Royal Roads University 2013 Waste Audit

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1.0 Executive Summary

Sustainability has been an integral part of Royal Roads University (RRU) since it was founded in 1995, and it continues to shape policies and decisions. While RRU has taken many measures to ensure that the waste management system results in a high diversion rate, inefficiencies still remain. This report was developed to identify and address these inefficiencies and improve the overall sustainability of RRU.

The 2013 RRU waste audit was conducted to determine the actual rate of diversion and areas where improvements could be made to improve the efficiency and reduce the cost of the waste system. The diversion rate was combined with an analysis of improper disposal, to determine the amount that possibly could be diverted from the landfill if all waste was properly disposed of. This was supplemented with surveys of the students and staff to gain a more complete understanding of where problems may lie. The addition of interviews with personnel from waste companies and other institutions, as well as research into the implementation of an on-site composting system supplied a full spectrum of information upon which to make recommendations.

With the data gathered from the primary waste audit, it was found that overall disposal rate was 63%, though 52% of the waste analyzed was improperly disposed of, and survey results pointed to a lack of user knowledge as the biggest cause. The greatest components of the waste stream were compost (38%) and garbage (36%), though 53% of garbage is actually compost. This large percentage makes compost the top priority for a change in the system – if all compost was disposed of correctly, the cost of overall disposal would be reduced by $7,000 annually, and the divergence rate would increase to approximately 80%.

Following the extensive research, surveys, interviews and the waste audits conducted during the course of this project, the main issues within the system were identified, allowing for recommendations that would allow for improvement in the functioning of the waste system and increase the overall divergence rate of the university. These recommendations included an increase in signage, with a focus on the cafeteria, education of the staff and students at RRU to reduce the current level of contamination, and the conduction of further in-depth research into

the possibility of an on-site compost system. To ensure continual improvement in the system, the implementation of future waste audits is recommended, which will also function to track any changes that may be implemented and gauge their potential success. The ongoing monitoring and continual adjustments to the system, paired with proper education, will result in an overall reduction of RRUs footprint and an increase in its presence in the field of sustainability.

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3.0 Acknowledgements

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Steve Grundy, Vice President Academic and Provost, Royal Roads University

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Eugene Zinkowski, Charge Hand, Production Services, Royal Roads University

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4.0 Acronyms and Abbreviations

RRU	Royal Roads University
LIC	Learning and Innovation Center
STARS	Sustainability Tracking Assessment & Rating System
UBC	University of British Columbia
UVIC	University of Victoria
WM	Waste Management, Inc.

5.0 Definitions

Bulking material: A number of dry materials, including woodchips, sawdust or peat moss, which can be added to compost to increase aeration, reduce moisture content, provide structure or adjust the carbon to nitrogen ratio (C:N)

Contamination: Any misplaced item within a specific waste stream (e.g. an aluminum can in a glass recycling bin)

Compost: Food and paper waste that can be broken down into humus and reused as nutrient-rich soil

Feedstock: The starting materials utilized in the composting process (ie: food waste, yard trimmings)

Foil-lined wrapper: A wrapper with metallic lining (e.g. granola bar wrapper, chip bags)

Garbage: Any item that cannot be recycled or composted which must be taken to the landfill (e.g. soiled materials, wax-coated coffee cups)

Hard plastic: Sturdy plastic which may be recycled (e.g. yoghurt containers, plastic juice bottles)

Organics: Items that can be composted (e.g. food items, leaves, twigs)

Pulper: A machine which grinds and breaks the feedstock into smaller pieces more easily broken down in the composter

Recycling: The treatment of waste materials in a way that makes them suitable for reuse as a new product (e.g. old tires into shoes)

Refundable items: Items for which a deposit is paid upon purchase, which is then redeemed upon return of the item (e.g. pop cans, glass juice containers)

Soft plastic: Flexible, thin plastic that is easily torn (e.g. plastic wrap, plastic shopping bags)

Sustainability: Meeting the needs of the present without affecting the ability of future generations to meet their own needs

Waste audit: The quantification and analysis of the different waste types produced within an institution

Waste stream: Flow of individual types of waste materials (e.g. recyclables, compost, wastes) from generation to final disposal

Zero waste: The elimination of waste destined for the landfill

6.0 Introduction

6.1 Scope of Project

The scope of the project was to determine the amount of waste that is being diverted from the landfill by the waste management system on Royal Roads University campus. This included analyzing the quantity and level of contamination of waste in each of the different waste streams, making recommendations on how to increase the waste divergence on campus, and establishing a waste audit template which will allow for subsequent waste audits to be performed at RRU in future years. In addition, an analysis of the expenditures of the current waste system was conducted and compared to possible alternative waste management options on the basis of cost and best practices, and the possible benefits of an on-site compost system. Recommendations were then made to employ the most cost-efficient and environmentally sound options. The above data, paired with interviews and surveys, helped in the determination of the weaknesses within the system and the formulation of solutions to these issues.

6.2 Background on Waste Management at Royal Roads University

Sustainability has been tied into every aspect of RRU since it was founded in 1995, and it continues to shape the University's policies and decisions. In 2010, RRU received a silver rating for STARS (Sustainability Tracking Assessment and Rating System), which is a measure of institutional sustainability over time.

RRU has several waste-management centers in each building to encourage proper waste disposal and help lessen the impact of waste on the environment (RRU, 2013). In addition, there is a paper towel composting program in place which diverts approximately 10,000kg of paper towel per year from the landfill. Habitat Café, the cafeteria at Royal Roads University, is very aware of the degree of recycling and composting that takes place in their kitchen and keeps garbage to a minimum (RRU, 2013).

In a 2007 waste audit, it was determined that 13,797kg of material were recycled, 22,000kg were composted and 13,449kg of waste were disposed of. This equated to the successful diversion of 72.6% of all waste materials, a value that RRU is continually striving to improve (RRU, 2008).

6.3 Background on Waste Contractors

6.3.1 BFI

BFI, currently undergoing a change of name to become part of a larger group called Progressive Waste Solutions, is a cross-Canada business (BFI, 2012). BFI is capable of handling all major waste and recycling streams and portions of both of these aspects of the waste stream leaving RRU.

6.3.2 reFUSE

reFUSE is a company that deals with compost from events, and residential and commercial areas (reFUSE, 2009). reFUSE is based in Victoria and has been in operation since 2002, when RRU became their first customer (reFUSE, 2009). At RRU they handle and remove all of the compost created on site, except the yard waste, which the RRU custodial staff compost and use on the grounds.

6.3.3 Alpine Group

Alpine Group is based in the Greater Victoria Area and collect recycling, yard waste, and garbage (Alpine, 2010). At RRU they pick up wood waste which cannot be used for mulch; this wood is usually contaminated with metal or has been painted or treated.

6.3.4 Pacific Mobile

Pacific Mobile is a company that will pick up most plastics for recycling, and operates on a call-for-pickup basis (Pacific Mobile, 2012). Pacific Mobile also currently has nine drop-off locations (Pacific Mobile, 2012). At RRU, they mainly handle appliances, styrofoam and soft plastics.

6.3.5 Williams Scrap Iron and Metals

Williams Scrap Iron and Metals is a Victoria based company that collects scrap iron and metals, free of charge, for recycling (Zinkowski, 2013).

6.3.6 Redux

Redux is a company that provides grease trap cleaning, oil collection and oil recycling services to restaurants, cafeterias, supermarkets and other commercial and industrial kitchens. Redux collects used cooking oil from Habitat Café free of charge and transports it to its Nanaimo plant for processing (Redux, 2013).

7.0 Methods

7.1 Research

Research was conducted primarily through interviews to obtain background information on the different waste managers currently employed by RRU and other companies that could be used as alternatives in the future. Past financial records were reviewed to determine annual expenditures on waste management to allow proper comparisons to be made with alternative contractors. An interview was also conducted with a representative from the University of Victoria (UVic) to investigate alternative waste management practices for possible application at RRU, and research into the plausibility of an on-site composting system was also explored. Waste audits were conducted to assess the quantity and type of waste produced by RRU and to update the divergence rate found in 2007, as well as to quantify the amount of contamination in the waste streams to determine areas of greatest concern. Surveys of the students and staff were conducted to supplement the data obtained by the above methods to gain insight into possible problem areas experienced at the user level, and possible improvements to the current system.

7.2 Interviews

Interviews were conducted via telephone or on-site with personnel from waste management facilities and individuals from other institutions, as well as the custodial staff at RRU. These interviews provided insight into, and understanding of, waste disposal practices and other institutions' waste management methods, as well as an inside look at the inner workings of the RRU waste management system. This allowed for a comparison to be made with the practices at RRU and helped form recommendations for the future.

7.3 Surveys

7.3.1 Survey 1

The first survey was conducted in the Habitat Café biweekly until the required 50 participants were reached, and contained questions regarding the ease of use of the system and the current state of knowledge of proper disposal by the students and staff at RRU. Participants were also shown a variety of objects commonly found around campus and asked which bin (Compost, Recycling/Refundable, Garbage, Mixed Paper) they would place the item in. These data gave an

indication of where gaps in the knowledge of the users existed, and the usability of the current disposal system. A copy of Survey 1 can be found in Appendix C, with results summarized in Appendix E.

7.3.2 Survey 2

The second survey (Appendix D) was conducted throughout the Grant Building on the alternate Tuesdays to Survey 1, featuring questions of a more open-ended variety that were geared toward possible improvements to the current system and its transparency. This gave an indication of possible changes that could be made with respect to the uniformity and location of the disposal bins. The results of Survey 2 are found in Appendix F.

7.4 Physical Waste Audit

Two separate waste audits were performed together on April 9, April 16, April 23 and April 30 to study the waste disposal system at RRU. The primary waste audit was conducted on all waste created on campus, and measured the amount of each individual waste stream and the breakdown of material within those streams. The subsequent diversion rate and the amount of contamination in each waste stream was also measured, and the resulting data were used to determine the specific areas to target in order to increase the diversion rate, and the recommendations required to do so.

A second, smaller audit was conducted on individual bins from the LIC, the Grant and the Nixon Buildings, separately, to measure the amount of contamination in each of the waste streams (Garbage, Compost, Mixed Paper and Recycling/Refundable), which was then used to compare the difference in the efficiency of the waste system for each individual building. This information was utilized when making recommendations as to which specific waste system, of the many currently utilized at RRU, was the most successful and should be uniformly employed.

To partially account for the variability in the daily consumption at Royal Roads University, the waste audit was split up into four separate sampling days. This ensured that there were different on-campus students involved in the study. In addition, due to a highly fluctuating student body, the student population was documented and used to calculate the amount of waste per student - a value which can be compared to future audits.

7.4.1 Materials

The following materials were used during each of the six waste audits:

- gloves
- personal protective clothing
- large scale
- small scale
- camera
- notepad and pen
- garbage bags
- empty bins (numerous)
- waste bags

7.4.2 Methods

For the first audit, all waste was brought to a central location (Appendix B) by the custodial staff at RRU for sorting and division into different categories, which can be seen in Appendix H. Yard waste was not considered, as it is dealt with on-site. Metal, wood, styrofoam, small appliances, and used cooking oil were dealt with separately in a visual waste audit.

All waste was weighed using a scale provided by the custodial staff and the weights of the full bags and bins were recorded based on type: Compost, Garbage, Mixed Paper, or Recyclable/Refundable. Every fourth garbage bag (black bag), and every second Mixed Paper and Recycling/Refundable (clear bags) was chosen to be analyzed and separated into Compost, Soft Plastic, Mixed Paper, Corrugated Cardboard, Refundables, Recyclables, Garbage and Other (Appendix H) - compost bags were not analyzed for sanitation reasons. The segregated waste from each category was then weighed individually on either the small scale (accurate to 0.001g) or the large scale (accurate to 0.1kg), for weights <200g and >200g, respectively, and the values were categorically recorded. In this way, the amount of improperly disposed of waste was quantified, and was redirected into the proper waste stream after weighing. Typically for an item to be considered recyclable or refundable they need to be clean, as soiled objects contaminate the stream and are thus considered garbage. However for the purpose of this audit soiled items placed in the garbage were allocated to their respective waste stream in order to get an idea of the total amount of otherwise recyclable or refundable waste going to the landfill. Alternately, if there was a soiled item in any of the other streams, it would be

considered improper disposal, as its presence contaminates and compromises the entire stream - reducing the divergence rate. The resulting weights of each stream were input into a spreadsheet in Excel, along with the number of students on campus, for data analysis. An improved sample of the template used can be found in Appendix G.

The secondary waste audit involved the three main buildings: Nixon, Grant, and LIC, as shown in Appendix B. The audit was conducted on the same days as the primary waste audit, and a sample bag of each waste stream (Recyclable/Refundable, Mixed Paper, Garbage, Compost) was collected from a single location within each building at approximately 5 P.M. the night before the waste audit (before collection by custodial staff), labelled with bin type and building, and stored in the central waste compound for analysis the following day.

Unlike the primary waste audit, each individual waste bag was opened for analysis and separated into categories (Appendix I) for weighing. The resulting numbers were input into Excel to determine the amount of contamination in each waste stream, and then used for comparison of the efficiencies of the different waste systems utilized in the studied buildings.

7.4.3 Quality Assurance and Quality Control

Quality assurance and quality control are an essential part of any study, and were achieved through the following measures:

- The use of systematic sampling to reduce bias
- Preliminary categorization of waste streams to reduce bias between samplers and waste audits
- Consultation of experts to determine the correct disposal of unknown waste items; Darren Gardham, Pieter Bosma, Eugene Zinkowski, waste management companies and product distributors
- Multiple audits performed to minimize any skewed results

7.5 Visual Waste Audit

The visual waste audit was performed throughout the duration of the project, which allowed for a visual interpretation of the waste streams that were not included in the aforementioned waste audits. These audits were conducted on the areas on campus that contain storage of the

styrofoam and small appliances, refundables, electronics, used cooking oil, metal scraps and waste wood. The exact determination of the daily disposal quantity of the above materials was outside the scope of this project due to extreme fluctuations in their accumulation and removal. Since these values can change from month to month, this portion of the waste audit was not quantifiable, it was used more as a representation of the extra ways that RRU is moving waste away from the landfill.

7.5.1 Materials

The following materials were used during each visual waste audit:

- camera
- notepad
- pen

7.5.2 Methods

A visual waste audit was performed throughout the project. Photos were taken of the separate areas which contained the refundables, the styrofoam and small appliances (Figure 1.1), scrap metal (Figure 1.2), scrap wood (Figure 1.3), and used cooking oil (Figure 1.4) to monitor the approximate volume of these waste streams. Photos were taken from the same location and angle for visual comparison. Notes were taken to record the date, along with any useful information pertaining to the audit.

Figure 1.1: Small appliances and styrofoam area located outside of Nixon Building

Figure 1.2: Scrap metal bin located in upper compound

Figure 1.3: Scrap wood bin located in upper compound

Figure 1.4: Used cooking oil bin located in upper compound

Please see section 9.1.3 for challenges encountered throughout the visual waste audit and associated recommendations.

7.6 Waste Event

A waste event was held on May 24, 2013, outside the Grant building, to exhibit the results of the waste audits and educate the staff and students of the proper disposal of common items found at RRU. Posters were made to showcase the diversion rate of each waste stream and important facts surrounding waste management at RRU. Lemonade and prizes were used as incentives to encourage attendance to the waste event, which also featured a 'proper waste disposal' relay; students and staff, in teams, competed (Figure 2.1) to correctly place a variety of items in labeled bins. The posters were made available for future display in appropriate locations for further educational purposes.

Figure 2.1: 'Proper waste disposal' relay

7.7 Cost Analysis

A cost analysis was conducted on the current waste system at RRU using past financial records concerning the expenditures for each individual contractor. This information was used in a comparison with other costing obtained through interviews with other waste contractors to ensure the best price, while always keeping the environmental benefits of each contractor at the forefront. The goal was to find a way to implement the best possible combination of strategies which would minimize costs, while maintaining or increasing the rate of diversion and environmental impact of the system.

7.7.1 Materials

The materials required for this section include the previous waste audit data from 2004 and the cost of waste disposal for RRU from 2006 to present. The cost data from 2011/2012 are included in Appendix J. Pricing was also obtained through numerous interviews and supplemental research to determine possible alternative contractors.

7.7.2 Methods

To complete the cost analysis, telephone interviews and site visits were conducted with different waste managers that could potentially be used by RRU. Information was also collected from other institutions to ascertain if there were any practices that RRU could employ without changing the current waste managers. These data were then compiled and costs and benefits were weighted to ensure the best possible strategy was implemented which was both economical and sustainable.

8.0 Results

8.1 Waste Audit

The raw data for the following results for the primary waste audit and the secondary waste audit can be found in Appendix H and Appendix I, respectively. These data were compiled in Excel and presented in a graphical format for visual representation.

8.1.1 Primary Waste Audit

Over the four waste audits, a total of 1012.6kg of waste was weighed, of which 54 bags (163kg) were opened, sorted and categorized. The on-campus population for the four waste audit days varied between 684 and 858 persons, which resulted in an average of a 0.33kg/person/day disposal rate over the four audit days (Appendix H).

The results of the primary waste audit showed that the diversion rate on average over the four waste audit days was 63.71%, as can be seen in Figure 3.1, though approximately 52% of the waste analyzed was improperly disposed of. This value is not representative of the waste streams studied in the visual waste audit, the inclusion of which would increase the overall diversion rate, but exact values for these streams were not determined. The majority of the waste comprised compost and garbage, which made up 38% and 36% of the total, respectively. Of the 'garbage' that was analyzed (Figure 3.2), 76% of the total weight belonged in other waste streams: 53% was Compost; 11% was Recyclable; 6% was Mixed Paper; 3% was Soft Plastics; and Cardboard, Refundables, and Other made up 1% each. The Mixed Paper bags (Figure 3.3), had a higher percentage of proper disposal as compared to the garbage at 84%; Corrugated Cardboard was 7%, Recyclables made up 3%, Soft Plastic made up 4% and Compost and Waste each made up 1%. The Recyclable/Refundable bags (Figure 3.4) also had a high amount of proper disposal at 78%; Corrugated Cardboard was 3%, Mixed Paper was 14%, and Compost and Soft Plastic were 1% each.

The average amount of waste disposed of each year is estimated to be approximately 92,400kg (Appendix H).

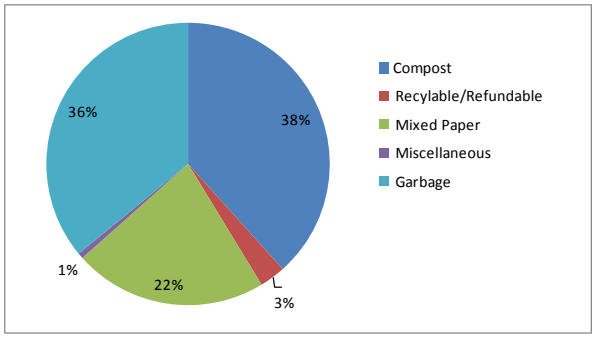

Figure 3.1: Overall Breakdown of the different waste streams at RRU (in percentage).

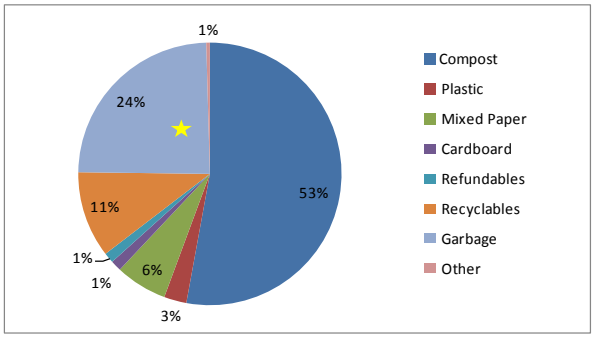

Figure 3.2: Breakdown of waste streams found in Garbage bags at RRU (in percentage). Stars indicate proper disposal bin.

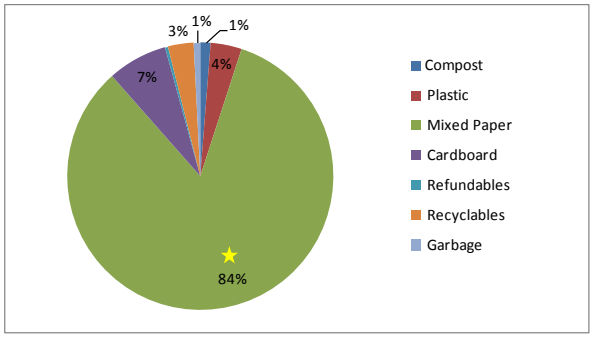

Figure 3.3: Breakdown of waste streams found in Mixed Paper bags at RRU (in percentage). Stars indicate proper disposal bin.

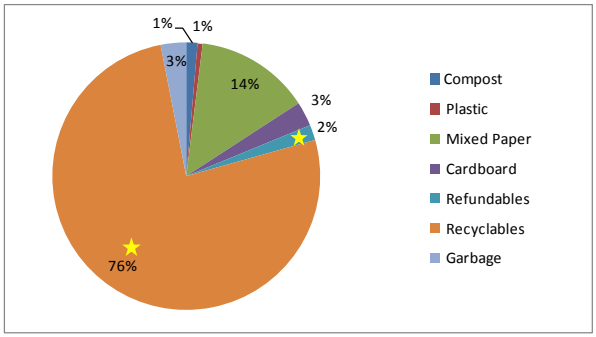

Figure 3.4: Breakdown of waste streams found in Recyclable/Refundable bags at RRU (in percentage). Stars indicate proper disposal bin.

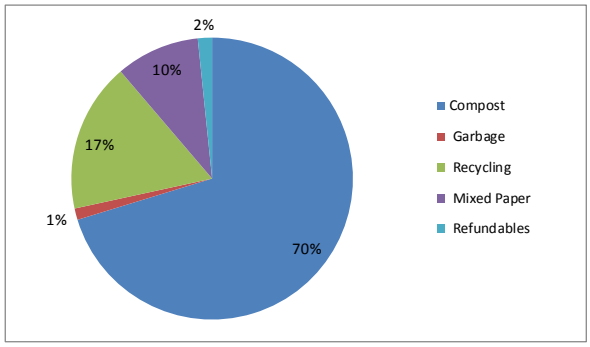

Figure 3.5: Breakdown of overall improperly disposed of waste (in percent) from all bags.

8.1.2 Secondary Waste Audit

The results of the secondary waste audit showed that of the buildings analyzed (LIC, Grant and Nixon), the Grant Building had the highest percentages of proper waste disposal overall (Figure 4.12), and specifically the highest percentage of Refundable/Recyclable (82.9%), and Garbage (44.6%) disposal. In contrast, it had the lowest correct disposal of Mixed Paper (77.7%), while

both the Nixon and the LIC had over 90% proper disposal in the Mixed Paper bin. The remainder of the Garbage stream in the Grant Building was made up of Compost (48.5%), Recyclable/Refundable (5.8%), Mixed Paper (1.76%), and Soft Plastic (0.24%), as shown in Figure 4.2.

The Nixon Building exhibited the lowest overall percentage of proper disposal; the lowest efficiency was exhibited in the garbage bin, in which only 33.7% of the overall content was considered Garbage - the remainder was made up of Compost (61.2%), Recyclables/Refundables (4.2%) and Mixed Paper (1%), which can be seen in Figure 4.10.

The values for compost could not be compared throughout all buildings, as the Nixon Building did not have a compost bin, instead having a central compost located in the lounge area, but comparing the LIC and the Grant Building, the values were 99.65% (Figure 4.8) and 98.32% (Figure 4.4), respectively.

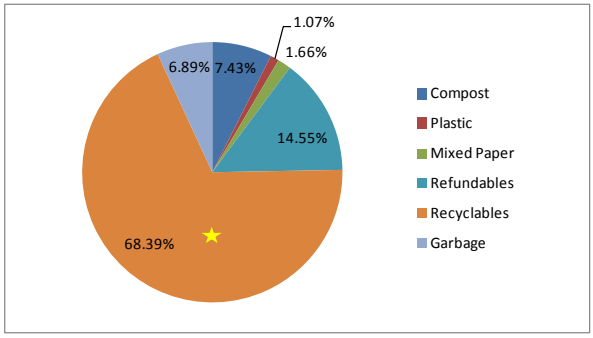

Figure 4.1: Breakdown of different waste streams found in the Recyclables/Refundables bin in the Grant Building.

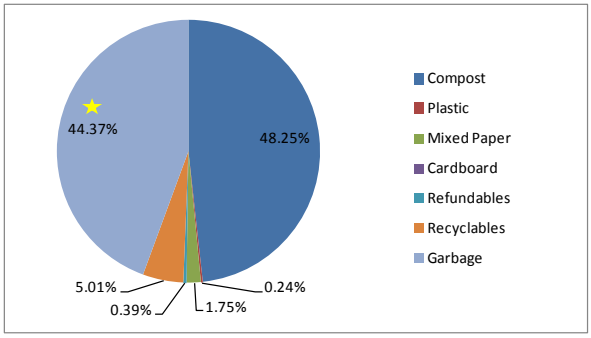

Figure 4.2: Breakdown of different waste streams found in the Garbage bin in the Grant Building.

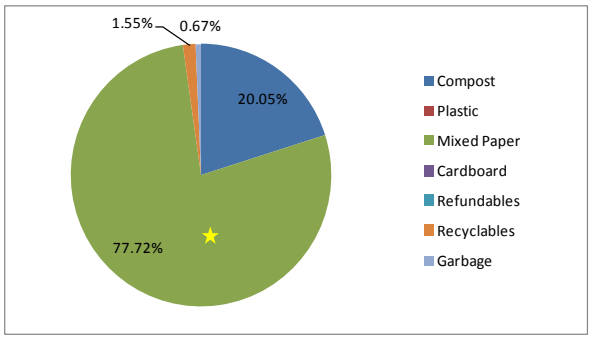

Figure 4.3: Breakdown of different waste streams found in the Mixed Paper bin in the Grant Building.

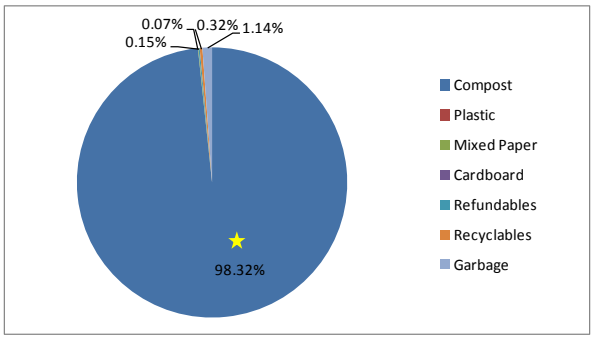

Figure 4.4: Breakdown of different waste streams found in the Compost bin in the Grant Building.

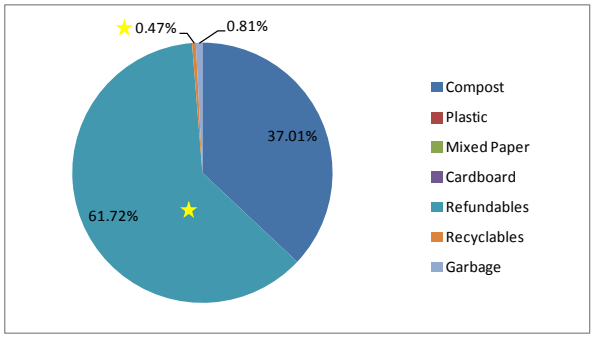

Figure 4.5: Breakdown of different waste streams found in the Recyclables/Refundables bin in the LIC.

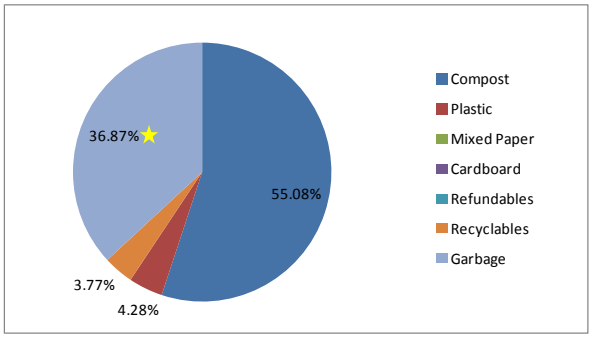

Figure 4.6: Breakdown of different waste streams found in the Garbage bin in the LIC.

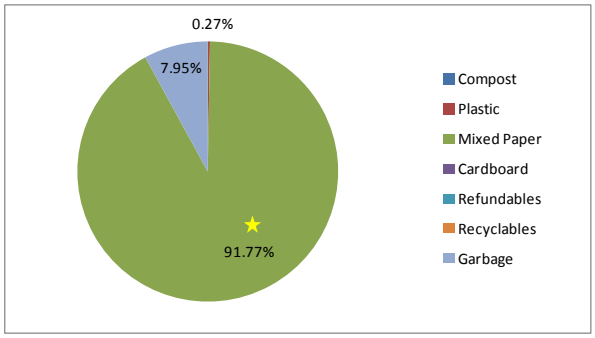

Figure 4.7: Breakdown of different waste streams found in the Mixed Paper bin in the LIC.

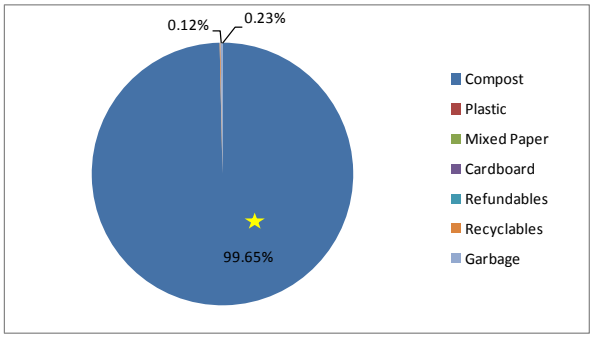

Figure 4.8: Breakdown of different waste streams found in the Compost bin in the LIC.

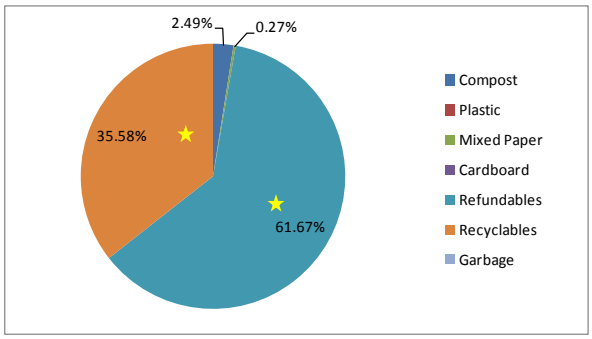

Figure 4.9: Breakdown of different waste streams found in the Recyclables/Refundables bin in the Nixon Building.

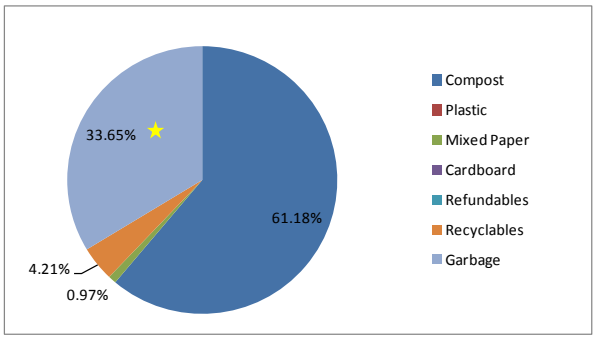

Figure 4.10: Breakdown of different waste streams found in the Garbage bin in the Nixon Building.

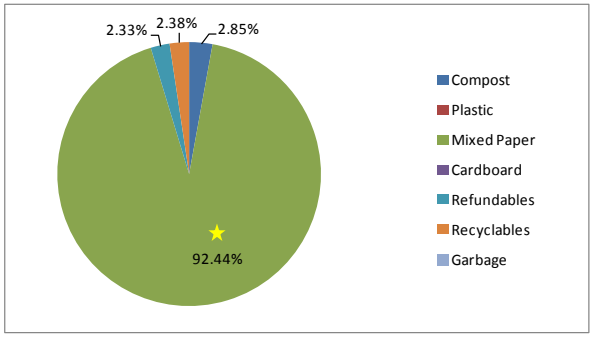

Figure 4.11: Breakdown of different waste streams found in the Mixed Paper bin in the Nixon Building.

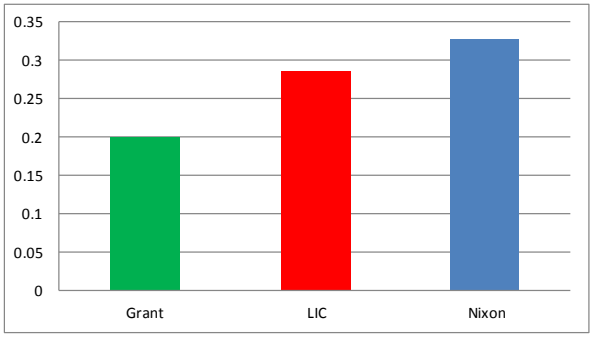

Figure 4.12: Percentage of the overall improperly disposed of waste in the LIC, Nixon and Grant Buildings.

8.1.3 Visual Waste Audit

The results of the visual waste audit did not lead to quantifiable data, as the irregularity of the sources of the streams in question and their resulting removal from campus, does not allow for accurate measurements to be made in a short timeframe. The following observations are a brief overview and estimation of the removal rates of the waste streams not included in the primary waste audit, and are not included in the overall diversion rate.

Styrofoam and Small Appliances

The styrofoam and small appliance storage area, located in the stairwell of the Grant Building, was observed from March 26, 2013 through to June 25, 2013, as shown in Figure 5.1-5.4. Pacific Mobile emptied the area once in that time frame and charged $5.00 per styrofoam bag and $2.00 per small appliance, as outlined in Appendix J. It is estimated that the styrofoam and small appliance storage area is emptied approximately four times per year (Gardham, 2013).

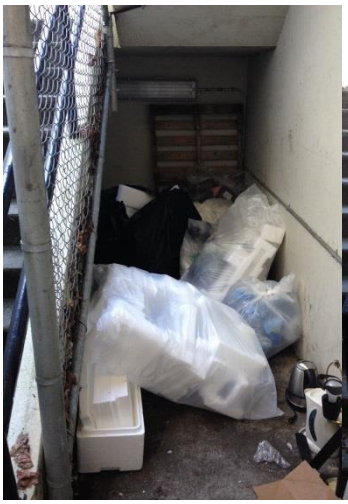

Figure 5.1: March 26, 2013

Figure 5.2: May 7, 2013

Figure 5.3: June 18, 2013

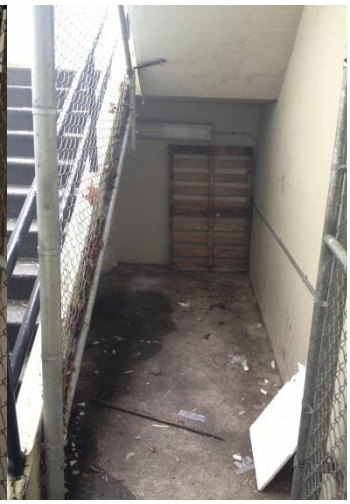

Figure 5.4: June 25, 2013

Wood Waste

The 14 yard wood waste bin was emptied on May 6, 2013 by Alpine Disposal, as shown in Figure 5.5. The bin was monitored from May 6 to June 25 and was emptied once in that time frame (Figure 5.5-5.7). Alpine charges $90 per removal with the addition of $140 per tonne (Appendix J) and the removal rate, on average, is once per month, though this number fluctuates depending on amount of construction or other activities on campus.

Figure 5.5:May 6, 2013 (emptied)

Figure 5.6: June 18, 2013

Figure 5.7: June 25, 2013

Wood waste suitable for mulch is brought to the yard waste compound (Figure 5.8) where it is converted for use on campus, simultaneously decreasing the cost of wood removal on campus and the cost of purchasing mulch from outside sources.

Figure 5.8: Yard waste compound

Metal Waste

The 14 yard metal waste bin was monitored from May 7, 2013 through June 25, 2013, and is shown in Figure 5.9-5.11. The bin did not fill up during that time, and so was not emptied during that time frame, so no real estimate can be established for this year, though typically it is emptied once or twice annually (Duckmanton, 2013).

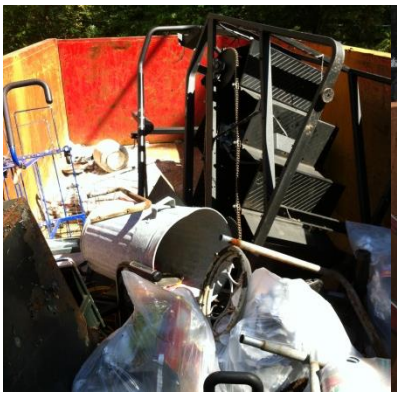

Figure 5.9: May 7, 2013

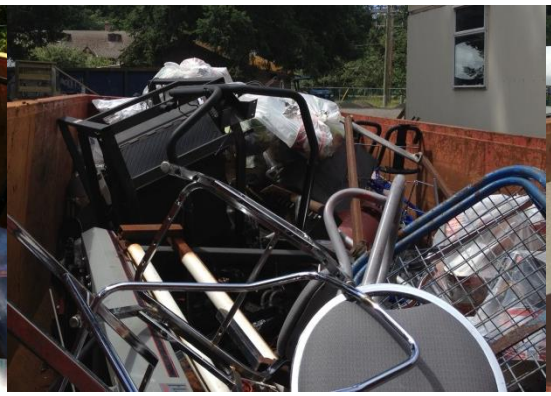

Figure 5.10: June 18, 2013

Figure 5.11: June 25, 2013

Used Cooking Oil

The used cooking oil bin from Habitat Café was monitored from May 7, 2013 through June 25, 2013, however, it was difficult to determine the change in volume, as the bin is solid metal. It was estimated that Redux empties the bin approximately once every five months, but is dependent on student volume and frequency of events hosted by RRU (Zinkowski, 2013).

Refundables

Refundables are sorted by RRU custodial staff and are usually collected by BFI weekly, although this varies depending on student volume and frequency of campus events. Approximately $18,000 has been made over the past 10 years from refundables at RRU. This money is used for charity, the annual RRU Recycling and Sustainability Award, and will be used towards a new recycling station for Habitat Café in the near future (Gardham, 2013).

8.2 Survey Results

8.2.1 Survey 1

The results of Survey 1 (Appendix E) determined that 90% of the 50 participants indicated that recycling was important to them (Figure 6.1); but that 58% had at least some difficulty with the system in place at RRU. The survey also indicated that 78% of respondents recycle often or always at home, while only 44% of participants composted at home.

The series of questions in which survey participants were asked to correctly identify the bin (Compost, Mixed Paper, Garbage, Recyclable/Refundable) they would place a variety of

different items returned varied results; the highest correctly disposed of item, by a large margin, was the juice box, which resulted in 80% of participants correctly disposing of the item in the Recyclable/Refundable bin (Figure 6.5). The remainder of the items all resulted in relatively low percentages of correct answers, with the second highest percentage of correct answers resulting from the coffee cup from Habitat (Figure 6.13), for which 56% of participants answered either compost or mixed paper, which was considered a correct answer solely because the cup shown was clean and dry.

The item which resulted in the lowest percentage of correct respondents was the plastic wrapper from Habitat (Figure 6.15); only 16% of participants correctly answered Compost, 52% answered Garbage, 18% Recyclable/Refundable and 14% answered Don't Know. Both the corrugated cardboard (Figure 6.7) and the foil-lined wrapper (Figure 6.12) returned correct answers, Mixed Paper and Recyclable/Refundable, respectively, 22% of the time. The main response for corrugated cardboard was Recyclable/Refundable (46%) and Garbage (54%) for the foil-lined wrapper.

When asked about whether the waste containers at RRU make it clear as to what type of waste belongs in each bin (Figure 6.17), 76% of people responded that they found them to be unclear at least part of the time, which was evident in the overall hypothetical disposal rate, seen in Figure 6.18, which showed that people would incorrectly dispose of the items displayed in the survey 47% of the time. When asked for suggestions which would result in greater clarity, which can be found in the survey result in Appendix E, the most common suggestions included; uniform bins in the same order throughout RRU, bins with pictures showing examples of items, increased signage around campus, and specifically in the cafeteria to inform about the compostable containers. There were also numerous suggestions for more education for both staff and students, or a list of proper disposal techniques in the orientation booklet for new students.

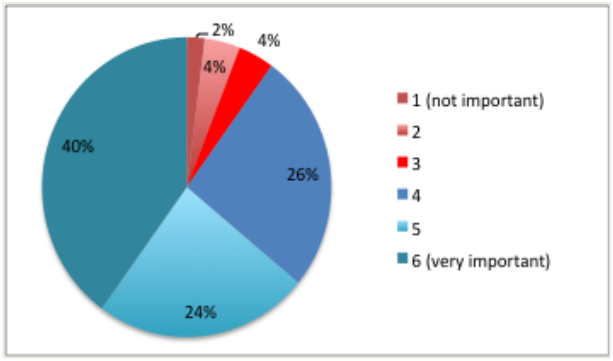

Figure 6.1 (Q1): How important is recycling to you? The red hues are indicative of a lesser degree of importance, and the blue hues show a greater importance (90%).

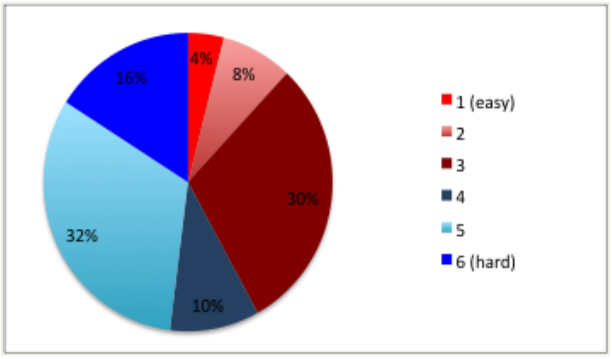

Figure 6.2 (Q2): How easy do you find it to recycle at Royal Roads University? The red hues indicate participants find recycling easy, and the blue shows participants that find it more difficult (58%).

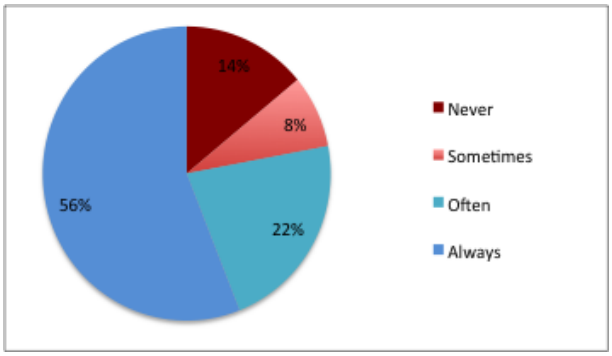

Figure 6.3 (Q3): How often do you recycle at home? The red colors show respondents that never or sometimes recycle at home and the blue colors show respondents that recycle often.

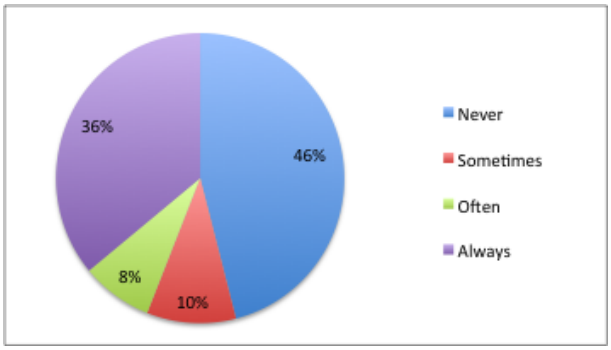

Figure 6.4 (Q3): How often do you compost at home? The red colors indicate participants which sometimes or never compost (56%); blue indicates composting often or always.

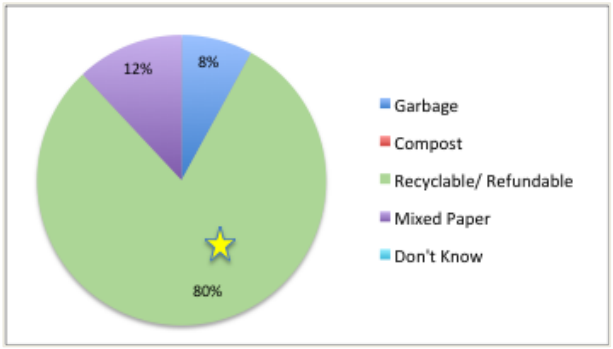

Figure 6.5 (Q5a): Which bin would you put a juice box in? Stars indicate correct bin (Recyclable/Refundable: 80%).

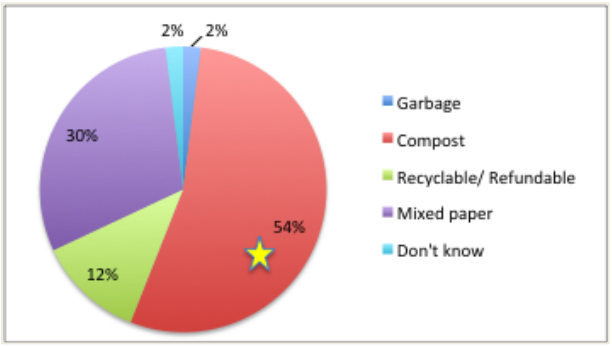

Figure 6.6 (Q5b): Which bin would you put paper towel in? Star indicates correct bin (Compost: 54%)

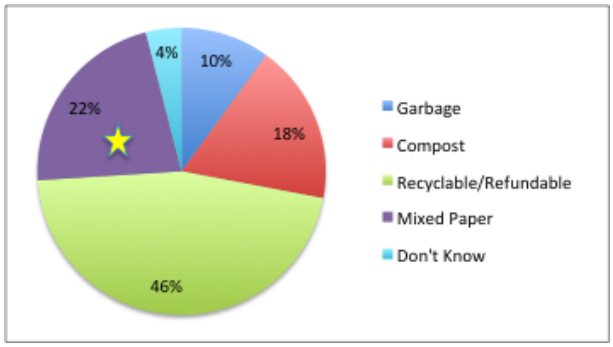

Figure 6.7 (Q5c): Which bin would you put corrugated cardboard in? Stars indicate correct bin (Mixed Paper: 22%).

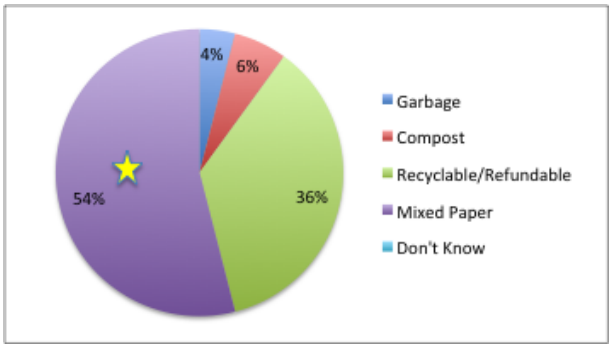

Figure 6.8 (Q5d): Which bin would you put newspaper in? Stars indicate correct bin (Mixed Paper: 54%).

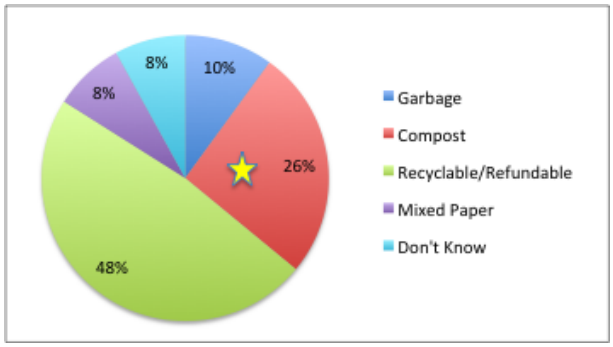

Figure 6.9 (Q5e): Which bin would you put a clear plastic takeout container from Habitat in? Stars indicate correct bin (Compost: 26%).

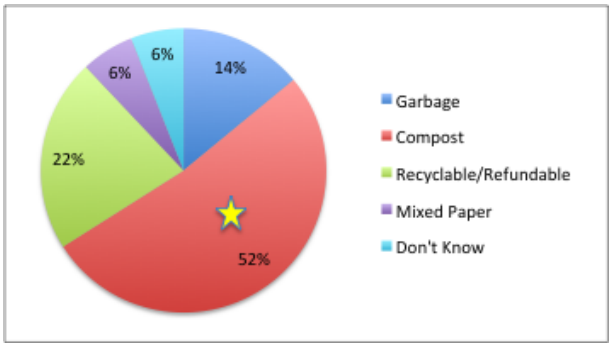

Figure 6.10 (Q5f): Which bin would you put the paper takeout container from Habitat in? Stars indicate correct bin (Compost: 52%).

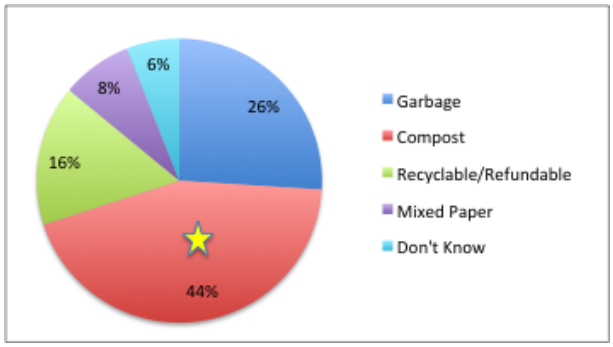

Figure 6.11 (Q5g): Which bin would you put a takeout fork from Habitat in? Stars indicate correct bin (Compost: 44%).

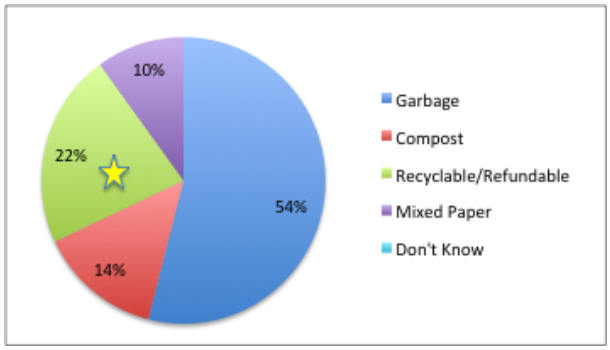

Figure 6.12 (Q5h): What bin would you put a foil-lined wrapper in? Stars indicate correct bin (Recyclable/ Refundable: 22%).

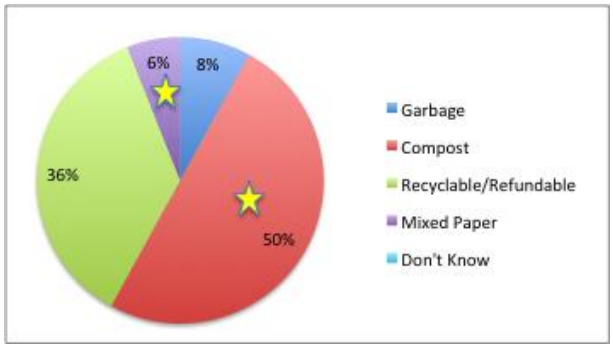

Figure 6.13 (Q5i): What bin would you put a coffee cup from Habitat in? Stars indicate correct bin (Compost or Mixed Paper: 56%).

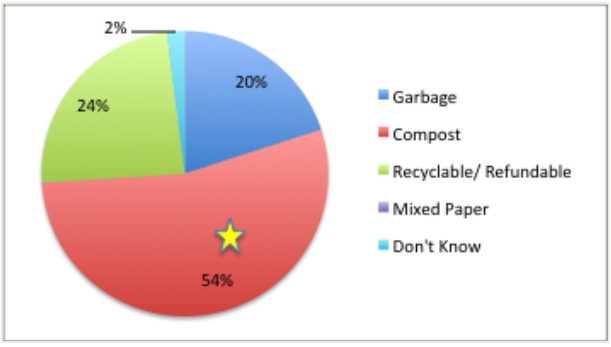

Figure 6.14 (Q5j): What bin would you put a coffee cup lid from Habitat in? Stars indicate correct bin (Compost: 54%).

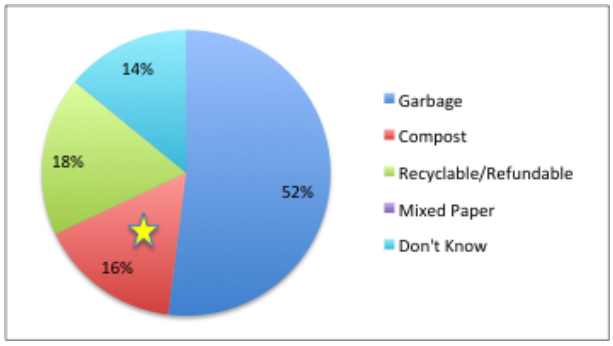

Figure 6.15 (Q5k): What bin would you put plastic wrapping from Habitat in? Stars indicate correct bin (Compost: 16%).

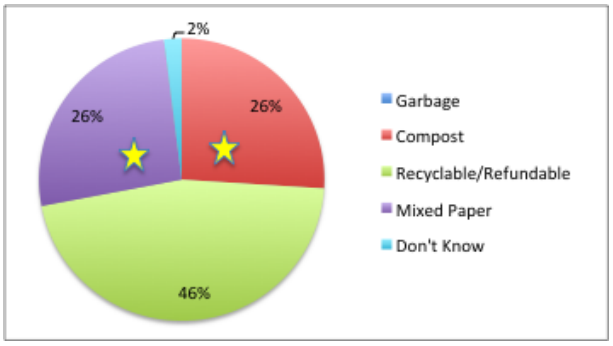

Figure 6.16 (Q5l): What bin would you put a coffee sleeve from Habitat in? Stars indicate correct bin (Compost or Mixed Paper: 52%).

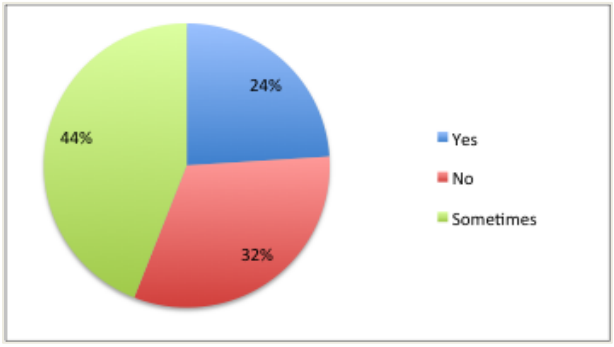

Figure 6.17 (Q6): Do the waste containers make it clear as to what types of waste belong in each bin?

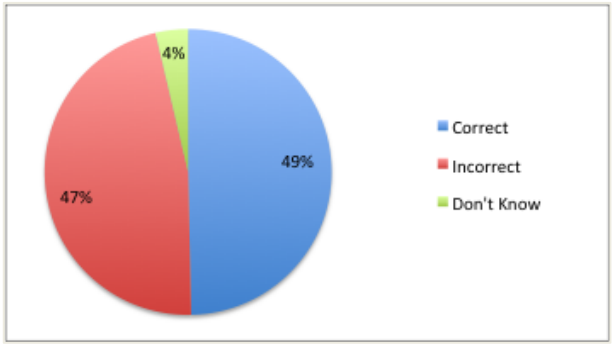

Figure 6.18: Overall disposal: The result of each item from Q5 was tallied to determine an overall incorrect disposal rate (47%).

8.2.2 Survey 2

Survey 2 was similar in some aspects to Survey 1, asking participants the level of importance they placed on recycling and composting; 92% of the participants felt recycling was important, while only 56% of the participants felt composting was important. The participants were asked

to rate the waste disposal system at RRU (Figure 7.2): 66% good; 14% fair; 14% very good; 4% haven't thought about it; and 2% thought it was poor. However, Figure 7.1 illustrates that 62% of the survey participants at RRU found it unclear as to what type of waste goes in each bin. Recommendations from participants to improve the clarity of the waste disposal system included better signage on bins, uniform bins throughout campus, and colour-coded bins distinguishing waste stream. Of the 50 participants, 58% felt that there are locations on campus that are easier to dispose of waste than others; 53% of which felt that the LIC was the simplest. In addition, 84% of participants believed that there were areas on campus that lacked proper disposal facilities, including parking lots, outside in general, the Nixon Building, Hatley Castle, residences, the Recreation Centre and Habitat Café. The results from each of the questions from Survey 2 can be found in Appendix F.

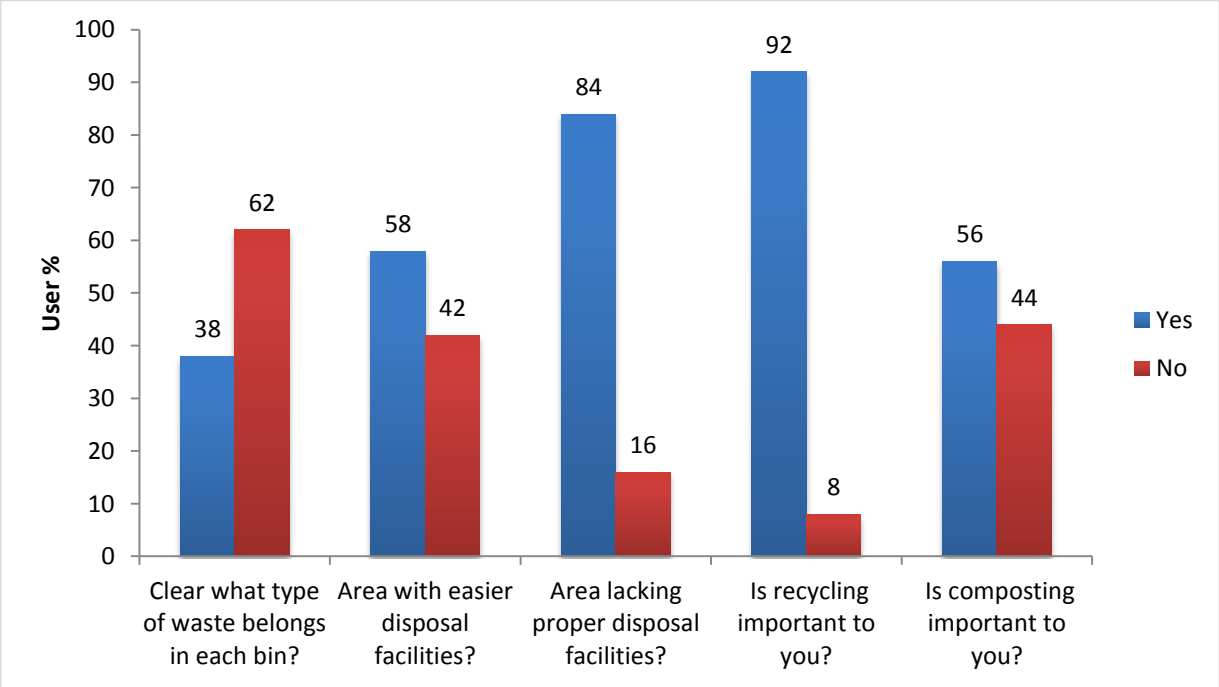

Figure 7.1: Responses of the users at Royal Roads University for Survey 2 questions 1-5 (Appendix D), which shows the percentages of 50 sampled users on campus for the Royal Roads waste system.

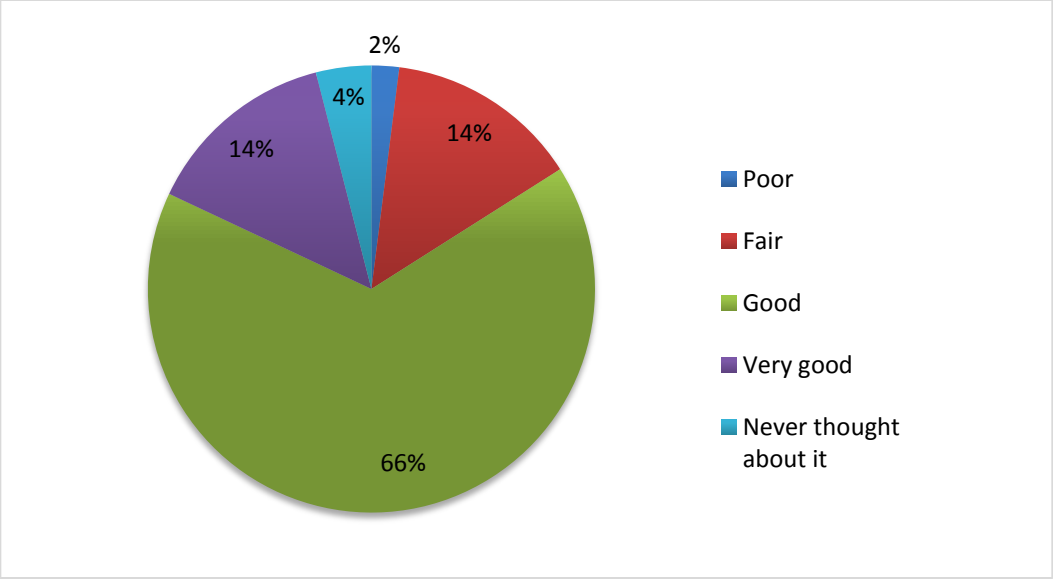

Figure 7.2: (Q6) *How would you rate the waste system in place at RRU?* Responses of the users at RRU for survey 2 (Appendix D), which shows the percentages of 50 sampled users on campus for the Royal Roads waste system.

8.3 Cost Analysis

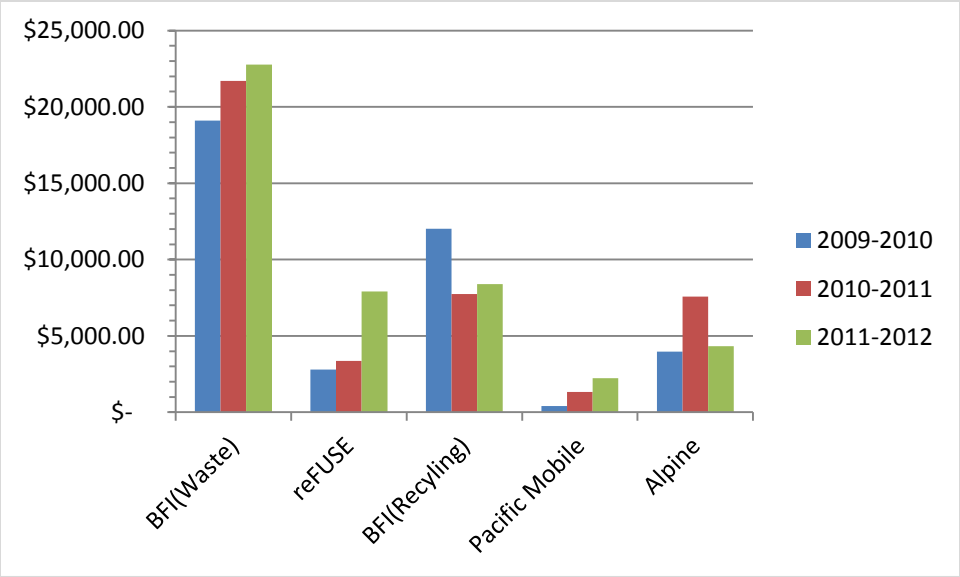

Figure 8.1: Overall cost of waste contractors from 2009-2012.

Figure 8.1 illustrates the costs expended by RRU on BFI, reFUSE, Pacific Mobile and Alpine over a three year period.

8.3.1 Alpine Group

Alpine Group is the contractor at RRU that deals with waste wood, which is picked up on an on-call basis due to the inconsistent nature of the waste stream. The basic costs for Alpine Group

can be found in Appendix J; these costs are negotiable but the specifics are kept confidential and are not included in this analysis. The waste wood bin on the RRU campus is utilized for treated wood, painted wood, and wood containing nails or other metal fixtures. The wood is taken to the Alpine Group facility in Langford for sorting and is subsequently broken down and converted into hog fuel, which is then utilized in greenhouses in Victoria and the surrounding areas (Brady, 2013).

The Alpine Group also collects garbage, metal and recycling, services which RRU does not currently utilize. The garbage is collected and taken directly to Hartland Landfill, while the recycling is taken to the Alpine Group facility and sorted (Brady, 2013). The recycling stream consists of cardboard, mixed paper, hard/soft plastic, tin and glass. Once sorted, the waste streams are shipped to Cascades Recovery Inc. in Victoria (Brady, 2013). Alpine uses subcontractors to dispose of other types of waste, such as batteries, light bulbs and paints; these companies are outlined in Appendix J with their respective costs.

At RRU the Alpine Group combines the costs of bin rental and pick-up services in three-year and five-year terms, and offers a price-reduction for these longer-term contracts. The 14-yard bin supplied to RRU costs approximately $90.00 per pick-up and is typically emptied two or three times per year (Duckmanton, 2013).

8.3.2 Ellice Recycle LTD

Ellice Recycle LTD is not a current contractor of RRU, however it is a recycling company which should be considered for RRU because of its positive reputation with other institutions, like UVic (Waddle, 2013). Ellice Recycle LTD collects residential, construction, and commercial wastes, along with recyclables which include cardboard, mixed paper, glass, tin/steel, soft/hard plastics, styrofoam, electronic waste, and appliances (Fuller, 2013). The waste collected is taken to Hartland Landfill and the recycling is taken to the Ellice Recycle LTD facility for sorting. The sorted cardboard, mixed paper, glass and tin/steel streams are taken to Cascades Recovery, Inc. in Victoria for further processing (Fuller, 2013).

Ellice Recycle LTD determines the cost per pick-up by the volume and frequency of trips required. A schedule can be made to suit the requirements of each individual establishment; if

at the scheduled pick-up time, the bin is not full, a call can be made to Ellice Recycle LTD to reschedule (Fuller, 2013). A brief cost breakdown of the services provided by Ellice Recycle LTD is outlined in Appendix J, however, specific pricing for bin rental and pick-up was not obtainable from the personnel at Ellice Recycle LTD. This is a drawback for the consideration of this company as a future contractor at RRU.

Another drawback to Ellice Recycle LTD, is that they will not sort the waste that has been collected, indicating that if recycling is contaminated it will be considered garbage (Fuller, 2013). Considering the amount of contamination found in the waste streams in the 2013 Waste Audit, Ellice Recycle LTD may not be the most suitable choice for RRU.

8.3.3 reFUSE

reFUSE collects compostable materials from Habitat Café twice weekly. The full compost bins are exchanged with clean, empty ones, and the collected compost is transported back to the reFUSE facility in Victoria, where it is then transferred to Fisher Road Recycling, an advanced in-vessel composting facility in Cobble Hill; located 42 kilometers north of Victoria (Adams, 2013). This transport from location to location emits a fair amount of CO_2, adding to the footprint of RRU.

Each tote collected is individually emptied and sorted, and contaminants are removed from the stream. Any contaminants found are subsequently disposed of in the proper manner, and reFUSE staff document the contaminants found, sharing these findings with the institution that supplied the material, so they can work on the problem (Adams, 2013). This can function to increase the functionality of the institution and is a great aspect of reFUSE.

reFUSE also collects hard to recycle materials including soft plastics, styrofoam, foil-lined packaging, e-waste, fluorescent light tubes, bulbs, fixtures, used cooking oil and batteries, a service which RRU does not currently utilize. The cost of service, $25.00/pick-up, from the reFUSE website is shown in Appendix J, but complete analysis of total cost cannot be determined, as the contractor costs, delivery costs, and fuel costs were deemed confidential.

8.3.4 Waste Management

WM is a Zero Waste company which means that their goal is to produce no waste that ends up in the landfill, a goal that aligns with the sustainability ideals of RRU. WM differs from other waste contractors in that they are an intermediary - collecting and hauling many different waste streams from the site and delivering it to the appropriate disposal facilities (WM, 2012). This simplifies and streamlines the hauling process, as only one contractor is visiting the site. They are currently under contract with University of Victoria, an institution which generates 682 tonnes of waste and 933 tonnes of recycling per year, which indicates that they are more than capable of handling the waste disposal at RRU (Green Squad, 2011).

After WM collects waste from the sites, there are several locations that the waste streams are transported to; garbage is taken to the Hartland Landfill, cardboard, paper, glass, tin and plastic are taken to Cascades Recovery, construction material is taken to Ellice Recycling, metal waste goes to Schnitzer and organics are taken to Vantreight Farms, which is approximately 25 km from RRU, or to Foundation Organics, located in Central Saanich (Stitt, 2013).

The cost of pick-up depends on the type and volume of material and the frequency of pick-up and approximate prices are shown in Appendix J, however the specific costs associated with waste removal and contract fees were, again, kept confidential. WM provides scheduled pick-up times during the week based on routing and scheduling – any time restrictions can be accommodated based on the customers' needs. Scheduled pick-ups are preferred by WM, not only for the customers benefit, but also to decrease cost, as it is more efficient and cuts down on the greenhouse gas emissions (Aitken, 2012).

WM compiled a proposal in 2012 for RRU which contained a number of services that would benefit the University, such as campus waste and recycling audits, public education and outreach programs (signage, decals, brochures), recycling workshops/presentations (conducted by recycling specialists), solar compactors, and e-waste collection. Other incentives include waste audits, community events or zero-waste events, the provision of education, posters and green bins and custom labels for bins if required. WM also processes any collected glass locally for use in road aggregate - keeping the waste, and its resulting products, local.

Many of these options could aid in the waste reduction and recycling goals of RRU, as the company offers the option of implementing a tracking system of the materials in the waste streams so that the necessary changes for waste reduction can be implemented and monitored (Aitken, 2012).

WM also has its own sustainability initiatives, and states that its plan is to reduce its impact on the environment through increased recycling, reduced fuel emissions, the preservation of wildlife habitat and energy generation. WM boasts a reduced travel time associated with waste pick-up and uses priority routing and biodiesel which is a cleaner-burning fuel, both practices which reduce the amount of emissions released into the atmosphere. With these sustainability initiatives and waste reduction goals proposed by WM, RRU can benefit and reach their waste divergence goals and decrease their footprint (Aitken, 2012).

8.3.5 BFI

BFI uses a table to display the cost of bin pick-up as well as cost of bin rental (Appendix J), however the potential negotiations associated with contract fees are not incorporated into the rental and pick-up costing, which does not allow for correct estimation of costs. The listed prices include a $15.00 rental cost for the 6-yard bins, and a scheduled pick-up cost of $45.00 (BFI, n.d.). RRU has two of the 6-yard bins, collected on a bi-weekly basis, dependent on the volume of garbage produced. On-call lifts are available at a cost of $55.00. BFI does not release the cost per tonne of waste collected to the organization that it is working for, including RRU; they are just given the cost for the transport and disposal (Duckmanton, 2013). A BFI representative was not available for interview, so a full cost analysis was not determined.

8.3.6 Pacific Mobile

Pacific Mobile collects the styrofoam, soft plastic, and electronics at RRU. The cost of styrofoam is divided into regular bags ($2.50/bag) and large bags ($5.00/bag) (Pacific Mobile Depots, 2013). A typical collection, made in May 2013, which involved 24 large styrofoam bags, cost approximately $120.00 (Duckmanton, 2013). Pacific Mobile also collects soft plastics, appliances and electronic waste from RRU. The cost of soft plastic is $2.50 per regular bag and $5.00 per large bag, and the cost of appliance pick-up is dependent on the size; a small appliance costs $2.00 and a large one costs $4.00, but these labels are unclear as to what

constitutes a ‘small’ or ‘large’ appliance, which creates a challenge in analyzing the costs associated with e-waste at RRU (Duckmanton, 2013).

9.0 Discussion

9.1 Challenges

9.1.1 Primary Waste Audit

On the first audit day, there was some discrepancy as to which category certain items from outside sources, such as Tim Horton's cups, belonged in. This resulted in a few items initially being placed in the wrong categories, but was soon cleared up after more background research was conducted. The systematic sampling methodology has an innate potential to result in skewed numbers, as only certain bags were chosen to sort, which may not have given accurate results for the daily diversion rates. The highly fluctuating student population also posed a challenge for accurate estimation of the diversion rate on campus. Considering only four days were utilized for auditing, it is unlikely that a completely representative sample was measured; RRU hosts many events involving people that do not attend RRU campus, and their disposal habits may be dissimilar to those of the staff and students at RRU, and were not captured in this study.

Another challenge that occurred was the categorization of soiled recyclable items; in order to be considered recyclable or refundable, they must be clean. Soiled objects have the potential to contaminate the waste stream and so must be considered garbage. This led to some initial discrepancies in the characterization of these objects when placed in Garbage as either correctly or incorrectly disposed. It was decided that any soiled item found in Garbage, that, when unsoiled, belonged in another waste stream would be considered 'contamination'. Alternately, if there was a soiled item in any of the other streams, it would also be considered improper disposal, as its presence could cause the entire contents of the bin/bag to be contaminated and disposed as garbage. The reasoning behind these decisions is that the amount of improper disposal and the resulting amount of material incorrectly arriving at the landfill was one of the main aims for this study so that problem areas could be addressed.

A final challenge was the decision about the division of categories for the separation of each waste stream. Originally the sections were divided into much more detailed categories: Refundables was divided into glass, tin, aluminum and juice boxes; Recyclables was divided into

glass, hard plastic, soft plastic, foil-lined wrappers and tin; Mixed Paper was corrugated cardboard and other paper. These categories were retained for the first waste audit, but upon consideration of the aim and scope of the project, which was to determine the divergence rate at RRU and the level of contamination of the waste streams to make recommendations for improvement, these detailed categories were reduced to Compost, Refundables, Recyclables, Garbage, Soft Plastic and Corrugated Cardboard. This change also made weighing easier, as the scale supplied by RRU was not very accurate for smaller amounts, and the more accurate scale was extremely small - making weighing difficult.

9.1.2 Secondary Waste Audit

The application of the secondary waste audit is uncertain, as on some of the audit days, there was only a small volume of waste to work with in some of the bins from the different buildings, which did not allow for a very accurate representation of the efficiencies of the individual systems, as with such small volumes, even one incorrectly disposed of item could constitute a large percentage of the overall weight of a bin, skewing the improper disposal percentage greatly.

To gain representative data, the secondary audit would have to be performed on a greater scale – throughout the entire LIC, Grant, and Nixon Buildings, and over a greater time scale. Even with this expansion, the collected data may not be indicative of the success of the differing systems employed in the separate buildings, but of the varying levels of knowledge of the staff and students in the respective buildings, as the same users would typically frequent the same areas.

9.1.3 Visual Waste Audit

The main challenge associated with the visual waste audit was the inconsistent production of waste in each stream. Volumes of used cooking oil and refundables were dependent on the population present at RRU, which fluctuates based on classes, residencies, and events. Computers are replaced periodically at RRU and this increases the amount of styrofoam waste produced on campus over a short time frame, and during times of construction or demolition, and influx of wood or metal waste would result. These fluctuations make an accurate portrayal

of the respective amounts of the waste streams included in the visual waste audit impossible over the time frame allocated to the study, and a much longer study period would be required to get representative data.

Since these values were not quantifiable in this study, the amounts of each stream could not be calculated and were not included in the overall campus divergence rate, equating to a lower divergence rate than would result if these streams were included.

9.1.4 Surveys

The days the surveys were conducted had variable user availability; some days the Habitat Café was full of people at lunch and it was easy to find participants, but on many days the Café did not have many people, which made it difficult to get sufficient numbers. In addition, most people did not have time to do the survey, or were unwilling to participate, and this was a challenge to overcome. Another limitation, for Survey 1, was the fact that it was limited to Habitat Café because setup and space was required for question 5, and as such, the results of this survey were limited to staff and students who visited the Café.

Another challenge was that people may have given dishonest answers, as they did not want to be known as a person who does not recycle or compost, which may have been compounded by the knowledge that they were being questioned by Environmental Science students. In addition, some of the answers may have been correct if the respondent was answering for his or her own home; discrepancies exist between what is disposed in which bin at RRU as compared to private residences with the Blue Box system.

9.1.5 Waste Event

Even though communication was established, participation was a challenge in the waste event; students participated, but staff did not seem to care to take part in the event. In addition, many people had a scheduled lunch break that differed from the time of the event, illustrated by the majority of people participating at the beginning of the event; very few were present at the end. Another challenge that was encountered was that the event had to be moved from the original date that had been planned and promoted, May 16, due to a conflict with an alternative event, scheduled for the same day. This may have discouraged participants who

may have attended had the date not been moved. A final challenge was the limited time allocated for this event, one hour, as more participants would have been expected given more time.

9.2 Waste Audit

The primary waste audit showed significant amounts (52.2%) of improperly disposed waste resulting, at least in part, from insufficient knowledge and improper communication as to which items belong in each bin. If the level of improper disposal remains constant throughout the year, the annual amount of improperly disposed waste will be approximately 47, 511 kg, which is a large quantity of material to end up in the landfill, when it could be utilized in a more sustainable manner. The overall divergence was found to be 64%, a value which, if all waste was properly placed, would become a divergence rate of 89% - a value which would greatly improve the sustainability of RRU, and cut down the burden on Hartland Landfill.

The amount of overall waste generated per person averaged 0.33kg per day, or 121kg annually; the majority of this was observed to be compostable coffee cups and takeout containers from Habitat Café. As seen in Figure 3.2, the major component of the garbage that was improperly disposed of was Compost (53%), again, the vast majority was compostable containers from Habitat. This indicates a lack of communication on the part of the school, informing customers that all of the takeout containers can be composted and the methods to remedy this problem will be addressed in the Recommendations section.

One thing to consider is the number of international students that attend RRU; these students may not have been exposed to the same disposal systems that are utilized in the area, once again indicating that knowledge is a major component of improper disposal on the campus grounds. A major issue that was encountered, and signified a disregard for sustainable practices, was the use in one instance, of ~200 sheets of unused paper used to make paper airplanes (Figure 8.1); showing that there are other behavioural barriers which must be overcome to improve the sustainability practices at RRU.

Figure 6.2: Paper airplanes from Mixed Paper

The staff at Habitat Café are very diligent in separating recyclable plastic that is used in the kitchen, but there were several incidences where the Recyclable bag from the cafeteria contained soiled containers, which would result in the receiving contractor disposing of the entire bag after pick-up. To avoid this situation from occurring in the future, the staff should be trained in proper disposal techniques and informed that soiled products cannot be recycled.

Figure 8.3: Soiled recycling bag from Habitat Café

Of the overall amount of improperly disposed of waste, 70% was Compost, 17% was Recycling, 10% was Mixed Paper, 2% was Refundables, and 1% was Garbage. These results show that the users do not know what constitutes compost on campus; signifying either an issue with educating and communicating what is compostable, or a lack of available compost bins for the community to use. With respect to the 17% incorrect disposal of Recyclables, the main issue is that most of the bins do not say both Refundable and Recyclable, despite being utilized for both, and are typically labelled for one or the other. This could cause confusion since many items that are recyclable are not refundable, therefore some people may dispose of recyclables in the garbage, for lack of another option.

The secondary waste audit showed that the Grant Building waste disposal system had a better overall proper disposal percentage as compared to the LIC and Nixon Buildings (Figure 4.12). The compost stream of the Grant system had 99.65% compost, as illustrated in Figure 4.8, which could either be indicative of the success of the system employed in the Grant Building, or of the knowledge base of the users that utilize the bins in the area in question.

The selection of sampling areas from each building could have had an effect on the outcome of the secondary waste audit; in the Grant Building, the samples used were taken near Room 321, which is the Environmental Science cohort's classroom and most of these students possess the knowledge and desire to properly dispose of waste in the correct bins. The LIC waste bins were collected on the first floor across from the computer lab and have a variety of different students and staff utilizing that particular hallway on any given day, giving a more representative sample of how well the system itself performs. The Nixon Building's elevated level of improperly disposed waste as compared to the other buildings, could have been a result of the lack of individual compost bins next to the other bins, instead having the compost bin located in the lounge area. This could have contributed to the higher percentage of compost (61.18%) in the garbage bin (Figure 4.10). The results of this survey are not completely accurate, as there was very little usage of any of the bins, apart from the Grant Building, over the course of the study, weighing a total of 21 kg for all the bags combined.

9.3 Analysis of Survey Results

9.3.1 Survey 1

From the results of Survey 1, it was evident that students and staff attending RRU have a great interest in recycling, as indicated by the 64% of respondents that selected a numerical value in the top two of six importance values (Figure 6.1). This value shows that the majority of staff and students would be willing participants in any recycling system employed at RRU and any future changes to improve the divergence rate. Of the 50 respondents, 78% indicated that they recycled either often or always at their home (Figure 6.3); this number could differ from the people that placed a high importance on recycling, in part, because of lack of programs at their place of residence, or ease of use of their particular home recycling system. The number of respondents who compost at home is slightly less (Figure 6.4), which is indicative of the less uniformly-dispersed compost programs in the Greater Victoria area, though that is soon to change with the implementation of the kitchen scraps compost bin program by the CRD that was implemented in 2013 (CRD, 2013).

The percentage of people who found the waste disposal system at RRU to be on the difficult side, as opposed to simple, was 58% (Figure 6.2). This number is reflected in the number of incorrectly placed items from Question 5 (Figures 6.5-6.16). Overall, the incorrect disposal rate was 47% (Fig.6.18), which makes it evident that there is a lack of pertinent knowledge for a large part of the school population with respect to waste disposal. This number is very close to the 52% improperly disposed waste which was calculated in the primary waste audit (Appendix H), which speaks to the consistency of the data.

The main items of concern were the compostable plastic wrapping from Habitat, which only 16% of people would correctly place in the compost bin, the corrugated cardboard, that only 22% of people correctly answered belonged in the mixed paper bin, the takeout fork from Habitat, which only 44% of respondents knew was compostable, and the foil-lined wrapper only 22% of respondents would place it in the recyclable bin. Many of the compostable items from Habitat were incorrectly disposed of, as was evident in the findings of our waste audit. This is an issue not only for the decreased divergence rate at RRU, but also ends up wasting a fair amount of money for the University. For example, one particular compostable takeout

container currently utilized by Habitat Café costs $0.32/piece, while the previous, non-compostable ones cost $0.25/piece - a difference of $0.07 per container (Nolan, 2013). If even half the average population of 750 people per day purchased something in a compostable container from the cafeteria, and assuming half of those people disposed of these takeout containers incorrectly, this equates to a loss to RRU of approximately $5000.00. These compostable containers are a large area of concern that could be aided with education and signage that will be addressed in the Recommendations section (12.0).

The results of Question 5 (Figure 6.5-6.16) clearly showed that the focus of any future recommendations for the betterment of the waste management system should be on the education of the users. This was made evident by the fact that when given clear bin choices, people were still unable to make the correct choice. So, while the uniformity and transparency of the waste system is important, the building block of any improvements should be to inform the staff and students of the correct disposal of common items, with emphasis on items from the Habitat Café.

When questioned as to whether the disposal bins on campus made it clear where to place items 76% of respondents found bins unclear at least part of the time. The most common suggestions that participants gave to help with the clarity of the system involved increased signage, on both bins and in the cafeteria, and more education. An additional comment, which came up as an aside from the survey, was the system for waste disposal in Habitat Café. Very few people were aware that proper disposal consisted of placing all unsorted waste, aside from refundables, on the tray rack beside the Refundable bin. Many survey participants mentioned a lack of bins in the café, and it is something that needs to be communicated to staff and students in future.

9.3.2 Survey 2

From the results of Survey 2, it was evident that the waste disposal bins on campus are not indicative of what waste belongs in each bin by the 62% of participants who stated the disposal system was unclear. Of the 58% of participants who specified that there were locations on campus that were easier to dispose of waste, 53% of those participants felt that waste disposal

was easiest in the LIC. These results are in accordance with the recommendations provided by participants stating that disposal bins should be uniform with better signage. Of the buildings on campus, the LIC is the only place with a uniform disposal system throughout the entire building.

Survey 2 was conducted in the dining area of Habitat Café and offices in the Grant Building, which allowed for more staff involvement as compared to Survey 1, which was limited to the café only. Staff who participated in the survey noted that there were no compost bins available in their offices, and even though there are compost bins located in the hallways, the consensus was that inevitably some compost was improperly disposed in the garbage due to the convenience and close proximity of the garbage bins in offices.

9.4 Cost analysis

When attempting to determine the exact costs associated with the waste contractors in the Greater Victoria area there was insufficient information provided to the Palindrome Group about certain key costs, which did not allow for a complete cost analysis to be performed. Each contractor (Alpine, Waste Management, reFUSE and Ellice Recycle LTD) that was interviewed stated that certain costs could not be divulged due to the confidentiality between the contractor and the employer, such as fuel surcharges, cost per tonne and contractor costs. The contractors did supply the Palindrome Group with costs of bin rental and scheduled pick-up rates from their websites, and this helped determine annual rental and bin costs for RRU, though exact overall costs could not be determined.

One of the main aspects that keeps BFI as a beneficial contractor, is the use of a 40-yard bin, which costs RRU only $26.80/month, and $173/pick-up, a Grandfathered fee which would would be much greater if quoted today. This allows the university to fill the large bin up with objects that otherwise would take too much time and effort to breakdown to fit in the smaller bins; including furniture and other objects that are left in front of the compound from outside sources (Duckmanton, 2013).

Due to the close proximity of the Alpine Group to RRU, only 5km away, it might be beneficial, both from an economic and environmental perspective, to utilize them as a contractor for

recyclables, garbage and other waste streams in addition to the wood collection, though the exact economic benefits of this option cannot be ascertained for the aforementioned reasons.

As a non-monetary comparison between composting contractors, the CO_2 emissions resulting from the transport of the compost was considered; the facility utilized by reFUSE, Fisher Road Recycling, is located 42 kilometers north of Victoria, where it is taken after first being transported to the reFUSE facility at 2111 Government Street (Adams, 2013). This extensive transportation increases the amount of CO_2 emissions, which increases the footprint of RRU. Alternately, WM takes the organics they collect to Vantreight Farms, which is only 25km from RRU, or to Foundation Organics, which is located in Central Saanich.

While each individual contractor that RRU employs may have lower overall prices for different waste streams, the streamlining of the system that would result from the adoption of one contractor, Waste Management, collecting each waste stream, might be worth the slight increase. A consideration to be made when comparing this option is the lessened traffic to the RRU site. If one contractor is responsible for all of the pick-ups, there may be multiple occasions where two different waste streams can be collected in one trip.

In lieu of a traditional cost analysis, other methods of decreasing the overall expenditures on waste removal were explored. If the correct disposal rate of compost increased to 100%, this would significantly impact the waste management expenditures; the amount of garbage taken off site would be reduced by over half - reducing the amount it would cost to remove this garbage. The following equation was used to determine the cost reduction in garbage removal rates if complete correct disposal for compost was achieved. The 2011/12 cost data (Figure 8.1) was used for the following equations, the total amount of waste produced for compost and garbage can be found in Appendix H, and the percentage of compost found in the garbage stream can be found in Figure 3.2.

(Current Annual Cost/Current Annual Weight) * ((Current Daily Weight - (Current Daily Weight * % Compost in Garbage)) * Days/Year = Reduced Annual Garbage Cost

($22774.39/32594 kg)*((89 kg-(89kg*0.53))*365) = $10,668.18

The equation above is used to find the cost of the garbage once it has been reduced via the increased percentage of correct disposal of the compost. To find this value, the cost for garbage disposal for 2011-2012 was divided by the total garbage produced in a year, as shown in Appendix H. This value was then multiplied by the new weight of garbage produced in one day multiplied by 365 days. This new weight value was found by subtracting the amount per day of compost that would be removed from the garbage if the compost was properly disposed of. This resulted in a decrease of $11,000. However, this value does not represent the overall savings that would result. Since the compost would increase by 47 kg per day, the cost of removing this would increase as well. The amount of compost produced per day would increase from 97 kg to 144 kg. The equation for the cost change is below.

(Current Annual Compost Cost/Current Annual Compost Weight) * (Increased Daily Compost Weight * Days/Year) = Increased Annual Compost Cost

($7,989/35450)*(144*365) = $11,844

The equation above is similar in method as the first. The cost of the compost removal for 2011-2012 was divided by the amount of compost produced in a year, found in Appendix H. This value is then multiplied by the new amount of compost produced in a year, which is found by multiplying the increased weight of compost by 365 days to get the cost for a year. This is an increase of $4,000, from $8,000 to $12,000; however, taking into account the savings that will be experienced from the lesser amount of garbage being hauled off site, it gives an average savings of $7,000, further showing the applicability of using an on-site compost facility, from a financial standpoint.

10.0 On-site Composting

The idea of an on-site compost facility has a number of benefits which include the avoidance of cost and emissions associated with collecting and transporting the material, the generation of compost which could be utilized for campus landscaping, and increasing the overall sustainability of RRU. The subject of an on-site composting system at RRU has been under consideration for quite a while, and the potential benefits have been met with a variety of concerns; the composting of food waste can be problematic, as it is extremely moist and can be malodorous, which could impact the on-campus residents as well as attract animals, such as rats, raccoons and cougars (Gardham, 2013). The implementation of an on-site composting system would also require increased personnel to manage and maintain the system.

The University of British Columbia (UBC) has been home to an in-vessel composting facility since 2004, and generates approximately 1,900 tonnes of compostable waste per year, which includes food waste, paper towel, wood, yard waste and animal bedding and waste (UBC, 2009). Of this total, they were able to compost 388 tonnes of material in 2010/11 (UBC, 2013).

kg Compost + (kg Garbage * % compost in Garbage)) = potential kg Compost

97kg + (89kg * 0.53 (% compost in garbage)) = 144kg

The average amount of compost generated daily by RRU was found to be 97kg (Appendix G), a value which would increase to approximately 144kg daily if the 70% of compost found in the garbage bags was properly disposed of. This number increases the average annual amount of compost from approximately 35,000kg to 52,500kg, a 67% increase. This increase, in turn, would raise the annual cost of compost removal, approximately $7800.00 in 2011/12, (Appendix J) would increase to $13,026.00.

In-vessel composting systems are typically utilized when space or odor are important considerations; the enclosed design provides aeration, limits composting time, reaches high enough temperatures to destroy pathogens and often includes a biofilter to limit odors, though they are an unavoidable element of decomposition. (Rynk, 2000). These systems are, for the most part, self-regulating, which keeps staff involvement to a minimum. There are many

systems available that have been utilized by institutions similar to RRU, though with the limited student population a smaller system is required.

Before implementing any type of system, there are several considerations which need to be addressed, including the proposed site of the composting system and the amount of space both for primary and secondary processing as well as for curing, which just means stabilizing the compost so it no longer gives off heat and smells earthy. In addition, the quantity and composition of the compost stream needs to be thoroughly examined and documented. This should be done for a longer duration than the waste audit contained within this report, and the type of material, its moisture content and porosity should be measured. The target moisture content for composting is 60%, and is achieved through the addition of such bulking materials as wood chips, sawdust or straw (Bonhotal, Schwarz & Feinland, 2011). Paper towel has been used in some instances for bulking material, which RRU is already adding to the compost stream, in addition to the napkins, compostable takeout containers and cups from Habitat Café, and should act to diminish the amount of added material required.

While concerns have been raised with respect to the ability for on-site composting systems to break down the cornstarch-based plastic materials of the type used in Habitat Café, and attempts were made to contact the facility said to be experiencing these difficulties, but unfortunately they were unavailable for contact. Speaking to representatives from several businesses which specialize in composting, assurances were made that the composting systems were capable of composting any material supplied, given that it was ground up into fine enough particles, giving the microbes more surface area on which to work (Willis, 2013). A representative from BW Organics suggested having a pulper in the cafeteria to break down food waste, but RRU would need a second pulper for the breakdown of other compostable materials, including the containers and utensils (Willis, 2013).

The composting system that BW Organics suggests for a facility the size of RRU is their Green Drum 105 Model, a rotating drum composter, which has a total capacity of $2.3m^3$. These systems function by tumbling the feedstock in an enclosed reactor, or drum, which acts to mix and move the material through the drum, add aeration, and release the gases and heat

produced by decomposition (Rynk, 2000). With this continuous flow system, which costs $1866.00, 0.8m^3 of feedstock is uploaded and 0.8m^3 is recovered per day (Willis, 2013). Using this system for economic comparison, even though there are a variety of systems and prices available (please see list in Appendix M), considering only the financial aspects a yearly compost disposal cost of $13,026.00, this system would take only a few years to pay itself off - this does not consider operation costs or time. Other benefits which should be considered, and which have not been quantified at this point, are the reductions in greenhouse gas emissions that would result from the avoidance of hauling the compost from RRU. The resulting nutrient-rich compost would also have value in the use of landscaping the grounds and would save the cost of purchasing compost.

While extensive research would need to be conducted before implementing an on-site compost system, considering the data gathered during the compilation of the report, it appears to be a viable and affordable option that could further reduce the environmental footprint of RRU, without attracting problem animals.

11.0 Recommendations

From the data obtained throughout the synthesis of this report, some of the recommendations that The Palindrome Group have found include increasing the number and clarity of signs on the disposal bins to increase proper disposal rates, and to make these signs and their corresponding bins uniform throughout the campus. Students and staff alike are very busy, and do not want to spend a great deal of time decoding unclear signs or figuring out discrepancies in different systems, and an unwavering and clear indication of what belongs in each bin could greatly reduce contamination. It is also recommended that the way the Recyclable/Refundable bin is labelled should be changed to encompass both the Recyclable and Refundable title. The one bin accepts both types of material, but currently is only marked with a single title in most cases, which makes proper disposal more difficult.

Signage is of the utmost importance in the cafeteria, and should be placed where students and staff order or pay for their food, where they have time to read and absorb the message that informs them that the containers they are purchasing are compostable. This may increase proper disposal rates as opposed to waiting until people dispose of their waste, when they may not take the time to look for the proper bin, which in many cases does not inform them that the takeout containers from Habitat belong in Compost. In addition to promoting the proper disposal of the takeout containers, signage should be implemented which encourages students to bring their own coffee cup from home, or to use the reusable plates and cutlery from the cafeteria. An extra cost should be implemented for the use of these containers and signs depicting this extra fee should be exhibited alongside with ones indicating the current cost associated with utilizing the disposable coffee cups as opposed to using reusable ones.

Another necessity with respect to cafeteria signage is the notification of the proper disposal methods in the Habitat Café; all waste, aside from refundables, is to be placed on the tray rack beside the Refundable bin, and staff will sort it. This can be easily communicated with the use of a simple sign, and would increase the clarity experienced by many staff and students.

The above recommendations should be preceded with the increase of the knowledge base of the users, both students and staff, at RRU because, as Survey 1 clearly indicated, even when the

bin was clearly marked, almost 50% were unable to correctly answer the question (Figure 6.18). This education could be incorporated into the new student orientation folder in the form of a pamphlet or laminated sheet describing the proper waste disposal practices and examples of each waste stream that would be common to RRU along with disposal locations (see Appendix M for UVic's example), or delivered via a short guest lecture during the first week of classes. In addition to student education, staff should undergo some type of orientation as well, because many are uncertain of proper practices, and they are longer-term residents of RRU, while many students stay for only a year, and thus have a greater impact on the overall divergence success of the university.

One of the tactics being investigated at the University of Victoria (UVic) is the removal of desk-side disposal bins from the offices of staff, in favour of a central recycling station, as is currently the case in classrooms at both RRU and UVic, in an attempt to phase out the practice of custodial services emptying the individual garbage and mixed paper bins from each office desk (Waddle, 2013). In September 2013, a pilot study will begin with the removal of collection of paper bins from offices – leaving only garbage bins being picked up and requiring staff to take all their recycling to a central sorting station (Waddle, 2013). In order to combat the potential increase of recyclable or refundable materials being disposed of in the desk-side garbage bin that may result from the removal of alternate bins, if there is contamination present in the bin, a sticker claiming that the bin will not be emptied due to contamination is placed on the bin until the user removes it (Waddle, 2013). Following the removal of collection service of the mixed paper bins, the garbage bin will be taken away as well if the pilot study is successful and staff have some willingness to take the program to this next level, leaving the staff to take all their waste out to the central sorting stations that will be made available campus-wide (Waddle, 2013).

A similar system should be implemented at RRU, where staff currently have a garbage bin and a 'Blue Bin', into which all recyclables and refundables are placed. The fact that only these two bins are conveniently available makes it unlikely that staff will separate their compost, likely placing it in the garbage. In addition, the presence of these bins, especially the all-inclusive Blue

Bin and the sorting that goes along with it, is very time-consuming for the custodial staff. The removal of these bins entirely would cut down the workload of the custodial staff and strongly motivate the staff to use the sorting stations; increasing their knowledge on proper waste disposal.

Future waste audits should be completed on a more regular basis to track progress, and a template was made to make this easier to accomplish, instructions for which can be found in Appendix G. A few changes were added to the new template including the separation of the compostable containers from the food waste when measuring the contamination in the audited bags. This would be a more accurate portrayal of actual amount of compostable containers that are being improperly disposed of because their mass is quite small compared to food waste, but their volume makes up a significant portion of the total. These subcategories are summed at the bottom of the template, to allow for future comparisons to this study to be made. For future visual waste audits, they should commence directly after the respective bins are emptied and, if possible, continue until the next date it is emptied to give a more accurate value for the quantity and timeframe of generation and removal.

Due to the insufficient data provided by the contractors and the presence of confidential costs, a full cost analysis could not be completed by the Palindrome Group, and informed recommendations could not be made. However, to increase the efficiency of the waste system at RRU and diminishing the amount of fuel required in transportation, the Palindrome Group recommends taking on one contractor for all of the waste streams at RRU. Waste Management has shown that they are capable of taking on these responsibilities as they have proposed an excellent plan for RRU, and are currently utilized by UVic, who are very pleased with their service (Waddle, 2013).

While a concrete recommendation cannot be given with respect to an on-site composting system, from the research conducted thus far, it does appear to be a viable option that has the potential to save RRU money and reduce its ecological footprint. Further research must be undertaken to determine the exact requirements, accurate costs and potential impacts of such a system by personnel more knowledgeable in this field.

A final recommendation is for the continuation of research and waste audits to continually monitor any progress gained with the implementation of new systems, and to determine what changes or adaptations need to be made in the future. With such a fluctuating and diverse population of students, a simple answer to a comprehensive waste management system does not exist, and it must be flexible to accommodate this fact. Successive waste audits will function to track the changes in the level of waste divergence, with any increases or decreases in the rates from previous years acting as an indicator which could signify the successes, or failures, of any changes implemented. For this purpose, a waste audit template has been supplied which will allow for comparisons to be made in subsequent years (Appendix G).

12.0 Conclusion

The waste audits performed on RRU campus by the Palindrome Group revealed some glaring, but manageable, issues within the current system. The major issue is the amount of waste that is being improperly disposed of: around 50% of the waste every day is being placed into incorrect bins. This could be simply remedied by proper education of the users and by supplying more consistent signage, as stated in our recommendations. With this increase of proper disposal, the level of divergence would increase as well to approximately 80%, greatly lowering the impact of the campus' waste on the landfill. With this increase in proper disposal, the associated costs will change as well. The change in waste levels, increased compost and decreased garbage, will reduce the cost of the current waste system by close to $7,000, which could be utilized for further improvements to the waste management system, including research into the viability of an on-site composting system.

This project is merely one step in a long and continuous process to improve the efficiency of the waste management system at RRU. The findings and resulting recommendations contained within this document are to be utilized as a stepping stone for future improvements to aid in the success of the campus waste system. Continued research, education and adjustments to the current system should be supplemented with a tracking system that will allow the success, or failure, of any future changes to be gauged, and any needed modifications to be made. The ongoing monitoring and continual adjustments to the system, paired with proper education, will result in an overall reduction of RRUs footprint and an increase in its presence in the field of sustainability.

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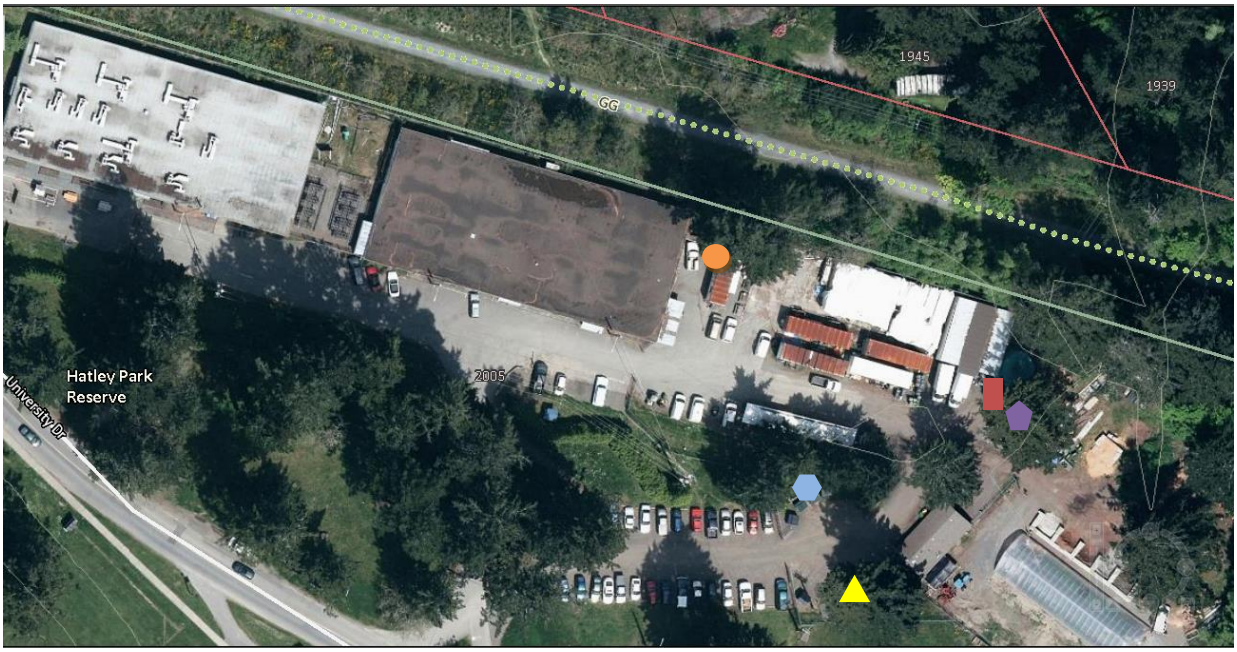
Appendices

Appendix A – Table of Figures

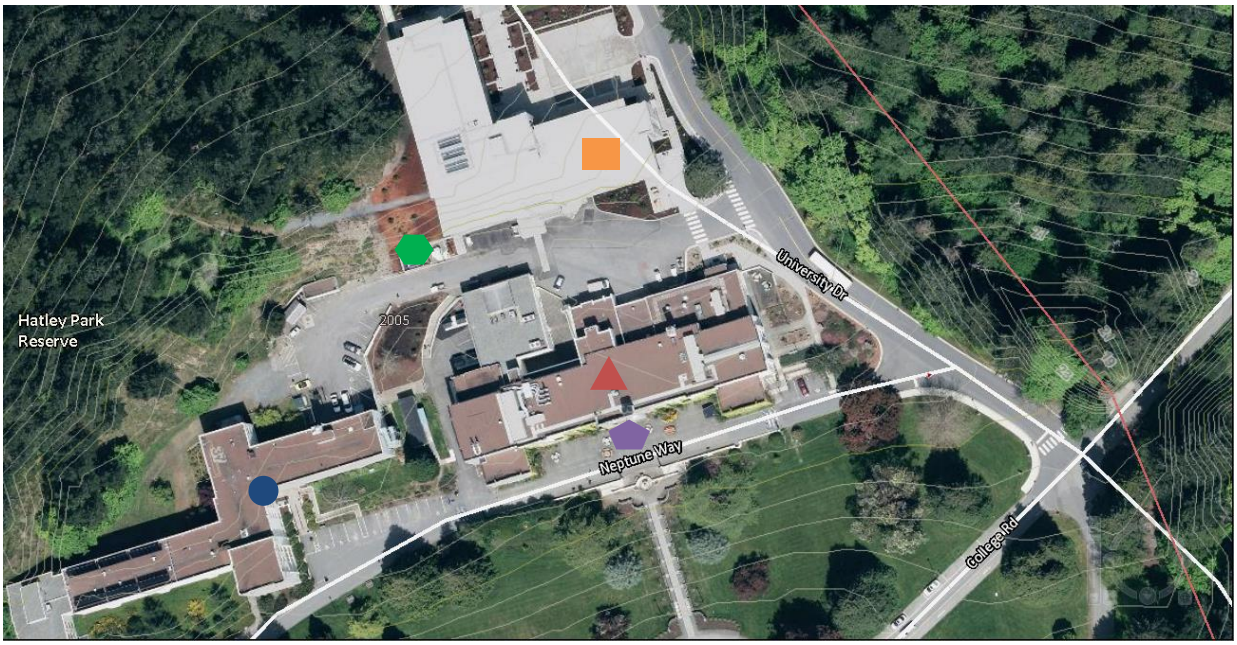
Appendix B – Site Maps

Upper Compound



Wood Waste Bin | Metal Waste Bin | 40 yard Garbage Bins | Waste Oil Bins | Garbage Bins

Core RRU Campus



Nixon Building | Grant Building | LIC | Audit/Waste Event Location | Lower Compound

Maps were obtained using CRD Natural Areas Atlas on July 9, 2013 (http://viewer.crdatlas.ca/public)

Appendix C – Survey 1

1) How important is recycling to you?
1(not important) 2 3 4 5 6(very important)

2) How easy do you find it to recycle at Royal Roads University?
1(easy) 2 3 4 5 6(hard)

3) How often do you recycle at home?
1(never) 2(sometimes) 3(often) 4(always) 5(I don't know)

4) How often do you compost at home?
1(never) 2(sometimes) 3(often) 4(always)

5) What bin would you put this item in? (when shown a variety of objects)
1(garbage) 2(compost) 3(refundable) 4(recyclable) 5(I don't know)

6) Do the waste containers make it clear as to what types of waste belong in each bin?
Yes/ no / sometimes
If no, how could this be improved?

Appendix D – Survey 2

1) Do the waste containers make it clear as to what types of waste belong in each bin?
If no, how could this be improved?

2) Is there a specific location on campus that makes it easier to properly dispose of waste than other locations?
If yes, where? Why?

3) Do you find some areas of the school lacking in proper disposal facilities?
If yes, where?

5) Is recycling important to you? Do you recycle at home?

6) Is composting important to you? Do you compost at home?

7) How would you rate the waste system in place at RRU?
1 – Poor 2 – Fair 3 – Good 4 – Very good 5 – Never thought about it
What would be one thing you would change about waste disposal on campus?

Appendix E - Survey 1 Results

Q1: How important is recycling to you?	
Importance	**# of Respondents**
1 (not important)	1
2	2
3	2
4	13
5	12
6 (very important)	20
Total	**50**

Q2: How easy do you find it to recycle at RRU?	
Difficulty	**# of Respondents**
1 (easy)	2
2	4
3	15
4	5
5	16
6 (hard)	8
Total	**50**

Q3: How often do you recycle at home?	
Frequency	**# of Respondents**
never	7
sometimes	4
often	11
always	28
Total	**50**

Q4: How often do you compost at home?	
Frequency	**# of Respondents**
never	23
sometimes	5
often	4
always	18
Total	**50**

Q5: What bin would you put this item in?							
Q5	**Item (H = from Habitat)**	**Garbage (1)**	**Compost (2)**	**Recyclable/ Refundable (3)**	**Mixed Paper (4)**	**I don't know (6)**	**Total**
a	**Juice Box**	4	0	22	0	0	50
b	**Paper Towel**	1	27	6	15	1	50
c	**Corrugated Cardboard**	5	9	23	11	2	50
d	**Newspaper**	2	3	0	18	27	50
e (H)	**Plastic Takeout Container**	5	13	24	4	4	50
f (H)	**Paper Takeout Container**	7	26	11	3	3	50
g (H)	**Takeout Fork**	13	22	8	4	3	50
h	**Foil-lined Wrapper**	27	7	11	5	0	50
I (H)	**Coffee Cup**	4	25	18	3	0	50
j (H)	**Coffee Lid**	10	27	12	0	1	50
k (H)	**Plastic Wrapping**	26	8	9	0	7	50
l (H)	**Coffee Sleeve**	0	13	23	13	1	50

Q6a: Do the bins make it clear as to what to put in each bin?	
Response	**# of Respondents**
yes	12
no	16
sometimes	22

Q6b: How could the waste containers be more clear as to what types of waste belong in each bin?
uniform bins
signs are helpful
a sign in the cafeteria - should be like LIC, or color-coded and in same order all the time
depends on where you are, better signage and communication
pictures to show what goes in what bin
there needs to be a compost bin in the cafeteria. LIC is good, Nixon is bad
midget pop up and tell you where to put your waste
more awareness- new employee orientation. More promotion and education
signage important - not as many containers. Corn products GMO- get people to bring own container
too small compost bins in offices for takeout containers, and not many available (some people know to compost but can't fit it in the bins. Need more information in the cafeteria- they are doing so many good things, but no one is taking advantage of them - seems like a waste
signage
take the materials in Habitat and have signage for them in the cafeteria - make it relevant for RRU
examples of pictures on bin (specific to RRU)
signs for international students- LIC difficult, pictures would help.
More/better signage
Consistent signage
Better labels/ more definition of products
more awareness- new employee orientation. More promotion and education
uniform bins/ better signage
Singular area that has all types of bins
more colourful larger labels on containers that show it's compostable
bins could have the PS numbers and better signage
simplified system - less confusing
stickers on the items that you purchase from the cafeteria
pictures/colours
labels on all bins with descriptive pictures
more signage - pictures and pamphlets
more compost bins, split refunds and plastics, better signage
more education
more bins in some areas, signage
clearer explanation of what's what - clearer signs, I'm confused
more detailed pictures
clearer signage, put in more compost
pictures are great
board above each bin with examples
more signs with better descriptions
more options for bins in the offices
more education
clearer signage, same bins in all locations
more compost, more bins in the cafeteria
more signage

Appendix F – Survey 2 Results

Question	Yes	No
Q1: Do the waste containers make it clear as to what types of waste belong in each bin?	19	31
Q2: Is there a specific location on campus that makes it easier to properly dispose of waste than other locations?	29	21
Q3: Do you find some areas of the school lacking in proper disposal facilities?	42	8
Q4: Is recycling important to you?	46	4
Q5: Is composting important to you?	28	22

Q6: How would you rate the waste system in place at RRU?				
Poor	**Fair**	**Good**	**Very Good**	**Never thought about it**
1	7	33	7	2

Q7: What would be one thing you would change about waste disposal on campus?
More consistency
More bins outside
Put some recycling bins outside with garbage cans and more around campus
More bins for recycling and garbage on campus
New here so no comment
The bins must be more consistent
Make the bins larger and more accessible, and better signage on the bins
More bins
More compost bins
Labelling
Labelling
Parking lot bins
Descriptions of where waste goes
Consistency, encourage cell phone waste, e wastes, battery wastes
Have same bins, consistency of bins, and communication
Consistent and better signage
Education on proper knowledge
More consistency through the campus of bins
More compost bins and more signs
Making it uniform, discourage the use of garbage bins for diversions
Appropriate signage for communication have designated areas for composting, recycling wastes
More awareness notifying students on green practices
Awareness, promotion, communication
More consistent bin, isolate areas that make waste, also communicate better
Improve bin consistency
Easier access to get rid of composting. Everywhere on campus with consistent bins with big signs to help communicate
More composting, accepting more for recycling and better bins for it.
More education, proper facilities more informative to give information
Uniformity in the bins
More signs, uniformity
Knowledge and awareness programs
Consistency
Properly labelled bins
More signage and better labels
Uniform bins and proper labels
Education programs at beginning of semesters
More knowledge, more bins
Signage and labels
More education and knowledge on importance of waste diversion
Posters around the school, better labels on bins
Have more than one bin at certain areas
Signs and more bins
Better signage

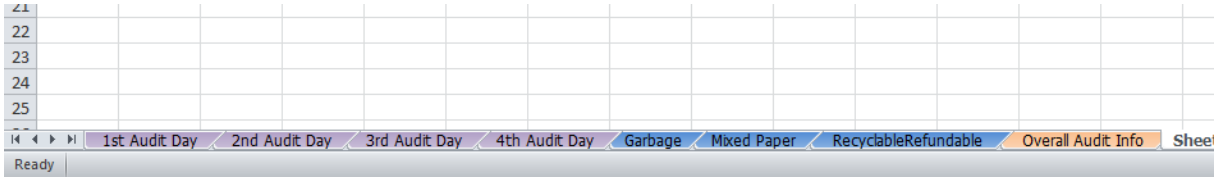
Appendix G – Waste Audit Template

Template directions are to be used in conjunction with waste audit methods (section 7.4.2) of the 2013 RRU Waste Audit report. For clarification on the categorization of specific items, please consult Darren Gardham.

Waste audit template tabs are colour coordinated for ease of use. **Purple tabs** are for each waste audit conducted (e.g. '1st Audit Day', '2nd Audit Day', etc.). If more than four waste audits are conducted, right click '4th Audit Day' tab, click 'Move or copy...', check the box 'Create a copy' and click 'Okay'. Right click and rename tab as '5th Audit Day'.

Blue tabs ('Garbage', 'Mixed Paper', 'Recyclable/Refundable') are tabs to input spot check data collected. It is recommended that spot checks be conducted on every 4th garbage bag and every 2nd mixed paper and recyclable/refundable bag. Spot checks for compost bags are not recommended due to sanitation concerns.

Orange tab ('Overall Audit Info') is used to determine the amount of improperly disposed of waste and the diversion rate.



Equations to cells are outlined on page 3 and 4**.**

Data Entry

1. Enter the weight of each bag (G=Garbage, C=Compost, P=Mixed Paper, R=Recyclable/Refundable) from waste audit into corresponding Excel tab ('1st Audit Day', '2nd Audit Day', '3rd Audit Day', etc.). To insert more rows, highlight the 'Total' row, right click and click 'Insert'.

Weight (kg) of individual waste streams							
Bag	Overall Weight (kg)	Bag	Overall Weight (kg)	Bag	Overall Weight (kg)	Bag	Overall Weight (kg)
G1		R1		P1		C1	
G2		R2		P2		C2	
G3		R3		P3		C3	
G4		R4		P4		C4	
Total	**0**	**Total**	**0**	**Total**	**0**	**Total**	**0**

2. Enter breakdown of spot check bags into their corresponding tabs – 'Garbage', 'Mixed Paper', or 'RecyclableRefundable' (e.g. Garbage spot check (bag G4) entered into 'Garbage' tab).

9													
10	**Garbage 1st Audit Day**												
11	Spot Checks (bag)	Overall Weight (kg)	Compost (kg)		Soft Plastic (kg)	Mixed Paper (kg)	Corrugated Cardboard (kg)	Recyclables (kg)	Refundables (kg)			Garbage (kg)	Improperly Disposed (kg)
12			Compostable Containers	Food/Paper Towel					Tin/ Aluminum	Plastic	Glass		
13	G4	0											0
14	G8	0											0
15	G12	0											0
16	**Total**	0	0	0	0	0	0	0	0	0	0	0	0
17	Overall Total	0	0		0	0	0	0	0			0	0

3. Cells in ‘Overall Audit Info’ tab will be automatically updated with data from purple and blue tabs.

Equations

'1st Audit Day' Tab

	A	B	C	D	E	F	G	H
10	Weight (kg) of individual waste streams							
11	Bag	Overall Weight (kg)	Bag	Overall Weight (kg)	Bag	Overall Weight (kg)	Bag	Overall Weight (kg)
12	G1		R1		P1		C1	
13	G2		R2		P2		C2	
14	G3		R3		P3		C3	
15	G4		R4		P4		C4	
16	**Total**	**=SUM(B12:B15)**	**Total**	**=SUM(D12:D15)**	**Total**	**=SUM(F12:F15)**	**Total**	**=SUM(H12:H15)**
17								

'Garbage' Tab

	A	B	C	D	E	F	G	H	I	J	K	L	M
10	Garbage 1st Audit Day												
11	Spot Checks (bag)	Overall Weight (kg)	Compost (kg)		Soft Plastic (kg)	Mixed Paper (kg)	Corrugated Cardboard (kg)	Recyclables (kg)	Refundables (kg)			Garbage (kg)	Improperly Disposed (kg)
12			Compostable Containers	Food/Paper Towel					Tin/ Aluminum	Plastic	Glass		
13	G4	=SUM(C13:L13)											=(B13-L13)
14	G8	=SUM(C14:L14)											=(B14-L14)
15	G12	=SUM(C15:L15)											=(B15-L15)
16	**Total**	=SUM(B13:B15)	=SUM(C13:C15)	=SUM(D13:D15)	=SUM(E13:E15)	=SUM(F13:F15)	=SUM(G13:G15)	=SUM(H13:H15)	=SUM(I13:I15)	=SUM(J13:J15)	=SUM(K13:K15)	=SUM(L13:L15)	=SUM(M13:M15)
17	Overall Total	=B16	=SUM(C16:D16)		=E16	=F16	=G16	=H16	=SUM(I16:K16)			=L16	=M16
18													

'Mixed Paper' Tab

	A	B	C	D	E	F	G	H	I	J	K	L	M
10	Mixed Paper 1st Audit Day												
11	Spot Checks (bag)	Overall Weight (kg)	Compost (kg)		Soft Plastic (kg)	Mixed Paper (kg)	Corrugated Cardboard (kg)	Recyclables (kg)	Refundables (kg)			Garbage (kg)	Improperly Disposed (kg)
12			Compostable Containers	Food/Paper Towel					Tin/ Aluminum	Plastic	Glass		
13	P2	=SUM(C13:L13)											=(B13-(F13+G13))
14	P4	=SUM(C14:L14)											=(B14-(F14+G14))
15	P6	=SUM(C15:L15)											=(B15-(F15+G15))
16	**Total**	=SUM(B13:B15)	=SUM(C13:C15)	=SUM(D13:D15)	=SUM(E13:E15)	=SUM(F13:F15)	=SUM(G13:G15)	=SUM(H13:H15)	=SUM(I13:I15)	=SUM(J13:J15)	=SUM(K13:K15)	=SUM(L13:L15)	=SUM(M13:M15)
17	Overall Total	=B16	=SUM(C16:D16)		=E16	=F16	=G16	=H16	=SUM(I16:K16)			=L16	=M16

‘Recyclable/Refundable’ Tab

	A	B	C	D	E	F	G	H	I	J	K	L	M
10	Recyclable/Refundable 1st Audit Day												
11	Spot Checks (bag)	Overall Weight (kg)	Compost (kg)		Soft Plastic (kg)	Mixed Paper (kg)	Corrugated Cardboard (kg)	Recyclables (kg)	Refundables (kg)			Garbage (kg)	Improperly Disposed (kg)
12			Compostable Containers	Food/Paper Towel					Tin/ Aluminum	Plastic	Glass		
13	R2	=SUM(C13:L13)											=(B13-(I13+H13+J13+K13+E13))
14	R4	=SUM(C14:L14)											=(B14-(I14+H14+J14+K14+E14))
15	R6	=SUM(C15:L15)											=(B15-(I15+H15+J15+K15+E15))
16	**Total**	=SUM(B13:B15)	=SUM(C13:C15)	=SUM(D13:D15)	=SUM(E13:E15)	=SUM(F13:F15)	=SUM(G13:G15)	=SUM(H13:H15)	=SUM(I13:I15)	=SUM(J13:J15)	=SUM(K13:K15)	=SUM(L13:L15)	=SUM(M13:M15)
17	Overall Total	=B16	=SUM(C16:D16)		=E16	=F16	=G16	=H16	=SUM(I16:K16)			=L16	=M16

‘Overall Audit Info’ Tab

	A	B	C	D	E	F	G	H	I	J	K
1	**Breakdown of individual waste streams per kg of waste from RRU, YEAR**										
2	**Date**	**Overall Weight (kg)**	**Compost (kg)**	**Mixed Paper (kg)**	**Recyclable/ Refundable (kg)**	**Misc. (kg)**	**Garbage (kg)**	**Improperly Disposed of Waste (kg)**	**Diversion Rate**	**Average kg/person**	**People on Campus**
3	1st Audit Day	=SUM(C3:G3)	='1st Audit Day'!H16	='1st Audit Day'!F16	='1st Audit Day'!D16	0	='1st Audit Day'!B16	=(B3*G12)/100	=(SUM(C3:F3)/B3)*100	=B3/K3	
4	2nd Audit Day	=SUM(C4:G4)	='2nd Audit Day'!H16	='2nd Audit Day'!F16	='2nd Audit Day'!D16	0	='2nd Audit Day'!B16	=(B4*G13)/100	=(SUM(C4:F4)/B4)*100	=B4/K4	
5	3rd Audit Day	=SUM(C5:G5)	='3rd Audit Day'!H16	='3rd Audit Day'!F16	='3rd Audit Day'!D16	0	='3rd Audit Day'!B16	=(B5*G14)/100	=(SUM(C5:F5)/B5)*100	=B5/K5	
6	4th Audit Day	=SUM(C6:G6)	='4th Audit Day'!H16	='4th Audit Day'!F16	='4th Audit Day'!D16	0	='4th Audit Day'!B16	=(B6*G15)/100	=(SUM(C6:F6)/B6)*100	=B6/K6	
7	**Avg. kg/day**	**=AVERAGE(B3:B6)**	**=AVERAGE(C3:C6)**	**=AVERAGE(D3:D6)**	**=AVERAGE(E3:E6)**	0	**=AVERAGE(G3:G6)**	**=AVERAGE(H3:H6)**	**=AVERAGE(I3:I6)**	**=AVERAGE(J3:J6)**	**N/A**
8	**Avg. annual kg**	**=B7*365**	**=C7*365**	**=D7*365**	**=E7*365**	0	**=G7*365**	**=H7*365**	**N/A**	**=J7*365**	**N/A**
9											

	A	B	C	D	E	F	G
10	**Breakdown (%) of individual waste streams from RRU, YEAR**						
11	**Date**	**Compost**	**Mixed Paper**	**Recyclable/ Refundable**	**Misc.**	**Garbage**	**Improperly Disposed of Waste**
12	1st Audit Day	=(C3/B3)*100	=(D3/B3)*100	=(E3/B3)*100	=(F3/B3)*100	=(G3/B3)*100	=((Garbage!M17/Garbage!B17)+('Mixed Paper'!M17/'Mixed Paper'!B17)+(RecyclableRefundable!M17/RecyclableRefundable!B17))*100
13	2nd Audit Day	=(C4/B4)*100	=(D4/B4)*100	=(E4/B4)*100	=(F4/B4)*100	=(G4/B4)*100	=((Garbage!P17/Garbage!AA17)+('Mixed Paper'!P17/'Mixed Paper'!AA17)+(RecyclableRefundable!P17/RecyclableRefundable!AA17))*100
14	3rd Audit Day	=(C5/B5)*100	=(D5/B5)*100	=(E5/B5)*100	=(F5/B5)*100	=(G5/B5)*100	=((Garbage!M31/Garbage!B31)+('Mixed Paper'!M31/'Mixed Paper'!B31)+(RecyclableRefundable!M31/RecyclableRefundable!B31))*100
15	4th Audit Day	=(C6/B6)*100	=(D6/B6)*100	=(E6/B6)*100	=(F6/B6)*100	=(G6/B6)*100	=((Garbage!P31/Garbage!AA31)+('Mixed Paper'!P31/'Mixed Paper'!AA31)+(RecyclableRefundable!P31/RecyclableRefundable!AA31))*100
16	**Average**	**=AVERAGE(B12:B1**	**=AVERAGE(C12:C15)**	**=AVERAGE(D12:D15)**	**=AVERAGE(E12:E15)**	**=AVERAGE(F12:F15)**	**=AVERAGE(G12:G15)**
17							

Appendix H – Primary Waste Audit Data

Breakdown of individual waste streams (kg) from Royal Roads University, 2013									
Date	**Overall Weight (kg)**	**Compost (kg)**	**Plastic (kg)**	**Mixed Paper (kg)**	**Misc. (kg)**	**Waste (kg)**	**Diversion rate**	**Improperly disposed waste (kg)**	**Average Kg/person**
09-Apr	253.55	83.80	9.65	54.29	6.5	99.31	60.83	172.19	0.34
16-Apr	211.49	78.20	7.81	32.05	0	89.02	55.82	126.98	0.28
23-Apr	285.34	122.40	9.41	69.67	0	83.85	70.61	98.34	0.42
30-Apr	262.23	104.10	2.61	70.49	0	85.02	67.58	123.17	0.31
Ave. kg/day	253.15	97.13	7.37	56.63	1.63	89.30	-	130.17	0.33
Ave. annual kg	92400.90	35450.63	2690.67	20669.74	593.13	32594.17	-	47511.58	121.73

Breakdown (%) of individual waste streams from Royal Roads University, 2013						
Date	**Compost**	**Plastic**	**Mixed Paper**	**Misc.**	**Waste**	**Improperly disposed waste (kg)**
09-Apr	33.05	3.81	21.41	2.56	39.17	67.91
16-Apr	36.98	3.69	15.15	0.00	42.09	60.04
23-Apr	42.90	3.30	24.42	0.00	29.39	33.90
30-Apr	39.70	0.99	26.88	0.00	32.42	46.97
Average	38.16	2.95	21.97	0.64	35.77	52.20

Weight (kg) of garbage bags analyzed for primary waste audit										
Bag	Weight	Compost	Soft Plastic	Mixed Paper	Corrugated Cardboard	Refundables	Recyclables	Garbage	Other	Date Conducted
G4	3.6	1.4			0.4			1.8		09-Apr-13
G8	8.989	3.2	0.05	0.1	0.8	0.039	4.1	0.7		09-Apr-13
G16	3.151	0.3	0.21	0.52		0.011	0.1	1.9		09-Apr-13
G21	6.48	3.9	0.1	0.5			0.1	1.8		09-Apr-13
G28	0.56	0.05					0.01	0.5		09-Apr-13
G4	3.8	1.8	0.1	0.5		0.2	0.5	1.2		16-Apr-13
G8	5.63	4.2	0.1			0.03	0.4	0.9		16-Apr-13
G12	4.1	2.4	0.1	0.1		0.1	0.1	1.3		16-Apr-13
G16	1.16	0.25	0.01	0.5		0.02	0.08	0.3		16-Apr-13
G20	2.634	1.4	0.004	0.2		0.03	0.7	0.5		16-Apr-13
G24	1.16	0.7	0.1	0.02		0	0.3	0.04		16-Apr-13
G28	3.08	1.4	0.05	0.1		0.01	0.92	0.6		16-Apr-13
G32	2.301	0.8	0.3	0.5	0.001		0.11	0.5		16-Apr-13
G36	2.051	1.6	0.2	0.05			0.001	0.2		16-Apr-13
G4	2.52	1.19	0.02	0.5			0.11	0.7		23-Apr-13
G8	2.35	1.9		0.15			0.1	0.2		23-Apr-13
G12	1.812	1.29	0.07	0.25			0.002	0.2		23-Apr-13
G16	5.062	3.85	0.2	0.2			0.212	0.6		23-Apr-13
G20	5.087	2.4	0.3	0.3		0.037	0.65	1.4		23-Apr-13
G24	1.7962	1.4	0.076	0.015			0.0052	0.3		23-Apr-13
G28	0.9917	0.8	0.0912	0.0438			0.051	0.0057		23-Apr-13
G32	1.213	0.8	0.0072	0.3			0.0058	0.1		23-Apr-13
G36	2.67	2.1	0.01	0.3		0.06		0.2		23-Apr-13
G4	2.9388	1.8		0.1		0.122	0.0168	0.9		30-Apr-13
G8	2.1545	0.7	0.012				0.011	0.4	0.4	30-Apr-13
G12	3.3877	2.7	0.035	0.1		0.0263	0.0264	0.5		30-Apr-13
G16	2.1941	1	0.031	0.08		0.0247	0.0584	1		30-Apr-13
G20	0.7074	0.2		0.0074				0.5		30-Apr-13
G24	1.7179	1.1	0.0229	0.059			0.036	0.5		30-Apr-13
G32	2.4183	0.121		0.063		0.428	0.0063	1.8		30-Apr-13
G36	3	1.1	0.3	0.2			0.9	0.5		30-Apr-13
Total	90.7166	47.851	2.4993	5.7582	1.201	1.138	9.6119	22.0457	0.4	

Weight (kg) of mixed paper bags analyzed for primary waste audit										
Bag	**Weight**	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**	**Other**	**Date Conducted**
P2	3				1	0.1	1.9			09-Apr-13
P3	1.6	0.5		0.3	0.5			0.3		09-Apr-13
P8	4.69		0.15	4.5			0.03	0.01		09-Apr-13
P2	0.92		0.02	0.9						16-Apr-13
P4	1.8			1.8						16-Apr-13
P6	3.312			3.1	0.1	0.1	0.075			16-Apr-13
P8	1.13			1.1		0.03	0.001			16-Apr-13
P2	3.9	0.2		3.7						23-Apr-13
P4	2.3			2.3						23-Apr-13
P6	0.6	0.1		0.5						23-Apr-13
P8	9.3			9.3						23-Apr-13
P10	8.898		0.2	8.5				0.198		23-Apr-13
P12	9.06	0.002	0.058	8	1					30-Apr-13
P2	2.4		2	0.4						30-Apr-13
P4	0.6028		0.0028	0.6						30-Apr-13
P6	5.808			5.5	0.29		0.0014	0.004		30-Apr-13
P8	1.2			0.5	0.7					30-Apr-13
P10	1.5			0.5	1					30-Apr-13
P12	2.489			2.4	0.089					30-Apr-13
Total	64.5098	0.802	2.4308	53.9	4.679	0.23	2.0074	0.512	0	

Weight (kg) of recyclable/refundable bags analyzed for primary waste audit										
Bag	**Weight**	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**	**Other**	**Date Conducted**
R2	1.55	0.1					1.3	0.15		09-Apr-13
R2	1.61	0.01	0.05	0.03			1.42	0.1		16-Apr-13
R2	3.113						3.113			23-Apr-13
R1	2.614			1.1	0.242	0.152	0.4			30-Apr-13
Total	8.887	0.11	0.05	1.13	0.242	0.152	6.233	0.25	0	

Improperly disposed of waste determined from spot checks				
Type	**In**	**Percent**	**Total**	**Amount**
Compost	Garbage	0.53	90.7166	48.0798
Compost	Recycling	0.01	8.887	0.08887
Compost	Paper	0.01	64.5098	0.645098
Waste	Paper	0.01	64.5098	0.645098
Waste	Recycling	0.03	8.887	0.26661
Recycling	Garbage	0.11	90.7166	9.978826
Recycling	Paper	0.03	64.5098	1.935294
Paper	Garbage	0.06	90.7166	5.442996
Paper	Recycling	0.14	8.887	1.24418
Refundables	Garbage	0.01	90.7166	0.907166
Refundables	Paper	0.0035	64.5098	0.225784

Appendix I – Secondary Waste Audit Data

Amount (%) of waste types from each waste stream in different buildings on RRU Campus							
Building	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**
Grant Compost	98.44	0.00	0.07	0.00	0.15	0.32	1.14
Grant Refundables	7.43	1.07	1.66	0.00	14.55	68.39	6.89
Grant Garbage	48.5	0.24	1.76	0.00	0.40	5.4	44.6
Grant Mixed Paper	20.05	0.00	77.72	0.00	0.00	1.55	0.67
LIC Compost	99.65	0.00	0.07	0.00	0.00	0.15	0.23
LIC Refundables	37.01	0.00	0.00	0.00	61.72	0.47	0.81
LIC Garbage	55.08	4.28	0.00	0.00	0.00	3.77	36.87
LIC Mixed Paper	0.00	0.27	91.77	0.00	0.00	0.00	7.95
Nixon Refundables	2.49	0.00	0.27	0.00	61.67	35.58	0.00
Nixon Mixed Paper	2.85	0.00	92.44	0.00	2.33	2.38	0.00
Nixon Garbage	61.18	0.00	0.97	0.00	0.00	4.21	33.65

Weight (kg) of Grant bags analyzed for secondary audit (G=Garbage, C=Compost, Rf= Recyclable/Refundable, MP= Mixed Paper)								
Buildings	**Overall**	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**
Grant C	1.206	1.2					0.001	0.005
Grant C	3.354	3.3				0.01	0.013	0.031
Grant C	1.28	1.25						0.03
Grant C	1.017	1		0.0047			0.008	0.0123
Total	6.857	6.75		0.0047		0.01	0.022	0.0783
Buildings	**Overall**	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**
Grant Rf	0.961	0.092	0.014				0.8	0.055
Grant Rf	0.212					0.1	0.085	0.027
Grant Rf	0.103	0.005				0.09		0.008
Grant Rf	0.0297			0.0217			0.008	
Total	1.3057	0.097	0.014	0.0217	0	0.19	0.893	0.09
Buildings	**Overall**	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**
Grant G	0.8471	0.44		0.063			0.143	0.2
Grant G	0.96	0.75					0.029	0.2
Grant G	1.1086	0.2	0.0086					0.9
Grant G	0.6728	0.35				0.0142	0.0086	0.3
Total	3.5885	1.74	0.0086	0.063	0	0.0142	0.1806	1.6
Buildings	**Overall**	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**
Grant MP	0.1			0.1				
Grant MP	0.111	0.101					0.01	
Grant MP	0.2			0.2				
Grant MP	0.2323	0.028		0.2				0.0043
Total	0.6433	0.129	0	0.5	0	0	0.01	0.0043

Weight (kg) of LIC bags analyzed for secondary audit (G=Garbage, C=Compost, Rf= Recyclable/Refundable, MP= Mixed Paper)								
Buildings	**Overall**	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**
LIC C	0.0575	0.0575						
LIC C	0.503	0.5					0.001	0.002
LIC C	0.2	0.2						
LIC C	0.1	0.1						
Total	0.8605	0.8575	0	0	0	0	0.001	0.002
Buildings	**Overall**	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**
LIC Rf	0.1512	0.0615				0.0897		
LIC Rf	0.949	0.2				0.73	0.007	0.012
LIC Rf	0.26	0.2				0.06		
LIC Rf	0.13	0.09				0.04		
Total	1.4902	0.5515	0	0	0	0.9197	0.007	0.012
Buildings	**Overall**	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**
LIC MP	0.066			0.066				
LIC MP	0.0584		0.0014	0.057				
LIC MP	0.191			0.15				0.041
LIC MP	0.2			0.2				
Total	0.5154	0	0.0014	0.473	0	0	0	0.041
Buildings	**Overall**	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**
LIC G	0.1	0.1						
LIC G	0.12	0.014					0.006	0.1
LIC G	0.113	0.013						0.1
LIC G	0.2607	0.2	0.0254				0.0164	0.0189
Total	0.5937	0.327	0.0254	0	0	0	0.0224	0.2189

Weight (kg) of Nixon bags analyzed for secondary audit (G=Garbage, Rf= Recyclable/Refundable, MP= Mixed Paper)								
Buildings	**Overall**	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**
Nixon G	0.1	0.1						
Nixon G	1.114	0.6		0.004			0.11	0.4
Nixon G	0.7013	0.3		0.0013				0.4
Nixon G	0.7	0.6		0.02				0.08
Total	2.6153	1.6	0	0.0253	0	0	0.11	0.88
Buildings	**Overall**	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**
Nixon MP	0.4294			0.4		0.0294		
Nixon MP	0.77	0.02		0.75				
Nixon MP	0.063	0.016		0.017			0.03	
Total	1.2624	0.036	0	1.167	0	0.0294	0.03	0
Buildings	**Overall**	**Compost**	**Soft Plastic**	**Mixed Paper**	**Corrugated Cardboard**	**Refundables**	**Recyclables**	**Garbage**
Nixon Rf	0.0995	0.0054				0.09	0.0041	
Nixon Rf	1.146	0.041		0.005		0.6	0.5	
Nixon Rf	0.121					0.061	0.06	
Nixon Rf	0.5					0.4	0.1	
Total	1.8665	0.0464	0	0.005	0	1.151	0.6641	0

Appendix J – Cost Breakdown of Waste Management at RRU

Cost of Waste Management at RRU from 2009-2012			
Waste Stream	**Year**		
	2009-2010	**2010-2011**	**2011-2012**
BFI(Waste)	$ 19,096.07	$ 21,699.73	$ 22,774.39
reFUSE	$ 2,805.67	$ 3,354.34	$ 7,898.95
BFI(Recyling)	$ 12,023.76	$ 7,744.37	$ 8,396.68
Pacific Mobile	$ 415.85	$ 1,318.05	$ 2,234.84
Alpine	$ 3,970.20	$ 7,569.82	$ 4,326.00
Recycling/Compost	$ 19,215.48	$ 19,986.58	$ 22,856.47
Total	$ 38,311.55	$ 41,686.31	$ 45,630.86

Alpine Group Cost Breakdown						
Removal Price	**Bin Size**	**Frequency**	**Month to Month**	**3 year term**	**5 year term**	**Cost (extra Pick up)**
Garbage (Hartland)	2 * 6 yard	1st Bin	$259.00	$255.00	$249.00	
		1st Bin	On Demand/As Required			$60
		2nd Bin	$25BR	$22.50BR	$20BR	$60
Cardboard (Cascade Recovery)	2 * 6 yard	1st Bin 2nd Bin	$65.00 $25.00BR	$60.00 $22.50	$50.00 $20.00	$20.00 per pick up
Glass/Tin /Plastic (Cascade Recovery)	8 * 96 gal	1 * week	$96.00	$88.00	$72.00	$25.00
Wood (Ground Alpine biofuel)	14 yard	On call	$90.00BR	$85.00BR	$80.00	$90.00/ removal $140/tonne
Refundable Bottles (Encorp, Return-It)	64 gal	On call	-	-	-	Refund (Minus $15.00)
Glass/Tin/Plastic (6 totes.. 2*/week – 6	6 totes (0.5 yards)	2*/week	$120.00	$110.00	$96.00	$20.00

yard)						
Multi item: Mixed Paper Metals Soft Plastics Styrofoam Paint Disposal E-Waste	14 yard	On-call	$90.00BR	85.00BR	80.00BR	$90/ removal

BR = Bin Rental

Alpine Group Sub-contractors for Different Waste Streams	
Contractor	**Waste**
Call 2 recycle	Batteries
LightRecycle	Lights and light fixtures
Product Care Plus	Paint, pesticides and fuel
Encorp Return-It Center	Refundable containers and milk cartons
Car Battery Recycle	Car batteries
Alarm Recycle	Smoke alarms
Outdoor Power equipment Recycle program	Any outdoor power equipment
Alpine Electronics	E-waste

reFUSE Cost Breakdown for Organics			
Bin	**Per pick up**	**Per pick up (Pay as you go credits involved)**	**Refund**
48 L (Kitchen scraps only)	$25.00 /every 2 weeks	$15.00/ 4 weeks	-
120L 240L (Kitchen / yard waste)	$25.00/pick up	$20.00/pick up when pre-paid for 6 or more pick ups	$95.00
360L Kitchen / Yard Waste	$25.00/Pick up	$22.50/Pick up when pre pay for 6 or more pick ups	$95.00

reFUSE Cost Breakdown of General Waste Streams		
Waste Types	Bag Type	Cost
Soft Plastics	(bagged - 35”x50” equivalent)	$6/bag
Styrofoam	(bagged - 35”x50” equivalent)	$6/bag
Foil-Lined Packaging	(bagged - 35”x50” equivalent)	$6/bag
Combination of any of the above	Any	$20/4 bags
E-Waste/Small Appliances/Toys	-	$2.50/item
Bicycle Tires (includes one tube per tire)	-	$0.75/tire
Mixed Rigid Containers	(bagged - 35”x50” equivalent)	$5/bag
Glass/Metal/Plastics	(must be in bag or bucket)	$0.10/kg
Oversize Hard Plastics	-	$4/item
Baby Car Seats	-	$10
Scrap Metal	-	Free
Household Batteries	-	Free
Fluorescent Tubes, All Bulbs, Fixtures and Non-PCB Ballasts	-	Free
Wood Pallets	-	$5/ea.
Used Cooking Oil	16L Container	$5/16L container

- DEPOT PRICE LIST –

Effective March 2013

Ellice RECYCLE LTD.
www.ellicerecycle.com

Mailing address: PO Box 907 Victoria, BC V8W 2R9

Enter at 524 David St.
Phone: 250 386-4342
Fax: 250 386-4377

Winter Hours: 7:30 a.m. - 5:00 p.m. Mon. to Fri.
8:30 a.m. - 5:00 p.m. Sat.
8:30 a.m. - 5:00 p.m. Sun. Closed Holidays

RECYCLING FACILITY USER FEE
$9.52 per VISIT + GST

- NUMBER 1 - 7 RIGID PLASTICS
- CARDBOARD (Corrugated)
- MIXED WASTE PAPER (Includes brown paper, cereal boxes, and egg cartons)
- GLASS JARS
- NEWSPAPER (Includes inserts)
- OFFICE PAK (Includes ledger and computer paper, envelopes, etc. NO CARBON PAPER)

Buy a Recycling Card for $38.10 and your fifth visit is FREE

NON-CHARGEABLE ITEMS

- ALL NON-FERROUS METALS
- CAR BATTERIES
- EMPTY PAINT CANS
- TIN CANS/STEEL
- PAINT, PESTICIDES, SOLVENTS (see attendant)
- GASOLINE (Only in ULC approved containers)

CHARGEABLE ITEMS

- *LARGE APPLIANCES (Stove, washer/dryer, dish washer) ..... $9.00 PER ITEM plus gst*
- *FRIDGES OR FREEZERS ..... $30.00 PER ITEM plus gst*
- *PROPANE TANKS (**Emptied** Refillable Only) ..... $9.00 PER ITEM plus gst*
- *TV OR MONITOR RECYCLING ..... $5.00 each 40" & UNDER plus gst*
  $7.00 each 41" & OVER plus gst
- *REFUSE / GARBAGE ..... $192.00 PER TONNE ..... $18.33 MIN plus gst*
- *REFUSE – OVERSIZE ..... $15.00 EACH ITEM per load*
  (e.g. Sofas, mattresses, etc.) PLUS weight charges
- *CARPET and UNDERLAY ..... $192.00 PER TONNE ..... $18.33 MIN plus hst*
  Plus $10.00 per 100kg. Handling Fee
- *WOOD ..... $192.00 PER TONNE ..... $18.33 MIN plus gst*
- *YARD and GARDEN ..... $120.00 PER TONNE ..... $26.67 MIN plus gst*
- *DRYWALL ..... $250.00 PER TONNE ..... $30.48 MIN plus gst*
- *CLEAN PANE GLASS ..... $192.00 PER TONNE ..... $18.33 MIN plus gst*
- *FLUORESCENT TUBES ..... $1.25 EACH plus gst*
- *SELF-SERVE PAPER SHREDDING ..... $15.00 Usage Fee + $9.60 Per Tote plus gst*
- *SOFT PLASTICS or ..... $5.00 MIN (Lrg garbage bag) plus gst*
  STYROFOAM (Clean only, white only) $10.00 PER 360L BAG OR TOTE plus gst
- *FLARES ..... $1.00 EACH plus gst (small gun type)*
  $4.00 EACH plus gst (med. hand held type)
  $9.00 EACH plus gst (large rocket type)

✓ We Buy Non-Ferrous Metals

Ellice Service Cost Breakdown		
Service Category	**Fee**	**Comment**
Mixed paper pick up	$2.50 / tote	120 litre tote ($5 / 360 litre tote) Weekly
Garbage pick up	$8.00 / tote	Two totes at site Weekly, both totes
Other recyclables	$3	Metal, plastic, cardboard, Styrofoam Weekly
Organics/compostables	$2	Bi-weekly (Finished compost available for purchase at discounted rates)
Special service fee	$10 / pickup	For extra pickups, per customer request Category fees still apply
Shredding	$38 / hr	Labour fee

Appendix K – Waste Contractor Interview Questions

Questions for contractors that are currently with RRU:

- What type of waste do the contractors deal with?
- What is the end result of the product? Here does the product go?
- If there is any contamination in the waste streams, is the bag/bin sorted or disposed of as waste? (e.g. Plastic in mixed paper bin)
- Is there a specific type of contaminant in the waste streams?

Questions for potential contractors with RRU:

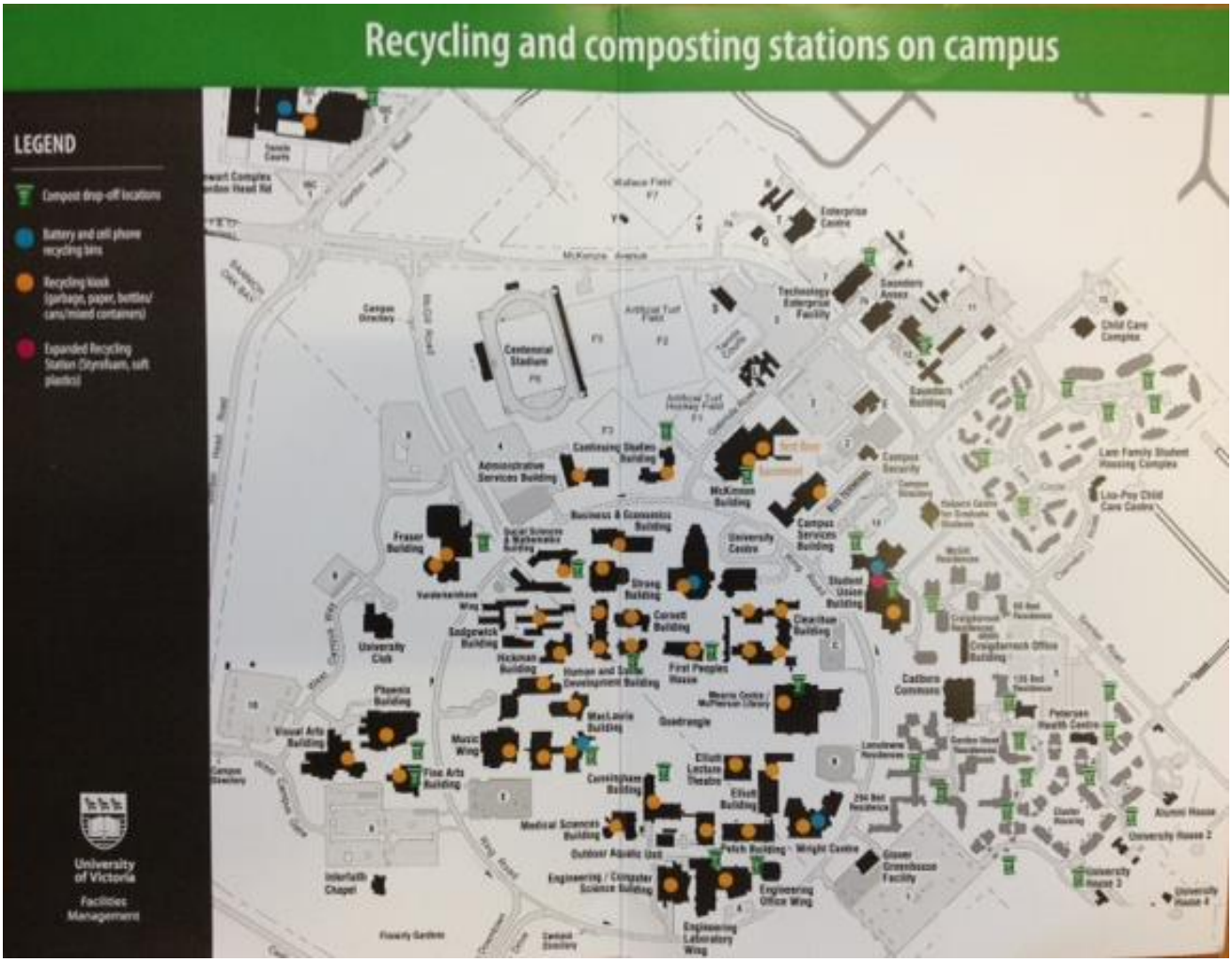
- What type of waste or waste streams do you deal with?
- What is the cost of services? (e.g. pick-up)
    - Is there a set time for pick-up?
    - Do the bins get picked up by call?
- What is the end result of the waste streams, and where does the product go?
- Is there any contamination in the waste streams, is the bag/bin sorted if there is contamination?
- Is there a common contaminant in the waste streams?
- Is there something your company offers that your competitors don't?

Appendix L – Compost Analysis

Potential Compost Systems for RRU			
Type of System	**Overview**	**Example**	**Description**
Aerated Containers	fully enclosed, fan aerated (remove heat and moisture), biofilter, two or more containers can share single biofilter and aeration system	Compost Man Pro Compost Man, LLC	approximately 1m x 1.1m x 1.1m (holds ~1.2m^3), Total system: 16 bins + 2 biofilters, Min. retention time: 3 weeks, Emptied by tipping with fork truck, 2nd stage: vermicomposting (after 1 week precomposting in CM Pro bin)
		NaturTech	smallest containers hold 12 - 30 m^3, aeration system operates while container being filled, so 2 containers are sufficient (new feedstock can be added while other is composting), better for higher volume applications
Agitated-Aerated Containers	contained, aerated and agitated (turns materials), results in more uniform compost, less amendment needed, elimination of premixing	Earth Tub Green Mountain Technologies	circular tub, auger for mixing, capacity: 2.3m^3, multiple tubs may be used with single biofilter and aeration system, loaded through hatch in lid, similar to CM Pro (scale and operation)
		WEMI Wright Environmental Management, Inc.	more automated than other systems, continuous composting, compost on metal trays (hold 1-2 days feedstock), perforated floor for aeration, one unit contains entire system, several sizes (136-907kg/day), more expensive
Rotating Drums	tumbling feedstock in an enclosed reactor, various sizes: from 1.5m (diameter) x 2.5 to 4.7m (length) to 3m (diameter) x 15m (length), horizontal drum rotated: feedstock loaded one end, compost out the other, very short retention times	Green Drum BW Organics	tumble continuously, passive air movement, 3-5 day retention time, portable or stationary, capacity: 2.3 - 73m^3
		EPTC drum	tumble intermittently, injection of air (80% oxygen) from O_2 generator, 2 day retention time (high O_2 & microbial inoculant)

(Rynk, 2000)

Appendix M – Recycling and Composting Pamphlet from UVic


Recycling and composting stations on campus
LEGEND
Compost drop-off locations
Battery and cell phone recycling bins
Recycling kiosk (garbage, paper, bottles/cans/mixed containers)
Expanded Recycling Station (Styrofoam, soft plastics)
University of Victoria
Facilities Management
Centennial Stadium
Administrative Services Building
Continuing Studies Building
McKinnon Building
Business & Economics Building
Fraser Building
Strong Building
Cornett Building
Clearihue Building
Campus Services Building
Student Union Building
University Centre
Sedgewick Building
Hickman Building
Human and Social Development Building
First Peoples House
University Club
Phoenix Building
Visual Arts Building
Music Wing
Fine Arts Building
MacLaurin Building
Quadrangle
Elliott Lecture Theatre
Elliott Building
Cunningham Building
Medical Sciences Building
Outdoor Aquatic Unit
Petch Building
Wright Centre
Engineering / Computer Science Building
Engineering Office Wing
Engineering Laboratory Wing
Interfaith Chapel
Flowerly Gardens
Technology Enterprise Facility
Enterprise Centre
Sauanders Annex
Saunders Building
Child Care Complex
Lam Family Student Housing Complex
Lisa-Foy Child Care Centre
Cadboro Commons
Petersen Health Centre
Alumni House
University House 2
University House 3
University House 4
Glasser Greenhouse Facility
McKinnon Avenue