



Study on the Operations and Effectiveness of the Major Appliance Collection and Recycling System in British Columbia

For the **Major Appliance Recycling Roundtable**

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EXECUTIVE SUMMARY

Background

Major household appliances are regulated under British Columbia’s Recycling Regulation, under which “Producers” of the regulated products (i.e. manufacturers, retailers & first importers) are obligated to develop, implement and operate a product stewardship program that manages the recycling of the regulated products at their end-of-life.

The Association of Home Appliance Manufacturers (Canada) (AHAM Canada) and the Retail Council of Canada (RCC) developed a stewardship plan for major residential appliances and received the approval of the British Columbia Ministry of Environment on June 29, 2012. To manage the implementation and operation of the stewardship plan, AHAM Canada and RCC incorporated a not-for-profit stewardship agency known as the Major Appliance Recycling Roundtable (MARR) which is governed by a Board of Directors comprised of major appliance manufacturers and retailers. Product Care Association has been contracted by MARR to manage the MARR stewardship program in British Columbia (BC).

The MARR stewardship program includes major household appliances (‘major appliances’) powered either by 120 volt or 240 volt input power that have been designed for use in residential homes, including those that use natural gas or propane for heating purposes. Appliances used in or sold for industrial, commercial and/or institutional (IC&I) applications that have the same essential design characteristics as major household appliances, as defined above, are also included.

Major appliances in the MARR program include the following 17 categories:

1. Full-size Refrigerators, Wine Coolers and Beverage Centres
2. Compact Refrigerators, Wine Coolers and Beverage Centres
3. Freezers
4. Room Air Conditioners
5. Portable Air Conditioners
6. Dehumidifiers
7. Clothes Washers
8. Clothes Dryers
9. Ranges
10. Range Hoods and Downdrafts
11. Built-in Ovens
12. Built-in and Over the Range Microwave Ovens
13. Surface Cooking Units
14. Dishwashers
15. Food Waste Disposers
16. Trash Compactors
17. Electric Water Dispensers

The MARR plan is focused on enhancing the performance and transparency of the existing market-driven system of collecting and recycling major household appliances in BC. This aspect of the program makes the MARR plan for the recycling of major household appliances unique in BC. The focus of the MARR plan is on the improvement of the existing market-driven collection, transportation and recycling system and includes a commitment to conduct a study on the operation and performance of this existing recycling system. This study was commissioned in the fall of 2013 and this report provides the results of that study.

The existing major appliance recycling system has been operating in BC for decades, collecting and recycling major appliances. The major appliances are collected by a variety of collectors, including retailers, local governments, utilities and private companies who channel those products through to processors. Once there, the appliances, along with other forms of scrap metal, are processed to recover and recycle metal components which are sold to end markets such as steel mills.

Objectives of the study were to:

1. Identify the parties involved in collecting major appliances in BC;
2. Define the specific operating characteristics and material flows within the BC system;
3. Summarize the processing practices and technologies used within the system;
4. Quantify the overall collection and diversion performance of the existing system; and
5. Determine how often and at what levels fees are charged to end users for collection.

The study involved extensive surveying and interviews of stakeholders involved in major appliance collection and recycling, including:

1. A survey of 125 retailers of major appliances and in-depth interviews with 22 retailers;
2. Interviews with all Regional Districts involved in solid waste management and all 22 municipalities that offer their own major appliance collection service;
3. Interviews with 99 private collection sites, 5 peddlers and 4 refurbishing companies;
4. Interviews with the two utility bounty programs for refrigerators run by the two main electric utilities in BC;
5. Interviews with 17 property managers and property management associations to identify practices at multi-family buildings;
6. Interviews with 4 processors; and
7. Interviews with industry leaders in the scrap metal field (including the Canadian Association of Recycling Industries, the Automotive Recyclers Environmental Association and brokers).

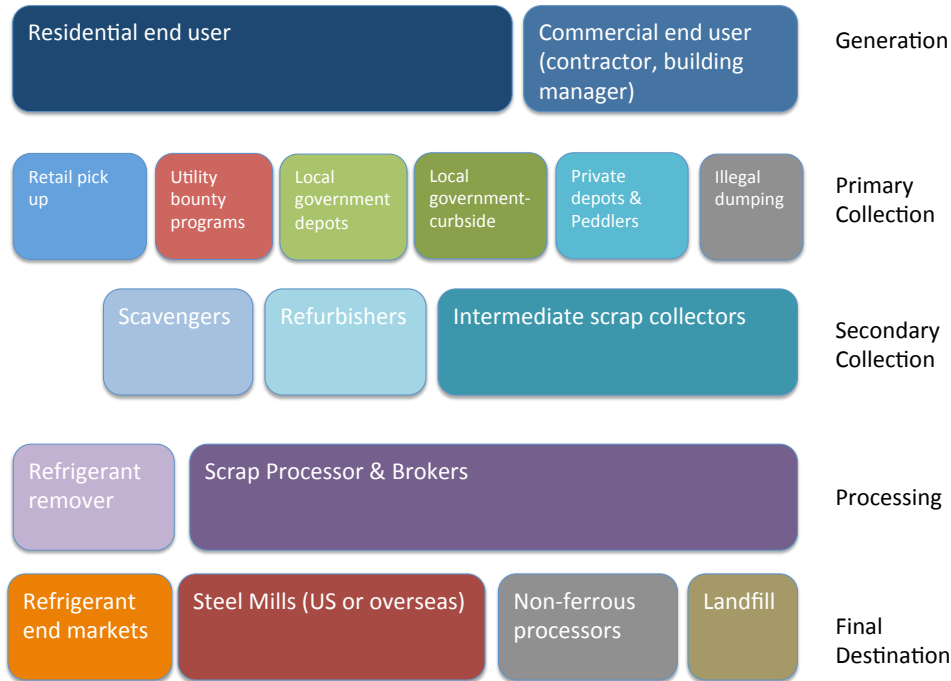
Chain of Custody

The infrastructure for managing end-of-life major appliances in BC consists of a number of different inter-related players:

- Major appliance owners (residential and commercial owners of household appliances);
- Collectors and collection sites (local government, private sites, retailers, not-for-profit, etc.);
- Some curbside and household level collection services; and
- Processing sites and end markets.

In general, major appliances at end-of-life flow down through the levels of various organizations shown in Figure ES-1 but not every appliance will flow through each level as some may follow a more direct path to the processor and some may flow through multiple parties on one level.

Figure ES-1: Chain of Custody for End-of-Life Major Appliances in BC

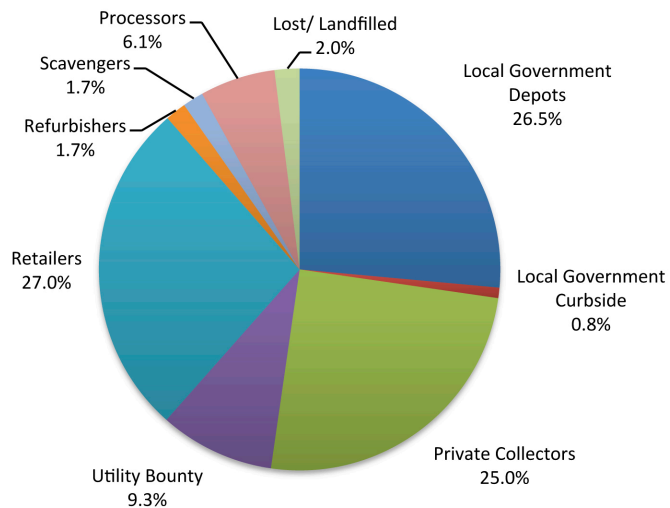


Collection of Major Appliances

Collection services, in the form of drop off sites and pick up services, are provided by a range of collectors including governments, private companies and not-for-profit organizations.

Figure ES-2 shows both forms of collection services (drop off and pick up services) and allocates the proportion of appliances received from generators to each type of collector. About 78% of all major appliances are collected by three players: retailers (27%), local governments (27%) and private collectors (25%).

Figure ES-2 Collectors of Major Appliances by Share Collected



Collection Site Accessibility and Fees

A Geographic Information System analysis of the collection sites in BC that accept all categories of major appliances showed that 98.5% of the BC population have access to a drop off location within the driving times set by the Stewardship Agencies of BC (30 minutes for urban communities and 45 minutes for rural communities). When the accessibility to only free drop off locations was analysed, 93.6% of the BC population was found to have access to collection sites for all major appliances that charge no fees for drop off, as shown in Table ES-1.

Table ES-1: Accessibility Analysis Results for Entire BC Population and for Communities of Over 4,000 People

Facility Category	Number of Collection Sites	Whole BC Population		SABC Standard (communities with a population over 4,000)	
		Population Covered	Percent Covered	Population Covered	Percent Covered
No Fee to Drop Off	110	4,119,076	93.6%	3,874,178	97.0%
All Sites	251	4,334,380	98.5%	3,979,391	99.6%

Across BC there are 305 identified sites where consumers can drop off some or all major appliance products for recycling. Of these:

- 186 (61%) are local government sites (both regional district and municipal);
- 102 (33%) are private and not-for-profit collectors; and
- 17 (6%) are processing companies.

Many private collection sites will pay the consumer for the major appliances they receive. The amount paid will generally depend on market prices for ferrous metal.

In addition to drop off accessibility, pick up services are also available to most generators in BC. Pick up services collect from the generator rather than requiring the generator to transport the appliance to a drop off location, and are offered by a number of stakeholders:

- 84% of retailers surveyed offered take-back services when a new appliance is delivered;
- 14 local BC governments offer either a pick-up day or curbside service on demand;
- Bounty programs offered by BC Hydro and Fortis BC provide a rebate to consumers; and
- Most tenant-occupied multi-family buildings provide removal of an old appliance at end-of-life.

The application of fees to drop off major appliances varies significantly between collectors, but generally it is more likely that a local government collection site will charge a fee than a private site, and sites will either charge for all appliances, or for only refrigerant-containing appliances.

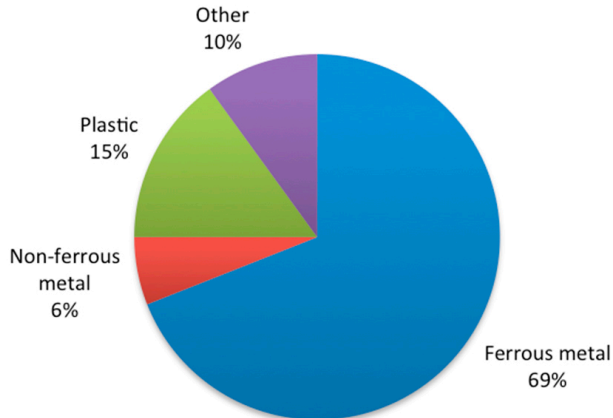
For sites that do charge fees to drop off, the fees charged ranged significantly from site to site between:

- \$5 to \$30 on a per unit basis; and
- \$10 to \$73 per tonne on a weight basis.

Composition of Appliances

The study estimates that the composition of the average major household appliance reaching end-of-life in 2012 is 69% ferrous metal, 6% non-ferrous metal and the remainder comprised of plastic and other materials (see Figure ES-3). Composition varies by appliance, and some appliances such as freezers and clothes dryers have a very high ferrous metal content, whereas other appliances such as refrigerators have a relatively low ferrous metal content.

Figure ES-3: Composition of Appliances Available to Collect by Weight



Processing & End Markets

The study looked at the systems and procedures for decommissioning major appliances. Decommissioning is the process for removing substances of concern and preparing the major appliances for processing. The study also examined the prevalence of removing valuable materials or parts prior to transporting the collected appliances. In general, refrigerant is extracted responsibly but there remain some gaps. Though the occurrence of some substances of concern in major appliances is very low, very few collectors or processors are aware of other substances of concern (e.g. mercury switches) or have a system to screen and remove them.

Almost all appliances in BC flow to two Lower Mainland-based metal shredders. The shredding process separates the scrap metal into ferrous metal, non-ferrous metals and residue. There is a 98% recovery of metals for recycling in the shredding process. The residue, composed of plastic, insulation, rubber and other non-metal components, is landfilled.

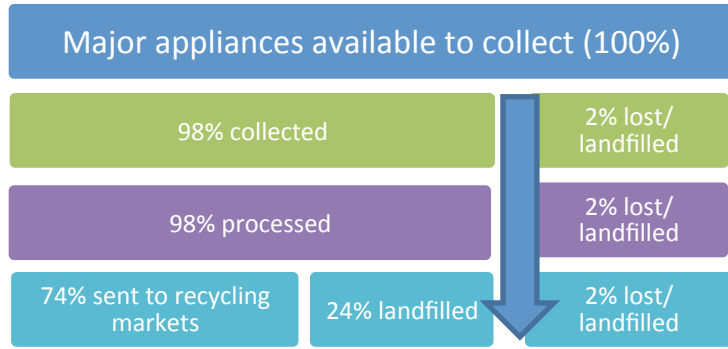
At present, ferrous metal material is generally transported by sea to Asian markets directly or via Washington State. Non-ferrous metal is generally transported via truck or rail into the North American market.

System Performance

To evaluate the system performance, a Lifespan Model was developed using historical sales data for each type of major appliance. The model output indicates that there were 594,000 units (36,248 tonnes) available to collect in 2012, the reference year for the study.

Using the information obtained from the surveys and interviews of collectors of major appliances, 35,699 tonnes are estimated to have been collected in 2012.

Figure ES-4 Flow of Discarded Major Appliances in BC



This represents a 98% capture rate, which is the amount collected in a given year divided by the amount available to collect in that same year. The remaining 2% of major appliances were estimated to have been illegally dumped or landfilled.

The collected appliances are processed into recyclable (75% of the weight of the appliances) and non-recyclable fractions (25% of the weight of the appliances). To establish the recycling rate, the amount of

materials recycled was divided by the amount of materials available to collect. Consequently, an estimated 26,775 tonnes, or 74% of the total weight of all major appliances available to collect in 2012 was ultimately recycled.

This value is also representative of the weight of major appliances recycled in 2013 as there were no significant changes in historic sales in the relevant years or collection habits over this short period of time that would greatly impact the recycling rate.

TABLE OF CONTENTS

1 MARR BACKGROUND 1

1.1 Description of MARR..... 1

1.2 MARR Stewardship Approach 1

1.3 MARR Program Products and Characteristics 1

2 STUDY BACKGROUND 2

2.1 Purpose of Study 2

2.2 Methodology..... 3

3 CHAIN OF CUSTODY 3

4 COLLECTION 6

4.1 Drop Off Locations 6

4.1.1 Local Government Drop Off Sites..... 6

4.1.2 Private and Not-for-profit Drop Off Collection Sites 7

4.1.3 Drop Off Sites Operated by Processors..... 7

4.2 Pick Up Services 7

4.2.1 Retail Delivery/Take-back Systems 8

4.2.2 Utility Bounty Programs 8

4.2.3 Local Government Curbside Collection Systems..... 8

4.2.4 Property Management Companies 8

4.2.5 Peddlers 9

5 CONSOLIDATION AND TRANSPORTATION..... 9

5.1 Consolidation 9

5.2 Transportation 10

6 COLLECTION SYSTEM ACCESSIBILITY AND FEES 11

6.1 Accessibility..... 11

6.1.1 Access to Collection – All Sites 12

6.1.2 Access to Collection – With or Without Fees 12

6.2 Collection Fees 15

6.2.1 Collection Fees for Pick Up Services..... 16

7 ESTIMATED AMOUNT AND COMPOSITION OF APPLIANCES AVAILABLE TO COLLECT IN BC..... 16

7.1 Amount of Appliances “Available to Collect” 16

7.1.1 Unit Sales Data and Assumptions 16

7.1.2 Unit Weight and Lifespan Data in Lifespan Model..... 17

7.1.3 “Available To Collect” Estimate..... 19

7.2 Composition of Appliances “Available to Collect” 21

8 DECOMMISSIONING 25

8.1 Current Systems for Refrigerant 25

8.1.1	Local Government Sites	25
8.1.2	Private and Not-for-profit Collection Sites.....	25
8.1.3	Retailers	25
8.1.4	Processors	26
8.1.5	Costs.....	26
8.1.6	Implications.....	26
8.2	Other Substances of Concern	26
8.3	Non-ferrous Metals.....	27
8.4	Usable Parts and Operating Units	27
9	PROCESSING	28
9.1	Processor Material Definitions.....	28
9.2	Processing	28
9.2.1	Material Recovery	29
10	END MARKETS	29
10.1	Role of Brokers.....	29
10.2	End Markets	29
10.3	Market Pricing.....	30
11	SYSTEM PERFORMANCE.....	31
11.1	Quantity of Appliances Collected.....	31
11.1.1	Methodology.....	31
11.1.2	Estimate of Quantity Collected	33
11.1.3	Estimated Share of Quantity Collected by Collector Type	35
11.2	Capture Rate	35
11.3	Recycling Rate	36
12	SUMMARY	37
13	BIBLIOGRAPHY.....	39
APPENDIX A	PRODUCT DEFINITIONS	41
APPENDIX B	MAP OF BC REGIONAL DISTRICTS	55
APPENDIX C	SOURCES OF MAJOR APPLIANCE UNIT SALES DATA USED IN LIFESPAN MODEL	56
APPENDIX D	REFRIGERANT OVERVIEW AND REGULATIONS	60
APPENDIX E	BACKGROUND ON OTHER SUBSTANCES OF CONCERN.....	62
APPENDIX F	DATA RELIABILITY	63

List of Figures

Figure 3-1: Chain of Custody for End-of-Life Major Appliances in BC..... 4

Figure 5-1: Frequency of Metal Shipments from Primary Collection Site..... 11

Figure 6-1: Major Appliance Collection Locations and Driving Times in BC..... 13

Figure 6-2: Major Appliance Collection Locations without Fees and Driving Times 14

Figure 7-1: Composition (by percentage weight) of MARR Products at End-of-life in BC in 2012..... 21

Figure 7-2: Estimated Composition of Major Appliances Available to Collect in BC in 2012 (by Weight) 24

Figure 10-1: Historic Steel and Aluminum Prices 30

Figure 11-1: Share of Major Appliances Collected by Type of Collector 35

Figure 11-2: Flow of Discarded Major Appliances in BC 36

List of Tables

Table 6-1: Accessibility Analysis Results for Entire BC Population and for Communities of Over 4,000 People 12

Table 6-2: Application of Fees at Collection Sites (not including pick up services)..... 15

Table 7-1: Proportion of BC to National Households 1971 to 2011..... 17

Table 7-2: Lifespan and Unit Weight Values for Major Appliances..... 18

Table 7-3: Estimated Number and Weight of Major Appliances Available to Collect in BC in 2012..... 19

Table 7-4: Measured Composition of Major Appliances Introduced Into the Market in 2005 (AHAM, 2005) 22

Table 7-5: Measured Composition of Major Appliances at End-of-life in 2005 (AHAM, 2005) 22

Table 7-6: Assumed Composition of MARR Appliances Available to Collect in BC for 2012..... 24

Table 11-1: Major Appliances as a Proportion of Scrap Metal at Local Government Sites 32

Table 11-2: Estimated Tonnes of Collected Major Appliances by Region..... 34

Table 11-3 Share of Total Capture Rate by Collector Type 36

Table 11-4: Flow of Major Appliances in BC (by tonne) 36

1 MARR BACKGROUND

1.1 *Description of MARR*

Major household appliances have been regulated under British Columbia's Recycling Regulation, under which "Producers" of the regulated products (i.e. manufacturers, retailers & first importers) are obligated to develop, implement and operate a product stewardship program that manages the recycling of the regulated products at their end-of-life. The regulation further requires that Producers set performance targets for their stewardship program and periodically report on the performance of their program against those targets.

The Association of Home Appliance Manufacturers (Canada) (AHAM Canada) and the Retail Council of Canada (RCC) have developed a stewardship plan for major residential appliances. This plan received the approval of the BC Ministry of Environment on June 29, 2012. To manage the implementation and operation of the stewardship plan, AHAM Canada and RCC incorporated a not-for-profit stewardship agency known as the Major Appliance Recycling Roundtable (MARR) which is governed by a Board of Directors comprised of major appliance manufacturers and retailers.

1.2 *MARR Stewardship Approach*

The MARR stewardship plan is the only approved stewardship plan for major household appliances in the province. The MARR plan is focused on enhancing the performance and transparency of the existing market-based system of collecting and recycling major household appliances in BC.

The MARR stewardship plan includes commitments to:

- Implement a recycling and processing standard and a processor certification and audit program to address the proper decommissioning in end-of-life major appliances;
- Work with collectors and recyclers to research and promote best practices to ensure on-going system performance and improvement;
- Create a branding and communications program to encourage market participation in the MARR processing standard;
- Conduct operational system studies on the operation and performance of the existing recycling system;
- Establish collection/diversion tracking and reporting systems to assess system performance over time; and
- Report annually to the BC Ministry of Environment on MARR's progress towards achieving the commitments outlined above.

Product Care Association has been contracted by MARR to manage the MARR stewardship plan in British Columbia.

1.3 *MARR Program Products and Characteristics*

The MARR stewardship program includes major household appliances ("major appliances") powered either by 120 volt or 240 volt input power that have been designed for use in residential homes, including those that use natural

gas or propane for heating purposes. Appliances used in or sold for industrial, commercial and/or institutional (IC&I) applications that have the same essential design characteristics as major household appliances, as defined above, are also included.

Major appliances in the MARR program include the following 17 categories. A full description of these categories can be found in Appendix A.

1. Full-size Refrigerators, Wine Coolers and Beverage Centres
2. Compact Refrigerators, Wine Coolers and Beverage Centres
3. Freezers
4. Room Air Conditioners
5. Portable Air Conditioners
6. Dehumidifiers
7. Clothes Washers
8. Clothes Dryers
9. Ranges
10. Range Hoods and Downdrafts
11. Built-in Ovens
12. Built-in and Over the Range Microwave Ovens
13. Surface Cooking Units
14. Dishwashers
15. Food Waste Disposers
16. Trash Compactors
17. Electric Water Dispensers

2 STUDY BACKGROUND

2.1 *Purpose of Study*

The MARR stewardship plan committed to a study on the operation and performance of the existing collection and recycling system for major household appliances in BC which has been operating in BC for decades collecting and recycling major appliances.

Objectives of the study were to:

1. Identify the parties involved in collecting major appliances in BC;
2. Define the specific operating characteristics and material flows within the BC system;
3. Summarize the processing practices and technologies used within the system;
4. Quantify the overall collection and diversion performance of the existing system; and
5. Determine how often and at what levels fees are charged to end users for collection.

2.2 Methodology

For this study, the project team undertook the following tasks:

1. Reviewed existing information including previous reports on major appliance recycling in Ontario, Canada and the United States, the stewardship plan and current and best practices;
2. Generated a list of collection sites using existing data from MARR, searches of directories, discussions with the Recycling Council of BC (RCBC), the Canadian Association of Recycling Industries (CARI), and existing collectors;
3. Created questionnaires to interview the various stakeholders;
4. Surveyed 125 retailers of major appliances and conducted in-depth interviews with 22 of those retailers. (This task was completed by MARR staff);
5. Interviewed all Regional Districts (28 for the purposes of waste management shown in a map in Appendix B) and any municipalities that offer their own major appliance collection service independent of their regional district (22);
6. Interviewed 99 private collection sites, 5 peddlers and 4 refurbishing companies;
7. Contacted an additional 223 private collection sites to confirm that they do not accept major appliances;
8. Interviewed the two utility bounty programs for refrigerators run by the two main electric utilities in BC;
9. Interviewed 17 property managers and property management associations to identify practices at multi-family buildings;
10. Interviewed and conducted site visits with 4 processors;
11. Interviewed industry leaders in the scrap metal field (including Canadian Association of Recycling Industries (CARI), the Automotive Recyclers Environmental Association (AREA) industry associations and brokers);
12. Generated a detailed list of collectors;
13. Identified access to recycling services through a Geographic Information Systems (GIS) analysis (This work was completed by Golder Associates and the results are discussed in Section 6);
14. Developed a Lifespan Model to estimate the amount of appliances entering end-of-life in the province annually (described in detail in Section 7.);
15. Analysed the data to quantify the amount of major appliances collected in the province and to understand the flow of appliances in the system. (An analysis of the quantity and flow of appliances by sector is provided in Section 11.);
16. Calculated a capture rate for major appliances in the province. (Details provided in Section 11.); and
17. Used composition data for major appliances and the outputs of the processing system to estimate the recycling rate. (Also provided in Section 11).

3 CHAIN OF CUSTODY

Major appliances, once they have reached the end of their product life, are often handled by a variety of organizations prior to being recycled. This section provides a brief overview of the types of organizations involved in the “chain of custody” for end-of-life major appliances.

Figure 3-1 illustrates the various levels of activities (generation, primary collection, secondary collection, processing and final destinations) and types of organizations involved in each of those activities. In general, end-of-life appliances “flow” from the generator through to primary and/or secondary collectors before reaching their final destination.

Figure 3-1: Chain of Custody for End-of-Life Major Appliances in BC



The following are brief descriptions of each type of the organization involved in the chain of custody. Sections 4, 5 and 9 provide specific details of how each organization currently contributes to managing end-of-life major appliances in BC.

Generators

“Generators” refers to the owners of major household appliances when they choose to dispose of their appliance. Generators include residents, as well as commercial users of household appliances such as managers of residential properties that are responsible for supplying major appliances to their tenants.

Primary Collection

“Primary collection” refers to the first receiver of a major appliance once it is removed from the generator’s custody. As shown in Figure 3-1, there are several types of organizations involved in primary collection in BC:

- **Retailers** may offer to pick up the used appliance with the delivery of a new appliance (residential or commercial). They may provide this service directly or hire another company to deliver the new appliance and remove the old one. These collectors are a major supplier of appliances to refurbishers. They may also take appliances to another form of primary collector, secondary collector or direct to a processor.

- **Utility bounty programs** are offered by two BC electrical utilities to their residential customers. To encourage residents to purchase more-energy efficient refrigerators, these programs pick up retired refrigerators at the household and deliver them to dismantlers who then ship them to processors.
- **Local government depots** generally accept major appliances from residents and may accept appliances from commercial generators.
- **Curbside collection by local governments** is not a common municipal service in BC, but a handful of local governments do provide a pickup service to single family households as part of their curbside collection service. Appliances picked up through these curbside programs may be taken to a local government depot, intermediate scrap collector or directly to a processor.
- **Private depots** include any private or not-for-profit sector organization that accepts major appliances from generators. They may include recycling depots, scrap metal yards and automotive junkyards.
- **Peddlers** are on-call waste collection businesses such as 1-800-GOT-JUNK. Peddlers provide pick up services to generators for unwanted goods or waste. Any end-of-life major appliances they collect are generally delivered to primary or secondary scrap metal collectors, or directly to processors.
- **Illegal dumping** has also been included at this level of activity but this method of major appliance disposal is used by a very small number of generators. Many illegally dumped appliances are recovered through clean-up activities and delivered to one of the collector organizations listed above. Some are never recovered.

Secondary Collection

Secondary collection refers to collectors that receive major appliances from primary collectors.

- **Refurbishers** are organizations involved in appliance reuse or the reuse of parts. They generally receive used major appliances from commercial generators or through retailers. The main goal of the refurbisher is to resell the unit into the second hand market, or at least use some of the parts for appliance repair. Parts or appliances that cannot be reused are taken to a primary or secondary collector, or to a processor.
- **Intermediate scrap collectors** receive scrap metal from primary collectors. This scrap metal includes major appliances. They may also operate as a primary collector and receive major appliances directly from generators. These collectors sell their metal to processors.
- **Scavengers** are individuals that take appliances or appliance parts without permission. Scavengers do not play a significant role in the major appliance recycling system in BC, however scavenging has been reported in areas where curbside collection of large appliances is offered (appliances are removed by scavengers rather than the collections service) and when metal market prices are high. It should be noted that scavenged appliances are generally sold back into the recycling system through a primary or secondary collector, and therefore those appliances would then enter into the regular chain of custody.

Processors

Processors are defined in this study as companies that either have shredders and are able to ship direct to end markets, or companies with large-scale balers on site that allows them to, when market conditions are appropriate, sell the baled metal to an off-shore processor.

- **Scrap processors** shred appliances along with other scrap metal products such as decommissioned automobiles to recover the ferrous and non-ferrous metals, which are then sold to end markets such as

steel mills. Shredder residue (non-recyclable material contained in large appliances such as plastic and insulation) is sent to landfill.

- **Refrigerant removal** generally occurs at the first location to receive the appliance (i.e. at the primary collection site). It is considered to be a processing type of activity because the refrigerant is removed by a technician and subsequently sent for recycling or destruction.

Final Destination

After processing, the marketable materials (ferrous metal, non-ferrous metals and refrigerant) are sent to end markets that will recycle these materials into new products. The other components of end-of-life major appliances that do not have a recycling market are included in the shredder residue that is sent to landfill. The markets and the landfill represent the end of the chain of custody.

4 COLLECTION

Collection services, as described in the above section, are provided by a range of collectors including governments, private companies and not-for-profit organizations. There are, however, two main *forms* of collection: drop off sites and pick up services.

This section describes the presence of these two forms of collection in BC. The information provided is based on interviews and surveys conducted with collectors in fall/winter of 2013.

4.1 Drop Off Locations

Across BC there are 305 identified sites where consumers can drop off major appliances for recycling. Of these:

- 186 (61%) are local government sites (both regional district and municipal);
- 102 (33%) are private collectors; and
- 17 (6%) are processing companies.

4.1.1 Local Government Drop Off Sites

The 186 local government drop off sites are located at landfills, transfer stations or recycling depots (which only accept materials and products for recycling). These facilities are owned by municipalities and regional districts.

Most local government sites (78%) accept major appliances from all types of generators (residents, contractors, movers, retailers, building managers, peddlers, etc.); and the others restrict service to residents only¹.

Local governments report that they provide drop off sites for major appliances for a number of reasons, with the following cited most frequently:

- To ensure appliances are recycled;
- To divert waste;

¹ Residents here are denoting individual users of the facilities as opposed to commercial users, not where they reside.

- To prevent illegal dumping;
- To ensure proper handling of appliances (particularly refrigerants); and
- Because there are no other options for residents in the area.

Part of the reason for the comprehensive local government collection infrastructure for major appliances is the fact that white goods² are banned from disposal in BC landfills under the BC *Landfill Criteria for Municipal Solid Waste* which states that landfills must have designated areas to collect these products (unless approved by a manager).

4.1.2 *Private and Not-for-profit Drop Off Collection Sites*

Major appliances in BC are also collected at 102 private and not-for-profit drop off collection sites across the province. The private sites include scrap yards, towing companies, auto wreckers, and recycling depots, including members of Automotive Recyclers Environmental Association (AREA) and Canadian Association of Recycling Industries (CARI).

Less than 10% of these drop off sites are operated by not-for-profit organizations; most of these sites are located on islands where the not-for-profit organization provides a collection site for a wide variety of recycling and product stewardship materials.

Not-for-profit organizations tend to be involved in the collection of major appliances for the same reasons as local governments. Private collectors, however, are motivated by the financial opportunities associated with the selling of scrap metal.

Of the 102 sites, 66% accept all appliances, and 34% only accept those without refrigerants. They accept from both residential and commercial generators.

4.1.3 *Drop Off Sites Operated by Processors*

Five companies, with a total of 17 collection sites in BC, were defined as “processor” in this study. These drop off sites receive major appliances directly from generators as well as from primary and secondary collectors.

4.2 *Pick Up Services*

Pick up services collect from the generator rather than requiring the generator to transport the appliance to a drop off location. Pick up services are provided by:

- Retailers of major appliances;
- Local governments;
- Utility bounty programs;
- Property management companies; and
- Peddlers.

²The Criteria refer to “white goods” which are defined as stoves, refrigerators, freezers, washers, dryers, hot water heaters and dishwashers. This covers some but not all of the products in the MARR program and includes hot water heaters.

4.2.1 *Retail Delivery/Take-back Systems*

The major appliance retail sector in BC includes both large major appliance retailers with multiple stores and franchisees, and small independent appliance stores in BC.

A survey of 125 retail companies was conducted to determine if they offered end-of-life appliance “take-back” services and if they charged an additional fee for that service. The variations in fee arrangements are described in Section 6 (Collection System Accessibility and Fees). Of the 116 retailers that responded to the survey, 84% offered take-back services (when a new appliance is delivered) and 16% did not offer take back services. After pick up, the appliances are generally delivered to a drop off site. Retailers report that some appliances may go to a refurbisher, although no specific data on the amount was available.

4.2.2 *Utility Bounty Programs*

Two electrical utilities in BC have bounty programs to encourage homeowners to retire working full-size refrigerators that are older and less energy efficient:

- The **BC Hydro** program, which started in 1990 and concluded at the end of 2013, divided the province into zones and contracted for collection service in those zones. Residential customers received a \$30 rebate if they retired an old refrigerator. There was a lifetime limit of two retired refrigerators per customer. BC Hydro contractors picked up the old refrigerators at the household. In fiscal 2012 year, 28,000 units were collected and delivered to three contracted dismantlers for removal of refrigerant and recycling. While the program ceased operation at the end of 2013, it is scheduled to restart in the spring of 2014.
- The **Fortis BC** program provides a pick up fee rebate to the resident if an old refrigerator was picked up when a new unit was delivered. Fortis provided rebates for 121 refrigerators in 2012 and for 210 refrigerators in 2013. This program is currently being evaluated for cost effectiveness for energy savings.

4.2.3 *Local Government Curbside Collection Systems*

Within BC, 14 local governments (seven of which are in Metro Vancouver) offer some form of curbside pick up service for major appliances including:

- A community-wide large item pickup day once or twice a year;
- Pickup days occurring throughout the year (usually on the garbage collection day); or
- Curbside service upon demand (usually with a limit on the number of times a household can use the service).

Pick up services are generally offered for all major appliances, although two municipalities do not take any appliance containing refrigerant and another will only pick up a limited range of refrigerant containing appliances.

4.2.4 *Property Management Companies*

Multi-family buildings include both strata developments (where each unit is privately owned) and rental developments (where each unit is rented out and the building is managed like a commercial entity). Property management companies typically manage rental buildings. The property management companies are responsible

for the purchase, maintenance and replacement of in-suite appliances and thus are significant generators of major appliances in BC.

Most tenant-occupied units have refrigerators and stoves, with a few starting to include dishwashers. Seventeen associations or property management companies were contacted to ask how their members handle major appliances. Most property managers bought all new units when replacing large appliances, while some purchased used or refurbished units if available. The appliances are usually replaced when existing units fail and cannot be repaired economically.³ Most property managers pay a private contractor to remove end-of-life units as part of the purchase of new appliances, or as part of an appliance service contract. The destination of the appliances is usually determined by the company removing them.

4.2.5 Peddlers

Based on interviews with on-call waste collection companies and intermediate collectors, peddlers do not play a large role in the collection of major appliances in BC. As noted in Section 3, when peddlers do receive appliances from their customers, they generally bring it to a drop off site, although working units may be sold to a refurbisher.

5 CONSOLIDATION AND TRANSPORTATION

Major appliances are typically consolidated at primary and secondary collection sites for varying lengths of time to accumulate enough scrap metal of sufficient size to warrant the cost of shipping to a processing facility. Most appliances ultimately end up at one of two processor sites with shredders. Both of these shredders are located in the Lower Mainland where there is ready access to overseas metal markets.

5.1 Consolidation



In general, major appliances are stored together with other scrap metal received at the collection site. Refrigerant containing products are set aside for removal of refrigerant, and once the refrigerant removal is complete, these appliances are added to the consolidated scrap metal.

At a small number of sites, some components of major appliances are removed from the appliance because they have a higher value than scrap metal. This includes stove coils because of their high nickel content, as well as cords and other parts containing copper.

To reduce storage space required, several sites reported compacting the scrap metal using their on-site equipment, such as a backhoe. The photo to the left shows an uncompact pile of mixed scrap metal.

³The SBR report (2009) notes that major appliances typically have shorter life spans in a rental setting.

5.2 Transportation

Once enough scrap metal is accumulated, the processor typically arranges transportation from the collection site to the processing facility. Scrap metal is shipped short distances in loose form (not compacted or baled); however, depending on the distance from the processing facility, the processor may opt to send a baler to the collection site to reduce transportation costs. The photo above shows bales of metal ready for shipping to processors.



Transportation from collector to processing site can occur by truck, rail or barge, or some combination of the three transportation modes, depending on location.

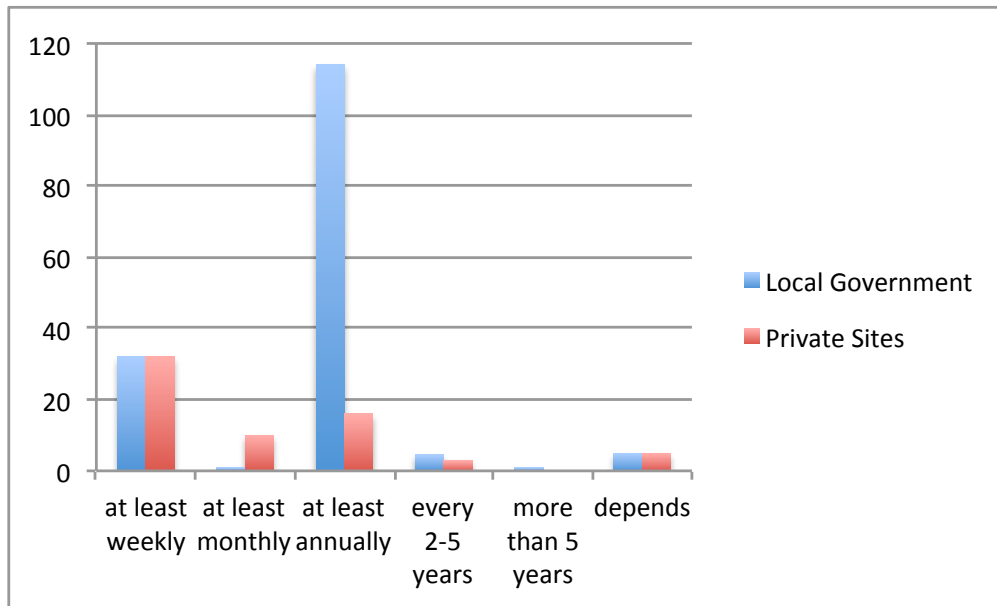
Processors usually use their own fleet of vehicles to transport loads of metals from satellite sites to the main processing site, or deal with transportation companies that operate in the vicinity of the collection site. Section 9 provides a description of activities at the processing sites.

Due to the large geography of BC, the distance of a collector from processors is reported to have a significant impact on the revenue potential of scrap metal. The more remote a collector is from the shredders in the Lower Mainland, the potential for revenue becomes more marginal.

Attractively priced backhauls improve the economics of scrap metal (appliance) recycling. Economical backhauls (because an empty vehicle is returning to its base) are available in some communities, and particularly in those with thriving economies due to the amount of transport traffic serving these areas (e.g. Kitimat and the Peace River areas where there is significant growth of the oil and gas industry). Contrastingly, many areas of the province have lost their traditionally inexpensive backhaul rates due to decreasing activity in the forestry sector.

The length of time between shipments from collection sites to scrap metal processors depends on the volume managed, the distance to market and the amount of storage space available at the collection site. Figure 5-1 summarizes information obtained from collectors on the frequency of metal shipments from primary collection sites. The figure shows that a number of sites ship metal weekly, and that most sites ship at least once per year.

Figure 5-1: Frequency of Metal Shipments from Primary Collection Site



6 COLLECTION SYSTEM ACCESSIBILITY AND FEES

6.1 Accessibility

As part of this study, an assessment was conducted by Golder Associates Ltd. to determine the percentage of the applicable BC population that has access to collection sites that accept major household appliances for recycling from individuals. The analysis considered only sites that accept all categories of major appliances from all users (251 sites in total). Companies providing pick up services, and collection sites that accept some, but not all, types of major household appliances in the MARR program were excluded from the analysis. A second analysis was also done to assess accessibility to only sites that don't charge fees.

'Fee' sites refer to collection sites that accept major household appliances for recycling, but charge a disposal fee for that service on some or all types of major appliances. 'No Fee' sites refer to collection sites that accept major household appliances and do not charge any kind of disposal fee for that service. In some cases, 'No Fee' sites provide payment for appliances based on their scrap metal value.

The assessment was conducted using the Stewardship Agencies of BC (SABC) Accessibility Standard (2013)⁴. This standard sets a 45-minute drive radius for collection facilities in rural communities with a population of 4,000 or more and a 30-minute driving radius for collection facilities in urban communities. Urban communities are

⁴ SABC standard excludes the 9.2% of the BC population that lives in communities with a population under 4,000. For the remaining 90.8% of the population, the analysis mapped out the collection locations and using a 2011 provincial road network file for BC from Statistics Canada, and then assigned driving speeds based on the type of roads (highway, arterial, local, etc.), to determine the driving times from population points to the collection sites. For the population points, Statistics Canada 2011 Census data was used with populations assigned to specific mapped blocks and the driving times from those blocks calculated. These mapped blocks of population were also classified as urban, rural or not included according to the SABC standard.

“defined as cities, district municipalities and towns within the Metro Vancouver and Capital Regional Districts with a population of 4,000 or more, and cities and district municipalities with a population of 30,000 or more in the remainder of the province.”⁵ The assessment was also conducted for the BC population as a whole using the same driving times.

6.1.1 Access to Collection – All Sites

The GIS analysis presented in Figure 6-1 and Table 6-1 (for the entire BC population) illustrates that 98.5% of the population have access to collection sites that accept all categories of major appliances (with fees or without). Using the SABC standard, there is 99.6% accessibility for the communities with populations over 4,000. These results represent a very high level of access to collection for BC residents despite not including pick up services and sites that do not accept *all* appliances in the analysis.

6.1.2 Access to Collection – With or Without Fees

Additional analysis was done on the accessibility of sites that charged a fee compared to those that did not. The analysis for the entire BC population showed that 93.6% of the population had access to collection sites without fees. The GIS analysis for the 90.8% of the population covered by the SABC standard showed that 97.0% of the population has access to sites that accept all the categories of major appliances *without fees* within the driving times used in the SABC standard. This analysis is shown in Figure 6-2 and Table 6-1 below.

These results show that BC residents have a high rate of accessibility to drop off locations without fees within the SABC recommended driving times. Even though there are a greater number of collection sites that charge fees than those that do not, a higher percentage of the population have access to sites without fees.

Table 6-1: Accessibility Analysis Results for Entire BC Population and for Communities of Over 4,000 People

Facility Category	Number of Collection Sites	Whole BC Population		SABC standard (communities with population over 4,000)	
		Population Covered	Percent Covered	Population Covered	Percent Covered
No Fee to Drop Off	110	4,119,076	93.6%	3,874,178	97.0%
All Sites	251	4,334,380	98.5%	3,979,391	99.6%

⁵ Ibid.

Figure 6-1: Major Appliance Collection Locations and Driving Times in BC

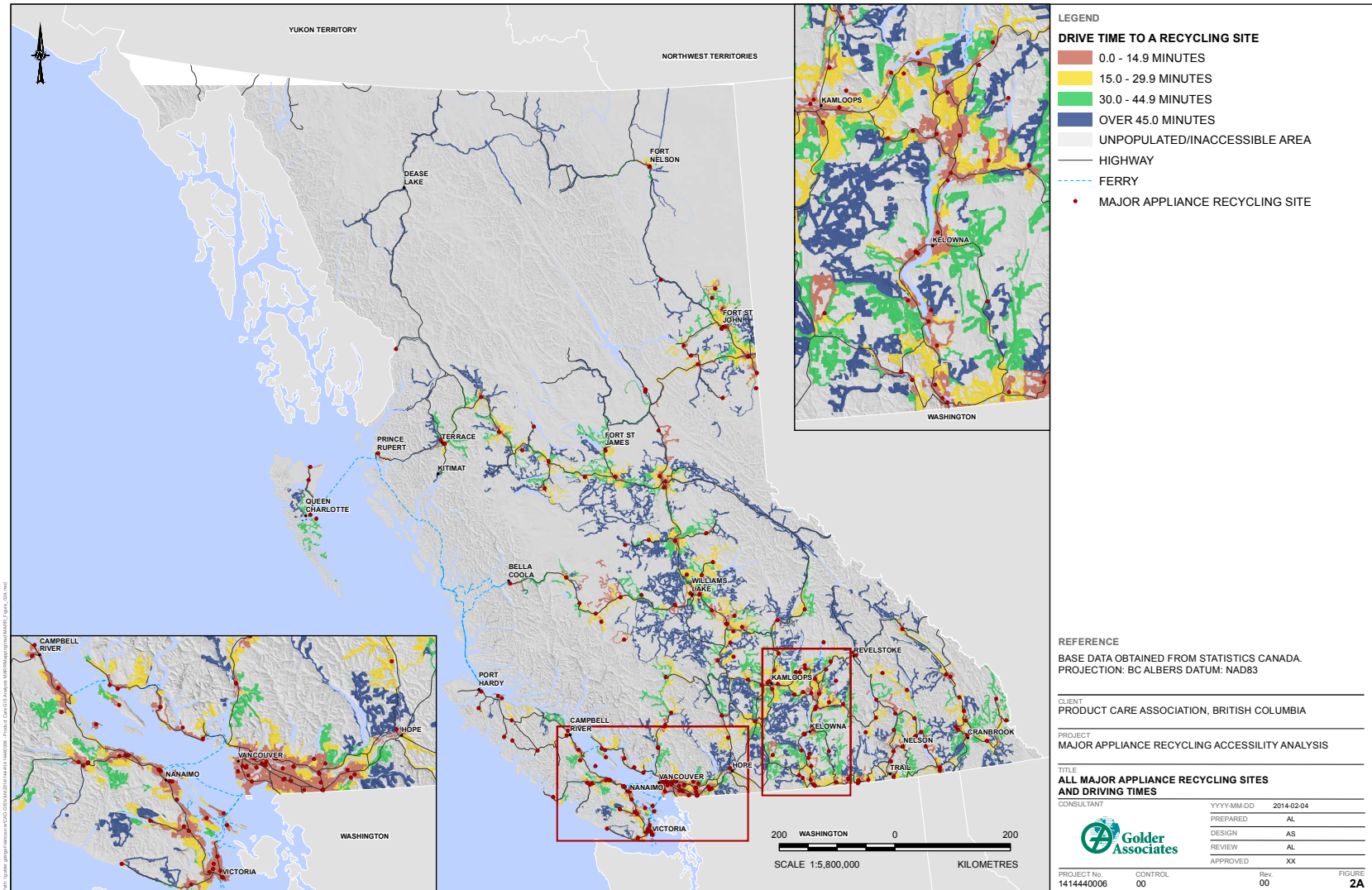
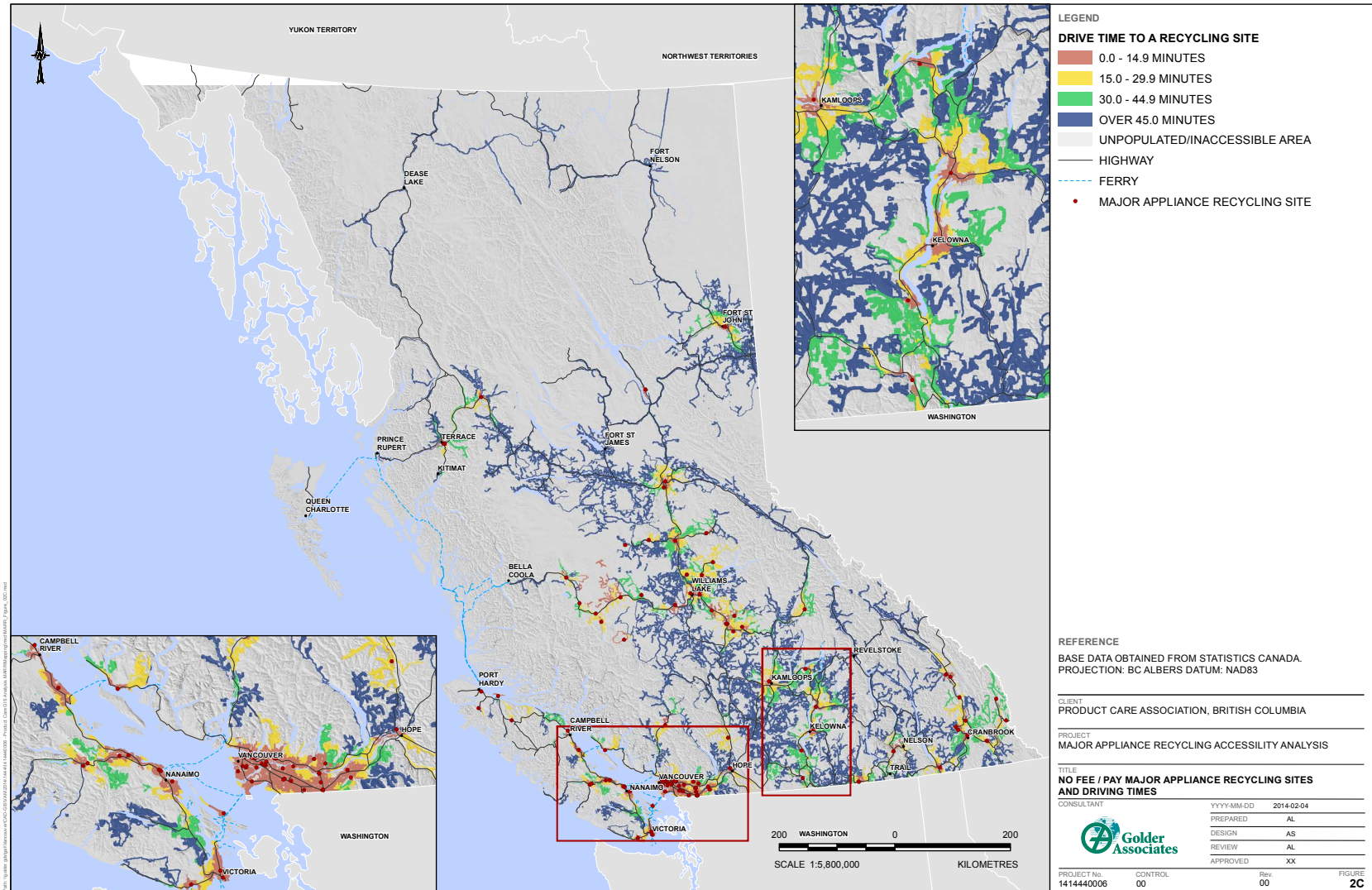


Figure 6-2: Major Appliance Collection Locations without Fees and Driving Times



6.2 Collection Fees

The application of fees to receive major appliances varies significantly between collectors, but generally falls into one of 3 categories:

1. Collectors that do not charge fees to accept major appliances;
2. Collectors that charge fees only for refrigerant-containing appliances; and
3. Collectors that charge fees to accept all appliances.

Using these categories, Table 6-2 provides a breakdown of how fees are applied at **collection sites in BC**. Pick up services **have not been included** in this analysis since this level of service is beyond what is required by a stewardship program in BC. The last column of Table 6-2 reflects collection sites that have a fee structure that does not fit into one of the above 3 categories and includes:

- Collection sites operated by the Cowichan Valley Regional District, where they accept one major appliance with refrigerant at no cost, but charge a fee for any additional appliance; and
- Chilliwack’s Bailey Landfill, where they generally charge a fee at the landfill for all appliances but have two months of the year when appliances are accepted for free.

Table 6-2: Application of Fees at Collection Sites (not including pick up services)

Method Applied	No fee charged	Fee for refrigerant-containing appliances	Fee for all appliances	Other
Distribution based on estimated tonnes collected (collection sites only)	67%	14%	17%	1%
Distribution based on number of collector sites	47%	22%	30%	1%

Many private collection sites will pay for the major appliances they receive. The amount paid will depend on market prices for ferrous metal and may also be influenced by the relationship with the customer (e.g. regular customer that supplies large volumes of appliances on a regular basis, as compared to a single-visit customer with one appliance).

For sites that do charge fees, the survey data provided the following general observations:

- It is more likely that a local government collection site will charge a fee than a private site:
 - 61% of local government collection sites charge a fee (83% of these sites charge a higher rate for refrigerant-containing appliances); and
 - 21% of private collection sites charge a fee (71% of these sites only charge for refrigerant-containing appliances).
- Collection sites may charge by the weight or by the unit, or some combination of both;
- Fees on a per unit basis range from \$5 to \$30;
- Fees on a weight basis range from \$10 to \$73/tonne; and

- Processors do not charge fees for appliances, with the exception of refrigerant-containing appliances (12% of the processors' sites charge a fee for these appliances).

6.2.1 Collection Fees for Pick Up Services

Of the 14 local governments that provide pick up services, only 29% charge a user fee. These fees are applied by the unit or by the hour.

Based on the retailer surveys, 80% of retailers that offer pick up services charge an additional fee for appliance take-back. Fees for pick up range from \$10 to \$50 per unit, with roughly 70% of retailers reporting that they charge between \$15 and \$30. Almost all retailers accepting the old appliances required the purchase of a new appliance.

7 ESTIMATED AMOUNT AND COMPOSITION OF APPLIANCES AVAILABLE TO COLLECT IN BC

7.1 Amount of Appliances "Available to Collect"

The amount of appliances available to collect in BC was estimated using a Lifespan Model. The model is designed to take into account the fact that appliances last many years in the household, and are often used in a "second life" or are stored for a period of time before they are discarded. The Lifespan Model combines historical annual unit sales data in BC (from 1987 on) with typical appliance lifespan data and appliance unit weight data to estimate the number of appliances and the total tonnage of appliances at end-of-life in BC each year.

The Lifespan Model takes into account the fact that while each appliance has an average lifespan (e.g. an average value of 20 years with the first owner for a refrigerator), some units will last longer than the average lifespan and others will not last as long as the average value. The Lifespan Model also takes into account the fact that some appliances may have a second life (e.g. as a beer fridge in the basement), after the first life is complete.

The year 2012 was used to develop the major appliances end-of-life estimate, as most of the collection data obtained during this study was for 2012. Calculation of the recycling rate (discussed in Section 11) needs the numerator and the denominator for the equation to be measured in the same year (2012).

7.1.1 Unit Sales Data and Assumptions

Annual unit sales data for the 17 major appliances on the MARR list were collected for as many years as possible. Many of the products at end-of-life in 2012 have a lifespan of 20 years or more; therefore unit sales data are needed for the years extending back to 1992 (20 years earlier than 2012). The Lifespan Model contains unit sales estimates back to 1987 to account for appliances that last longer than 20 years.

Historical unit sales data for most products were obtained from the Canadian Appliance Manufacturers Association (CAMA) annual reports dating back to 2002. Different types of data have been reported in the CAMA publications over time:

- The 2002 CAMA annual report includes annual sales data for Canada as far back as 1997 for a number of major appliances on the MARR list (refrigerators; electric ranges; automatic clothes washers; electric and

gas dryers; dishwashers; freezers; microwave ovens; electric/gas cook tops; room air conditioners and food waste disposers);

- The 2005 CAMA report includes annual unit sales for Canada for a number of major appliances on the MARR list for the years 2000 to 2004, and
- The 2012 CAMA report includes annual unit sales for Canada for a number of major appliances on the MARR list for the years 2006 to 2011.

Unit sales data for 2005 were calculated as the average between 2004 and 2006.

Where annual unit sales data were needed for years before 1997, (e.g. for refrigerators), the 1997 data were extended back to 1987 using a 5-year rolling average starting from 1996 (average of sales for 1997 to 2001). In some cases, if the rolling average values appear high, 1997 values were extended back to 1987, assuming annual unit sales remained flat in these years. Sales data for BC are not available for years earlier than 1997, therefore this approach was considered the best available.

The proportion of units sold in BC (as a percentage of Canadian national unit sales) was available for most of the products tracked by CAMA for each year from 1997 to 2004 and for 2011. BC unit sales were calculated by applying the reported BC percentage to the reported national unit sales values. For the years 2005 to 2010, an even distribution of values for the percentage of the national market in BC was assumed.

Where information was not available on BC unit sales of appliances as a percentage of Canadian national totals, the proportion of BC versus national households shown in Table 7-1 was used as a default value to pro-rate national data to BC.

Table 7-1: Proportion of BC to National Households 1971 to 2011⁶

	1976	1981	1986	1991	1996	2001	2006	2011
Total BC Households	830,617	999,086	1,089,636	1,246,839	1,427,540	1,537,235	1,646,680	1,768,940
Total Canada Households	7,182,540	8,298,901	9,011,472	10,039,287	10,842,665	11,588,730	12,463,435	13,349,450
BC vs National Households	11.6%	12.0%	12.1%	12.4%	13.2%	13.3%	13.2%	13.3%

Sources of annual unit sales data in BC used for the Lifespan Model, as well as BC unit sale values for 1987 to 2011 are presented in Appendix C.

7.1.2 Unit Weight and Lifespan Data in Lifespan Model

Lifespan and unit weight data for most major appliances were taken from a comprehensive report produced for the Association of Home Appliance Manufacturers (AHAM) by R.W. Beck and Weston in 2005⁷. The report includes results from an earlier, similar study in 1997.

Over 2,100 appliances were collected from 20 sites in 10 US states and make, model, name plate and serial number data were recorded. This information was sent to manufacturers who were able to identify the year the appliance was manufactured for 1,350 of the 2,100 appliance sampled. Appendix C presents the lifespan data from the AHAM study which was used in the Lifespan Model. In all cases, lifespan values are rounded to the nearest full year. In a few cases (e.g. trash compactors, where only one data set was collected in the AHAM study, and electric

⁶ <http://www12.statcan.gc.ca/census-recensement/2011>

⁷ Association of Home Appliance Manufacturers (AHAM): Recycling, Waste Stream Management and Material Composition of Major Home Appliances, R.W.Beck and Weston Solutions, December, 2005.

water dispensers, which were not measured in the AHAM study), lifespan data from other sources such as Appliance Magazine were used.

The unit weight of new and old appliances was measured in the 1997 and 2005 AHAM studies. The old unit weight in the 2005 study measured the weight of appliances at end-of-life in 2005. This value, presented in Table 7-2, was used for each appliance in the Lifespan Model.

Table 7-2: Lifespan and Unit Weight Values for Major Appliances

MARR #	Product	Average Lifespan (years) ⁸	Unit Weight (kg) ⁹
1a	Top/Bottom Refrigerators	20	120.3
1b	Side-by-side Refrigerators	20	137.8
1	Full Size Refrigerators	20	129.0
2	Compact Refrigerators	11	25.1
3	Freezers	19	79.5
4	Room Air Conditioner	18	20.2
5	Portable Air Conditioner	18	53.0
6	Dehumidifiers	12	26.2
7	Clothes Washers	15	61.9
8b	Electric Clothes Dryers	16	53.0
8a	Gas Clothes Dryers	16	53.8
8	Clothes Dryers	16	53.4
9a	Gas Ranges	13	79.4
9b	Electric Ranges	16	81.4
9	Ranges	13-16	80.4
10	Range Hoods	10	33.1
11	Built In Ovens	10	59.4
12	Microwaves	14	25.0
13	Surface Cooking Units	10	23.4
14	Dishwashing Machines	13	45.3
15	Food Waste Disposers	13	5.2
16	Trash Compactors	6 ¹⁰	66.0
17	Electric Water Dispensers	5	13.6

⁸ Rounded to nearest full year.

⁹ Unit weight is "old" weight measured in 2005 AHAM study (Beck and Weston – Appendix C).

¹⁰ AHAM only measured one data point at a lifespan of 28 years. Lifespan was assumed to be closer to that of a toaster at 5 years.

7.1.3 “Available To Collect” Estimate

Estimates of the number and weight of major appliances that will reach end-of-life in BC in 2012 were developed using the Lifespan Model and the assumptions discussed above, as well as data presented in Appendix C. The results are presented in Table 7-3. The Lifespan Model estimates that approximately 594,000 major appliances, with a weight of about 36,428 tonnes, reached end-of-life in BC in 2012. This would not be significantly different for 2013 as the historic sales did not change significantly and the same lifespan estimates would apply.

Almost 90% of the weight of major appliances at end-of-life in BC in 2012 is made up of six major appliances:

- Refrigerators (34%)
- Ranges (16%)
- Washing Machines (14%)
- Dryers (10%)
- Dishwashers (8%)
- Freezers (7%)

For some MARR product categories, the total value for unit sales and the weight sold into the marketplace are made up of two or more categories reported separately by CAMA or other sources. In these cases, separate estimates of the total amount available to collect are developed and are then added together to give the MARR total. As an example, full size refrigerators are reported in two categories (top/bottom and side by side refrigerators). These two categories are added together to estimate the value for full size refrigerators. In other cases (e.g. ranges or dryers made up of electric and gas units), the electric and gas units have different weights and market share, and are dealt with separately in the Lifespan Model and are presented as one total in the report.

The Lifespan Model estimates that on average, side-by-side door refrigerators should not yet be available to collect as they were introduced to the Canadian market in year 2000 and have not yet reached the end of their average lifespan.

Table 7-3: Estimated Number and Weight of Major Appliances Available to Collect in BC in 2012

MARR #	Major Appliance Category Description	Estimated Number of Units Available to Collect in BC in 2012	Estimated Tonnes at End-of-life in BC By Appliance Category in 2012	% of EOL Tonnes By Major Appliance Category
1b	Top/Bottom Refrigerators	102,000	12,240	33.6%
1a	Side-by-side Refrigerators ¹¹	0	0	0.0%
2	Compact Refrigerators	11,000	267	0.7%
3	Freezers	32,000	2,567	7.1%
4	Room Air Conditioners	19,000	77	0.2%
5	Portable Air Conditioners	19,000	96	0.3%
6	Dehumidifiers	13,000	328	0.9%
7	Clothes Washers	83,000	5,118	14.1%
8b	Electric Clothes Dryers	66,000	3,498	9.6%

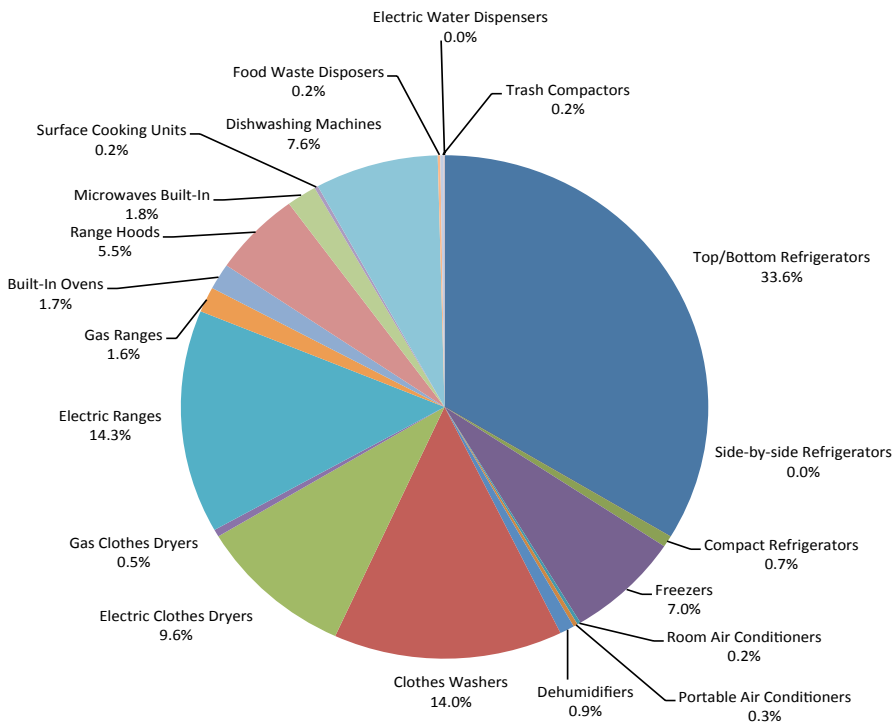
¹¹ The Lifespan Model estimates that no side by side refrigerators will reach end-of-life in 2012, as they were only introduced to the market in year 2000, and with a 20-year lifespan, none should be at end-of-life in 2012.

MARR #	Major Appliance Category Description	Estimated Number of Units Available to Collect in BC in 2012	Estimated Tonnes at End-of-life in BC By Appliance Category in 2012	% of EOL Tonnes By Major Appliance Category
8a	Gas Clothes Dryers	3,000	171	0.5%
9a	Electric Ranges	64,000	5,219	14.3%
9b	Gas Ranges	7,000	594	1.6%
10	Range Hoods ¹²	60,000	1,986	5.5%
11	Built-In Ovens	10,000	609	1.7%
12	Microwaves Built-In	27,000	671	1.8%
13	Surface Cooking Units	3,000	80	0.2%
14	Dishwashing Machines	61,000	2,755	7.6%
15	Food Waste Disposers	11,000	57	0.2%
16	Trash Compactors	1,150	76	0.2%
17	Electric Water Dispensers	1,000	18	0.1%
	Total	594,000	36,428	

The contribution of each major appliance category to the total available to collect (by weight) is presented in Figure 7-1. Information on the reliability is provided in Appendix F.

¹² The estimate of range hoods is based on pro-rating values for the US from *Appliance Magazine* to the Canadian market, and then applying a 50% factor to the value which was very high.

Figure 7-1: Composition (by percentage weight) of MARR Products at End-of-life in BC in 2012



7.2 Composition of Appliances “Available to Collect”

Major appliances are made of metal (both ferrous and non-ferrous), glass, plastics, rubber and sometimes other materials like paper, electronics, refrigerants, oils, etc. The composition of appliances has changed over time with new designs and a trend in some cases to increase the plastic content of some units. With the trend towards more stainless steel refrigerators in the last few years, the ferrous metal content of refrigerators, which had been dropping, is increasing again.

The 2005 AHAM study measured the composition of appliances manufactured in 2005, as well as appliances available to collect in 2005, by dismantling over 80 appliances dropped off for recycling at 20 sites in 10 US states. A similar approach was used on a small number of appliances in the 1997 study carried out for AHAM by Beck and Weston.

A combination of two data sources from the 2005 AHAM study was used to estimate the composition of the appliances available to collect in BC in 2012. The composition of appliances manufactured in 2005 reflects appliances that are 7 years old in 2012 (younger than collected), and the composition of end-of-life appliances received in 2005 would reflect appliances which are older than the appliances “available to collect” in BC in 2012. An average of the two values provides a reasonable indication of the likely composition of the appliances “available to collect” in 2012, and is the best data source currently available on which to base the composition estimates.

Table 7-4 presents composition data for appliances which were new to the US market in 2005. Table 7-5 presents the measured composition of appliances which were collected at end-of-life at various US sites in 2005, and were dismantled as part of the AHAM 2005 study to measure their composition.

Table 7-4: Measured Composition of Major Appliances Introduced Into the Market in 2005 (AHAM, 2005)

Category	Ferrous Metal Content (%)	Non Ferrous Metal Content (%)	Plastic Content (%)	Other Content (%)
Top/Bottom Refrigerators	45.9%	7.1%	38.7%	8.3%
Side-by-side Refrigerators	55.9%	5.8%	33.1%	5.2%
Compact Refrigerators	45.9%	7.1%	38.7%	8.3%
Freezers	81.4%	1.8%	15.2%	1.5%
Room Air Con BC	62.6%	18.0%	15.2%	4.1%
Portable Air Cond BC	62.6%	18.0%	15.2%	4.1%
Dehumidifiers	62.6%	18.0%	15.2%	4.1%
Clothes Washers	63.1%	5.7%	19.5%	11.7%
Electric Clothes Dryers	80.7%	3.9%	4.5%	10.9%
Gas Clothes Dryers	93.3%	3.9%	4.5%	0.1%
Electric Ranges	83.9%	3.9%	1.4%	10.9%
Gas Ranges	86.7%	2.0%	2.2%	9.1%
Built-In Ovens BC	83.9%	3.9%	1.4%	10.9%
Range Hoods	83.9%	3.9%	1.4%	10.9%
Microwaves Built-In	68.1%	7.1%	12.8%	12.0%
Surface Cooking Units	83.9%	3.9%	1.4%	10.9%
Dishwashing Machines	65.0%	4.4%	28.0%	2.5%
Food Waste Disposers*	65.0%	4.4%	28.0%	2.5%
Trash Compactors*	65.0%	4.4%	28.0%	2.5%
Electric Water Dispensers *	65.0%	4.4%	28.0%	2.5%

*denotes categories where composition was estimated as the AHAM study did not examine these.

Table 7-5: Measured Composition of Major Appliances at End-of-life in 2005 (AHAM, 2005)

Category	Ferrous Metal Content (%)	Non Ferrous Metal Content (%)	Plastic Content (%)	Other Content (%)
Top/Bottom Refrigerators	72.2%	7.3%	9.2%	11.3%
Side-by-side Refrigerators	61.4%	3.6%	33.1%	1.9%
Compact Refrigerators	60.4%	7.1%	15.6%	16.9%
Freezers	78.1%	7.9%	7.5%	6.5%
Room Air Con BC	70.6%	20.8%	5.4%	3.2%
Portable Air Cond BC	70.6%	20.8%	5.4%	3.2%
Dehumidifiers	71.4%	18.7%	5.8%	4.1%
Clothes Washers	57.6%	5.8%	13.9%	22.7%

Electric Clothes Dryers	90.5%	3.3%	5.8%	0.4%
Gas Clothes Dryers	85.1%	5.4%	7.2%	2.3%
Electric Ranges	79.3%	3.0%	3.6%	14.3%
Gas Ranges	84.9%	4.5%	1.4%	9.2%
Built-In Ovens BC	79.3%	3.0%	3.6%	14.3%
Range Hoods	79.3%	3.0%	3.6%	14.3%
Microwaves Built-In	75.4%	5.9%	11.6%	7.1%
Surface Cooking Units	79.3%	3.0%	3.6%	14.3%
Dishwashing Machines	58.5%	5.8%	28.1%	7.6%
Food Waste Disposers	54.8%	39.6%	4.7%	0.9%
Trash Compactors	94.6%	3.4%	1.5%	0.5%
Electric Water Dispensers	58.5%	5.8%	28.1%	7.6%

The tables show how the composition of major appliances has changed over time with the ferrous metal content generally decreasing as ferrous metal is replaced by plastic.

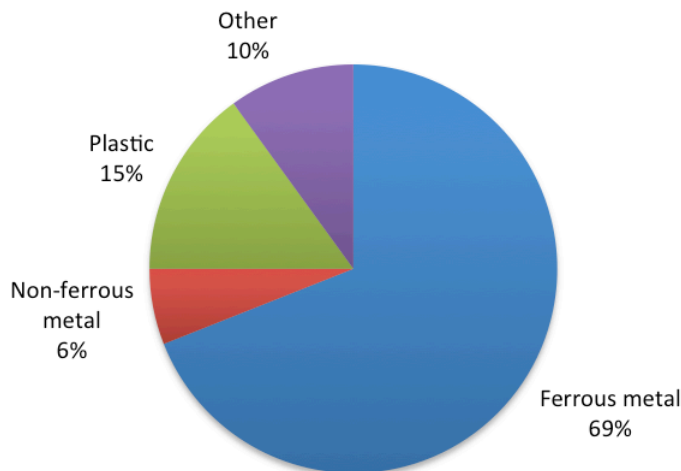
The composition values (as %) in both Tables 7-4 and 7-5 were applied to the estimated weight of appliances “available to collect” in 2012 (in Table 7-3) to estimate the overall composition (by material) of the major appliance stream. The weighted average estimated composition values are presented in Table 7-6.

Table 7-6: Assumed Composition of MARR Appliances Available to Collect in BC for 2012¹³

Data Source Used	Estimated Ferrous Metal Composition (%)	Estimated Non Ferrous Metal Composition (%)	Estimated Plastic Composition (%)	Estimated Other Materials Composition (%)
Applying composition of appliances sold in 2005	65.4%	5.4%	20.6%	8.6%
Applying composition of appliances at End-of-life in 2005	73.1%	5.8%	9.5%	11.6%
Average of two approaches	69.2%	5.6%	15.5%	10.1%
Estimated Composition (tonnes) in Appliances Available For Collection in BC (2012)	25,208	2,040	5,646	3,680

The estimated composition is presented graphically in Figure 7-2.

Figure 7-2: Estimated Composition of Major Appliances Available to Collect in BC in 2012 (by Weight)



¹³ Weighted average of compositions measured in AHAM 2005 study for new and old appliances in the US market.

8 DECOMMISSIONING

Decommissioning is the process for removing substances of concern and preparing the major appliances for processing. This section describes the current approaches used by collectors for the extraction of refrigerant and other substances of concern, as well as the removal of non-ferrous metals and parts. An overview of refrigerant type and trends as well as the regulatory context is provided in Appendix D. Background on other substances of concern is included in Appendix E.

8.1 Current Systems for Refrigerant

8.1.1 Local Government Sites



Some local government sites do not accept appliances that contain or contained refrigerant (for example, they would not accept any refrigerators, freezers or air conditioners), or only accept appliances that do not contain refrigerant (for example, they would accept a freezer with the refrigerant removed but would not take one that still contained refrigerant).

At the sites that do not accept an appliance with refrigerant or that charge a higher fee for appliances containing refrigerant, there is typically a process to check that the appliances are received without refrigerant. However, only 23% of sites require proof that a certified technician had done the removal procedure.

For local government sites that accept appliances with refrigerant, 95% arrange for removal of refrigerant on site. Removal of the refrigerant is contracted out at 77% of these sites, often as part of the scrap metal removal contract.

8.1.2 Private and Not-for-profit Collection Sites

For the private collection sites that accept cooling appliances, 31% require that the refrigerant be removed in order for them to accept the appliance and 52% do not (the rest did not respond to this question). Of those that do not require removal beforehand, 89% will accept the appliance if the refrigerant had already been removed. Only 7% charge a different fee (lower) if the refrigerant was removed already. Only a very limited number of sites apply a rigorous process to checking that the refrigerant had been removed by a certified technician.

Like local government collection sites, refrigerant removal is done by on-site staff, a contractor, or arranged through the scrap metal buyer.

8.1.3 Retailers

Of the retailers that said they provide appliance pick up services, only 3% report that they remove the refrigerants, with the vast majority preferring to transfer refrigerant-containing appliances “as is” to another collector.

8.1.4 Processors

The percentage of appliances that have the refrigerant removed upon arrival at the processor site varied from 60 to 100% based on the customer base and the processor's requirements. Most processors have on-site staff to perform refrigerant removal, as this is also required for automobiles, which is their largest source of scrap metal.

8.1.5 Costs

For collectors that contract out the removal of refrigerant, there was significant variability in the amount paid per unit, ranging from \$6.30 to \$40, with the higher costs being reported by more remote locations.

8.1.6 Implications

Appliances that contain refrigerant are the main type of major appliances that are subject to different levels of acceptability and fees within the recycling system. The statistics are shown here:

- Some drop off collection sites do not accept refrigerant-containing appliances (6% of local government appliance collection sites, 31% of private appliance collection sites, 12% of processor collection sites);
- Some only charge a fee for refrigerant-containing appliances (24% of local government sites, 15% of private collection sites);
- Some charge a higher rate for refrigerant-containing appliances (30% of local government sites, 2% of private collection sites); and
- 29% of processor collection sites reduce their payment for metal if there are a numerous refrigerant-containing appliances coming from a single scrap metal customer.

While it may be appropriate for collectors to not accept or charge higher fees for refrigerant-containing appliances due to the cost of refrigerant removal, there are potential implications for recovering both the refrigerant and the appliances:

- Refrigerant is a factor in the decision of collectors to accept certain appliances so fewer sites accept these appliances than others;
- High fees at drop off sites may encourage some generators to abandon/illegally dump their appliance, or to seek lower cost sites or ones that apply less rigor to refrigerant removal; and
- Lower fees on refrigerant-containing appliances *that no longer contain refrigerant* may encourage some generators and/or informal collectors to purge the refrigerant prior to arriving at the collection site.

8.2 Other Substances of Concern

Other substances of concern include mercury, PCBs, heavy metals and polyurethane foam. Very few of appliances reaching end-of-life today will contain mercury switches or PBCs and some will contain heavy metals (circuit boards), mercury (fluorescent lights), compressor oil and polyurethane foam (insulation). More information on these substances is provided in Appendix E.

At collection sites in BC, it is uncommon for major appliances to be checked for the "other substances of concern" discussed above. Less than 1% of collector sites reported removing of mercury switches and fluorescent tubes. Very few organizations mentioned mercury as an item to check for when receiving appliances, possibly reflecting a

lack of knowledge of the potential for mercury-containing components in some of the appliances they collect. Consequently, it is likely that some mercury switches and other substances of concern are arriving at processing facilities as commingled scrap metal (loose and baled).

During interviews with processors, they confirmed that they were aware that some older appliances contain mercury switches; and they reported that the presence of these substances in the appliances they currently receive is minimal or non-existent. Processors reported that they remove mercury switches, have an onsite supervisor checking all appliances to ensure the substances of concern are removed as part of their environmental program or felt that they do not need to check for mercury switches because the appliances they currently receive no longer contain them.

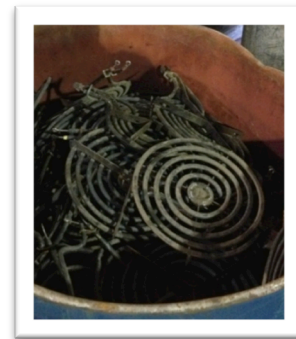
8.3 Non-ferrous Metals

Non-ferrous metals are significantly more valuable than ferrous metal, as is evidenced by the fact that they are priced per kilogram and not per tonne as ferrous metals are. In particular, aluminum, copper and brass are high value commodities. Major appliances contain small amounts of non-ferrous metals; for example:

- Copper is found in the refrigeration coils and electric wiring;
- Motors also contain non-ferrous metals; and
- Nickel is found in stovetop coils.

During the surveys, collectors were asked about their practices related to removing non-ferrous metals. The following is a summary of the data collected on their practices:

- 3% of local government sites report removing the easily accessible aluminum, brass and copper;
- 12% of private collection sites report removing non-ferrous metals;
- About 8% of collectors report removing the power cords for the copper; and
- Some private collection sites may receive appliances with the valuable metals removed (11% said often or sometimes), either unintentionally if collection bin is left unattended, or intentionally if it came from an appliance repair shop.



The data suggests that non-ferrous metals may be removed from the major appliances at any point during the chain of custody. These metals will be sold to a scrap metal buyer and eventually sold into the non-ferrous metal market. (See Section 10 for more information on metal end markets.) Non-ferrous metals that remain intact within the appliance when it reaches the processor are recovered as part of the shredding process.

8.4 Usable Parts and Operating Units

As discussed in Section 4, retailers and peddlers may bring some of the appliances they collect to refurbishers. Very few collection sites reported the separation of usable parts and operating units for the purposes of refurbishing or reuse.

Refurbishers aim to reintroduce the appliance into the consumer marketplace, thereby diverting the appliance from the waste management system. Refurbishers also recover usable parts from the appliances that cannot be

refurbished. Refurbishers manage a wide array of appliances, from those that are new but cosmetically damaged (generally received from retailers) to older but still functional (or repairable) appliances that are closer to the end of their usable life. Data specific to the quantity of “end-of-life” major appliances that are refurbished for resale or used for parts was not available.

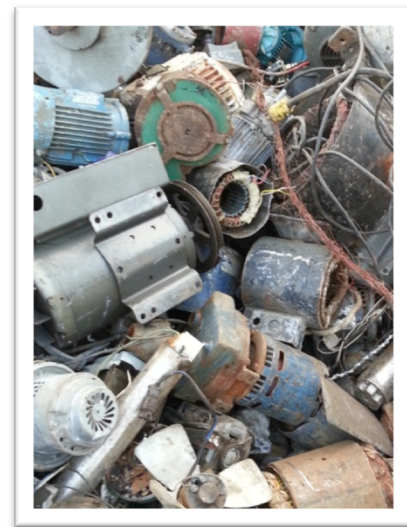
9 PROCESSING

9.1 Processor Material Definitions

Appliances are collected in a scrap metal category known as “tin” which is a lower grade of ferrous metal. In a few cases, motors from appliances (like garburators) may be separated out for their copper content and put in a category called “breakage” (shown to the right).

Once the “tin” is shredded, the ferrous metals are separated from non-ferrous metals. The non-ferrous materials are referred to as “zorba” and are composed of mostly aluminum, but also copper, nickel, tin, zinc, lead and magnesium.

All other materials (plastic, glass, rubber, foam, etc.) end up as shredder residue, referred to as “shredder fluff” with no further sorting. This material currently goes to landfill. The processing industry conducts on-going research into alternative uses for shredder fluff.



9.2 Processing

In BC, there are two sites with shredders where ferrous and non-ferrous metals are segregated from the “fluff”. At these sites, loose and baled tin is received and stored in a pile. Mobile cranes are used to feed the tin into the shredder. A hammer mill shreds the tin and magnets are used to remove the ferrous metals. The remaining material is processed through a variety of sorting mechanisms (reverse magnets, eddy current and manual systems) to recover the non-ferrous metals. The residue of this process can be run through the sorting mechanisms once or multiple times to recover as much metal as possible. Processors report that 98% of the ferrous and non-ferrous metal in the tin is recovered.

The shredder residue (fluff) goes to landfills in BC or Alberta, wherever has the lowest combined cost for disposal and transport.

Most of the collected appliances are shredded in BC. There have been instances where scrap metal, including the appliances, is shipped direct to US or Asia for shredding, if prices and transport options warrant bypassing the processors in BC. At the time of this study, all major appliances were being shredded in BC.

9.2.1 Material Recovery

The processors in BC report that the shredding facilities are 98% efficient in capturing the metals in the tin. Metals are the only materials that are recycled once the appliances are processed aside from some refrigerant taken out prior to processing.

The material composition of major appliances is 75% metal and 25% other materials including plastic, glass, rubber and foam. These “other materials” are not recycled and are sent to landfill as part of the shredder residue.¹⁴

Consequently, processors recover and recycle 73.5% of the materials that comprise major appliances.¹⁵

10 END MARKETS

10.1 Role of Brokers

Brokers link collectors to processors and end markets. They may work for a company in the supply chain (such as a processor or an end market) or be independent. Their business depends on establishing long-term relationships and preferred pricing. They are integral to the on-going supply of metal to processors and mills, both domestic and overseas. In some cases there may be an immediate need to fill a shipment or demand from a certain mill. In these cases a broker may try to source more material and may offer a better price. These one-off demands for supply may be local or from overseas.

10.2 End Markets

The end markets for the processed tin (called “shred”) are steel mills. Buyers of shred from BC are generally in Washington State or in Asia. Buyers are both static, where metal processing companies own both shredders and steel mills so the metals stay within the company, and variable, where the metals are shipped to the highest bidder based on the demand at the time.

Shred (pictured here) is generally shipped by sea to end markets. Some of the shred is currently barged to Washington State for reloading into ships heading overseas. The largest market for shred is presently in Asia; primarily China and India. The export market has been dominant for the past decade, with occasional short-lived periods where higher prices are offered by the North American market.



¹⁴ Though separation of plastics occurs in Europe and Asia, this has not been the case in North America. As reported in a 2013 Resource Recycling article, a 2013 US EPA ruling that allows plastics from shredders to be recycled (related to the reduction in PCB contamination in the shredder residue from older cars) may spur investments in plastic recycling as it both creates revenue and reduces waste costs.

¹⁵ 98% of 75% = 73.5%

Ferrous metal sent to Washington mills may be smelted into rebar (sometimes sold back into the Lower Mainland) or steel billets.

Non-ferrous metals are generally sold to the North American market and are shipped via land, although some may be shipped overseas as market conditions dictate. While there can be multiple grades of aluminum and copper, this higher degree of sorting is not usually cost effective in North America and, if needed, is undertaken overseas.

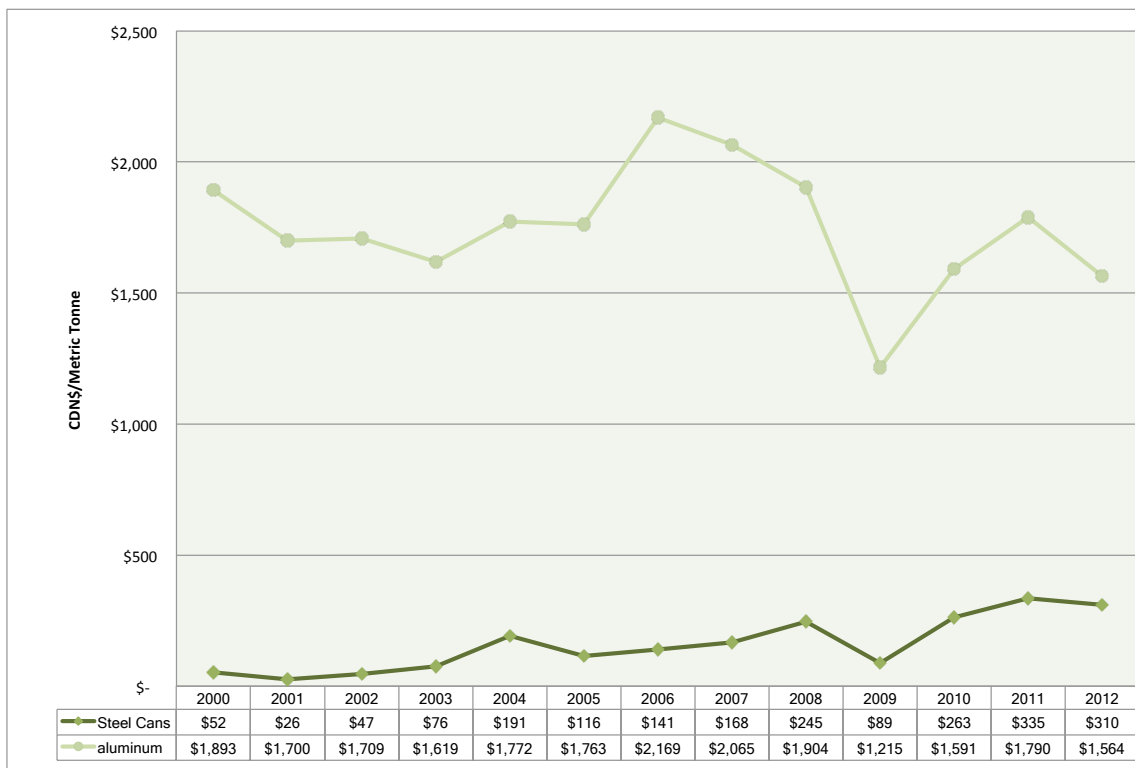
For both ferrous and non-ferrous metals, the end markets require that the metals are commodity grade (quality specifications), contain no hazardous materials, and meet the destination country’s specifications.

10.3 Market Pricing

Ferrous and non-ferrous metals are commodities which are traded on world markets and prices fluctuate with changing economic conditions. The prices paid for metals depend on supply and demand and fluctuate considerably from month to month. Market prices were at a historical high in late 2008 before the global economic slowdown. At the time of the interviews, the price paid for “tin” ranged from \$120 to \$140/tonne.

The figure below, while using data for steel cans, does show the pattern of the metals prices as well as the scale of difference for steel cans (ferrous metal) and aluminum cans (a non-ferrous metal). Industry sources noted that metal prices for both generally trend together.

Figure 10-1: Historic Steel and Aluminum Prices¹⁶



¹⁶ Reclay Steward Edge Ontario Price Sheet

11 SYSTEM PERFORMANCE

11.1 *Quantity of Appliances Collected*

11.1.1 *Methodology*

The data obtained through surveying collectors provided the baseline information from which the quantity of major appliances collected was estimated. As determined through the surveys and interviews, very few collectors track detailed data regarding the quantity of major appliances they handle; instead some collectors provided an estimate of the quantity of major appliances they collect, and others provided partial data, such as the amount of scrap metal collected. This information was used to extrapolate the quantity of appliances collected.

In those instances where a collector provided an estimate of the amount of major appliances collected, this estimate was generally considered to be the best available data for that collector. However, if the estimate appeared to be disproportionate (for the size of the collector or the size of the capture area), further analysis of the site was conducted, including consultation with CARI representatives, to determine a tonnage that better reflected the situation at that site. This was done after all data was collected and reviewed so that the adjusted estimated reflected the total sum of information received from collectors in BC.

In those instances where data was provided on the amount of scrap metal collected, additional research was undertaken to establish the proportion of scrap metal that is major appliances.

For local government collectors, an appliance count was done for a period of 2-4 weeks by four local governments in various locations in BC that reflected a range of BC geographies (urban, rural, island, interior). For these counts, each appliance entering the collection site in the designated time frame was counted and allocated to a MARR appliance category (e.g. freezer, clothes washer, range). The data generated through appliance counts carried out in December and January was adjusted to account for seasonal variation. In general, these two months receive the lowest number of appliances (estimated to be 70% of the average amount of appliances collected in the other ten months). These counts provided data on the total number of units entering a facility as well as the relative distribution by category of appliance.

Using the appliance counts to establish an estimate of the annual quantity of major appliances collected, this annualized quantity was compared to the total scrap metal collected at each respective local government to provide an indication of the proportion of scrap metal that is major appliances. As shown in Table 11-1, major appliances represented 18-22% of the scrap metal received at these local government sites. A rounded average of 20% was selected to be a reasonable representation of the proportion of scrap metal that is major appliances, and this number was then applied to scrap metal data provided by other local government collectors to develop estimates of the appliances collected.

Table 11-1: Major Appliances as a Proportion of Scrap Metal at Local Government Sites

Appliance Type	Regional Distict of North Okanagan		Chilliwack		Capital Regional District		Cowichan Valley Regional District	
	composition	annual kg	composition	annual kg	composition	annual kg	composition	annual kg
Top/Bottom Refrigerators	39%	127,208	25.0%	40,421	35%	55,605	40%	62,400
Compact Refrigerators	1%	2,625	1.5%	2,410	4%	5,801	2%	3,729
Freezers	12%	39,432	14.2%	22,896	14%	22,048	11%	17,717
Room Air Con BC	1%	2,157	1.1%	970	1%	934	3%	4,011
Portable Air Cond BC	1%	2,663	5.5%	8,904	2%	2,450	3%	3,937
Dehumidifiers	0%	-	0.4%	629	2%	2,422	0%	-
Clothes Washers	11%	34,487	18.4%	29,712	8%	12,875	16%	25,291
Dryers	9%	29,529	11.1%	17,808	6%	9,799	9%	13,780
Ranges	7%	23,932	10.7%	17,582	18%	28,219	8%	11,886
Range Hoods	4%	14,462	1.2%	1,987	0%	765	2%	2,460
Built-In Ovens BC	1%	1,997	0.4%	713	2%	2,747	0%	-
Microwaves Built-In	0%	429	0.6%	900	1%	1,733	1%	929
Surface Cooking Units	1%	1,769	0.3%	562	1%	1,082	0%	-
Dishwashing Machines	13%	43,488	9.4%	15,221	7%	11,516	5%	8,413
Food Waste Disposers	0%	-	0.0%	62	0%	240	0%	-
Trash Compactors	0%	-	0.0%	-	0%	-	0%	-
Electric Water Dispensers	0%	-	0.0%	-	0%	314	0%	-
Estimated Annual Large Appliances	100%	324,176	100%	160,776	100%	158,550	100%	154,552
Annual Scrap Metal		1,805,000		876,710		782,000		718,350
Appliances as a % of Scrap Metal		18%		18%		20%		22%

Based on site visits to non-profit collection sites, it was concluded that these sites tend to operate like local government recycling depots and are often the only recycling option in their community. Consequently, any scrap metal data provided by non-profit collectors was assumed to be composed of 20% major appliances (by weight).

For private collectors, estimating the amount of major appliances as a proportion of scrap metal was based on conversations with experts in the scrap metal collection industry who reported that between 1 and 4% of the scrap metal collected could be attributed to major appliances. The application of the 1 to 4% range to scrap metal data supplied by private collectors was done based on a number of factors:

- The presence of other local government and private collectors in the area;
- Accessibility by the general public (e.g. is there a public drop off area at the site, is the site conveniently located relative to other collectors);
- If the collector accepts refrigerant-containing appliances;
- Fees charged to receive major appliances relative to other collectors in the area; and
- If the collector also collects automobiles.

Some collectors were able to provide data on the number of refrigerant-containing appliances they collected. In these instances, this data was used to extrapolate the total quantity of appliances collected, using the following assumptions:

- The average weight of a refrigerant-containing appliance is 75kg (based on unit weights and estimated quantity of refrigerant-containing appliances discarded); and
- 40% of appliances received by the collector are refrigerant-containing appliances (based on estimated BC discards).

Some small collectors (i.e. those that collect less than 10 appliances per month) were able to provide an estimate of the total number of appliances they collect, but were unable to report by type of appliance. In these instances, the average weight of a large appliance was assumed to be 60 kg (based on the total weight of appliances discarded divided by the total number of units discarded).

For some parts of the province, no data were available from the collectors (generally regional districts). In these instances, a per capita quantity of 4.0 kg/capita was applied to the population for the area to provide an estimated of the quantity of appliances discarded. This per capita estimate is based on data provided by the Regional District of North Okanagan (RDNO) – one of the local governments that participated in an appliance count. RDNO was the only identified collector of major appliances in the area and therefore their data is assumed to reflect the collection of all major appliances discarded in that regional district. RDNO's per capita collection rate of 4.0 kg was assumed to be a reasonable representation of the *total* amount of large appliances collected in a given geography, particularly in those areas with similar characteristics (combination of urban and rural). The 4.0 kg/capita estimate was applied to 4 regional districts that collectively represent 3% of BC's population, because no other data were available.

Some collectors provided volume-based data for scrap metal. To convert this data to weight-based data, it was assumed that a 40 cubic yard container of mixed, loose scrap metal weighed 4,000 kg.¹⁷

The estimated amount of appliances collected by retailers (through take back services offered to customers) was based on data provided through the retailer surveys completed by MARR. These surveys queried retailers on the extent that appliance delivery services are used by customers, whether they offer an appliance take-away service, and how often a customer will take advantage of the take away service. The data suggests that roughly 27% of major appliances sales involve a pickup of an end-of-life appliance; therefore it was concluded that 27% of appliances are collected through the retailer system. This estimate is in line with Hilken and Hanson's 2005 study which allocated 29% of major appliance collection to retailers.

Although the project team surveyed representatives of refurbishers and scavengers, the data resulting from these surveys were insufficient for the purposes of estimating the quantity of appliances collected. Instead, an approximate estimate of the amount of large appliances collected by refurbishers and scavengers was based on establishing estimates for all other collectors and then allocating the remaining tonnes to refurbishers and scavengers. These estimates, although approximate, are believed to fairly represent that proportion of collection activities undertaken by refurbishers and scavengers based on the suite of research conducted during the course of this study.

Details on the reliability of the data gathered can be found in Appendix F.

11.1.2 Estimate of Quantity Collected

Based on various assumptions noted above, it is estimated that approximately 35,699 tonnes of major appliances were collected in 2012. Table 11-2 shows the estimated quantity of large appliances collected by regional district and for the province overall. The quantities listed by regional district reflect the combined tonnes of major appliances collected by local government, non-profit and private sector collectors. Quantities collected by bounty

¹⁷ Based on volume to weight conversion estimates provided by the US EPA, SWANA and confirmed by CARI representative.

programs, retailers, scavengers and refurbishers are presented separately, with tonnes reported on a provincial basis. This would be similar for 2013 as no significant changes in collection processes were reported.

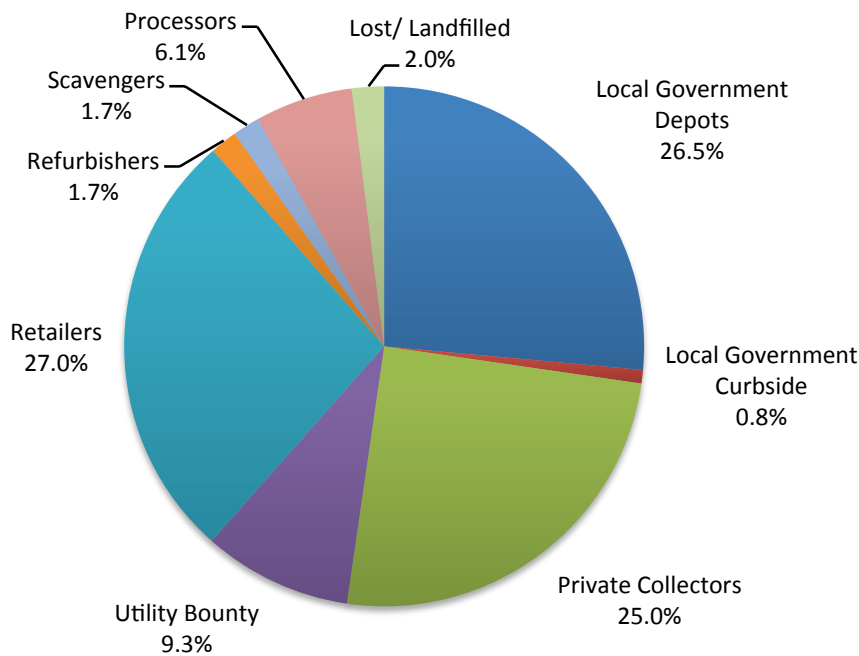
Table 11-2: Estimated Tonnes of Collected Major Appliances by Region

Local Government, Non-Profit and Private Collectors including Processors (by regional district)	Estimated Tonnes Collected
Alberni Clayoquot	82
Bulkley-Nechako	294
Capital	1,520
Cariboo	206
Central Coast	22
Central Kootenay	271
Central Okanagan	997
Columbia Shuswap	204
Comox Valley/Strathcona	606
Cowichan Valley	318
East Kootenay	332
Fraser Valley	1,453
Fraser-Fort George	497
Kitimat Stikine	164
Kootenay-Boundary	198
Metro Vancouver	11,027
Mount Waddington	66
Nanaimo	600
North Okanagan	324
Northern Rockies	24
Okanagan Similkameen	339
Peace River	313
Powell River	129
Skeena Queen Charlotte	76
Squamish-Lillooet	349
Sunshine Coast	172
Thompson-Nicola	656
Subtotal	21,240
Other Collectors (tonnes collected provincially)	Estimated Tonnes Collected
<i>Bounty programs</i>	3,368
<i>Retailers</i>	9,836
<i>Refurbishers</i>	627
<i>Scavengers</i>	627
TOTAL	35,699

11.1.3 *Estimated Share of Quantity Collected by Collector Type*

Figure 11-1 shows the types of collectors and the estimated share of discarded appliances each collects (based on the total tonnes collected). This data reflects primary collection activities, meaning that these are the first receivers of a discarded appliance. By weight collected, the most significant collectors are retailers, local government depots (includes landfills, transfer stations and recycling depots) and private collectors, which together account for over three-quarters of the collected tonnes of major appliances.

Figure 11-1: Share of Major Appliances Collected by Type of Collector



11.2 *Capture Rate*

The capture rate is calculated as the amount of appliances collected divided by the amount of appliances available to collect in 2012, the year chosen as the baseline for the study.

$$\text{Capture Rate} = \frac{\text{Amount Collected}}{\text{Amount Available to Collect}}$$

The numerator for the calculation is discussed in section 11.1.2 above and is estimated at about 35,699 tonnes. The denominator is the estimated amount of appliances discarded in 2012, as discussed in section 7.1.3 and is estimated at about 36,428 tonnes.

An estimated 98% (35,699 tonnes) of all discarded appliances are collected by a variety of collectors. Table 11-3 shows estimated tonnes captured by type of collector.

Table 11-3 Share of Total Capture Rate by Collector Type

Collector	Collection (t)	Collection (%)
Local Government Depot	9,627	26.5%
Local Government Curbside	305	0.8%
Private Collector/ Peddler	9,101	25.0%
Utility Bounty	3,368	9.3%
Retailer	9,836	27.0%
Refurbisher	612	1.7%
Scavenger	612	1.7%
Processor Company	2,208	6.1%
Total Collected	35,699	98%
Lost/ Landfilled	729	2%
Total Discarded Appliances	36,428	100%

11.3 Recycling Rate

The recycling rate is the amount of the materials from the appliances captured that is recycled into materials to be used again in the manufacture of new products when compare to the total amount of materials that were available to collect.

$$\text{Recycling Rate} = \frac{\text{Amount of Materials Recycled}}{\text{Amount of Material Available to Collect}}$$

Figure 11-2 below and Table 11-4 show how the tonnes of discarded appliances in 2012 “flowed” from the point of collection through to end markets. As indicated, approximately 98% of end-of-life major appliances are collected for the purposes of recycling; once the appliances are processed into recyclable and non-recyclable fractions, approximately 74% of the total weight of end-of-life major appliances is ultimately recycled. This would be the same rate for 2013 as there were no significant changes in historic sales, life span or collection systems between these two years.

Details on the reliability of the data can be found in Appendix F.

Figure 11-2: Flow of Discarded Major Appliances in BC

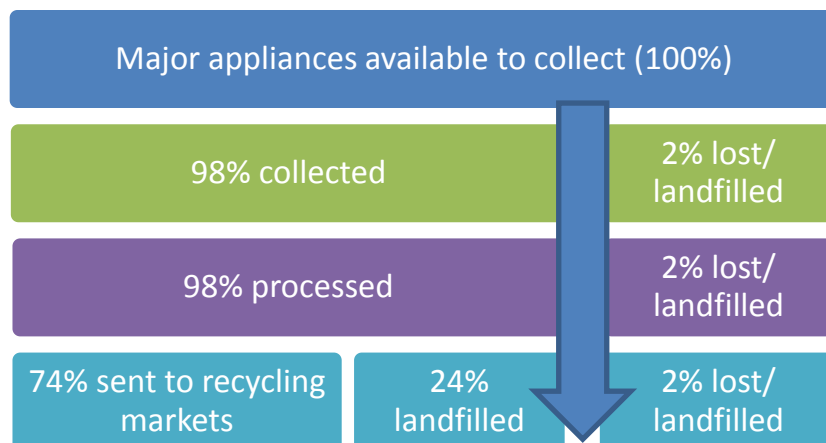


Table 11-4: Flow of Major Appliances in BC (by tonne)

	Local Government Depot	Local Government Curbside	Private Collector/ Peddler	Utility Bounty	Retailer	Refurbisher	Scavenger	Processors	End Market	Lost/ Landfilled	Total
Available to Collect (t)											36,428
Collection (t)	9,628	305	9,101	3,369	9,836	627	627	2,208	-	729	36,428
Collection %	26%	1%	25%	9%	27%	1.7%	1.7%	6.1%	0.0%	2%	100%
Processing (t)								35,699		729	36,428
Processing %								98%	0%	2%	100%
Final destination (t)									26,775	9,653	36,428
Final destination %									74%	26%	100%

12 SUMMARY

The infrastructure for managing end-of-life major appliances in BC consists of a number of different inter-related players:

- Major appliance generators (residential and commercial owners of household appliances);
- Collectors and collection sites (local government, private sites, retailers, not-for-profit, etc);
- Processors; and
- End markets.

In general, major appliances at end-of-life flow through the levels of various organizations from collection through to end markets. There are 305 drop off collection sites in BC including local government sites, private collectors and processor's sites. In addition to the drop off sites, there are direct pick up programs offered by retailers, utility bounty programs, local government curbside collection, and by peddlers.

Major appliances are stored at collection sites for varying lengths of time to accumulate a load of sufficient size to ship to the processor economically. In some cases, appliances are compacted or baled to reduce the volume they occupy and reduce transportation costs. Transportation from collector to processing site can occur by truck, rail or barge, or some combination of the three transportation modes, depending on location. The distance that a collection site is from the processors in the Lower Mainland has a significant influence on the revenue potential of scrap metal collection.

A GIS analysis of the collection sites in BC that accept all categories of major appliances showed that 98.5% of the BC population had access to a drop off location within the driving times set by the Stewardship Agencies of BC (drive time of 30 minutes for urban communities and 45 minutes for rural communities). When considering if there are fees charged for the service, 93.6% of the BC population has access to collection sites that do not charge a fee.

Appliances are made of metal (both ferrous and non-ferrous) (71%), plastics (21%) and other materials (8%) like glass, rubber and sometimes paper, electronics, refrigerants, oils, mercury switches and other substances of concern. Decommissioning is the process for removing substances of concern and preparing the major appliances

remove them, although the likelihood of receiving appliances with mercury switches is low and continues to diminish with time.

Almost all appliances in BC flow to two metal shredders in the Lower Mainland. Processed ferrous metal is generally sold to end markets in Asia, and non-ferrous metals are sold into the North American market. There is a 98% recovery of metals for recycling in the shredding process.

An estimated 36,428 tonnes of major appliances were available to collect in 2012 and 35,699 tonnes are estimated to have been collected in 2012. This represents a 98% collection rate. Only 2% are estimated to have been lost to illegal dumping or landfills.

All of the collected appliances were sent to processors that mechanically separate scrap metal into recyclable metal and non-recyclable components. Based on a composition estimate that indicates that appliances are composed of 75% metal, the resulting recycling rate of *all major appliances available for collection* is 74%. The remaining 26% is made up of materials that went to landfill from the shredding facilities as “shredder fluff”, including plastic, foam, glass and rubber, and materials that did not get captured and processed (2% of available appliances).

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APPENDIX A PRODUCT DEFINITIONS

Updated July 15, 2013

Major Appliance Recycling Roundtable - Product List and Definitions

Background:

The following document provides a detailed list of products and relevant definitions captured by the Major Appliance Recycling Roundtable's (MARR) stewardship program in British Columbia.

Administrative Program Fee (APF) rates can be found in the summary table below, as well as through the product list. These APFs will be applied to the sale and supply of new major household appliances in British Columbia, effective **August 1, 2013**. These fees will be reported and remitted to MARR on a calendar quarter basis by registered MARR participants (manufacturers, distributors, retailers) who have joined MARR to fulfill their regulatory obligations. All sales reported to the program must be categorized into the 17 fee categories outlined below.

Definition of Included Products – All Categories:

The program includes major household appliances powered either by 120 volt or 240 volt input power that have been designed for use in residential homes, including those that use natural gas or propane for heating purposes. Appliances used in or sold for industrial, commercial and/or institutional (IC&I) applications that have the same essential design characteristics as major household appliances, as defined above, are also included. All program products that are used for the purpose of refrigeration or freezing must contain a compressor and/or refrigerant gases.

Excluded Products:

The following products are excluded from the program:

- Products that do not meet the definitions of included products listed above, including non-electrical appliances and small electrical appliances captured by the Canadian Electrical Stewardship Association's *BC Small Appliance and Power Tool Recycling Program*
- Products designed for use in recreational vehicles or boats
- Products designed for use in industrial, commercial or institutional (IC&I) applications (grocery stores, restaurants, retail stores, hotels etc.) unless otherwise specified below
- Residential and commercial furnaces whether electric, gas or heating oil
- Hot water heaters whether electric or gas that are permanently attached to the home's water supply system

- Products that are used for the purpose of refrigeration or freezing are chilled by thermoelectric cooling and do not contain a compressor and/or refrigerant gases
- Products listed as excluded in the detailed product list included below

Summary of Product Categories and APF Rates:

Refer to the pages below for a detailed definition and list of included products for each category.

Product Category	APF Rate
1. Full-Size Refrigerators & Wine Coolers/Beverage Centres	\$1.25
2. Compact Refrigerators & Wine Coolers/Beverage Centres	\$1.25
3. Freezers	\$1.25
4. Room Air Conditioners	\$1.25
5. Portable Air Conditioners	\$1.25
6. Dehumidifiers	\$1.25
7. Clothes Washers	\$1.10
8. Clothes Dryers	\$1.10
9. Ranges	\$1.10
10. Range Hoods and Downdrafts	\$1.10
11. Built-In Ovens	\$1.10
12. Built-In and Over the Range Microwave Ovens	\$1.10
13. Surface Cooking Units	\$1.10
14. Dishwashers	\$1.10
15. Food Waste Disposers	\$1.10
16. Trash Compactors	\$1.10
17. Electric Water Dispensers	\$1.10

1. Full-Size Refrigerators & Wine Coolers/Beverage Centres		APF Rate: \$1.25	
Category Definition	<ul style="list-style-type: none"> • A self-contained insulated cabinet greater than 6.4 cubic feet in volume that uses electricity to power a heat pump to cool the inside of the cabinet • May include Built-In and free-standing type models and units dedicated for garage applications • May include separate compartments that cool the interior of each compartment to temperatures above and/or below the freezing point • Typically used for the storage of household foods and/or beverages that require or benefit from cool or frozen storage • Must contain a compressor and/or refrigerant gases for cooling purposes 		
Product List and Details	<p>Side-by-side refrigerators with two vertical doors separating a cooling and a freezing compartment</p> <p>Top mount refrigerators with two horizontally mounted doors separating a cooling and freezing compartment where the freezing compartment is located on the top</p> <p>3+ Door refrigerator with separate cooling and freezing compartments where either compartment has more than a single door</p>	<p>Bottom mount refrigerators with two horizontally mounted doors separating a cooling and freezing compartment where the freezing compartment is located on the bottom</p> <p>Dedicated cooling only refrigerators where there is no freezing compartment</p> <p>Full size refrigerators intended as wine coolers and beverage centres</p>	<p>Beer keg and wine dispensers with the ability to dispense contents through one or more attached taps. Unit performs cooling, preserving and dispensing functions.</p>
Products Excluded from Program	<ul style="list-style-type: none"> • Cold boxes not powered by electricity • Refrigerators and wine coolers/beverage centres that use thermoelectric cooling and do not contain a compressor and/or refrigerant gases • Refrigerators designed for use in industrial, commercial or institutional (IC&I) applications 		

2. Compact Refrigerators & Wine Coolers/Beverage Centres		APF Rate: \$1.25
Category Definition	<ul style="list-style-type: none"> A self-contained insulated cabinet of 6.4 cubic feet or less in volume that uses electricity to power a heat pump to cool the inside of the cabinet May include built-in, free-standing and countertop type models May include separate compartments that cool the interior of each compartment to temperatures above and/or below the freezing point Typically used for the storage of household foods and/or beverages that require or benefit from cool or frozen storage Must contain a compressor and/or refrigerant gases for cooling purposes 	
Product List and Details	<p>Refrigerator or refrigerator/freezer combinations with one or more door or drawer</p> <p>Beer keg and wine dispensers with the ability to dispense contents through one or more attached taps. Unit performs cooling, preserving and dispensing functions.</p>	<p>Under-counter refrigerator drawers which are designed to be installed below the countertop and which include one or more pull-out drawers. May include units with cooling only compartments or a combination of cooling and freezing compartments.</p> <p>Compact refrigerators intended as wine coolers and beverage centres</p> <p>Compact refrigerators with a built-in cooking unit(s) and/or sink integrated into a single chassis and sold as a single unit</p>
Products Excluded From Program	<ul style="list-style-type: none"> Cold boxes not powered by electricity Battery or 12VDC powered portable coolers Portable single bottle wine chillers Compact refrigerators and wine coolers/beverage centres that use thermoelectric cooling and do not contain a compressor and/or refrigerant gases Compact refrigerators designed for use in industrial, commercial or institutional (IC&I) applications 	

3. Freezers		APF Rate: \$1.25
Category Definition	<ul style="list-style-type: none"> A self-contained insulated cabinet that uses electricity to power a heat pump to cool the entire cabinet to temperatures below the freezing point Typically used to freeze residential food store to prevent spoilage May include built-in and free-standing type models Must contain a compressor and/or refrigerant gases for cooling purposes 	

3. Freezers			APF Rate: \$1.25
Product List and Details	<p>Chest freezers where the door hinges on a horizontal access and food is placed into the freezer from the top</p> <p>Upright freezers where the door hinges on a vertical access and food is placed into the freezer from the front</p>	<p>Under-counter freezer drawers with freezing compartments under the counter <i>(Note: combination under-counter refrigerator/freezer drawers captured by Category 2)</i></p> <p>Compact freezers of 6.4 cubic feet or less in volume</p>	<p>Ice makers including countertop units where the ice is stored either inside the unit or dispensed through a mechanism in the wall of the unit</p>
Products Excluded from Program	<ul style="list-style-type: none"> • Battery or 12VDC power portable freezing units • Freezers that use thermoelectric cooling and do not contain a compressor and/or refrigerant gases • Ice makers that have been integrated into a free-standing or countertop water dispenser (refer to Category 17) • Freezers designed for use in industrial, commercial or institutional (IC&I) applications 		

4. Room Air Conditioners			APF Rate: \$1.25
Category Definition	<ul style="list-style-type: none"> • Factory made encased unit designed for cooling air in a residential setting where the refrigeration equipment is entirely contained with the chassis • Designed to be mounted in a window or through a hole in a wall • Delivers conditioned air to an enclosure or zone without ducts for air supply or return • May also perform air heating functions in addition to air cooling • Must contain a compressor and/or refrigerant gases for cooling purposes 		
Product List and Details	Horizontal, vertical and through the wall air conditioners	Horizontal and/or vertical air conditioners mounted in a window	
Products Excluded from Program	<ul style="list-style-type: none"> • Central air conditioners connected to a residential furnace or a home's central ventilation system • Split and mini-split systems, packaged terminal air conditioners and heat pumps • Residential space heaters that are either mounted permanently to the home or are portable and have been designed to be moved from place to place in the home • Air cleaners • Room air conditioners that use thermoelectric cooling and do not contain a compressor and/or refrigerant gases • Room air conditioners designed for use in industrial, commercial or institutional (IC&I) applications 		

5. Portable Air Conditioners		APF Rate: \$1.25	
Category Definition	<ul style="list-style-type: none"> • Factory made encased unit designed for cooling air in a residential setting where the refrigeration equipment is entirely contained with the chassis • Typically (but not always) mounted on wheels and designed to be moved from place to place within a building structure • May also perform air heating functions in addition to air cooling • Must contain a compressor and/or refrigerant gases for cooling purposes 		
Product List and Details	Air conditioners that are specifically designed to be moved from place to place within a residence		
Products Excluded from Program	<ul style="list-style-type: none"> • Residential space heaters that are either mounted permanently to the home or are portable and have been designed to be moved from place to place in the home • Portable fans • Air cleaners • Portable air conditioners that use thermoelectric cooling and do not contain a compressor and/or refrigerant gases • Portable air conditioners designed for use in industrial, commercial or institutional (IC&I) applications 		

6. Dehumidifiers		APF Rate: \$1.25	
Category Definition	<ul style="list-style-type: none"> • Electrically powered dehumidifiers that are self-contained units encased in an assembly that includes a refrigerating surface, electric motor, circulating fan and a drain system to collect condensation • Can be moved from place to place in the home • Must contain a compressor and/or refrigerant gases for cooling purposes 		
Product List and Details	Free standing dehumidifiers designed for use in a residential setting that can be moved from place to place in the building or structure		
Products Excluded from Program	<ul style="list-style-type: none"> • Dehumidifiers permanently installed on a home's furnace or ventilation/air duct system • Dehumidifiers that use thermoelectric cooling and do not contain a compressor and/or refrigerant gases • Dehumidifiers designed for use in industrial, commercial or institutional (IC&I) applications 		

7. Clothes Washers		APF Rate: \$1.10	
Category Definition	<ul style="list-style-type: none"> An electrically powered machine designed for washing clothing or other fabrics that fills with water at selected temperatures and washes, rinses and extracts water from the fabrics or clothing 		
Product List and Details	<p>Top loading clothes washers where access to the washing tub is through a horizontally mounted door/lid on the top of the machine</p> <p>Front loading clothes washers where access to the washing tub is through a vertically mounted door located on the front of the machine</p>	<p>Top or front loading clothes washers designed to be assembled by the end user into a stacked laundry unit with a clothes dryer</p> <p>Stacked laundry product that contains both a washer and a dryer (each with their own tub/drum) that has been manufactured in a common chassis as a single unit</p>	<p>Top or front loading clothes washers that also dries clothes or fabric following the washing cycle within the same tub/drum</p>
Products Excluded from Program	<ul style="list-style-type: none"> Clothes washers that are not electrically powered Dry cleaning equipment Clothes washers designed for use in industrial, commercial or institutional (IC&I) applications (e.g. load capacity greater than 10kg, permanently affixed to the floor) 		

8. Clothes Dryers		APF Rate: \$1.10
Category Definition	<ul style="list-style-type: none"> An electrically powered machine designed for drying clothing or other fabrics that dries by evaporation through the use of various combinations of heat, air flow and tumbling Either electricity or gas may be used as the heat source 	
Product List and Details	<p>Top loading clothes dryers where access to the washing tub is through a horizontally mounted door/lid on the top of the machine</p> <p>Front loading clothes dryers where access to the washing tub is through a vertically mounted door located on the front of the machine</p>	<p>Top or front loading clothes dryers designed to be assembled by the end user into a stacked laundry unit with a clothes washer</p>
Products Excluded from Program	<ul style="list-style-type: none"> Steamers Irons Pressing machines Dry cleaning equipment Drying racks or shelving Clothes dryers designed for use in industrial, commercial or institutional (IC&I) applications (e.g. load capacity greater than 10kg, permanently affixed to the floor) 	

9. Ranges		APF Rate: \$1.10	
Category Definition	<ul style="list-style-type: none"> A thermal cooking appliance designed for residential use comprised of a surface cook top and an oven where the surface cook top, oven and controls are consolidated in one chassis at the factory Thermal cooking in a range can be accomplished through induction or with either electricity, gas or a combination of electricity and gas as the energy source 		
Product List and Details	<p>Free standing ranges that stand on the floor or base cabinet and support, does not have to be permanently fastened or fitted to the dwelling structure or adjacent cabinets</p> <p>Ranges that include a warming drawer</p>	<p>Slide in ranges that are floor supported with an oven below the surface cooktop and designed to be installed between or adjacent to kitchen cabinets, but not support by such cabinets</p> <p>Ranges with dual cavities within the same chassis platform</p>	<p>Drop-in ranges that have an oven below the cooktop surface and are designed to be installed in a cavity in a kitchen base cabinet and supported by a cabinet counter top or similar structure</p>
Products Excluded from Program	<ul style="list-style-type: none"> Electric or gas barbecues Ranges designed for use in industrial, commercial or institutional (IC&I) applications 		

10. Range Hoods & Downdrafts		APF Rate: \$1.10	
Category Definition	<ul style="list-style-type: none"> Hoods or other devices designed for residential use and installed above or in proximity to ranges or surface cook-tops designed to capture and filter and/or exhaust cooking odours and vapours Canopies can be comprised of a variety of material types, including steel and glass 		
Product List and Details	<p>“Downdraft” kitchen cooking ventilation systems that are separate from the cooking unit and that capture, filter and remove air downward from a fixed or pop-up venting system along rear or sides of a cooking surface using either an internal or external power blower</p>	<p>Range hoods with fans that are connected to an externally vented duct and that discharge cooking vapours and odours to the exterior of the home</p>	<p>Decorative hoods including wall mount, canopy mount, undercabinet, insert, and island hood</p> <p>Range hoods that contain a filter and fan that are not connected to an externally vented duct and circulate air back into the home</p>
Products Excluded from Program	<ul style="list-style-type: none"> Ventilation equipment used for purposes other than filtering or ventilating odours and vapours from ranges or surface cooking units Fire suppression systems Range hoods & downdrafts designed for use in industrial, commercial or institutional (IC&I) applications 		

11. Built-In Ovens		APF Rate: \$1.10	
Category Definition	<ul style="list-style-type: none"> Separate ovens that are installed in a cavity in the wall, in a wall cabinet or fixed to the wall Controls can be independent units and can be installed separately Heating power may be provided by gas or electricity 		
Product List and Details	Built-in ovens Separate warming drawers	Built-in oven in combination with a microwave oven integrated into a single chassis and sold as a single unit	Double wall ovens with two built-in compartments integrated into a single chassis and sold as a single unit
Products Excluded from Program	<ul style="list-style-type: none"> Built-in ovens designed for use in industrial, commercial or institutional (IC&I) applications 		

12. Built-In & Over the Range Microwave Ovens		APF Rate: \$1.10	
Category Definition	<ul style="list-style-type: none"> A completely self-contained cooking appliance designed for residential use that is mounted to walls or cabinets of a home and that uses electricity to create electromagnetic energy to cook food within a single cavity Units may also incorporate the ability to cook using thermal heating capability in addition to electromagnetic energy 		
Product List and Details	Over the range microwave ovens with or without hood vent combinations	Microwave ovens that are designed to be permanently installed and affixed with kitchen cabinetry	
Products Excluded from Program	<ul style="list-style-type: none"> Free standing counter-top microwave ovens Built-in & over the range microwave ovens designed for use in industrial, commercial or institutional (IC&I) applications 		

13. Surface Cooking Units			APF Rate: \$1.10
Category Definition	<ul style="list-style-type: none"> A unit with heating/cooking elements that is designed to be built-into the surface of a residential counter-top and that is separate from an oven Cooking can be accomplished through induction or with either electricity, gas or a combination of electricity and gas as the energy source 		
Product List and Details	<p>Cook-tops installed into the counter top where the controls are either integrated into the unit or installed separately from the cook-top</p>	<p>Surface cooking units used in IC&I applications that have the same design characteristics as residential surface cooking units and otherwise meet the definitions above</p>	
Products Excluded from Program	<ul style="list-style-type: none"> Portable electric and/or gas cooktops containing one or more burner Surface cooking units designed for use in industrial, commercial or institutional (IC&I) applications 		

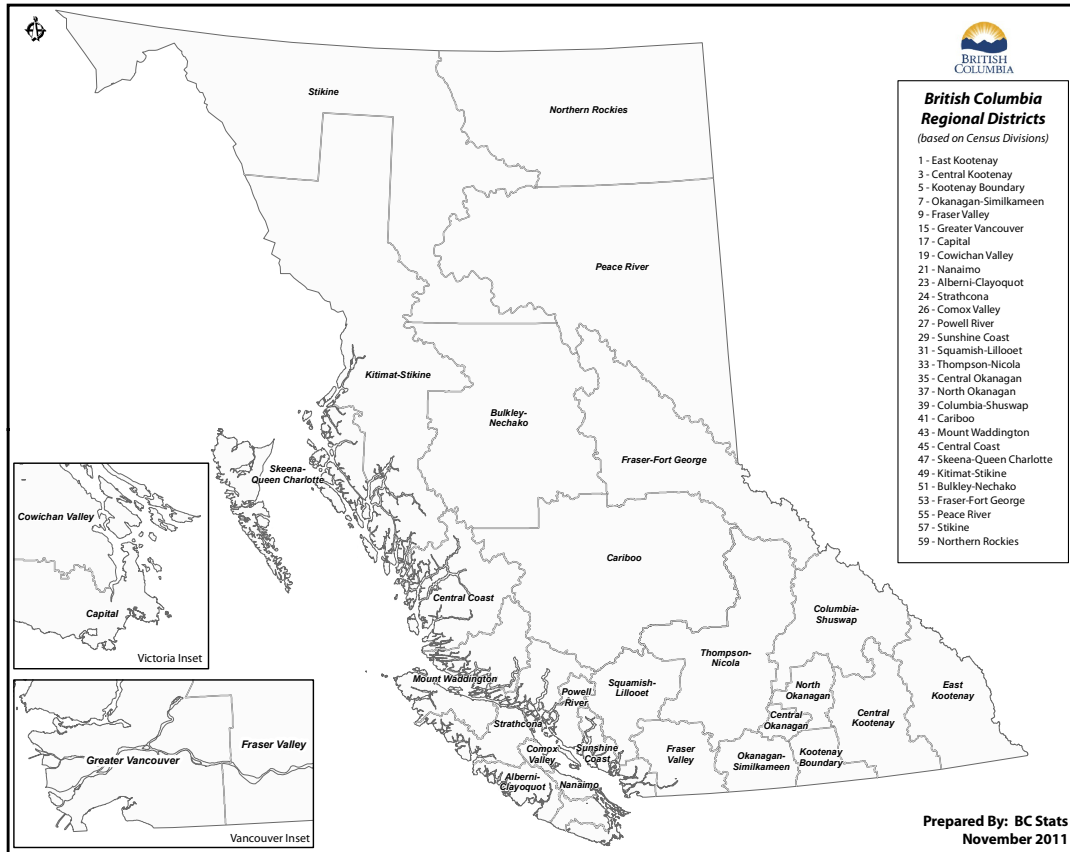
14. Dishwashers			APF Rate: \$1.10
Category Definition	<ul style="list-style-type: none"> An electrically powered appliance designed for residential use that uses water to wash dishes within one or more self-contained compartments 		
Product List and Details	<p>Portable dishwashers designed for mobile use within the kitchen that have a functional top, wheels, hoses and cord attached and that can be hooked up to a kitchen water source</p>	<p>Built-in dishwashers that are permanently installed under the counter, dropped into kitchen cabinetry or are in-sink mounted</p> <p>Dishwasher drawers with slide in access. This may include single or double drawers</p>	<p>Convertible dishwashers that can operate as a portable or built-in dishwasher</p>
Products Excluded from Program	<ul style="list-style-type: none"> Dishwashers designed for use in industrial, commercial or institutional (IC&I) applications 		

15. Food Waste Disposers		APF Rate: \$1.10
Category Definition	<ul style="list-style-type: none"> Electrically powered apparatuses used to dispose of food waste or to process household refuse for subsequent disposal 	
Product List and Details	Food waste disposers that are integrated into the plumbing system of a household and that use electromechanical means to shred food waste so that it can be disposed of through the household plumbing system	
Products Excluded from Program	<ul style="list-style-type: none"> Food waste disposers designed for use in industrial, commercial or institutional (IC&I) applications 	

16. Trash Compactors		APF Rate: \$1.10
Category Definition	<ul style="list-style-type: none"> Electrically powered apparatuses used to receive and compress household refuse for subsequent disposal 	
Product List and Details	Trash compactors whether permanently installed or portable that consist of a storage container, a power source and a compaction ram	
Products Excluded from Program	<ul style="list-style-type: none"> Trash compactors designed for use in industrial, commercial or institutional (IC&I) applications 	

17. Electric Water Dispensers		APF Rate: \$1.10
Category Definition	<ul style="list-style-type: none"> Electrically powered devices designed for residential use that are used to dispense chilled and/or heated water 	
Product List and Details	Water dispensers mounted under the counter and integrated into the residential plumbing system that are used to dispense chilled and/or heated water	Electric Water Dispensers used in IC&I applications that have the same design characteristics as residential electric water dispensers and otherwise meet the definitions above
Products Excluded from Program	<ul style="list-style-type: none"> Free standing and countertop water dispensers that dispense chilled and/or heated water, including those that are or are not integrated into the residential plumbing system, models that contain an ice maker and models that contain an integrated compact refrigerator. Electric water dispensers designed for use in industrial, commercial or institutional (IC&I) applications 	

APPENDIX B MAP OF BC REGIONAL DISTRICTS



APPENDIX C SOURCES OF MAJOR APPLIANCE UNIT SALES DATA USED IN LIFESPAN MODEL

Table C-1: Sources of Unit Sales Data for Major Appliances in BC Used In Lifespan Model

MARR #	Product	Annual Unit Sales
1	Full Size Refrigerators	<ul style="list-style-type: none"> CAMA 2002 (1997 to 2002), CAMA 2005 (2000 to 2004) and CAMA 2012 (for 2006 and 2007). 2005 is average of 2004 and 2006. BC sales calculated as % of national sales for each year reported in CAMA reports. All are top/bottom until year 2000 when separate records of side by side were started. Split into full size and compact using 2007 proportions (75% full size; 25% compact).
2	Compact Refrigerators	<ul style="list-style-type: none"> CAMA 2002, 2005 and 2012 per above.
3	Freezers	<ul style="list-style-type: none"> National sales in CAMA 2002 (1997 to 2002), CAMA 2005 (2000 to 2004) and CAMA 2012 (for 2006 and 2007). 2005 is average of 2004 and 2006. BC sales as % of national total not provided so refrigerator values used.
4	Room Air Conditioners	<ul style="list-style-type: none"> National total room air conditioners 1997 to 2002 in CAMA 2002 (no details or discussion beyond reporting totals). Break out of % of national sales to BC not provided in CAMA for AC. BC sales estimated using proportion of households BC to Canada for each year from Canadian Census (Statistics Canada). Annual sales for Canada for all air conditioners 1997 to 2004 in CAMA (2002, 2005). CAMA 2012 reports air conditioner imports only (2006 to 2011). These values are used and split 50:50 room AC and portable AC.
5	Portable Air Cond BC	<ul style="list-style-type: none"> See discussion for room AC. Calculations assume portable and room air conditioners same values.
6	Dehumidifiers	<ul style="list-style-type: none"> No sales data identified. US shipments of de-humidifiers only data source which could be found. Canada assumed to be 10% of US value. BC proportion by year based on BC households as % of Canada. This estimate considered lower reliability than others because of very limited information. Actual total is likely higher.
7	Clothes Washers	<ul style="list-style-type: none"> Clothes washers reported by CAMA 2002, 2005 and 2012 for years which cover 1997 to 2011. BC sales as % of national sales reported for each year.
8b	<i>Electric Clothes Dryers</i>	<ul style="list-style-type: none"> Electric and gas clothes dryers reported separately by CAMA 2002, 2005 and 2012 reports for years which cover 1997 to 2011. BC sales as % of national sales reported for each year. Total dryer category is combination of electric and gas dryers.
8a	<i>Gas Clothes Dryers</i>	<ul style="list-style-type: none"> Electric and gas clothes dryers reported separately by CAMA 2002, 2005 and 2012 reports for years which cover 1997 to 2011. BC sales as % of national sales reported for each year. Total dryer category is combination of electric and gas dryers.

MARR #	Product	Annual Unit Sales
8	Clothes Dryers	<ul style="list-style-type: none"> Electric and gas clothes dryers reported separately by CAMA 2002, 2005 and 2012 reports for years which cover 1997 to 2011. BC sales as % of national sales reported for each year. Total dryer category is combination of electric and gas dryers.
9a	Gas Ranges	<ul style="list-style-type: none"> Unit sales for gas, electric and total ranges for 1997 to 2011 were provided in CAMA 2002, 2005 and 2012 reports, along with % of national sales in BC.
9b	Electric Ranges	<ul style="list-style-type: none"> Unit sales for gas, electric and total ranges for 1997 to 2011 were provided in CAMA 2002, 2005 and 2012 reports, along with % of national sales in BC.
9	Ranges	<ul style="list-style-type: none"> Total ranges category is combination of gas and electric ranges. All reported in CAMA 2002, 2005 and 2012.
10	Range Hoods	<ul style="list-style-type: none"> US sales shipments found for 2006 to 2010 in 2006-2001: PASSPORT-Personal Care Appliances in Canada, Euromonitor Int'l, Jan. 2012 Canada, Euromonitor 2012. Pro-rated to Canada by 10% of US; pro-rated to BC by population. This yielded values of 120,000 units per year so was reduced to 60,000 units per year as the 120,000 value seemed too high compared to other MARR products. It is likely that this estimate is still high but no better data is available at this time.
11	Built In Ovens	<ul style="list-style-type: none"> No data were available from CAMA. Preliminary estimate from Appliance Magazine which provided US Sales in 2007 to 2010: Appliance Magazine April 2011, U.S. Appliance Unit Shipments, Statistics. Pro-rated to BC by households (10% from US to Canada; 12.5% from Canada to BC).
12	Microwaves	<ul style="list-style-type: none"> MARR Plan includes built in microwaves only, and excluded portable microwave ovens. Total microwave oven sales from CAMA 2002, 2005 and 2012 reports. Built in % for 2006 to 2011 provided in CAMA 2012 report. 5 year rolling average calculated back to 1987 for each year. This percentage applied to total sales to estimate built in sales. Pro-rated to BC by households.
13	Surface Cooking Units	<ul style="list-style-type: none"> Surface cooktop values for Canada provided in CAMA 2002, 2005 and 2012 to cover years 1997 to 2011. Electric range values for BC as % of national sales were used.
14	Dishwashing Machines	<ul style="list-style-type: none"> Dishwasher values for Canada provided in CAMA 2002, 2005 and 2012 to cover years 1997 to 2011. Pro-rated to BC by households.
15	Food Waste Disposers	<ul style="list-style-type: none"> Annual food waste disposer shipment summary in CAMA 2002 and 2005 covers 1997 to 2004. No data CAMA 2011, so flat sales assumed from 2004. No market share data so pro-rated to BC by household counts for each year.
16	Trash Compactors	<ul style="list-style-type: none"> Annual US shipments for 2005 to 2010 from Statistica 2014. Pro-rated to Canada at 10% and to BC based on households. Six year rolling average used to approximate sales from 1987 to 2005.
17	Electric Water Dispensers	<ul style="list-style-type: none"> 2008 US sales data were found in Appliance Magazine and were pro-rated to Canada at 10% of US sales and to BC at 12% of Canadian sales.

Table C-2: Major Appliance Unit Sales Data in BC, 1987 to 1999 (Thousands of Units)¹⁸

	Major Appliance	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1 (a)	Total Refrigerators	106.6	106.8	106.6	106.0	105.3	108.2	108.0	105.4	103.1	101.7	122.8	106.9	92.7
	Top Bottom Refrigerators	98.2	98.5	98.3	97.8	97.1	99.5	99.5	97.3	95.3	94.0	111.5	99.6	86.1
	Side By Side Refrigerators	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	Full Size Refrigerators	98.2	98.5	98.3	97.8	97.1	99.5	99.5	97.3	95.3	94.0	111.5	99.6	86.1
2	Compact Refrigerators	8.4	8.4	8.3	8.3	8.2	8.7	8.5	8.1	7.8	7.7	11.3	7.3	6.6
3	Freezers	32.5	32.5	32.3	32.3	32.2	33.0	32.6	31.5	31.9	31.9	37.3	30.6	25.9
4	Room Air Conditioners	19.0	19.0	18.9	18.9	18.9	19.1	19.0	18.6	18.8	19.0	20.3	18.3	16.6
5	Portable Air Conditioners	19.0	19.0	18.9	18.9	18.9	19.1	19.0	18.6	18.8	19.0	20.3	18.3	16.6
6	Dehumidifiers	11.5	11.6	11.6	11.7	11.8	11.9	12.2	12.4	12.6	12.3	12.0	13.6	12.6
7	Clothes Washers	81.1	81.2	80.9	80.4	79.8	83.1	81.7	79.6	78.0	76.9	99.2	74.8	69.3
8A	Electric Dryers	64.5	64.6	64.4	64.1	63.7	65.6	65.0	63.7	62.3	61.9	75.2	61.7	57.5
8B	Gas Dryers	3.0	3.0	3.0	2.9	2.8	3.1	3.0	2.9	2.7	2.5	4.6	2.5	2.2
8	Clothes Dryers	67.4	67.5	67.4	67.0	66.6	68.8	68.0	66.6	65.1	64.4	79.7	64.2	59.7
9 (b)	Gas Ranges	7.0	7.0	7.0	7.0	6.9	7.1	7.2	7.0	6.8	6.4	7.9	7.8	6.0
9 (a)	Electric Ranges	66.0	66.1	65.9	65.7	65.4	66.8	66.5	65.3	64.5	64.0	73.5	65.0	59.4
9	Ranges	73.0	73.1	72.9	72.7	72.3	73.8	73.7	72.3	71.3	70.5	81.4	72.8	65.4
10	Built In Ovens	10.2	10.3	10.3	10.2	10.2	10.3	10.3	10.2	10.3	10.3	10.2	10.2	10.3
11	Range Hoods and Downdrafts	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
12 (A)	Microwaves (Total)	146.5	146.2	146.2	146.5	146.7	146.7	145.1	146.0	148.2	147.3	147.0	132.7	148.7
12	Microwaves (Built In and Over Range)	27.4	27.4	27.4	27.4	27.4	27.4	27.1	27.3	27.8	27.6	27.4	24.8	27.9
13	Surface Cooking Units	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	4.0	2.7
14	Dishwashing Machines	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	60.0	58.3
15	Food Waste Disposers	9.7	9.7	9.7	9.8	9.9	9.9	9.9	10.1	10.7	10.7	9.9	9.9	11.2
16	Trash Compactors	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3
17	Electric Water Dispensers	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4

Table C-3: Major Appliance Unit Sales Data in BC, 2000 to 2011(Thousands of Units)¹⁹

	Major Appliance	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
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¹⁸ Calculated for BC Based on National unit sales data provided in CAMA national reports.

¹⁹ Calculated for BC Based on National unit sales data provided in CAMA national reports

1 (a)	Total Refrigerators	91.5	94.7	102.3	119.7	126.8	143.2	158.2	158.9	154.1	132.5	140.6	128.1
	Top Bottom Refrigerators	74.7	76.9	81.8	83.0	80.0	88.3	95.1	93.8	87.4	75.7	77.9	69.1
	Side By Side Refrigerators	10.6	10.8	12.1	26.4	27.4	29.6	32.2	32.3	30.5	25.7	27.9	24.8
1	Full Size Refrigerators	85.3	87.7	93.9	109.4	107.4	117.9	127.3	126.1	117.9	101.4	105.8	93.8
2	Compact Refrigerators	6.2	7.0	8.4	10.3	19.4	25.4	30.8	32.8	36.2	31.1	34.8	34.3
3	Freezers	33.9	31.9	34.0	36.5	36.7	34.8	33.2	31.2	28.4	26.0	30.9	26.7
4	Room Air Conditioners	19.6	20.0	25.2	35.1	39.6	42.8	46.0	49.4	42.2	26.8	21.3	38.3
5	Portable Air Conditioners	19.6	20.0	25.2	35.1	39.6	42.8	46.0	49.4	42.2	26.8	21.3	38.3
6	Dehumidifiers	13.0	10.7	10.5	17.3	17.7	13.8	14.0	14.7	15.5	15.1	14.6	14.8
7	Clothes Washers	69.6	71.4	75.9	76.6	79.4	56.4	35.2	43.9	49.6	51.6	53.0	47.2
8A	Electric Dryers	55.4	59.8	65.1	67.1	71.0	74.7	78.3	82.4	83.4	81.3	84.2	77.4
8B	Gas Dryers	1.9	1.2	1.4	1.4	1.4	1.3	1.3	1.4	1.3	1.1	1.2	1.3
8	Clothes Dryers	57.3	61.1	66.5	68.5	72.3	76.0	79.6	83.7	84.7	82.3	85.3	78.7
9 (b)	Gas Ranges	5.7	4.6	5.8	6.7	6.9	8.2	9.5	12.0	11.3	10.9	12.1	12.1
9 (a)	Electric Ranges	60.5	61.8	70.7	77.7	76.5	75.0	73.0	74.9	74.9	69.7	77.2	71.5
9	Ranges	66.2	66.4					82.5	86.9	86.3	80.5	89.2	83.6
10	Built In Ovens	10.3	10.2	10.1	10.5	10.4	9.9	9.6	12.2	9.9	7.8	8.5	9.6
11	Range Hoods and Downdrafts	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	
12 (A)	Microwaves (Total)	137.6	118.3	148.8	122.6	151.8	146.8	121.7	126.0	125.1	118.2	122.1	126.1
12	Microwaves (Built In and Over Range)	25.9	22.2	27.6	22.6	28.5	28.0	23.7	22.7	21.9	21.3	25.0	26.5
13	Surface Cooking Units	2.9	3.3	3.5	4.4	3.9	5.3	6.5	4.7	4.8	4.4	4.7	4.5
14	Dishwashing Machines	58.2	58.9	69.7	72.2	80.0	94.8	92.3	95.0	83.6	70.6	69.3	68.7
15	Food Waste Disposers	12.9	10.0	11.3	10.7	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
16	Trash Compactors	1.4	1.4	1.3	1.2	1.1	1.6	1.5	1.3	1.0	0.6	0.6	0.6
17	Electric Water Dispensers	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.1	1.1	1.1	1.1

APPENDIX D REFRIGERANT OVERVIEW AND REGULATIONS

Overview of Refrigerant Type and Trends

Chlorofluorocarbons (CFCs) were a commonly used refrigerant in cooling appliances such as refrigerators, freezers, air conditioners, some dehumidifiers and some water coolers. CFCs are a powerful ozone depleting substance. Regulations were put in place to phase out their use once their relationship to ozone depletion was understood. Hydrochlorofluorocarbons (HCFCs) replaced CFC's after CFC use was phased out in 1996. Though these are also ozone depleting, they are less potent. These also are regulated to phase out their use. Hydrofluorocarbons (HFCs) have been introduced to replace HCFC's and while HFCs are beneficial in that they do not deplete ozone, they have a high global warming potential and so are considered problematic in terms of greenhouse gas emissions (GHGs).

Proper removal of refrigerant is mandated under ODS (Ozone Depleting Substance) regulations. To remove the refrigerant, certified technicians puncture the refrigerant line and refrigerant is extracted into a collection tank using an extraction pump. The technician puts a label or tag on the appliance to indicate that the refrigerant has been removed. Based on the refrigerant type, it is either destroyed or reclaimed and reused.

Regulatory Context

The *Montreal Protocol on Substances that Deplete the Ozone Layer* is an international agreement, to which Canada is a signatory and which through the Canadian Council of Ministers of Environment (CCME) the provincial and federal governments have agreed to share responsibility to reduce the production and import of ODS²⁰. There was a target to eliminate chlorofluorocarbon (CFC) use by 1996. A 90% reduction target has been agreed for hydrochlorofluorocarbons (HCFCs) and a 100% by 2030. In 2013, there was an agreement to use the Montreal Protocol to phase out the use of HFCs as more climate friendly alternatives are available²¹.

BC Regulation 387/99 "The Ozone Depleting Substances and other Halocarbons Regulation" requires that extraction of refrigerants be performed in accordance with Environment Canada's Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems and prohibits the release of ozone depleting refrigerants²² into the atmosphere. The regulation further requires that refrigerants can only be extracted by an approved technician, that equipment used to extract refrigerants must meet specified performance standards and that all units that have had the refrigerant extracted must be properly tagged and labelled.

An approved technician is one that has trade credentials (or is a trainee or apprentice) and has taken an environmental awareness course approved by Environment Canada and the BC Ministry of Environment. The record keeping provision requires that the person who evacuates the ozone-depleting substances must put a permanent tag or label on product and record in a service log (leak test results, type and amount removed, that it is empty, date, name and registration of approved person). This regulation does not apply if the person is operating an enterprise that is certified by a director for following a code of practice for motor vehicle dismantling and recycling (which essentially meets the requirements of this regulation), which may be the case for some of the auto-wreckers and scrap metal companies interviewed. Only approved technicians can purchase or possess ODS for servicing equipment. ODS can only be sold to approved technicians. Only approved technicians can service equipment. Records must be maintained of all sales of ozone-depleting substances (except when part of a product) and there must be a tag stating what is in a product for all new products or those brought into BC. The regulation also notes the phase out dates for specific refrigerants with a final date of January 1, 2015 being the latest for any

²⁰ SBR (2009)

²¹ Hower (2013)

²² In the regulation, ozone-depleting refrigerants are defined as Class I (those containing specific chlorofluorocarbons (CFCs), halons and chlorocarbons) and Class II (hydrochlorofluorocarbons (HCFCs)). Hydrofluorocarbons (HFCs) are not included.

charging using Class I substances. Fines can be up to \$50,000 for some infractions (including using the right containers, labelling and record keeping) or up to \$200,000 for any other infraction.

APPENDIX E BACKGROUND ON OTHER SUBSTANCES OF CONCERN

A study done by SBR International in 2009 that examined the appliance collection system in Ontario reported that there are other substances of concern that may be found in the appliances received by collectors. These substances include mercury, PCBs, heavy metals and polyurethane foam.

The Ontario Association of Municipal Recycling Coordinators (AMRC) guidelines for mercury component removal indicate that mercury can be found in:

- Mercury switches that were used in appliances like the lids of chest freezers (stopped in all makes by 2000) and washing machines (prior to 1972, used to sense when the machine was out of balance or turn off the machine when opened);
- Safety shut off mechanisms for pilot lights of some gas ranges (until 2007) and potentially in some gas dryers; and
- Fluorescent lights that backlight the control panels on some stoves and washing machines.

While the use of mercury in certain appliances ceased for different appliances at different times, prior to that, mercury was only used by some manufacturers for some models, not in all models leading up to the change. The SBR report (2009) noted that mercury switches would only have been found in 5% of freezers and 31% of gas ranges available for collection in 2008 and that this would decline to only 2% of freezers and 6% of gas ranges available for collection in 2020. As the use of mercury switches in washing machines ceased in 1972, it would be very unlikely to collect one of these types of washing machines now as they would have reached end-of-life in the previous decades.

In terms of the other substances of concern noted in the AMRC guidelines, PCBs were used as a dielectric in capacitors in some refrigerators and freezers prior to 1978 so there is a very low probability of collecting an appliance with PCBs now as most of these appliances would have reached end-of-life in the previous decades. Heavy metals were identified as being in circuit boards and the use of circuit boards is increasing as more features are added to appliances. There may also be compressor oil from refrigeration appliances.

Hanson and Hilken (2005) noted that foam used as insulation in refrigerators and freezers (not air conditioners or dehumidifiers) prior to 2003 contained CFCs or HCFCs which are ODS and greenhouse gases. After 2003, manufacturers used foam that used HFC which did not impact the ozone layer but was still a greenhouse gas. There is a trend towards using foam without ODS and that is more climate friendly but many older units with CFCs or HCFCs will still be collected for some time.

APPENDIX F DATA RELIABILITY

Details are provided here on data reliability for the collector data, the amount available to collect and the recycling rate.

Data uncertainty associated with the collector data stems from the following issues:

- Collectors generally do not track data specific to appliances;
- The quality of the data received from collectors;
- Limited or no data supplied by some collectors;
- The potential for double-counting; and
- Market variability.

Collectors generally do not track data specific to appliances

With the exception of retailers and utility bounty programs, collectors regard major appliances as a form of scrap metal and consequently data is generally not collected on the number of appliances collected. As a result, almost all of the collector data is based on reasonable assumptions made by the collector or the study team. One exception is appliances containing refrigerants. As many sites pay for refrigerant removal by the unit, some sites maintain data on number of refrigerated units that were serviced.

The quality of the data received from collectors

If the total amount of scrap metal is known, many collectors were able to provide an estimate on the percentage of scrap metal that is appliances; however because there has not been a need to quantify appliances previously, this is not an exercise that collectors are well-practiced in and, in many cases, the estimates provided reflected the collector's best guess rather than any measured amount.

To mitigate the impact of poor estimates, all collector estimates were reviewed for consistency and as required, some collector estimates were revised to reflect a more reasonable approach to the data.

Limited or no data supplied by some collectors

Many of the collectors contacted during the course of this study indicated that they did not know the amount of scrap metal they collected or they were not willing to share this information. Local government collectors were more likely to track and provide the information. The issue of no available data was more prevalent with private sector collectors who were frequently unwilling to share data or attempt to estimate the quantity of appliances or scrap metal collected. The challenge to provide estimates was more significant for collectors that do not have on-site scales. In several cases, quantitative data was provided on a volumetric basis and converted to weights using industry standard calculations.

Potential for double counting

Many primary collectors will directly or eventually sell their collected appliances to a consolidator or processor. These buyers are typically primary collectors as well. In addition, some primary collectors (such as retailers) may ship their collected appliances to local government or private collection sites. The study team attempted to identify where primary collectors sold their scrap metal in order to avoid the potential for double counting. This was particularly challenging as primary collectors will often vary the company they sell their metal to, based on factors such as price paid and location. To the extent possible, the estimates developed for each collector were reviewed so that the resulting data would reflect primary collections only.

Market variability

This study is a snapshot of the major appliance collection system in BC in the fall of 2013. The number of collectors, where they are located, prices paid, fees charged and available markets are fluid and are subject to change.

As a market driven system, much depends on the market price, primarily of “tin” – the ferrous metal category that most appliances fall into. As the price goes up, there are more collectors (both new and those willing to expand their range of accepted items) and more interest in separating out higher value metals. If there are fees, they may be reduced, and certainly more will be paid for discarded appliances. When prices fall, the reverse may be true. This can change the flow of the materials considerably.

Other broader factors may play a role as well such as economic activity within the province as well as within a specific region- both for sales of appliances and resulting end-of-life ones as well as for transportation costs. Annual data from local governments shows that the amount of metal collected can vary year to year.

Available to collect

The estimated denominator for the recycling rate calculation is based on calculations carried out by the Lifespan Model which assumes that each product purchased will be at end-of-life within a reasonably set period of time. In some cases the product may last a shorter or longer period. The model is designed to account for products that are available to collect within a few years of their projected lifespan, but some products last many more years than projected (for instance some refrigerators are 30 years or older when available to collect), and others break down or are discarded in a period much shorter than the projected lifespan range, due to house renovations and other reasons. This leads to some slight differences between the tonnages calculated through a Lifespan Model, and the actual tonnages available to collect. It would require an extensive field study for one year to estimate the end-of-life tonnage more accurately. For this reason, Lifespan Models are generally used for this type of calculation.

Recycling rate

The most significant uncertainty factor associated with the calculation of the recycling rate is the application of composition data for the average appliance. Although the application of composition data is a reasonable approach to estimating the amount materials actually available for recycling, appliance composition will vary with time as appliance construction and consumer preferences change. In addition, processors are exploring opportunities to recover more materials from their shredder residue, such as the plastics which could increase the overall proportion of the appliance that gets recycled.