and electronic tools; toys; leisure and sports equipment; medical devices; monitoring and control instruments; automatic dispensers.	The WEEE Directive: Requires selective collection of WEEE to preserve integrity of the waste. Requires manufacturers to finance treatment, recovery and environmentally sound disposal of their waste. Requires manufacturers to reach a recycling target of 75% according to the category of equipment by the end of 2006. Requires member states to reach a collection target of 4 kg per capita by the end of 2006. Requires manufacturers to label products with information to end users and treatment facilities.	Collection target of 4kg /capita from households by the end of 2006. This represents about 25% of what is generated (sold) per year. Directive sets out required recovery (including energy recovery) and reuse/ recycling rates (by weight) of separately collected WEEE, to be achieved by end of 2006: *Large household appliances and automatic dispensers*: Recovery of 80 percent; reuse/recycling of 75 percent *IT, telecoms equipment and consumer equipment*: recovery of 75 percent; reuse/ recycling of 65 percent *Small household appliances, lighting equipment, electrical/electronic tools, toys/ leisure/sports equipment and monitoring/control instruments*: recovery of 70 percent; reuse/ recycling of 50 percent *Gas discharge lamps*: reuse/ recycling: 80 percent	Member states must setup collection schemes and encourage the involvement of end users. Collection sites must be adaptable to the density of the population; accessible for consumers and distributors, which are able to return WEEE and collection should be offered free-of-charge. Distributors (i.e.: retailers) must offer consumers the possibility of returning WEEE free-of-charge on a one-on-one basis, when buying new products. Member states may deviate from this rule provided the convenience is as good or better, and the service is free.	Only 5 member states have fully implemented take-back programs for WEEE. Collection rates are available, but recycling targets have not been determined as of yet.	Distributors (retailers) are responsible for financing their own collection on a "buy-one, take-one-back" basis. Producers must guarantee at least the financing and transport from collection points, as well as the recovery, treatment and environmentally sound disposal of WEEE for products placed on the market as of Aug 13, 2005. Producers may choose to indirectly bear the responsibility by paying a third party to undertake their obligation (i.e.: through a collective system). Historical waste management will be financed collectively by producers based on their market share of a type of equipment. Manufacturers are required to 1) join a collective agency and pay up front; 2) set up a blocked account; 3) or pay a guarantee provision at the point of import.
Denmark	White goods; radios; TVs; IT products; office equipment; monitoring and control instruments.	The program regulation mandates that local municipal authorities must ensure that WEEE is collected and properly treated through approved companies. Producers may be granted permission by local authorities to take-back their own products or similar products free of charge. Distributors and retailers may offer a take-back service within the municipal collection scheme.	There are no official targets set out in the Statutory Order, although the Danish EPA has an unofficial target of 75%. Therefore, WEEE Directive targets apply.	For the most part, municipalities collect WEEE, although, some retailer/distributors may also collect WEEE.	The Danish EPA reports that about one third of WEEE is currently being collected.	All costs associated with the program paid for by municipal authorities through local taxes. Commercial delivered WEEE pays municipalities for the recycling service.

Table G-1b: EOL Electronic Product Producer Responsibility Program Summaries – Regulatory Programs.

Jurisdiction	Product Scope	Program Summary	Targets	Collection Model	Recycling Rates	Financing Model
Belgium	The program covers: refrigerators; freezers; air conditioners; small and large white goods; TVs; computer monitors; radios; amplifiers; synthesizers; record players; CD players; cameras; computers; printers; videos; telephones; photocopiers; mobile phones; loudspeakers; small household appliances; toys; lighting; control equipment, electric and electronic equipment.	All retailers must take-back (free of charge) on a one-for-one basis and indicate their take-back service. All recovered WEEE must be sent to a registered recovery centre. Retailers and distributors must annually report to the national government the types and quantities of waste that they recovered that year. Manufacturers must account for amount of equipment recovered by weight; the treatment method in place and the amount of recycling/reuse, incineration and landfilling. Manufacturers or first importers finance the system and pay for the historical waste based on their market share of collected WEEE. The programs are implemented and managed regionally through Flanders, Wallonia and Brussels - each program differs slightly but most elements are shared.	Collection target: Average of 4 kg per person per year from households Reuse and recycling targets: metals: 95%; plastics: 20% large white goods: 90%; refrigerators and freezing appliances: 70%; TV and PC screens: 70%; other: 70%	There exist over 2150 collection points. About 74% are distribution points (retailers) which collect about 15% of the volume; about 25% are container parks (municipal collection) which capture about 75%; and less than 1% are used-good centres which capture the remaining 10%.	In 2003, 4.5 kg/capita were collected from households, which is .5 kgs per capita above the WEEE directive target. This represents about 26% by weight of the amount of designated materials declared in 2003 (i.e.: put into the market place). Recupel reports two separate performance rates - the first is a recycling rate: white goods: 84%; fridges and freezers: 81%; screens: 83%; other appliances: 82%. The second performance measurement is the recovery rate which includes incineration: white goods: 84%; fridges & freezers: 92%; screens: 91%; other appliances: 83%. In addition, Recupel reports recycling and recovery rates by material type. These are: metals: 100% & 100%; and synthetic materials (plastics) 62% & 78% respectively.	Consumers pay an up front Recycling Premium on most products to the retailer who passes it on throughout the chain till it reaches the manufacturer who transfers it to Recupel, the company that undertakes the transport and recycling obligation. This contribution is used to cover the costs associated with the collection, sorting, transport and recycling of discarded appliances. Retailers take-back at their expense WEEE at no charge from consumers. Distributors must accept back at their own expense all WEEE from retailers. Producers and importers accept back at their expense all WEEE from distributors and ensure that transport and storage arrangements provide reuse opportunities.
Switzerland	Most electronic and electrical equipment. Defined broadly as appliances that depend on electricity: consumer electronics; office; information and telecommunication equipment; and household appliances.	The program obligates producers and importers to take-back and dispose of WEEE. Distributors (and retailers) are required to take-back products that are similar to those they sell from consumers. Householders are responsible for returning WEEE to collection sites. Two collective agencies have been setup. The first is SWICO, which deals with office equipment and consumer electronics. The second agency is SENS, which deals with refrigerators and freezers. Both agencies work together where efficiencies can be gained. SWICO tenders out recycling contracts to recycling firms every two years.	The regulations do not identify of collection or recycling target. Therefore, WEEE Directive targets apply.	WEEE is returned to dealers, retailers and "accredited SWICO return centres". There are over 10,000 dealers and about 250 SWICO collection points.	In 2002 about 8 kg per capita of WEEE were collected. Of this about 20% was reused. Of the remaining 80% of WEEE, 76% was recycled, 21% incinerated and 3% sent to landfills.	Consumers pay an advance recycling fee (ARF) at the point of purchase. Funds collected go to SWICO to fund the program. It is estimated that in 2001 the program costs were 11.27 M ($EU), of which 18% was for transport; 72% treatments; 6% disposal of packaging; and 4% education and administration.

Table G-1b: EOL Electronic Product Producer Responsibility Program Summaries – Regulatory Programs.

Jurisdiction	Product Scope	Program Summary	Targets	Collection Model	Recycling Rates	Financing Model
Netherlands	White goods; small appliances; electronics; refrigerators; freezers; air conditioners; ventilation equipment; washers; dryers; stoves; ovens	Manufacturers are responsible for taking back from municipal authorities, repair companies, and retailers (on a "similar" product for product basis) for proper end-of-life management. Manufacturers have opted out of their responsibility by joining collective schemes. Currently there are two collectives - NVMP which covers white goods and brown goods, and; ICT - Milieu, which covers grey goods. Consumers pays visible fees at the point of purchase for products represented by NVMP - from 0 - 17 ($EU). These fees cover retail handling, transport and recycling. Manufacturers of grey goods have chosen to internalize their costs of managing existing, historical and orphan waste based on their current market share. Local authorities are required to finance their collection and partial transportation of WEEE.	Recycling targets are a measurement of the % of weight being processed, which does not include incineration). They are: TVs: 69%; large white goods: 73%; Refrigerators and freezers: 75%; small appliances: 53%.	Municipal authorities must provide separate collection (via curbside or depot). Municipalities also accept material from suppliers who have taken-back products. Municipalities sort by brand. Retailers must accept product back on a "buy-one, take-one back" basis until 2005. About 10% of the white and brown goods WEEE is collected through retailers, about 3% through repair companies, and 87% through municipal collection points. About 5% of grey goods are collected via retailers and the remaining 95% through municipal authorities.	In 2002, 4.13 kg/ capita were collected.	Collection and transportation costs are shared between producers and municipalities. Municipalities finance collection and transport of WEEE to regional transfer stations. Manufacturers finance other transport and sorting costs. As of 2003, manufacturers, based on their current market share finance orphan waste collectively.
Norway	Board coverage of electrical and electronic goods and components. Reusable EE products are exempt from the regulation	The program covers most electronic and electrical equipment, except for permanently installed large devices (like elevators, escalators etc.) In the program, manufacturers are obliged to ensure that any EE products introduced must be recovered, recycled and managed properly once they become WEEE. Municipalities are responsible for receiving WEEE at their facilities and finance the collection function of consumer WEEE themselves. Municipalities may charge for handling commercial WEEE. Distributors/retailers must accept WEEE of products that they carry from consumers free of charge. They must also accept these products from the commercial sector on an old-for-new basis. Two collective agencies exist - Hvitevarereretur AS represents large and small household appliances; and Elecktroikkretur AS represents IT; consumer electronics, toys, medical and other electronic equipment. In addition RENAS is responsible for industrial and commercial waste including fluorescent tubes; bulbs; lamps; electric tools; cables and leads; transformers etc.	The Ministry of Environment set a WEEE collection rate of 80% by July 1, 2004.	Collection takes place at over 7,000 retailers and 435 municipalities. There are 3 regional collection facilities responsible for collection logistics and all material is sent nine recycling facilities in the country.	In 2002 Norway collected 8 kg per capita of WEEE. RENAS reports a materials recycling rate of 82% for 2002.	Members of Hvitevarereretur pay a recycling fee through the federal tax system monthly. These funds are used to help finance retailers, collection logistics and recycling costs. Members of Elektronikkretur members pay a recycling fee per unit on the market. For IT goods, fees are based on costs per market share. Visible fees are not prohibited, but mostly fees have been internalized.

Table G-1b: EOL Electronic Product Producer Responsibility Program Summaries – Regulatory Programs.

Jurisdiction	Product Scope	Program Summary	Targets	Collection Model	Recycling Rates	Financing Model
ASIA						
Taiwan	TVs; white goods; PCs, laptops; printers; fluorescent lights; batteries	The electronics program in Taiwan has been introduced in stages, starting in 1998 for white goods and TVs. In 2001 it expanded to include laptops, desktop PCs and monitors. Fluorescent lights were added in 2003. Manufacturers pay fees based on sales and product type to a government committee, which flows the funds to recycling and disposal. Material is collected through curbside recycling, drop-off depots and recycling organizations. There are about 600 take-back points in the country.	There are no targets set out in the law.	There exist about 600 drop-off point as well as municipal curbside collection.	Recycling rates for 2002 are: Printers: 16.4%; Notebooks, mother boards, hard drives, power packs, computer casings, and monitors: 85%.	The government's Appliance Resource Recycling Fund Management Committee sets fees annually. Funds are collected from manufacturers and used to finance collection, transport and recycling. Funds change based on costs, level of compliance and end-of-year surplus or deficits.
South Korea	TVs; large white goods; air conditioners; computers; peripherals; laptops; cameras; razors; hair dryers; digital watches; and toys.	The Product Recycling Liability Law requires electronics producers to meet targets for collection, transportation and recycling of EOL electronics. Non-compliance may result in fines 130% of the recycling costs. The government is encouraging companies to comply themselves or setup collectives to take-on their legal obligation. Nearly 50% of the material is currently being recovered by manufacturers and sellers, about 46% by local governments and 4% by recyclers. The current law does not deal with importers, and therefore may hurt the competitive nature of the domestic business.	The program imposes targets for collection, transportation and recycling of e-waste.	50% of electronics collected are recovered directly by manufacturers and sellers. 46% are recovered by local governments and the remaining 4% by recyclers.	Data unavailable	Customers bear about 16% of the costs, local governments 13% and manufacturers about 68%.
Japan	TVs; large appliances; air conditioners; PCs (ICI); laptops (ICI)	EOL management of white goods, TVs personal computers and related products regulated under the Law for the Promotion of Effective Reutilisation of Materials and the Home Appliances Recycling Law. Manufacturers are responsible for managing collection and recycling of these products. They finance the programs through backend user fees on PCs and related products, and front end-retail fees on white goods. Fees range depending on the product type and brand. Manufacturers set their own fees, as such; several collective agencies have been setup to represent the different interests of companies. These agencies manage about 190 collection points, and 15 and 24 recycling plants. A new collective agency called JEITA has been formed to handle consumer PCs.	The following recycling targets are established in law: TVs: 55 percent Refrigerators: 50% Washing machines: 50% Air conditioners: 60% Office-use PCs: 20-55% Rechargeable batteries: 30 – 60%	About 80% of the collection points are retailers and 20% municipal authorities. Collection points transport material to manufacturers who take-on responsibility for recycling. The Home Appliance Association manages orphan products.	For the appliances, about 7.9 million of 18 million used appliances are currently being recycled. There are no recycling rates for PCs yet, as the program is less than one-year old.	The program is financed through visible recycling fees charged at the point of purchase by retailers. These fees are $4-$20 US. In the newer program for PCs and related products, PC makers individually collect WEEE through their office door-to-door delivery service or collection points that they have setup. They charge users a recycling fee to cover transportation and recycling. These fees range from $7-$8 for transportation and $26-$32 for recycling.

Table G-1b: EOL Electronic Product Producer Responsibility Program Summaries – Regulatory Programs.

Jurisdiction	Product Scope	Program Summary	Targets	Collection Model	Recycling Rates	Financing Model
CANADA						
Alberta	Laptops; printers; PCs; monitors; TVs.	The program began collecting designated electronic waste on October 1, 2004. Collection takes place via municipal depots. Municipalities will receive $50/tonne of eligible materials. Once collected municipalities choose an approved collector to pickup and process the material. Registered processors receive about $700/tonne of eligible materials, plus a transportation subsidy based on distance zones. Vendor qualification requirements exist in order to become a registered processor. Registered processors must be based in Alberta only. Reuse is not subsidized, as it is believed that financial forces will result in segregation of components for reuse and/or refurbishing.	There are no targets for collection, recovery or reuse/recycling in the legal framework.	Municipal depots are the primary means of collecting designated electronic materials; some private depots as well.	The program has not been in place long enough to measure recycling rates.	Funds are raised through an advance disposal surcharge levied by Alberta Recycling Management Authority (ARMA) on manufacturers and/or retailers and/or importers. ARMA manages the fees. Funds are distributed according to a pre-set formula to municipalities for collection services and to registered processors for transportation and processing services.
USA						
Maine	Flat screen monitors; CRT monitors; flat screen TVs; CRT TVs; all over 4 inches in diameter.	The program covers household monitors and TVs only as a result of a ban on disposal in municipal disposal sites of CRT waste. Municipalities are required to ensure that designated products get from households to points of consolidation that are registered with the state. Consolidation businesses are responsible for counting the units and classifying them by brand. Materials must be shipped to recyclers that are registered with the state and have signed statements that they meet the state's end-of-life management guidelines. Brandowners that want to continue to sell in Maine must submit plans by March 1, 2005,which will outline their billing information, how they intend to pay bills, reporting etc.	There are no targets in this bill	Municipalities are responsible for ensuring that household monitors and TVs end up at registered in-state consolidation points. They can encourage their citizens to take their e-waste to consolidation points directly, offer take-back to municipal transfer stations/depots or provide special collection days.	Not Known	Municipalities finance collection and education of designated waste to the consolidation points. Brand owners directly finance the costs of consolidation and recycling of their own brand waste and their share of orphan waste (based on their market share in the non-orphan waste) Consolidators send invoices to brandowners based on the number of units that they counted belonging to each brand. This includes historical waste. Orphan waste costs are billed to brand owners based on their market share of non-orphan material.

Table G-1b: EOL Electronic Product Producer Responsibility Program Summaries – Regulatory Programs.

Jurisdiction	Product Scope	Program Summary	Targets	Collection Model	Recycling Rates	Financing Model
California	Two separate EOL electronics programs are operated: (i) CRT program, including CRT monitors; flat screen TVs; flat screen computer monitors and laptops; video display devices with a screen of 4 inches or larger; and (ii) mobile phone program.	*CRT Program* The Electronic Waste Recycling Act mandates that regulated products carry a recycling fee from sellers or retailers. It is assumed that most retailers will pass-on the fee to consumers as a visible recycling fee. Managed by the State government's California Integrated Waste Management Board, fees are collected and redistributed to collectors and processors of the designated wastes. Processors must be registered and meet program and state requirements in order to be eligible for funds. Retail (or consumer) fees will be evaluated and possibly modified at the beginning of each year. The Board has authority to tier fees according the true costs of recycling. *Mobile Phone Program* Sellers of mobile phones must take-back the units at end of life..	*CRT Program and Mobile Phone Program* There are no collection, recovery, reuse or recycling targets specified in the legislation. .	*CRT Program* Local governments that already collect household hazardous wastes by law will collect designated electronic materials as well. Collectors will receive a payment to cover collection, which is equal to 28-cents ($US) per lb. They will receive this payment when they take these products to a processor. Processors are registered through the state of California. Processors may also act as collectors. *Mobile Phone Program* Return-to-retail by consumers	*CRT Program and Mobile hone Program* Not known	*CRT Program* Retailers pay a recycling fee, which may be passed onto consumers. The California Integrated Waste Management Board collects the funds and re-distributes them to registered processors to cover collection, transport and recycling. Registered processors receive 48-cents ($US) per lb. They are expected to pay collectors 28-cents ($US) per lb., and retain 20-cents ($US) per lb. for processing. *Mobile Phone Program* Service providers and retailers will share the cost.

Table G-1b: EOL Electronic Product Producer Responsibility Program Summaries – Voluntary Programs.

Jurisdiction	Product Scope	Program Summary	Targets	Collection Model	Recycling Rates	Financing Model
Australia Mobile Telecommun-ications Association	Mobile phones	The Association of Mobile Telecommunication Association (AMTA) launched this voluntary initiative in 1998. The Mobile Phone Industry Recycling Program works with over 1650 retail stores and some municipal depots to take-back used handsets. AMTA coordinates transportation and recycling from collection points. Mobile phones are granulated and sent to a high temperature furnace where metals are recovered. Some plastics are also recovered prior to being incinerated. The program is financed by carriers, service providers and handset manufacturers.	25% take-back rate by 2002; 50% take-back rate by 2004.	Over 1650 stores and a few municipal depots nationwide collect mobile phones.	To date over 2600 tonne of mobile phone have been collected. This represents 400,000 handsets and 900,000 batteries, and about 40 tonnes of cadmium-bearing batteries.	The program is financed by the various industries that are involved in providing mobile phones and service. Specifically, carriers, service providers and handset manufacturers all contribute per handset levies monthly towards the program. The levies fund promotion, collection, sorting and recycling. Carriers aggregate monthly mobile phone sales and manufacturers are changed based on market share.
Apple	Apple computer products / batteries / printer toner cartridges	In 2001, Apple launched an end-of-life program to recycle it products from it customers in the US. Consumers pay a fee to cover the shipping cost to the Apple recycling vendor. For those participating in the program, Apple estimates that 85%-90% on the collected products are diverted from landfill.	No targets are specified, however Apple does have a series of overall environmental goals around meeting environmental requirements, safety standards, and standards to protect human health.	Customers are requested to package their product in a box (with a maximum size limit) and send to the Apple recycling vendor listed on their web site.	A recycling rate is not available. In 1999 Apple sent 1500 tonnes of its products for recycling - which is an 85% recycling rate. The remaining 15% was sent to a smelter for further low-grade metal recovery.	Consumers pay a fee for shipping. Apple finances the recycling costs.
Dell	Computers; ink cartridges; batteries	Dell Computer believes in fully integrating environmental stewardship into their business. Currently Dell offers its US customers a recycling program whereby $15 is charged for the service. Alternatively, customers can donate their computers to a foundation for a tax deduction. Dell is also part of the EPA's "Plug-in to eCycling" program aimed to inform consumers about reuse and recycling and create recycling partnerships. Since July 2003, Dell has collected almost 2 million lbs of electronic waste.	There are no targets, except to fully integrate environmental stewardship into their business.	Waste electronics and associated batteries and ink and toner cartridges can be sent to Dell's recycling program for a fee. Dell Financial Services provides asset recovery programs for business consumers to ensure safe recycling.	Dell's Financial Services (DFS) has brought back 2 million computers for reuse and recycling. They have also bought-back 300,000 computers through trade-in or buy-back fees from their customers in the US.	Customers are charged a fee mainly for shipping. Dell Financial Services finances treatment for returned electronic goods.

Table G-1b: EOL Electronic Product Producer Responsibility Program Summaries – Voluntary Programs.

Jurisdiction	Product Scope	Program Summary	Targets	Collection Model	Recycling Rates	Financing Model
Bell Mobility	Mobile phones; wire phones; PDAs; pages.	Bell Mobility's *Reduce, Reuse, Redial* program was launched in 2003 in British Columbia, Alberta, Ontario and Quebec. Through some retail partners, corporate clients and Bell Mobility Stores, customers can take-back any mobile phone, telephone and phone accessories. Shop clerks put equipment in special bins, and when full are sealed and picked-up by a courier who is prepaid. Equipment is sent to recycling consolidation point. Phones are either recycled or refurbished and sold or donated to charities.	There are no targets identified in this program.	Over 350 Bell Mobility Stores, some government agencies, large corporate clients and some other retailers that sell Bell Mobility products.	About 900 units are returned each month. Since the launch the program recovered over 2600 kg of batteries.	By early 2004 the program paid for itself through the revenue generated from as-is, graded and refurbished phone sales.
Hewlett Packard (HP)	HP Hardware; Ink and Toner cartridges	HP's InkJet Recycling Program was launched in 1996. They also offer Canadian customers a recycling option for a fee to cover shipping and handling. HP's tracks where their collected material is shipped for final processing and ensure that any hazardous components are appropriately managed	There are no recovery targets identified	Customers may ship end-of-life products	Not known	Consumers wishing to recycle their computer hardware pay a recycling cost of $20-454 to cover shipping and handling. HP finances the program.
IBM	IBM hardware	IBM operates eight major and twenty minor asset recovery centres in the world mostly used for take-back from commercial users. IBM also offers US customers the opportunity to recycle any PCs, monitors, printers and attachments for $30 ($US) including shipping.	There are no recovery targets identified.	Customers may ship used computers, monitors and printers to its PC Recycling Service.	Not known	The service is financed through backend per unit fees and by IBM directly.

Table G-2a: Fees, Guidelines and Operations – Regulatory Programs

Jurisdiction	Consumer Fees	Design Considerations	End-of-Life Management Guidelines	Operating Organization	Oversight Body	Web link
EUROPE						
European Union	Consumer fees are determined by member states. The WEEE Directive prohibits visible fees after February 13, 2011.	Design of products must facilitate dismantling, reuse and recycling of WEEE components and materials. Unless there are overriding reasons, producers may not prevent WEEE from being reused. The *Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS Directive*) restricts the use of lead, mercury, cadmium, hexavalent chromium and certain brominated flame retardants (polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs)) in the manufacture of new electrical and electronic equipment as of July 1st, 2006. RoHS Directive contains a list of exemptions for some applications (where no current replacement for the restricted substance is available) and sets out procedure for reviewing the list.	"Treatment" is the depollution, disassembly, shredding, recovery or disposal of WEEE. Prior to recycling, the following must be removed: PCBs; mercury; batteries; printed circuit board in cell phones and other devices > 10 sq. cm; toner cartridges; plastic with BFR; asbestos; CRTs; CFC, HCFCs, HFCs, HC; LCD with > 100 sq. cm, external electric cables; components containing refractory ceramic fibres; radioactive components; electrotype capacitors containing substances of concern. CRTs must have fluorescent coatings removed. Mercury shall be removed from gas discharge lamps. Recycling shall not hinder reuse.	Not applicable.	European Union	www.europa.eu.int/comm/environment/waste/weee_index.htm
Denmark	There are no consumer fees.	RoHS Directive	Treatment standards for CRTs, printed circuit boards, electronic displays, mercury-containing switches and relays, mercury dry cell batteries, PCB-containing capacitors, flame retardant plastics and selenium drums.	The system is government run.	The Danish Environment Ministry - EPA.	
Belgium	Consumer fees range from no fees on items like small domestic appliances; 0.50 € on telecommunication devices; 6.00 € on monitors; 8.00 € on laptops; and the highest fee is 20.00 € on refrigerators	Per the European Union RoHS Directive, see above	EOL electronics must be taken to a registered recovery centre. Appliances are dismantled, stripped of pollutants and recycled in an environmentally approved ways. The program calls for the separation of reusable and non-reusable equipment.	Recupel Asbl is a not-for-profit organization established to organize legal obligation on behalf of five sector associations covering large household appliances, consumer electronics, small household appliances, IT - telecommunication equipment and electrical tools and gardening equipment. Recupel coordinates the collection/recycling of EOL electronics in Belgium. Recupel works closely with merchants, municipalities, and municipal waste associations and used-good centers, as well as with companies specialized in the transport and the approved treatment of the discarded appliances.	Three Regional governments in Belgium oversee the program directly. The European Union oversees compliance with the EU Directive.	www.recupel.be

Table G-2a: Fees, Guidelines and Operations – Regulatory Programs Cont:

Jurisdiction	Consumer Fees	Design Considerations	End-of-Life Management Guidelines	Operating Organization	Oversight Body	Web link
Switzerland	Consumers pay an advance-recycling fee (ARF) when they purchase electronics. Fees are based on the quantity of units being collected and their relative recycling costs. The fees structure is relative to the equipment type and price.	Per the European Union RoHS Directive, see above	The legal framework includes requirements for EOL electronics disposal: i) pollutants must be removed before further treatment and disposed of in an environmentally acceptable way; ii) cathode ray tubes and metal components must be recycled as far as it is environmentally worthwhile and economically justifiable; iii) un-recycled organo-chemical components (e.g. mixed plastic wastes) must be incinerated in suitable plants. Switzerland treats all EOL electronics as hazardous waste for export purposes.	SWICO - represents over 400 members. SENS represents manufacturers of refrigerators and freezers	The Swiss Environ-mental Protection Agency - BUWAL	www.swico.ch
Netherlands	Consumer fees are only on NVMP goods (i.e.: white goods and brown goods). They range from no fees on small electrical devices; 2 ($EU) on keyboard instruments; 3 - 8 ($EU) on electrical appliances; and 5 - 17 ($EU) on large white goods. IT Equipment managed through ICT Milieu do not carry consumer fees.	RoHS Directive	Recycling rates are defined as the proportion of material not going to landfill or incineration. There is a prohibition of incineration of products, which have been taken back separately. Reuse is prohibited for refrigeration and freezing equipment containing CFCs and HCFCs.	Netherlands Association for Disposal of Metalelectro Products or NVMP represents 5 main producers of white goods. ICT-Milieu manages grey goods (IT and telecommunications equipment) on behalf of those manufacturers.	Ministry of Housing, Spatial Planning and the Environment. (VROM)	www.nvmp.nl; www.vrom.nl/ international www.ictmilieu.nl
Norway	There are no consumer fees.	RoHS Directive; voluntary producer agreements with government to reduce WEEE.	WEEE Directive guidelines.	Hvitevareretur AS; Elecktronikkretur AS/ El-Retur; RENAS	Environ-ment Ministry	www.elretur.no
Sweden	Visible fees are prohibited.	RoHS Directive	A regulation under the Ordinance on Waste Collection and Disposal requires that EOL electronics cannot be landfilled, shredded or incinerated without first being "treated" by a certified "pretreatment" company. The "pretreater" removes potentially hazardous materials including plastic components weighing more than 25 g.	El-Kretsen; El-retur	Ministry of Environment	www.el-kretsen.se
ASIA						
Japan	Consumers pay fees are paid at the point of purchase for TVs, refrigerators, washing machines and air conditioners, generally $US 4-20. For PCs and related items consumer fees are paid at the collection point; generally $US 7-8 covers collection and $US 26-32 covers recycling.	Reduction, reuse and recycled content requirements are promoted.	Measures to extend a product's life; designing resource saving technology; disputability; reusing reusable parts as raw materials; and reducing the amount of toxic materials used in production are among the various 3Rs "measures" to be undertaken when manufacturing, selling, and repairing a product.	Two operators agencies for managing EOL white goods and TVs: Group A (Matsushita, Toshiba, GE, Electrolux, DAIKIN...); Group B (Sony, Daewoo, Sharp ...) Both operate 190 collection points and 24 and 15 recycling plants respectively. JEITA manages obligations for consumer PCs.	Ministry of Environment	www.jeita.org

Table G-2a: Fees, Guidelines and Operations – Regulatory Programs Cont:

Jurisdiction	Consumer Fees	Design Considerations	End-of-Life Management Guidelines	Operating Organization	Oversight Body	Web link
CANADA						
Alberta	"Suppliers" (including manufacturers, distributors, wholesalers and/or retailers) are assessed an advance disposal surcharge (ADS). The ADS may ot exceed $5 on a laptop; $8 for printers; $10 for PCs; $12 for monitors; and $15-$45 for TVs (depending on their screen size).	Legal framework does not address design.	A series of vendor qualification criteria have been developed in order to qualify processors to receive, process and receive funding forprocessing designated materials.	Alberta Recycling Management Association (ARMA)	Alberta Environment	www.albertarecycling.ca
USA						
Maine	There are no consumer fees.	Legal framework does not address design	Guidelines have been developed for facilities that recycle or dismantle televisions or computer monitors that are generated in Maine. The Guidelines address health and safety, insurance, hazardous materials identification and management, documentation and other aspects of facility operation. Televisions or computer monitors may only be shipped to facilities that meet the requirements of these guidelines.	Municipalities and "consolidators" approved by State of Maine Department of Environmental Protection	Maine Department of Environmental Protection	www.maine.gov/dep/rwm/ewaste
California	*CRT Program* Retail fees (or consumer fees) are $6-$8-$10 per device depending on screen size, which will be originally paid by the retailers, who will pass it on to consumers. *Mobile Phone Program* There are no consumer fees.	*CRT Program and Mobile Phone Program* California has adopted the RoHS Directive in principle and will track RoHS as it evolves and adopt regulations that conform to it.	*CRT Program* Registered processors must meet criteria set out by the State government. Currently there are about 150 registered recyclers. *Mobile Phone Program* Phones must be recycled and may not be disposed of. Recycling means that recycler must demonstrate that it is either recycled or reused in state out of state. Processors must track the chain of custody.	*CRT Program* California Integrated Waste Management Board. *Mobile Phone Program* Wireless Recycling Foundation (collective of providers); and T-Mobile, which has its own program.	*CRT Program and Mobile Phone Program* California Integrated Waste Management Board.	*CRT Program and Mobile Phone Program* www.ciwmb.ca.gov/Law.htm

Table G-2a: Fees, Guidelines and Operations – Voluntary Programs Cont:

Jurisdiction	Consumer Fees	Design Considerations	End-of-Life Management Guidelines	Operating Organization	Oversight Body	Web link
Australia Mobile Telecommun-ications Association	There are no consumer fees.	Design issues are not addressed	The program does not have end-of-life management guidelines. Material is granulated and sent to a high temperature furnace where metals are extracted.	Australian Mobile Telecommunications Association	None – voluntary program	www.phonerecycling.com.au
Apple	US Consumers pay $US 30 to ship their products to Apple recycling vendors. Printer toner cartridge recycling is offered free-of-charge for US customers through a postage paid mailing label contained in the toner packaging.	Apple does not use recycled material in their products, but does use recycled content in their packaging. Some products meet the Energy Star guidelines.	Apple has not approved, qualified or evaluated specific recyclers throughout the world and highly recommends that customers call their local municipality's waste collection agency for alternatives and recommendations.	Apple Computer Inc.	None – voluntary program	www.apple.com
Dell	Customers are charged a recycling fee of $15 for computers and printers.	Dell's Environmental Program has adopted approaches to make product parts more modular for easy repairs and upgrades. Screw and glue use is minimal - most parts snap together.	As a partner of EPA's "Plug-in to eCycling" program, Dell uses the program's end-of-life management guidelines. These are available at: http://www.epa.gov/epaoswer/osw/conserve/plugin/pdf/guide.pdf.	Dell Computer Corporation	None – voluntary program	www.dell.com
Bell Mobility	There are no consumer fees.		The program does not have end-of-life management guidelines. EOL products are sent to a centralized facility and are sorted into: recyclable (36%) and re-sellable (64%) product. All batteries are removed and sent to the Rechargeable Battery Recycling Corporation (RBRC). Reusable (re-sellable) phones are send to a partner U S company where all memory is "scrubbed" or erased. The material is sorted as "as-is", "graded", or "fully refurbished". Phones are sold in the US, Asia or South America. Some are returned to Bell Mobility and donated to charities in Canada.	Bell Mobility	None – voluntary program	
Hewlett Packard (HP)	Backend fees ($20-$52) to cover shipping of HP brand and non-HP brand hardware in Canada and abroad. Inkjet and toner cartridges can be shipped back to HP for free, using postage in paid packages in Canada and abroad.	Plastics greater than 25 grams have no halogenated flame retardants. No-ozone depleting substances are used. HP claims they will be in compliance of the RoHS directive by July 1, 2006. Assemblies are designed to allow easy separation of plastics and metal.	HP has a set of global recycling standards for end-of-life management for its hardware. These require HP recyclers to: (i) reuse, recover and recycle materials and components; (ii) prohibit export of materials unless approved by HP; (iii) store and process materials in a way that prevents releases to the environment; (iv) provide accounting of materials processed; (v) conform to HP's Supplier Code of Conduct; (vi) permit HP to conduct assessments to ensure compliance with recycling standards. HP is also a partner of the US EPAs "Plug-in to eCycling" program.	Hewlett-Packard (Canada)	None – voluntary program	www.hp.ca/recycle
IBM	Backend fees which include shipping exist for recycling services in the US.	Goal that 10 percent of plastics should be sourced from secondary plastics in electronics manufacture	Agreements in place with vendors of electronics recycling services	IBM Corporation.	None – voluntary program	www.ibm.com/environment/annual 2002

ANNEX H
Opportunities for EOL Electronics Reuse And Value Added Recycling

ANNEX H
Opportunities for EOL Electronics Reuse
And Value Added Recycling

Data in this Annex has been compiled through review of national and international databases supplemented by discussions with industry representatives. The nature of markets for reuse opportunities and value-added recycling does not permit the precise quantification of reuse opportunities. However, broad opportunity trends emerge, and these are identified in this Annex.

Table H .1 summarises an array reuse and value added recycling opportunities for EOL electronics, and supplements the markets identified in Section 3.

The greatest reuse opportunities are in the reuse of computers and computer components. This is already being undertaken at a commercial scale with respect to EOL computers in the IC&I sector, largely for international markets where demand is strong for late model computers are related equipment. However, the reuse of computers in schools is well-established in Canada (e.g. through the Computers for Schools program), and there is continuing opportunity for this activity to grow.

Reuse opportunities exist for EOL electronics products associated with computers (e.g. monitors, printers), but these opportunities are less than for computers themselves.

A rapidly emerging opportunity exists with the reuse of cell phones. Companies in North America are now engaging in the refurbishment of used cell phones for the purpose of exporting the phones. This is still a very minor activity in comparison to the number of cell phones discarded, but is growing rapidly as a result f the cost-attractiveness of “pre-owned” cell phones as compared to new cell phones.

There is limited opportunity for the reutilisation of EOL electronic products through charity donation. Niche opportunities exist, however, such as the donation of used cell phones programmed to accept only 911 calls. Initiatives are also being undertaken to donate used computers and related equipment to socially disadvantaged groups; however, many of the EOL electronics used for charity purposes is equipment that has the least commercial value and the shortest life time. While charity donations provide an opportunity for EOL electronic product reuse, it is not considered likely to play a major role as a management strategy for EOL electronic products.

Opportunities are emerging for value-added recycling of glass from monitors and CRT’s. “Value-added” recycling are recycling opportunities that carry greater value than simply recycling materials in the lowest value commodity applications. CRT glass has potential for incorporation into cathedral glass and other types of architectural and art glass. One Toronto-based company engaged in recovering CRT’s is marketing recovered CRT glass to a U.S.-based light bulb manufacturer.

Table H-1
Opportunities for Reuse and Value Added Recycling of EOL Electronic Products

PRODUCT	COMPONENT	CURRENT REUSE APPLICATION/VALUE ADDED RECYCLING APPLICATION	FUTURE MARKET OPPORTUNITY AND MARKET DEVELOPMENT ACTIONS
Computers	Whole Computer (Desktop and Laptop)	Resold domestically and internationally Refurbished for discounted sale/donation Disassembled for recovery/resale of parts	Growing domestic and international market for late-model used computers. Limited opportunity for donation of computers to disadvantaged groups Significant long term opportunity for refurbished computers to be used in schools and possibly other institutions (e.g. prisons)
	Video Card	Purchased for resale or use in computer assembly (domestic and international markets)	Growing domestic and international market for late-model units
	Memory	Purchased for resale or use in computer assembly (domestic and international markets)	Growing domestic and international market for late-model units
	Network Cards/Hardware	Purchased for resale or use in computer assembly (domestic and international markets)	Growing domestic and international market for late-model units
	Zip Drive	Purchased for resale or use in computer assembly (domestic and international markets)	Growing domestic and international market for late-model units
	Hard Drive	Purchased for resale or use in computer assembly (domestic and international markets)	Growing domestic and international market for late-model units
	Processors	Purchased for resale or use in computer assembly (domestic and international markets)	Growing domestic and international market for late-model units
	Fax/Modems	Purchased for resale or use in computer assembly (domestic and international markets)	Growing domestic and international market for late-model units
	Motherboards	Purchased for resale or use in computer assembly (domestic and international markets)	Growing domestic and international market for late-model units
Monitors	Whole Monitors (CRT and LCD)	Purchased for resale in Canada for resale domestically and internationally	As part of computer systems, opportunity for donation to disadvantaged groups, schools and possibly other institutions
	CRTs (Whole)	Reused internationally in assembly of monitors.	On-going export opportunity
	CRTs (Whole or Broken)	Used in cathedral glass manufacture Used in manufacture of light bulbs	Value-added recycling opportunities in cathedral glass applications and in manufacture of light bulbs
Computer Peripherals	Whole Printers	Resold domestically and internationally Refurbished for discounted sale/donation	Continuing domestic and international demand for late model printers
TVs	Whole TV's	Resold domestically	Limited opportunity for charity donation and sale of TV's
Telephones	Whole telephones (single line, multi-line, and specialty)	Resold domestically and internationally	Continuing demand for handsets and related equipment. High demand for business/commercial telephones (e.g. PBX systems)
Cell Phones	Whole Cell Phones	Resold domestically and internationally Donated for emergency use to individuals	Rapidly growing international demand for refurbished cell phones Donation to individuals for emergency use.
Stereos	Whole Stereo Systems	Resold domestically	Limited reuse opportunities
Rechargeable Batteries		No reuse/value added recycling identified	No reuse/value added recycling opportunities but significant and growing opportunity to extend existing recycling activities

The following companies are engaged in the production of cathedral and architectural glass in North America.

Spectrum Glass Company
Box 646 Woodinville
Washington 98072
Phone: 425-483-6699
www.spectrumglass.com

Kokomo Opalescent Glass Co.
Box 2265
Kokomo
Indiana 46904-2265
Phone: 765-457-8136
www.kog.com

Uroboros Glass Studios
2139 N. Kerby Avenue
Portland
Oregon
Phone: 503-284-4900
www.uroboros.com

BullsEye Glass Company
3722 Se 21st Street
Portland
Oregon
97202
Phone: 503-232-8867
www.bullseyeglass.com

Youghiogheny Opalescent Glass Company
90 West Crawford Avenue
Connellsville
Pennsylvania 15425
Phone: 724-628-0332
www.youghioghenyglass.com

Wissmatch Glass Company
420 Stephen Street
Paden City
West Virginia 26159
Phone: 304-337-2253
www.wissmachglass.com

Armstrong Glass Company
1025 Cobb International Boulevard
Suite 250
Kennesaw
Georgia 30152
Phone: 770-919-9924
www.armstrongglass.com

ANNEX I
Regional EOL Electronic Product Discards, Intermediate Processors and Markets

Annex I
Regional EOL Electronic Product Discards, Intermediate Processors and Markets

Regional EOL Electronic Product Discards

Table I-1 identifies estimated EOL electronic product intermediate processing activity and capacity in Canada and the US by region. Regions are defined as follows:

Canada	
Atlantic Canada:	Provinces of Newfoundland and Labrador, Prince Edward Island, Nova Scotia and new Brunswick
Quebec	Province of Quebec
Ontario	Province of Ontario
Western Canada	Provinces of Manitoba, Saskatchewan, Alberta and British Columbia
Territories	Territories of Nunavut, Northwest Territories and Yukon
United States	
Northeast	States of Maine, New Hampshire, Vermont, New York, Pennsylvania, Massachusetts, Rhode Island, Connecticut, New Jersey, Delaware, Maryland, Washington D.C.
Southeast	States of Virginia, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Arkansas, Florida
Mid-West	Michigan, Wisconsin, Ohio, Indiana, Illinois, West Virginia, Kentucky
North Central	Minnesota, North Dakota, South Dakota, Montana, Wyoming, Nebraska, Iowa,
South Central	Colorado, Kansas, Missouri, Oklahoma, Texas
Northwest	Idaho, Washington, Oregon
Southwest	California, Nevada, Utah, New Mexico, Arizona

The "estimated EOL electronic product discards" data identified in Table I-1are based on data presented in Table 2 for 2005[72]. For regions in Canada, the "estimated EOL electronic product discards" data identified in Table I-1 reflect the data presented in Table 2. Regional estimates of EOL electronic product discards for the US shown in Table I-1 have been developed by pro-rating national data from Table 2 on the basis of mid-2004 population estimates for individual states available from the US Census Bureau[73]. Thus, it is assumed in Table I-1 that regional discards of EOL electronic products in the US reflects population distribution. As noted in Section 1, however, the distribution of discards of these products from the IC&I sector does not necessarily precisely reflect population distribution. To this extent, the regional US estimates of EOL electronic product discards identified in Table I-1 may underestimate EOL electronic product discards in regions where IC&I sector use of electronic equipment is high relative to population distribution, and to overestimate EOL electronic product discards where IC&I sector use of electronic equipment is low relative to population distribution. Notwithstanding this uncertainty, this approach to estimating regional discards of EOL electronic products is considered sufficient for the purposes of identifying broad EOL electronic product discard trends.

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[72] "Discards" exclude IC&I sector discards to reuse/recycle.

[73] *Annual Estimates of the Population of the united States and States, and Puerto Rico: April 1, 2000 - July 1, 2004 (NST-EST2004-01)*, Population Division, U.S. Census Bureau, 22 December 2004.

Table I-1
Preliminary Estimated Regional EOL Electronic Product Intermediate Processing Activity and Capacity (Tonnes, 2005)

Country/Region	Estimated EOL Electronic Product Discards[1]		Estimated Annual Quantity of EOL Electronic Products Processed		Estimated Annual Capacity of EOL Electronic Product Processors	
	Tonnes	Percent	Tonnes	Percent	Tonnes	Percent
Canada						
Atlantic Canada	11,281	6.8	<1,000	<1.6	<1,000	<1.6
Quebec	37,274	22.5	6,583	10.8	9,875	10.8
Ontario	65,485	39.5	36,387	60.0	54,580	60.0
Western Canada	51,069	30.8	16,514	27.3	24,771	27.3
Territories	626	0.4	<1,000	<1.6	<1,000	<1.6
Total – Canada	**165,735**	**100**	**60,484**	**100**	**90,226**	**100**
United States						
Northeast	502,512	20.9	186,377	24.8	279,566	24.8
Southeast	552.951	23.0	140,327	18.7	210,491	18.7
Mid West	429,016	17.9	126,931	16.9	190,396	16.9
North Central	104,252	4.3	23,444	3.1	35,165	3.1
South Central	322,603	13.4	114,037	15.2	171,055	15.2
Northwest	92,243	3.8	17,918	2.4	26,876	2.4
Southwest	398,260	16.6	142,641	19.0	214,007	19.0
Total – United States	**2,401,837**	**100**	**751,704**	**100**	**1,127,556**	**100**

Notes
1. Excludes IC&I sector discards to reuse/recycle.
2. In addition to the processing and capacity identified, Teck Cominco expects to introduce the capacity to process 15,000 tonnes of EOL electronics during 2005.

Preliminary estimates of intermediate EOL electronic products processing for 2005 identified in Table I-1 for Canada are based on data presented in Section 3.4.3. As identified in that section, survey and research (including industry interviews, collation of proprietary industry information and discussion with provincial and NGO electronics waste management officials) has specifically identified companies that expect to process 55,740 tonnes of EOL electronics waste in 2005. Based on the companies from whom specific data has been obtained, these data are believed to represent approximately 90 percent of the quantity of EOL electronics products that will be processed by intermediate processors in 2005. Thus, a total of 60,484 tonnes of EOL electronics products are estimated to be processed in Canada by intermediate processors in 2005.

As shown in Table I-1, the distribution of EOL electronics processing in Canada is skewed. Ontario is projected to account for approximately 60 percent of EOL electronics products that are processed by intermediate processors in 2005. Processing facilities in western Canada are primarily located in Alberta and British Columbia, and account for approximately 27 percent of the quantity of EOL electronic products projected to be processed through intermediate processing facilities in 2005.

A limited number of intermediate processing facilities are estimated to exist in Quebec, and the intermediate processing of EOL electronics products in Atlantic Canada is highly limited.

Processing activity in the U.S. has been estimated based on industry survey, industry interviews and document review. Analysis has been undertaken of 83 intermediate processing facilities across the U.S. whose business includes some form of reprocessing, either disassembly and/or shredding/grinding. As

identified in Table I-1, the percent of total of EOL electronics that are projected to be processed through intermediate facilities in the Northeast, South Central and Southwest regions is higher than the estimated percentages of total EOL electronic product generation in these regions. This suggests a concentration of intermediate EOL electronic product processing capacity in these regions, but this concentration is not to the extent found in Canada.

Estimates of EOL electronic processing tonnages includes both the EOL electronic products that are the subject of this document and other EOL electronic products that enter intermediate processing facilities. The potential range of these products is wide; and includes the range of products identified in Annex D.

In most jurisdictions in Canada and the US, EOL electronic products that are currently entering processing facilities are generated largely by the IC&I sector. As identified elsewhere in this document, private sector activity to process EOL electronics is driven by: (i) the opportunity to recover value from reuse of either whole EOL electronic devices or their parts, an opportunity that has been largely associated with IC&I sector computing equipment; or (ii) the willingness of the IC&I sector to pay for the destruction of electronic data records at the time that equipment is replaced. The household sector contributes larger proportions of EOL electronic products in jurisdictions where programs have been developed to address management of EOL electronic products (e.g. Alberta).

Regional Intermediate Processing Capacity

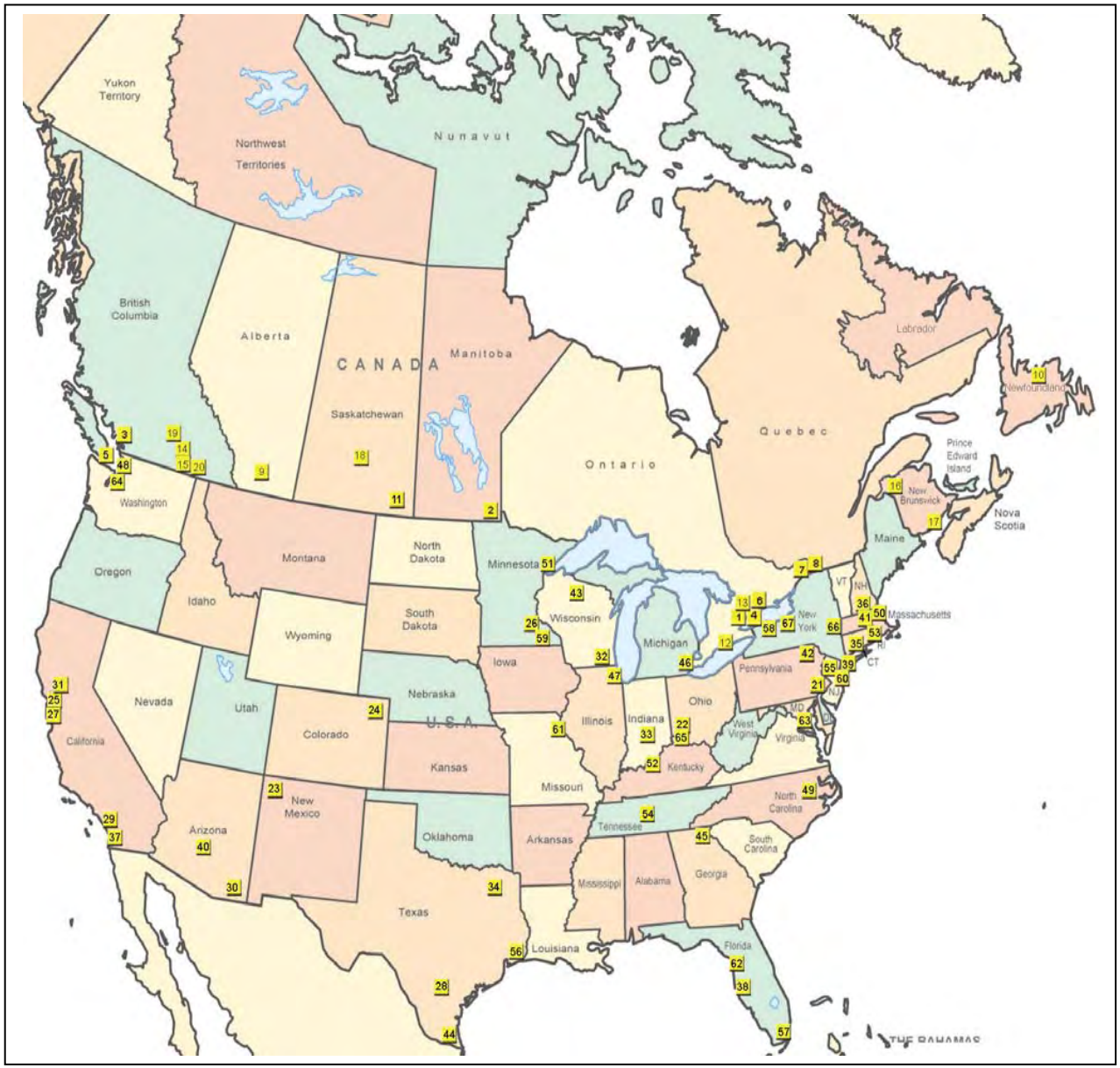
EOL electronic processing capacity in Canada and the U.S. has been estimated through extending the activities undertaken to estimate processing activity to also address processing capacity. As identified in Table I-1, processing capacity in 2005 is estimated to significantly exceed the tonnages of materials that will be processed. Data from 2003 has identified that intermediate processors typically ran at about 50 - 75 percent of their capability at that time[74]. Industry interviews in the preparation of this document have confirmed that this remains generally the case in 2004/2005.

The concept of "processing capacity" in the context of intermediate processing of EOL electronics frequently varies as compared to other industries. In highly mechanised manufacturing sectors, processing or manufacturing capacity is defined by the rate at which capital plant is able to produce; labour and other operational requirements are defined by the requirements of the capital plant. The operations of many intermediate EOL electronics processing facilities, however, are characterised by low levels of mechanisation. These operations do not have “capital plant” and “processing capacity” is related to the number of staff working at a facility. Many organisations with operations at this level consider that they operate at 100 percent of capacity as long as their workforce is fully busy, even though they may only operate a single shift per day.

Work undertaken to prepare this document identifies clear evidence of growth in intermediate processing capacity. New organisations are starting operations, some existing facilities are extending the geographic area from which they capture EOL electronic products and some existing organisations planning the establishment of new facilities. The largest identified planned addition to existing intermediate processing capacity is being undertaken by Teck Cominco in Trail, British Columbia. The firm has applied for government approval to establish an operation to process 15,000 tonnes/year of EOL electronic products at its smelting facilities on a fee-for-service basis, and without any pre-treatment or disassembly of EOL electronic products; materials that are recoverable from the furnace will be sold to end-users. Map I-1 identifies a non-exhaustive range of EOL electronics intermediate processors; additional processors and facilities also exist.

[74] *IAER Electronics Recycling Industry Report - 2003*, International Association of Electronics Recyclers, Albany, 2003.

Map I-1: Selected Intermediate Processors of EOL Electronic Products



Key to Numbers
See next page for companies associated with each number

Notes:

1. Includes all identified Canadian organizations
2. Includes all identified U.S. organizations with 10 or more employees.
3. Identified organizations in Canada and the U.S. may have multiple operations which are not separately identified.
4. **The intermediate processors identified on this map are not exhaustive; additional intermediate processors may exist.**
5. Some organisations have multiple facilities across a province or state, or across and between Canada and the U.S. (e.g. Computers for Schools across Canada and Centres de Formation en Entreprise et Récupération in Québec).

Sources:
Directory of North American Electronics Recycling Industry, e-scrap news, Portland, Oregon 2004;
IAER Directory of the Electronics Recycling Industry, International Association of Electronics Recyclers, Albany, 2003

Canada

1. Accu-Shred Limited, Mississauga, Ont
2. Acme Computer Company, Winnipeg, Man
   All About Computers, Winnipeg, Man
   Computer Recycle Center, Winnipeg, Man
   Computer Renaissance, Winnipeg, Man
   Computer Search International Inc., Winnipeg, Man
   Micro Trader, Winnipeg, Man
   Powerland Computers, Winnipeg, Man
   SyroTech Industries Ltd., Winnipeg, Man
3. Advanced Industrial Manufacturing, Vancouver, BC
   BTR Recycling, Vancouver, BC
   Core Computer Recycling Society, Vancouver, BC
   Camdow Computer Enterprises Inc., Vancouver, BC
   Electronics Recycling Co. Ltd., Vancouver, BC
   Fraser Valley Metal Exchange, Vancouver, BC
   Genesis Recycling, Vancouver, BC
   Tradeworks Training Society, Vancouver, BC
   Monitor King, Vancouver, BC
4. Arlen Scrap Metals, Toronto, On
   Asset Recovery & Recycling, Toronto, ON
   Computation, Toronto, ON
   DBM Recycling, Toronto, ON
   Electronics Recycling Canada, Toronto, ON
   Hi-Tech Recycling Ltd., Toronto ON
   Phones for Food, Toronto, ON
   reboot, Toronto ON
   Synergy Computer Services Inc., Toronto ON
   TRI Toronto, Recycling, Toronto ON
   Valu Shred, (Mississauga)Toronto ON
5. Breakdown Recycling, Victoria, BC
   Compucycle, Victoria, BC
6. Cartridges 4 Kids, Pickering, ON
7. Computer Recyclers Inc., Ottawa, ON
8. Ecosys Canada Inc., Montreal, Que
   Federal Commercial Metals, Lavaltrie (Montreal), Que InserTech Angus, Montreal, Que
   Hy Tech Sal. , Montreal, Que
9. Electronic Recycling Association, Calgary, AB
   GEKO, Calgary, AB Maxus Technology, Calgary, AB Rainville Electronic Recycling, Red Deer (Calgary), AB RetroSystems, Calgary, AB
   Techno Trash Global, Calgary, AB
10. Excite Corp., Grand Falls, NF
11. E-Waste Canada, Regina, SK
12. International Marine Salvage Inc., Port Colborne, ON
13. Noranda, Brampton, ON
    The Charitable Recycling Program of PhoneBack, Newmarket, ON
    Barrie Metals, Barrie, ON
14. Okanagan Computer Products, Kelowna, BC
    Techno Trash Global, Kelowna, BC
15. Penticton and Area Cooperative Enterprises (PACE), Penticton, BC
16. Project Pilote RESNET, Edmundston, NB
17. Triple R Telecom, St.John, NB
18. SARCAN, Saskatoon, SK
19. Stop Computer Land Fill, Vernon, BC
20. Toxco Wastee Management Ltd., Trail, BC

United States of America

21. AERC Recycling Solutions, Allentown, PA
22. Access Systems, Trotwood, OH
23. Ace Metals Inc., Albuquerque, NM
24. Action Computers Inc., Denver, CO
25. AER Worldwide, Hayward (San Francisco), CA
    Computer Recycling Centre, Santa Rosa, CA
    ECS Refining, Santa Clara, CA
    HMR USA Inc, San Francisco, CA
    Metech International, Gilroy, CA
    Recycle America Alliance, San Leandro, CA
    United Datatech Distributors, Santa Clara, CA
26. Asset Recovery Corp., St. Paul, MN
    Electronic Recovery Inc., Minneapolis, MN
    Enviro-Chem Inc.,Rogers, MN
    Metals Processing Corp., Eagan, MN
    Recycle America Alliance, Minneapolis, MN
27. Auction BDI, San Jose, CA
    Noranda Recycling, San Jose, CA
28. Axcess Technologies, Austin, TX
    Vadico, Austin, TX
29. BCS Recycling Specialists, Canoga Park (Los Angeles), CA
    Beacon Management Inc., Commerce (Los Angeles), CA
    Electronic Partners Corp., Los Angeles, CA
    HMR USA Inc., Gardena, CA
    Salvage 1 Recycling, Brea, CA
30. Box Q Inc., Phoenix, AZ
    Recycle America Alliance, Phoenix, AZ
    Earth Protection Services Inc., Phoenix, AZ
31. California Electronic Asset Recovery, Sacramento, CA
    Noranda Recycling., Roseville, CA
32. Cascade Asset Management, Madison, WI
33. Chesapeake Electronic Recycling Inc., Winamac (Indianapolis), IN
    Goldsmith Group, Inc., Indianapolis, IN
    Virtual Scavengers, Indianapolis, IN
34. City Industries Inc., Dallas, TX
    Computer Recycle Centre, Fort Worth, TX
    HOBI International, Dallas, TX
    Resource Concepts Inc., Carrollton, TX
35. Clean Harbors of Connecticut, Bristol, CT
36. Colt Refining Inc, Merrimack, NH
37. Computer Recyclers of America, Vista, CA
38. Creative Recycling Systems Inc, Tampa, FL
    Global Investment Recovery Inc., Tampa, FL
    Quicksilver Recycling Services, Tampa, FL
    Secure Environmental, Tampa, FL
39. Dan Mar Components, Deer Park, NY
    Per Scholas., Inc, New York City, NY
40. Gold Circuit Inc., Chandler, AZ
    Nxtcycle, Mesa, AZ

United States Continued

41. Electronicycle Inc., Gardner, MA
42. Envirocycle Inc., Hallstead, PA
43. 5R processors Ltd, Glen Fora, WI
44. Fortune Plastic and Metal, Pharr, TX
45. GSAN Inc., Gainesville, GA
46. Great Lakes Electronics Corp., Detroit, MI
    ReCellular, Dexter, MI
47. HOBI International, Batavia, IL
    Intercon Solutions Inc., Chicago, IL
    Supply Chain Services Inc., Lombard, IL
    United Recycling Industries, West Chicago, IL
    Universal Scrap Metals, Chicago, IL
48. Hallmark Refining Corp., Mt. Vernon, WA
49. IBM Credit Corp., Raleigh, NC
50. Inert Corp., Newfields (Boston Area), NH
    MidCity Scrap Iron, Westport, MA
    Windfield Alloy Inc, Lawrence, MA
51. Lifecyclers Electronics Recycling Services, Duluth, MN
52. McConnell Technology/Training Center, Louisville, KY
53. Metech International, Mapleville, RI
54. Noranda Recycling, La Vergne, TN
55. NewTech Recycling Inc., Bridgewater, NJ
56. Recycle America Alliance, Humble, TX
57. RecycledPCParts.com Inc., Miami, FL
58. Regional Computer Recycling/Recovery, Rochester, NY
59. Scientific Recycling Inc., Holmen, WI
60. Supreme Computer Recycling Inc., Lakewood, NJ
61. The Surplus Exchange, Kansas City, MO
62. Technology Conservation Group, Crystal River, FL
63. Terrapin Recycling, Baltimore, MD
64. Total Reclaim Inc., Seattle, WA
65. USA lamp and Ballast Recycling Inc., Cincinnati, OH
66. Waste Management and Recycling Products Inc., Schenectady, NY
67. Yukon Marketing Group, Palmyra, NY

Apparent Additional Processing Opportunity

Table I-2 presents the apparent additional intermediate processing opportunity associated with EOL electronic products on the basis that all EOL electronic products that are the subject are captured for separate management. The apparent opportunity represents the difference between the tonnage of EOL electronic products that are currently processed and the tonnage of EOL electronic products that is estimated to be discarded in each region of Canada and the United States, based on the data and assumptions presented in Table I-1. The extent to which additionally available EOL electronic products would in fact be available for intermediate processing within the region in which they are generated is subject to the following factors.

- Large quantities of EOL electronic products (particularly from the household sector) will remain unprocessed in the absence of programs to require their collection and management.

- Decisions regarding where and how to process additional quantities of EOL electronics products will be contingent on several Private sector influences:
  - (i) Intermediate processors whose markets are international may choose to locate at a port or border location (or foreign location) that is convenient to their markets rather than in the region in which EOL electronic products are generated.
  - (ii) Vertical integration may profoundly influence how intermediate processors source EOL electronic products. Some intermediate processors are associated with transportation companies, with the result that inter-regional transportation between EOL product generation and intermediate processing becomes commercially viable.
  - (iii) Some intermediate processors are developing a "hub-and-spoke" strategy for the intermediate processing of EOL electronic products. Based on models in other sectors (e.g. mail courier services) this approach is intended to include (in at least one specific instance) in every EOL electronic product that is handled being electronically tracked from source through intermediate processing.
  - (iv) Intermediate processing itself may be a multi-step process. Organisations that engage in dismantling for reuse of components may use a crushing/materials classification operation to extract value from components with inadequate reuse value, and these operations may be conducted in different locations.
  - (v) Some intermediate processors are product-specific in terms of the EOL products they process (e.g. telecommunications equipment, and monitors/TV's). These types of operation may source EOL electronic products from a much wider geographic range that is defined by the adjacent region.

- Although governments do not track exports of EOL electronics, large quantities of EOL electronic products are believed to be exported without intermediate processing. Without effective mechanisms to close the export of EOL electronic products, initiatives that increase the availability of EOL electronic products may result in increased export of these products, which would then not be available for processing at the local regional level.

As shown in Figure 5, an estimated 25,065 tonnes of EOL electronic products are anticipated to be placed in storage in 2005 as a consequence of inadequate management options for these products. It may be expected that stored EOL electronic products will be placed into the collection/management systems when these are implemented. The consequence of this will be a larger quantity of EOL electronic waste entering a collection/management system than would be anticipated based simply on annual EOL electronic product generation estimates. The magnitude of stored EOL products that might enter the collection/management system is potentially great since stored items may have been accumulated over several years. Actions to address this situation include:

- EOL electronic products can be collected from collection points with greater frequency than otherwise required.
- Local intermediate processors can operate longer working hours to process the required amounts of EOL products.
- EOL products can be shipped to other facilities where capacity is available to process them.

Table I-2
Apparent EOL Electronic Product Intermediate Processing Opportunity (2005)

COUNTRY/ REGION	ESTIMATED EOL ELECTRONIC PRODUCTS REPROCESSED (TONNES)	ESTIMATED GENERATION OF EOL ELECTRONIC PRODUCTS (TONNES)	APPARENT ADDITIONAL INTERMEDIATE PROCESSING OPPORTUNITY (TONNES)
Canada			
Atlantic Canada	<1,000	11,281	10,281
Quebec	6,583	37,274	30,691
Ontario	36,387	65,485	29,098
Western Canada	16,514	51,069	34,555
Territories	<1,000	626	Less than 1,000
Total – Canada	**60,484**	**165,735**	**105,251**
United States			
Northeast	186,377	502,512	316,135
Southeast	140,327	552,951	412,624
Mid-West	126,931	429,016	302,085
North Central	23,444	104,252	80,808
South Central	114,037	322,603	208,566
Northwest	17,918	92,243	74,325
Southwest	142,641	398,260	255,619
Total – United States	**751,704**	**2,401,837**	**1,650,133**

In practice, and for reasons that are not clear, this appears to not necessarily be a significant operational issue. In Alberta, for example, the first 6 months of program operations to collect EOL electronic products have not resulted in large quantities of stored items flooding into collection systems.

Product Streams

Product streams from the intermediate processing of EOL electronic products fall into two categories:

- Whole devices or components for reuse
- Materials for recycling

Increased intermediate processing of EOL electronics will result in increased quantities of devices/ components for reuse and/or increased quantities of materials for recycling. The extent to which increases in these outputs from intermediate processing will occur will be a function of:

- The intermediate processing strategies that are followed. Strategies that focus on disassembly (with or without refurbishment/repair) will produce streams of whole devices and components for reuse where feasible, and for recycling where reuse is not feasible. Strategies that focus on grinding/crushing or melting will produce streams of recyclable materials.
- Markets for reusable devices/components and recyclable materials.

In either case, levels of intermediate processing that approach the apparent intermediate processing opportunity identified in Table I-2 will significantly add to products available for reuse or recycle that are currently produced by intermediate processors. Concerns may therefore arise regarding the markets

available for these products. These issues are addressed separately for "reuse" product strategies and for "recycle" product strategies.

Market Issues for Reuse

Annex H identifies current reuse issues and market development opportunities for EOL electronic product and component reuse for each of the products that are the focus of this document.

Estimates of the reused computer market in Canada have been presented in Section 3.4.1.2. Industry representatives report that commercial international demand for recent-model IT equipment (whole devices and components) and cell phones exceeds supply and the growth of used IT equipment use in Canada suggests that in this segment, at least, there is potential for continued growth.

Non-profit organisations play an important role in electronic equipment reuse in Canada. The Computers for Schools program supplies IT equipment to schools across Canada. There is a recurring need for this equipment in order to replace old devices and to upgrade obsolete equipment. Other organisations are also engaged in the refurbishment of IT equipment (e.g. Centres de Formation en Entreprise et Récupération in Québec) there is continued opportunity for expansion in this sector. Charitable initiatives have been taken to supply IT equipment to disadvantaged groups (e.g. single parent families) and to supply cell phones to individuals for use in emergency situations. Other charitable opportunities exist at the community level across Canada.

Key issues in the marketing of electronics equipment include addressing:

- Warranty concerns (e.g. if original equipment has been refurbished, to what extent should warranties be valid). This can be addressed at the industry-specific level.
- Perspectives that export of used electronic equipment amounts to export of waste since used equipment will not last as long as new equipment. The development and adoption of standards for the export of reusable equipment should be undertaken to address this issue.

Market Issues for Recycling

Table I-3 identifies the quantities of materials that are potentially available for recycling from EOL electronics in 2005 on a regional basis[75]. The table assumes that all EOL electronics are sent for recycling without reuse. Maps I-2, I-3, I-4 and I-5 identify selected markets that may accept materials from EOL electronic products.

In excess of 90 percent of all the materials identified in Table I-3 are technically recyclable: i.e. technology exists to recycle the materials. However, the way in which materials are made available by intermediate processors to end-users does not allow all materials that are technically recyclable to be commercially recycled. The single most important issue is related to the separation of materials. Recycling is facilitated, and the value of recyclable materials is maximised, to the extent that separation is undertaken of each material from other materials. In particular:

[75] The following tonnage data help to place the potential tonnages of materials identified in Table I-3 into perspective relative to existing international levels of recycling activity: Post-consumer glass recycled in North America and the European Union (2003): approx. 9.4 million tonnes; post-consumer aluminum recycled in North America (2003): approx. 1.25 million tonnes; copper scrap exported from US (2003): 689,000 tonnes; global trade in scrap steel (2004): 93 million tonnes; post consumer plastics recycled in North America (2003): approx. 600,000 tonnes.

Table I-3
Potential Materials Availability From Intermediate Processing Of EOL Electronics By Region

Country/ Region	Glass		Metals					Plastics			Other
	Glass	PWB Glass/ Silica Oxide	Aluminum	Copper	Ferrous	Misc. Metals	Other PWB Metals	PWB Epoxy Resin	Wire Insulation	Other Plastics	
Canada											
Atlantic Canada	3,147	207	292	389	3,177	939	55	226	20	2,404	406
Quebec	10,273	685	983	1,280	10,635	3,038	184	747	68	7,975	1,357
Ontario	17,604	1,212	1,789	2,218	19,169	5,105	325	1,322	123	14,121	2,408
Western Canada	13,674	945	1,398	1,725	14,968	3,957	255	1,030	96	11,006	1,876
Territories	162	12	19	21	191	45	4	15	1	137	25
Total - Canada	**44,861**	**3,060**	**4,481**	**5,633**	**48,146**	**13,085**	**822**	**3,337**	**306**	**35,645**	**6,076**
United States											
Northeast	137,333	10,241	16,694	17,283	166,313	35,699	2,761	11,169	1,136	99,121	18,568
Southeast	151,122	11,269	18,371	19,028	182,909	39,182	3,024	12,290	1,245	109,180	20,431
Mid-West	117,635	8,773	14,300	14,803	142,373	30,505	2,353	9,567	969	84,993	15,895
North Central	28,335	2,105	3,443	3,564	34,277	7,316	565	2,296	233	20,393	3,825
South Central	88,087	6,570	10,707	11,087	106,606	22,799	1,762	7,165	725	63,625	11,902
Northwest	25,052	1,869	3,044	3,151	30,303	6,465	500	2,032	206	18,022	3,382
Southwest	109,056	8,126	13,272	13,729	132,040	28,263	2,182	8,873	898	78,828	14,752
Total - United States	**656,619**	**48,953**	**79,830**	**82,645**	**794,822**	**170,140**	**13,146**	**53,392**	**5,412**	**474,263**	**88,745**

- Markets for mixed plastics recovered from EOL electronics are low value and limited in extent, but are very significant if the plastics are separated. Application of DfRe (see Section 3) and demonstrated technology for separating mixed plastics provide the single greatest market development opportunity associated with recycling EOL electronics materials.
- Metals separation (including disassembly and shredding) does not consistently produce metals streams that meet end-market specifications, requiring either subsequent processing or application in less stringent applications. Application of DfRe (see Section 3) can address this issue.
- Additives (including alloying metals) and fire retardants are added to metals and plastics. These generally reduce the value of the secondary metal or plastic. In addition, beryllium (added to copper), fire retardants (added to some plastics) and other RHoS-regulated substances may cause occupational health and safety concerns and these may impact the extent to which end-users accept the materials. Several of these materials also limit the recyclability of the primary material. Technologies exist to recover many additives, including fire retardants. In many cases, new products are being developed that do not require the use of these materials.

Material-specific recycling issues (and related market development requirements) include the following, which should be considered together with opportunities for enhanced recycling identified in Table I-4 and the "product"-related opportunities identified in Annex H:

- Glass. Inadequate markets exist for leaded glass. North American manufacturers of CRT's have moved offshore, but still provide a market for leaded glass. Other offshore CRT markets also exist. Niche markets (including cathedral glass and light bulb manufacture) are available for leaded glass, but new markets are required. Secondary lead smelters may be reluctant to accept glass from EOL electronics because the silica attacks the refractory lining of the furnace; however, primary smelters may be willing to accept larger quantities of leaded glass. *Market Development Priorities*: Identification of new markets for leaded glass;

Map 2: Selected Ferrous Metals Processors in North America

Notes:
1. Includes all identified Canadian processors.
2. Includes all identified U.S. processors with production capacity greater than 1 million tons per year.

Sources:
1. *The Steel Industry of Canada, Mexico and the United States: Steel Production facilities – 2005*, Association for Iron and Steel Technology, Warrendale, 2005

Canada
1. AltaSteel Ltd, Edmonton, AB
2. IPSCO Inc, Regina, SK
3. Gerdau MRM Steel Inc. Selkirk, MB
4. Algoma Steel Inc., Sault Ste. Marie, ON
5. Dofasco Inc., Hamilton, ON
6. Stelco Inc., Hamilton, ON
7. Lake Erie Steel Co. (Stelco) Nanticoke, ON
8. Slater Steels, Specialty Bar Division Hamilton, ON
9. Gerdau Courtice Steel Inc., Cambridge, ON
10. Lasco Steel, Whitby, ON
11. Ivaco Inc., L'Orignal, ON
12. Ispat Sidbec Inc., Contrecoeur, QC
13. Stelco-McMaster Ltée, Contrecoeur, QC
14. QIT-Fer et Titane Inc., Sorel, QC

United States
15. AK Steel Corp, Middletown, OH
16. AK Steel Corp, Ashland KY
17. Mittal Steel USA, Burns Harbor, IN
    Mittal Steel USA, East Chicago, IN
    Mittal Steel USA, Riverdale, IL
    U.S. Steel Corp., Gary, IN
18. Mittal Steel USA, Cleveland, OH
    Republic Engineered Products LLC, Lorain, OH
19. Mittal Steel USA, Sparrows Point, MD
20. Mittal Steel USA, Steelton, PA
21. Mittal Steel USA, Weirton, WV
22. Severstal North America Inc., Dearborn, MI
    U.S. Steel Corp., Ecorse, MI
23. U.S. Steel Corp., Braddock, PA
24. U.S. Steel Corp., Fairfield, AL
25. U.S. Steel Corp., Granite City, IL
26. WCI Steel, Warren, OH
    Republic Engineered Products LLC, Canton, OH
    The Timken Co., Canton, OH
    Wheeling-Pittsburgh Steel Corp, Steubenville, OH
27. AK Steel Corp., Butler, PA
28. Gallatin Steel, Ghent, KY
    North American Stainless, Ghent, KY
29. IPSCO Steel Inc., Axis, AL
30. IPSCO Steel Inc., Muscatine, IA
31. North Star Bluescope Steel LLC, Delta, OH
32. Nucorp Corp., Norfolk, NE
33. Nucorp Corp., Jewett, TX
34. Nucorp Corp., Plymouth, UT
35. Nucorp Corp., Winton, NC
36. Nucorp Corp., Armorel, AR
37. Nucorp Corp., Trinity, AL
38. Nucorp Corp., Crawfordsville, IN
39. Nucorp Corp., Mt. Pleasant, SC
40. Nucorp-Yamato Steel Co., Blytheville, AR
41. Oregon Steel Mills Inc., Pueblo, CO
42. Steel Dynamics Inc., Butler, IN
    Steel Dynamics Inc., Columbia City, IN
43. TXI Chaparral Steel, Midlothian, TX
44. TXI Chaparral Steel, Petersburg, VA

Map 3: Selected Processors of Secondary Aluminum and Copper from EOL Electronics

Canada

Noranda, Rouyn, Quebec

Canada

1. Alcan, Kingston, Ontario
2. Bon L Canada, Pickering, Ontario
3. Indalloy, Toronto, Ontario
   Meridian Technologies Inc., Toronto, Ontario
   Rochester Aluminum Smelting Co., Toronto, Ontario
4. Wabash Alloys, Mississauga, Ontario
5. Kaiser Aluminum, London, Ontario
6. Wabash Alloys, Guelph, Ontario
7. Alcan, Chicoutimi, Quebec
8. Alcan, Jonquiere, Quebec
9. Alcan, Sagenuary, Quebec
10. Alcoa, Cap-de-la Madelaine, Quebec
11. Alcoa Extrusions, Ste.Therese, Quebec

United States of America

12. Wise Metals, Muscle Shoals, Alabama
13. Wise Metals, Sheffield, Alabama
14. Alcoa Inc., Hot Springs, Arkansas
15. Columbia Ventures Corp., City of Industry, California
16. Nichols Homeshield, Fort Lupion, Colorado
17. OmniSource, New Haven, Indiana
18. Nicholas Homeshield, Davonport, Iowa
19. Alcan Inc., Berea, Kentucky
20. Audubon Metals LLC, Henderson, Kentucky
    Hydro Aluminium, Henderson, Kentucky
21. Imco, Morgantown, Kentucky
22. Imco, Coldwater, Michigan
23. Aluminum Shapes LLC, Delair, New Jersey
24. Imco, Uhrichsville, Ohio
25. Indalex, Niles, Ohio
26. Imco, Sapulpa, Oklahoma
27. Alcan Inc., Greensboro, South Carolina
28. Norandal USA Inc., Huntingdon, Tennessee
29. Imco, Loudon, Tennessee
30. Imco, Rockwood, Tennessee
31. Scepter Inc., Waverly, Tennessee
32. Hydro Aluminium, Commerce, Texas
33. Aisco Metal Products, Bellwood, Virginia
34. Kaiser Aluminum & Chemicals, Trentwood, Washington
35. Ormet Corporation, Ben's Run, West Virginia
36. Alumitech, Friendly, West Virginia

Legend:

Secondary Aluminum Processors (in U.S., only those over 75,000 tonnes annual capacity)

Scrap Copper Processors

Note: Identified facilities do not necessarily represent all processors

Sources

1. Listing provided by United States Geological Survey
2. Industry Discussions

Map 4: Selected Secondary Lead, Leaded Glass and Plastics Processors in North America

Selected Lead Processors

1. Noranda, Belledune, New Brunswick
2. Teck Cominco, Trail, British Columbia
3. The Doe Run Company, Boss, Missouri

Selected CRT (Leaded Glass) Processors

1. Dlubak Glass, Upper Sandusky, Ohio
2. EnviroCycle, Hallstead, Pennsylvania
3. The Doe Run Company, Boss, Missouri
4. Noranda, Belledune, New Brunswick
5. Teck Cominco, Trail, British Columbia

Nova Pb (Montreal) may accept small quantities if leaded glass. Cathedral glass manufacturers may accept small amounts of leaded glass (see Annex I)

Selected Secondary Plastic Processors

1. Alternative Plastic Products, Red Deer, Alberta
2. AWAX Manufacturing Company, Calgary, Alberta
3. Cascades Re-Plast, Kingsey Falls, Quebec
4. Encore Plastics, Richmond, British Columbia
5. Engineered Plastic Resic, Fort Myers, Florida
6. Genor Recycling, Brantford, Ontario
7. Hammers' Plastic Recycling, Iowa Falls, Iowa
8. MBA Polymers, Richmond, California
9. Merlin Plastics, Calgary, Alberta
10. Merlin Plastics, Delta, British Columbia
11. Turtle Island Plastics, Toronto, Ontario
12. Phoenix Recycled Plastics, Norristown, Pennsylvania
13. Renew Plastics, Luxemburg, Wisconsin
14. Trimax Plastic Lumber, Ronkonkoma, New York

Sources:
Environment and Plastics Institute of Canada
American Plastics Council
Industry discussions

Notes:
1. This list identifies potential markets for plastics from EOL electronic products.
2. Recycling of EOL electronics plastics, in particular, is subject to product specific criteria. The organizations identified on this map are a small sample of over 400 companies that may recycle EOL electronics plastics in North America. An up-to-date database of potential markets can be accessed at www.plasticsresourse.com

Map 5: Selected Processors of Printed Circuit Boards and Rechargeable Batteries from EOL Electronics

Printed Circuit Boards:

1. Abington Metals Refining and Manufacturing, Philadelphia, Pennsylvania
2. ECS Refining, Terrell, Texas
3. Kinsbursky Waste Solutions, Anaheim, California
4. Mercury Waste Solutions, Union Grove, Wisconsin
5. Mercury Waste Solutions, Marietta, Georgia
6. Mercury Waste Solutions, Roseville, Minnesota
7. Metech International, Mapleville, Rhode Island
8. Metech International, Gilroy, California
9. Noranda Recycling, San Jose, California
10. Noranda Recycling, Roseville, California
11. Noranda Recycling, Nashville, Tennessee
12. Noranda Recycling, East Providence, Rhode Island
13. Noranda Recycling, Brampton, Ontario
14. Sipi Metals, Chicago, Illinois
15. Specialty Metals Smelters and Refiners, Fairfield, Connecticut
16. United Refining and Smelting Company, Chicago, Illinois
17. Noranda Horne Smelter, Rouyn, Quebec

Rechargeable Batteries:

1. INMETCO, Ellwood City,Pennsylvania
2. TOXCO, Trail, British Columbia

Sources

1. Discussions with International Precious Metals Institute, Pensacola, Florida
2.. *IAER Electronics Recycling Industry Report - 2003*, International Association of Electronics Recyclers, Albany, 2003
3. Industry discussions

Note: Identified facilities do not necessarily represent all processors

- increased application of leaded glass processing in smelters (primary and secondary); identification of opportunities for application of glass from EOL electronics in construction.
- Metals. Although there are domestic markets for the metals produced by intermediate processors of EOL electronics, many end-users are located overseas. The trend towards the export of secondary metals overseas has been in place for at least 20 years for some metals (e.g. copper) and marketing of these materials (as well as others) should be seen in a global context. *Market Development Priorities:* Separation of higher percentages of individual metals from each other and from other materials sufficient to meet secondary materials specifications.
- Plastics. Clean, separated engineering-grade plastics such as those used in electronics manufacture may average in the range of at least $1.00/kg, or at least three times their value when sold as mixed plastics. There are many potential buyers of clean, separated engineering-grade plastics but there are inadequate markets for mixed plastics. *Market Development Priorities*: Separation of plastics from each other and from other materials using: (i) visual keys (e.g. colour or numeric code); and/or (ii) application of mixed plastics separation technology.
- "Other" materials. New markets for these materials may be identified on a case by case basis. However, application of DfRe to provide for separation of materials from each other will be important to achieving new recycling opportunities. *Market Development Priorities:* Separation of materials, identification of markets for separated materials.

New Intermediate Processing Facility Requirements Associated With Enhanced Recovery of EOL Electronics

Requirements for new intermediate processing facilities for EOL electronic products will be determined by the extent to which public policy interventions require:

- The collection/separate management of EOL electronic products.
- That EOL electronic products be managed is certain ways.

The Effect of Public Policy Interventions to Require Collection/Separate Management

In the absence of public policy interventions, the development of the EOL electronic products sector will continue to develop in the future along the lines that it has developed to date: progressively larger amounts of EOL electronics will be processed to the extent that it is profitable and to the extent that agencies may support processing by non-profit organisations.

While this approach will result in incremental increases in the tonnages of EOL electronics that are collected/separately managed, it will not address the great majority of the tonnages of EOL electronics that enter the "disposal" streams identified in Figure 5. Public policy interventions will therefore be required to address these disposal streams, consistent with the C-WPEPS. These interventions may, however, vary widely in terms of the EOL electronic products they address. Ontario, for example, has identified (early 2005) its intention to regulate the management of a much wider range of EOL electronic products than those considered by this document. Other provinces may address a narrower range of EOL electronic products. Decisions at this level impact the quantity of EOL electronic products available for intermediate processing and therefore influence the extent to which new intermediate processing facilities are required.

The Effect of Public Policy Interventions on How EOL Electronics Should Be Managed

As identified elsewhere in this document, EOL electronic products may be managed in one of two ways:

- Non-destructive approaches. These generally involve disassembly for reuse and recycling.
- Destructive approaches. These generally involve crushing/grinding or thermal treatment for recycling.

Table I-4
Opportunities for Enhanced Recycling of EOL Electronic Products

MATERIAL	*PRINCIPLE CONSTRAINTS TO RECYCLING*	*POTENTIAL FUTURE RECYCLING OPPORTUNITIES*	*MARKET DEVELOPMENT ACTON*
Glass	Inadequate markets for leaded glass PWB/silica oxide not recycled	Development of niche markets (e.g. cathedral glass, small batch secondary lead smelter processing, light bulbs)	Research and development of potential applications
		Use in construction materials	Research and development
		Export for use in leaded glass/other applications	Identification of export markets
		Expanded recovery of lead/use of glass as flux in primary smelters	Economic instruments in support of leaded glass use
Metals	Alloys reduce market value of aluminum, copper and may pose OHS risks	High levels of recycling achieved, but increasingly dependent on export markets	Development of OHS standards, particularly for beryllium, to safeguard worker health
	Inadequate separation of metals from each other and from other materials reduces recyclability	Enhanced recyclability of metals through improved separation of materials	Application of DfRe techniques to facilitate/maximise metals recovery
	Declining preciouss metals values in electronic products	Continuing recycling opportunity for precious metals	Application of DfRe techniques to minimise circuit board recovery costs
Plastics	Inadequate separation of mixed plastics limits recycling opportunities, reduces value of plastics	Routine recycling of plastics	Economic instruments to attract mixed plastics processing technology; application of DfRe to facilitate plastics recovery
	Contamination with other materials limits recycling opportunities, reduces value of plastics	Routine recycling of plastics	Economic instruments to attract mixed plastics processing technology; application of DfRe to facilitate plastics recovery
	PWB epoxy resin not recycled	Low future recycling potential based on current technologies	Development of new technology
	Fire retardants limits recyclability	Recovery of fire retardants	Application of new technology
Other	Inadequate separation of materials from each other reduces recyclability	High recyclability potential for separated components	Application of DfRe

The benefits associated with these approaches vary and the way in which provinces may capture benefits also varies. The following considerations have are relevant to the actions that provinces might take to capture benefits:

- Principle 4 of the C-WPEPS (see Annex C) identifies that “management of e-waste is…..consistent with the 4R hierarchy”. This places focus on reuse as a management approach that is preferred over recycling. In turn, this favours the application of non-destructive approaches to management of EOL electronic products where reuse benefits can be achieved.
- Principle 11 of the C-WPEPS (see Annex C) identifies that “e-waste is managed in the most economically and logistically feasible manner while striving to maximize local economic and social benefits".
- The unit costs of non-destructive approaches (i.e. manual disassembly) to intermediate processing of EOL electronic products are relatively constant as compared to destructive approaches, in which unit costs decline as processing capacity is approached.

Local economic and social benefits will be maximised to the extent that processing of EOL electronics is undertaken at the local level. Local economic and social benefits will be maximised through adoption of

labour intensive non-destructive approaches to intermediate processing. However, cost structures associated with capital intensive destructive approaches will lead operators of those systems to maximize throughputs to the extent feasible considering the cost of transportation and other logistics; companies have already begun to implement strategies to achieve this with the result that EOL electronic products are leaving their province (or region) of discard for management elsewhere. Accordingly, if provinces are to maximize local economic and social benefits associated with intermediate processing of EOL electronics, public policy intervention will be necessary to ensure these benefits are achieved over the long term.

There are a variety of ways public policy interventions can be achieved for the purpose of maximising local benefits associated with intermediate processing of EOL electronic products. These will be based on priorities, opportunities and constraints in individual provinces. In turn, decisions at this level will impact the number of facilities that are viable at the local level for undertaking disassembly operations, and the remaining requirement for use of destructive technologies to achieve additional recycling benefits.

The maximum number of processing (destructive approach) facilities that might be required to process EOL electronic products is identified in Section 6.2.2 under the assumptions identified in that section.

Business Opportunities

Business opportunities are associated with the following aspects of enhanced management of EOL electronic products.

- Receiving/handling of collected EOL electronic products
- Transportation of EOL electronic products
- Intermediate processing of EOL electronic products (disassembly and crushing/grinding)
- Processing of recyclable materials from EOL electronic products.

The extent to which these business opportunities will be achieved in any region/province will be a function of policy decisions that govern the overall management of EOL electronic products.

ANNEX J
FEASIBILITY ANALYSIS DATA:

NEW BRUNSWICK
NEWFOUNDLAND AND LABRADOR
NOVA SCOTIA
PRINCE EDWARD ISLAND

USER GUIDE TO ANNEX J

HOW TO USE THIS ANNEX

This Annex includes data in support of the analysis and conclusions regarding the feasibility of EOL electronics product recovery and processing in the Atlantic provinces. Data related to the following is presented:

- Collection depots
- Processing options
- Investment costs
- Job creation

Data in this Annex is presented in a series of tables that have been assembled as packages specific to each province. The format of the tables is the same for all provinces and for all provinces the tables are numbered consecutively beginning with Table J-1; thus, reference in the "user guide" to Table J-3, for example, refers to Table J-3 in each of the provincial data packages. In the balance of this "user guide", details are provided regarding the assumptions and calculations included in each Table in this Annex. Users in each province may therefore refer to this "user guide" as they review the data for their province. Table JS-1, following, summarises the basis and assumptions used in Tables J-1 – J-14 for each province.

COLLECTION DEPOT DATA

Table J-1 provides technical data regarding collection depots for EOL electronic products. The data in the table are based on the following:

- *Approximate Population Served* This has been calculated using Statistics Canada data from the 2001 census. Population estimates are "approximate" because (i) Statistics Canada estimates that an error margin of up to 5 percent occurred in the population counts of the 2001 census in Atlantic Canada; and (ii) generators of EOL electronics may choose to use a collection depot other than the one that is closest to them.
- *Quantity of EOL Electronics Generated* These data are pro-rated from Table 2 based on the population served by each collection depot.
- *Quantity of EOL Electronics Collected* These data reflect the BMP assumption that the quantity of EOL electronic products that is captured by a collection system is 95 percent of the quantiy that is generated.
- *Number of EOL Electronic Products Collected* These data estimate the numbers of EOL electronic products that will be collected, based on the BMP assumption of collection of 95 percent of items that are generated.
- *Volume of EOL Electronics* These data are calculated based on a calculated average volume of whole EOL electronic products of 5.06 m^3/tonne. The estimated volume of individual EOL electronic products is: cell phones – 0.613 m^3/tonne; telephones – 2.08 m^3/tonne ; stereos – 6.502 m^3/tonne; rechargeable batteries – 0.825 m^3/tonne; computers – 3.851 m^3/tonne; monitors – 4.952 m^3/tonne; peripherals – 4.049 m^3/tonne; TV's - 6.146 m^3/tonne.
- *Gross Number of Gaylord Containers* These data represent the annual number of gaylord containers that will be filled in a year, based on 2.788 gaylords being required to accommodate an average of 1 tonne of EOL electronic product. Each gaylord is assumed to have a capacity of 1.815 m^3, corresponding to 64 ft^3.
- *Annual Trailer Loads* These data assume transportation by a 53 foot trailer in which 48 gaylords are loaded double stacked. (The theoretical capacity of this size of trailer is for 52 gaylords, double stacked).

Table J-2 details collection depot requirements and costs for depots located in each of the locations identified in Table 29. These are based on the following:

Table JS-1
Summary of Assumptions Used To Evaluate and Cost EOL Electronics Management System Options

System Option Component	Annex J Table Number(s)	Key Assumption		
		Parameter	**Assumption**	**Basis of Assumption**
Collection Points	J-1	Population Served	Urban Areas: 1 collection point per city of 50,000 and 1 additional collection point for cities with a metro population of 200,000 or more.	Agreement with Steering Committee *Review of the Newfoundland and Labrador Green Depot Recycling System*, Multi-Materials Stewardship Board, St. John's
			Rural Areas: 1 collection point per 10,000 people or 50 km radius	Industry discussions
		Quantities Generated	Data from Tables 2 and 3, pro-rated	Prior estimates of EOL electronics, see Section 2
		Quantities Collected	95 percent of quantities generated	BMP estimate, see Section 6
		Volume of Collected Items	5.06 m^3/tonne	Calculated volumes for average sized products
		Gaylord Containers	Capacity of 1.815 m^3	Capacity of standard 4x4x4 foot gaylord
		Trailer Loads	53 foot trailer	Calculation of volumes, industry quote. Includes 15 percent allowance for dead space.
	J-2	Depot Area	Minimum required area	Industry discussions
		Gaylord Cost	Procurement at commercial price	Industry quote
		Labour Cost	$11.50/hour	Current market rates
		Building Cost	$9.00/$ft^2$ (urban), $7.50/$ft^2$ (rural) – includes lease and operating cost	Industry quotes
		Equipment/Supplies	Fork lift rental, office supplies	Industry quotes
Processing Option 1: Ship pre-processed CRTs to Belledune lead smelter, cell phones to Toronto for reuse/processing, remaining materials to Noranda (Brampton) for processing and management.	J-3	Disassembly of TVs/ Monitors ("Pre-processing")	Average disassembly times, labour and equipment depreciation (incl. travel)	Industry quotes and current marketplace rates
		Transportation	Contracted transport from collection points to markets in Ontario and New Brunswick	Industry quotes
		Processing	Payment of quoted commercial prices	Industry quotes
Processing Option 2: Ship TVs/ monitors to Pennsylvania for "glass-to-glass" recycling, cell phones to Toronto for reuse/processing, remaining materials to Noranda (Brampton) for processing and management	J-4	Transportation	Contracted transportation from collection points to markets in Ontario and Pennsylvania	Industry quotes
		Processing	Payment of quote commercial prices	Industry quotes
Processing Option 3: Same as Option 2, except process monitors and TVs prior to shipment in order to ship only whole CRTs, not whole monitor and TV units, to Pennsylvania.	J-5	Disassembly of TVs/ Monitors ("Pre-processing")	Average disassembly times, labour and equipment depreciation (incl. travel)	Industry quotes and current marketplace rates
		Transportation	Contracted transport from collection points to markets in Ontario and New Brunswick	Industry quotes
		Processing	Payment of quoted commercial prices	Industry quotes

Table JS-1
Summary of Assumptions Used To Evaluate and Cost EOL Electronics Management System Options

System Option Component	Annex J Table Number(s)	Key Assumption		
		Parameter	Assumption	Basis of Assumption
Processing Option 4: Local disassembly of EOL electronic products and sale of recovered materials to end-use markets .	J-6	Transportation to Disassembly	Contracted transportation from collection points to provincial disassembly centres	Industry quotes
	J-7	Disassembly Facility Design Basis	Gaylords and storage Labour Work station/logistics/office space	Calculated from Table J-1, J-2 Time and motion studies for disassembly of EOL electronic products Industry practice and quotes
	J-8	Disassembly Equipment	Equipment typically associated with disassembly of electronic products	Industry quotes for capital costs; depreciation over 3-10 years, based on type of equipment
	J-9	Annual Cost Estimates for Disassembly Facilities and Transport to Markets	Disassembly conducted in leased building or procured building in which cost of financing is equal to commercial lease rate; operating costs as identified in Tables J-6 to J-8	Industry quotes
	J-10	Net Annual Costs	Cost estimates from previous Tables	Collection cost from Table J-2; disassembly/transport costs from Table J-9; total annual cost from the sum of Tables J-2 and J-9; kilograms of product from Table J-1, cost/kg equals total cost divided by kilograms managed.
Option 5: Undertake mechanical processing of materials at regional facilities in Atlantic Canada,	J-11	Collection Depot Costs	Same collection depot costs as for other options	See Table J-1 and Table J-2, above
		Transportation cost from collection points to processing facility	Processing facility located in Halifax – Moncton corridor	Location minimises overall transportation costs
		Processing Cost	Net processing cost of $0.70 - $1.00/kg of EOL electronic product, including cost of transportation to end use markets	Actual current processing costs for mechanical processing in Canada
		Provincial share of regional facilities	All provinces process EOL electronics at he regional facilities	Costs are shared between provinces according to their shares of total materials processed.
Investment costs for Option 4 and Option 5	J-12	Investment cost	Capital costs of construction and equipment associated with Option 4 and Option 5	Construction cost: cost for construction of basic industrial building. Equipment cost: from relevant previous tables.
Cost Per EOL Electronic Item	J-13	For each option, cost for managing average sized EOL electronic products	Quantities of materials managed and costs as reported/calculated in other tables.	Same assumptions as identified in other tables.
Job Creation	J-14	Person years of jobs created	Person-year requirements based on typical times to perform tasks associated with each management Option.	“One person year” equals 2000 hours of paid employment; transportation based on typical travel times; disassembly based on time/motion data for specific tasks

Approximate Population Served This has been calculated on the basis of the above criteria using Statistics Canada data from the 2001 census. Population estimates are "approximate" because (i) Statistics Canadaestimates that an error margin of up to 5 percent occurred in the population counts of the 2001 census in Atlantic Canada; and (ii) generators of EOL electronics may choose to use a collection depot other than the one that is closest to them.

- *Depot Area* This identifies the area (in square feet) that is required for collecting EOL electronic products. The feasibility assessment assumes that EOL electronics will be transported in gaylord containers (see below). The size of the depot allows for EOL electronics to be sorted by the depot operator according to product type (e.g. computer, telephone etc) and for each product type to be placed directly in gaylords. In order to maximise efficiencies and to minimise transportation costs, each depot will have sufficient gaylords to fill a 53 foot trailer. As gaylords are filled they will be stacked 2 high in the depot. Sufficient space is provided for receipt of EOL electronic products and for movement of the gaylords within the depot. All depots are assumed to be the same size, calculated at the size required to accommodate a 53 foot trailer load of EOL electronic products. Differences between depots in the quantity of materials they receive will be addressed through the frequency of transportation of EOL materials from the depots.
- *Net Gaylord Containers* Consistent with the waste reduction basis of this initiative, reusable gaylords will be used. These will measure 4 feet x 4 feet x 4 feet, will be made from wire mesh and will have collapsible sides to facilitate loading and unloading. A total of 48 gaylords will be double stacked in a 53 foot trailer, and a "float" of 7 gaylords will be maintained at all times at each depot to ensure that products can always be accepted and directly loaded into a gaylord.
- *Annual Amortised Gaylord Cost* These costs are calculated based on industry quotes for the cost of the gaylords amortised over an assumed period of 5 years, at the end of which new gaylords would be procured and the used gaylords are assumed to have no financial value.
- *Labour Cost* This is calculated on the basis of requiring 1.5 minutes to receive and place an EOL electronic product in a gaylord and move gaylords within the depot, and on 10 minutes to load and unload gaylords to and from transport trailers. A labour cost of $11.50/hour is assumed. Based on these assumptions, a full time staff person will be required for depots serving 94,000 people.
- *Annual Building Operating Cost* These costs include assumed typical lease cost of depot-type facilities in urban centres and rural towns ($6/sq. ft./year and $4.50/sq. ft./year respectively), taxes in urban and rural centres ($1.00/sq. ft./year and $0.75/sq. ft./year respectively) and utilities ($2.00/sq. ft./year). These costs total $9.00/sq.ft/year in urban centres and $7.50/sq.ft/year in rural centres.
- *Annual Equipment and Supplies* This includes provision for equipment (forklift) to load, unload and manoeuvre gaylords, and for office supplies is support of the operation of the depot.

In addition to the costs identified for each individual depot, a centralised gaylord "float" is provided for to ensure that gaylords are available to depots at all times in the event that unforeseen circumstances delays the normal flow of gaylords to depots.

DATA ON MANAGEMENT OF EOL ELECTRONIC PRODUCTS FOLLOWING COLLECTION

Option 1

The data in Table J-3 identify estimated costs and revenues associated with Option 1, requiring the disassembly of monitors and TVs, the sale of CRT's to Noranda's lead smelter in Belledune, the shipment of cell phones to ReCellular in Toronto and the shipment of remaining EOL electronic products to Noranda in Brampton, Ontario for processing and marketing. The table is based on the following assumptions and calculations:

- *TV and Monitor Preprocessing* The number of items are the number of monitors and TV's estimated to be collected under the BMP. Disassembly time is average time required to disassemble monitors and TV's based on industry estimates obtained in October 2005 from western Canada; these are faster than other disassembly times that have been achieved elsewhere in the world, but slower than those targetted by some European operations. Labour cost is assumed to be $11.50/hour, including benefits. Equipment depreciation is calculated on basis of $1,000/employee/year required to disassemble monitors and TV's.

- *Transportation to Noranda, Brampton and Recellular, Toronto* Tonnes are calculated as tonnes of EOL electronic product received at the collection depot minus CRT's. Loads are calculated as full 53 foot trailer loads in which gaylords hold an average of 375 kgs. each (calculated as the average weight of collected EOL products excluding CRT's). The Rate per Load is a quoted truck transportation rate for full trailer loads between the collection depot and Brampton/Toronto; this rate does not include the fuel surcharge, which is commonly charged by trucking companies and which varies with the cost of fuel; in October 2005 this rate was 11.9 percent. The Cost is the calculated by multiplying the rate per load by the number of loads.
- *Transportation to Noranda, Belledune* These data are calculated in the same way and with the same assumption as the data for 'Transportation to Noranda, Brampton and Recellular, Toronto", see above, except that Tonnes refers only to the weight of CRT's.
- *Preprocessing* Monitors and TV's will require preprocessing prior to transport to Noranda, Belledune, since this market will accept CRT's only and n ot whole devices containing CRT's. Preprocessing costs are calculated using the TV and Monitor Preprocessing data, above, and applying a cost of $2.27/unit to monitors and TV's.
- *Processing* All items sent to Noranda, Brampton, would be processed at a current quoted price of $1.00/kg. These items include stereos, telephones, computers, peripherals and all parts of monitors and TV's except the CRT. CRT's would be processed at Noranda's led smelter in Belledune at an assumed cost of $250/tonne, representing the mean of a quoted cost range of $200 – 300/tonne. Cell phones would be sent to Recellular in Toronto for reuse of those models for which there is sufficient demand. These have the potential to generate revenue. The extent of revenue generation that is feasible from cell phones sold to this market is not clear and depends on demand for specific brands of cell phone. It is unlikely that revenue would exceed $1.00/cell phone, in which case overall costs of this option would be reduced by about 1.8 percent; for the purpose of this analysis, however, no revenue is assumed for cell phones.
- *Total Cost and Cost per Kilogram* The total cost is the sum of the preprocessing, transportation and processing costs. The cost per kilogram reflects the total cost divided by the total number of kilograms of EOL electronic products managed through this option.

Option 2

Option 2 involves shipment of whole devices containing CRT's to EnviroCycle in Hallstead, Pennsylvania, shipment of cell phones to ReCellular in Toronto and shipment of stereos, telephones, computers, and peripherals to Noranda in Brampton, Ontario. The coasts associated with Option 2 are detailed in Table J-4.

The main difference between this option and Option 1 is that whole devices containing CRT's would go to a "glass-to-glass" recycling market at a quoted cost of $US 6.00 per item, considered to be equivalent to $Cdn 7.20 at an exchange rate of $US 1.00:$Cdn 1.20. This option therefore does not require preprocessing of monitors or TV's, and results in a reduction of almost 50 percent in the quantity of material sent to (and processed by) Noranda, Brampton. Transportation rates are based on quoted rates for full truck loads.

All other assumptions for Option 2 are the same as those for Option 1, above.

Option 3

Option 3 is the same as Option 2, except that monitors and TV's are disassembled locally (i.e. same as for Option 1) but the CRT's are sent to EnviroCycle in Hallstead, Pennsylvania for "glass-to-glass" recycling (i.e. similar to Option 2). This option allows determination of differences in system costs between the "smelting" of CRT's and the "glass-to-glass" recycling of CRT's. The quoted cost for "glass-to-glass" recycling of CRT's that have been disassembled from the devices of which they were a part is $US 3.00, assumed to be equivalent to $Cdn 3.60 at an exchange rate of 20 percent. Table J-5 details costs associated with Option 3.

All other assumptions for Option 3 are the same as for Option 2.

Option 4

Option 4 involves the disassembly of EOL electronics and the sale of disassembled recyclable products to secondary materials markets. Three operations are required:

- Transportation from collection depots to disassembly facilities.
- Disassembly of EOL electronic products
- Shipment of recovered materials to end use markets.

For the purpose of analysis it is assumed that disassembly facilities are located in the cities/towns that are highlighted in Table J-6. Each disassembly facility would receive EOL electronic products from the collection depots that were located in proximity to it.

The data in Tables J-6 to J-10 identify costs and revenues associated with disassembly of EOL electronic products. It is assumed that initially disassembly would be limited to EOL computers, monitors, peripherals (except keyboards) and TV's; these items represent the largest EOL quantity of EOL products (approximately 92 percent of the weight of EOL electronic products). Remaining products (keyboards, stereos and telephones) comprise approximately 8 percent by weight of EOL electronic products, but approximately 47 percent of EOL electronic product items; these items could be added to a disassembly initiative, as appropriate, at a later date but over an initial period are assumed to increase the number of items disassembled to beyond what can be properly managed within disassembly facilities. Items that are not disassembled are assumed to be shipped to ReCellular (cell phones) for reuse/recycling, or to Noranda, Brampton, for processing and recycling.

- *Table J-6: Transportation for Disassembly* This table identifies collection depots and the city/town in which each disassembly facility is located. It is assumed that collection depots would be located in the same facility as disassembly operations in towns/cities where disassembly takes place; this will minimise transportation and cost. The table identifies the annual trailer loads of EOL electronic products that would be collected at each collection depot, the disassembly facility to which it would be transported, the cost per load of transportation (based on quoted industry rates) and teh total cost of transportation.

- *Table J-7: Design Basis for Disassembly Facilities* This table identifies the percentage of EOL electronic products destined for each disassembly facility (in terms of gaylords) and the annual number of gaylords each facility would receive (based on a calculated requirement of 5.06 m^3 per tonne of EOL electronics plus 15 percent to allow for packaging inefficiencies) The area required to store gaylords at each disassembly facility is identified, together with the area required to store separated materials prior to shipment to markets (assumed to be undertaken with gaylords).

  The number of labourers required to disassemble EOL electronics is identified based on the following times required to disassemble each product: computers – 60 minutes/computer (including hard drive); monitors: 11 minutes/monitor; peripherals – 30 minutes/peripheral (excluding keyboards); and 11 minutes/TV. These disassembly times are all based on time and motion studies for the disassembly of these products in Western Canada.

  Management and supervisory staff are assumed on the basis of a manager/supervisor for the first 10 labourers required and a separate supervisor for the next 10 labourers and one supervisor for every 15 additional labourers required. One office support staff person is assumed at all facilities, with an additional office support staff person assumed for every 20 labourers after the first 25. Floor staff are calculated equal to the number of forklift vehicles required.

- Work station space is calculated on the basis of 100 sq. ft./labourers. Logistics space is the space calculated to be required to provide for ease of movement and access. Office space is calculated on the basis of 100 sq. ft./manager and supervisor; it is assumed that space efficiencies from within this allocation will be provided for office support staff. Washroom/lunchroom space is estimated on a fixed area basis.

- *Table J-8: Equipment Basis for Disassembly Facilities* Equipment estimates reflect the requirements of the scale of disassembly that will be undertaken at each facility. Disassembled materials will be placed directly in gaylords and these will be moved with forklift trucks. Each work stations will comprise a stool, benches,

shelving and drawers; cost estimates are based on a work space of 50 sq. ft. per labourer to allow disassembly of multiple devices at a time.It is assumed that disassembly will be undertaken with hand tools provided by the disassembly facility, and that additional sets of spare hand tools will be kept available. Computers and office furnishings are provided for office staff. A baler will be used to bale plastics in order to reduce transportation costs. The miscellaneous equipment allowance provides scope for provision of small equipment needs not specifically foreseen or itemised. Unit prices are based on supplier quotes in all cases. Annual depreciation is calculated by dividing equipment costs by the number of years the equipment is assumed to operate for; the residual value of equipment is assumed to be zero.

- *Table J-9: Cost Estimates for Disassembly Facilities and Associated Transport* Labour costs are based on $11.50/hour (including 15% benefits) for 2000 hours/year for labourers, office support staff and floor staff, supervisor costs are based on labour cost (including benefits) plus 33 percent. Manager costs are based on $57,500/year (including benefits).

  Building operation and maintenance costs are calculated at $9.00/sq.ft., including a mortgage or lease cost of $6.00/sq.ft. plus $1.00/sq.ft for taxes and $2.00/sq.ft for utilities. Equipment costs and equipment depreciation are taken from "Equipment Basis for Disassembly Facilities", above. Equipment cost – operations reflects operational and maintenance costs for fork lift vehicles and balers, assumed at 7 percent of capital cost. Haulage cost to disassembly facility is taken from "Transportation for Disassembly", see above. Haulage cost to markets is calculated based on industry quotes for the transportation of materials recovered from disassemble EOL products transported to end use markets; the following markets are assumed to be located as follows: aluminum – Alcan (Kingston, Ontario); copper – Noranda (Horne smelter, Rouyn, Quebec); ferrous – Gerdau Ameristeel (Whitby, Ontario); CRTs – Noranda (Belledune, New Brunswick); printed circuit boards – Noranda (Rouyn, Quebec); plastics – Turtle Island Recycling (Toronto, Ontario). Stereo/phones haul and processing cost is the combined transportation and processing cost for processing stereos and telephones at Noranda (Brampton, Ontario).

  Waste management cost assumes 2 percent of input materials to a disassembly facility are "waste" that requires local disposal at a cost of $100/tonne. Materials revenue is calculated as the revenue associated with recovered materials assuming: aluminum - $0.90/kg; copper - $0.55/kg; ferrous - $0.19/kg; glass - negative $0.25/kg; plastics - $0.11/kg; printed circuit boards - $2.00/kg.

  Total annual cost is the sum of all costs and revenues (except "Equipment Cost – Capital", which is not an annual cost). Cost per kilogram is the net cost (including revenues) of managing 1 kilogram of EOL electronic product following its collection to the delivery of products and materials to markets.

- *Table J-10: Summary of Net Costs* This table summarizes total estimated costs for the disassembly of EOL electronic products, including the cost of collection depots (shown as "collection costs"). Collection costs are shown as the total costs of the collections depots that supply each disassembly facility.

As indicated above, it is assumed that telephones, stereos and keyboards would initially be managed through transportation to a mechanised processing facility and would be added to a disassembly initiative as a second step in the development of such an initiative. However, the net cost associated with disassembly of these items is estimated to be higher than the cost of transporting them to, and processing them at, Noranda (Brampton, Ontario). Incorporation of telephones, stereos and keyboards into a disassembly program would increase the cost of the management of these items by the following amounts on a provincial basis, as compared with hte alternative of transporting them to, and processing them at, Noranda (Brampton, Ontario):

- New Brunswick - $150,944
- Newfoundland and Labrador – 109,846
- Nova Scotia - $197,260
- Prince Edward Island - $28,888

Option 5

Option 5 involves the processing of EOL electronics at a new mechanised processing facility in Atlantic Canada to serve all provinces. The costs associated with such facilities are related to the specific technologies used by the

facilities, their capacity and the extent to which their capacity is utilised. Costs at the provincial level would vary according to where the processing facilities were located; this would particularly affect the costs of transportation from collection depots to the processing facilities. On a regional basis, costs will be minimised if processing facilities are located such that overall transportation costs are minimised. Within the Atlantic Canada region, this would imply facilities generally in the Moncton – Halifax corridor.

Table J-11 summarizes the annual costs associated with Option 5:

- *Total Regional Processing Cost* This is the estimated costs associated with processing all EOL electronic products generated in Atlantic Canada at mechanised facilities. Currently, this is being undertaken at facilities in Canada at a cost of between $0.70 - $1.00/kg of material received. It is therefore assumed that the cost of processing EOL electronic products at regional mechanised processing facilities would fall within this range, and the high and low total regional processing cost is identified on this basis.
- *Provincial Share of Processing Cost* This represents the cost to a province to process all the EOL electronic products that are the focus of this document at a mechanised processing facility located in Atlantic Canada. The high and low estimates represent the potential variation in unit cost associated with these operations.
- *Transportation from Collection Depots* The specific location of regional mechanised processing facilities will impact the cost of transportation from collection depots to the processing facilities. As indicated above, the costs associated with transportation assume that regional facilities are located in the Moncton-Halifax corridor. Facilities located in a different part of the Atlantic Canada region would result in different transportation costs that would be higher overall than those identified in the table, but which might nevertheless be lower for a specific province in which the facilities were located.
- *Collection Depot Cost* These costs are the same as for other options.
- *Total Cost* Total costs are expressed as a range, subject to the specific processing and transportation costs that are incurred.
- *Cost/kilogram* These costs are expressed as a range, subject to the specific processing and transportation costs that are incurred.

INVESTMENT COST DATA

Investment cost data are presented in TableJ-12. It is assumed that facilities for collection of EOL electronics would be located in existing buidings/businesses, so that new costs would be limited to the procurement of gaylords. Investment in Options 4 and 5 would require new facilities. Across Atlantic Canada there are existing buildings that may be suitable for implementation of Option 4 or Option 5; these facilities are available on a lease or purchase basis and net investment costs may be reduced if required facilities were leased or purchased. Data in this Annex, however, assume that new facilities are constructed. Investment costs are therefore comprised of land cost, construction cost and equipment cost. Land costs vary greatly; serviced industrial and commercial zoned land in the Atlantic Provinces varies in price from approximately $60,000 – 120,000 per acre; land costs are in addition to the costs identified in Table J-12. Construction and equipment costs are estimated as follows:

- *Construction Cost* The average quoted price of industrial facility construction is $60 – 70/sq. foot. Precise costs will be subject to specific design requirements. Construction cost is therefore calculated as area of facility multiplied by average expected construction cost.

- *Equipment Cost* For Option 4, equipment costs are as shown in Table J-8: Option 4 - Equipment Basis For Disassembly Facilities.

  For Option 5, “mechanised processing equipment costs” are based on procurement of new crushing, grinding and materials classification equipment rated at processing capacity of 3 tonnes per hour together with necessary conveyor belts, feed equipment and other structural requirements for mechanised processing, including noise reduction, dust controls and installation costs. “Disassembly and materials handling equipment costs” identify costs for the disassembly of monitors and televisions, together with materials handling equipment for all products managed at the facility. The cost of gaylord containers is also shown.

- *Total Estimated Cost* and *Provincial Share of Total Cost* The total estimated investment cost of a regional processing facility is calculated as the construction cost, plus all equipment costs including gaylords. The provincial share of the total cost is calculated as the proportion of total investment cost that a province would pay if its share of total cost was equal to its percentage of all EOL electronic products collected in Atlantic Canada.

COST PER EOL ELECTRICAL PRODUCT ITEM

Table J-13 identifies the cost of the five options considered in this document in terms of the cost per EOL electronic product managed through the system. The table identifies the total cost of each option. For each option, the total cost is multiplied by the percent of each type of EOL electrical product. This identifies the cost of managing each type of electrical product (value not shown in the table); the cost of managing each type of EOL electrical product is then divided by the number of that type of EOL electrical products anticipated to be managed through the management system.

JOB CREATION DATA

Job creation data are presented in Table J-14.

Data under "Collection" represent the number of person years of employment created through establishment of the collection depots for EOL electronic products.

Data under "Option 1 Total" represent the total number of person years that would be created through implementation of Option 1, including the employment created through collection depots. Thus the data under Option 1 Total include employment in the collection depots and employment created in the transportation of EOL electronic products and materials that would be required to implement Option 1. Likewise, data shown under Option 2 Total and Option 3 Total include collection depot employment and employment created through transportation of EOL electronic products and materials.

Data under Option 4 Total also include employment created in collection depots, together with employment created in both the disassembly of EOL electronic products under the assumptions presented above, and in the transportation of EOL electronic products to disassembly depots and the transportation of disassembled materials, stereos, phones and keyboards to markets.

COST RECOVERY

As identified in Section 8 of this document, Option 4 is the preferred approach for managing EOL electronic products in Atlantic Canada. Table J-15 identifies, for Option 4, the average unit cost incurred in managing EOL electronic products for 2005 and the unit cost that would need to have been charged to new product sales in 2005 in order to recover EOL management costs in that year through the internalisation of EOL management costs, as recommended in Section 5.3. The analysis is extended for years 2006 and 2007 for computers, peripherals and monitors based on computer sales projections provided by EPSC and on estimates of monitor and peripherals sales based on computer sales.

New Brunswick

Table J-1
Collection Depot Data

	Approximate Population Served	Quantity of EOL Electronics Generated (t)	Quantity of EOL Electronics Collected (t)	Number of EOL Electonic Items Collected	Volume of EOL Electronics (m^3)	Gross Number of Gaylord Containers	Annual Trailer loads
Depot Location							
Bathurst	30000	145.91	138.61	16,231	701.37	444.39	9.26
Buctouche	31000	150.17	142.66	16,772	721.84	457.37	9.53
Campbellton	36000	175.02	166.26	19,477	841.30	533.05	11.11
Caraquet	27000	131.35	124.78	14,608	631.40	400.06	8.33
Edmundston	36000	175.02	166.26	19,477	841.30	533.05	11.11
Fredericton	119000	578.65	549.72	64,382	2,781.57	1,762.43	36.72
Grand Falls	11000	53.61	50.92	5,951	257.68	163.27	3.40
Miramichi City	51000	248.15	235.74	27,592	1,192.83	755.79	15.75
Moncton	151000	734.50	697.77	81,695	3,530.72	2,237.09	46.61
Perth-Andover	11000	53.61	50.92	5,951	257.68	163.27	3.40
St. John	124000	603.15	572.99	67,087	2,899.32	1,837.03	38.27
St. Stephen	27000	131.35	124.78	14,608	631.40	400.06	8.33
Sussex	23000	111.83	106.23	12,444	537.54	340.59	7.10
Tracadie	25000	121.77	115.68	13,526	585.32	370.87	7.73
Woodstock	28000	136.32	129.50	15,149	655.29	415.20	8.65
Total	**730000**	**3,550.36**	**3,372.84**	**394,948**	**17,066.56**	**10,813.52**	**225.28**

Table J-2
Collection Depot Requirements and Costs

	Approximate Population Served	Depot Area (sq ft)	Net Gaylord Containers	Annual Amortised Gaylord Cost	Labour Cost	Annual Building Operating Cost	Annual Equipment and Supplies	Total Cost ($)	Cost/kg ($)
Depot Location					*0*	*0*	*0*		
Bathurst	30,000	1,000	55	2,640	7,428	7,250	3,002	20,320	0.147
Buctouche	31,000	1,000	55	2,640	7,676	7,250	3,056	20,621	0.145
Campbellton	36,000	1,000	55	2,640	8,914	7,250	3,371	22,175	0.133
Caraquet	27,000	1,000	55	2,640	6,685	7,250	2,817	19,392	0.155
Edmundston	36,000	1,000	55	2,640	8,914	7,250	3,371	22,175	0.133
Fredericton	119,000	1,000	55	2,640	29,465	9,000	8,493	49,598	0.090
Grand Falls	11,000	1,000	55	2,640	2,724	7,250	1,830	14,444	0.284
Miramichi City	51,000	1,000	55	2,640	12,628	7,250	4,299	26,817	0.114
Moncton	151,000	1,000	55	2,640	37,388	9,000	10,471	59,499	0.085
Perth-Andover	11,000	1,000	55	2,640	2,724	7,250	1,830	14,444	0.284
St. John	124,000	1,000	55	2,640	30,703	9,000	8,804	51,147	0.089
St. Stephen	27,000	1,000	55	2,640	6,685	7,250	2,817	19,392	0.155
Sussex	23,000	1,000	55	2,640	5,695	7,250	2,569	18,154	0.171
Tracadie	25,000	1,000	55	2,640	6,190	7,250	2,695	18,775	0.162
Woodstock	28,000	1,000	55	2,640	6,933	7,250	2,880	19,703	0.152
Float			289	13,860				13,860	
Total	**730,000**		**1,114**	**53,460**	**180,751**	**114,000**	**62,306**	**410,517**	**0.122**

Table J-3
Option 1: Estimated Annual Costs and Revenues

	Transportation to Noranda Brampton and ReCellular Toronto				Transportation to Noranda, Belledune, N.B.			
	Tonnes	**Loads**	**Rate/load**	**Cost**	**Tonnes**	**Loads**	**Rate/load**	**Cost**
Transportation								
Bathurst	100.20	6.39	1,400	8,952	38.42	2.88	475	1,366
Buctouche	103.13	6.58	1,575	10,366	39.54	2.96	475	1,406
Campbellton	120.20	7.67	1,400	10,739	46.08	3.45	475	1,639
Caraquet	90.21	5.76	1,400	8,059	34.58	2.59	475	1,230
Edmundston	126.52	8.07	1,400	11,304	46.08	3.45	475	1,639
Fredericton	397.40	25.36	1,575	39,943	152.36	11.41	875	9,981
Grand Falls	36.81	2.35	1,400	3,289	14.11	1.06	475	502
Miramichi City	170.42	10.88	1,575	17,129	65.34	4.89	475	2,324
Moncton	504.43	32.19	1,575	50,701	193.39	14.48	875	12,670
Perth-Andover	36.81	2.35	1,575	3,700	14.11	1.06	475	502
St. John	414.22	26.43	1,575	41,634	158.81	11.89	875	10,404
St. Stephen	90.21	5.76	1,575	9,067	34.58	2.59	875	2,266
Sussex	80.84	5.16	1,575	8,125	29.44	2.20	875	1,929
Tracadie	83.62	5.34	1,400	7,471	32.06	2.40	475	1,140
Woodstock	93.62	5.97	1,575	9,410	35.89	2.69	475	1,277
Total	**2,448.65**	**156.26**		**239,890**	**934.80**	**69.99**		**50,274**
Sub-Total - Transportation								**290,164**
Preprocessing					**Items**	**Cost per Item**		**Cost**
Monitors and TVs Preprocessing Quantities/Cost					105,450	2.27		**239,420**
Processing	**Kilograms**	**Cost/kg**		**Cost**	**Tonnes**	**Cost/tonne**		**Cost**
Processing Quantities/Cost	2,440,096	1.00		**2,440,096**	934.80	250.00		**233,700**
Sub-Total: Preprocessing and Processing								**2,913,215**
Total Cost								**3,203,379**
Cost/Kilogram								**0.95**

New Brunswick TV and Monitor Preprocessing					
	Items	**Disassembly Time**	**Labour Cost per hour**	**Equipment Depreciation**	**Cost**
Monitors	57,000	0.183	11.5	9,450	129,407
TVs	48,450	0.183	11.5	8,050	110,013
Total					239,420
Cost/kg					**0.11**
Cost/Item					**2.27**

Table J-4
Option 2: Estimated Annual Costs and Revenues

	Transportation to Noranda (Brampton) and ReCellular (Toronto)				Transportation to Hallstead, PA.			
	Tonnes	**Loads**	**Rate/load**	**Cost**	**Tonnes**	**Loads**	**Rate/load**	**Cost**
Transportation								
Bathurst	51.66	2.80	1,400	3,922	86.95	6.51	1,675	10909
Buctouche	53.17	2.88	1,575	4,541	89.49	6.70	1,575	10557
Campbellton	61.96	3.36	1,400	4,704	104.30	7.81	1,675	13085
Caraquet	46.50	2.52	1,400	3,530	78.28	5.86	1,675	9821
Edmundston	61.96	3.36	1,400	4,704	104.30	7.81	1,675	13085
Fredericton	204.87	11.11	1,575	17,497	344.84	25.83	1,575	40681
Grand Falls	18.98	1.03	1,400	1,441	31.95	2.39	1,675	4008
Miramichi City	87.86	4.76	1,575	7,503	147.88	11.08	1,575	17446
Moncton	260.05	14.10	1,575	22,209	437.72	32.79	1,575	51638
Perth-Andover	18.98	1.03	1,575	1,621	31.95	2.39	1,575	3769
St. John	213.55	11.58	1,575	18,238	359.44	26.92	1,575	42403
St. Stephen	46.50	2.52	1,575	3,972	78.28	5.86	1,575	9234
Sussex	39.59	2.15	1,575	3,381	66.64	4.99	1,575	7862
Tracadie	43.11	2.34	1,400	3,273	72.57	5.44	1,675	9104
Woodstock	48.26	2.62	1,575	4,122	81.24	6.08	1,575	9584
Total	**1,257.01**	**68.16**		**104,658**	**2,115.82**	**158.48**		**253187**
Sub-Total: Transportation								**357844**
Preprocessing					**Items**	**Cost/Item**		**Cost**
Monitors and TVs					**000**	**000**		**000**
Preprocessing Quantities/Cost								
Processing	**Kilograms**	**Cost/kg**		**Cost**	**Items**	**Cost/Item**		
	1,257,014	1.00		**1,257,014**	105,450.00	7.20		**759,240**
Processing Quantities/Cost								
Sub-Total: Preprocessing and Processing								**2,007,704**
Total Cost								**2,365,548**
Cost/Kilogram								**0.70**

Table J-5
Option 3: Estimated Annual Costs and Revenues

	Transportation to Noranda (Brampton) and ReCellular (Toronto)				Transportation to Hallstead, PA.			
	Tonnes	**Loads**	**Rate/Load**	**Cost**	**Tonnes**	**Loads**	**Rate/load**	**Cost**
Transportation								
Bathurst	100.20	6.39	1,400	8,952	38.42	2.88	1,675	4818
Buctouche	103.13	6.58	1,575	10,366	39.54	2.96	1,575	4663
Campbellton	120.20	7.67	1,400	10,739	46.08	3.45	1,675	5779
Caraquet	90.21	5.76	1,400	8,059	34.58	2.59	1,675	4337
Edmundston	126.52	8.07	1,400	11,304	46.08	3.45	1,675	5779
Fredericton	397.40	25.36	1,575	39,943	152.36	11.41	1,575	17967
Grand Falls	36.81	2.35	1,400	3,289	14.11	1.06	1,675	1770
Miramichi City	170.42	10.88	1,575	17,129	65.34	4.89	1,575	7705
Moncton	504.43	32.19	1,575	50,701	193.39	14.48	1,575	22806
Perth-Andover	36.81	2.35	1,575	3,700	14.11	1.06	1,575	1664
St. John	414.22	26.43	1,575	41,634	158.81	11.89	1,575	18727
St. Stephen	90.21	5.76	1,575	9,067	34.58	2.59	1,575	4078
Sussex	80.84	5.16	1,575	8,125	29.44	2.20	1,575	3472
Tracadie	83.62	5.34	1,400	7,471	32.06	2.40	1,675	4021
Woodstock	93.62	5.97	1,575	9,410	35.89	2.69	1,575	4233
Total	**2,448.65**	**156.26**		**239,890**	**934.80**	**69.99**		**111818**
Sub-Total: Transportation								**351708**
Preprocessing					**Items**	**Cost/Item ($)**		**Cost**
Monitors/TVs Preprocessing Quantities/Cost					105,450	2.27		**239,420**
Processing	**Kilograms**	**Cost/kg**		**Cost**	**Items**	**Cost/Item**		**Cost**
Processing Quantities/Cost	2,440,096	1.00		**2,440,096**	105,450.00	3.60		**379,620.00**
Sub-Total: Preprocessing and Processing								**3.059,136**
Total Cost								**3,410,844**
Cost/Kilogram								**1.01**

New Brunswick TV and Monitor Preprocessing					
	Items	**Disassembly Time**	**Labour Cost per hour**	**Equipment Depreciation**	**Cost**
Monitors	57,000	0.183	11.5	9,450	129,407
TVs	48,450	0.183	11.5	8,050	110,013
Total					239,420
Cost/kg					0.11
Cost/Item					2.27

Table J-6
Option 4 - Transportation for Disassembly

TRANSPORTATION FOR DISASSEMBLY: New Brunswick							
Collection Depot City/Town	**Annual Trailer Loads**	**Destination and Cost**					
		Moncton		**St. John**		**Fredericton**	
		Cost/Load	**Total Cost**	**Cost/Load**	**Total Cost**	**Cost/Load**	**Total Cost**
Bathurst	9.26	300	2,777				
Buctouche	9.53	300	2,859				
Campbellton	11.11	475	5,275				
Caraquet	8.33	475	3,959				
Edmundston	11.11					475	5,275
Fredericton	36.72						
Grand Falls	3.40					300	1,020
Miramichi City	15.75	300	4,724				
Moncton	46.61						
Perth-Andover	3.40					300	1,020
St. John	38.27						
St. Stephen	8.33			300	2,500		
Sussex	7.10			300	2,129		
Tracadie	7.73	300	2,318				
Woodstock	8.65					300	2,595
Total			**21,912**		**4,629**		**9,911**

Note: Disassembly centres assumed to be located in shaded cities.

A disassembly facility in Fredericton is assumed to receive EOL electronic products from collection depots in Edmundston, Grand Falls, Perth-Andover and Woodstock as well as materials delivered to a collection depot in Fredericton located at the disassembly facility.

A disassembly facility in Moncton is assumed to receive EOL electronic products from collection depots in Bathurst, Buctouche, Caraquet, Campbellton, Miramichi City, Tracadie as well as materials delivered to a collection depot in Moncton located at the disassembly facility.

A disassembly facility in St. John is assumed to receive EOL electronic products from collection depots in Sussex and St. Stephen as well as materials delivered to a collection depot in St. John located at the disassembly facility.

Table J-7: Option 4 - Design Basis For Disassembly Facilities in New Brunswick

Location	Percentage of Total Gaylords in Province	Annual Gaylords in Catchment	Storage Capacity: Delivery and Product (Sq Ft)	Number of Labourers	Supervision	Managers	Office Support Staff	Floor staff	Work Station Space (sq ft)	Logistics Space (sq ft)	Office	Lunch Room/ Wash Room (sq ft)	Total Area (Sq Ft)
Moncton	48.08	5,198.62	3,999	23	1	1	1	3	2,302	12,457	200	400	18,958
St. John	23.84	2,577.69	2,080	11	0	1	1	3	1,141	6,468	100	400	10,190
Fredericton	28.09	3,037.21	2,336	13	1	1	1	3	1,345	7,278	200	400	11,559

Table.J-8: Option 4 - Equipment Basis For Disassembly Facilities in New Brunswick

	Moncton				St. John				Fredericton			
	Number	Unit Price	Total	Annual Depreciation	Number	Unit Price	Total	Annual Depreciation	Number	Unit Price	Total	Annual Depreciation
Fork Lift Truck	3	30,000	90,000	9,000	3	30,000	90,000	9,000	3	30000	90,000	9,000
Baler	1	100,000	100,000	10,000	1	100,000	100,000	10,000	1	100000	100,000	10,000
Work Stations	23	5,000	115,000	16,429	11	5,000	55,000	7,857	13	5,000	65,000	9,286
Hand Tools	28	500	14,000	4,667	14	500	7,000	2,333	17	500	8,500	2,833
Computer	2	2,000	4,000	1,000	1	2,000	2,000	500	2	2,000	4,000	1,000
Office Furnishings	2	2,000	4,000	571	1	2,000	2,000	286	2	2,000	4,000	571
Miscellaneous	1	LS	10,000	1,429	1	LS	10,000	1,429	1	LS	10,000	1,429
Installation			86,250	12,321			41,250	5,893			48,750	6,964
Total			**423,250**	**55,417**			**307,250**	**37,298**			**330,250**	**41,083**

Table J-9: Option 4: Annual Cost Estimates for Disassembly Facilities and Associated Transport in New Brunswick

Location	Staff Cost	Building Operation and Maintenance	Equipment Costs-Capital	Equipment Cost - Operations	Equipment Depreciation	Haulage Cost To Disassembly Facility	Haulage Cost to Markets	Stereo/Phones Haul and Processing Cost	Waste Management Cost	Materials Revenue	Total Cost	Kilograms Managed	Cost/Kg
Moncton	709,592	170,625	423,2500	13,500	55,417	21,912	126,691	93,412	2,998	232,334	955,202	1,621,498	0.59
St. John	412,043	91,708	307,250	13,500	37,298	4,629	62,819	46,318	1,487	115,201	551,323	804,004	0.69
Fredericton	489,447	104,033	330,250	13,500	41,083	9,911	74,017	49,897	1,752	135,738	644,041	947,335	0.66
											2,150,566	**3,372,837**	**0.64**

Table J-10: Option 4 - Summary of Net Annual Costs

	Collection Cost	Disassembly Facility and Associated Transport Cost	Total Annual Cost	Kilograms of EOL Electronic Product	Cost/Kg
Moncton	194,263	955,202	1,149,465	1,621,498	0.71
St. John	124,257	551,323	675,579	804,004	0.84
Fredericton	91,997	644,041	736,038	947,335	0.78
Total	**410,517**	**2,150,566**	**2,561,083**	**3,372,837**	**0.76**

Table J-11: Option 5 – Annual Costs

Total Regional Processing Cost		Provincial Share of Regional Processing Cost		Transportation from Collection Depots		Collection Depot Cost	Total Cost		Cost/Kg	
High	Low	High	Low	High	Low		High	Low	High	Low
10,716,781	7,501,754	3,372,834	2,360,986	165,580	106,984	410,517	3,948,931	2,878,487	1.17	0.85

Table J-12:Investment Cost Data for Option 4 and Option 5

Option 4: Disassembly at major Centres						Option 5: Regional Processing Facility						
Location	Floor Area (sq. ft.)	Construction Cost/ Sq. Ft	Gaylords Cost	Equipment Cost	Total Estimated Cost	Floor Area (Sq ft)	Construction Cost/ sq ft	Gaylords Cost	Mechanised Equipment Cost	Disassembly and Materials Handling Equipment	Total Estimated Cost	Provincial Share of Total Cost
Moncton	18,958	70	128,505	423,250	1,878,837							
St. John	10,190	70	63,718	307,250	1,084,253							
Fredericton	11,559	70	75,077	330,250	1,214,475	80,000	70	980,100	5,000,000	450,000	12,030,100	3,786,167
Total			**267,300**		**4,177,566**							

Notes:

1. Estimated investment cost excludes land costs
2. Provincial share of Option 5 calculated on basis of proportion of total regional tonnes collected attributable to each province

Table J-13: Cost Per EOL Electronic Product Item

	Percent by Weight	Number Collected	Option 1	Option 2	Option 3	Option 4	Option 5	
							Low	High
Total Cost ($)			3,613,896	2,776,065	3,821,361	2,561,083	2,878,487	3,948,931
Cell Phones	0.27	54,150	0.18	0.14	0.19	0.13	0.14	0.19
Telephones	1.23	39,900	1.11	0.85	1.18	0.79	0.89	1.22
Stereos	3.76	47,500	2.86	2.19	3.02	2.02	2.28	3.12
Computers	18.20	50,350	13.06	10.03	13.81	9.26	10.40	14.27
Monitors	24.00	57,000	15.22	11.69	16.09	10.78	12.12	16.63
Peripherals	15.74	95,000	5.99	4.60	6.33	4.24	4.77	6.54
TVs	36.80	48,450	27.45	21.09	29.03	19.46	21.87	30.00

Table J-14: Job Creation (person years)

Collection	Option 1		Option 2	Option 3		Option 4			Option 5
	Disassembly	Transport		Disassembly	Transport	Transport: Depot To Disassembly	Disassembly	Transport To Market	Transport: Depot to Processing
7.38	9.65	1.36	1.81	9.65	1.81	0.08	64.89	1.24	0.57

Notes:
1. Table shows estimated person years of employment per calendar year
2. In addition, Option 5 is projected to result in the creation of 51.51 jobs at a centralised processing facility and in transportation of materials to end-use markets. These jobs would be located in the province in which the centralised facility was located.

Table J-15: Option 4: Comparison of Attribution of Option 4 Costs to EOL Items and to New Sales Items

	Cost/ EOL Item ($)	2005			2006			2007		
		EOL Units (000s)	Units Sold (000)s	EOL Cost/ Unit Sold ($)	EOL Units (000s)	Units Sold (000)s	EOL Cost/ Unit Sold ($)	EOL Units (000s)	Units Sold (000)s	EOL Cost/ Unit Sold ($)
Cell Phones	0.12	54	63	0.11	ND	ND	ND	ND	ND	ND
Telephones	0.77	40	32	0.97	ND	ND	ND	ND	ND	ND
Stereos	1.98	47	58	1.62	ND	ND	ND	ND	ND	ND
Computers	9.03	50	69	6.58	52	72	6.58	53	72	6.65
Monitors	10.52	57	78	7.69	59	81	7.68	61	81	7.98
Peripherals	4.14	95	114	3.46	99	118	3.45	101	118	3.54
TVs	18.98	48	58	15.79	ND	ND	ND	ND	ND	ND

Note. Sources of 2005 sales data: Computers and televisions – EPSC; cell phones, telephones and stereos – Electro-Federation Canada; peripherals estimated based on printer sales data provided by EPSC adjusted to also include scanners and keyboards. Source of 2006 and 2007 sales data: Computers – EPSC; monitors and peripherals sales data estimated.

Comments Received from New Brunswick Beverage Container and Recycling Program

The locations of the collection depots as indicated would provide adequate service to most New Brunswickers. The only addition to the list might be to add a collection depot in the Blackville/Doaktown/Centreville area of the Province. This is not suggested due to the population base (using statistical data from the 2001 Census setting the total population of these communities at approximately 2,505) but due to the travel distance of these locations to the nearest collection depots identified in the list (Miramichi City and Fredericton).

Consideration can be given to the Regional Solid Waste Commissions and the transfer stations acting as collection depots in New Brunswick when cost estimates are provided. This infrastructure, as well as the Redemption Centre system in NB (80 Redemption Centres), can be used in an effort to reduce costs associated with establishing collection facilities.

Newfoundland and Labrador

Table J-1
Collection Depot Data

	Approximate Population Served	Quantity of EOL Electronics Generated (t)	Quantity of EOL Electronics Collected (t)	Number of EOL Electonic Items Collected	Volume of EOL Electronics (m^3)	Gross Number of Gaylord Containers	Annual Trailer loads
Newfoundland and Labrador							
Baie Verte	14000	71.14	67.59	7,574	341.99	216.69	4.51
Bonavista	15000	76.10	72.29	8,115	365.79	231.77	4.83
Carbonear	35000	177.73	168.84	18,936	854.34	541.32	11.28
Channel-Port aux Basques	19000	96.42	91.60	10,279	463.50	293.68	6.12
Clarenville	10000	51.86	49.27	5,410	249.29	157.95	3.29
Corner Brook	40000	203.27	193.10	21,641	977.11	619.11	12.90
Gander	25000	126.91	120.57	13,526	610.07	386.54	8.05
Happy Valley-Goose Bay	16000	81.31	77.24	8,656	390.84	247.64	5.16
Grand Falls-Windsor	29000	147.24	139.88	15,690	707.78	448.45	9.34
Labrador City	12000	60.98	57.93	6,492	293.13	185.73	3.87
Lewisporte	24000	121.96	115.86	12,985	586.27	371.46	7.74
Marystown	24000	121.96	115.86	12,985	586.27	371.46	7.74
Placentia	10000	50.82	48.28	5,410	244.28	154.78	3.22
St. Anthony	20000	101.63	96.55	10,821	488.55	309.55	6.45
St. John's	188000	955.10	907.34	101,713	4,591.16	2,909.00	60.60
Stephenville	22000	110.23	104.72	11,903	529.89	335.75	6.99
Trepassey	10000	50.82	48.28	5,410	244.28	154.78	3.22
Total	**513000**	**2,605.48**	**2,475.20**	**277,546**	**12,524.54**	**7,935.66**	**165.33**

Table J-2.
Collection Depot Requirements and Costs

	Approximate Population Served	Depot Area (sq ft)	Net Gaylord Containers	Annual Amortised Gaylord Cost	Labour Cost	Annual Building Operating Cost	Annual Equipment/ Supplies	Total Cost ($)	Cost/kg ($)
Depot Location									
Baie Verte	14,000	1,000	55	2,640	3,466	7,250	2,053	15,409	0.228
Bonavista	15,000	1,000	55	2,640	3,714	7,250	2,116	15,720	0.217
Carbonear	35,000	1,000	55	2,640	8,666	7,250	3,406	21,962	0.130
Channel-Port aux Basques	19,000	1,000	55	2,640	4,704	7,250	2,374	16,968	0.185
Clarenville	10,000	1,000	55	2,640	2,476	7,250	1,808	14,174	0.288
Corner Brook	40,000	1,000	55	2,640	9,904	9,000	3,730	25,274	0.131
Gander	25,000	1,000	55	2,640	6,190	7,250	2,761	18,841	0.156
Happy Valley-Goose Bay	16,000	1,000	55	2,640	3,962	7,250	2,182	16,034	0.208
Grand Falls-Windsor	29,000	1,000	55	2,640	7,181	7,250	3,019	20,089	0.144
Labrador City	12,000	1,000	55	2,640	2,971	7,250	1,924	14,785	0.255
Lewisporte	24,000	1,000	55	2,640	5,942	7,250	2,698	18,530	0.160
Marystown	24,000	1,000	55	2,640	5,942	7,250	2,698	18,530	0.160
Placentia	10,000	1,000	55	2,640	2,476	7,250	1,795	14,161	0.293
St. Anthony	20,000	1,000	55	2,640	4,952	7,250	2,440	17,282	0.179
St. John's	188,000	1,000	55	2,640	46,550	9,000	13,271	71,460	0.079
Stephenville	22,000	1,000	55	2,640	5,447	7,250	2,549	17,886	0.171
Trepassey	10,000	1,000	55	2,640	2,476	7,250	1,795	14,161	0.293
Float			327	15,708				15,708	
Total	**513,000**		**1,262**	**60,588**	**127,021**	**126,750**	**52,615**	**366,974**	**0.148**

Table J-3
Option 1: Estimated Costs and Revenues

	Transportation to Noranda (Brampton) and ReCellular (Toronto)				Transportation to Noranda (Belledune).			
	Tonnes	**Loads**	**Rate/Load**	**Cost**	**Tonnes**	**Loads**	**Rate/load**	**Cost**
Depot Location								
Baie Verte	49.18	2.73	3,074	8,390	18.42	1.20	1,775	2,128
Bonavista	52.61	2.92	3,177	9,275	19.70	1.28	1,925	2,469
Carbonear	122.87	6.82	3,177	21,662	46.01	3.00	1,925	5,766
Channel-Port aux Basques	66.66	3.70	3,074	11,371	24.96	1.62	1,775	2,884
Clarenville	35.85	1.99	3,177	6,321	13.42	0.87	1,925	1,682
Corner Brook	140.53	7.80	3,074	23,971	52.62	3.43	1,775	6,081
Gander	87.74	4.87	3,074	14,967	32.85	2.14	1,775	3,796
Happy Valley-Goose Bay	56.21	3.12	3,500	10,917	21.05	1.37	2,275	3,117
Grand Falls-Windsor	101.79	5.65	3,074	17,364	38.11	2.48	1,775	4,404
Labrador City	42.16	2.34	3,500	8,188	15.78	1.03	2,275	2,338
Lewisporte	84.32	4.68	3,074	14,383	31.57	2.06	1,775	3,648
Marystown	84.32	4.68	3,177	14,865	31.57	2.06	1,925	3,957
Placentia	35.13	1.95	3,177	6,194	13.15	0.86	1,925	1,649
St. Anthony	70.26	3.90	3,074	11,986	26.31	1.71	1,775	3,040
St. John's	660.29	36.64	3,177	116,409	247.23	16.10	1,925	30,985
Stephenville	76.21	4.23	3,074	13,000	28.53	1.86	1,775	3,298
Trepassey	35.13	1.95	3,177	6,194	13.15	0.86	1,925	1,649
Total	**1,801.24**	**99.96**		**315,455**	**674.43**	**43.91**		**82,892**
Sub-Total: Transportation								**398,347**
Preprocessing					**Items**	**Cost/Item**		**Cost**
Monitors/TVs Preprocessing Quantities/Cost					**76,950**	**2.27**		**174,691**
Processing Cost	**Kilograms**	**Cost/kg**		**Cost**	**Tonnes**	**Cost/tonne**		**Cost**
	1,794,593	1.00		**1,794,593**	674.43	250.00		**168,607**
Sub-Total: Preprocessing and Processing								**2,137,892**
Total Cost								**2,595,991**
Cost/Kilogram								**1.05**

Newfoundland and Labrador Monitor and TV Preprocessing

	Items	**Disassembly Time**	**Labour Cost/Hour**	**Equipment Depreciation**	**Cost**
Monitors	42,750	0.183	11.5	6,885	96,852
TVs	34,200	0.183	11.5	5,865	77,839
Total					174,691
Cost/kg					0.11
Cost/item					**2.27**

Table J-4
Option 2: Estimated Costs and Revenues

	Transportation to Noranda (Brampton) and ReCellular (Toronto)				Transportation to Hallstead, PA.			
	Tonnes	**Loads**	**Rate/Load**	**Cost**	**Tonnes**	**Loads**	**Rate/Load**	**Cost**
Depot Location								
Baie Verte	25.92	1.22	3,074	3,757	41.66	2.71	3,074	8,321
Bonavista	27.73	1.31	3,177	4,154	44.56	2.90	3,177	9,221
Carbonear	64.76	3.05	3,177	9,701	104.08	6.78	3,177	21,537
Channel-Port aux Basques	35.13	1.66	3,074	5,092	56.47	3.68	3,074	11,306
Clarenville	18.90	0.89	3,177	2,831	30.37	1.98	3,177	6,284
Corner Brook	74.07	3.49	3,074	10,735	119.04	7.75	3,074	23,833
Gander	46.24	2.18	3,074	6,703	74.32	4.84	3,074	14,881
Happy Valley-Goose Bay	29.63	1.40	3,500	4,889	47.62	3.10	3,500	10,855
Grand Falls-Windsor	53.65	2.53	3,074	7,776	86.23	5.62	3,074	17,264
Labrador City	22.22	1.05	3,500	3,667	35.71	2.33	3,500	8,141
Lewisporte	44.44	2.10	3,074	6,441	71.42	4.65	3,074	14,300
Marystown	44.44	2.10	3,177	6,657	71.42	4.65	3,177	14,779
Placentia	18.52	0.87	3,177	2,774	29.76	1.94	3,177	6,158
St. Anthony	37.03	1.75	3,074	5,368	59.52	3.88	3,074	11,917
St. John's	348.01	16.41	3,177	52,133	559.33	36.43	3,177	115,739
Stephenville	40.17	1.89	3,074	5,822	64.56	4.20	3,074	12,925
Trepassey	18.52	0.87	3,177	2,774	29.76	1.94	3,177	6,158
Total	**949.37**	**44.76**		**141,275**	**1,525.84**	**99.38**		**313,640**
Sub-Total: Transportation								**454,915**
Preprocessing					**Items**	**Cost/Item**		**Cost**
Monitors/TVs					000	000		**000**
Preprocessing Quantities/Cost								
Processing Cost	**Kilograms**	**Cost/kg**		**Cost**	**Items**	**Cost/Item**		**Cost**
	942,718	1.00		**942,718**	76,950	7.60		**584,820**
Sub-Total: Preprocessing and Processing								**1,527,538**
Total Cost								**2,050,689**
Cost/Kilogram								**0.83**

Table J-5
Option 3: Estimated Costs and Revenues

	Transportation to Noranda (Brampton) and ReCellular (Toronto)				Transportation to Hallstead, PA.			
	Tonnes	**Loads**	**Rate/Load**	**Cost**	**Tonnes**	**Loads**	**Rate/Load**	**Cost**
Depot Location								
Baie Verte	49.18	2.73	3,074	8,390	18.42	1.20	3,074	3,686
Bonavista	52.61	2.92	3,177	9,275	19.70	1.28	3,177	4,074
Carbonear	122.87	6.82	3,177	21,662	46.01	3.00	3,177	9,516
Channel-Port aux Basques	66.66	3.70	3,074	11,371	24.96	1.62	3,074	4,995
Clarenville	35.85	1.99	3,177	6,321	13.42	0.87	3,177	2,777
Corner Brook	140.53	7.80	3,074	23,971	52.62	3.43	3,074	10,531
Gander	87.74	4.87	3,074	14,967	32.85	2.14	3,074	6,575
Happy Valley-Goose Bay	56.21	3.12	3,500	10,917	21.05	1.37	3,500	4,796
Grand Falls-Windsor	101.79	5.65	3,074	17,364	38.11	2.48	3,074	7,628
Labrador City	42.16	2.34	3,500	8,188	15.78	1.03	3,500	3,597
Lewisporte	84.32	4.68	3,074	14,383	31.57	2.06	3,074	6,318
Marystown	84.32	4.68	3,177	14,865	31.57	2.06	3,177	6,530
Placentia	35.13	1.95	3,177	6,194	13.15	0.86	3,177	2,720
St. Anthony	70.26	3.90	3,074	11,986	26.31	1.71	3,074	5,265
St. John's	660.29	36.64	3,177	116,409	247.23	16.10	3,177	51,138
Stephenville	76.21	4.23	3,074	13,000	28.53	1.86	3,074	5,710
Trepassey	35.13	1.95	3,177	6,194	13.15	0.86	3,177	2,720
Total	**1,801.24**	**99.96**		**315,455.34**	**674.43**	**43.91**		**138,578**
Sub-Total: Transportation								**454,033**
Preprocessing					**Items**	**Cost/Item**		**Cost**
Monitors/TVs Preprocessing Quantities/Cost					76,950	2.27		**174,691**
Processing Cost	**Kilograms**	**Cost/kg**		**Cost**	**Items**	**Cost/kg**		
	1,794,593	1.00		**1,794,593**	76,950.00	3.60		**277,020**
Sub-Total: Preprocessing and Processing								**2,246,304**
Total Cost								**2,768,442**
Cost/Kilogram								**1.12**

Newfoundland and Labrador Monitor and TV Preprocessing					
	Items	**Disassembly Time**	**Labour Cost/Hour**	**Equipment Depreciation**	**Cost**
Monitors	42,750	0.183	11.5	6,885	96,852
TVs	34,200	0.183	11.5	5,865	77,839
Total					174,691
Cost/kg					**0.11**
Cost/item					**2.27**

Table J-6
Option 4 – Transportation for Disassembly

TRANSPORTATION FOR DISASSEMBLY:					
Collection Depot City/Town	**Annual Trailer Loads**	**Destination and Cost**			
		Corner Brook		**St. John's**	
		Cost/Load	**Total Cost**	**Cost/Load**	**Total Cost**
Baie Verte	4.51	300	1,354		
Bonavista	4.83		0	475	2,294
Carbonear	11.28		0	300	3,383
Channel-Port aux Basques	6.12	300	1,835		0
Clarenville	3.29		0	300	987
Corner Brook	12.90		0		0
Gander	8.05	475	3,825		0
Happy Valley-Goose Bay	5.16	975	5,030		0
Grand Falls-Windsor	9.34	475	4,438		0
Labrador City	3.87	975	3,773		0
Lewisporte	7.74	475	3,676		0
Marystown	7.74		0	475	3,676
Placentia	3.22		0	300	967
St. Anthony	6.45	475	3,063		0
St. John's	60.60		0		0
Stephenville	6.99	300	2,098		0
Trepassey	3.22		0	300	967
Total			**29,093**		**12,275**

Note: Disassembly centres assumed to be located in shaded cities.

A disassembly facility in Corner Brook is assumed to receive EOL electronic products from collection depots in Baie Verte, Channel-Port aux Basques, Gander, Happy Valley-Goose Bay, Grands Falls-Windsor, Labrador City, Lewisporte, St. Anthony, Stephenville as well as materials delivered to a collection depot in Corner Brook located at the disassembly facility.

A disassembly facility in St. John’s is assumed to receive EOL electronic products from collection depots in Bonavista, Carbonear, Clarenville, Marystown, Placentia and Trepassey as well as materials delivered to a collection depot in St. John’s located at the disassembly facility.

Table J-7: Option 4 - Design Basis For Disassembly Facilities in Newfoundland and Labrador

Location	Percentage of Total Gaylords in Province	Annual Gaylords in Catchment	Sorage Capacity: Delivery and Product (Sq Ft)	Number of Labourers	Supervision	Managers	Office Support Staff	Floor staff	Work Station Space (sq ft)	Logistics Space (sq ft)	Office	Lunch Room/ Wash Room (Sq ft)	Total Area (Sq Ft)
St. John's	56.97	4,521.05	3,478	20	1	1	1	4	2,049	10,843	200	400	16,970
Corner Brook	43.03	3,414.60	2,627	15	1	1	1	3	1,548	8,189	200	400	12,964

Table J-8: Option 4 - Equipment Basis For Disassembly Facilities in Newfoundland and Labrador

	St. John's				Corner Brook			
	Number	Unit Price	Total	Annual Depreciation	Number	Unit Price	Total	Annual Depreciation
Fork Lift Truck	4	30000	120,000	12,000	3	30,000	90,000	9,000
Baler	1	100000	100,000	10,000	1	100,000	100,000	10,000
Work Stations	20	5,000	100,000	14,286	15	5,000	75,000	10,714
Hand Tools	24	500	12,000	4,000	19	500	9,500	3,167
Computer	2	2,000	4,000	1,000	2	2,000	4,000	1,000
Office Furnishings	2	2,000	4,000	571	2	2,000	4,000	571
Miscellaneous	1	LS	10,000	1,429	1	LS	10,000	1,429
Installation			75,000	10,714			56,250	8,036
Total			**425,000**	**54,000**			**348,750**	**43,917**

Table J-9: Option 4 - Cost Estimates for Disassembly Facilities and Associated Transport in Newfoundland and Labrador

Location	Staff Cost	Building Operation and Maintenance	Equipment Costs-Capital	Equipment Cost – Operations	Equipment Depreciation	Haulage Cost To Disassembly Facility	Haulage Cost to Markets	Stereo/Phones Haul and Processing Cost	Waste Management Cost	Materials Revenue	Total Cost	Kilograms Managed	Cost/Kg
St. John's	674,409	152,729	425,000	18,000	54,000	12,275	227,940	84,952	2,617	192,795	1,029,767	1,410,159	0.73
Corner Brook	536,064	116,673	348,750	13,500	43,917	29,093	164,812	63,831	1,977	156,369	805,095	1,065,046	0.76
											1,834,861	**2,475,205**	**0.74**

Table J-10: Option 4 - Summary of Net Costs

	Collection Cost	Disassembly Facility and Associated Transport Cost	Total Annual Cost	Kilograms of EOL Electronic Product	Cost/Kg
St. John's	179,117	1,029,767	1,208,884	1,410,159	0.86
Corner Brook	187,857	805,095	992,952	1,065,046	0.93
Total	**366,974**	**1,834,861**	**2,201,835**	**2,475,205**	**0.89**

Table J-11: Option 5 - Costs

Total Regional Processing Cost		Provincial Share of Regional Processing Cost		Transportation from Collection Depots		Collection Depot Cost	Total Cost		Cost/Kg	
High	Low	High	Low	High	Low		High	Low	High	Low
10,716,781	7,501,754	2,475,202	1,732,643	250,857	234,635	366,974	3,093,033	2,334,253	1.25	0.94

Table J-12:Investment Cost Data for Option 4 and Option 5

Option 4: Disassembly at Major Centres						Option 5: Regional Processing Facility						
Location	Floor Area (sq. ft.)	Construction Cost/ Sq. Ft	Gaylords Cost	Equipment Cost	Total Estimated Cost	Floor Area (Sq ft)	Construction Cost/sq ft	Gaylords Cost	Mechanised Processing Equipment Cost	Disassembly and Materials Handling Equipment	Total Estimated Cost	Provincial Share of Total Cost
St. John's	16,970	70	172,589	425,000	1,785,485							
Corner Brook	12,964	70	130,351	348,750	1,386,558	80,000	70	980,100	5,000,000	450,000	12,030,100	2,778,533
Total			**302,940**		**3,172,043**							

Notes:
1. Estimated investment cost excludes land costs
2. Provincial share of Option 5 calculated on basis of proportion of total regional tonnes collected attributable to each province

Table J-13: Cost Per EOL Electronic Product Item

	Percent by Weight	Number Collected	Option 1	Option 2	Option 3	Option 4	Option 5	
							Low	High
Total Cost			2,962,965	2,417,663	3,135,416	2,201,835	2,334,253	3,093,033
Cell Phones	0.27	40,850	0.19	0.16	0.21	0.14	0.15	0.20
Telephones	1.23	29,450	1.24	1.01	1.31	0.92	0.97	1.29
Stereos	3.76	33,250	3.35	2.73	3.54	2.49	2.64	3.49
Computers	18.20	38,000	14.19	11.58	15.02	10.54	11.18	14.81
Monitors	24.00	42,750	16.64	13.57	17.60	12.36	13.11	17.37
Peripherals	15.74	72,200	6.46	5.27	6.84	4.80	5.09	6.74
TVs	36.80	34,200	31.89	26.02	33.74	23.70	25.12	33.29

Table J-14: Job Creation (person years)

Collection	Option 1		Option 2	Option 3		Option 4			Option 5
	Disassembly	Transport		Disassembly	Transport	Transport: Depot To Disassembly	Disassembly	Transport To Market	Transport: Depot to Processing
5.18	7.04	3.15	3.48	7.04	3.47	0.11	48.97	2.89	2.07

Notes:

1. Table shows estimated person years of employment per calendar year
2. In addition, Option 5 is projected to result in the creation of 51.51 jobs at a centralised processing facility and in transportation of materials to end-use markets. These jobs would be located in the province in which the centralised facility was located.

Table J-15: Option 4: Comparison of Attribution of Option 4 Costs to EOL Items and to New Sales Items

	Cost/ EOL Item ($)	2005			2006			2007		
		EOL Units (000s)	Units Sold (000)s	EOL Cost/ Unit Sold ($)	EOL Units (000s)	Units Sold (000)s	EOL Cost/ Unit Sold ($)	EOL Units (000s)	Units Sold (000)s	EOL Cost/ Unit Sold ($)
Cell Phones	0.14	43	43	0.14	ND	ND	ND	ND	ND	ND
Telephones	0.89	31	21	1.21	ND	ND	ND	ND	ND	ND
Stereos	2.42	35	40	2.03	ND	ND	ND	ND	ND	ND
Computers	10.27	40	47	8.23	39	49	8.23	40	49	8.43
Monitors	12.04	45	53	9.61	44	56	9.61	46	56	10.05
Peripherals	4.67	76	78	4.33	75	81	4.32	77	81	4.43
TVs	23.07	36	40	19.74	ND	ND	ND	ND	ND	ND

Note. Sources of 2005 sales data: Computers and televisions – EPSC; cell phones, telephones and stereos – Electro-Federation Canada; peripherals estimated based on printer sales data provided by EPSC adjusted to also include scanners and keyboards. Source of 2006 and 2007 sales data: Computers – EPSC; monitors and peripherals sales data estimated.

Comments Received From Multi-Materials Stewardship Board (MMSB)

Long road distances between communities means that either: (i) the identified distribution of collection points would require support from "satellite" collection points, or (ii) the owner of an EOL electronic product be required to travel a greater distance to return the product to a collection depot.

MMSB will give first priority to integrating the collection of EOL electronics into the collection activities of the existing network of beverage container recycling depots, supported by sub-depots or "satellite" depots where appropriate. However, the floor area available for storage in many of these depots is insufficient to accommodate the gaylords necessary for collecting EOL electronic products, and this will need to be addressed.

Long periods of time would be required to fill gaylord containers in some communities. Rather than transporting full truckloads of EOL electronics from each collection point, it may therefore be preferred to assemble truckload quantities through collection of partial loads from several collection points. This approach would also reduce the floor space required for storing EOL electronic products at collection points.

Transportation rates are particularly important to MMSB because of the distance from Newfoundland and Labrador to markets for EOL electronic products and materials.

Nova Scotia

Table J-1
Collection Depot Data

	Approximate Population Served	Quantity of EOL Electronics Generated (t)	Quantity of EOL Electronics Collected (t)	Number of EOL Electonic Items Collected	Volume of EOL Electronics (m^3)	Gross Number of Gaylord Containers	Annual Trailer loads
Depot Location							
Amherst	33000	163.67	155.48	17,854	786.74	498.49	10.39
Annapolis Royal	11000	54.26	51.54	5,951	260.81	165.25	3.44
Antigonish	24000	118.38	112.46	12,985	569.04	360.55	7.51
Baddeck	16000	78.92	74.97	8,656	379.36	240.37	5.01
Bridgewater	48000	237.20	225.34	25,969	1,140.24	722.46	15.05
Cape Breton RM	111000	548.39	520.97	60,054	2,636.13	1,670.27	34.80
Digby	10000	49.32	46.86	5,410	237.10	150.23	3.13
Halifax 1	180000	889.18	844.72	97,385	4,274.27	2,708.22	56.42
Halifax 2	180000	889.18	844.72	97,385	4,274.27	2,708.22	56.42
Kentville	46000	228.68	217.25	24,887	1,099.28	696.52	14.51
Kingston	25000	123.31	117.14	13,526	592.75	375.57	7.82
Liverpool	12000	59.19	56.23	6,492	284.52	180.27	3.76
Meteghan	11000	54.26	51.54	5,951	260.81	165.25	3.44
New Glasgow	47000	232.27	220.66	25,428	1,116.53	707.44	14.74
Port Hawkesbury	21000	103.58	98.40	11,362	497.91	315.48	6.57
Shelburne	16000	79.37	75.40	8,656	381.52	241.73	5.04
Truro	49000	242.14	230.03	26,510	1,163.95	737.49	15.36
Yarmouth	28000	134.97	128.22	15,149	648.79	411.08	8.56
Windsor	40000	197.74	187.86	21,641	950.56	602.28	12.55
Total	**908000**	**4,484.00**	**4,259.80**	**491,251**	**21,554.59**	**13,657.18**	**284.52**

Table J-2
Collection Depot Requirements and Costs

	Approximate Population Served	Depot Area (sq ft)	Net Gaylord Containers	Annual Amortised Gaylord Cost	Labour Cost	Annual Building Operating Cost	Annual Equipment and Supplies	Total Cost ($)	Cost/kg ($)
Depot Location									
Amherst	33,000	1,000	55	2,640	8,171	7,250	3,227	21,288	0.137
Annapolis Royal	11,000	1,000	55	2,640	2,724	7,250	1,839	14,452	0.280
Antigonish	24,000	1,000	55	2,640	5,942	7,250	2,652	18,485	0.164
Baddeck	16,000	1,000	55	2,640	3,962	7,250	2,152	16,003	0.213
Bridgewater	48,000	1,000	55	2,640	11,885	7,250	4,160	25,935	0.115
Cape Breton RM	111,000	1,000	55	2,640	27,484	9,000	8,109	47,234	0.091
Digby	10,000	1,000	55	2,640	2,476	7,250	1,776	14,142	0.302
Halifax 1	180,000	1,000	55	2,640	44,569	9,000	12,434	68,643	0.081
Halifax 2	180,000	1,000	55	2,640	44,569	9,000	12,434	68,643	0.081
Kentville	46,000	1,000	55	2,640	11,390	7,250	4,052	25,332	0.117
Kingston	25,000	1,000	55	2,640	6,190	7,250	2,715	18,795	0.160
Liverpool	12,000	1,000	55	2,640	2,971	7,250	1,901	14,762	0.263
Meteghan	11,000	1,000	55	2,640	2,724	7,250	1,839	14,452	0.280
New Glasgow	47,000	1,000	55	2,640	11,637	7,250	4,098	25,625	0.116
Port Hawkesbury	21,000	1,000	55	2,640	5,200	7,250	2,465	17,554	0.178
Shelburne	16,000	1,000	55	2,640	3,962	7,250	2,157	16,009	0.212
Truro	49,000	1,000	55	2,640	12,133	7,250	4,223	26,245	0.114
Yarmouth	28,000	1,000	55	2,640	6,933	7,250	2,863	19,686	0.154
Windsor	40,000	1,000	55	2,640	9,904	7,250	3,660	23,454	0.125
Float			366	17,556				17,556	
Total	**908,000**		**1,411**	**67,716**	**224,824**	**143,000**	**78,755**	**514,295**	**0.121**

Table J-3
Option 1: Estimated Costs and Revenues

	Transportation to Noranda (Brampton) and ReCellular (Toronto)				Transportation to Noranda (Belledune).			
	Tonnes	**Loads**	**Rate/Load**	**Cost**	**Tonnes**	**Loads**	**Rate/Load**	**Cost**
Depot Location								
Amherst	112.56	6.25	1,796	11,218	42.99	2.80	995	2,785
Annapolis Royal	37.31	2.07	1,940	4,017	14.25	0.93	1,125	1,044
Antigonish	81.41	4.52	1,940	8,765	31.09	2.02	1,125	2,278
Baddeck	54.28	3.01	1,940	5,843	20.73	1.35	1,125	1,518
Bridgewater	163.14	9.05	1,940	17,563	62.31	4.06	1,125	4,564
Cape Breton RM	377.16	20.93	1,940	40,603	144.05	9.38	1,125	10,551
Digby	33.92	1.88	1,940	3,652	12.96	0.84	1,125	949
Halifax 1	611.53	33.94	1,796	60,949	233.56	15.21	995	15,130
Halifax 2	611.53	33.94	1,796	60,949	233.56	15.21	995	15,130
Kentville	157.28	8.73	1,940	16,932	60.07	3.91	1,125	4,400
Kingston	84.81	4.71	1,940	9,130	32.39	2.11	1,125	2,372
Liverpool	40.71	2.26	1,940	4,382	15.55	1.01	1,125	1,139
Meteghan	37.31	2.07	1,940	4,017	14.25	0.93	1,125	1,044
New Glasgow	159.75	8.86	1,940	17,198	61.01	3.97	1,125	4,469
Port Hawkesbury	71.24	3.95	1,940	7,669	27.21	1.77	1,125	1,993
Shelburne	54.58	3.03	1,940	5,876	20.85	1.36	1,125	1,527
Truro	166.53	9.24	1,796	16,597	63.60	4.14	995	4,120
Yarmouth	92.82	5.15	1,940	9,993	35.45	2.31	1,125	2,597
Windsor	136.00	7.55	1,940	14,641	51.94	3.38	1,125	3,804
Total	**3,083.88**	**171.13**		**319,994**	**1,177.82**	**76.68**		**81,414**
Sub-Total: Transportation								**401,408**
Preprocessing Cost					**Items**	**Cost/item**		**Cost**
Monitor/TV Preprocessing Quantity/Cost					133,000	2.27		**301,899**
Processing Cost	**Kilograms**	**Cost/kg**		**Cost**	**Tonnes**	**Cost/tonne**		**Cost**
	3,073,431	1.00		**3,073,431**	1,177.82	250.00		**294,454**
Sub-Total: Preprocessing and Processing								**3,669,784**
Total Cost								**4,131,404**
Cost/Kilogram								**0.97**

Nova Scotia Monitor and TV Preprocessing					
	Items	**Disassembly Time (Hours)**	**Labour Cost per hour ($)**	**Equipment Depreciation ($)**	**Cost ($)**
Monitors	72,200	0.183	11.5	11,880	163,825
TVs	60,800	0.183	11.5	10,120	138,074
Total					301,899
Cost/kg					0.11
Cost/Item					2.27

Table J-4
Option 2: Estimated Costs and Revenues

	Transportation to Noranda (Brampton) and ReCellular (Toronto)				Transportation to Hallstead (PA)			
	Tonnes	**Loads**	**Rate/Load**	**Cost**	**Tonnes**	**Loads**	**Rate/Load**	**Cost**
Depot Location								
Amherst	58.31	2.75	1,796	4,938	97.17	6.33	1,796	11,367
Annapolis Royal	19.33	0.91	1,940	1,768	32.21	2.10	1,940	4,070
Antigonish	42.18	1.99	1,940	3,858	70.28	4.58	1,940	8,881
Baddeck	28.12	1.33	1,940	2,572	46.86	3.05	1,940	5,920
Bridgewater	84.51	3.98	1,940	7,731	140.83	9.17	1,940	17,795
Cape Breton RM	195.38	9.21	1,940	17,872	325.59	21.21	1,940	41,141
Digby	17.57	0.83	1,940	1,607	29.28	1.91	1,940	3,700
Halifax 1	316.79	14.94	1,796	26,828	527.93	34.38	1,796	61,755
Halifax 2	316.79	14.94	1,796	26,828	527.93	34.38	1,796	61,755
Kentville	81.47	3.84	1,940	7,453	135.78	8.84	1,940	17,156
Kingston	43.93	2.07	1,940	4,019	73.21	4.77	1,940	9,251
Liverpool	21.09	0.99	1,940	1,929	35.14	2.29	1,940	4,440
Meteghan	19.33	0.91	1,940	1,768	32.21	2.10	1,940	4,070
New Glasgow	82.75	3.90	1,940	7,570	137.90	8.98	1,940	17,425
Port Hawkesbury	36.90	1.74	1,940	3,376	61.50	4.01	1,940	7,771
Shelburne	28.28	1.33	1,940	2,587	47.12	3.07	1,940	5,954
Truro	86.27	4.07	1,796	7,306	143.76	9.36	1,796	16,817
Yarmouth	48.09	2.27	1,940	4,399	80.13	5.22	1,940	10,125
Windsor	70.45	3.32	1,940	6,445	117.41	7.65	1,940	14,835
Total	**1,597.54**	**75.33**		**140,852**	**2,662.26**	**173.40**		**324,229**
Sub-Total: Transportation								**465,081**
Preprocessing Cost					**Items**	**Cost/Item**		**Cost**
Monitor/TV Preprocessing Quantity/Cost					000	000		**000**
Processing Cost	**Kilograms**	**Cost/kg**		**Cost**	**Items**	**Cost/Item**		**Cost**
	1,587,094	1.00		**1,587,094**	133,000	7.20		**957,600**
Sub-Total: Preprocessing and Processing								**2,544,694**
Total Cost								**3,079,537**
Cost/Kilogram								**0.72**

Table J-5: Option 3
Estimated Costs and Revenues

	Transportation to Noranda (Brampton) and ReCellular (Toronto)				Transportation to Hallstead (PA)			
	Tonnes	**Loads**	**Rate/Load**	**Cost**	**Tonnes**	**Loads**	**Rate/Load**	**Cost**
Depot Location								
Amherst	112.56	6.25	1,796	11,218	42.99	2.80	1,796	5,027
Annapolis Royal	37.31	2.07	1,940	4,017	14.25	0.93	1,940	1,800
Antigonish	81.41	4.52	1,940	8,765	31.09	2.02	1,940	3,927
Baddeck	54.28	3.01	1,940	5,843	20.73	1.35	1,940	2,618
Bridgewater	163.14	9.05	1,940	17,563	62.31	4.06	1,940	7,870
Cape Breton RM	377.16	20.93	1,940	40,603	144.05	9.38	1,940	18,194
Digby	33.92	1.88	1,940	3,652	12.96	0.84	1,940	1,636
Halifax 1	611.53	33.94	1,796	60,949	233.56	15.21	1,796	27,311
Halifax 2	611.53	33.94	1,796	60,949	233.56	15.21	1,796	27,311
Kentville	157.28	8.73	1,940	16,932	60.07	3.91	1,940	7,587
Kingston	84.81	4.71	1,940	9,130	32.39	2.11	1,940	4,091
Liverpool	40.71	2.26	1,940	4,382	15.55	1.01	1,940	1,964
Meteghan	37.31	2.07	1,940	4,017	14.25	0.93	1,940	1,800
New Glasgow	159.75	8.86	1,940	17,198	61.01	3.97	1,940	7,706
Port Hawkesbury	71.24	3.95	1,940	7,669	27.21	1.77	1,940	3,437
Shelburne	54.58	3.03	1,940	5,876	20.85	1.36	1,940	2,633
Truro	166.53	9.24	1,796	16,597	63.60	4.14	1,796	7,437
Yarmouth	92.82	5.15	1,940	9,993	35.45	2.31	1,940	4,478
Windsor	136.00	7.55	1,940	14,641	51.94	3.38	1,940	6,561
Total	**3,083.88**	**171.13**		**319,994.50**	**1,177.82**	**76.68**		**143,388**
Sub-Total: Transportation								**463,383**
Preprocessing Cost					**Items**	**Cost/Item**		**Cost**
Monitor/TV Preprocessing Quantity/Cost					133,000	2.27		**301,899**
Processing Cost	**Kilograms**	**Cost/kg**		**Cost**	**Items**	**Cost/Item**		
	3,073,431	1.00		**3,073,431**	133,000	3.60		**478,800**
Sub-Total: Preprocessing and Processing								**3,854,130**
Total Cost								**4,387,020**
Cost/Kilogram								**1.03**

Nova Scotia Monitor and TV Preprocessing

	Items	Disassembly Time (Hours)	Labour Cost per hour ($)	Equipment Depreciation ($)	Cost ($)
Monitors	72,200	0.183	11.5	11,880	163,825
TVs	60,800	0.183	11.5	10,120	138,074
Total					301,899
Cost/kg					**0.11**
Cost/Item					**2.27**

Table J-6
Option 4: Transportation for Disassembly

TRANSPORTATION FOR DISASSEMBLY:					
Collection Depot City/Town	**Annual Trailer Loads**	**Destination and Cost**			
		Cape Breton		**Halifax**	
		Cost/Load	**Total Cost**	**Cost/Load**	**Total Cost**
Amherst	10.39			300	3,116
Annapolis Royal	3.44			300	1,033
Antigonish	7.51			300	2,253
Baddeck	5.01	300	1,502		0
Bridgewater	15.05			300	4,515
Cape Breton RM	34.80				0
Digby	3.13			300	939
Halifax 1	56.42			150	8,463
Halifax 2	56.42				0
Kentville	14.51			300	4,353
Kingston	7.82			300	2,347
Liverpool	3.76			300	1,127
Meteghan	3.44			475	1,635
New Glasgow	14.74			300	4,422
Port Hawkesbury	6.57	300	1,972		0
Shelburne	5.04			300	1,511
Truro	15.36			300	4,609
Yarmouth	8.56			475	4,068
Windsor	12.55			300	3,764
Total			**3,474**		**48,156**

Note: Disassembly centres assumed to be located in shaded cities. Two depots are assumed to be located in Halifax, and one of these depots is assumed to be located at the disassembly facility.

A disassembly facility in Cape Breton Regional Municipality is assumed to receive EOL electronic products from collection depots in Baddeck and Port Hawkesbury as well as materials delivered to a collection depot in Cape Breton RM located at the disassembly facility.

A disassembly facility in Halifax is assumed to receive EOL electronic products from collection depots in Amherst, ,Annapolis Royal, Antigonish, Bridgewater, Digby, Halifax, Kentville, Kingston, Liverpool, Meteghan, New Glasgow, Shelburne, Truro, Yarmouth, Windsor as well as materials delivered to a second collection depot in Halifax located at the disassembly facility.

Table J-7: Option 4 - Design Basis For Disassembly Facilities in Nova Scotia

Location	Percentage of Total Gaylords in Province	Annual Gaylords in Catchment	Storage Capacity: Delivery and Product (Sq Ft)	Number of Labourers	Supervision	Managers	Office Support Staff	Floor staff	Work Station Space (sq ft)	Logistics Space (sq ft)	Office	Lunch Room/ Wash Room (sq ft)	Total Area (Sq Ft)
Cape Breton RM	16.30	2,226.12	2,080	10	0	1	1	3	988	6,438	100	400	10,005
Halifax	83.70	11,431.06	8,793	51	4	1	3	7	5,071	27,394	500	800	42,558

Table J-8: Option 4 - Equipment Basis For Disassembly Facilities in Nova Scotia

	Cape Breton RM				Halifax			
	Number	Unit Price	Total	Annual Depreciation	Number	Unit Price	Total	Annual Depreciation
Fork Lift Truck	3	30,000	90,000	9,000	7	30,000	210,000	21,000
Baler	1	100,000	100,000	10,000	1	100,000	100,000	10,000
Work Stations	10	5,000	50,000	7,143	51	5,000	255,000	36,429
Hand Tools	13	500	6,500	2,167	56	500	28,000	9,333
Computer	1	2,000	2,000	500	5	2,000	10,000	2,500
Office Furnishings	1	2,000	2,000	286	5	2,000	10,000	1,429
Miscellaneous	1	LS	10,000	1,429	1	LS	25,000	3,571
Installation			37,500	5,357			191,250	27,321
Total			**298,000**	**35,881**			**829,250**	**111,583**

Table J-9: Option 4 - Cost Estimates for Disassembly Facilities and Associated Transport in Nova Scotia

Location	Staff Cost	Building Operation/ Maintenance	Equipment Costs - Capital	Equipment Cost - Operations	Equipment Depreciation	Haulage Cost To Disassembly	Haulage Cost to Markets	Stereo/Phones Haul and Processing Cost	Waste Management Cost	Materials Revenue	Total Cost	Kilograms Managed	Cost/Kg
Cape Breton RM	376,629	90,045	298,000	13,500	35,881	3,474	67,564	40,592	1,285	100,122	525,363	694,347	0.76
Halifax	1,576,200	383,018	829,250	31,500	111,583	48,156	326,821	206,837	6,597	514,125	2,159,706	3,565,453	0.61
											2,685,069	**4,259,800**	**0.63**

Table J-10: Option 4 - Summary of Net Costs

	Collection Cost	Disassembly Facility and Associated Transport Cost	Total Annual Cost	Kilograms of EOL Electronic Product	Cost/Kg
Cape Breton RM	83,653	525,363	609,015	694,347	0.88
Halifax	430,643	2,159,706	2,590,349	3,565,453	0.73
	514,295	**2,685,069**	**3,199,364**	**4,259,800**	**0.75**

Table J-11: Option 5 - Costs

Total Regional Processing Cost		Provincial Share of Regional Processing Cost		Transportation from Collection Depots		Collection Depot Cost	Total Cost		Cost/Kg	
High	Low	High	Low	High	Low		High	Low	High	Low
10,716,781	7,501,754	4,259,796	2,981,860	239,049	121,128	514,295	5,013,140	3,617,284	1.18	0.85

Table J-12: Investment Cost Data for Option 4 and Option 5

Option 4: Disassembly at Major Centres						Option 5: Regional Processing Facility						
Location	Floor Area (sq. ft.)	Construction Cost/ Sq. Ft	Gaylords Cost	Equipment Cost	Total Estimated Cost	Floor Area (Sq ft)	Construction Cost/sq ft	Gaylords Cost	Mechanised Processing Equipment Cost	Disassembly and Materials Handling Equipment	Total Estimated Cost	Provincial Share of Total Cost
Cape Breton RM	10,005	70	55,189	298,000	1,053,540							
Halifax	42,558	70	283,391	829,250	4,091,668	80,000	70	980,100	5,000,000	450,000	12,030,100	4,781,825
Total			**338,580**		**5,145,208**							

Notes:

1. Estimated investment cost excludes land costs
2. Provincial share of Option 5 calculated on basis of proportion of total regional tonnes collected attributable to each province

Table J-13: Cost Per EOL Electronic Product Item

	Percent by Weight	Number Collected	Option 1	Option 2	Option 3	Option 4	Option 5 Low	Option 5 High
Total Cost			4,645,699	3,593,832	4,901,316	3,199,364	3,617,284	5,013,141
Cell Phones	0.27	68,400.00	0.18	0.14	0.19	0.12	0.14	0.20
Telephones	1.23	50,350.00	1.13	0.88	1.20	0.78	0.88	1.22
Stereos	3.76	59,850.00	2.92	2.26	3.08	2.01	2.27	3.15
Computers	18.20	63,650.00	13.28	10.28	14.01	9.15	10.34	14.33
Monitors	24.00	72,200.00	15.44	11.95	16.29	10.64	12.02	16.67
Peripherals	15.74	120,650.00	6.06	4.69	6.40	4.18	4.72	6.54
TVs	36.80	60,800.00	28.12	21.76	29.67	19.37	21.90	30.35

Table J-14: Job Creation (person years)

Collection	Option 1		Option 2	Option 3		Option 4			Option 5
	Disassembly	Transport		Disassembly	Transport	Transport: Depot To Disassembly	Disassembly	Transport To Market	Transport: Depot to Processing
9.18	12.17	2.28	2.86	12.17	2.85	0.19	80.58	2.13	0.71

Notes:
1. Table shows estimated person years of employment per calendar year
2. In addition, Option 5 is projected to result in the creation of 51.51 jobs at a centralised processing facility and in transportation of materials to end-use markets. These jobs would be located in the province in which the centralised facility was located.

Table J-15: Option 4: Comparison of Attribution of Option 4 Costs to EOL Items and to New Sales Items

	Cost/ EOL Item ($)	2005			2006			2007		
		EOL Units (000s)	Units Sold (000)s	EOL Cost/ Unit Sold ($)	EOL Units (000s)	Units Sold (000)s	EOL Cost/ Unit Sold ($)	EOL Units (000s)	Units Sold (000)s	EOL Cost/ Unit Sold ($)
Cell Phones	0.12	72	78	0.11	ND	ND	ND	ND	ND	ND
Telephones	0.76	53	39	0.97	ND	ND	ND	ND	ND	ND
Stereos	1.96	63	72	1.63	ND	ND	ND	ND	ND	ND
Computers	8.94	67	86	6.60	66,069	89,440	6.60	67,243	89,382	6.72
Monitors	10.39	76	97	7.71	74,944	101,067	7.70	78,073	101,001	8.03
Peripherals	4.08	127	142	3.47	125,235	147,576	3.46	128,573	166,652	3.15
TVs	18.92	64	73	15.83	ND	ND	ND	ND	ND	ND

Note. Sources of 2005 sales data: Computers and televisions – EPSC; cell phones, telephones and stereos – Electro-Federation Canada; peripherals estimated based on printer sales data provided by EPSC adjusted to also include scanners and keyboards. Source of 2006 and 2007 sales data: Computers – EPSC; monitors and peripherals sales data estimated.

Comments Received from Nova Scotia Resource Recovery Fund Board

An additional collection depot is suggested for Inverness, 4 additional collection depots are suggested for HRM and 2 additional collection depots for CBRM. RRFB believes an average collection depot floor area of area of 600 square feet is required and that gaylord container numbers can be reduced.

Regarding Options 1, 2, And 3, transportation rates will be based on the appropriate rates quoted at the time of program implementation; these may also include consideration of rail transport.

Regarding Option 4, RRFB considers that a third disassembly facility located in Bridgewater may be desirable. This would reduce transportation costs.

Prince Edward Island

Table J-1
Collection Depot Data

	Approximate Population Served	Quantity of EOL Electronics Generated (t)	Quantity of EOL Electronics Collected (t)	Number of EOL Electonic Items Collected	Volume of EOL Electronics (m^3)	Gross Number of Gaylord Containers	Annual Trailer loads
Depot Location							
Alberton	22000	104.48	99.26	11,307	577.59	318.23	6.63
Charlottetown	72000	341.85	324.75	37,006	1,889.74	1,041.18	21.69
Montague	18000	85.45	81.17	9,252	472.35	260.25	5.42
Summerside	23000	109.23	103.77	11,821	603.81	332.68	6.93
Total	**135000**	**641.00**	**608.95**	**69,386**	**3,543.48**	**1,952.33**	**40.67**

Table J-2
Collection Depot Requirements and Costs

	Approximate Population Served	Depot Area (sq ft)	Net Gaylord Containers	Annual Amortised Gaylord Cost	Labour Cost	Annual Building Operating Cost	Annual Equipment and Supplies	Total Cost ($)	Cost/kg ($)
Depot Location									
Alberton	22,000	1,000	55	2,640	5,447	7,250	2,476	17,813	0.179
Charlottetown	72,000	1,000	55	2,640	17,827	9,000	5,488	34,956	0.108
Montague	18,000	1,000	55	2,640	4,457	7,250	2,234	16,581	0.204
Summerside	23,000	1,000	55	2,640	5,695	7,250	2,536	18,121	0.175
Float			*77*	*3,696*				3,696	
Total	**135,000**	**1,000**	**297**	**14,256**	**33,427**	**30,750**	**12,735**	**91,167**	0.150

Table J-3: Option 1
Estimated Costs and Revenues

	Transportation to Noranda (Brampton) and ReCellular (Toronto)				Transportation to Noranda (Belledune).			
	Tonnes	**Loads**	**Rate/Load**	**Cost**	**Tonnes**	**Loads**	**Rate/Load**	**Cost**
Depot Location								
Alberton	71.58	3.97	1,953	7,758	26.99	1.76	1364	2397
Charlottetown	234.20	13.00	1,953	25,382	88.31	5.75	1364	7842
Montague	58.54	3.25	1,953	6,344	22.07	1.44	1364	1960
Summerside	74.83	4.15	1,953	8,110	28.22	1.84	1364	2506
Total	**439.16**	**24.37**		**47,595**	**165.58**	**10.78**		**14705**
Sub-Total: Transportation								**62300**
Preprocessing Cost					**Items**	**Cost/Item**		**Cost**
Monitor/TV Preprocessing Quantity/Cost					19,000	2.27		**43,116**
Processing Cost	**Kilograms**	**Cost/kg**		**Cost**	**Tonnes**	**Cost/tonne**		**Cost**
	437,261	1.00		**437,261**	165.58	250.00		**41,396**
Sub-Total: Preprocessing and Processing								**521,772**
Total Cost								**593,417**
Cost/Kilogram								**0.98**

Prince Edward Island Monitor and TV Preprocessing

	Items	Disassembly Time (Hours)	Labour Cost per hour ($)	Equipment Depreciation ($)	Cost ($)
Monitors	10,450	0.183	11.5	1,690	23,682
TVs	8,550	0.183	11.5	1,440	19,433
Total					43,116
Cost/kg					**0.11**
Cost/Item					**2.27**

Table J-4: Option 2
Estimated Costs and Revenues

	Transportation to Noranda (Brampton) and ReCellular (Toronto)				Transportation to Hallstead (PA)			
	Tonnes	**Loads**	**Rate/Load**	**Cost**	**Tonnes**	**Loads**	**Rate/Load**	**Cost**
Depot Location								
Alberton	36.60	1.73	1,953	3,371	62.66	4.08	1,953	7,970
Charlottetown	119.75	5.65	1,953	11,028	205.00	13.35	1,953	26,077
Montague	29.93	1.41	1,953	2,756	51.24	3.34	1,953	6,518
Summerside	38.26	1.80	1,953	3,524	65.50	4.27	1,953	8,332
Total	**224.55**	**10.59**		**20,678**	**384.40**	**25.04**		**48,897**
Sub-Total: Transportation								**69,575**
Preprocessing Cost					**Items**	**Cost/Item**		**Cost**
Monitor/TV Preprocessing Quantity/Cost					000	000		**000**
Processing Cost	**Kilograms**	**Cost/kg**		**Cost**	**Items**	**Cost/Item**		**Cost**
	222,650	1.00		**222,650**	19,000	7.20		**136,800**
Sub-Total: Preprocessing and Processing								**359,450**
Total Cost								**439,462**
Cost/Kilogram								**0.73**

Table J-5: Option 3
Estimated Costs and Revenues

	Transportation to Noranda (Brampton) and ReCellular (Toronto)				Transportation to Hallstead (PA)			
	Tonnes	**Loads**	**Rate/Load**	**Cost**	**Tonnes**	**Loads**	**Rate/Load**	**Cost**
Prince Edward Island								
Alberton	71.58	3.97	1,953	7,758	26.99	1.76	1,953	3,432
Charlottetown	234.20	13.00	1,953	25,382	88.31	5.75	1,953	11,228
Montague	58.54	3.25	1,953	6,344	22.07	1.44	1,953	2,807
Summerside	74.83	4.15	1,953	8,110	28.22	1.84	1,953	3,588
Total	**439.16**	**24.37**		**47,595**	**165.58**	**10.78**		**21,055**
Sub-Total: Transportation								**68,650**
Preprocessing Cost					**Items**	**Cost/Item**		
Monitor/TV Preprocessing Quantity/Cost					19,000	2.27		**43,116**
Processing Cost	**Kilograms**	**Cost/kg**		**Cost**	**Items**	**Cost/Item**		
	437,261	1.00		**437,261**	19,000	3.60		**68,400**
Sub-Total: Preprocessing and Processing								**548,776**
Total Cost								**627,723**
Cost/Kilogram								**1.04**

Prince Edward Island Monitor and TV Preprocessing

	Items	Disassembly Time (Hours)	Labour Cost per hour ($)	Equipment Depreciation ($)	Cost ($)
Monitors	10,450	0.183	11.5	1,690	23,682
TVs	8,550	0.183	11.5	1,440	19,433
Total					43,116
Cost/kg					**0.11**
Cost/Item					**2.27**

Table J-6
Option 4 – Transportation for Disassembly

TRANSPORTATION FOR DISASSEMBLY:			
Collection Depot City/Town	**Annual Trailer Loads**	**Destination and Cost**	
		Charlottetown	
		Cost/Load	**Total Cost**
Alberton	6.63	300.00	1,989
Charlottetown	21.69		0.00
Montague	5.42	300.00	1,627
Summerside	6.93	300.00	2,079
Total			**5,695**

All collection depots in Prince Edward Island are assumed to feed into a disassembly facility in Charlottetown.

Table J-7: Option 4 - Design Basis For Disassembly Facilities in Prince Edward Island

Location	Percentage of Total Gaylords in Province	Annual Gaylords in Catchment	Sorage Capacity: Delivery and Product (Sq Ft)	Number of Labourers	Supervision	Managers	Office Support Staff	Floor staff	Work Station Space (Sq ft)	Space to Move (Sq ft)	Office	Lunch Room/ Wash Room (Sq ft)	Total Area (Sq Ft)
Charlottetown	100.00	1,952.33	2,080	8	0	1	1	2	836	6,407	100	400	9,824

Table J-8: Option 4 - Equipment Basis For Disassembly Facilities in Prince Edward Island

	Charlottetown			
	Number	Unit Price	Total	Annual Depreciation
Fork Lift Truck	2	30,000	60,000	6,000
Baler	1	100,000	100,000	10,000
Work Stations	8	5,000	40,000	5,714
Hand Tools	10	500	5,000	1,667
Computer	1	2,000	2,000	500
Office Furnishings	1	2,000	2,000	286
Miscellaneous	1	LS	10,000	1,429
Installation			30,000	4,286
Total			**249,000**	**29,881**

Table J-9: Option 4 - Cost Estimates for Disassembly Facilities and Associated Transportation in Prince Edward Island

Location	Staff Cost	Building Operation and Maintenance	Equipment Costs – Capital	Equipment Cost - Operations	Equipment Depreciation	Haulage Cost To Disassembly Facility	Haulage Cost to Markets	Stereo/Phones Haul and Processing Cost	Waste Management Cost	Materials Revenue	Total Cost	Kilograms Managed	Cost/Kg
Charlottetown	318,889	88,414	249,000	9,000	29,881	5,695	62,266	36,055	1,126	87,005	461,004	608,950	0.76
											461,004	**608,950**	**0.76**

Table J-10: Option 4 - Summary of Net Costs

	Collection Cost	Disassembly Facility and Associated Transport Cost	Total Annual Cost	Kilograms of EOL Electronic Product	Cost/Kg
Charlottetown	91,167	461,004	552,171	608,950	0.91
	91,167	**461,004**	**552,171**	**608,950**	**0.91**

Table J-11: Option 5 - Costs

Total Regional Processing Cost		Provincial Share of Regional Processing Cost		Transportation from Collection Depots		Collection Depot Cost	Total Cost		Cost/Kg	Processing Cost
High	Low	High	Low	High	Low		High	Low	High	Low
10,716,781	7,501,754	608,949	426,265	35,371	19,201	91,167	735,487	536,633	1.21	0.88

Table J-12:Investment Cost Data for Option 4 and Option 5

Option 4: Disassembly at Major Centres						Option 5: Regional Processing Facility						
Location	Floor Area (sq. ft.)	Construction Cost/ Sq. Ft	Gaylords Cost	Equipment Cost	Total Estimated Cost	Floor Area (Sq ft)	Construction Cost/sq ft	Gaylords Cost	Mechanised Processing Equipment Cost	Disassembly and Materials Handling Equipment	Total Estimated Cost	Provincial Share of Total Cost
Charlottetown	9,824	70	71,280	249,000	1,007,944	80,000	70	980,100	5,000,000	450,000	12,030,100	683,575
Total			**71,280**		1,007,944							

Notes:
1. Estimated investment cost excludes land costs
2. Provincial share of Option 5 calculated on basis of proportion of total regional tonnes collected attributable to each province

Table J-13: Cost Per EOL Electronic Product Item

	Percent by Weight	Number Collected	Option 1	Option 2	Option 3	Option 4	Option 5 Low	Option 5 High
Total Cost			684,584	530,629	718,891	552,171	536,633	735,487
Cell Phones	0.27	9,500.00	0.19	0.15	0.20	0.16	0.15	0.21
Telephones	1.23	6,650.00	1.26	0.98	1.33	1.02	0.99	1.36
Stereos	3.76	8,550.00	3.01	2.33	3.16	2.43	2.36	3.23
Computers	18.20	8,550.00	14.57	11.29	15.30	11.75	11.42	15.65
Monitors	24.00	10,450.00	15.72	12.19	16.51	12.68	12.33	16.89
Peripherals	15.74	17,100.00	6.30	4.89	6.62	5.08	4.94	6.77
TVs	36.80	8,550.00	29.47	22.84	30.95	23.77	23.10	31.66

Table J-14: Job Creation (person years)

Collection	Option 1		Option 2	Option 3		Option 4			Option 5
	Disassembly	Transport		Disassembly	Transport	Transport: Depot To Disassembly	Disassembly	Transport To Market	Transport: Depot to Processing
1.36	1.74	0.28	0.37	1.74	0.36	0.01	12.36	0.26	0.10

Notes:
1. Table shows estimated person years of employment per calendar year
2. In addition, Option 5 is projected to result in the creation of 51.51 jobs at a centralised processing facility and transportation of materials to end use markets. These jobs would be located in the province in which the centralised facility was located.

Table J-15: Option 4: Comparison of Attribution of Option 4 Costs to EOL Items and to New Sales Items

	Cost/ EOL Item ($)	2005			2006			2007		
		EOL Units (000s)	Units Sold (000)s	EOL Cost/ Unit Sold ($)	EOL Units (000s)	Units Sold (000)s	EOL Cost/ Unit Sold ($)	EOL Units (000s)	Units Sold (000)s	EOL Cost/ Unit Sold ($)
Cell Phones	0.15	10	12	0.12	ND	ND	ND	ND	ND	ND
Telephones	1.00	7	6	1.14	ND	ND	ND	ND	ND	ND
Stereos	2.37	9	11	1.91	ND	ND	ND	ND	ND	ND
Computers	11.50	9	13	7.76	8,875	13,159	7.75	9,393	13,150	8.21
Monitors	12.41	11	14	9.05	10,847	14,869	9.05	10,970	14,859	9.16
Peripherals	4.97	18	21	4.08	17,750	21,712	4.07	17,927	21,697	4.11
TVs	23.25	9	11	18.59	ND	ND	ND	ND	ND	ND

Note. Sources of 2005 sales data: Computers and televisions – EPSC; cell phones, telephones and stereos – Electro-Federation Canada; peripherals estimated based on printer sales data provided by EPSC adjusted to also include scanners and keyboards. Source of 2006 and 2007 sales data: Computers – EPSC; monitors and peripherals sales data estimated.

Comments Received from Island Waste Management Corporation

Consideration may be given in the implementation of the EOL electronics product management program to the collection of EOL electronic products using Waste Waste Drop Off Centres located in Brockton, Wellington Centre, New London, Charlottetown, Murray River and Dingwells Mills.