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PRELIMINARY DRAFT
Waste Characterization Report

Mangrove Pond Green Energy Complex

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Sanitation Service Authority

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Table of Contents

Record of Revisions

Table of Contents (Continued)

Appendices

1.0 Introduction

The purpose of a solid waste characterization study is to identify the quantity and composition of the waste stream being generated or collected by a facility. In this case the waste stream of interest is the total solid waste stream consisting of a mixture of municipal solid waste, as well as wastes generated by agriculture, industry, commercial, and institutional enterprises in Barbados, respective to its suitability for use in a Waste-To-Energy (WTE) facility.

The majority of waste produced in Barbados is landfilled at the Mangrove Pond Landfill Site. The waste supply that will be made available to the WTE Plant will be a subset of the overall **Solid Waste** stream that now arrives at the Solid Waste Management Centre Vaucluse (SWMCV) for classification, sorting, recovery, diversion, or transfer to landfill by the SWMCV MRF-Transfer Operator (currently **Sustainable Barbados Recycling Centre Inc.**, or "**SBRC**".)

The SWMCV receives all but a few sub-streams (such as source-separated Tyres) of the solid waste generated in Barbados that could potentially serve as waste supply to the WTE Plant. SBRC classifies loads into one of 18 waste type categories as loads arrive at the scalehouse. As a result, the actual tonnage delivered to the SWMCV from each of the waste types is known and well documented.

We understand from the Sanitation Service Authority that there are other points of waste processing or disposal on the island including

- Airport
- Port lands
- Edgecomb quarry
- Hospital Facilities
- B's Recycling
- Barbados located recycler's

Efforts are currently underway to interview these facility operators to get a better understanding of the quantity and composition of waste generated at these facilities.

It should be noted that current waste management contracts and infrastructure in place at SBRC, the airport, or any of the other facilities listed above will need to be taken into consideration if this waste is to be diverted to the WTE facility.

2.0 Waste Quantities

Figure 1 - Solid Waste Overview: 2005 through 2012 Tonnages shows, in its main table, for years 2005 through 2012, by column:

- For highlighted year **2005**, a previous waste composition study by L.H. Consulting measured tonnage arriving at the Mangrove Pond Landfill over 5 months in 2005. This quantity is annualized to **330,418 TPY** over 12 months. **Year 2005 is used as the beginning reference point in the data series for 2005 through 2012, since it is based on actual weighed tonnage arriving.**

- No other consistent weighing of tonnage is known until the opening of the SWMCV under SBRC in May 2009. Since tonnage deliveries to SBRC ramped up gradually from May through December during 2009, tonnage weighed as received by SBRC in 2009 is known to be incomplete.

- For highlighted year **2011,** actual waste received by SBRC at the SWMCV was weighed as **348,531 TPY**. **Year 2011 is used as the end reference point in the data series for 2005 through 2016, since it is based on actual weighed tonnage arriving.** Diversion of some Rock & Soil late in year 2011 is not considered permanently significant.

- **Figure 1 interpolates between the two reference points of 2005 and 2011** (please see Note [B]) as follows: The total TPY increase over the 6-year period was 18,113 TPY, or about 1.0% growth per year. This growth index is used again in Figure

- It is noted that during the three latest years of 2010, 2011, and 2012, Total Waste to SBRC varied from 437,749 to 348,531 to 298,317 TPY. In 2010, debris generated from Hurricane Thomas atypically inflated waste tonnage arriving at SWMCV. In 2012, a significant amount of waste Rock & Soil and other waste was diverted from SBRC (possibly because of shorter Rock & Soil disposal haul distances to alternative quarries for various construction projects around the island.) **For these reasons, 2010 and 2012 are not used as the interpolation reference points.** Even with this variability, primarily caused by diversion or inclusion of Rocks & Soil, we note that the categories of waste considered potential (please see below) sources of waste processable by the WTE Plant do not vary widely during 2010, 2011, and 2012: from 586 to 546 to 520 TPD.

Barbados WTE
RFP Technical Criteria
Figure 1 - Solid Waste Overview: 2005 through 2012 Tonnages

	Total Waste to Mangrove Pond Landfill or to SBRC		Total Waste to SBRC		SBRC Solid Waste Processable by WTE Plant					
					MSW-Mixed to SBRC		Supplementary Waste Source Categories		Total	
	TPY	Notes	TPY	Notes	TPY	TPD	TPY	TPD	TPY	TPD
2005	**330,418**	**Actual-Base [A]**	**N/A**		**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
2006	333,722	Interpolated / Est. [B]	N/A		N/A	N/A	N/A	N/A	N/A	N/A
2007	337,059	Interpolated / Est. [B]	N/A		N/A	N/A	N/A	N/A	N/A	N/A
2008	340,430	Interpolated / Est. [B]	N/A		N/A	N/A	N/A	N/A	N/A	N/A
2009	343,834	Interpolated / Est. [B]	N/A	[D]	N/A	N/A	N/A	N/A	N/A	N/A
2010	347,273	Interpolated / Est. [B]	437,749	[E]	116,732	320	97,056	266	213,788	586
2011	**348,531**	**Actual-Reference**	**348,531**		**109,795**	**301**	**89,354**	**245**	**199,149**	**546**
2012	352,016	Interpolated / Est. [B]	298,317	[F]	105,689	290	84,106	230	189,796	520

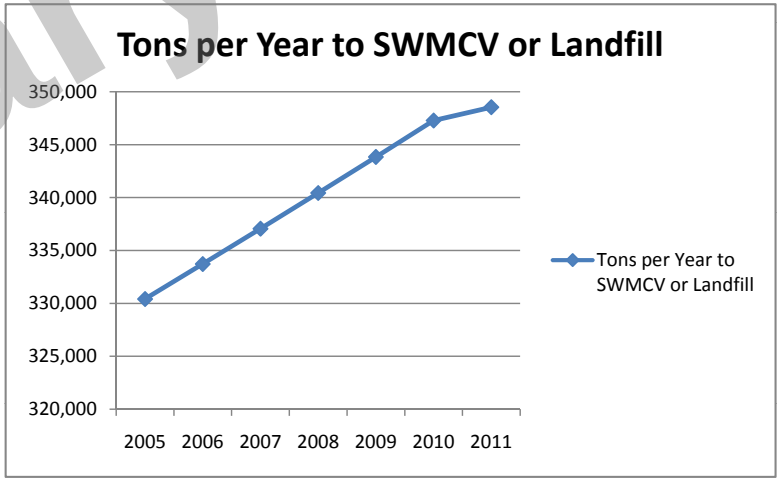
[A] Source:

	5 Month Sample Period in 2005	Annualized to 12 Months
Total Waste	137,674	330,418

Note: Total Waste of 137,674 tons is Actual 5-month 2005 tonnages (from L.H. Consulting Ltd. 2005 study Table 11) annualized to 12 months.

[B] Interpolation between Actual 2005 and Actual 2011:

Y = mX + b		
b =	330,418	Tons per Year (TPY) 2005
	18,113	= 348,531 - 330,418 Total TPY Increase Over 6 Years
	5.5%	= 18,113 / 330,418 Total Percent Increase Over 6 Years
m =	3,019	(348,531 - 330,418) / 6 Years = Avg Annual Increase TPY
m as % annual	0.91%	Percent Growth per Year = m / b
m % Rounded	**1.00%**	Percent Growth per Year



[C] Tons per Day on 365 days per year basis.

[D] Transition year when SBRC opened in May 2009, with only lmiited categories of waste being delivered during 2009.

[E] Outlier year with "bump" caused by Hurricane Thomas. Note WTE Processable categories relatively stable compared to 2011.

[F] Diversion of Rock & Soil away from SBRC.

[G] Sum of waste categories Processable by WTE Plant. Please see highlighted columns in Figure 2.

3.0 Waste Characterization by SBRC Sorting Categories

Figure 2 – Minimum and Maximum Waste to WTE Plant in 2011 Tonnages shows actual tonnages delivered to the SWMCV by waste type (columns) on its third row "TPY Generated Actual 2011 [A]". The year 2011 has been selected as the reference year, for the reasons explained above, under the discussion of Figure 1.

In the far right hand column, where totals are presented, Figure 1 reflects that 348,531 tons of all types of waste were delivered to the SWMCV during the 365 days of 2011.

Figure 1 shows that actual weighed tonnage arriving at the SWMCV in 2011 was 348,531. To obtain this amount, in Figure 2 Tyres have been added in the amount of 907 TPY to the 348,531 TPY reported by SBRC (which has not received Tyres historically), for a total tonnage of **349,438 TPY**. The basis for waste Tyre generation of 907 TPY is:

- **100,000 vehicles in Barbados x 1 waste Tyre per year per vehicle x 20 lbs per Tyre / 2204.6 lbs per Metric Ton = 907 TPY.**

This addition of Tyres was necessary because Tyres have never been delivered, other than incidentally, to the SWMCV and have been stored north of the highway bordering the SWMCV. In practice, additional Tyres will be available for the first few years of operations of the WTE Plant, as the existing Tyres stockpile is consumed gradually. A fire which occurred at the site in 2012 reduced the existing stockpile at the facility. It anticipated that the existing tire stockpile is currently between 180 and 360 tonnes.

Much of the overall 349,438 tons of waste are not suitable for processing ("non-processable") waste through the WTE Plant, primarily as a result of being simultaneously bulky and non-combustible or simply non-combustible. Generally, **the primary source of waste supply to the WTE Plant will be the MSW-Mixed** category, which encompasses "garbage" or "rubbish" from residential, commercial, and industrial sources. The MSW-Mixed category consists predominantly of mixed waste that fits into plastic bags or curbside containers that can be lifted by hand. The **MSW-Mixed category** (highlighted in Figure 2) appears in a column positioned near the center of Figure 2, and encompassed 109,795 tons delivered, or 31% of the overall 349,438 tons delivered.

In addition, wastes in categories other than MSW-Mixed will be suitable for processing through the WTE Plant. The primary "supplemental" categories ("Supplemental Waste" as defined herein) are also highlighted in yellow in Figure 2:

- Green Waste (from 20% to 100% projected to be directed to the WTE Plant);

- Mixed C&D (from 20% to 50% projected to be directed to the WTE Plant); and
- Tyres.(100% projected to be directed to the WTE Plant).

Many of these categories such as Paper, Green Waste and Plastic & Other, for example are currently intended for recycling programs, although significant portions of which are still entering the landfill.

For the Supplemental Waste categories highlighted in Figure 2 and discussed immediately above, it is possible that only a fraction of each supplemental category will be directed to the WTE Plant for one of two reasons: (a) some of the Supplemental Waste category will not be processible through the WTE Plant (as in the case of some Mixed-C&D); or (b) some of the Supplemental Waste category will be preferably directed to recycling programs (as is the case for most of the Green Waste.) Discussions with current recyclers and the Government of Barbados will be needed to confirm quantities of waste that can or should be diverted from recycling programs to the WTE plant. The ability of the WTE plant to adequately process and segregate unsuitable wastes from suitable wastes will also depend on the technology used.

While the details of the current operating contract with SBRC is unknown, it is understood that the Government of Barbados can contractually direct SBRC with regard to the final disposition of waste (excluding recovered materials) leaving the SWMCV.
The fractions from the Supplemental Waste categories that are directed by GOB to the WTE Plant may vary over time, depending on recycling markets, energy costs, etc. Therefore, in Figure 2, two cases are shown, reflected in the five lines grouped as either "Minimum Tonnages to WTE" or "Maximum Tonnages to WTE". The only difference in each case is that GOB has elected to direct a lower or a higher percentage of each Supplemental Waste category to the WTE Plant (in both cases, 100% of MSW-Mixed is delivered to the WTE Plant.)

As a result, Figure 2 reflects that, within 2011 overall tonnage, **130,712 TPY** Minimum to **187,153 TPY** Maximum would have been directed to the WTE Plant.

Also in Figure 2, the Minimum and Maximum delivery tonnages are expressed not only in the annual amounts described immediately above, but also as Tons per Day (TPD) and Tons per Hour (TPH). TPD capacity required from the WTE Plant in 2011 tonnage terms is calculated on a 328.5 days per year basis (398 TPD to 570 TPD). The 328.5 days per year is shown calculated in the Notes to Figure 2 as the number of available operating days if the WTE Plant meets an availability of 90.0%.

This means that 365 – 328.5 = 36.5 days per year are taken up with scheduled and unscheduled maintenance. This means that the WTE Plant must have daily capacity to

process the annual tonnage over 328.5 days, not 365 days. The Tons per Hour (TPH) row in Figure 1 shows in the far right hand column the rate at which waste would have to be processed by the WTE Plant on an hourly basis (16.6 to 23.9 TPH). This is calculated by dividing the TPD figure @ 90.0% availability by 24 hours. The WTE industry in Europe tends to express plant processing capacities in TPH, while the industry in North America tends to use TPD ratings.

Barbados WTE

RFP Technical Criteria

Figure 2 - Minimum and Maximum Waste to WTE Plant in 2011 Tonnages

Waste Types Tracked at SWMCV:	Aluminum	Appliances	Cardboard	Coconut Husks	Glass Clear	Glass Green	Green Waste	Manure	Mixed C&D	MSW - Mixed	MSW-Bulky	Pallets/ Lumber	Paper	Plastic & Other	Pure Concrete	Rocks & Soil C&D	Scrap Metal	Shingles	Tyres	Total
Source-Separated or Mixed on Arrival at SWMCV	Primarily Source-Separated								Primarily Mixed			Primarily Source-Separated								
TPY Generated ACTUAL 2011 [A]	-	1	701	4,990	296	35	38,467	1,496	50,887	109,795	1	7,129	156	219	34	134,070	-	252	907	**349,438**
Minimum Tonnage to WTE																				
Percent to WTE [B]	0%	0%	0%	0%	0%	0%	20%	0%	20%	100%	0%	30%	0%	0%	0%	0%	0%	0%	100%	
TPY to WTE Est. @ 2011 Tonnages [C]	-	-	-	-	-	-	**7,693**	-	10,177	**109,795**	-	2,139	-	-	-	-	-	-	**907**	**130,712**
WTE Capacity: TPD to WTE Est. @ 2011 Tonnages [E]	-	-	-	-	-	-	23.42	-	30.98	334.23	-	6.51	-	-	-	-	-	-	2.76	**398**
WTE Capacity: TPH to WTE Est. @ 2011 Tonnages [F]																				**16.6**
Maximum Tonnage to WTE																				
Percent to WTE [B]	0%	0%	100%	100%	0%	0%	100%	0%	50%	100%	0%	100%	100%	100%	0%	0%	0%	100%	100%	
TPY to WTE Est. @ 2011 Tonnages [C]	-	-	**701**	**4,990**	-	-	38,467	-	**25,444**	**109,795**	-	**7,129**	**156**	**219**	-	-	-	**252**	**907**	**187,153**
WTE Capacity: TPD to WTE Est. @ 2011 Tonnages [D]	-	-	2.13	15.19	-	-	117.10	-	77.45	334.23	-	21.70	0.47	0.67	-	-	-	0.77	2.76	**570**
WTE Capacity: TPH to WTE Est. @ 2011 Tonnages [E]																				**23.7**

Notes:

[A] Source: SBRC Daily Tonnage Report for 2011 (ACTUAL), except for Tyres projected at: (100,000 Cars) x (1 Waste Tyre/Year/Car) / (20 lbs per Tyre / 2204.6 lbs per MT) =

[B] Percent to WTE is driven by GOB instructions to the Operator of the SWMCV with regard to final disposition of incoming waste streams. For example, a GOB instruction could be that X% of all Coconut Husks be sent to WTE instead of converted to other products. [C] TPY to WTE = A X B

[D] TPD to WTE @ 365 DPY X 90.0% = 328.5 Available Days per Year

[E] TPH (Tons per Hour) = E / 24 In North America, most WTE capacities are stated in TPD, while in Europe, TPH is widely used.

4.0 Additional Waste Sampling Undertaken in December 2013

A waste sampling program was conducted during the week of December 9-13, 2013. The goal of the study was to provide a more recent assessment of composition and amount of variability in a variety of streams including both residential and commercial sources. The study focused primarily on residential, commercial and hotel waste as these are expected to be the primary waste generators on the island, but also included samples from an institution and supermarkets in order to capture the entire waste stream.

In addition to the characterization efforts, interviews with other generators on the island including large institutions and recyclers are being conducted on an ongoing basis. The information on the materials handled and material fate will be included in an updated report once it has been finalized.

4.1 Materials and Methods

The study, when possible was conducted in accordance with ASTM D5231 which describes the methodologies typically used during an audit. A copy of the Method is attached as Appendix B.

Loads were obtained from vehicles identified as containing MSW when crossing the scales into the SBRC facility during daytime operations.

Once identified, the loads were tipped onto a paved surface and inspected. If the load contained a mixture of various materials considered to be representative of the selected waste type it was deemed acceptable. At this point the driver was briefly interviewed to determine the source of the load and the driver's observations on how the load conformed to the 'typical' load. If accepted the load separated lengthwise and mixed via front end loader. After separation, a sample estimated to weigh 100kg was collected using the loader bucket. The sample was visually inspected to ensure general conformance to the bulk load, if the sample did not appear to be consistent, for example consisting primarily of one or more materials, it was rejected and the load resampled.

Once sampled the load was sorted into various material categories which were selected to be consistent with previous study efforts at the site. These categories were adjusted as needed in the field to group wastes not of interest to the WTE plant together (for example coloured versus non-coloured glass). In addition materials with similar properties and low masses were grouped together while separating out materials which came in in large quantities, for example all Styrofoam was grouped together, while brake

parts were separated out of a commercial load where they were encountered in large quantities.

Once sorted samples were photographed in their containers, and weighed via a digital shipping scale.

4.2 Results and Observations

Several relevant key observations were made during the study period which should be considered when interpreting and making use of these results.

The short time period (3 days) for this sampling period results in a snapshot of the waste characteristics and volumes of this period alone, as opposed to accounting for an entire calendar year. The timing of the study was shorty before the Christmas period, as a result it was noted that waste volumes during this period may be increased respective to the average and composition may be shifted due to holiday preparations, as well as representing the peak travel season for the area.

This was confirmed during the study as it was noted that some loads contained significant amount of textiles located within the same load portion as well as certain easily identifiable items such as footwear which occurred highly frequently within the loads. These materials and the frequency at which they were found seem to indicate that a significant amount of bulk cleaning and disposal activities were being undertaken during the study period. A differing waste pattern was also indicated by certain loads, for example two loads of supermarket waste were sampled, both of these loads consisted primarily of cardboard materials, as well as containing waste goods and amounts of food wastes. During discussions with collections staff it was identified that in general the loads typically include larger amount of food wastes than was represented during the period.

Additionally a significant amount of green waste (palm leaves, tree cuttings and other yard wastes) was encountered during the sampling. It is unclear at this point if these materials are solely a result of the lengthened growing season due to the tropical climate or if they are an indication of additional preparations for the holiday season.

Also of relevance to the data is that significant rainfall events occurred in the days preceding, as well as during the study period which occurred immediately after the typical rainy season for the Country. This increased the weight of absorbent materials such as paper products and organics compared to other materials. It is worthwhile to note that the rainfall experienced by the areas varies significantly through the year, and as a result the moisture contents in WTE feedstock's is anticipated to be correlated to these values.

An additional limitation when studying wastes in Barbados is that it is recognized that the truck size is often limited due to the narrow roads. As a result variability is expected to be increased between samples, as less material is available to blend within a load.

In regarding the total waste composition entering the site it was noted that classification studies have been limited in scope in determining the source of the wastes. During the characterization study the quality of the various MSW contributing fractions was confirmed to differ by source. Further investigation is required to identify how much each waste type contributes to the overall tonnage.

4.3 Data Analysis

In order to characterize the results statistical analysis was conducted on the collected results. The methods undertaken were an arithmetic average, standard deviation as well as a 75% and 95% confidence interval based on a student's t distribution. The range in average confidence interval was used as a reflection of the variability encountered within the wastes, as well as the limited number of samples available for analysis after the first sampling round. The raw data (after category combinations) can be found in Appendix A.

4.3.1 Residential Wastes

Four loads of residential wastes were analyzed during the audit. In general the residential wastes were found to contain primarily organic material, followed by papers, plastics and textiles. In general, of the loads sampled, three loads of the materials were relatively similar. The fourth load contained less organic material, instead having increased amounts of textiles and other wastes. This load was noted as appearing to be strongly influenced by used clothing items and other textile materials. Most of the wastes encountered within this material is combustible, although the food and green wastes may be less valuable from an energy perspective. As somewhat expected, the wastes contained within different loads had some significant variance, especially with regards to the amount of organic wastes being disposed of.

4.3.2 Commercial Wastes

Four loads of commercial wastes were identified, three being purely from commercial sources, and an additional load being explained as an approximate 60/40 split (commercial/residential), although the material within this load appeared to be more consistent with the commercial loads than other residential trucks.

These loads were observed to vary significantly by business type served. Although information on the types of businesses was not generally available prior to the load

being tipped it was usually able to be determined during the waste sorting either by the type of waste being encountered or specific company literature being noted within the waste. In general most of the commercial wastes were a mixture of paper products (mostly cardboard) and other organic wastes (a mixture of food and green wastes). The exception was that one load of waste appeared to originate from an automotive shop and as such contained significant amounts of metal products, as well as quantities of sorbent materials, which in this case appeared to be woodchips which had been exposed to oil.

Due to the varying nature of the businesses the confidence interval for the true mean composition is relatively large. A significant number of samples, or additional information on the business composition on the Island of Barbados is necessary to reduce the confidence interval to a more appropriate level.

4.3.3 Hotel Wastes

Three loads of hotel wastes were sorted during the study. An additional load from a prison (institution) was included within this sample data, as it appeared similar in composition to the hotel wastes. Of these loads, it was observed that the majority of the generated wastes were organic in nature, primarily being foods wastes, with the next most common being papers and plastics. This is reasonable as most hotels contain a restaurant facility as well as serve as locations where visitors dispose of waste foods purchased elsewhere, as well as beverage containers. Depending on the level of service at the hotel newspapers or magazines may be available to visitors. As these are specialty operations with a generally established service type, the overall variation was less than other waste types yielding narrower confidence intervals at the 75% and 95% levels.

4.3.4 Supermarket Wastes

The supermarket wastes were limited in composition mainly to cardboard and food wastes, as is expected from his type of business. Only two loads were sampled during the study, as such standard deviations and confidence intervals were not able to be calculated for these loads. It was noted in one of the loads that unsold products (small appliances) were also contained within the load. It is expected that this corresponded to an end of season/end of year inventory reduction of non-moving products.

4.3.5 Supplemental Waste Discussions

As a portion of the auditing portion of the study interviews and other discussions are being arranged involving Burnside and SSA personnel as well as other waste producers and processers within Barbados. The numbers referenced here are those which were collected during the interviews, and represent unconfirmed data. Also of note the

wastes represented here represent wastes currently being handled by private businesses who may or may not be in existing contracts and would need to be approached on an individual basis to determine the fraction of materials available and how much compensation would be required to account for lost revenues.

4.3.5.1 Recycler Interviews

Recycler interviews were recently conducted. Several local businesses collect and process various types of materials of which a portion are transferred off island. Based on the results of the interviews, there are three main recyclers who appear to handle the bulk of the combustible materials Ace recycling, B's recycling and Diceabed. Based on the results of these interviews up to 36.6 tonnes of day may be recovered. Although the inclusion of the Diceabed composting operation may include materials which are not completely combustible and degrade rapidly.

4.3.5.2 Significant Waste Producers

Discussions were also conducted with major waste producers who may be currently disposing of their waste via incineration to determine if the quantity is viable for trucking, and if the nature of the waste is suitable for processing within a combined facility. These facilities include the hospital, port authority and airport facilities. Based on interviews with the port authority and airport up to approximately 6.7 tonnes per day of materials are being produced. However, in the case of the Airport several specialized wastes are also dealt with including seized narcotics, worn or damaged paper currency and international wastes. Due to the sensitive nature of these wastes they may be unsuitable for transport, or will require specialized handling procedures during destruction.

Similarly the quantities of waste being generated by the cruise ships, and the persistent presence of contaminating wastes (such as food waste) mean that these materials can pose a potential hazard to the local flora and fauna. Additional discussions would be needed to determine if this waste can be processed safely.

4.3.5.3 Waste Importation

As a result of an initial scouting visit to the port facilities an incinerator stack was located. Upon a brief visual inspection it appears that this unit is a small scale unit designed to destroy small quantities of special wastes less that 50 tonnes per day which was confirmed during the site visit. At the time of the visit one cruise ship was located within the port facilities and it was observable that the port had capacity for up to four large cruise ships. With each ship containing between 1,000 and 3,000 people there is the

potential for significant waste to be generated, with some sources identifying between 1 and 7 tonnes of waste being produced each year, depending on a variety of factors including more modern recycling programs being put in place and the installation of incinerators on board. These ships although, seasonally present at the port and may be a potential waste source. Further discussion and investigation with individual cruise line operators and port and customs officials is required to investigate this possibility further.

Similarly tyres have been identified as a potentially importable material source. This would most likely be done using pre-granulated or shredded tyres being transported via container or barge to a sea terminal for transfer and processing at a central facility. As with other waste imports port and customs officials would need to be included in the development of this source.

4.4 Waste Quantities

Additional information on the total average daily masses is still being pursued at this time. As such this section is based on incomplete information and should be confirmed.

Based on observations made at the landfill during the waste audit small quantities of combustible waste generated from clearing activities, primarily green materials, are not being recognized by the scales at present. This material quantity is not expected to significantly affect the total material available for combustion.

An additional disposal facility located at the Edgecomb quarry also receives waste. Based on the quality and quantity of waste present at the time of the visit (largely C&D and green waste), this site would account for an insignificant amount of the total waste stream on a daily basis.

In total the amount of waste suitable for a WTE plant generated within the island each day is estimated at approximately 610 tonnes comprising of from the landfill (~570), recyclers (~35), and other generators (~5). This estimate assumes all suitable wastes can be sourced from existing generators and processed adequately for the proposed WTE plant. These assumptions will warrant further investigation before establishing the design capacity of the facility.

4.5 Agreement with Previous Reports

As discussed previously in the report, waste studies have been undertaken for the Island of Barbados in the past, the most recent of which was in 2005. A cursory review of the presented result of this report was undertaken. Based on a review of the report a similar material composition was determined to be present at this time period, the level of

statistical similarity between the two studies has not been determined due to the limited sampling period during this characterization effort. The statistical accuracy of the 2005 report is also not known. The similarities between the reports have been evaluated for the wastes to date and are presented in Figure 3. The raw data and statistical analysis of the December 2013 audit is contained in Appendix A. Statistically, the low number of samples taken result in wide confidence values for the average which span the previously indicated values. However, the ranges of the compositions seen in the various sectors appear to agree in general with the compositions presented previously. The most prevalent area of variation appears to be in the relative fractions of paper versus plastics present in the waste stream, as well as the amounts of organic wastes present in the stream. These values are likely to vary seasonally as well as shift periodically as packaging materials change and consumption rates of various items shift.

RFP Technical Criteria
Figure 3 - Waste Composition Comparison

			LH Draft Report Findings	Dec 2013 Burnside Waste Characterization Report			
Category		Sub Category	Overall	Residential	Commercial	Supermarket	Hotel
Paper+ Cardboard			**24.7%**	**19.7%**	**37.4%**	**52.6%**	**21.2%**
	1	Newspaper	3.8%	7.2%	0.9%	0.0%	2.4%
	2	Uncoated Corrugate Cardboard	6.2%	2.0%	30.9%	50.8%	5.4%
	3	Boxboard	5.4%	3.2%	0.0%	0.0%	0.0%
	4	Clean (Office, Magazines, etc.) Paper	1.5%	3.1%	2.0%	0.0%	1.5%
	5	Glossy Magazines	1.1%	0.9%	1.0%	0.0%	2.4%
	6	Tetrapak	3.1%	0.0%	0.6%	1.7%	3.6%
	7	Remainder/Composite Paper	3.6%	3.3%	2.1%	0.2%	5.9%
Glass			**8.2%**	**3.7%**	**1.4%**	**0.7%**	**5.5%**
	8	Clear Beverage Containers	4.0%	0.0%	0.0%	0.0%	0.0%
	9	Clear Food Containers	0.9%	3.7%	1.8%	0.7%	4.8%
	10	Coloured Beverage Containers	2.6%	0.0%	0.0%	0.0%	0.0%
	11	Coloured Food Containers	0.6%	0.0%	0.0%	0.0%	0.0%
	12	Remainder/Composite Glass	0.1%	0.0%	0.0%	0.0%	2.5%
Metal			**9.2%**	**4.9%**	**6.1%**	**1.0%**	**7.9%**
	13	Tin/Steel Beverage Containers	3.5%	0.0%	0.0%	0.0%	0.0%
	14	Tin/Steel Food Containers	2.6%	3.4%	0.6%	1.0%	5.9%
	15	Other Ferrous Metal	0.1%	0.0%	2.9%	0.0%	0.0%
	16	Aluminium Beverage Containers	1.5%	0.0%	0.0%	0.0%	0.0%
	17	Aluminum Food Containers	1.3%	0.0%	0.0%	0.0%	0.0%
	18	Other Non-Ferrous Metal	0.1%	0.0%	0.0%	0.0%	0.0%
	19	Remainder/Composite Metal	0.1%	1.5%	2.7%	0.0%	2.1%
Plastic			**21.2%**	**17.1%**	**7.2%**	**11.6%**	**17.3%**
	20	PET Beverage Containers	2.9%	1.9%	0.9%	0.7%	1.9%
	21	HDPE Containers	5.9%	4.5%	2.0%	2.3%	4.3%
	22	LDPE Containers	0.0%	2.4%	0.8%	0.9%	2.0%
	23	Styrofoam Food Containers	1.7%	1.7%	0.8%	1.8%	2.0%
	24	Styrofoam Packaging Containers	1.5%	0.0%	0.0%	0.0%	0.0%
	25	Miscellaneous Plastic Containers	0.3%	1.2%	0.0%	0.0%	0.0%
	26	Film Plastic (e.g. Plastic Bags) Bags)	6.8%	2.0%	1.7%	5.9%	7.0%
	27	Remainder/Composite Plastic	2.1%	3.5%	1.0%	0.0%	0.0%
Textiles + leather			**7.0%**	**12.1%**	**1.8%**	**3.0%**	**5.2%**
	28	Leather	0.5%	0.0%	0.0%	0.0%	0.0%
	29	Clothing/Rags	2.9%	0.0%	0.0%	0.0%	0.0%
	30	Carpet	0.1%	0.0%	0.0%	0.0%	0.0%
	31	Disposable Pampers (Diapers)	3.3%	2.7%	0.0%	0.0%	2.0%
	32	Other Textiles	0.2%	9.4%	2.5%	3.0%	3.2%
Organics			**26.6%**	**36.9%**	**30.8%**	**16.3%**	**41.6%**
	33	Food Waste	10.6%	18.3%	15.9%	16.3%	27.9%
	34	Green Waste	11.4%	18.6%	15.0%	0.0%	9.6%
	35	Coconut Husks	4.2%	0.0%	0.0%	0.0%	4.1%
	36	Remainder/Composite Organic	0.4%	0.0%	0.0%	0.0%	0.0%
Construction & Demolition			**0.3%**	**0.0%**	**4.7%**	**0.0%**	**1.1%**
	37	Concrete and Masonry	0.0%	0.0%	0.0%	0.0%	0.0%
	38	Lumber	0.3%	0.0%	4.5%	0.0%	1.1%
	39	Asphalt Shingles	0.0%	0.0%	0.0%	0.0%	0.0%
	40	Drywall	0.0%	0.0%	0.0%	0.0%	0.0%
	41	Rock, Soil, and Fines	0.0%	0.0%	0.2%	0.0%	0.0%
	42	Tiles	0.0%	0.0%	0.0%	0.0%	0.0%
	43	Remainder/Composite C&D	0.0%	0.0%	0.0%	0.0%	0.0%
Special Care Wastes			**2.7%**	**0.3%**	**6.4%**	**0.0%**	**0.1%**
	44	Paint	0.2%	0.0%	0.0%	0.0%	0.0%
	45	Aerosol Cans	2.0%	0.0%	0.0%	0.0%	0.0%
	46	Used Vehicle Oil and Filters	0.2%	0.0%	5.3%	0.0%	0.0%
	47	Batteries (Alkaline)	0.1%	0.0%	0.0%	0.0%	0.0%
	48	Batteries (Li-Ion)	0.0%	0.0%	1.0%	0.0%	0.0%
	49	Biomedical	0.0%	0.0%	0.0%	0.0%	0.4%
	50	Remainder/Composite Special Care Wastes	0.2%	0.3%	0.0%	0.0%	0.0%
Other Wastes			**0.2%**	**5.4%**	**4.1%**	**14.8%**	**0.0%**
	51	Tires [E]	0.0%	0.0%	0.0%	0.0%	0.0%
	52	Furniture	0.0%	0.0%	0.0%	0.0%	0.0%
	53	Appliances	0.2%	5.3%	4.1%	14.8%	0.0%
	54	Ash	0.0%	0.0%	0.0%	0.0%	0.0%
	55	Port Waste	0.0%	0.0%	0.0%	0.0%	0.0%
	56	Chicken Offal (Chicken Remains)	0.0%	0.0%	0.0%	0.0%	0.0%
	57	Fish Offal (Fish Remains)	0.0%	1.6%	0.6%	-0.5%	0.9%
	58	Sewage Solids	0.0%	1.5%	0.5%	-0.6%	0.8%
	59	Industrial Sludge	0.0%	1.5%	0.4%	-0.7%	0.7%
	60	Pallets	0.0%	1.5%	0.4%	-0.9%	0.7%
	61	Other Unspecified	0.0%	1.4%	0.3%	-1.0%	0.6%

5.0 Limitations on Liability and Use of this Report

The material in this report reflects best judgement in light of the information available at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. R.J. Burnside International Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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BURNSIDE

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Appendix A – Waste Characterization Result and Figures

Barbados Waste to Energy Facility Waste characterization Study
Round 1

Material Type	Residential			Commercial			Hotel			Supermarket
	Average	75% Confidence Interval (+/-)	95% Confidence Interval (+/-)	Average	75% Confidence Interval (+/-)	95% Confidence Interval (+/-)	Average	75% Confidence Interval (+/-)	95% Confidence Interval (+/-)	Average
Paper and Cardboard	**19.70**	**2.06**	**4.61**	**37.44**	**16.76**	**37.50**	**21.25**	**4.30**	**9.61**	**52.62**
Newspaper	7.18	3.00	6.70	0.94	0.56	1.25	2.35	1.53	3.42	-
Uncoated Corrugated Cardboard	2.02	1.55	3.48	30.85	16.04	35.88	5.44	2.74	6.12	50.78
Boxboard	3.18	2.02	4.53	-	-	-	-	-	-	-
Clean (Office, Magazines etc.) Paper	3.09	1.49	3.33	1.96	1.28	2.87	1.54	0.87	1.94	-
Glossy Magazines	0.94	0.87	1.95	0.97	1.36	3.03	2.41	1.92	4.30	-
TetraPak	-	-	-	0.56	0.61	1.37	3.57	1.71	3.81	1.69
Remainder/Composite Paper (tissues)	3.31	1.55	3.47	2.15	1.33	2.97	5.94	0.24	0.54	0.15
Glass	**3.68**	**1.72**	**3.85**	**1.37**	**0.88**	**1.97**	**5.46**	**3.65**	**8.17**	**0.71**
Clear Beverage Containers	-	-	-	-	-	-	-	-	-	-
Clear Food Containers	3.68	1.72	3.85	1.37	0.88	1.97	4.83	2.79	6.24	0.71
Coloured Beverage Containers	-	-	-	-	-	-	-	-	-	-
Coloured Food Containers	-	-	-	-	-	-	-	-	-	-
Remainder/Composite Glass	-	-	-	-	-	-	2.52	-	-	-
Metal	**4.85**	**1.31**	**2.94**	**6.12**	**7.55**	**16.88**	**7.94**	**5.47**	**12.24**	**1.04**
Tin/Steel Beverage Containers	-	-	-	-	-	-	-	-	-	-
Tin/Steel Food Containers	3.35	0.73	1.64	0.55	0.48	1.06	5.86	3.48	7.79	1.04
Other Ferrous Metal	-	-	-	2.87	4.08	9.14	-	-	-	-
Aluminum Beverage Containers	-	-	-	-	-	-	-	-	-	-
Aluminum Food Containers	-	-	-	-	-	-	-	-	-	-
Other Non-Ferrous Metal	-	-	-	-	-	-	-	-	-	-
Remainder/Composite Metal	1.50	1.70	3.81	2.70	3.00	6.72	2.07	2.16	4.83	-
Plastic	**17.11**	**5.99**	**13.40**	**7.21**	**4.29**	**9.60**	**17.27**	**4.83**	**10.81**	**11.60**
PET Beverage Containers	1.85	0.79	1.76	0.90	0.77	1.71	1.93	0.93	2.08	0.71
HDPE Containers	4.49	1.86	4.17	1.98	2.42	5.42	4.34	1.16	2.59	2.30
LDPE Containers	2.39	1.97	4.42	0.82	0.61	1.37	1.97	1.01	2.26	0.90
Styrofoam	1.65	1.02	2.29	0.84	0.46	1.03	2.00	0.52	1.16	1.76
Styrofoam Packaging Materials	-	-	-	-	-	-	-	-	-	-
Miscellaneous Plastic Containers	1.25	0.94	2.09	-	-	-	-	-	-	-
Film Plastic	1.97	2.15	4.81	1.67	0.93	2.08	7.04	2.35	5.27	5.93
Remainder/Composite Plastic	3.51	1.86	4.16	1.00	0.84	1.87	-	-	-	-
Textiles	**12.12**	**5.40**	**12.07**	**1.84**	**1.40**	**3.14**	**5.22**	**1.83**	**4.09**	**2.97**
Leather	-	-	-	-	-	-	-	-	-	-
Clothing/Rags	-	-	-	-	-	-	-	-	-	-
Carpet	-	-	-	-	-	-	-	-	-	-
Disposable Pampers	2.72	1.13	2.52	-	-	-	2.02	1.89	4.24	-
Other Textiles	9.40	5.79	12.95	2.45	1.35	3.01	3.20	1.80	4.03	2.97
Organics	**36.86**	**14.79**	**33.09**	**30.82**	**8.83**	**19.75**	**41.63**	**10.37**	**23.19**	**16.28**
Food Waste	18.27	8.28	18.53	15.85	13.54	30.30	27.90	13.90	31.09	**16.28**
Green Waste	18.59	7.60	17.01	14.97	9.39	21.01	9.60	6.02	13.47	-
Coconut Husks	-	-	-	-	-	-	4.13	5.87	13.13	-
Remainder/Composite Organic	-	-	-	-	-	-	-	-	-	-
Construction and Demolition (C&D)	-	-	-	**4.66**	**4.43**	**9.92**	**1.14**	**1.29**	**2.88**	-
Concrete and Masonry	-	-	-	-	-	-	-	-	-	-
Lumber	-	-	-	4.50	4.46	9.98	1.14	1.29	2.88	-
Asphalt Shingles	-	-	-	-	-	-	-	-	-	-
Drywall	-	-	-	-	-	-	-	-	-	-
Rock, Soil and Fines	-	-	-	0.16	0.23	0.52	-	-	-	-
Tiles	-	-	-	-	-	-	-	-	-	-
Remainder/Composite C&D	-	-	-	-	-	-	-	-	-	-
Special Care Wastes	**0.26**	**0.26**	**0.57**	**6.40**	**7.25**	**16.22**	**0.10**	**0.14**	**0.30**	-
Paint	-	-	-	-	-	-	-	-	-	-
Aerosol Cans	-	-	-	-	-	-	-	-	-	-
Used Vehicle Oil and Filters	-	-	-	5.35	7.61	17.02	-	-	-	-
Batteries (Alkaline)	-	-	-	-	-	-	-	-	-	-
Batteries (Li-Ion)	-	-	-	1.04	1.48	3.30	-	-	-	-
Biomedical	-	-	-	-	-	-	0.10	0.14	0.30	-
Remainder/Composite Special Care Wast	0.26	0.26	0.57	0.01	0.02	0.04	-	-	-	-
Other Wastes	**5.42**	**4.14**	**9.26**	**4.15**	**3.41**	**7.64**	**-**	**-**	**-**	**14.78**
Tires	-	-	-	-	-	-	-	-	-	-
Furniture	-	-	-	-	-	-	-	-	-	-
Appliances / Electronics	**5.32**	**5.07**	**11.34**	**4.15**	**3.41**	**7.64**	**-**	**-**	**-**	**14.78**
Ash	-	-	-	-	-	-	-	-	-	-
Port Waste	-	-	-	-	-	-	-	-	-	-
Chicken Offal	-	-	-	-	-	-	-	-	-	-
Fish Offal	-	-	-	-	-	-	-	-	-	-
Sewage Solids	-	-	-	-	-	-	-	-	-	-
Industrial Sludge	-	-	-	-	-	-	-	-	-	-
Pallets	-	-	-	-	-	-	-	-	-	-
Other Unspecified	**2.86**	-	-	-	-	-	-	-	-	-

					10/12/2013	10/12/2013	10/12/2013	12/12/2013
					1	3	4	1
Material Type	Average	Standard Deviation	Confidence Interval (75%)	Confidence Interval	Residential	Residential	Residential	Residential
Paper and Cardboard	**19.70**	**2.90**	**2.06**	**4.61**	**20.00**	**22.22**	**15.57**	**21.00**
Newspaper	7.18	4.21	3.00	6.70	5.19	10.05	2.22	11.24
Uncoated Corrugated Cardboard	2.02	2.18	1.55	3.48	3.27	0.00	4.45	0.35
Boxboard	3.18	2.84	2.02	4.53	0.00	2.44	3.41	6.86
Clean (Office, Magazines etc.) Paper	3.09	2.09	1.49	3.33	3.85	5.33	2.82	0.35
Glossy Magazines	0.94	1.23	0.87	1.95	1.15	2.59	0.00	0.00
TetraPak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Remainder/Composite Paper (tissues)	3.31	2.18	1.55	3.47	6.54	1.83	2.67	2.19
		0.00	0.00	0.00				
Glass	**3.68**	**2.42**	**1.72**	**3.85**	**5.38**	**0.91**	**6.00**	**2.40**
Clear Beverage Containers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clear Food Containers	3.68	2.42	1.72	3.85	5.38	0.91	6.00	2.40
Coloured Beverage Containers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coloured Food Containers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Remainder/Composite Glass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		0.00	0.00	0.00				
Metal	**4.85**	**1.85**	**1.31**	**2.94**	**4.81**	**7.46**	**3.26**	**3.89**
Tin/Steel Beverage Containers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tin/Steel Food Containers	3.35	1.03	0.73	1.64	4.81	2.44	3.26	2.90
Other Ferrous Metal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aluminum Beverage Containers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aluminum Food Containers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Non-Ferrous Metal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Remainder/Composite Metal	1.50	2.39	1.70	3.81	0.00	5.02	0.00	0.99
		0.00	0.00	0.00				
Plastic	**17.11**	**8.42**	**5.99**	**13.40**	**7.12**	**24.96**	**23.13**	**13.22**
PET Beverage Containers	1.85	1.11	0.79	1.76	1.35	3.04	2.45	0.57
HDPE Containers	4.49	2.62	1.86	4.17	2.88	8.22	4.37	2.48
LDPE Containers	2.39	2.78	1.97	4.42	0.77	6.54	1.11	1.13
Styrofoam	1.65	1.44	1.02	2.29	0.77	3.50	0.30	2.05
Styrofoam Packaging Materials	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous Plastic Containers	1.25	1.31	0.94	2.09	1.35	0.61	3.04	0.00
Film Plastic	1.97	3.02	2.15	4.81	0.00	0.00	6.38	1.49
Remainder/Composite Plastic	3.51	2.61	1.86	4.16	0.00	3.04	5.49	5.52
		0.00	0.00	0.00				
Textiles	**12.12**	**7.59**	**5.40**	**12.07**	**7.31**	**23.44**	**8.60**	**9.12**
Leather	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clothing/Rags	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carpet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Disposable Pampers	2.72	1.58	1.13	2.52	2.50	2.13	4.97	1.27
Other Textiles	9.40	8.14	5.79	12.95	4.81	21.31	3.63	7.85
		0.00	0.00	0.00				
Organics	**36.86**	**20.79**	**14.79**	**33.09**	**54.23**	**6.70**	**41.88**	**44.63**
Food Waste	18.27	11.65	8.28	18.53	22.31	0.91	24.24	25.60
Green Waste	18.59	10.69	7.60	17.01	31.92	5.78	17.64	19.02
Coconut Husks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Remainder/Composite Organic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction and Demolition (C&D)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Concrete and Masonry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lumber	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Asphalt Shingles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Drywall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rock, Soil and Fines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tiles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Remainder/Composite C&D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Special Care Wastes	**0.26**	**0.36**	**0.26**	**0.57**	**0.00**	**0.76**	**0.30**	**0.00**
Paint	0.00	0.00	0.00	0.00	0.00			
Aerosol Cans	0.00	0.00	0.00	0.00	0.00			
Used Vehicle Oil and Filters	0.00	0.00	0.00	0.00	0.00			
Batteries (Alkaline)	0.00	0.00	0.00	0.00	0.00			
Batteries (Li-Ion)	0.00	0.00	0.00	0.00	0.00			
Biomedical	0.00	0.00	0.00	0.00	0.00			
Remainder/Composite Special Care Waste	0.26	0.36	0.26	0.57	0.00	0.76	0.30	0.00
		0.00	0.00	0.00				
Other Wastes	**5.42**	**5.82**	**4.14**	**9.26**	**1.15**	**13.55**	**1.26**	**5.73**
Tires	0.00	0.00	0.00	0.00	0.00			
Furniture	0.00	0.00	0.00	0.00	0.00			
Appliances / Electronics	5.32	7.12	5.07	11.34	1.15	13.55	1.26	
Ash	0.00	0.00	0.00	0.00	0.00			
Port Waste	0.00	0.00	0.00	0.00	0.00			
Chicken Offal	0.00	0.00	0.00	0.00	0.00			
Fish Offal	0.00	0.00	0.00	0.00	0.00		0.00	
Sewage Solids	0.00	0.00	0.00	0.00	0.00			
Industrial Sludge	0.00	0.00	0.00	0.00	0.00			
Pallets	0.00	0.00	0.00	0.00	0.00			
Other Unspecified	2.86	0.00	0.00	0.00	0.00			5.73
			0.00	0.00				
TOTALS					**100.00**	**100.00**	**100.00**	**100.00**

					10/12/2013	11/12/2013	12/12/2013	10/12/2013
					2	5	4	5
Material Type	Average	Standard Deviation	Confidence Interval (75%)	Confidence Interval	Commercial	Commercial	Commercial	Mix Res 60, Com 40
Paper and Cardboard	**37.44**	**23.57**	**16.76**	**37.50**	**30.70**	**7.25**	**52.19**	**59.62**
Newspaper	0.94	0.78	0.56	1.25	1.24	1.83	0.00	0.68
Uncoated Corrugated Cardboard	30.85	22.55	16.04	35.88	24.27	2.05	52.19	44.90
Boxboard	0.00	0.00	0.00	0.00				
Clean (Office, Magazines etc.) Paper	1.96	1.80	1.28	2.87	3.11	0.92	0.00	3.83
Glossy Magazines	0.97	1.91	1.36	3.03	0.00	0.04	0.00	3.83
TetraPak	0.56	0.86	0.61	1.37	0.00	0.44	0.00	1.82
Remainder/Composite Paper (tissues)	2.15	1.87	1.33	2.97	2.07	1.97	0.00	4.56
Glass	**1.37**	**1.24**	**0.88**	**1.97**	**2.28**	**0.66**	**0.00**	**2.55**
Clear Beverage Containers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clear Food Containers	1.37	1.24	0.88	1.97	2.28	0.66	0.00	2.55
Coloured Beverage Containers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coloured Food Containers	0.00	0.00	0.00	0.00				
Remainder/Composite Glass	0.00	0.00	0.00	0.00				
Metal	**6.12**	**10.61**	**7.55**	**16.88**	**1.04**	**22.01**	**0.06**	**1.37**
Tin/Steel Beverage Containers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tin/Steel Food Containers	0.55	0.67	0.48	1.06	0.21	1.53	0.06	0.41
Other Ferrous Metal	2.87	5.74	4.08	9.14	0.00	11.48	0.00	0.00
Aluminum Beverage Containers	0.00	0.00	0.00	0.00				
Aluminum Food Containers	0.00	0.00	0.00	0.00				
Other Non-Ferrous Metal	0.00	0.00	0.00	0.00				
Remainder/Composite Metal	2.70	4.22	3.00	6.72	0.83	9.00	0.00	0.96
Plastic	**7.21**	**6.03**	**4.29**	**9.60**	**15.98**	**4.10**	**2.55**	**6.20**
PET Beverage Containers	0.90	1.08	0.77	1.71	2.49	0.48	0.11	0.50
HDPE Containers	1.98	3.41	2.42	5.42	7.05	0.87	0.00	0.00
LDPE Containers	0.82	0.86	0.61	1.37	1.66	0.04	0.11	1.46
Styrofoam	0.84	0.65	0.46	1.03	1.45	1.22	0.00	0.68
Styrofoam Packaging Materials	0.00	0.00	0.00	0.00				
Miscellaneous Plastic Containers	0	0	0	0				
Film Plastic	1.67	1.31	0.93	2.08	1.04	1.48	0.61	3.56
Remainder/Composite Plastic	1.00	1.18	0.84	1.87	2.28	0.00	1.72	0.00
Textiles	**1.84**	**1.97**	**1.40**	**3.14**	**4.15**	**2.79**	**0.00**	**0.41**
Leather	0.00	0.00	0.00	0.00				
Clothing/Rags	0.00	0.00	0.00	0.00	0.00			0.00
Carpet	0.00	0.00	0.00	0.00				
Disposable Pampers	0.00	0.00	0.00	0.00				
Other Textiles	2.45	1.89	1.35	3.01	4.15	2.79		0.41
Organics	**30.82**	**12.41**	**8.83**	**19.75**	**24.27**	**37.95**	**44.10**	**16.96**
Food Waste	15.85	19.04	13.54	30.30	10.17	5.76	44.10	3.37
Green Waste	14.97	13.20	9.39	21.01	14.11	32.18	0.00	13.58
Coconut Husks	0.00	0.00	0.00	0.00				
Remainder/Composite Organic	0.00	0.00	0.00	0.00		0.00		
	0.00	0.00	0.00	0.00				
Construction and Demolition (C&D)	**4.66**	**6.23**	**4.43**	**9.92**	**13.69**	**3.84**	**1.11**	**0.00**
Concrete and Masonry	0.00	0.00	0.00	0.00				
Lumber	4.50	6.27	4.46	9.98	13.69	3.19	1.11	0.00
Asphalt Shingles	0.00	0.00	0.00	0.00				
Drywall	0.00	0.00	0.00	0.00				
Rock, Soil and Fines	0.16	0.33	0.23	0.52	0.00	0.66	0.00	0.00
Tiles	0.00	0.00	0.00	0.00				
Remainder/Composite C&D	0.00	0.00	0.00	0.00				
Special Care Wastes	**6.40**	**10.19**	**7.25**	**16.22**	**0.00**	**21.40**	**0.00**	**4.19**
Paint	0.00	0.00	0.00	0.00				
Aerosol Cans	0.00	0.00	0.00	0.00				
Used Vehicle Brakes	5.35	10.70	7.61	17.02	0.00	21.40	0.00	0.00
Batteries (Alkaline)	0.00	0.00	0.00	0.00				
Batteries (Li-Ion)	1.04	2.07	1.48	3.30	0.00	0.00	0.00	4.15
Biomedical	0.00	0.00	0.00	0.00				
Remainder/Composite Special Care Waste	0.01	0.02	0.02	0.04	0.00	0.00	0.00	0.05
Other Wastes	**4.15**	**4.80**	**3.41**	**7.64**	**7.88**	**0.00**	**0.00**	**8.71**
Tires	0.00	0.00	0.00	0.00				
Furniture	0.00	0.00	0.00	0.00				
Appliances	4.15	4.80	3.41	7.64	7.88	0.00	0.00	8.71
Ash	0.00	0.00	0.00	0.00				
Port Waste	0.00	0.00	0.00	0.00				
Chicken Offal	0.00	0.00	0.00	0.00				
Fish Offal	0.00	0.00	0.00	0.00				
Sewage Solids	0.00	0.00	0.00	0.00				
Industrial Sludge	0.00	0.00	0.00	0.00				
Pallets	0.00	0.00	0.00	0.00				
Other Unspecified	0.00	0.00	0.00	0.00				
TOTALS					**100.00**	**100.00**	**100**	**100.00**

					11/12/2013 1	11/12/2013 3	12/12/2013 3	11/12/2013 2
Material Type	Average	Standard Deviation	Confidence Interval (75%)	Confidence Interval	Hotel	Hotel	Hotel	Institution - Prison
Paper and Cardboard	**21.25**	**6.04**	**4.30**	**9.61**	**26.51**	**21.12**	**12.83**	**24.53**
Newspaper	2.35	2.15	1.53	3.42	5.19	2.33	0.00	1.89
Uncoated Corrugated Cardboard	5.44	3.85	2.74	6.12	0.00	7.47	5.59	8.71
Boxboard	0.00	0.00	0.00	0.00				
Clean (Office, Magazines etc.) Paper	1.54	1.22	0.87	1.94	2.87	1.24	0.00	2.04
Glossy Magazines	2.41	2.70	1.92	4.30	6.28	1.86	0.00	1.51
TetraPak	3.57	2.40	1.71	3.81	6.59	2.52	0.99	4.16
Remainder/Composite Paper (tissues)	5.94	0.34	0.24	0.54	5.58	5.71	6.25	6.21
Glass	5.46	5.14	3.65	8.17	4.57	12.94	2.74	1.59
Clear Beverage Containers	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Clear Food Containers	4.83	3.92	2.79	6.24	4.57	10.42	2.74	1.59
Coloured Beverage Containers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coloured Food Containers	0.00	0.00	0.00	0.00				
Remainder/Composite Glass	2.52	0.00	0.00	0.00		2.52		
Metal	7.94	7.69	5.47	12.24	4.42	2.43	5.59	19.30
Tin/Steel Beverage Containers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tin/Steel Food Containers	**5.86**	**4.90**	**3.48**	**7.79**	**2.56**	**2.43**	**5.59**	**12.87**
Other Ferrous Metal	0.00	0.00	0.00	0.00				
Aluminum Beverage Containers	0.00	0.00	0.00	0.00				
Aluminum Food Containers	0.00	0.00	0.00	0.00				
Other Non-Ferrous Metal	0.00	0.00	0.00	0.00				
Remainder/Composite Metal	2.07	3.04	2.16	4.83	1.86	0.00	0.00	6.43
Plastic	17.27	6.79	4.83	10.81	25.12	15.46	8.99	19.53
PET Beverage Containers	1.93	1.31	0.93	2.08	2.87	2.28	0.00	2.57
HDPE Containers	4.34	1.63	1.16	2.59	3.72	4.76	2.52	6.36
LDPE Containers	**1.97**	**1.42**	**1.01**	**2.26**	**3.88**	**1.81**	**0.44**	**1.74**
Styrofoam Food Containers	2.00	0.73	0.52	1.16	2.79	1.24	1.54	2.42
Styrofoam Packaging Materials	0.00	0.00	0.00	0.00				
Miscellaneous Plastic Containers	0.00	0.00	0.00	0.00				
Film Plastic	7.04	3.31	2.35	5.27	11.86	5.38	4.50	6.43
Remainder/Composite Plastic	0.00	0.00	0.00	0.00				
Textiles	5.22	2.57	1.83	4.09	7.91	2.38	6.80	3.79
Leather	0.00	0.00	0.00	0.00				
Clothing/Rags	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carpet	0.00	0.00	0.00	0.00				
Disposable Pampers	**2.02**	**2.66**	**1.89**	**4.24**	**1.40**	**0.76**	**5.92**	**0.00**
Other Textiles	3.20	2.53	1.80	4.03	6.51	1.62	0.88	3.79
Organics	41.63	14.57	10.37	23.19	31.47	41.48	62.28	31.26
Food Waste	27.90	19.54	13.90	31.09	17.44	22.60	56.80	14.76
Green Waste	9.60	8.47	6.02	13.47	14.03	18.89	5.48	0.00
Coconut Husks	4.13	8.25	5.87	13.13	0.00	0.00	0.00	16.50
Remainder/Composite Organic	0.00	0.00	0.00	0.00				
Construction and Demolition (C&D)	1.14	1.81	1.29	2.88	0.00	3.81	0.77	0.00
Concrete and Masonry	0.00	0.00	0.00	0.00				
Lumber	1.14	1.81	1.29	2.88	0.00	3.81	0.77	0.00
Asphalt Shingles	0.00	0.00	0.00	0.00				
Drywall	0.00	0.00	0.00	0.00				
Rock, Soil and Fines	**0.00**	**0.00**	**0.00**	**0.00**				
Tiles	0.00	0.00	0.00	0.00				
Remainder/Composite C&D	0.00	0.00	0.00	0.00				
Special Care Wastes	0.10	0.19	0.14	0.30	0.00	0.38	0.00	0.00
Paint	0.00	0.00	0.00	0.00				
Aerosol Cans	0.00	0.00	0.00	0.00				
Used Vehicle Oil and Filters	0.00	0.00	0.00	0.00				
Batteries (Alkaline)	0.00	0.00	0.00	0.00				
Batteries (Li-Ion)	0.00	0.00	0.00	0.00				
Biomedical	**0.10**	**0.19**	**0.14**	**0.30**	**0.00**	**0.38**	**0.00**	**0.00**
Remainder/Composite Special Care Waste	0.00	0.00	0.00	0.00				
Other Wastes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tires	0.00	0.00	0.00	0.00				
Furniture	0.00	0.00	0.00	0.00				
Appliances	0.00	0.00	0.00	0.00				
Ash	0.00	0.00	0.00	0.00				
Port Waste	0.00	0.00	0.00	0.00				
Chicken Offal	0.00	0.00	0.00	0.00				
Fish Offal	**0.00**	**0.00**	**0.00**	**0.00**				
Sewage Solids	0.00	0.00	0.00	0.00				
Industrial Sludge	0.00	0.00	0.00	0.00				
Pallets	0.00	0.00	0.00	0.00				
Other Unspecified	0.00	0.00	0.00	0.00				
TOTALS					**100**	**100**	**100**	**100**

				11/12/2013	12/12/2013
				4	2
Material Type	Average	Confidence Interval (75%)	Confidence Interval	Supermarket	Supermarket
Paper and Cardboard	**52.62**	**0.00**	**0.00**	**70.63**	**34.61**
Newspaper	0.00	0.00	0.00		
Uncoated Corrugated Cardboard	50.78	0.00	0.00	67.26	34.30
Boxboard	0.00	0.00	0.00		
Clean (Office, Magazines etc.) Paper	0.00	0.00	0.00		
Glossy Magazines	0.00	0.00	0.00		
TetraPak	1.69	0.00	0.00	3.37	0.00
Remainder/Composite Paper (tissues)	0.15	0.00	0.00	0.00	0.31
Glass	0.71	0.00	0.00	1.41	0.00
Clear Beverage Containers	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Clear Food Containers	0.71	0.00	0.00	1.41	0.00
Coloured Beverage Containers	0.00	0.00	0.00	0.00	0.00
Coloured Food Containers	0.00	0.00	0.00		
Remainder/Composite Glass	0.00	0.00	0.00		
Metal	1.04	0.00	0.00	1.47	0.61
Tin/Steel Beverage Containers	0.00	0.00	0.00	0.00	0.00
Tin/Steel Food Containers	**1.04**	**0.00**	**0.00**	**1.47**	**0.61**
Other Ferrous Metal	0.00	0.00	0.00		
Aluminum Beverage Containers	0.00	0.00	0.00		
Aluminum Food Containers	0.00	0.00	0.00		
Other Non-Ferrous Metal	0.00	0.00	0.00		
Remainder/Composite Metal	0.00	0.00	0.00		
Plastic	11.60	0.00	0.00	10.18	13.02
PET Beverage Containers	0.71	0.00	0.00	1.41	0.00
HDPE Containers	2.30	0.00	0.00	0.00	4.59
LDPE Containers	**0.90**	**0.00**	**0.00**	**1.04**	**0.77**
Styrofoam	1.76	0.00	0.00	0.92	2.60
Styrofoam Packaging Materials	0.00	0.00	0.00		
Miscellaneous Plastic Containers	0.00	0.00	0.00		
Film Plastic	5.93	0.00	0.00	6.81	5.05
Remainder/Composite Plastic	0.00	0.00	0.00		
Textiles	2.97	0.00	0.00	5.95	0.00
Leather	0.00	0.00	0.00		
Clothing/Rags	0.00	0.00	0.00	0.00	
Carpet	0.00	0.00	0.00		
Disposable Pampers	**0.00**	**0.00**	**0.00**		
Other Textiles	2.97	0.00	0.00	5.95	0.00
Organics	16.28	0.00	0.00	10.36	22.21
Food Waste	16.28	0.00	0.00	10.36	22.21
Green Waste	0.00	0.00	0.00		
Coconut Husks	0.00	0.00	0.00		
Remainder/Composite Organic	0.00	0.00	0.00		
	0.00	**0.00**	**0.00**		
Construction and Demolition (C&D)	0.00	0.00	0.00	0.00	0.00
Concrete and Masonry	0.00	0.00	0.00		
Lumber	0.00	0.00	0.00		
Asphalt Shingles	0.00	0.00	0.00		
Drywall	0.00	0.00	0.00		
Rock, Soil and Fines	**0.00**	**0.00**	**0.00**		
Tiles	0.00	0.00	0.00		
Remainder/Composite C&D	0.00	0.00	0.00		
Special Care Wastes	0.00	0.00	0.00	0.00	0.00
Paint	0.00	0.00	0.00		
Aerosol Cans	0.00	0.00	0.00		
Used Vehicle Oil and Filters	0.00	0.00	0.00		
Batteries (Alkaline)	0.00	0.00	0.00		
Batteries (Li-Ion)	0.00	0.00	0.00		
Biomedical	**0.00**	**0.00**	**0.00**		
Remainder/Composite Special Care Waste	0.00	0.00	0.00		
Other Wastes	14.78	0.00	0.00	0.00	29.56
Tires	0.00	0.00	0.00		
Furniture	0.00	0.00	0.00		
Appliances	14.78	0.00	0.00	0.00	29.56
Ash	0.00	0.00	0.00		
Port Waste	0.00	0.00	0.00		
Chicken Offal	0.00	0.00	0.00		
Fish Offal	**0.00**	**0.00**	**0.00**		
Sewage Solids	0.00	0.00	0.00		
Industrial Sludge	0.00	0.00	0.00		
Pallets	0.00	0.00	0.00		
Other Unspecified	0.00	0.00	0.00		
	0.00	0.00	0.00	0.00	0.00
TOTALS				**100**	**100**

BURNSIDE

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Appendix B – Waste Characterization Methodology

R.J. Burnside International Limited 15 Greenidge Drive, Payne's Bay St. James Barbados
telephone (246) 432-7456 **fax** **web** www.rjburnside.com

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Memorandum

Date: December 9, 2013 **File No.:** 300030295

Project: Barbados WTE

From: Andrew Evans

Comments

This document is to track the inconsistencies with the ASTM D5231 and previous studies which occurred during the December 2013 waste characterization study.

These inconsistencies occurred in order to adapt to conditions encountered in the field with regards to weather, as well as to increase throughput where possible due to the limited sampling timeframe which existed.

8.4 – During load selection waste densities varied significantly. As a result the range of samples weighed exceeded the 91-136 kg recommendation.

Additionally the number of loads which were able to be sampled during the allocated time did not meet the recommended number.

8.5 – The categories of sorted materials did not correspond completely to either the 2005 study or the ASTM method. This is a result of certain materials being represented in small quantities such as glass, as a result the various types of materials comprising low masses, and generally incombustible were combined. Samples were documented photographically in the event additional information is requested.

8.6 – Loads were not selected entirely randomly. It was desirable to collect loads from several subsections (residential, commercial, hotel). Loads were collected from these sectors over as wide of a range of time as possible to account for daily fluctuations however as some of the loads come in during shorter windows (for example hotel wastes) the load selection times were adjusted as normal.

8.9 – The sample was taken in a manner modified from the recommended quartering and coning procedure. Due to high winds encountered at the site during sampling it was desirable to minimize material loss due to wind from both a material, as well as a litter generation perspective. The modified procedure was to have the loader separate the load longitude as described and then proceed to push up and mix the pile then collect a sample from an internal points In order to ensure that samples were not biased loader bucket was inspected briefly and compared to the wastes within the pile. If it was

apparent that the bucket had collected material which did not represent the entire load additional sampling occurred.

This method was also necessary due to the smaller load sizes typically encountered which could possess material biases as fewer locations were served by a particular truck. There is some bias introduced by checking that a sample is representative as the variability is artificially reduced, however due to the scale of the proposed project, and the timelines to collect data it was determined in the field that the data quality would be better served by collecting a true cross section of the average materials received.