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[A CASE STUDY OF A WASTE AUDIT OF POST-CONSUMER WASTE AT HOFSTRA UNIVERSITY DINING HALL]

A student-led waste audit expands on the preliminary baseline data of the quantity and composition of waste at Bits & Bytes Café, a dining hall at Hofstra University, from a student initiative in the Spring 2013 semester.

Purpose

The objective of this research is to inform Hofstra's decision-making process as we begin to develop an Integrated Waste Management System (IWMS). The goal of this waste audit is to analyze the current waste management structure and identify the specific needs to Hofstra's waste management system. Meanwhile, the physical properties of the campus contribute to the overall process of waste production at Hofstra. So, a holistic view of waste at Hofstra is necessary to complete an Integrated Waste Management System.

Introduction

Universities and colleges have a special role in society as hubs for future leaders who train to take positions in which they will make decisions that steer our environment, culture, and economy. Climate change is arguably the most pressing concern of contemporary generations and will require innovative solutions and new technologies. Higher education institutions (HEIs) are a pivotal player in the implementation of environmental education to students (Lozano 2011; Pacheco 2006; Stevens 2009; Trencher 2013). HEIs can create and disseminate knowledge and techniques to local communities and regions (Gunasekara 2006; Etzkowitz 2002, 2013; Bowen 2006).

Hofstra University Sustainability Studies curriculum embodies the response to international academic consensus appealing for global action on climate change. Our focus on waste reduction at Hofstra is part of an ad hoc process to implement policies according to principles of sustainability (De Vega 2003; "Creating"; "The Swansea"; "Magna Charta"; "The University Charter"). The project to look at waste management fulfills the "SMART" criteria of sustainability projects, being specific, measurable, actionable, realistic, and time-based.

The purpose of this study is to encourage the best practices for waste reduction and recycling. There are three critical components to implementing a solid waste management plan.

1. Waste reduction;
2. Recycling bins for plastics, aluminum, and glass at dining halls;
3. Plastic clam-shell-on-request for dining halls that use compostable cardboard;
4. Installation of industrial dishwashers, including proper electrical and water pipe, in permanent dining halls;
5. Industrial-scale composting.

Background

Hofstra University is a suburban university in Hempstead on Long Island about 30 miles east of New York City. It had been a college that catered to commuter students until the residential high rise towers were built around mid-century. Long Island is the historical first adopter of planned suburbs, including Levittown, the first such development. As part of a policy of urban sprawl, decision makers chose to build passenger-vehicle-centered road infrastructure, which has left a lasting impact on the perceived and actual quality of public transit. Dormitories allowed Hofstra to open to foreign students and promised to make Hofstra an international university. Today there are about 11,000 undergraduate and graduate students and 2,500 employees.

The engineering and medical schools are planning to increase enrollment and develop or further develop graduate programs, respectively. There is an ongoing discussion about the potential of developing green areas and new constructions following the addition of a medical school building. In 2009, Hofstra opened its Office of Sustainability and hired a Sustainability Officer. At around the same time, the process to develop a Sustainability Studies Program curriculum began. The major was first offered in the Fall 2012 semester. Students began conducting on-campus research on sustainability issues including waste, energy, and community education.

As part of Hofstra's path towards sustainability, a waste audit is a particular spectacle to bring attention to sustainability in a positive way. This project has a number of components that contribute to the overall sense of sustainability at Hofstra:

1. Setting in a popular dining hall;
2. Managed as a student initiative;
3. Examined university waste management system (capacity building);
    a. Physical campus properties,
    b. Institutional infrastructure,
    c. Labor issues,
4. Sustainability Curriculum;
    a. Waste issues,
    b. Baseline measurement,
    c. Education – educate ourselves, educate the educators, educate the community,
    d. Economics.

The baseline data from our preliminary waste audit in the Spring 2013 semester marked the first time an attempt had been made to measure the quantity and contents of dining hall waste `at Hofstra. A representative sample of waste produced on a single day over a period of about

seven hours for over 300 pounds of waste can be extrapolated using common statistical methods (Abu Qdais 1997). This waste audit expands on that baseline.

Physical Properties

Hofstra has 115 buildings on its 240-acre campus, which is bisected by Hempstead Turnpike, a sometimes 4- or 6-lane highway to north and south campus. In general, the south campus is the academic and administrative side of campus with classrooms, labs, and offices. North campus is residential with dormitories, the fitness center, and is about 50% green spaces in contrast to south campus, which is largely developed.

There are 14 dining locations including sit down cafes, large cafeterias, and mini-marts. Part way through the fall semester the couple of dining halls that offer silverware run out and only plastic silverware is available after. Only two dining halls offer plates, however, a culture of disposable containers prevails on campus even where plates are available. An obstacle to offering plates is that there are no dishwashers in some dining halls that need proper pipes and electric. Since we run fewer dishwashers Hofstra uses less heated water and energy, however, our contribution to the waste stream is made up largely of single-use cups and food containers.

Our recycling program is expanding. Currently some of our buildings have no waste diversion methods. Our previous waste management contractor, Jamaica Ash, used to sort all our waste on-site. We did not install recycling bins because the glass, ferrous metals, non-ferrous metals, and plastics were sorted on a belt by pickers at the Jamaica Ash waste management plant. In the past five years we signed a contract with Covanta to send our waste to an incinerator with energy recovery, who do not sort our waste. We have started the process to source-sort our waste, but we do not have recycling bins in some buildings, and there are logistical limits to our physical campus and regional infrastructure.

All the waste collected that is not separated at the source goes to a nearby energy-from-waste (EFW) facility to be incinerated with energy recovery. The EFW method captures energy stored in solid waste by combusting it to produce heat that boils water to steam, which turns a turbine, a common mechanism for making electricity. This is relevant when calculating the carbon emissions of the EFW method relative to other waste management methods.

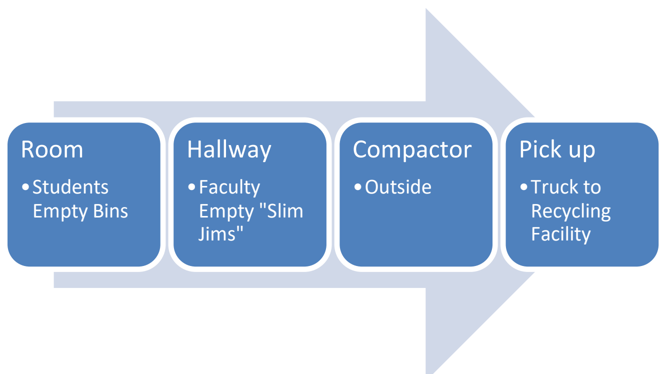

Figure 2. There is a series of steps to remove recyclables from high-rise dorms in a cascade.

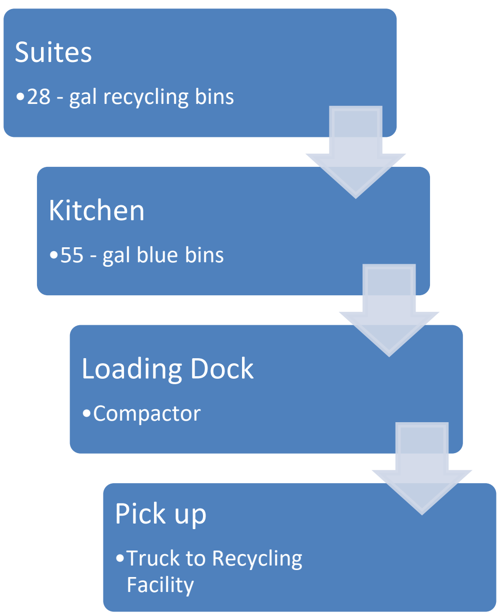

Figure 1. Waste produced in a dormitory is combined at stages before pick up.

Labor/ Legal

There is a multi-step process from source-sorting to the compactor. Custodial staff remove recyclables from bins at a location that has recycling bins to sort recyclables. Then the recyclables might be moved to a compactor or to another collection bin before finally be taken to the compactors (Fig 1 and Fig 2). We should examine the legal and regulatory framework around waste management to find out what is doable and what changes can be made to the law to better suit our needs (EPA

2002, NYSDEC 1988, NYSDEC 1992) and be in compliance with all federal, state and local waste regulations.

Background

The amount of waste we produce is a monument to our resource management. Mountains of waste have affected the surface and chemistry of our planet so that geologists have termed this current period of geologic history the Anthropocene. At no other time since the Earth's existence has a species made such widespread changes on our planet to warrant the name of an epoch (Zalasiewicz 2008).

Meanwhile, there is enough landmass made of waste that millions of people spend their whole lives sifting through the rubble of our civilization for scraps and bottles to sell, living and working in garbage, recycling much of the recyclables we dispose of as landfill waste ("Waste Land" 2011). Communities of garbage pickers are widespread. They exist in Latin America, Africa, Eastern Europe, and Asia (ILO 2004). This suggests that the type of society we live in promotes consumerism in such a way that produces billions of tons of waste globally per year (Worldbank 2010).

Anthropogenic greenhouse gases (GHG) are contributing to a wide range of changes in our biosphere with unpredictable but drastic consequences (IPCC 2013). We use the unit of megatons of carbon dioxide equivalent (MTCO2E) as a proxy for the environmental damage our waste causes. Units of MTCO2E are measurable over many processes and general to many waste products and GHGs (e.g. methane, nitrous oxide, carbon dioxide) (WARM 2010). Another unit of measurement could be the water footprint of food that is wasted (Kosoff 2011; Mekonnen Hoekstra 2011).

Waste management produces 5% of total global GHG emissions (Worldbank 2012). In the United States, landfills account for 16% of our total production of methane, which is a GHG 20 times more powerful than carbon dioxide (CO2), behind only natural-gas burning and cattle production (EPA 2012). We use the WARM in concurrence with waste management hierarchy to analyze potential avenues of waste reduction and diversion of waste from incineration.

The Waste Reduction Model (WARM) provides net carbon costs based on life-cycle assessment of a number of variables in several waste management techniques. These analyses take in to account four basic processes: 1) resource extraction, 2) manufacture, 3) distribution, and 4) end-of-life management including associated carbon costs associated with each process in a particular waste management technique. (WARM 2010, 2012).

Previous Waste Audits

Waste audits may be used to measure medical waste in hospitals and university medical programs (Mohee 2005), some of which is considered hazardous, and municipal solid waste (Smyth 2010). The process has been used in various forms at universities, and by municipalities to determine the composition of waste. In general, a waste audit is a measurement of the quantity and content of waste produced in an area. The process of a waste audit could reasonably include assessment of legal and labor framework, current waste management techniques, an inventory of purchased materials and waste produced at dining halls, cafeterias, academic offices, classrooms, laboratories, bathrooms, public areas, warehouses, equipment maintenance areas, and construction sites (Purdy 2013; Dowie 1998).

Waste Reduction Model (WARM)

Overall, there is a net carbon benefit to combustion over landfill, especially for paper products and cardboard; however, plastic, glass, and aluminum have net carbon costs when burned, and recycling is a preferred method of waste management for paper and cardboard because of forest carbon storage (WARM 2010). Furthermore, composting food waste is preferable to combustion at a rate of 0.08 MTCO2E per metric ton of waste.

Our waste audit will be more impactful if we include an aspect of campus involvement and marketing. There should be a campus-wide announcement at least 24 hours before the waste audit to let faculty and students know that we'll be in the dining halls. It would be helpful to have a student posted at waste bins to help student and faculty consumers sort waste if possible.

A comprehensive waste audit will help guide the university's actions by providing facts about waste patterns. Our interest in source reduction and diversion from the waste stream will guide our project to gather baseline data at dining halls this spring. We will make goals to reduce waste in a way that encourages preferred waste management methods that increase our avoided GHG emissions by diverting waste from incineration and landfilling.

Goals

In general, our first priority should be source reduction. The most efficient way to reduce our waste is not to produce it. We want to empower our students to reduce waste by providing the tools necessary for reduction and reuse of waste (PlaNYC 2011). From our previous audit, we found that post-consumer and kitchen food waste was above the national average on the day we measured (Garfinkel 2013).

Eyewitnesses to closing time at dining halls have recounted the disposal of remaining uneaten food. Our next goal should be to divert as much recyclable waste as possible from the mass-burn waste stream including plastic, glass, and aluminum in particular. To donate excess food to feed people who are hungry is preferable after reduction (EPA 2013, FNBLI).

We want to use a methodology for measuring our waste to prioritize what and how much we can divert from incineration. This report will make statistical analyses based on the weight of our data. We extrapolate to the weekdays in an academic year as a way to increase the control of the experiment.

There is an incentive to collect baseline data for our dining halls that we may participate in the Food Recovery Challenge and WasteWise programs to use resources from the EPA (Food 2013, WasteWise 2013). Our first step is to find out what we're throwing away in what amounts so we can use facts to think critically about our current waste management system.

Methods

The waste audit project at Hofstra started last spring on Tuesday, April 16, 2013. The manager of Bits and Bytes, Nicole Karyotakis made her kitchen and cafeteria staff aware that we would be on the loading dock and to take out waste periodically throughout the day instead of only once at the end of the day, a departure from the normal routine. In this way we were able to collect time points of data for waste produced and had access to waste periodically.

This semester, from Monday, April 7th to Friday, April 11th, 2014, sustainability students went back to Bits & Bytes to expand on the baseline data collected during the preliminary waste audit last year. The staff brought out waste as it became full rather than at intervals, which meant to us that there were long stretches without waste, and on Monday cafeteria waste was removed only two or three times. In between garbage take-outs we measured what was available on the loading dock, which was bags of plastic in the blue containers outside from the previous day and corrugated cardboard packaging material from the kitchen.

A waste audit is a measurement of the quantity and composition of waste. The staff left bags of waste on the loading dock when the bags were removed from the kitchen and cafeteria. Waste was separated in to cardboard, compost, plastic, landfill, aluminum, and glass. There was no differentiation between kitchen and cafeteria waste, although the information would estimate the actual post-consumer waste as opposed to pre-consumer waste, a common way to split waste in broad categories.

A luggage scale was used to weigh the waste after separation. Sometimes we took initial weights of waste before separation as a quality control. The weight of a plastic bag was estimated to be about a fifth of a pound, and was considered negligible and wasn't subtracted from measured weights. The waste audit team arrived in the morning around 10 am, and were present until around 3 o'clock p.m. on Monday Tuesday, and Wednesday. The schedule for a member changed based on one's class schedule, and there was not always a person there during the day. Thursday and Friday the waste audit team came back in the late afternoon after 5 o'clock to collect waste that was thrown away after we left on previous days.

It was difficult to keep perfectly homogenous bags of waste for specific types of waste. Some small pieces fell to the bottom of the bag and were discarded with another category of waste, usually compost or landfill. The waste was separated to a degree that a first attempt of baseline measurement requires.

Hard plastic like yogurt containers, plastic clamshells, plastic cups and lids, plastic coffee lids, utensils, and cereal bowls were put in a bag for plastic recycling. All corrugated cardboard was put in a bag or put in to another cardboard box to be measured. Compost consisted of all food waste, tea bags, and wooden stirrers, and the compostable cardboard clamshells that have a symbol on them denoting that they are compostable. The glass consisted of Snapple bottles, glass coffee drink containers, and glass juice containers, and other glass containers. The landfill waste consisted of the remaining waste, usually cellophane food wrappers, paper coffee cups, paper plates, and any other non-recyclables. On the raw data, the paper category consisted of recyclable paper, which was two or three newspapers and cardboard food boxes like cereal boxes. The miscellaneous waste was one mechanical food scale.

The data collected over five consecutive days is in pounds of waste by category. A challenge the project met is the amount of waste produced at Bits & Bytes Café. While the waste audit team collected over one thousand pounds of waste during the collection period, we missed cardboard data on some days. A larger number of smaller samples based on a number of bags of waste from the cafeteria or the kitchen might return more accurate results.

The average waste collected was calculated by summing up the data for five days and dividing by the number of data there were:

$$\bar{x}=\sum_{i=0}^{n}\frac{x_i}{n}$$

Where n is the number of data, and x_i is a particular data point for a given category of waste. The error was calculated from sample standard deviation, which has the general form:

$$s_x = \sqrt{\frac{1}{n-1}\sum_{i=0}^{n}(x_i - \bar{x})^2},$$

Where n is the number of data, and $\bar{x}$ is the average of the data. Excel has a function called STDEV.S() that calculates this formula. There is a further transformation to find the error:

$$\text{Error} = t_{\frac{\alpha}{2}}(n-1)\left(\frac{s_x}{\sqrt{n}}\right),$$

Where $t_{\frac{\alpha}{2}}$ is a value from the student t-table using n-1 degrees of freedom, and α is the desired one-tailed percent error, in this case 10%. This was calculated by hand using a calculator. Note that a smaller percent error corresponds with a larger range of values. The error is a measure of the probability that the actual mean for a population falls within the margin of error.

Results

Day	Cardboard	Compost	Landfill	Plastic	Aluminum	Glass	Paper	Misc.
Monday 4/7	83.93	25.53	11.78	18.61	0.7	33.76	-	-
Tuesday 4/8	35.36	65.06	8.53	17.86	0.09	10.53	-	-
Wednesday 4/9	53.79	58.1	13.63	26.52	0.22	47.21	-	-
Thursday 4/10	-	187.44	28.96	25.4	0.97	2.05	-	-
Friday 4/11	-	233.22	15.51	14.97	3.37	5.01	0.97	14.13

Chart 1. The data collected each day in all categories. Some categories of waste that were not collected every day were not used in analysis and discussion. The recyclable paper collected was made of two or three newspapers and some cereal boxes. The miscellaneous category is for a food scale found in the compactor on Friday, and also shows that not all types of waste fit easily in one category.

Column1	Customer Count	Daily Sales
Monday 4/7	738	4,612
Tuesday 4/8	2,135	13,570
Wednesday 4/9	1,945	12,600

Thursday 4/10	2,257	14,370
Friday 4/11	1,840	12,030
SUM	8,915	57,182

Chart 2. The customer count and daily sales during the week of the waste audit.

Category	Average	(+/-10%)
Cardboard	57.69	(30.99, 84.39)
Compost*	113.87	(53.96, 173.78)
Landfill	15.68	(10.50, 20.87)
Plastic	20.67	(17.35, 23.99)
Aluminum	1.07	(.19, 1.95)
Glass	19.71	(6.65, 32.77)
Total	228.70	(119.64, 337,76)

Chart 3. The average waste by category with a margin of error, which is measure of the probability that the actual mean is within a certain range.

* Compost had a wide margin of error and the calculations were done removing the highest and lowest data points, yielding an average of 103.53 and a margin of error (+/-10%) of (55.51, 151.55). Note this slightly raises the lower bound and reduces the upper bound, indicating a smaller margin of error.

Results (cont.)

The questions asked in the results are whether the data collected are the same as absolute weights and as proportions to the results of the preliminary waste audit, and which type of waste is the largest by weight by category. We collected less aluminum, plastic, and landfill, and cardboard (p=.0001; p=.0013; p=.0196; p=.0759, respectively) and about the same glass, and compost (p=.3913; p=.1342, respectively). Overall, we collected less waste per day than last spring (p=.0015).

As a proportion of the average total waste per day, we collected less aluminum (p=.0341) and more compost and glass (p=.0800; p=.0172, respectively), and about the same other types of waste (plastic, p=.4425; landfill, p=.4796; cardboard, p=.3364). We also conducted the statistical tests without the largest and smallest values of compost weight as per request from stakeholders. The results of this test showed that the proportion of compost was less than last year (p=.0906) and the average compost collected was larger than the average amount of cardboard collected ($p=2.018 \times 10^{-54}$). In questions about the inclusion of data I tended to include more, unless a specific request was made.

Limitations

On Monday, Tuesday, and Wednesday, less compost was collected than we expected because there were fewer take-outs during the time we were collecting waste on those days. We didn't differentiate between cafeteria waste and kitchen waste consistently in our data. However, cafeteria waste tended to have higher proportions of compost than sorted recyclables by observation. On Monday, the cafeteria waste was only taken out once, at the end of the day, after the waste audit team had left. Also, one bag with an estimated 20 pounds of waste was misplaced, which means it might have moved to the compactor while the waste audit team took a break.

On Thursday and Friday, no cardboard was collected because the author didn't have time. On Thursday and Friday the amount of compost collected was higher than the weekly average. At the end of the week, on Friday, the remaining food in the displays and the serving counter including single servings of tuna salad, egg salad, fruit, pastries wrapped in cellophane, and large containers of soup of perhaps more than 3 gallons based on weight and the density of liquid water. Hopefully taking a weekly average accounts for some of the differences in the daily amounts of compost collected.

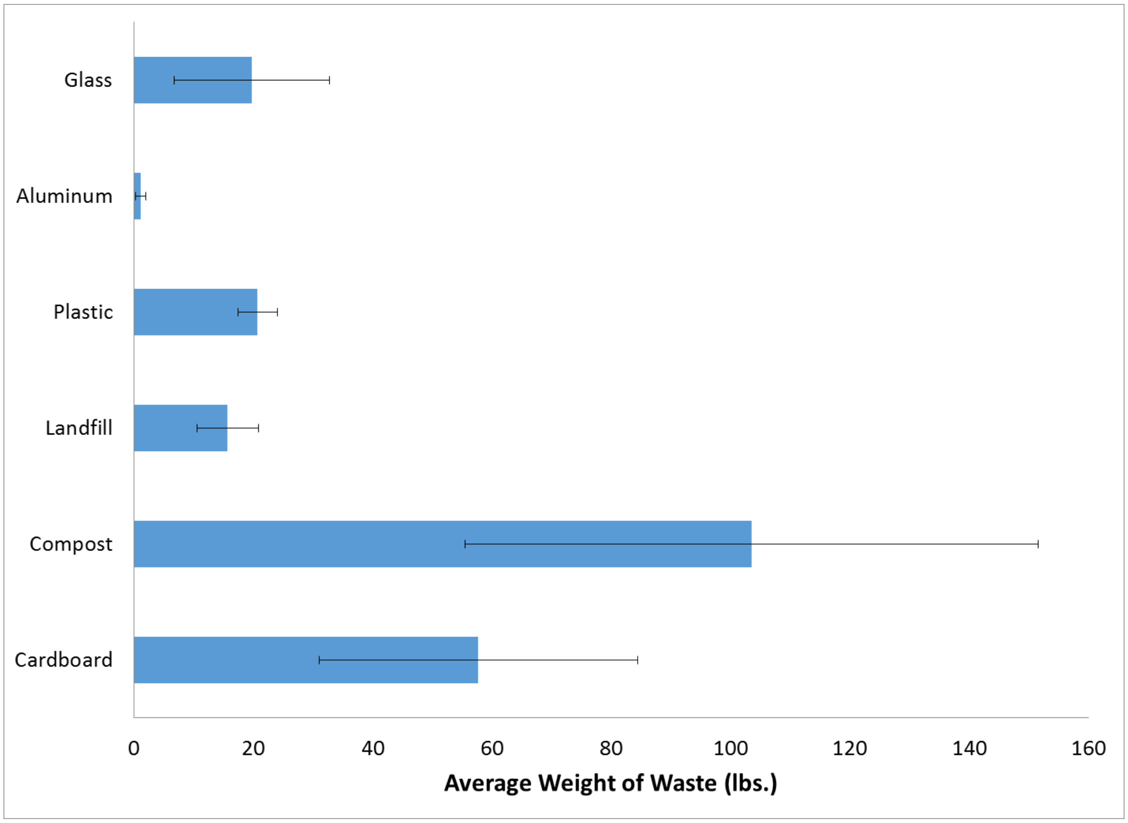

Figure 3. This is a graph of the averages with error bars, which estimate the probability that the actual mean for a population falls within a certain range.

Data Quality

The quality of data on each day in each category is variable. In general, the data quality can be split between Monday, Tuesday, and Wednesday, when there were multiple team members available to help collect data, and Thursday and Friday, during which only the author separated waste. Also, cardboard was measured on Monday, Tuesday and Wednesday, but not Thursday and Friday, while we measured waste from the recycling on Monday, Tuesday, and Wednesday, but not on Thursday and Friday.

Most data was not normally distributed with contributes to the perception of some inconsistent reporting. Only aluminum waste was normally distributed (p=.4455), and landfill waste was almost normally distributed (landfill, $p=.0799$; plastic, $p=.0375$; glass, $p=1.992 \times 10^{-20}$; compost, $p=3.485 \times 10^{-28}$; cardboard, $p=.0030$).

Compost

The compost data collected on Monday, Tuesday, and Wednesday is considered low quality for the reasons above. The compost data from last semester is considered high quality data, but some data is missing from last semester, in particular the number of customers and daily sales. The compost data on Thursday is considered high quality because it was taken at the end of day after much of the waste had been discarded.

Plastic

The waste audit team learned that clam shells with food residue are not recyclable during an impromptu conversation with a representative from Jamaica Ash for which the Sustainability Officer was present. On Monday, Tuesday, and Wednesday, almost all of the plastic was from the recycling bin, which was composed mostly of water bottles. This is considered high quality data. On Thursday and Friday, much of the plastic was made of plastic clam shells with food residue, so this is low quality data.

Cardboard

Medium quality data was collected on Monday, Tuesday, and Wednesday because part of the waste audit team left before all the cardboard had been measured and the cardboard that was left was not measured. Some cardboard could have been discarded after the whole team was gone.

Glass

Data for glass was high on Monday, Tuesday, and Wednesday, because the glass was collected from the recycling bins, and there is a large proportion of glass capture in recycling by observation. The second part of the week saw very low glass collected because no waste from the recycling bins was collected.

Aluminum

There was generally little aluminum besides a few single-serve cans of soft drinks and canned food containers from kitchen waste. The data was normally distributed (p=.4455). The data might have been high quality.

Landfill

Landfill data was almost normally distributed (p=.0799), so the data might have been medium quality.

Discussion/ Analysis

The purpose of this report is to inform our waste management strategy based on a widely applicable method of analysis. It should be noted that the waste collected this semester was less than that collected last year, which indicates that the estimates this semester are an underestimate of waste as opposed to a reduction in food waste. This is probably due to the change in methodology that staff removed waste bins only when they were full rather than periodically throughout the day. Essentially, if a waste audit is conducted in the future, we may see a rise in waste that would apparently contradict our efforts to reduce waste, but this might be a result of better reporting instead of an actual rise in waste production.

As it is, the results are analyzed with the lens of greenhouse gas emissions using the suggested criteria of potential reduction of greenhouse gases to guide our waste management decisions. Another criteria might be the amount of waste diverted from the waste stream through recycling and composting. It may be worth noting that our waste hauler, Jamaica Ash, pays a tipping fee based on the weight of waste brought to the Covanta EFW plant. There is a potential benefit of waste reduction that Hofstra could position itself to renegotiate our contract.

Other points of discussion may be that compost has the highest average value of waste by weight per day, and the author speculates that further data may show that compost makes up the largest part of waste (p=.1250). Although the author expected the weight per day to correlate strongly with the number of customers and sales each day, the data showed mostly weak correlations.

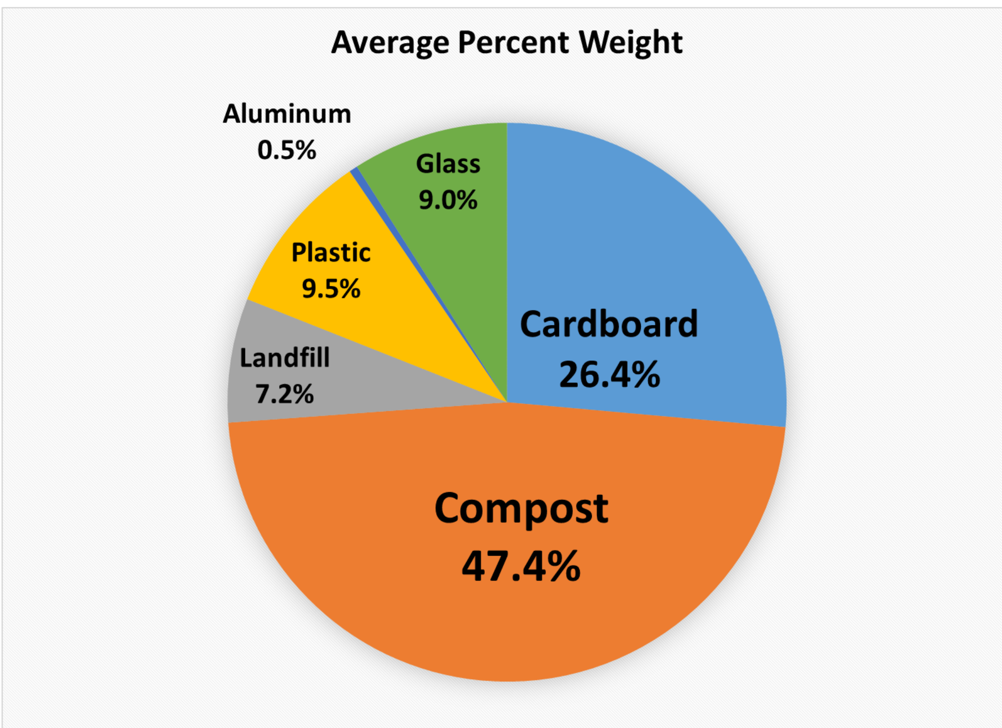

Figure 4. The average percent weight of categories of waste excluding the highest and lowest compost data.

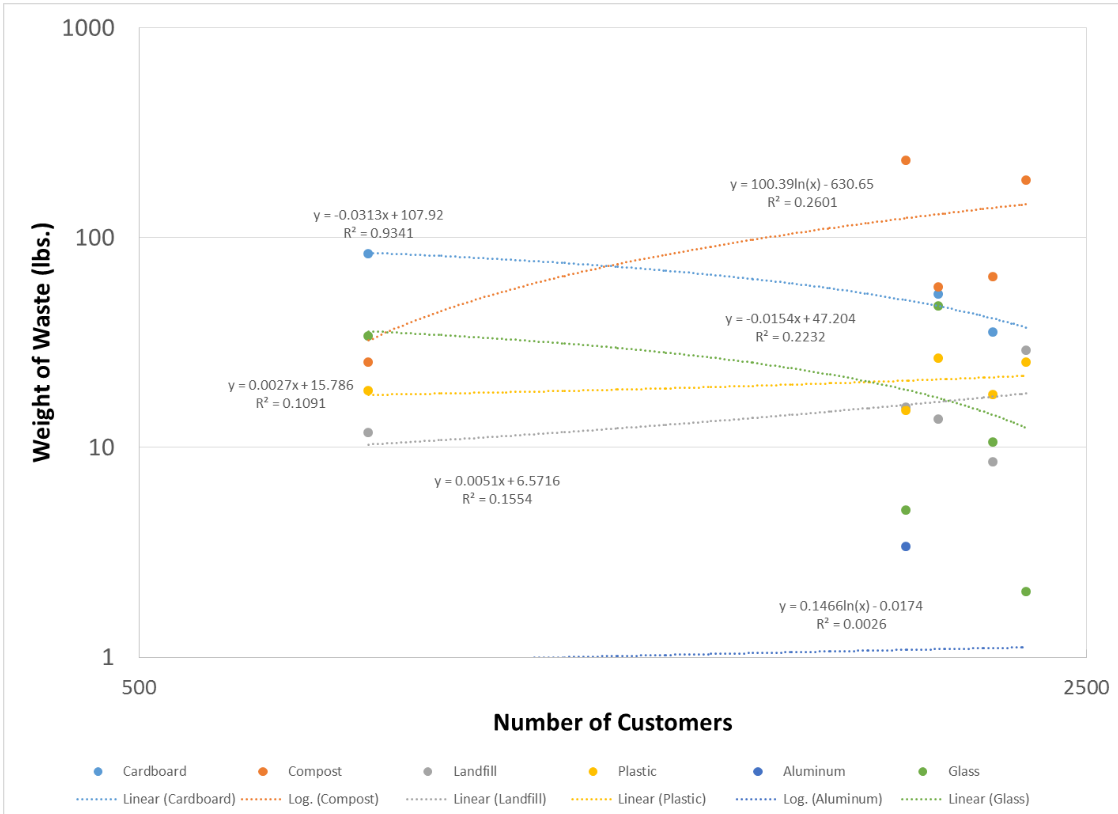

Figure 7. The best fit lines shown are the higher correlated regression lines from Microsoft Excel between linear and logarithmic. Waste produced per person theoretically would be equal to the slope, however, this graph shows low correlation between regression lines except for cardboard (r-squared=.9341), which has a negative slope of -0.0313. This would signify that 0.0313 fewer pounds of cardboard are produced per customer served.

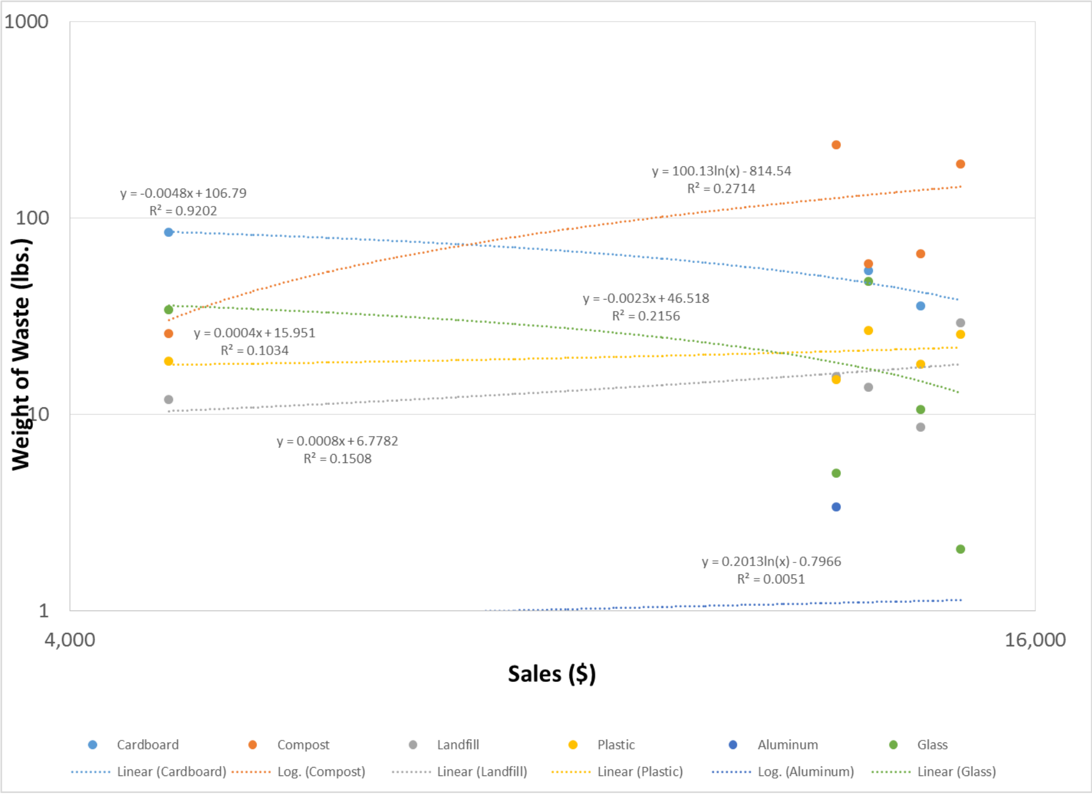

Figure 8. There could theoretically be analysis of waste per dollar of business, however, these regression lines, the better fit of linear and logarithmic from Microsoft Excel, show low correlation except for cardboard (r-squared=.9202), which has a negative slope of -0.0048. This would mean that there are 0.0048 fewer pounds of cardboard waste produced per dollar of business done.

Some standard weight-to-volume conversion factors are available to calculate volumes of municipal solid wastes ("Standard Weight"). We already are source-sorting plastic, aluminum, and glass, which means to divert compost is a significant potential reduction in waste volume, up to 45.1% of our waste by volume under upper bound conditions of waste volume by volume. Another large portion of our waste is cardboard, which is up to 40.0% of waste by volume using upper bounds for calculated volumes. Another finding is that the average volume of waste calculated from weight-to-volume conversion factors was 55.3 to 78.0 cubic feet of waste produced per day, or with 10% error, between 34.8 and 108.9 cubic feet of waste per day.

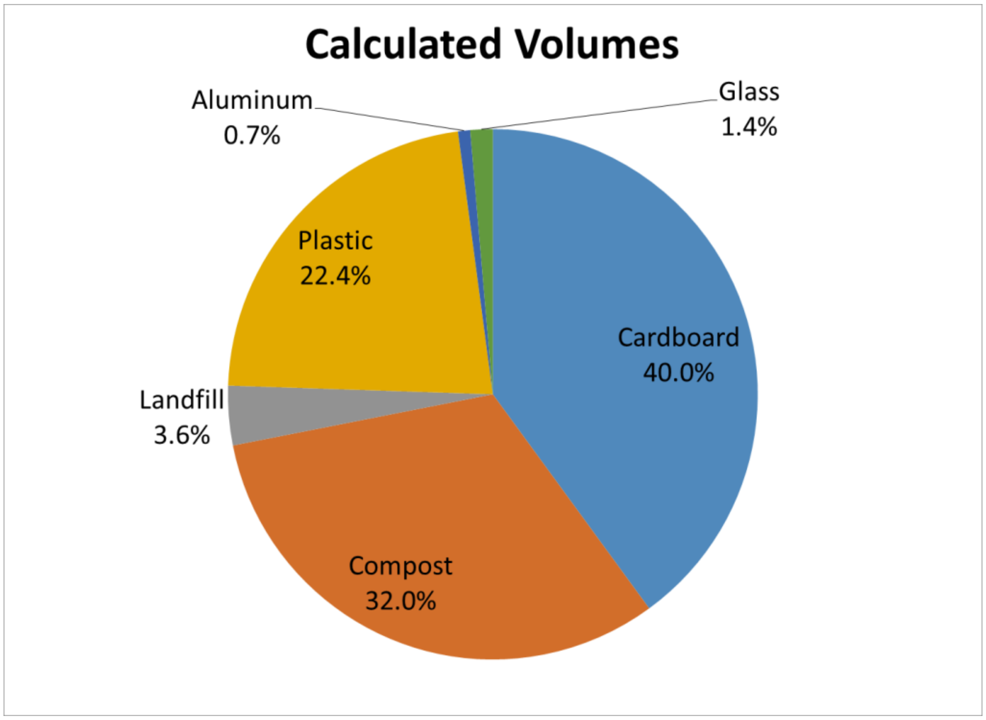

Figure 5. These are the calculated percent volumes using the lower bound of weight-to-volume conversion factors.

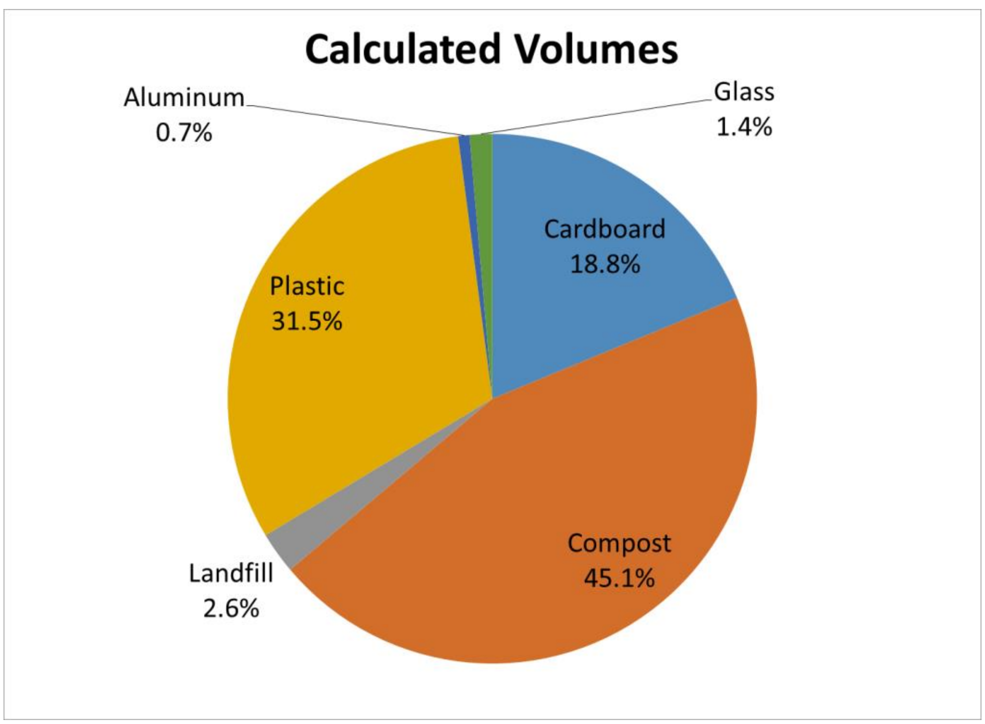

Figure 6. These are calculated percent volumes based on upper bound of weight-to-volume conversion factors. Compost makes up the larger portion of waste by volume under these conditions.

The Waste Reduction Model (WARM) uses life-cycle assessment modeling to estimate the net greenhouse gas (GHG) emissions effects of various waste management techniques. In our current waste system we recycle plastic, aluminum, and glass by source-sorting. Ferrous materials are recovered for recycling at the mass-burn WTE site. Regardless, recycling cardboard is the greater potential for avoided GHG emissions. The calculated potential avoided GHG emissions based on the average weight of cardboard collected that the savings from recycling cardboard is 27.3 metric tons of carbon dioxide equivalent per academic year. The calculated avoided GHGs for other recyclables were less than that of cardboard (units MTCO2E/semester: plastic=8.74; aluminum=1.72; glass=1.17; compost=1.49).

Recommendations

A high priority in the recommendations of this report is to reduce waste. Avoided GHGs from waste reduction are considered to be higher than source-sorting for recycling in most cases ("Why Recycling"). The process of engaging the community to find out what attitudes contribute to waste and addressing those issues soonest is key. During impromptu discussions with students, the issues of food quality and the speed of service were cited as reasons to produce waste. We should actually address these concerns by finding ways to make food tastier and available more quickly for students without reducing the foods nutritional content. The basic idea of waste reduction is to ask students to consume less and throw away less. This may require negotiations and concessions on both sides, but the main object of waste reduction is to continue to fully engage in a campus-wide discussion about food waste with students.

There is a sense among the staff members and students that the amount of food waste is of special concern based on high food insecurity in our country. In 2012, more than 1 in 7 households were food insecure, meaning they didn't know if they would have enough money for their next meal. More than once, a number of members on staff at Bits & Bytes asked me to stay after hours on Friday to witness the amount of food thrown away at the end of the week. To look at the Long Island infrastructure for food recovery and the potential to donate excess food, especially on the day we dispose the most food, Friday, is one way to address these calls.

After food reduction and food recovery, to divert waste produced by Bits & Bytes from the waste stream by recycling and composting is the next priority. There are potential avoided GHG emissions for food waste, about 1.5 MTCO2E, but this would probably be of secondary importance for argument's sake to the volume reduction of waste. The highest potential avoided GHG emissions are from recycling cardboard, which could avoid a maximum of 27.3 MTCO2E, or 40.0 MTCO2E at the upper bound of the margin of error for cardboard.

A cost-benefit analysis may be conducted to meet the needs of the Hofstra community on our path to waste reduction, which might include cultural factors and risks of climate change. In the future, Hofstra should clarify its Integrated Waste Management System so it can be viewed by the public. The benefits of this would be those that are emergent in the learning process of investigating our waste management system.

It may make sense to plan to make Bits and Bytes a permanent dining hall by installing proper water pressure and electrical voltage piping to power an industrial dishwasher if the dining hall is to remain at its current location. This would empower students to reduce their waste by using reusable plates instead of single-use clam shells. Another option would be to offer students plastic clam shells on request and to use compostable clam shells by default. Plastic has higher GHG emissions when incinerated (2.06 MTCO2E/ Short Ton) compared to compost (.06 MTCO2E/ Short Ton), which could be composted and not incinerated in the future.

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