APPENDIX G

CRD-P001 – GASIFICATION TECHNOLOGIES

GASIFICATION TECHNOLOGIES

CHARACTERIZATION OF WASTE RESOURCES IN THE CAPITAL REGION

PREPARED FOR CAPITAL REGIONAL DISTRICT

FINAL REPORT – SEPTEMBER 2016

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Talent with Energy – twe is a strategy and project development services consultancy specialized on sustainable and emerging energy technologies.

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Abbreviations

ASTM	*American Society for Testing of Materials*
AWT	*Advanced Waste Treatment*
BC	*biomass content*
BCC	*biogenic carbon content*
CDM	*Clean Development Mechanism*
CRD	*Capital Regional District*
DLC	*Demolition and Land Clearing Waste*
EfW	*Energy from Waste*
HHV	*Higher Heating Value*
ICI	*Industrial, Commercial and Institutional Waste*
LHV	*Lower Heating Value*
REC	*renewable energy content*
TWE	*Talent with Energy*
UNFCCC	*United Nations Framework Convention on Climate Change*
WBS	*Waste Breakdown Structure*

Content

List of figures

List of tables

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Introduction

In this study we present an assessment of waste resources available within the Capital Region, with the aim to enable CRD gain a better understanding of the potential for energy recovery associated with these resources, and to inform the planning and the development of energy from waste initiatives across the Region.

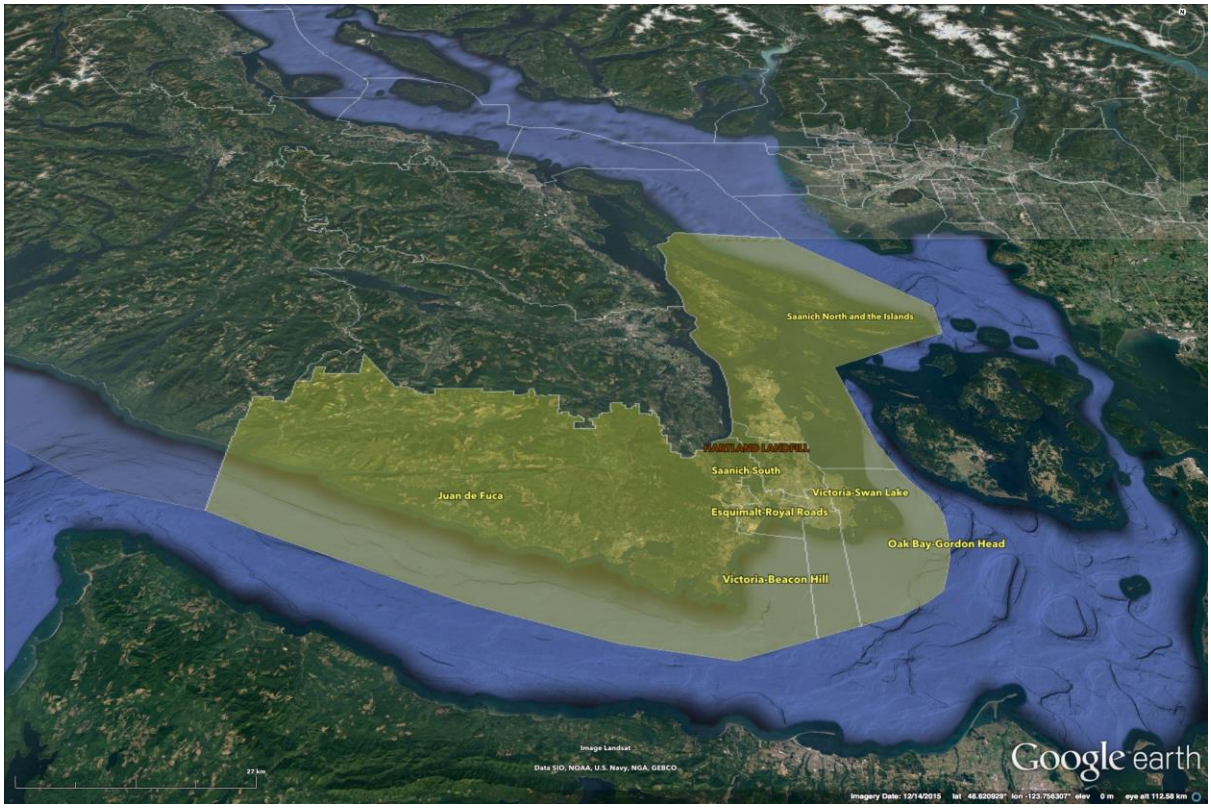
The analysis developed by Talent with Energy (TWE) for this study builds on the results of composition studies for the solid waste streams collected across the region, and a proprietary methodology originally developed by TWE within the context of the City of Sydney Advanced Waste Treatment Master Plan.

The aim of the assessment is to derive highly representative estimates of key waste properties of interest to energy recovery initiatives, including:

- composition analysis;
- elemental analysis;
- energy content;
- biomass fraction;
- renewable energy content; and
- biogenic carbon content.

It is envisaged that knowledge of these properties will enable CRD to conduct a detailed assessment of the energy recovery potential across a wide range of alternative waste treatment (AWT) options.

Figure 1. CRD Region



Resource Assessment

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Overview

In this section we present a scalable scenario analysis framework developed by TWE for the CRD to carry out a preliminary assessment of key waste properties of relevance to thermal conversion, enabling in particular the evaluation of "first-order" estimates of the potential for energy recovery associated with residues from waste management facilities across the Capital Region.

a detailed assessment of a wide range of waste properties for individual waste and aggregated waste streams, including:

- Composition analysis;
- Elemental analysis;
- Energy content;
- Biomass fraction;
- Renewable energy content; and
- Biogenic carbon content.

Through being made available in this Study, knowledge of these properties enables CRD and prospective project developers to conduct detailed assessments of the energy recovery potential across a wide range of proposed thermal conversion schemes.

The methodology used in this study, was developed originally by TWE within the scope of the foundation study of the City of Sydney *Advanced Waste Treatment Master Plan* (TWE 2014).

The analysis framework developed specifically for the CRD builds on a combination of elemental analysis data, sourced from (Niessen 2010) for the range of materials typically found in the domestic and commercial and industrial waste streams, and data from a composition study for solid waste streams collected within the Capital Region, developed for the CRD by Sperling Hansen Associates (SHA, 2010).

Step-by-step Methodology

The table below illustrates the key steps in the methodology used to calculate waste resource and calorific values in this study.

Each step is described in detail in the remainder of this section. Later in the report aspects of the methodology are also repeated alongside the presented data and figures for clarity of the calculation component conducted.

Table 1. Step-by-step methodology

STEP 1. **COMPOSITION ANALYSIS**	Aggregate waste material composition data from kerbside bin audit (reported according to EPA definitions) by: • **waste category,** eg. materials with similar production methods or characteristics (Oils, Paper, Plastics, Wood, etc.); and • **waste fractions,** eg. homogeneous fractions for the purpose of processing (recyclable, combustible, putrescible, inert, hazardous, etc.);
STEP 2. **ELEMENTAL ANALYSIS**	Calculate chemical composition expressed in terms of its content, by weight, of carbon (C), hydrogen (H), oxygen (O), nitrogen (N), sulphur (S), inorganic compounds (Ash) and water content (Moisture); and by weight for each waste category and fraction;
STEP 3. **CALORIFIC VALUES**	Calculate Gross and Net Calorific Contents for each waste category and fraction, on an *as received* and *dry-basis*, on the basis of elemental analysis data.
STEP 4. **RENEWABLE FRACTIONS ANALYSIS**	Calculate biomass, renewable energy, and biogenic carbon content from elemental analysis data in accordance with methods published by the Clean Energy Regulator and the Department of the Environment.

Step 1. Composition analysis

The first step of the analysis is the sorting and aggregation of waste stream composition data from the source kerbside-bin and disposal-based audit activities according to a *Waste Breakdown Structure* (WBS), organized in four levels:

1. **Streams,** aggregating waste materials by source (e.g. Domestic, commercial and industrial, etc.);
2. **Fractions,** aggregating waste materials into homogeneous fractions for the purpose of processing (e.g. Recyclable, combustible, putrescible, inert, hazardous, etc.);
3. **Categories,** aggregating waste materials with similar production methods or characteristics (e.g. Oils, paper, plastics, wood, food wastes, etc.); and
4. **Materials,** the individual materials typically defined in waste audit activities (eg. For the paper and paper products category: newspapers, magazines, timber, leather, rubber, glass, etc.).

The allocation of each of the materials identified in the 2009-10 Composition Study according to the waste breakdown structure is presented in Table 2 through to Table 6 in Appendix A. 'Waste Breakdown Structure'.

Step 2. Elemental analysis

Detailed knowledge of the physicochemical properties of the different materials found in the waste stream is key to provide accurate estimates of waste characteristics such as moisture content, elemental analysis, and energy content. At this regard, waste sampling and characterization campaigns, carried out at quarterly intervals for a minimum period of 12 months horizon, are a critical activity in the development of energy from waste projects.

In the absence of detailed sampling data in the above described format we resort here to use in the interim an internationally benchmarked database of physico-chemical characteristics for waste materials and categories, sourced from (*Combustion & Incineration Processes*, 2010b), to provide these accurate estimates, and determine elemental composition including the following:

- **Moisture content** of homogeneous waste categories;
- **Ultimate analysis**, to determine elemental composition, by weight dry basis, in terms of key elements (carbon, hydrogen, nitrogen, oxygen and sulphur) and inert residuals (ash), conducted in accordance with standard test methods prescribed by the american society for standardisation and testing of materials (ASTM).

This data are presented in the tables in Appendix B.

Step 3. Energy contents

The energy content, calorific value or *heating value* of a fuel is defined on the basis of either of the following two conventions, as follows (*Biomass Gasification and Pyrolysis*, 2010a):

- the **Higher Heating Value (HHV)** or Gross Calorific Value, is the amount of heat released by the unit mass or volume of fuel (initially at the standard temperature condition of 25 °C) once it is combusted and the products have returned to the standard temperature, thus including the latent heat of vaporization of water in the combustion product; and
- the **Lower Heating Value (LHV),** is defined as the amount of heat released by fully combusting a specified quantity of fuel, minus the latent heat of vaporization of the water in the combustion product.

In addition, the heating values (HHV or LHV) can be reported on an *as received* (e.g. including moisture) and *dry basis*.

Throughout this study to ensure the consistency of data values and reporting we provide energy quantities and energy performances on a HHV basis.

The relationship between the LHV and HHV of a fuel is expressed as follows:

$$\boldsymbol{LHV = HHV - h_g}\left(\frac{9\boldsymbol{H}}{100} + \frac{\boldsymbol{M}}{100}\right) \quad (1)$$

where:

- $\boldsymbol{LHV}$ and $\boldsymbol{HHV}$ are the lower and higher heating values of the fuel;
- $\boldsymbol{h_g}$ is the latent heat of vaporization for water, 2,260 kJ/kg;
- $\boldsymbol{H}$ is the hydrogen content, by weight on an as received basis; and
- $\boldsymbol{M}$ is the moisture content, by weight on an as received basis.

The most reliable means of determining the heating value of a fuel is through experimental methods, such as the D5468 standard test method issued by the American Society for Testing of Materials (ASTM, n.d.) This method involves direct measurement of energy released from complete combustion of a sample of material in a confined reactor, the *calorimetric bomb*. Conducting such experiments on the basis of a yet undefined waste stream, over a statistically significant waste

campaign, is costly and beyond the scope of preliminary assessments such as the one presented for this Study.

Alternatively, a number of empirical relationships are available to estimate the heating value of fuels on the basis of its ultimate analysis and moisture content data.

Consistent with the approach for the evaluation of the heating values of feedstocks for pyrolysis (the high temperature anaerobic decomposition of organic material), and gasification processes (the high temperature non-combustion conversion reaction with oxygen or steam of organic materials) presented in (Basu, 2013) we compute the HHV (dry basis, db) based on the unified correlation published in (Channiwala & Parikh, 2002):

$$\boldsymbol{HHV_{db}} = 349.1 \cdot \boldsymbol{C} + 1178.3 \cdot \boldsymbol{H} + 100.5 \cdot \boldsymbol{S} - 103.4 \cdot \boldsymbol{O} - 15.1 \cdot \boldsymbol{N} - 21.1 \cdot \boldsymbol{Ash} \quad (2)$$

where $\boldsymbol{C}$, $\boldsymbol{H}$, $\boldsymbol{S}$, $\boldsymbol{O}$, $\boldsymbol{N}$, and $\boldsymbol{Ash}$ are the percentages, by weight, of carbon, hydrogen, sulphur, oxygen, nitrogen and ash, as determined by ultimate analysis on a dry basis.

Lower and Higher Heating Values, as received basis (ar) can be calculated from the respective dry basis (db) figures as follows:

$$\boldsymbol{HHV_{ar}} = \boldsymbol{HHV_{db}} \cdot \frac{\boldsymbol{M}}{100} \quad (3)$$

Step 4. Renewable content analysis

Three factors – biomass content, renewable energy content and biogenic carbon content (BCC) – are calculated on an as received basis for each resource stream and conversion strategy on the basis of the feedstock composition analysis data presented earlier.

Biomass content

The individual biomass fractions used for the estimation of the total biomass content have been selected according to methods prescribed in a general methodology document published under by the UNFCCC Clean Development Mechanism (EB CDM, n.d.), these are:

- **Biomass fractions:** Food, paper, green waste, wood, textile, leather and rubber;
- **Non-biomass fractions:** oils, plastic, construction and demolition waste, glass and metal, hazardous fractions and other (e-waste, whitegoods, shredder residues, etc.)

The biomass content is the weight of the biomass fractions as a percentage of the waste content on an as received basis

Renewable energy content

The renewable energy content is calculated as the ratio between the energy content (HHV, as received basis) for the biomass fractions and for the total resource stream.

Biogenic carbon content

The biogenic carbon content (BCC) for waste feedstocks is calculated as the ratio between the carbon content for the biomass fractions and the total resource stream (both on an as received basis).

2009-10 Composition Study – Resource Characterization

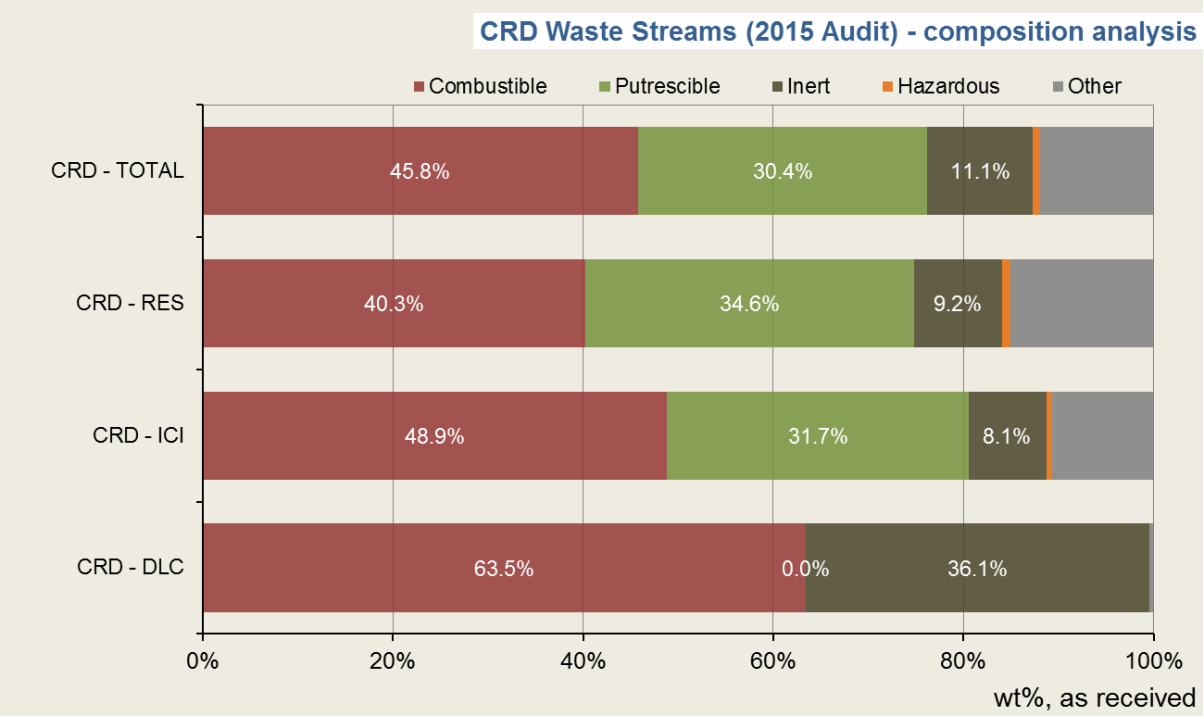
Composition Analysis

Composition data for the general waste bin stream from the 2009-10 composition study, reported on an *as received* basis have been aggregated according to five distinct process fractions, and the underlying homogeneous waste categories:

- Combustible (including Oils, Paper, Plastics, Rubber, Leather, Textile, and Wood);
- Putrescible (including Food and Green waste);
- Inert (Including C&D, Glass, and Metal);
- Hazardous; and
- Other (Including E-waste, Whitegoods and Other).

The resulting figures for the Capital Region are presented in Figure 2. below.

Figure 2. Capital Region Solid Waste Streams (2009-10) – composition analysis



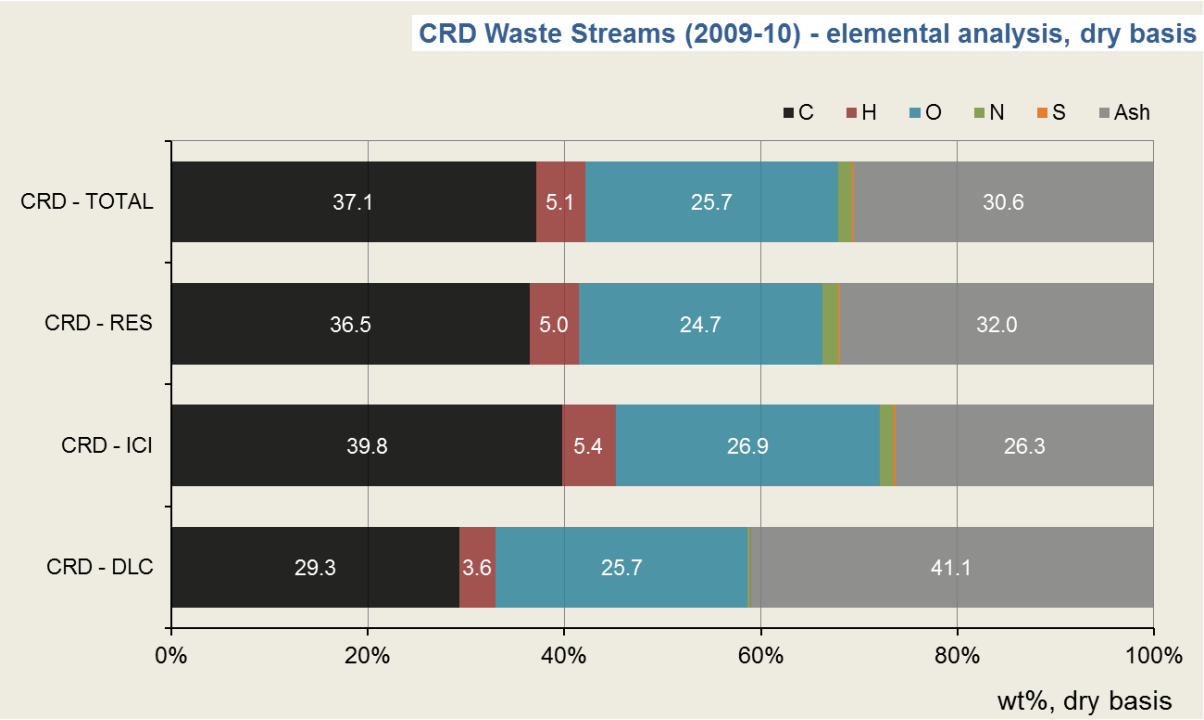
Elemental Analysis

A profile of the elemental composition for the solid waste stream as a whole and for each of the RES, ICI and DLC waste streams has been derived by applying the default elemental composition figures sourced from (*Combustion & Incineration Processes*, 2010c) to each homogeneous waste category, and aggregating these on a *dry basis* for each of the following elemental components:

- Carbon (C);
- Hydrogen (H);
- Oxygen (O);
- Nitrogen (N);
- Sulphur (S), and
- Ash.

In order to derive *dry-basis* composition figures, we have applied the moisture content for reference waste categories estimated at the point of collection (*as-discarded* basis). The resulting figures for solid waste collected across the Capital Region are presented in the diagram below.

Figure 3. Capital Region Solid Waste Streams (2009-10) – elemental analysis, dry basis

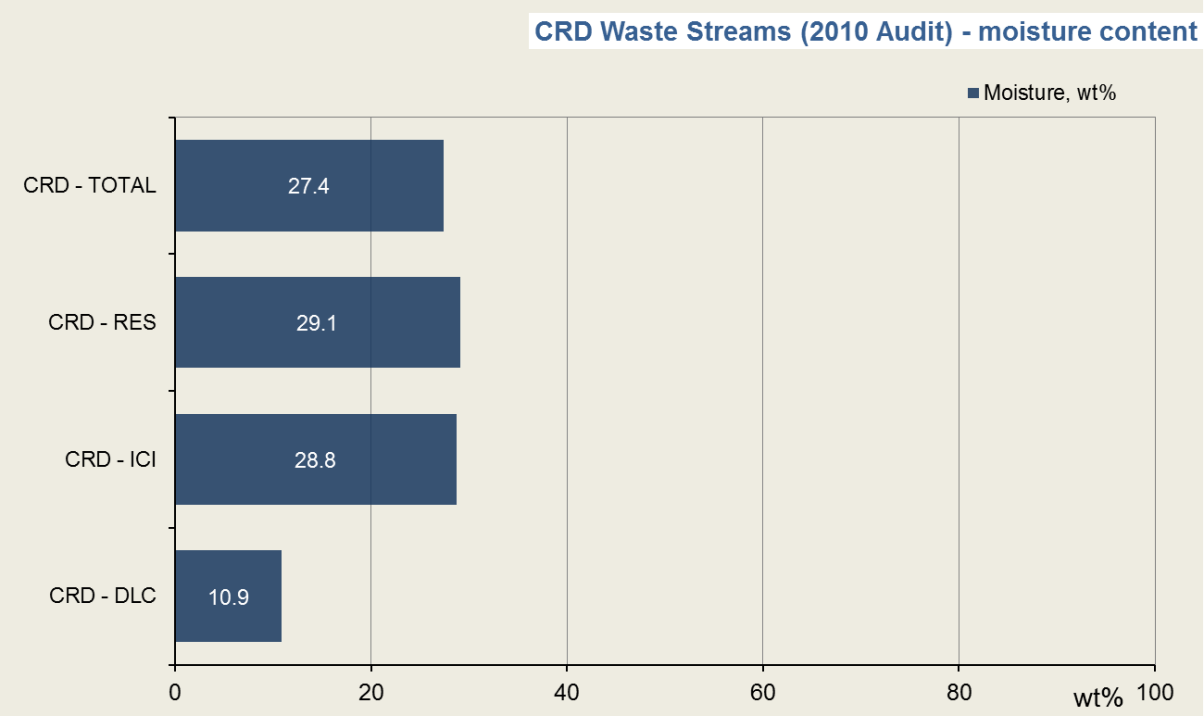


Moisture Content

The moisture content for the solid waste stream as a whole and for each of the RES, ICI and DLC waste streams has been derived by applying the default moisture figures sourced from (Niessen, 2010) to the composition figures for each of the homogeneous waste categories, and aggregating these across the entire waste stream.

In order to provide a representative estimate of the characteristics of the waste at the point of use, the moisture content estimates have been derived by applying to the dry basis composition figures reference values of moisture content for each individual homogeneous waste category estimated on an *as-fired* basis. The resulting moisture content figures are presented in the diagram**Error! Reference source not found.** below.

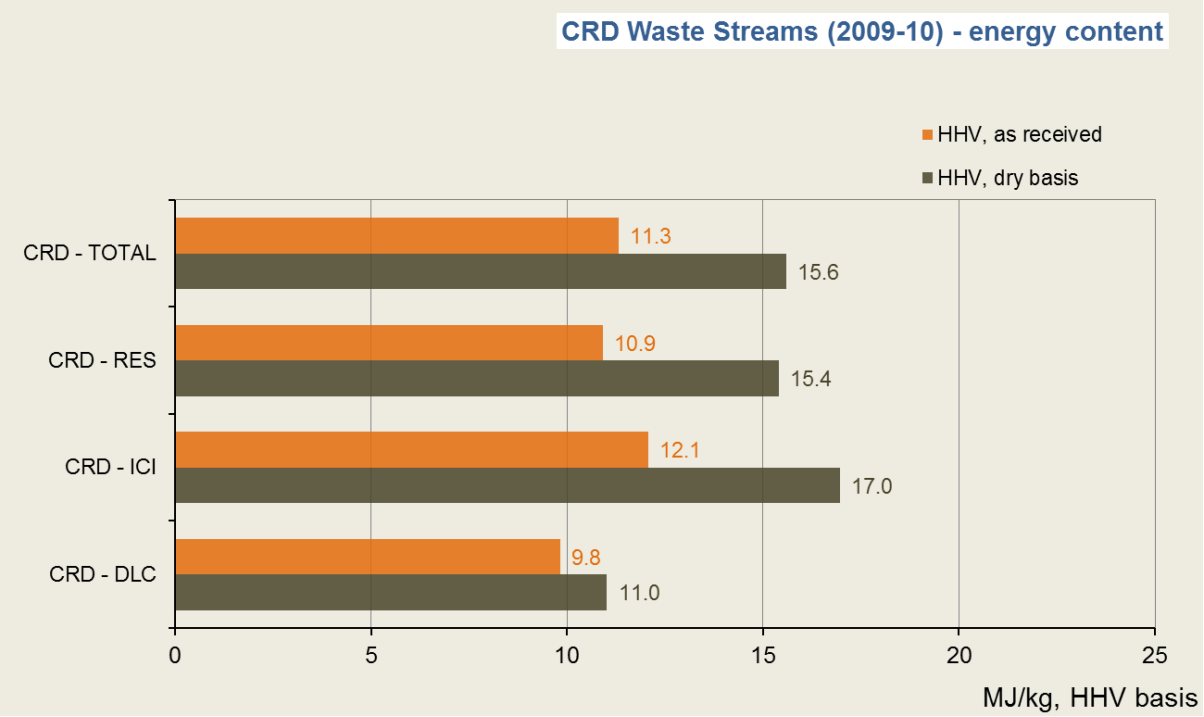
Figure 4. Capital Region Solid Waste Streams (2009-10) – moisture content



Energy content

The Higher Heating Value, dry basis (HHV_{db}) is calculated for the aggregated waste stream on the basis of the elemental analysis, through the empirical correlation in (Channiwala & Parikh, 2002), and from these derive the Higher Heating Value, as received basis by applying the moisture content figures as per Equation (3). The resulting figures are presented in the diagram in Figure 5 below.

Figure 5. Capital Region Solid Waste Streams (2009-10) – energy content



Renewable fractions analysis

For the purpose of this study we consider the renewable fraction of residual waste resources on the basis of its organic, or biomass fractions, in accordance with methods prescribed in the consolidated general methodology AM0025 *Alternative Waste Treatment Processes* published under by the UNFCCC Clean Development Mechanism (EB CDM, n.d.) these are[1]:

- **Biomass fractions:** Food, paper, green waste, wood, textile, leather and rubber;
- **Non-biomass fractions:** oils, plastic, construction and demolition waste, glass and metal, hazardous fractions and other (e-waste, whitegoods, shredder residues, etc.)

For the biomass or *renewable* fractions we assess the following key parameters:

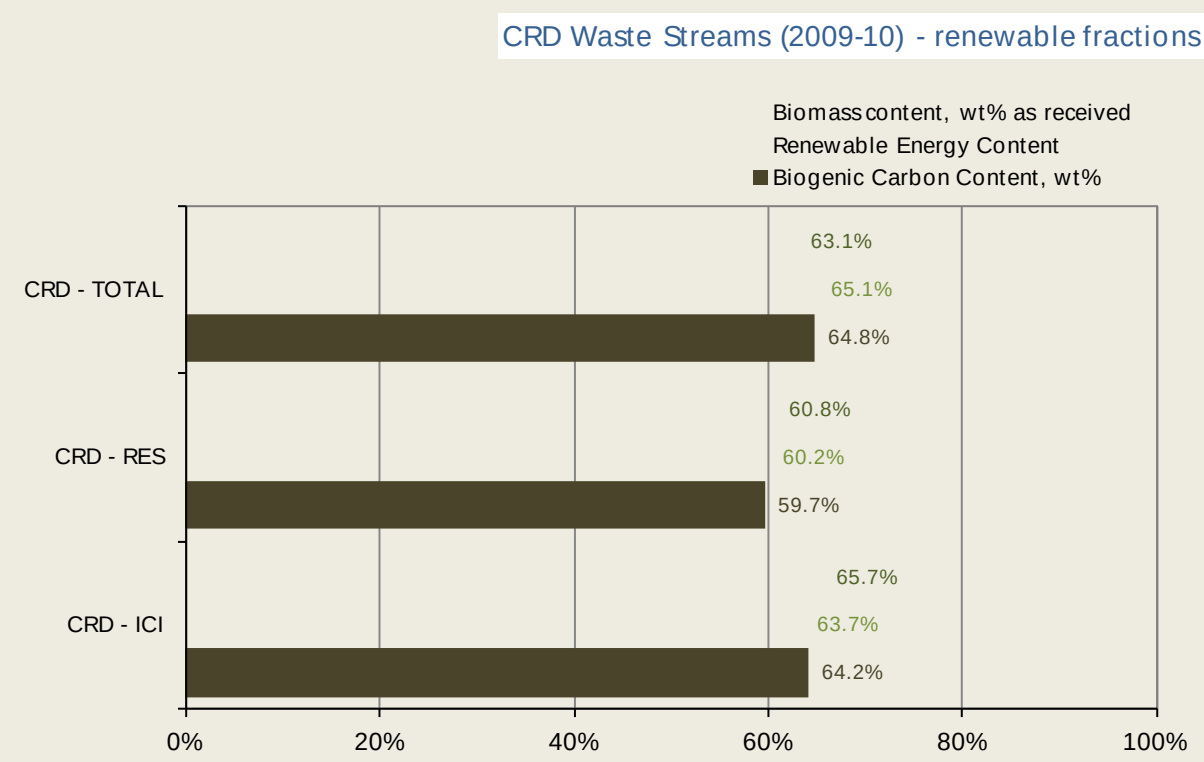
- **Biomass content (BC),** e.g. the ratio of the combined weight of the biomass fractions, to the weight of the incoming waste stream, both calculated on an *as received* basis;

[1] Within the context of this study we have considered the entire amount of wastes from the leather, rubber and textiles categories as eligible for consistency with the methods prescribed under (Executive Board, Clean Development Mechanism, United Nations Framework Convention on Climate Change*Approved consolidated baseline and monitoring methodology ACM0022 "Alternative waste treatment processes,"* 2012b), and (Department of Climate Change and Energy Efficiency, Commonwealth of Australia*National Greenhouse and Energy Reporting System Measurement - Technical Guidelines for teh estimation of greenhouse gas emissions by facilities in Australia*, 2012b).

- **Renewable energy content (REC),** e.g. the ratio of the combined energy content of the biomass fractions, to the energy content of the incoming waste feedstock, both calculated on an as received, higher heating value (HHV) basis; and
- **Biogenic Carbon Content (BCC),** e.g. the ratio between the carbon content for the biomass fractions and the total feedstock resource stream on the basis of elemental analysis data for each individual waste fraction.

The resulting figures for each of Biomass Content, Renewable Energy Content and Biogenic Carbon Content for MSW based on the results of the 2011 Kerbside Waste Bin Audit are presented in Figure 6 below.

Figure 6. Capital Region Solid Waste Streams (2009-10) – renewable fractions analysis



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Technical Appendices

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Waste Breakdown Structure

Combustible fractions

Table 2. Combustible fractions, waste breakdown structure

Category	Waste materials Domestic wastes[a]	Commercial and Industrial wastes[b]
Oils		
	C05-Oils	n/a
Paper		
	A01-Newspapers A02-Magazines, Brochures A03-Miscellaneous Packaging A04-Corrugated Cardboard A05-Package Board A06-Liquid Paperboard Containers A07-Disposable Paper Products A08-Print/Writing Office Paper A09-Composite (mostly paper) A092-Contaminated Soiled Paper A90-Nappies	Paper – all other Paper – office Compacted dry cardboard Loose dry cardboard Compacted wet cardboard Loose wet cardboard Waxed cardboard Compacted dry cardboard production spoils Loose dry cardboard production spoils
Plastics		
	E01-PET #1 E02-HDPE #2 E03-PVC #3 E04-LDPE #4 E05-Polypropylene #5 E06-Polystyrene #6 E07-Other Plastic E071-Foams E072-Plastic Bags E073-Film E08-Composite (mostly plastic)	Plastic – bags & film Plastic – hard Plastic – other Plastic – recyclable containers Polystyrene/foam
Rubber		
	Rubber	Rubber – shredded tyres Rubber – other Rubber – tyres/tubes
Textile		
	C02-Textile/Rags/Carpet (Organic) C03-Leather	Textile – cloth Textile – furniture Textile – leather/other Textile – mattress
Wood		
	C01-Wood/Timber	Wood – pallets/ other Wood – mdf/chipboard Wood – furniture Wood – fencing/board/pole (untreated) Wood – fencing/board /pole (treated) Sawdust

[a] Domestic waste: adapted from (APC 2011a,b)

[b] C&I waste: adapted from (DECCW 2010)

Putrescible fractions

Table 3. Putrescible fractions, waste breakdown structure

Category	Waste materials	
	Domestic wastes[a]	Commercial and Industrial wastes[b]
Food		
	B01-Food/Kitchen	Food/kitchen Food – dense
Green waste		
	B02-Garden/Vegetation B03-Other Putrescible	Vegetation – branches/grass clips Vegetation – tree stumps /logs

[a] Domestic waste: adapted from (APC 2011a,b)

[b] C&I waste: adapted from (DECCW 2010)

Inert fractions

Table 4. Inert fractions, waste breakdown structure

Category	Waste materials	
	Domestic wastes[a]	Commercial and Industrial wastes[b]
Construction and Demolition (C&D)		
	I01-Ceramics	Concrete/cement
	I02-Dust/Dirt/Rock/Inert	Clay
	I03-Ash/Earth-based	Plasterboard
		Rubble > 150mm
		Rock
		Tiles
		Bricks
		Soil/cleanfill
		Insulation
		Fibreglass
		Asphalt
		Sand
		Ceramic
		Dirt
Glass		
	D0121-Glass Clear Packaging/Containers	Glass – containers/other
	D0122-Glass Green Packaging/Containers	Glass – plate
	D0123-Glass Brown/Blue Packaging/Containers	
	D050-Mixed Glass/Fines	
	D02-Miscellaneous/Other Glass	
Metal		
	F01-steelCans Food & Pet	Metal – ferrous
	F011-steel Aerosols	Metal – non ferrous
	F012-steelPaint Cans	
	F03-Composite (mostly ferrous)	
	F02-Other ferrous	
	G01-Aluminium	
	G03-Composite (mostly non-ferrous}	
	G02-Other Non-Ferrous	

[a] Domestic waste: adapted from (APC 2011a,b)

[b] C&I waste: adapted from (DECCW 2010)

Hazardous fractions

Table 5. Hazardous fractions, waste breakdown structure

Category	Waste materials	
	Domestic wastes[a]	Commercial and Industrial wastes[b]
Hazardous		
	H01-Paint	Hazardous/special – chemical/clinical
	H02-Fluorescent tubes	Hazardous/special – light globes
	H03-Dry cell batteries	Batteries
	H04-Car batteries	
	H05-Household chemicals	
	H06-Building Materials	
	H07-Clinical (Medical)	
	-Gas Bottles	
	-Hazardous other	

[a] Domestic waste: adapted from (APC 2011a,b)

[b] C&I waste: adapted from (DECCW 2010)

Other fractions

Table 6. Other fractions, waste breakdown structure

Category	Waste materials	
	Domestic wastes[a]	Commercial and Industrial wastes[b]
Whitegoods		
	n/a	Whitegoods – washing machine/ fridges
e-Waste		
	Y57-Toner Cartridges	Electronics/electrical television etc.
	-Computer Equipment	Computer/office equipment
	-Electrical Items	Toner cartridges
	-Mobile Phones	
Other		
	XX00 -Other	Sludge
		Foundry sand
		Storm water
		Christmas decorations
		Animals
		Other

[a] Domestic waste: adapted from (APC 2011a,b)

[b] C&I waste: adapted from (DECCW 2010)

Reference waste materials

Detailed knowledge of the physicochemical properties of the different materials found in the waste stream is key to provide accurate estimates of waste characteristics such as moisture content, elemental analysis, and energy content.

These characteristics are key to estimate the energy recovery potential associated with individual and aggregate waste resource streams.

At this regard, waste sampling and characterization campaigns, carried out at quarterly intervals for a minimum period of 12 months horizon, are a critical activity in the development of energy from waste projects.

In the absence of detailed sampling data collected within the Capital Region, for the purpose of the analysis presented under Section 1 'Resource Assessment' we resort here to use instead an internationally benchmarked database of physico-chemical characteristics for waste materials and categories, sourced from (*Combustion & Incineration Processes*, 2010e), including the following:

- **moisture content** of homogeneous waste categories;
- **ultimate analysis**, to determine elemental composition, by weight dry basis, in terms of key elements (Carbon, Hydrogen, Nitrogen, Oxygen and Sulphur) and inert residuals (Ash).

Moisture content data

Table 7. Typical moisture contents of waste categories (wt%, as received)

Waste category	Moisture content, wt%	
	As-fired	As-discarded
Oils	0	0
Paper	24.3	8
Plastics	13.8	2
Rubber	13.8	2
Leather	13.8	2
Textiles	23.8	10
Wood	15.4	15
Food wastes	63.6	70
Yard wastes	37.9	55.3
Glass	3	2
Metal	6.6	2
Miscellaneous	3	2

Adapted from: (Niessen 2010), Table 4.7, p.111

Ultimate analysis data

Table 8. Ultimate analysis of waste categories (wt%, dry basis)

Category/material	Ultimate analysis (dry basis), weight %					
	C	H	O	N	S	Ash
Oils	66.85	9.63	5.2	2	0.02	16.3
Paper	45.4	6.1	42.1	0.3	0.12	5.98
Plastics	59.8	8.3	19	1	0.3	11.6
Rubber	77.65	10.35			2	10
Leather	60	8	11.5	10	0.4	10.1
Textiles	46.2	6.4	41.8	2.2	0.2	3.2
Wood	48.3	6	42.4	0.3	0.11	2.89
Food wastes	41.7	5.8	27.6	2.8	0.25	21.85
Yard wastes	49.2	6.5	36.1	2.9	0.35	4.95
Glass	0.52	0.07	0.36	0.03	0	99.02
Metal	4.5	0.6	4.3	0.05	0.01	90.54
Miscellaneous	13	2	12	3		70

Adapted from: (Niessen 2010), Table 4.28, p.127

Waste Composition Analysis

Table 9. Capital Region, 2009-10 Composition Study – raw data

Sorting Category		Generation tonnes/y	Composition, wt% CRD - TOTAL	CRD - RES	CRD - ICI	CRD - DLC
Category 1 - Paper and Paperboard		25,362.00	16.55%	15.45%	21.20%	0.00%
1:01	Newsprint (including flyers)	2,226.00	1.45%	1.38%	1.83%	0.00%
1:02	Magazines and mixed recyclable paper	3,939.00	2.57%	2.74%	2.89%	0.00%
1:03	Corrugated cardboard	1,589.00	1.04%	0.74%	1.60%	0.00%
1:04	Pizza boxes	269.00	0.18%	0.23%	0.15%	0.00%
1:05	Waxed corrugated cardboard	614.00	0.40%	0.06%	0.88%	0.00%
1:06	Boxboard	2,090.00	1.36%	1.53%	1.45%	0.00%
1:07	Telephone books	85.00	0.06%	0.08%	0.04%	0.00%
1:08	Books	293.00	0.19%	0.22%	0.20%	0.00%
1:09	Fine paper	637.00	0.42%	0.28%	0.66%	0.00%
1:10	Tissue paper, paper towels, napkins	8,181.00	5.34%	4.69%	7.19%	0.00%
1:11	Feminine Hygiene Products	518.00	0.34%	0.39%	0.34%	0.00%
1:12	Gabletop Cartons - Milk and Milk Substitutes	662.00	0.43%	0.56%	0.37%	0.00%
1:13	Gabletop Cartons - Juice & Other	54.00	0.04%	0.05%	0.03%	0.00%
1:14	Aseptic boxes - Milk and Milk Substitutes	99.00	0.06%	0.09%	0.04%	0.00%
1:15	Aseptic boxes - Juice & Other	110.00	0.07%	0.08%	0.07%	0.00%
1:16	Brown kraft paper, including bags	684.00	0.45%	0.50%	0.47%	0.00%
1:17	Paper Cups	1,161.00	0.76%	0.43%	1.30%	0.00%
1:18	Other paper (non-recyclable)	2,151.00	1.40%	1.40%	1.69%	0.00%
Category 2 - Glass		2,974.00	1.94%	2.38%	1.82%	0.00%
2:01	Beverage Containers - alcoholic	469.00	0.31%	0.35%	0.32%	0.00%
2:02	Beverage Containers - non alcoholic	173.00	0.11%	0.10%	0.15%	0.00%
2:03	Food Containers	804.00	0.52%	0.72%	0.40%	0.00%
2:04	Other Glass Containers	123.00	0.08%	0.11%	0.06%	0.00%
2:05	Other glass and ceramics (plate, mirrors, light bulbs, ceramics)	1,404.00	0.92%	1.10%	0.89%	0.00%
Category 3 - Ferrous Metals		3,638.00	2.37%	2.59%	2.57%	0.19%
3:01	Beverage Containers - alcoholic	22.00	0.01%	0.00%	0.03%	0.00%
3:02	Beverage Containers - non alcoholic	11.00	0.01%	0.01%	0.01%	0.00%
3:03	Food Containers	760.00	0.50%	0.62%	0.46%	0.00%
3:04	Large metal appliances (white goods)	0.00	0.00%	0.00%	0.00%	0.00%
3:05	Other ferrous metals	2,845.00	1.86%	1.96%	2.07%	0.19%
Category 4 - Non-ferrous Metals		982.00	0.64%	0.85%	0.53%	0.00%
4:01	Beverage Containers - non alcoholic	94.00	0.06%	0.06%	0.08%	0.00%
4:02	Beverage Containers - alcoholic	74.00	0.05%	0.05%	0.06%	0.00%
4:03	Food Containers	67.00	0.04%	0.06%	0.04%	0.00%
4:04	Aluminum trays & foil	523.00	0.34%	0.49%	0.23%	0.00%
4:05	Other non-ferrous metals	224.00	0.15%	0.19%	0.12%	0.00%
Category 5 - Plastics		20,059.00	13.09%	13.94%	14.75%	0.08%
5:01	Bottles/Jugs - PET beverage bottles (#1) (soft drink, juice)	234.00	0.15%	0.13%	0.21%	0.00%
5:02	Bottles/Jugs - PET other bottles and jars (#1)	336.00	0.22%	0.30%	0.17%	0.00%
5:03	Bottles/Jugs - HDPE beverage bottles (#2) (juice)	54.00	0.04%	0.03%	0.05%	0.00%
5:04	Milk Jugs - HDPE	161.00	0.11%	0.13%	0.10%	0.00%
5:05	Bottles/Jugs - HDPE other bottles and jugs (#2)	580.00	0.38%	0.44%	0.39%	0.00%
5:06	Bottles/Jugs - PVC bottles and jars (#3)	32.00	0.02%	0.02%	0.02%	0.00%
5:07	Bottles/Jugs - other bottles, jars and jugs (#4 LDPE, #5 PP, #7)	177.00	0.12%	0.14%	0.11%	0.00%
5:08	Other Rigid Containers - PET Food take out (#1)	51.00	0.03%	0.04%	0.03%	0.00%
5:09	Other Rigid Containers - PET Other food containers (#1)	387.00	0.25%	0.29%	0.26%	0.00%
5:10	Other Rigid Containers - #6 PS rigid take out	585.00	0.38%	0.34%	0.51%	0.00%
5:11	Other Rigid Containers - #6 PS foam take out	218.00	0.14%	0.19%	0.12%	0.00%
5:12	Other Rigid Containers - #6 PS foam packaging	1,044.00	0.68%	0.78%	0.70%	0.00%
5:13	Other Rigid Containers - #6 PS rigid packaging	236.00	0.15%	0.16%	0.18%	0.00%
5:14	Other Rigid Containers - #5 PP wide mouth food take out	182.00	0.12%	0.16%	0.09%	0.00%
5:15	Other Rigid Containers - Other wide mouth containers and lids (#2, #	459.00	0.30%	0.32%	0.34%	0.00%
5:16	Other Rigid Containers - # 2 HDPE & #5 PP Large pails and lids (4- 25	316.00	0.21%	0.09%	0.38%	0.00%
5:17	Other Rigid Containers - All other rigid plastic packages	565.00	0.37%	0.45%	0.35%	0.00%
5:18	Film Packaging - Polyethylene plastic bags and film - non carry-out bags	352.00	0.23%	0.32%	0.17%	0.00%
5:19	Film Packaging - Polyethylene retail and grocery carry-out bags empty	251.00	0.16%	0.20%	0.15%	0.00%
5:20	Film Packaging - commercial stretch wrap	259.00	0.17%	0.05%	0.33%	0.04%
5:21	Film Packaging - Laminates	5,248.00	3.42%	3.96%	3.50%	0.00%
5:22	Film Non Packaging - Polyethylene retail and grocery carry-out bags - r	965.00	0.63%	0.92%	0.41%	0.00%
5:23	Film Non Packaging - Polyethylene plastic bags and film	4,540.00	2.96%	2.84%	3.72%	0.00%
5:24	Durable Plastic Products - Non-packaging	2,808.00	1.83%	1.63%	2.44%	0.04%
5:25	Durable Plastic Products - Vinyl Siding	21.00	0.01%	0.01%	0.02%	0.00%
Category 6 - Organic Waste		46,606.00	30.41%	34.56%	31.73%	0.00%
6:01	Food waste - Backyard Compostable	12,229.00	7.98%	9.54%	7.77%	0.00%
6:02	Food Waste - Kitchen Waste	25,218.00	16.45%	18.90%	16.93%	0.00%
6:03	Food Waste - FOG (Fats-Oil-Grease) - Brown grease	348.00	0.23%	0.00%	0.54%	0.00%
6:04	Food Waste - FOG (Fats-Oil-Grease) - Yellow grease	29.00	0.02%	0.04%	0.00%	0.00%
6:06	Yard Waste (<3" diameter)	5,139.00	3.35%	3.50%	3.87%	0.00%
6:07	Animal Faeces	2,258.00	1.47%	1.57%	1.66%	0.00%
6:08	Other organic waste	1,385.00	0.90%	1.01%	0.96%	0.00%

… continued

Table 9. (continued)

Sorting Category	Generation tonnes/y	Composition, wt% CRD - TOTAL	CRD - RES	CRD - ICI	CRD - DLC
… continued					
Category 7 - Wood and Wood Products	15,225.00	9.93%	3.89%	6.12%	63.38%
7:01 Pallets/skids	971.00	0.63%	0.00%	0.35%	5.63%
7:02 Wood shingles	6,314.00	4.12%	0.00%	0.00%	47.99%
7:03 Wood furniture (>80% wood)	887.00	0.58%	0.74%	0.51%	0.00%
7:04 Other wood - Clean	3,569.00	2.33%	1.44%	1.96%	9.25%
7:05 Other wood - Contaminated	3,483.00	2.27%	1.71%	3.30%	0.51%
Category 8 - Construction/Demolition Material	9,385.00	6.12%	3.42%	3.19%	35.92%
8:01 Drywall	278.00	0.18%	0.17%	0.23%	0.00%
8:02 Asphalt shingles	3,138.00	2.05%	0.41%	0.14%	20.77%
8:03 Carpet & underlay	2,773.00	1.81%	1.48%	1.36%	5.88%
8:04 Masonry (bricks, blocks, concrete, ceramic)	268.00	0.17%	0.16%	0.22%	0.00%
8:05 Rock/sand/dirt	840.00	0.55%	0.06%	0.10%	5.56%
8:06 Other C/D wastes	2,089.00	1.36%	1.14%	1.14%	3.71%
Category 9 - Textiles	8,441.00	5.51%	6.50%	5.46%	0.00%
9:01 Clothing	3,219.00	2.10%	2.83%	1.67%	0.00%
9:02 Footwear	933.00	0.61%	0.81%	0.49%	0.00%
9:03 Other textiles	4,289.00	2.80%	2.86%	3.30%	0.00%
Category 10 - Rubber	1,083.00	0.71%	0.42%	1.18%	0.00%
10:01 Vehicle tires	54.00	0.04%	0.00%	0.08%	0.00%
10:02 Other rubber products	1,029.00	0.67%	0.42%	1.10%	0.00%
Category 11 - Composite Products	7,931.00	5.17%	6.70%	4.35%	0.43%
11:01 Disposable diapers	5,032.00	3.28%	4.89%	2.06%	0.00%
11:02 Furniture	930.00	0.61%	0.42%	0.86%	0.43%
11:03 Other composites, Q-tips…..	1,969.00	1.28%	1.39%	1.43%	0.00%
Category 12 - Hazardous Wastes	1,179.00	0.77%	0.85%	0.81%	0.00%
12:01 Fluorescent lighting - CFL (Compact Fluorescent Lamps) bulbs	3.00	0.00%	0.00%	0.00%	0.00%
12:02 Fluorescent lighting - CFL (Compact Fluorescent Lamps) tubes	79.00	0.05%	0.00%	0.12%	0.00%
12:03 Batteries - automotive (lead acid)	2.00	0.00%	0.00%	0.00%	0.00%
12:04 Batteries - Dry cell, alkaline, button cell, other non rechargable househ	176.00	0.11%	0.17%	0.07%	0.00%
12:05 Batteries - Rechargeable	5.00	0.00%	0.01%	0.00%	0.00%
12:06 Oil - Lubricating (motor, transmission) oil, including containers	23.00	0.02%	0.03%	0.00%	0.00%
12:07 Oil - Empty Lubricating (motor, transmission) oil containers	81.00	0.05%	0.02%	0.10%	0.00%
12:08 Oil Filter - Automotive (include number of units)	23.00	0.02%	0.00%	0.04%	0.00%
12:09 Paint - Latex, including containers, PCA	57.00	0.04%	0.03%	0.05%	0.00%
12:10 Paint - Empty latex paint containers (PCA)	20.00	0.01%	0.02%	0.01%	0.00%
12:11 Paint - Oil-based, including containers, (PCA)	82.00	0.05%	0.10%	0.01%	0.00%
12:12 Paint - Empty oil based paint containers, (PCA)	12.00	0.01%	0.01%	0.01%	0.00%
12:13 Paint - (non PCA) paint including container	9.00	0.01%	0.01%	0.00%	0.00%
12:14 Paint - Empty (non PCA) container	1.00	0.00%	0.00%	0.00%	0.00%
12:15 Paint in aerosol cans (PCA)	1.00	0.00%	0.00%	0.00%	0.00%
12:16 Paint - Empty aerosol paint cans (PCA)	21.00	0.01%	0.01%	0.02%	0.00%
12:17 Paint - Aerosol cans (non PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:18 Paint - Empty aerosol paint cans (non PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:19 Solvents including containers (<10L) (PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:20 Solvents - Empty containers (PCA)	23.00	0.02%	0.00%	0.03%	0.00%
12:21 Solvents including containers (non PCA)	7.00	0.00%	0.00%	0.01%	0.00%
12:22 Solvents - Empty containers (non PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:23 Pesticides including containers (<10L) (PCA)	2.00	0.00%	0.00%	0.00%	0.00%
12:24 Pesticide - Empty pesticide containers (PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:25 Pesticides including containers (non PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:26 Pesticide - Empty pesticide containers (non PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:27 Pharmaceuticals, including containers	50.00	0.03%	0.05%	0.02%	0.00%
12:28 Needles & Sharps	11.00	0.01%	0.01%	0.00%	0.00%
12:29 Other empty aerosol cans (not applicable to above categories)	209.00	0.14%	0.21%	0.08%	0.00%
12:30 Other hazardous waste (record description)	284.00	0.19%	0.17%	0.24%	0.00%
Category 13 - Electronics	2,928.00	1.91%	1.75%	2.48%	0.00%
13:01 Display Devices (monitors/TVs) less than 30"	753.00	0.49%	0.49%	0.59%	0.00%
13:02 Display Devices (monitors/TVs) more than 30"	8.00	0.01%	0.01%	0.00%	0.00%
13:03 Computers (desktops, laptops, desktop servers)	141.00	0.09%	0.06%	0.15%	0.00%
13:04 Desktop Computer printers, copiers, faxes,	221.00	0.14%	0.02%	0.32%	0.00%
13:05 Computer scanners	0.00	0.00%	0.00%	0.00%	0.00%
13:06 Computer Peripherals (keyboards, mice)	24.00	0.02%	0.02%	0.01%	0.00%
13:07 Personal/Portable audio/video playback and/or recording devices	182.00	0.12%	0.20%	0.05%	0.00%
13:08 Vehicle audio/video devices	10.00	0.01%	0.00%	0.02%	0.00%
13:09 Home audio/video playback and/or recording systems	121.00	0.08%	0.05%	0.12%	0.00%
13:10 Non-cellular telephones and answering machines	20.00	0.01%	0.02%	0.01%	0.00%
13:11 Cell phones, PDAs and pagers	11.00	0.01%	0.01%	0.00%	0.00%
13:12 Other miscellaneous electronics - consumer	783.00	0.51%	0.42%	0.72%	0.00%
13:13 Other miscellaneous electronics - commercial	109.00	0.07%	0.07%	0.09%	0.00%
13:14 Small appliances	545.00	0.36%	0.38%	0.40%	0.00%
Category 14 - Other	7,468.00	4.87%	6.65%	3.81%	0.00%
14:01 Cat litter	4,267.00	2.78%	4.18%	1.71%	0.00%
14:02 Non-distinct fines	3,014.00	1.97%	2.35%	1.92%	0.00%
14:03 Other wastes, dental floss, …..	187.00	0.12%	0.12%	0.15%	0.00%
Total	53,640.00	100.00%	100.00%	100.00%	100.00%

Table 10. Capital Region, 2009-10 Composition Study – Composition Analysis

Fraction/Category	CRD - TOTAL tonnes/y	CRD - TOTAL wt%	CRD - RES wt%	CRD ICI wt%	CRD - DLC wt%
Combustible fractions	70,297.0	45.83%	40.25%	48.85%	63.46%
Oils	127.0	0.08%	0.05%	0.14%	0.00%
Paper	25,362.0	16.53%	15.45%	21.20%	0.00%
Plastics	20,059.0	13.08%	13.94%	14.75%	0.08%
Rubber	1,083.0	0.71%	0.42%	1.18%	0.00%
Leather	0.0	0.00%	0.00%	0.00%	0.00%
Textile	8,441.0	5.50%	6.50%	5.46%	0.00%
Wood	15,225.0	9.93%	3.89%	6.12%	63.38%
Putrescible fractions	46,606.0	30.38%	34.56%	31.73%	0.00%
Food and Animal Waste	37,824.0	24.66%	28.48%	25.24%	0.00%
Green waste	8,782.0	5.73%	6.08%	6.49%	0.00%
Inert fractions	16,979.0	11.07%	9.24%	8.11%	36.11%
C&D	9,385.0	6.12%	3.42%	3.19%	35.92%
Glass	2,974.0	1.94%	2.38%	1.82%	0.00%
Metal	4,620.0	3.01%	3.44%	3.10%	0.19%
Hazardous fractions	1,179.0	0.77%	0.80%	0.67%	0.00%
Hazardous	1,179.0	0.77%	0.80%	0.67%	0.00%
Other fractions	18,327.0	11.95%	15.10%	10.64%	0.43%
Whitegoods		0.00%			
E-waste	2,928.0	1.91%	1.75%	2.48%	0.00%
Other	15,399.0	10.04%	13.35%	8.16%	0.43%
TOTAL	153,388.0	100.00%	99.95%	100.00%	100.00%
Biomass	96,717.0	63.05%	60.82%	65.69%	63.38%
Non-biomass	56,671.0	36.95%	39.13%	34.31%	36.62%

References

ASTM. (n.d.). *ASTM D5468 - 02 Standard Test Method for Gross Calorific and Ash Value of Waste Materials*. *compass.astm.org*. ASTM International.

Basu, P. (2013). Biomass Gasification, Pyrolysis and Torrefaction (Second Edition) (pp. i–iii). Elsevier. http://doi.org/10.1016/B978-0-12-396488-5.00014-9

Channiwala, S. A., & Parikh, P. P. (2002). A unified correlation for estimating HHV of solid, liquid and gaseous fuels. *Fuel*, *81*(8), 1051–1063. http://doi.org/10.1016/S0016-2361(01)00131-4

EB CDM. (n.d.). *AM0025: Alternative waste treatment processes --- Version 14.0.0*. *cdm.unfccc.int*.

Niessen, W. (2010). Combustion and Incineration Processes. CRC Press. http://doi.org/10.1201/EBK1439805039

SHA. (2010). *Capital Regional District - Solid Waste Stream Composition Study 2009-2010* (No. PRJ09042). *crd.bc.ca*.

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CONTENT

Project:
CRD-p001 - Gasification Technologies

Filename:
CRD-p001_CalorificValues.xlsx

Prepared for:
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Version:
DRAFT

Last saved:
December 2017

efficiency | renewables | innovation

This Excel™ spreadsheet is a companion data file to the TwE report
Gasification Technologies - Characterization of Waste Resources in the Capital Region

File:
CRD-p001_ResourceCharacterization.pdf

Use the links below to navigate through the sections in the spreadsheet.
(Hidden worksheets need to be first unhid)

WORKSHEET/MODULES

MSW - 2015 Audit

Project: CRD-p001 - Gasification Technologies
File: CRD-p001_CalorificValues.xlsx

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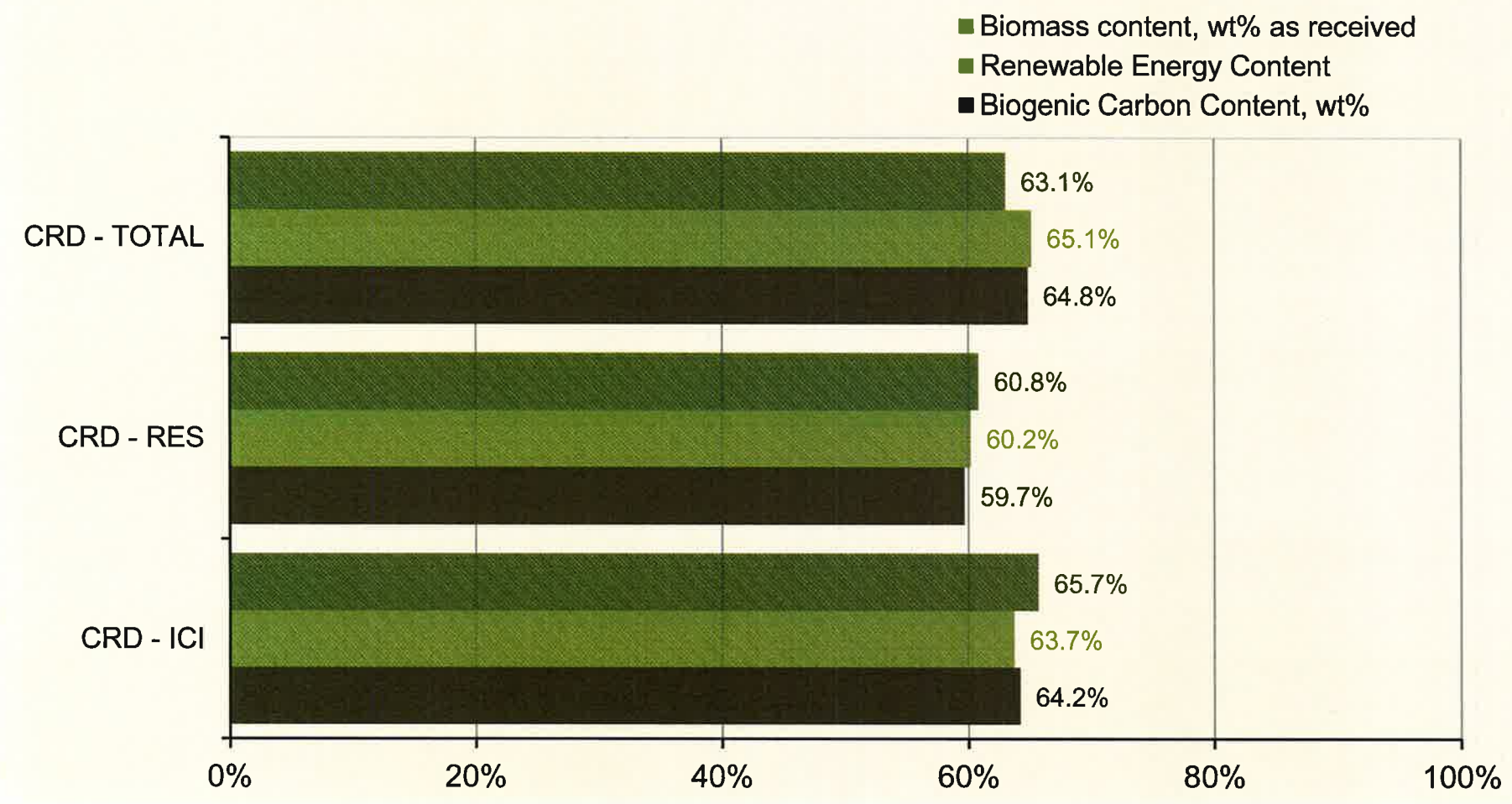
December 2017

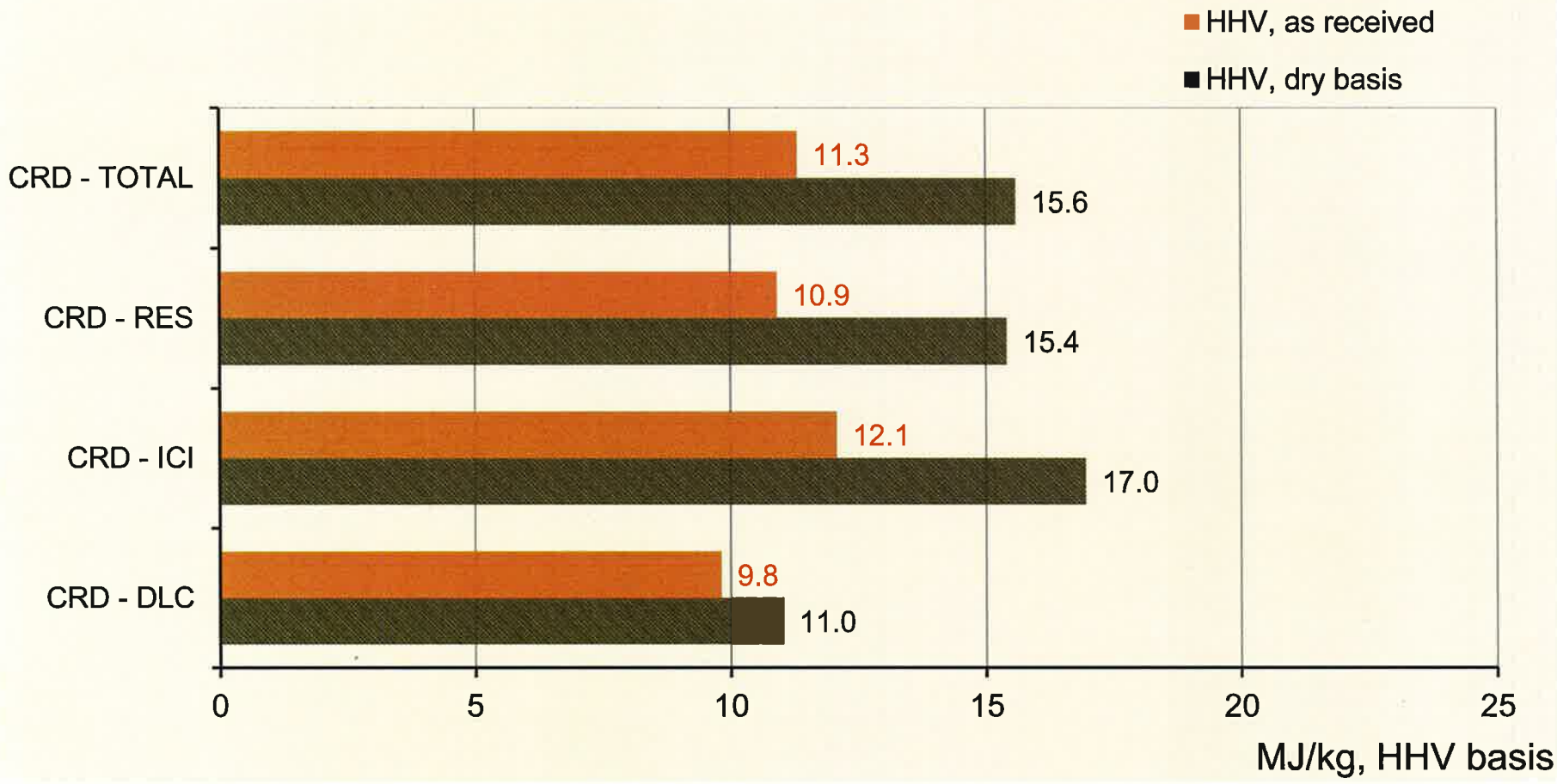
CRD 2009-10 AUDIT - Renewable Fraction Coefficients

Council	Biomass Content	Renewable Energy Conter	Biogenic Carbon Content
	wt%, as received	HHV, as received	wt%
CRD - TOTAL	63.05%	65.13%	64.85%
CRD - RES	60.82%	60.18%	59.68%
CRD - ICI	65.69%	63.70%	64.18%
CRD - DLC	63.38%	106.39%	98.83%

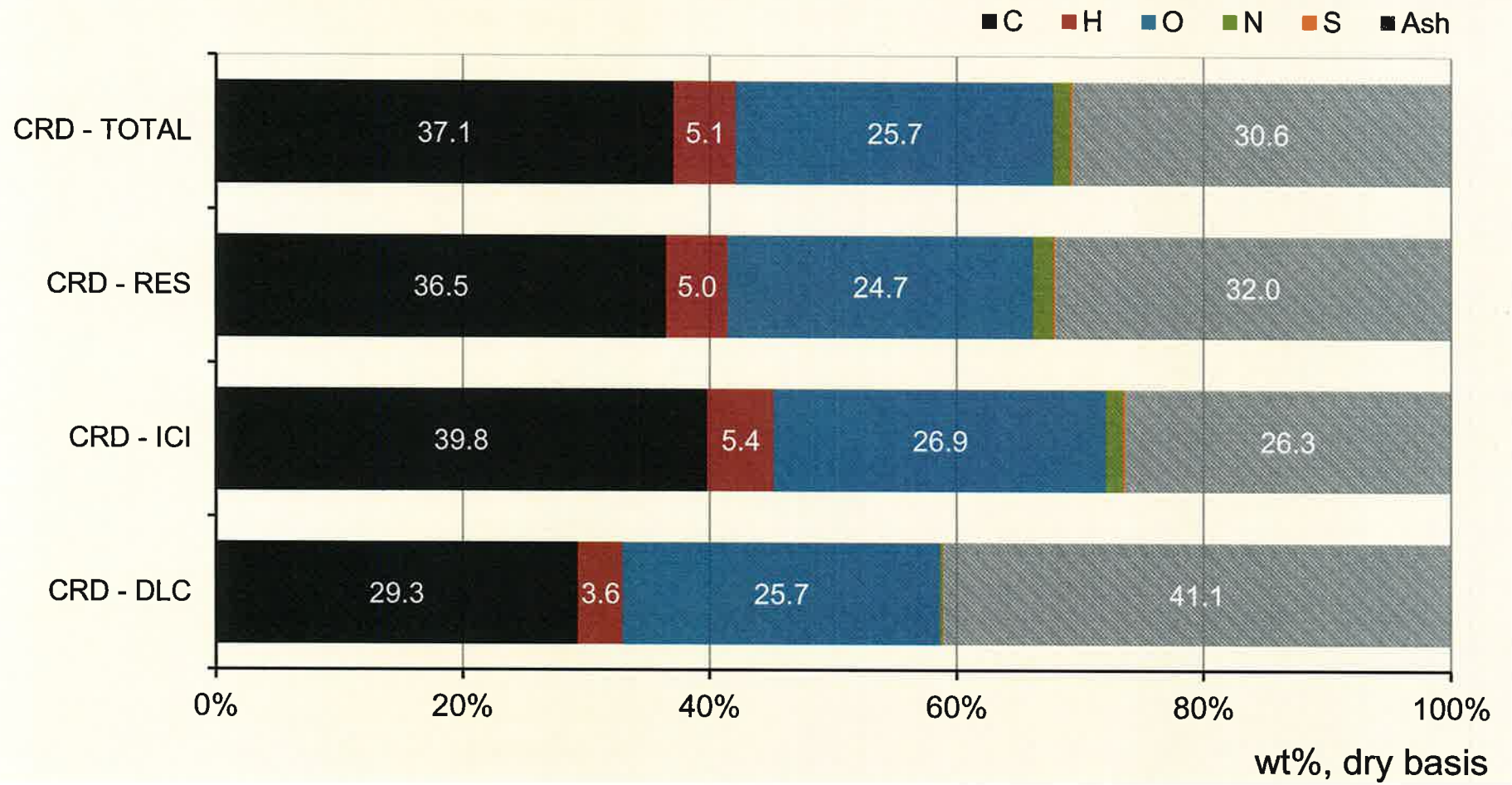
CRD Waste Streams (2009-10) - renewable fractions

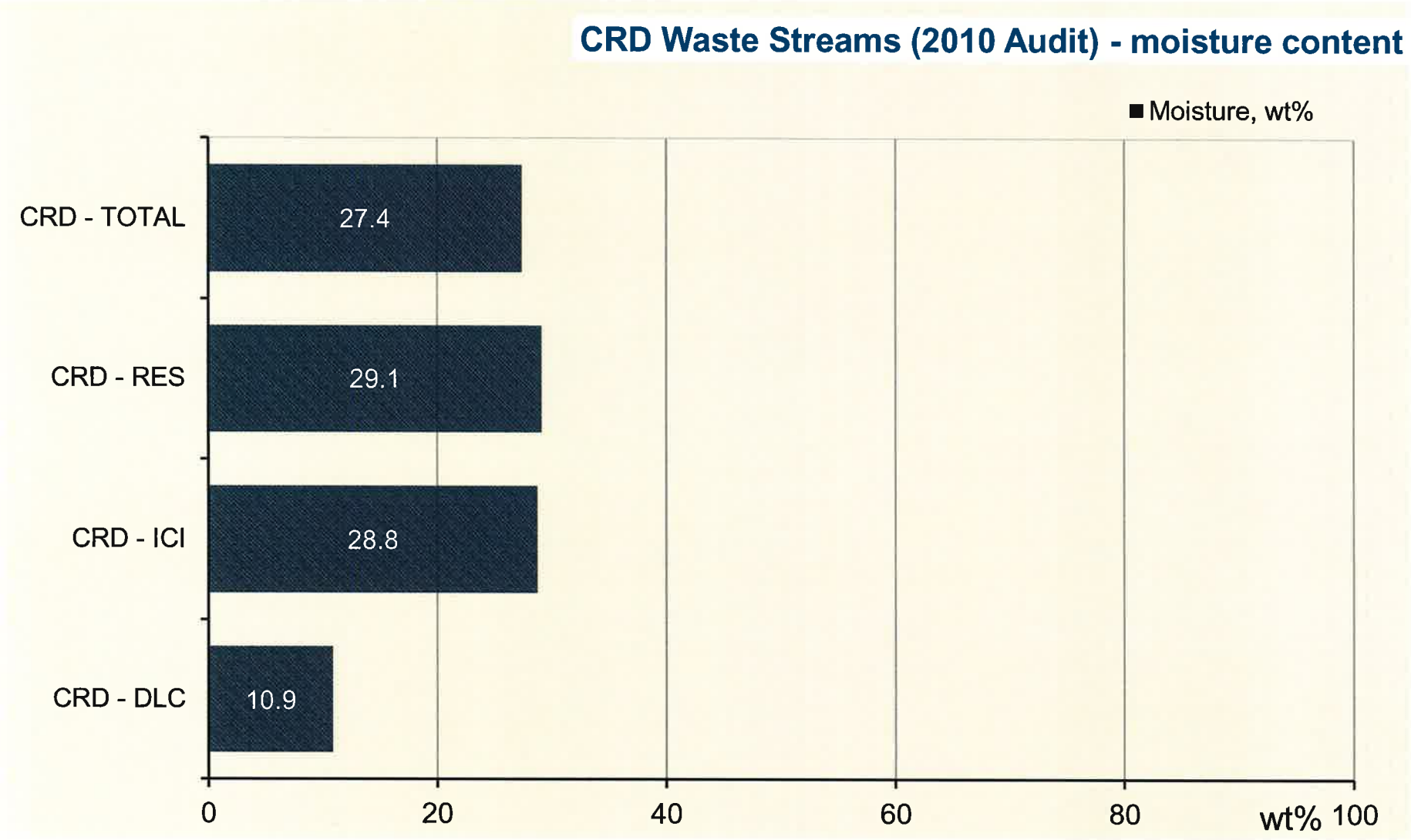


CRD Waste Streams (2009-10) - energy content

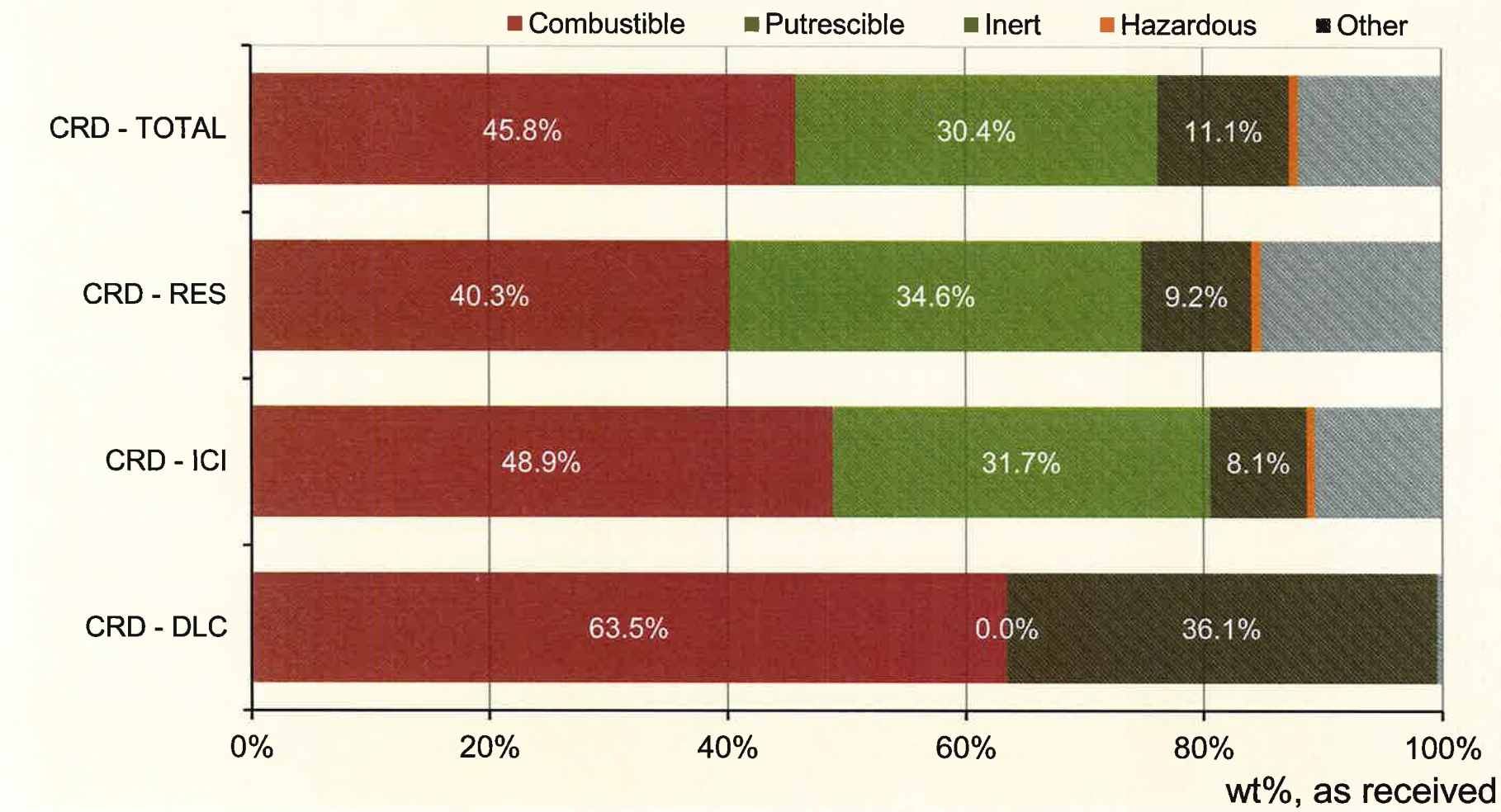


CRD Waste Streams (2009-10) - elemental analysis, dry basis




CRD Waste Streams (2010 Audit) - moisture content
Moisture, wt%
CRD - TOTAL
27.4
CRD - RES
29.1
CRD - ICI
28.8
CRD - DLC
10.9
0
20
40
60
80
wt% 100

CRD Waste Streams (2015 Audit) - composition analysis



CRD 2009-10 AUDIT - General Waste Bin, Moisture and Energy Content

	All Fractions					Combustible Fractions					Putrescible Fractions					Inert Fractions					Hazardous Fractions					Other Fractions				
Council	Moisture, wt%	HHV,	HHV,	LHV,	LHV,	Moisture, wt%	HHV,	HHV,	LHV,	LHV,	Moisture, wt%	HHV,	HHV,	LHV,	LHV,	Moisture, wt%	HHV,	HHV,	LHV,	LHV,	Moisture, wt%	HHV,	HHV,	LHV,	LHV,	Moisture, wt%	HHV,	HHV,	LHV,	LHV,
CRD - TOTAL	27.39	11.32	15.59	10.13	13.95	19.11	17.96	22.21	16.49	20.38	58.76	7.76	18.81	6.71	16.27	3.63	0.08	0.08	-0.14	-0.14	3.00	4.01	4.13	3.55	3.66	3.00	4.01	4.13	3.55	3.66
CRD - RES	29.14	10.92	15.41	9.73	13.73	19.58	18.18	22.61	16.68	20.75	59.08	7.68	18.77	6.64	16.22	3.93	0.80	0.83	0.53	0.55	3.00	4.01	4.13	3.55	3.66	3.00	4.01	4.13	3.55	3.66
CRD - ICI	28.75	12.08	16.96	10.83	15.20	19.64	18.06	22.48	16.57	20.62	58.34	7.86	18.87	6.80	16.33	3.81	0.80	0.83	0.53	0.55	3.00	4.01	4.13	3.55	3.66	3.00	4.01	4.13	3.55	3.66
CRD - DLC	10.87	9.82	11.02	8.94	10.03	15.40	16.50	19.51	15.17	17.94	0.00	0.00	0.00	0.00	0.00	3.00	-1.78	-1.83	-1.86	-1.92	0.00	0.00	0.00	0.00	0.00	3.00	4.01	4.13	3.55	3.66

Biomass Fractions					Non-Biomass Fractions				
Moisture, wt%	HHV_{ar}	HHV_{db}	LHV_{ar}	LHV_{db}	Moisture, wt%	HHV_{ar}	HHV_{db}	LHV_{ar}	LHV_{db}
39.34	11.70	19.28	10.59	17.45	14.44	9.92	11.60	7.75	9.05
43.37	10.80	19.08	9.75	17.21	16.14	10.11	12.06	7.97	9.51
39.68	11.72	19.42	10.60	17.57	15.34	11.80	13.93	9.65	11.40
15.40	16.49	19.49	15.16	17.92	4.06	-1.63	-1.70	-1.63	-1.70

CRD 2009-10 AUDIT - General Waste Bin, Elemental Analysis

	All Fractions						Combustible Fractions							Putrescible Fractions							Inert Fractions							Hazardous Fractions							Other Fractions						
Council	C	H	O	N	S	Ash	TOTAL	C	H	O	N	S	Ash	TOTAL	C	H	O	N	S	Ash	TOTAL	C	H	O	N	S	Ash	TOTAL	C	H	O	N	S	Ash	TOTAL	C	H	O	N	S	Ash	TOTAL
CRD - TOTAL	37.09	5.05	25.72	1.40	0.16	30.58	100.00	51.02	6.86	34.35	0.73	0.21	6.83	100.00	43.63	5.98	29.78	2.83	0.28	17.51	100.00	4.61	0.69	4.22	0.84	0.00	89.64	100.00	13.00	2.00	12.00	3.00	0.00	70.00	100.00	13.00	2.00	12.00	3.00	0.00	70.00	100.00
CRD - RES	36.46	5.03	24.74	1.65	0.15	31.97	100.00	51.41	6.99	33.15	0.85	0.22	7.38	100.00	43.51	5.97	29.65	2.82	0.27	17.77	100.00	6.19	0.93	5.71	1.14	0.00	86.03	100.00	13.00	2.00	12.00	3.00	0.00	70.00	100.00	13.00	2.00	12.00	3.00	0.00	70.00	100.00
CRD - ICI	39.79	5.44	26.90	1.40	0.18	26.29	100.00	51.30	6.94	33.56	0.73	0.23	7.25	100.00	43.78	5.99	29.95	2.83	0.28	17.17	100.00	6.18	0.93	5.69	1.17	0.00	86.02	100.00	13.00	2.00	12.00	3.00	0.00	70.00	100.00	13.00	2.00	12.00	3.00	0.00	70.00	100.00
CRD - DLC	29.33	3.65	25.69	0.21	0.07	41.05	100.00	48.32	6.00	42.37	0.30	0.11	2.90	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.08	0.42	0.05	0.00	98.87	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.00	2.00	12.00	3.00	0.00	70.00	100.00

Biomass Fractions							Non-Biomass Fractions						
C	H	O	N	S	Ash	TOTAL	C	H	O	N	S	Ash	TOTAL
46.24	6.16	38.26	1.18	0.20	7.96	100.00	27.17	3.85	12.13	1.64	0.11	55.09	100.00
45.58	6.15	37.58	1.42	0.20	9.06	100.00	28.13	4.00	13.00	1.85	0.11	52.91	100.00
46.35	6.22	37.84	1.16	0.22	8.21	100.00	31.73	4.49	13.49	1.70	0.13	48.46	100.00
48.30	6.00	42.40	0.30	0.11	2.89	100.00	0.86	0.12	0.60	0.08	0.00	98.34	100.00

CRD 2009-10 AUDIT - General Waste Bin, Composition Analysis, dry basis

	CRD - TOTAL		CRD - RES		CRD ICI		CRD - DLC	
Fraction/Category	tonnes/y	wt%	wt%	wt%, scaled	wt%	wt%, scaled	wt%	wt%, scaled
Combustible fractions	64717.35	55.91%	37.49%	51.09%	45.37%	60.60%	53.95%	60.11%
Oils	127.00	0.11%	0.05%	0.07%	0.14%	0.19%	0.00%	0.00%
Paper	23333.04	20.16%	14.21%	19.37%	19.50%	26.05%	0.00%	0.00%
Plastics	19657.82	16.98%	13.66%	18.61%	14.46%	19.31%	0.08%	0.09%
Rubber	1061.34	0.92%	0.41%	0.56%	1.16%	1.54%	0.00%	0.00%
Leather	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Textile	7596.90	6.56%	5.85%	7.97%	4.91%	6.56%	0.00%	0.00%
Wood	12941.25	11.18%	3.31%	4.51%	5.20%	6.95%	53.87%	60.02%
Putrescible fractions	15272.75	13.20%	11.26%	15.34%	10.47%	13.99%	0.00%	0.00%
Food	11347.20	9.80%	8.54%	11.64%	7.57%	10.11%	0.00%	0.00%
Green waste	3925.55	3.39%	2.72%	3.70%	2.90%	3.87%	0.00%	0.00%
Inert fractions	16639.42	14.38%	9.06%	12.34%	7.95%	10.61%	35.39%	39.42%
C&D	9197.30	7.95%	3.35%	4.57%	3.13%	4.18%	35.20%	39.22%
Glass	2914.52	2.52%	2.33%	3.18%	1.78%	2.38%	0.00%	0.00%
Metal	4527.60	3.91%	3.37%	4.59%	3.04%	4.06%	0.19%	0.21%
Hazardous fractions	1155.42	1.00%	0.78%	1.07%	0.66%	0.88%	0.00%	0.00%
Hazardous	1155.42	1.00%	0.78%	1.07%	0.66%	0.88%	0.00%	0.00%
Other fractions	17960.46	15.52%	14.80%	20.16%	10.43%	13.93%	0.42%	0.47%
Whitegoods	0.00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
E-waste	2869.44	2.48%	1.72%	2.34%	2.43%	3.25%	0.00%	0.00%
Other	15091.02	13.04%	13.08%	17.83%	8.00%	10.68%	0.42%	0.47%
TOTAL	115745.40	100.00%	73.39%	100.00%	74.88%	100.00%	89.76%	100.00%
Biomass	60205.28	52.02%	35.04%	47.75%	41.25%	55.09%	53.87%	60.02%
Non-biomass	55540.12	47.98%	38.35%	52.25%	33.63%	44.91%	35.89%	39.98%

CRD 2009-10 AUDIT - General Waste Bin, Composition Analysis, as received

Fraction/Category	CRD - TOTAL tonnes/y	CRD - TOTAL wt%	CRD - RES wt%	CRD ICI wt%	CRD - DLC wt%
Combustible fractions	70,297.0	45.83%	40.25%	48.85%	63.46%
Oils	127.0	0.08%	0.05%	0.14%	0.00%
Paper	25,362.0	16.53%	15.45%	21.20%	0.00%
Plastics	20,059.0	13.08%	13.94%	14.75%	0.08%
Rubber	1,083.0	0.71%	0.42%	1.18%	0.00%
Leather	0.0	0.00%	0.00%	0.00%	0.00%
Textile	8,441.0	5.50%	6.50%	5.46%	0.00%
Wood	15,225.0	9.93%	3.89%	6.12%	63.38%
Putrescible fractions	46,606.0	30.38%	34.56%	31.73%	0.00%
Food and Animal Waste	37,824.0	24.66%	28.48%	25.24%	0.00%
Green waste	8,782.0	5.73%	6.08%	6.49%	0.00%
Inert fractions	16,979.0	11.07%	9.24%	8.11%	36.11%
C&D	9,385.0	6.12%	3.42%	3.19%	35.92%
Glass	2,974.0	1.94%	2.38%	1.82%	0.00%
Metal	4,620.0	3.01%	3.44%	3.10%	0.19%
Hazardous fractions	1,179.0	0.77%	0.80%	0.67%	0.00%
Hazardous	1,179.0	0.77%	0.80%	0.67%	0.00%
Other fractions	18,327.0	11.95%	15.10%	10.64%	0.43%
Whitegoods		0.00%			
E-waste	2,928.0	1.91%	1.75%	2.48%	0.00%
Other	15,399.0	10.04%	13.35%	8.16%	0.43%
TOTAL	153,388.0	100.00%	99.95%	100.00%	100.00%
Biomass	96,717.0	63.05%	60.82%	65.69%	63.38%
Non-biomass	56,671.0	36.95%	39.13%	34.31%	36.62%

Council	Composition					
	Combustible	Putrescible	Inert	Hazardous	Other	TOTAL
CRD	45.83%	30.38%	11.07%	0.77%	11.95%	100.00%
RES	40.25%	34.56%	9.24%	0.80%	15.10%	99.95%
ICI	48.85%	31.73%	8.11%	0.67%	10.64%	100.00%
CDL	63.46%	0.00%	36.11%	0.00%	0.43%	100.00%

CRD 2009-10 AUDIT - General Waste Bin, Original Audit Data

Sorting Category	Waste Generation tonnes/y	Waste Stream Composition, wt% CRD - TOTAL	CRD - RES	CRD - ICI	CRD - DLC
Category 1 - Paper and Paperboard	25,362.00	16.55%	15.45%	21.20%	0.00%
1:01 Newsprint (including flyers)	2,226.00	1.45%	1.38%	1.83%	0.00%
1:02 Magazines and mixed recyclable paper	3,939.00	2.57%	2.74%	2.89%	0.00%
1:03 Corrugated cardboard	1,589.00	1.04%	0.74%	1.60%	0.00%
1:04 Pizza boxes	269.00	0.18%	0.23%	0.15%	0.00%
1:05 Waxed corrugated cardboard	614.00	0.40%	0.06%	0.88%	0.00%
1:06 Boxboard	2,090.00	1.36%	1.53%	1.45%	0.00%
1:07 Telephone books	85.00	0.06%	0.08%	0.04%	0.00%
1:08 Books	293.00	0.19%	0.22%	0.20%	0.00%
1:09 Fine paper	637.00	0.42%	0.28%	0.66%	0.00%
1:10 Tissue paper, paper towels, napkins	8,181.00	5.34%	4.69%	7.19%	0.00%
1:11 Feminine Hygiene Products	518.00	0.34%	0.39%	0.34%	0.00%
1:12 Gabletop Cartons - Milk and Milk Substitutes	662.00	0.43%	0.56%	0.37%	0.00%
1:13 Gabletop Cartons - Juice & Other	54.00	0.04%	0.05%	0.03%	0.00%
1:14 Aseptic boxes - Milk and Milk Substitutes	99.00	0.06%	0.09%	0.04%	0.00%
1:15 Aseptic boxes - Juice & Other	110.00	0.07%	0.08%	0.07%	0.00%
1:16 Brown kraft paper, including bags	684.00	0.45%	0.50%	0.47%	0.00%
1:17 Paper Cups	1,161.00	0.76%	0.43%	1.30%	0.00%
1:18 Other paper (non-recyclable)	2,151.00	1.40%	1.40%	1.69%	0.00%
Category 2 - Glass	2,974.00	1.94%	2.38%	1.82%	0.00%
2:01 Beverage Containers - alcoholic	469.00	0.31%	0.35%	0.32%	0.00%
2:02 Beverage Containers - non alcoholic	173.00	0.11%	0.10%	0.15%	0.00%
2:03 Food Containers	804.00	0.52%	0.72%	0.40%	0.00%
2:04 Other Glass Containers	123.00	0.08%	0.11%	0.06%	0.00%
2:05 Other glass and ceramics (plate, mirrors, light bulbs, ceramics)	1,404.00	0.92%	1.10%	0.89%	0.00%
Category 3 - Ferrous Metals	3,638.00	2.37%	2.59%	2.57%	0.19%
3:01 Beverage Containers - alcoholic	22.00	0.01%	0.00%	0.03%	0.00%
3:02 Beverage Containers - non alcoholic	11.00	0.01%	0.01%	0.01%	0.00%
3:03 Food Containers	760.00	0.50%	0.62%	0.46%	0.00%
3:04 Large metal appliances (white goods)	0.00	0.00%	0.00%	0.00%	0.00%
3:05 Other ferrous metals	2,845.00	1.86%	1.96%	2.07%	0.19%
Category 4 - Non-ferrous Metals	982.00	0.64%	0.85%	0.53%	0.00%
4:01 Beverage Containers - non alcoholic	94.00	0.06%	0.06%	0.08%	0.00%
4:02 Beverage Containers - alcoholic	74.00	0.05%	0.05%	0.06%	0.00%
4:03 Food Containers	67.00	0.04%	0.06%	0.04%	0.00%
4:04 Aluminum trays & foil	523.00	0.34%	0.49%	0.23%	0.00%
4:05 Other non-ferrous metals	224.00	0.15%	0.19%	0.12%	0.00%
Category 5 - Plastics	20,059.00	13.09%	13.94%	14.75%	0.08%
5:01 Bottles/Jugs - PET beverage bottles (#1) (soft drink, juice)	234.00	0.15%	0.13%	0.21%	0.00%
5:02 Bottles/Jugs - PET other bottles and jars (#1)	336.00	0.22%	0.30%	0.17%	0.00%
5:03 Bottles/Jugs - HDPE beverage bottles (#2) (juice)	54.00	0.04%	0.03%	0.05%	0.00%
5:04 Milk Jugs - HDPE	161.00	0.11%	0.13%	0.10%	0.00%
5:05 Bottles/Jugs - HDPE other bottles and jugs (#2)	580.00	0.38%	0.44%	0.39%	0.00%
5:06 Bottles/Jugs - PVC bottles and jars (#3)	32.00	0.02%	0.02%	0.02%	0.00%
5:07 Bottles/Jugs - other bottles, jars and jugs (#4 LDPE, #5 PP, #7)	177.00	0.12%	0.14%	0.11%	0.00%
5:08 Other Rigid Containers - PET Food take out (#1)	51.00	0.03%	0.04%	0.03%	0.00%
5:09 Other Rigid Containers - PET Other food containers (#1)	387.00	0.25%	0.29%	0.26%	0.00%
5:10 Other Rigid Containers - #6 PS rigid take out	585.00	0.38%	0.34%	0.51%	0.00%
5:11 Other Rigid Containers - #6 PS foam take out	218.00	0.14%	0.19%	0.12%	0.00%
5:12 Other Rigid Containers - #6 PS foam packaging	1,044.00	0.68%	0.78%	0.70%	0.00%
5:13 Other Rigid Containers - #6 PS rigid packaging	236.00	0.15%	0.16%	0.18%	0.00%
5:14 Other Rigid Containers - #5 PP wide mouth food take out	182.00	0.12%	0.16%	0.09%	0.00%
5:15 Other Rigid Containers - Other wide mouth containers and lids (#2, #4,	459.00	0.30%	0.32%	0.34%	0.00%
5:16 Other Rigid Containers - # 2 HDPE & #5 PP Large pails and lids (4- 25L)	316.00	0.21%	0.09%	0.38%	0.00%
5:17 Other Rigid Containers - All other rigid plastic packages	565.00	0.37%	0.45%	0.35%	0.00%
5:18 Film Packaging - Polyethylene plastic bags and film - non carry-out bags	352.00	0.23%	0.32%	0.17%	0.00%
5:19 Film Packaging - Polyethylene retail and grocery carry-out bags empty	251.00	0.16%	0.20%	0.15%	0.00%
5:20 Film Packaging - commercial stretch wrap	259.00	0.17%	0.05%	0.33%	0.04%
5:21 Film Packaging - Laminates	5,248.00	3.42%	3.96%	3.50%	0.00%
5:22 Film Non Packaging - Polyethylene retail and grocery carry-out bags - rei	965.00	0.63%	0.92%	0.41%	0.00%
5:23 Film Non Packaging - Polyethylene plastic bags and film	4,540.00	2.96%	2.84%	3.72%	0.00%
5:24 Durable Plastic Products - Non-packaging	2,808.00	1.83%	1.63%	2.44%	0.04%
5:25 Durable Plastic Products - Vinyl Siding	21.00	0.01%	0.01%	0.02%	0.00%
Category 6 - Organic Waste	46,606.00	30.41%	34.56%	31.73%	0.00%
6:01 Food waste - Backyard Compostable	12,229.00	7.98%	9.54%	7.77%	0.00%
6:02 Food Waste - Kitchen Waste	25,218.00	16.45%	18.90%	16.93%	0.00%
6:03 Food Waste - FOG (Fats-Oil-Grease) - Brown grease	348.00	0.23%	0.00%	0.54%	0.00%
6:04 Food Waste - FOG (Fats-Oil-Grease) - Yellow grease	29.00	0.02%	0.04%	0.00%	0.00%
6:06 Yard Waste (<3" diameter)	5,139.00	3.35%	3.50%	3.87%	0.00%
6:07 Animal Faeces	2,258.00	1.47%	1.57%	1.66%	0.00%
6:08 Other organic waste	1,385.00	0.90%	1.01%	0.96%	0.00%
Category 7 - Wood and Wood Products	15,225.00	9.93%	3.89%	6.12%	63.38%
7:01 Pallets/skids	971.00	0.63%	0.00%	0.35%	5.63%
7:02 Wood shingles	6,314.00	4.12%	0.00%	0.00%	47.99%
7:03 Wood furniture (>80% wood)	887.00	0.58%	0.74%	0.51%	0.00%
7:04 Other wood - Clean	3,569.00	2.33%	1.44%	1.96%	9.25%
7:05 Other wood - Contaminated	3,483.00	2.27%	1.71%	3.30%	0.51%
Category 8 - Construction/Demolition Material	9,385.00	6.12%	3.42%	3.19%	35.92%
8:01 Drywall	278.00	0.18%	0.17%	0.23%	0.00%
8:02 Asphalt shingles	3,138.00	2.05%	0.41%	0.14%	20.77%
8:03 Carpet & underlay	2,773.00	1.81%	1.48%	1.36%	5.88%
8:04 Masonry (bricks, blocks, concrete, ceramic)	268.00	0.17%	0.16%	0.22%	0.00%
8:05 Rock/sand/dirt	840.00	0.55%	0.06%	0.10%	5.56%
8:06 Other C/D wastes	2,089.00	1.36%	1.14%	1.14%	3.71%
Category 9 - Textiles	8,441.00	5.51%	6.50%	5.46%	0.00%
9:01 Clothing	3,219.00	2.10%	2.83%	1.67%	0.00%
9:02 Footwear	933.00	0.61%	0.81%	0.49%	0.00%
9:03 Other textiles	4,289.00	2.80%	2.86%	3.30%	0.00%
Category 10 - Rubber	1,083.00	0.71%	0.42%	1.18%	0.00%
10:01 Vehicle tires	54.00	0.04%	0.00%	0.08%	0.00%
10:02 Other rubber products	1,029.00	0.67%	0.42%	1.10%	0.00%
Category 11 - Composite Products	7,931.00	5.17%	6.70%	4.35%	0.43%
11:01 Disposable diapers	5,032.00	3.28%	4.89%	2.06%	0.00%
11:02 Furniture	930.00	0.61%	0.42%	0.86%	0.43%
11:03 Other composites, Q-tips.....	1,969.00	1.28%	1.39%	1.43%	0.00%
Category 12 - Hazardous Wastes	1,179.00	0.77%	0.85%	0.81%	0.00%
12:01 Fluorescent lighting - CFL (Compact Fluorescent Lamps) bulbs	3.00	0.00%	0.00%	0.00%	0.00%
12:02 Fluorescent lighting - CFL (Compact Fluorescent Lamps) tubes	79.00	0.05%	0.00%	0.12%	0.00%
12:03 Batteries - automotive (lead acid)	2.00	0.00%	0.00%	0.00%	0.00%
12:04 Batteries - Dry cell, alkaline, button cell, other non rechargable househol	176.00	0.11%	0.17%	0.07%	0.00%
12:05 Batteries - Rechargeable	5.00	0.00%	0.01%	0.00%	0.00%
12:06 Oil - Lubricating (motor, transmission) oil, including containers	23.00	0.02%	0.03%	0.00%	0.00%
12:07 Oil - Empty Lubricating (motor, transmission) oil containers	81.00	0.05%	0.02%	0.10%	0.00%
12:08 Oil Filter - Automotive (include number of units)	23.00	0.02%	0.00%	0.04%	0.00%
12:09 Paint - Latex, including containers, PCA	57.00	0.04%	0.03%	0.05%	0.00%
12:10 Paint - Empty latex paint containers (PCA)	20.00	0.01%	0.02%	0.01%	0.00%
12:11 Paint - Oil-based, including containers, (PCA)	82.00	0.05%	0.10%	0.01%	0.00%
12:12 Paint - Empty oil based paint containers, (PCA)	12.00	0.01%	0.01%	0.01%	0.00%
12:13 Paint - (non PCA) paint including container	9.00	0.01%	0.01%	0.00%	0.00%
12:14 Paint - Empty (non PCA) container	1.00	0.00%	0.00%	0.00%	0.00%
12:15 Paint in aerosol cans (PCA)	1.00	0.00%	0.00%	0.00%	0.00%
12:16 Paint - Empty aerosol paint cans (PCA)	21.00	0.01%	0.01%	0.02%	0.00%
12:17 Paint - Aerosol cans (non PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:18 Paint - Empty aerosol paint cans (non PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:19 Solvents including containers (<10L) (PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:20 Solvents - Empty containers (PCA)	23.00	0.02%	0.00%	0.03%	0.00%
12:21 Solvents including containers (non PCA)	7.00	0.00%	0.00%	0.01%	0.00%
12:22 Solvents - Empty containers (non PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:23 Pesticides including containers (<10L) (PCA)	2.00	0.00%	0.00%	0.00%	0.00%
12:24 Pesticide - Empty pesticide containers (PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:25 Pesticides including containers (non PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:26 Pesticide - Empty pesticide containers (non PCA)	0.00	0.00%	0.00%	0.00%	0.00%
12:27 Pharmaceuticals, including containers	50.00	0.03%	0.05%	0.02%	0.00%
12:28 Needles & Sharps	11.00	0.01%	0.01%	0.00%	0.00%
12:29 Other empty aerosol cans (not applicable to above categories)	209.00	0.14%	0.21%	0.08%	0.00%
12:30 Other hazardous waste (record description)	284.00	0.19%	0.17%	0.24%	0.00%
Category 13 - Electronics	2,928.00	1.91%	1.75%	2.48%	0.00%
13:01 Display Devices (monitors/TVs) less than 30"	753.00	0.49%	0.49%	0.59%	0.00%
13:02 Display Devices (monitors/TVs) more than 30"	8.00	0.01%	0.01%	0.00%	0.00%
13:03 Computers (desktops, laptops, desktop servers)	141.00	0.09%	0.06%	0.15%	0.00%
13:04 Desktop Computer printers, copiers, faxes,	221.00	0.14%	0.02%	0.32%	0.00%
13:05 Computer scanners	0.00	0.00%	0.00%	0.00%	0.00%
13:06 Computer Peripherals (keyboards, mice)	24.00	0.02%	0.02%	0.01%	0.00%
13:07 Personal/Portable audio/video playback and/or recording devices	182.00	0.12%	0.20%	0.05%	0.00%
13:08 Vehicle audio/video devices	10.00	0.01%	0.00%	0.02%	0.00%
13:09 Home audio/video playback and/or recording systems	121.00	0.08%	0.05%	0.12%	0.00%
13:10 Non-cellular telephones and answering machines	20.00	0.01%	0.02%	0.01%	0.00%
13:11 Cell phones, PDAs and pagers	11.00	0.01%	0.01%	0.00%	0.00%
13:12 Other miscellaneous electronics - consumer	783.00	0.51%	0.42%	0.72%	0.00%
13:13 Other miscellaneous electronics - commercial	109.00	0.07%	0.07%	0.09%	0.00%
13:14 Small appliances	545.00	0.36%	0.38%	0.40%	0.00%
Category 14 - Other	7,468.00	4.87%	6.65%	3.81%	0.00%
14:01 Cat litter	4,267.00	2.78%	4.18%	1.71%	0.00%
14:02 Non-distinct fines	3,014.00	1.97%	2.35%	1.92%	0.00%
14:03 Other wastes, dental floss, ...	187.00	0.12%	0.12%	0.15%	0.00%
Total	153,261.00	100.00%	100.00%	100.00%	100.00%

SOURCE: SHA. (2010). Capital Regional District - Solid Waste Stream Composition Study 2009-2010 (No. PRJ09042). https://www.crd.bc.ca/service/waste-recycling/solid-waste-management/reports-publications

Table B-1. Overal Waste Composition 2009-2010

	Waste Composition (Percentage)			Waste Generation (kg/pers/year)	Waste Disposal (tonnes/year)
	Mean (%) (N=198)	S.D. (%)	C.O.V (%)	Mean (N=198)	Mean (N=198)
Category 1 - Paper and Paperboard	**16.56**	**8.83**	**53**	**68.58**	**25,362.00**
1:01 Newsprint (including flyers)	1.45	2.58	177	6.02	2,226.00
1:02 Magazines and mixed recyclable paper	2.57	2.86	111	10.65	3,939.00
1:03 Corrugated cardboard	1.04	1.47	141	4.30	1,589.00
1:04 Pizza boxes	0.18	0.42	241	0.73	269.00
1:05 Waxed corrugated cardboard	0.4	1.78	439	1.66	614.00
1:06 Boxboard	1.36	0.96	71	5.65	2,090.00
1:07 Telephone books	0.06	0.3	532	0.23	85.00
1:08 Books	0.19	0.7	371	0.79	293.00
1:09 Fine paper	0.42	0.92	218	1.72	637.00
1:10 Tissue paper, paper towels, napkins	5.34	4.53	85	22.12	8,181.00
1:11 Feminine Hygiene Products	0.34	1.38	409	1.40	518.00
1:12 Gabletop Cartons - Milk and Milk Substitutes	0.43	0.65	152	1.79	662.00
1:13 Gabletop Cartons - Juice & Other	0.04	0.11	317	0.15	54.00
1:14 Aseptic boxes - Milk and Milk Substitutes	0.06	0.1	160	0.27	99.00
1:15 Aseptic boxes - Juice & Other	0.07	0.09	132	0.30	110.00
1:16 Brown kraft paper, including bags	0.45	0.58	129	1.85	684.00
1:17 Paper Cups	0.76	1	132	3.14	1,161.00
1:18 Other paper (non-recyclable)	1.4	1.28	91	5.82	2,151.00
Category 2 - Glass	**1.94**	**1.91**	**99**	**8.04**	**2,973.00**
2:01 Beverage Containers - alcoholic	0.31	0.66	215	1.27	469.00
2:02 Beverage Containers - non alcoholic	0.11	0.24	211	0.47	173.00
2:03 Food Containers	0.52	0.61	116	2.18	804.00
2:04 Other Glass Containers	0.08	0.27	351	0.33	123.00
2:05 Other glass and ceramics (plate, mirrors, light bulbs, ceramics)	0.92	1.39	151	3.80	1,404.00
Category 3 - Ferrous Metals	**2.38**	**3.43**	**144**	**9.84**	**3,638.00**
3:01 Beverage Containers - alcoholic	0.01	0.19	1319	0.06	22.00
3:02 Beverage Containers - non alcoholic	0.01	0.06	763	0.03	11.00
3:03 Food Containers	0.5	0.48	98	2.06	760.00
3:04 Large metal appliances (white goods)	0	0		0.00	0.00
3:05 Other ferrous metals	1.86	3.4	182	7.69	2,845.00
Category 4 - Non-ferrous Metals	**0.64**	**0.54**	**85**	**2.66**	**982.00**
4:01 Beverage Containers - non alcoholic	0.06	0.1	163	0.25	94.00
4:02 Beverage Containers - alcoholic	0.05	0.13	269	0.20	74.00
4:03 Food Containers	0.04	0.13	305	0.18	67.00
4:04 Aluminum trays & foil	0.34	0.33	96	1.41	523.00
4:05 Other non-ferrous metals	0.15	0.37	254	0.61	224.00
Category 5 - Plastics	**13.09**	**6.77**	**52**	**54.25**	**20,061.00**
5:01 Bottles/Jugs - PET beverage bottles (#1) (soft drink, juice)	0.15	0.2	128	0.63	234.00
5:02 Bottles/Jugs - PET other bottles and jars (#1)	0.22	0.23	105	0.91	336.00
5:03 Bottles/Jugs - HDPE beverage bottles (#2) (juice)	0.04	0.06	159	0.15	54.00
5:04 Milk Jugs - HDPE	0.1	0.17	160	0.43	161.00
5:05 Bottles/Jugs - HDPE other bottles and jugs (#2)	0.38	0.33	88	1.57	580.00
5:06 Bottles/Jugs - PVC bottles and jars (#3)	0.02	0.07	339	0.09	32.00
5:07 Bottles/Jugs - other bottles, jars and jugs (#4 LDPE, #5 PP, #7)	0.12	0.18	159	0.48	177.00
5:08 Other Rigid Containers - PET Food take out (#1)	0.03	0.08	227	0.14	51.00
5:09 Other Rigid Containers - PET Other food containers (#1)	0.25	0.25	99	1.05	387.00
5:10 Other Rigid Containers - #6 PS rigid take out	0.38	0.37	97	1.58	585.00
5:11 Other Rigid Containers - #6 PS foam take out	0.14	0.45	315	0.59	218.00
5:12 Other Rigid Containers - #6 PS foam packaging	0.68	0.71	104	2.82	1,044.00
5:13 Other Rigid Containers - #6 PS rigid packaging	0.15	0.21	136	0.64	236.00
5:14 Other Rigid Containers - #5 PP wide mouth food take out	0.12	0.48	403	0.49	182.00
5:15 Other Rigid Containers - Other wide mouth containers and lids (#2, #4,#5)	0.3	1	335	1.24	459.00

Table B-3. Waste Composition By Sector 2009-2010

	RES	ICI	DLC	TOTAL
	Mean (%) (N=98)	Mean (%) (N=83)	Mean (%) (N=17)	Mean (%) (N=198)
Category 1 - Paper and Paperboard	**15.45**	**21.20**	**0.00**	**16.56**
1:01 Newsprint (including flyers)	1.38	1.83	0.00	1.45
1:02 Magazines and mixed recyclable paper	2.74	2.89	0.00	2.57
1:03 Corrugated cardboard	0.74	1.60	0.00	1.04
1:04 Pizza boxes	0.23	0.15	0.00	0.18
1:05 Waxed corrugated cardboard	0.06	0.88	0.00	0.40
1:06 Boxboard	1.53	1.45	0.00	1.36
1:07 Telephone books	0.08	0.04	0.00	0.06
1:08 Books	0.22	0.20	0.00	0.19
1:09 Fine paper	0.28	0.66	0.00	0.42
1:10 Tissue paper, paper towels, napkins	4.69	7.19	0.00	5.34
1:11 Feminine Hygiene Products	0.39	0.34	0.00	0.34
1:12 Gabletop Cartons - Milk and Milk Substitutes	0.56	0.37	0.00	0.43
1:13 Gabletop Cartons - Juice & Other	0.05	0.03	0.00	0.04
1:14 Aseptic boxes - Milk and Milk Substitutes	0.09	0.04	0.00	0.06
1:15 Aseptic boxes - Juice & Other	0.08	0.07	0.00	0.07
1:16 Brown kraft paper, including bags	0.50	0.47	0.00	0.45
1:17 Paper Cups	0.43	1.30	0.00	0.76
1:18 Other paper (non-recyclable)	1.40	1.69	0.00	1.40
Category 2 - Glass	**2.38**	**1.82**	**0.00**	**1.94**
2:01 Beverage Containers - alcoholic	0.35	0.32	0.00	0.31
2:02 Beverage Containers - non alcoholic	0.10	0.15	0.00	0.11
2:03 Food Containers	0.72	0.40	0.00	0.52
2:04 Other Glass Containers	0.11	0.06	0.00	0.08
2:05 Other glass and ceramics (plate, mirrors, light bulbs, ceramics)	1.10	0.89	0.00	0.92
Category 3 - Ferrous Metals	**2.59**	**2.57**	**0.19**	**2.38**
3:01 Beverage Containers - alcoholic	0.00	0.03	0.00	0.01
3:02 Beverage Containers - non alcoholic	0.01	0.01	0.00	0.01
3:03 Food Containers	0.62	0.46	0.00	0.50
3:04 Large metal appliances (white goods)	0.00	0.00	0.00	0.00
3:05 Other ferrous metals	1.96	2.07	0.19	1.86
Category 4 - Non-ferrous Metals	**0.85**	**0.53**	**0.00**	**0.64**
4:01 Beverage Containers - non alcoholic	0.06	0.08	0.00	0.06
4:02 Beverage Containers - alcoholic	0.05	0.06	0.00	0.05
4:03 Food Containers	0.06	0.04	0.00	0.04
4:04 Aluminum trays & foil	0.49	0.23	0.00	0.34
4:05 Other non-ferrous metals	0.19	0.12	0.00	0.15
Category 5 - Plastics	**13.94**	**14.75**	**0.08**	**13.07**
5:01 Bottles/Jugs - PET beverage bottles (#1) (soft drink, juice)	0.13	0.21	0.00	0.15
5:02 Bottles/Jugs - PET other bottles and jars (#1)	0.30	0.17	0.00	0.22
5:03 Bottles/Jugs - HDPE beverage bottles (#2) (juice)	0.03	0.05	0.00	0.04
5:04 Milk Jugs - HDPE	0.13	0.10	0.00	0.10
5:05 Bottles/Jugs - HDPE other bottles and jugs (#2)	0.44	0.39	0.00	0.38
5:06 Bottles/Jugs - PVC bottles and jars (#3)	0.02	0.02	0.00	0.02
5:07 Bottles/Jugs - other bottles, jars and jugs (#4 LDPE, #5 PP, #7)	0.14	0.11	0.00	0.12
5:08 Other Rigid Containers - PET Food take out (#1)	0.04	0.03	0.00	0.03
5:09 Other Rigid Containers - PET Other food containers (#1)	0.29	0.26	0.00	0.25
5:10 Other Rigid Containers - #6 PS rigid take out	0.34	0.51	0.00	0.38
5:11 Other Rigid Containers - #6 PS foam take out	0.19	0.12	0.00	0.14
5:12 Other Rigid Containers - #6 PS foam packaging	0.78	0.70	0.00	0.68
5:13 Other Rigid Containers - #6 PS rigid packaging	0.16	0.18	0.00	0.15
5:14 Other Rigid Containers - #5 PP wide mouth food take out	0.16	0.09	0.00	0.12
5:15 Other Rigid Containers - Other wide mouth containers and lids (#2, #4,#5)	0.32	0.34	0.00	0.30

5:16 Other Rigid Containers - # 2 HDPE & #5 PP Large pails and lids (4- 25L)	0.21	0.52	253	0.85	316.00	0.09	0.38	0.00	0.21
5:17 Other Rigid Containers - All other rigid plastic packages	0.37	0.34	92	1.53	565.00	0.45	0.35	0.00	0.37
5:18 Film Packaging - Polyethylene plastic bags and film - non carry-out bags	0.23	0.31	133	0.95	352.00	0.32	0.17	0.00	0.23
5:19 Film Packaging - Polyethylene retail and grocery carry-out bags empty	0.16	0.17	101	0.68	251.00	0.20	0.15	0.00	0.16
5:20 Film Packaging - commercial stretch wrap	0.17	0.46	272	0.70	259.00	0.05	0.33	0.04	0.17
5:21 Film Packaging - Laminates	3.42	4.05	118	14.19	5,248.00	3.96	3.50	0.00	3.42
5:22 Film Non Packaging - Polyethylene retail and grocery carry-out bags - reused	0.63	0.89	141	2.61	965.00	0.92	0.41	0.00	0.63
5:23 Film Non Packaging - Polyethylene plastic bags and film	2.96	1.74	59	12.28	4,540.00	2.84	3.72	0.00	2.96
5:24 Durable Plastic Products - Non-packaging	1.83	1.83	100	7.59	2,808.00	1.63	2.44	0.04	1.83
5:25 Durable Plastic Products - Vinyl Siding	0.01	0.12	874	0.06	21.00	0.01	0.02	0.00	0.01
Category 6 - Organic Waste	**30.40**	**15.82**	**52**	**126.03**	**46,606.00**	**34.56**	**31.73**	**0.00**	**30.40**
6:01 Food waste - Backyard Compostable	7.98	7.36	93	33.07	12,229.00	9.54	7.77	0.00	7.98
6:02 Food Waste - Kitchen Waste	16.45	10.65	65	68.19	25,218.00	18.90	16.93	0.00	16.45
6:03 Food Waste - FOG (Fats-Oil-Grease) - Brown grease	0.23	3.21	1396	0.94	348.00	0.00	0.54	0.00	0.23
6:04 Food Waste - FOG (Fats-Oil-Grease) - Yellow grease	0.02	0.12	605	0.08	29.00	0.04	0.00	0.00	0.02
6:06 Yard Waste (<3" diameter)	3.35	6.09	181	13.90	5,139.00	3.50	3.87	0.00	3.35
6:07 Animal Faeces	1.47	5.39	373	6.11	2,258.00	1.57	1.66	0.00	1.47
6:08 Other organic waste	0.9	2.44	269	3.74	1,385.00	1.01	0.96	0.00	0.90
Category 7 - Wood and Wood Products	**9.93**	**21.82**	**218**	**41.17**	**15,224.00**	**3.89**	**6.12**	**63.38**	**9.93**
7:01 Pallets/skids	0.63	6.47	1011	2.63	971.00	0.00	0.35	5.63	0.63
7:02 Wood shingles	4.12	19.02	457	17.08	6,314.00	0.00	0.00	47.99	4.12
7:03 Wood furniture (>80% wood)	0.58	2.43	415	2.40	887.00	0.74	0.51	0.00	0.58
7:04 Other wood - Clean	2.33	8.87	377	9.65	3,569.00	1.44	1.96	9.25	2.33
7:05 Other wood - Contaminated	2.27	4.27	190	9.42	3,483.00	1.71	3.30	0.51	2.27
Category 8 - Construction/Demolition Material	**6.12**	**14.92**	**262**	**25.38**	**9,386.00**	**3.42**	**3.19**	**35.92**	**6.12**
8:01 Drywall	0.18	0.79	432	0.75	278.00	0.17	0.23	0.00	0.18
8:02 Asphalt shingles	2.05	10.52	664	8.49	3,138.00	0.41	0.14	20.77	2.05
8:03 Carpet & underlay	1.81	7.6	416	7.50	2,773.00	1.48	1.36	5.88	1.81
8:04 Masonry (bricks, blocks, concrete, ceramic)	0.17	0.93	525	0.72	268.00	0.16	0.22	0.00	0.17
8:05 Rock/sand/dirt	0.55	6.76	1221	2.27	840.00	0.06	0.10	5.56	0.55
8:06 Other C/D wastes	1.36	3.27	237	5.65	2,089.00	1.14	1.14	3.71	1.36
Category 9 - Textiles	**5.51**	**5.06**	**92**	**22.83**	**8,441.00**	**6.50**	**5.46**	**0.00**	**5.51**
9:01 Clothing	2.1	2.7	129	8.71	3,219.00	2.83	1.67	0.00	2.10
9:02 Footwear	0.61	0.92	151	2.52	933.00	0.81	0.49	0.00	0.61
9:03 Other textiles	2.8	2.96	105	11.60	4,289.00	2.86	3.30	0.00	2.80
Category 10 - Rubber	**0.71**	**2.35**	**329**	**2.93**	**1,083.00**	**0.42**	**1.18**	**0.00**	**0.71**
10:01 Vehicle tires	0.04	0.43	1204	0.15	54.00	0.00	0.08	0.00	0.04
10:02 Other rubber products	0.67	2.25	331	2.78	1,029.00	0.42	1.10	0.00	0.67
Category 11 - Composite Products	**5.17**	**5.01**	**97**	**21.45**	**7,931.00**	**6.70**	**4.35**	**0.43**	**5.17**
11:01 Disposable diapers	3.28	4.46	137	13.61	5,032.00	4.89	2.06	0.00	3.28
11:02 Furniture	0.61	1.93	315	2.52	930.00	0.42	0.86	0.43	0.61
11:03 Other composites, Q-tips.....	1.28	2.05	159	5.33	1,969.00	1.39	1.43	0.00	1.28
Category 12 - Hazardous Wastes	**0.77**	**1.69**	**219**	**3.19**	**1,181.00**	**0.85**	**0.81**	**0.00**	**0.75**
12:01 Fluorescent lighting - CFL (Compact Fluorescent Lamps) bulbs	0.0022	0.02	1017	0.01	3.00	0.00	0.00	0.00	0.00
12:02 Fluorescent lighting - CFL (Compact Fluorescent Lamps) tubes	0.05	0.72	1396	0.21	79.00	0.00	0.12	0.00	0.05
12:03 Batteries - automotive (lead acid)	0.0011	0.01	1029	0.00	2.00	0.00	0.00	0.00	0.00
12:04 Batteries - Dry cell, alkaline, button cell, other non rechargable household batt.	0.115	0.52	455	0.48	176.00	0.17	0.07	0.00	0.12
12:05 Batteries - Rechargeable	0.0031	0.03	856	0.01	5.00	0.01	0.00	0.00	0.00
12:06 Oil - Lubricating (motor, transmission) oil, including containers	0.0147	0.17	1117	0.06	23.00	0.03	0.00	0.00	0.01
12:07 Oil - Empty Lubricating (motor, transmission) oil containers	0.0527	0.37	686	0.22	81.00	0.02	0.10	0.00	0.05
12:08 Oil Filter - Automotive (include number of units)	0.0147	0.13	896	0.06	23.00	0.00	0.04	0.00	0.01
12:09 Paint - Latex, including containers, PCA	0.0372	0.19	528	0.15	57.00	0.03	0.05	0.00	0.04
12:10 Paint - Empty latex paint containers (PCA)	0.0131	0.07	527	0.05	20.00	0.02	0.01	0.00	0.01
12:11 Paint - Oil-based, including containers, (PCA)	0.0535	0.5	926	0.22	82.00	0.10	0.01	0.00	0.05
12:12 Paint - Empty oil based paint containers, (PCA)	0.0077	0.06	726	0.03	12.00	0.01	0.01	0.00	0.01
12:13 Paint - (non PCA) paint including container	0.0056	0.05	904	0.02	9.00	0.01	0.00	0.00	0.01
12:14 Paint - Empty (non PCA) container	0.0007	0.01	991	0.00	1.00	0.00	0.00	0.00	0.00
12:15 Paint in aerosol cans (PCA)	0.0007	0.01	994	0.00	1.00	0.00	0.00	0.00	0.00

12:16 Paint - Empty aerosol paint cans (PCA)	0.0135	0.1	746	0.06	21.00	0.01	0.02	0.00	0.01
12:17 Paint - Aerosol cans (non PCA)	0	0 -		0.00	0.00	0.00	0.00	0.00	0.00
12:18 Paint - Empty aerosol paint cans (non PCA)	0	0	1396	0.00	0.00	0.00	0.00	0.00	0.00
12:19 Solvents including containers (<10L) (PCA)	0	0 -		0.00	0.00	0.00	0.00	0.00	0.00
12:20 Solvents - Empty containers (PCA)	0.015	0.14	947	0.06	23.00	0.00	0.03	0.00	0.01
12:21 Solvents including containers (non PCA)	0.0044	0.05	1195	0.02	7.00	0.00	0.01	0.00	0.00
12:22 Solvents - Empty containers (non PCA)	0	0 -		0.00	0.00	0.00	0.00	0.00	0.00
12:23 Pesticides including containers (<10L) (PCA)	0.0015	0.02	1396	0.01	2.00	0.00	0.00	0.00	0.00
12:24 Pesticide - Empty pesticide containers (PCA)	0	0 -		0.00	0.00	0.00	0.00	0.00	0.00
12:25 Pesticides including containers (non PCA)	0	0 -		0.00	0.00	0.00	0.00	0.00	0.00
12:26 Pesticide - Empty pesticide containers (non PCA)	0	0	1396	0.00	0.00	0.00	0.00	0.00	0.00
12:27 Pharmaceuticals, including containers	0.0328	0.15	445	0.14	50.00	0.05	0.02	0.00	0.03
12:28 Needles & Sharps	0.0069	0.04	531	0.03	11.00	0.01	0.00	0.00	0.01
12:29 Other empty aerosol cans (not applicable to above categories)	0.1362	0.23	167	0.56	209.00	0.21	0.08	0.00	0.14
12:30 Other hazardous waste (record description)	0.185	1.13	605	0.77	284.00	0.17	0.24	0.00	0.19
Category 13 - Electronics	**1.92**	**4.92**	**255**	**7.92**	**2,928.00**	**1.75**	**2.48**	**0.00**	**1.92**
13:01 Display Devices (monitors/TVs) less than 30"	0.49	3.94	793	2.04	753.00	0.49	0.59	0.00	0.49
13:02 Display Devices (monitors/TVs) more than 30"	0.01	0.07	1396	0.02	8.00	0.01	0.00	0.00	0.01
13:03 Computers (desktops, laptops, desktop servers)	0.09	0.5	541	0.38	141.00	0.06	0.15	0.00	0.09
13:04 Desktop Computer printers, copiers, faxes,	0.14	0.81	554	0.60	221.00	0.02	0.32	0.00	0.14
13:05 Computer scanners	0	0 -		0.00	0.00	0.00	0.00	0.00	0.00
13:06 Computer Peripherals (keyboards, mice)	0.02	0.09	548	0.07	24.00	0.02	0.01	0.00	0.02
13:07 Personal/Portable audio/video playback and/or recording devices	0.119	0.64	536	0.49	182.00	0.20	0.05	0.00	0.12
13:08 Vehicle audio/video devices	0.01	0.09	1396	0.03	10.00	0.00	0.02	0.00	0.01
13:09 Home audio/video playback and/or recording systems	0.08	0.55	688	0.33	121.00	0.05	0.12	0.00	0.08
13:10 Non-cellular telephones and answering machines	0.01	0.08	636	0.05	20.00	0.02	0.01	0.00	0.01
13:11 Cell phones, PDAs and pagers	0.01	0.04	549	0.03	11.00	0.01	0.00	0.00	0.01
13:12 Other miscellaneous electronics - consumer	0.51	1.14	222	2.12	783.00	0.42	0.72	0.00	0.51
13:13 Other miscellaneous electronics - commercial	0.07	0.44	617	0.29	109.00	0.07	0.09	0.00	0.07
13:14 Small appliances	0.36	1.84	513	1.47	545.00	0.38	0.40	0.00	0.36
Category 14 - Other	**4.87**	**5.42**	**112**	**20.20**	**7,468.00**	**6.65**	**3.81**	**0.00**	**4.90**
14:01 Cat litter	2.78	4.84	176	11.54	4,267.00	4.18	1.71	0.00	2.78
14:02 Non-distinct fines	1.97	1.63	83	8.15	3,014.00	2.35	1.92	0.00	1.97
14:03 Other wastes, dental floss, …..	0.12	0.77	620	0.51	187.00	0.12	0.15	0.00	0.12
Total	**100**			**414.46**	**153,264.00**	**99.95**	**100.00**	**100.00**	**100.00**

WASTE PROPERTIES

Project: PROJECT NAME HERE
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DRAFT

September 2015

MOISTURE CONTENT and PROXIMATE ANALYSIS

Typical moisture contents of waste categories (wt%, dry basis)

Waste category	Moisture content, wt%		
	As-fired	As-discarded	%change
Oils	0	0	0.0%
Paper	24.3	8	103.8%
Plastics	13.8	2	490.0%
Rubber	13.8	2	490.0%
Leather	13.8	2	490.0%
Textiles	23.8	10	38.0%
Wood	15.4	15	-97.3%
Food wastes	63.6	70	-109.1%
Yard wastes	37.9	55.3	-131.5%
Glass	3	2	-50.0%
Metal	6.6	2	130.0%
Miscellaneous	3	2	-50.0%

Adapted from: (Niessen 2010), Table 4.7, p.111

Proximate analysis of waste materials, paper and paper products (wt%, as received)

Category/material	Proximate analysys (as received), wt %			
	Moisture	Volatile matter	Fixed carbon	Non comb.
Paper and Paper Products				
Paper, Mixed	10.24	75.94	8.44	5.38
Newsprint	5.97	81.12	11.48	1.43
Brown Paper	5.83	83.92	9.24	1.01
Trade Magazine	4.11	66.39	7.03	22.47
Corrugated Boxes	5.2	77.47	12.27	5.06
Plastic-Coated Paper	4.71	84.2	8.45	2.64
Waxed Milk Cartons	3.45	90.92	4.46	1.17
Paper Food Cartons	6.11	75.59	11.8	6.5
Junk Mail	4.56	73.32	9.03	13.09

SOURCE: (Niessen 2010), Table 4.32, pp.132-133.

Proximate analysis of waste materials - food and food wastes (wt%, as received)

Category/material	Proximate analysys (as received), wt %			
	Moisture	Volatile matter	Fixed carbon	Non comb.
Food and Food Wastes				
Vegetable Food Wastes	78.29	17.1	3.55	1.06
Citrus Rinds and Seeds	78.7	16.55	4.01	0.74
Meat Scraps (cooked)	38.74	56.34	1.81	3.11
Fried Fats	0	97.64	2.36	0

SOURCE: (Niessen 2010), Table 4.32, pp.132-133.

Proximate analysis of waste materials - green waste (wt%, as received)

Category/material	Proximate analysys (as received), wt %			
	Moisture	Volatile matter	Fixed carbon	Non comb.
Green Waste				
Green Logs	50	42.25	7.25	0.5
Rotten Timbers	26.8	55.01	16.13	2.06
Demolition Softwood	7.7	77.62	13.93	0.75
Waste Hardwood	12	75.05	12.41	0.54
Furniture Wood	6	80.92	11.74	1.34
Evergreen Shrubs	69	25.18	5.01	0.81
Balsam Spruce	74.35	20.7	4.13	0.82
Flowering Plants	53.94	35.64	8.08	2.34
Lawn Grass	75.24	18.64	4.5	1.62
Ripe Leaves	9.97	66.92	19.29	3.82
Wood and Bark	20	67.89	11.31	0.8
Brush	40	--	--	5
Mixed Greens	62	26.74	6.32	4.94

SOURCE: (Niessen 2010), Table 4.32, pp.132-133.

Proximate analysis of waste materials - domestic wastes (wt%, as received)

Category/material	Proximate analysys (as received), wt %			
	Moisture	Volatile matter	Fixed carbon	Non comb.
Domestic Wastes				
Upholstery	6.9	75.96	14.52	2.62
Tires	1.02	64.92	27.51	6.55
Leather	10	68.46	12.49	9.1
Leather Shoe	7.46	57.12	14.26	21.16
Shoe, Heel & Sole	1.15	67.03	2.08	29.74
Rubber	1.2	83.98	4.94	9.88
Mixed Plastics	2	--	--	10
Plastic Film	3-20	--	--	--
Polyethylene	0.2	98.54	0.07	1.19
Polystyrene	0.2	98.67	0.68	0.45
Polyurethane	0.2	87.12	8.3	4.38
Polyvinyl Chloride	0.2	86.89	10.85	2.06
Linoleum	2.1	64.5	6.6	26.8
Rags	10	84.34	3.46	2.2
Textiles	15-31	--	--	--
Oils, Paints	0	--	--	16.3
Vacuum Cleaner Dirt	5.47	55.68	8.51	30.34
Household Dirt	3.2	20.54	6.26	70

SOURCE: (Niessen 2010), Table 4.32, pp.132-133.

Proximate analysis of waste materials - municipal wastes (wt%, as received)

Category/material	Proximate analysys (as received), wt %			
	Moisture	Volatile matter	Fixed carbon	Non comb.
Municipal Wastes				
Street Sweepings	20	54	6	20
Mineral	2-6	--	--	--
Metallic	3-11	--	--	--
Ashes	10	2.68	24.12	63.2

SOURCE: (Niessen 2010), Table 4.32, pp.132-133.

ULTIMATE ANALYSIS

Ultimate analysis of waste categories (wt%, dry basis)

Category/material	Ultimate analysis (dry basis), weight %					
	C	H	O	N	S	Ash
Oils	66.85	9.63	5.2	2	0.02	16.3
Paper	45.4	6.1	42.1	0.3	0.12	5.98
Plastics	59.8	8.3	19	1	0.3	11.6
Rubber	77.65	10.35			2	10
Leather	60	8	11.5	10	0.4	10.1
Textiles	46.2	6.4	41.8	2.2	0.2	3.2
Wood	48.3	6	42.4	0.3	0.11	2.89
Food wastes	41.7	5.8	27.6	2.8	0.25	21.85
Yard wastes	49.2	6.5	36.1	2.9	0.35	4.95
Glass	0.52	0.07	0.36	0.03	0	99.02
Metal	4.5	0.6	4.3	0.05	0.01	90.54
Miscellaneous	13	2	12	3		70

Adapted from: (Niessen 2010), Table 4.28, p.127

Ultimate analysis of waste materials, paper and paper products (wt%, dry basis)

Category/material	Ultimate analysis (dry basis), weight %					
	C	H	O	N	S	Ash
Paper and Paper Products						
Paper, Mixed	43.41	5.82	44.32	0.25	0.2	6
Newsprint	49.14	6.1	43.03	0.05	0.16	1.52
Brown Paper	44.9	6.08	47.34	0	0.11	1.07
Trade Magazine	32.91	4.95	38.55	0.07	0.09	23.43
Corrugated Boxes	43.73	5.7	44.93	0.09	0.21	5.34
Plastic-Coated Paper	45.3	6.17	45.5	0.18	0.08	2.77
Waxed Milk Cartons	59.18	9.25	30.13	0.12	0.1	1.22
Paper Food Cartons	44.74	6.1	41.92	0.15	0.16	6.93
Junk Mail	37.87	5.41	42.74	0.17	0.09	13.72

Adapted from: (Niessen 2010), Table 4.28, p.127

Ultimate analysis of waste materials - food and food wastes (wt%, dry basis)

Category/material	Ultimate analysis (dry basis), weight %					
	C	H	O	N	S	Ash
Food and Food Wastes						
Vegetable Food Wastes	49.06	6.62	37.55	1.68	0.2	4.89
Citrus Rinds and Seeds	47.96	5.68	41.67	1.11	0.12	3.46
Meat Scraps (cooked)	59.59	9.47	24.65	1.02	0.19	5.08
Fried Fats	73.14	11.54	14.82	0.43	0.07	0

Adapted from: (Niessen 2010), Table 4.28, p.127

Ultimate analysis of waste materials - food and food wastes (wt%, dry basis)

Category/material	Ultimate analysis (dry basis), weight %					
	C	H	O	N	S	Ash
Food and Food Wastes						
Vegetable Food Wastes	49.06	6.62	37.55	1.68	0.2	4.89
Citrus Rinds and Seeds	47.96	5.68	41.67	1.11	0.12	3.46
Meat Scraps (cooked)	59.59	9.47	24.65	1.02	0.19	5.08
Fried Fats	73.14	11.54	14.82	0.43	0.07	0

Adapted from: (Niessen 2010), Table 4.28, p.127

Ultimate analysis of waste materials - green waste (wt%, dry basis)

Category/material	Ultimate analysis (dry basis), weight %					
	C	H	O	N	S	Ash
Green Waste						
Green Logs	50.12	6.4	42.26	0.14	0.08	1
Rotten Timbers	52.3	5.5	39	0.2	1.2	2.8
Demolition Softwood	51	6.2	41.8	0.1	<.1	0.8
Waste Hardwood	49.4	6.1	43.7	0.1	<.1	0.6
Furniture Wood	49.7	6.1	42.6	0.1	<.1	1.4
Evergreen Shrubs	48.51	6.54	40.44	1.71	0.19	2.61
Balsam Spruce	53.3	6.66	35.17	1.49	0.2	3.18
Flowering Plants	46.65	6.61	40.18	1.21	0.26	5.09
Lawn Grass	46.18	5.96	36.43	4.46	0.42	6.55
Ripe Leaves	52.15	6.11	30.34	6.99	0.16	4.25
Wood and Bark	50.46	5.97	42.37	0.15	0.05	1
Brush	42.52	5.9	41.2	2	0.05	8.33
Mixed Greens	40.31	5.64	39	2	0.05	13

Adapted from: (Niessen 2010), Table 4.28, p.127

Ultimate analysis of waste materials - domestic wastes (wt%, dry basis)

Category/material	Ultimate analysis (dry basis), weight %					
	C	H	O	N	S	Ash
Domestic Wastes						
Upholstery	47.1	6.1	43.6	0.3	0.1	2.8
Tires	79.1	6.8	5.9	0.1	1.5	6.6
Leather	60	8	11.5	10	0.4	10.1
Leather Shoe	42.01	5.32	22.83	5.98	1	22.86
Shoe, Heel & Sole	53.22	7.09	7.76	0.5	1.34	30.09
Rubber	77.65	10.35			2	10
Mixed Plastics	60	7.2	22.6	--	--	10.2
Plastic Film	67.21	9.72	15.82	0.46	0.07	6.72
Polyethylene	84.54	14.18	0	0.06	0.03	1.19
Polystyrene	87.1	8.45	3.96	0.21	0.02	0.45
Polyurethane	63.27	6.26	17.65	5.99	0.02	4.38 [(a)]
Polyvinyl Chloride	45.14	5.61	1.56	0.08	0.14	2.06 [(b)]
Linoleum	48.06	5.34	18.7	0.1	0.4	27.4
Rags	55	6.6	31.2	4.12	0.13	2.45
Textiles	46.19	6.41	41.85	2.18	0.2	3.17
Oils, Paints	66.85	9.63	5.2	2		16.3
Vacuum Cleaner Dirt	35.69	4.73	20.08	6.26	1.15	32.09
Household Dirt	20.62	2.57	4	0.5	0.01	72.3

Adapted from: (Niessen 2010), Table 4.28, p.127

Ultimate analysis of waste materials - municipal wastes (wt%, dry basis)

Category/material	Ultimate analysis (dry basis), weight %					
	C	H	O	N	S	Ash
Municipal Wastes						
Street Sweepings	34.7	4.76	35.2	0.14	0.2	25
Mineral	0.52	0.07	0.36	0.03	0	99.02
Metallic	4.54	0.63	4.28	0.05	0.01	90.49
Ashes	28	0.5	0.8	--	0.5	70.2

SOURCE: (Niessen 2010), Table 4.32, pp.132-133.

ENERGY CONTENT

Energy contents of waste categories

Category/material	Higher Heating Value (MJ/kg)			Lower Heating Value (MJ/kg)		
	as received	dry basis	dry, ash free	as received	dry basis	dry, ash free
Oils	33.77	33.77	40.35	31.82	31.82	38.39
Paper	14.05	18.57	20.16	12.26	16.78	18.37
Plastics	24.53	28.46	32.89	22.53	26.46	30.89
Rubber	33.87	39.29	44.45	31.45	36.88	42.03
Leather	24.88	28.86	32.69	22.94	26.92	30.75
Textiles	14.68	19.27	20.11	12.84	17.43	18.27
Wood	16.49	19.49	20.18	14.92	17.92	18.61
Food wastes	6.57	18.06	45.18	3.96	15.44	42.56
Yard wastes	13.03	20.99	22.81	10.86	18.81	20.63
Glass	-1.81	-1.86	89.46	-1.89	-1.95	89.38
Metal	-0.07	-0.08	-2.51	-0.34	-0.35	-2.78
Miscellaneous	4.01	4.13	14.84	3.53	3.66	14.37

Adapted from: (Niessen 2010), Table 4.32, pp.132-133.

Energy contents of waste materials - paper and paper products

Category/material	Higher Heating Value (MJ/kg)			Lower Heating Value (MJ/kg)		
	as received	dry basis	dry, ash free	as received	dry basis	dry, ash free
Paper and Paper Products						
Paper, Mixed	15.82	17.61	18.74	14.40	16.20	17.32
Newsprint	18.55	19.72	20.00	17.17	18.35	18.63
Brown Paper	16.88	17.92	18.14	15.51	16.56	16.77
Trade Magazine	12.22	12.74	16.63	11.12	11.64	15.53
Corrugated Boxes	16.38	17.28	18.26	15.11	16.00	16.98
Plastic-Coated Paper	17.07	17.92	18.47	15.71	16.55	17.11
Waxed Milk Cartons	26.35	27.29	27.66	24.39	25.33	25.70
Paper Food Cartons	16.88	17.98	19.19	15.50	16.60	17.81
Junk Mail	14.16	14.83	17.21	12.96	13.63	16.01

Adapted from: (Niessen 2010), Table 4.32, pp.132-133.

Energy contents of waste materials - food and food wastes

Category/material	Higher Heating Value (MJ/kg)			Lower Heating Value (MJ/kg)		
	as received	dry basis	dry, ash free	as received	dry basis	dry, ash free
Food and Food Wastes						
Vegetable Food Wastes	4.17	19.23	20.23	1.06	16.12	17.12
Citrus Rinds and Seeds	3.97	18.64	19.31	1.04	15.71	16.37
Meat Scraps (cooked)	17.73	28.94	30.49	14.93	26.14	27.69
Fried Fats	38.30	38.30	38.30	0.16	0.16	0.16

Adapted from: (Niessen 2010), Table 4.32, pp.132-133.

Energy contents of waste materials - green waste

Category/material	Higher Heating Value (MJ/kg)			Lower Heating Value (MJ/kg)		
	as received	dry basis	dry, ash free	as received	dry basis	dry, ash free
Green Waste						
Green Logs	4.89	9.78	9.89	2.46	7.35	7.45
Rotten Timbers	10.96	14.81	15.26	9.23	13.09	13.53
Demolition Softwood	16.98	18.41	18.60	15.55	16.98	17.16
Waste Hardwood	14.96	16.98	17.07	13.44	15.47	15.56
Furniture Wood	17.09	18.17	18.47	15.72	16.80	17.09
Evergreen Shrubs	6.30	20.32	20.84	3.41	17.43	17.95
Balsam Spruce	5.69	22.19	22.91	2.65	19.16	19.88
Flowering Plants	8.60	18.67	19.68	6.04	16.11	17.11
Lawn Grass	4.79	19.33	20.70	1.87	16.42	17.79
Ripe Leaves	18.57	20.63	21.56	17.10	19.16	20.09
Wood and Bark	16.05	20.03	20.23	14.38	18.37	18.57
Brush	11.04	18.38	20.00	8.93	16.27	17.90
Mixed Greens	6.26	16.46	18.92	3.71	13.91	16.37

Adapted from: (Niessen 2010), Table 4.32, pp.132-133.

Energy contents of waste materials - domestic wastes

Category/material	Higher Heating Value (MJ/kg)			Lower Heating Value (MJ/kg)		
	as received	dry basis	dry, ash free	as received	dry basis	dry, ash free
Domestic Wastes						
Upholstery	16.19	17.40	17.89	14.79	16.00	16.49
Tires	32.10	32.35	34.66	30.69	30.94	33.25
Leather	18.51	20.59	22.91	16.66	18.73	21.06
Leather Shoe	16.85	18.20	23.61	15.60	16.95	22.36
Shoe, Heel & Sole	25.35	25.65	36.73	23.88	24.18	35.26
Rubber	26.05	26.35	29.31	23.92	24.22	27.18
Mixed Plastics	32.80	33.42	37.22	31.29	31.91	35.71
Plastic Film	--	32.20	34.59	--	--	--
Polyethylene	45.77	45.89	46.52	42.88	43.00	43.63
Polystyrene	38.19	38.26	38.40	36.47	36.54	36.68
Polyurethane	26.06	26.11	27.29	24.78	24.83	26.01
Polyvinyl Chloride	22.69	22.74	23.26	21.54	21.59	22.12
Linoleum	18.96	19.33	26.63	17.82	18.20	25.50
Rags	16.05	17.80	18.25	14.48	16.23	16.68
Textiles	--	18.69	19.31	--	--	--
Oils, Paints	31.17	31.17	37.22	29.21	29.21	35.26
Vacuum Cleaner Dirt	14.85	15.71	23.17	13.77	14.63	22.08
Household Dirt	8.54	8.82	31.75	7.94	8.22	31.15

Adapted from: (Niessen 2010), Table 4.32, pp.132-133.

Energy contents of waste materials - municipal wastes

Category/material	Higher Heating Value (MJ/kg)			Lower Heating Value (MJ/kg)		
	as received	dry basis	dry, ash free	as received	dry basis	dry, ash free
Municipal Wastes						
Street Sweepings	11.17	13.95	18.61	9.75	12.53	17.19
Mineral	--	0.20	--	--	--	--
Metallic	--	1.72	18.14	--	--	--
Ashes	8.75	9.71	32.56	8.42	9.38	32.24

Adapted from: (Niessen 2010), Table 4.32, pp.132-133.

REFERENCES

Project: CRD-p001 - Gasification Technologie
File: CRD-p001_CalorificValues.xlsx

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efficiency | renewables | innovation

Ref. No.	Author-Date	Content Type	Full Bibliographic record
1	(SHA 2010)	Technical Report	SHA. (2010). Capital Regional District - Solid Waste Stream Composition Study 2009-2010 (No. PRJ09042). crd.bc.ca.
2	(Channiwala and Parikh 2	Journal Article	Channiwala, S.A. & Parikh, P.P., 2002. A unified correlation for estimating HHV of solid, liquid and gaseous fuels. Fuel. 81(8). pp.1051–1063.
3	(Lide 2005)	Reference Work	Lide, D.R., 2005. CRC Handbook of Chemistry and Physics, Internet Version 2005. Boca Raton, FL: CRC Press.
4	(Mohr and Taylor 2004)	Technical Report	Mohr, P.J., and B.N. Taylor, 2004. The 2002 CODATA Recommended Values of the Fundamental Physical Constants. Web Version 4.0. NIST Physical Data (December 2003): Rev. Mod. Phys. 76. No.
5	(Niessen 2010)	Book	Niessen, W.R., 2010. (Niessen 2010) Combustion & Incineration Processes. pp.1–712.
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