Date: 1 May, 2013

To:
Dee Ann Sanders
Department of Civil and Environmental Engineering
Oklahoma State University
Stillwater, OK

From:
Bhuvana Kandula
Oklahoma State University
Stillwater, OK

Subject: Oklahoma State University Waste Audit Report

Dear Dr. Dee Ann Sanders,

Please find enclosed the waste stream analysis report on the Stillwater campus of Oklahoma State University. A waste stream analysis was conducted for six buildings by the Waste Audit and Sustainability Management Team during spring 2013. You will find final recommendations based on the data obtained through the audit.

Please feel free to get in touch with Bhuvana Kandula for any further questions. She can be contacted at bhuvana.kandula@okstate.edu

Thank you,
Bhuvana Kandula

Oklahoma State University
Waste Audit Report

Spring 2013

Bhuvana Kandula

CONTENTS

SUMMARY:

Waste audit: a process of sorting waste from different buildings on the Stillwater campus of Oklahoma State University was conducted in spring 2013 to quantify the amount and type of solid waste that is generated. Data from the waste audit helped to identify current waste generation practices and the potential to reduce specific waste products and commodities, as well as implement and improve the existing recycling, pilot composting and education programs. The waste audit helped by generating data that facilitated the determination of ways to improve waste management practices aimed in not only cutting the costs involved in handling the wastes but also in encouraging integrated waste management disposal techniques like recycling, reusing and composting. The waste audit was conducted on six selected campus buildings. A pre-audit was conducted in which waste from all the buildings was collected, examined, sorted, and weighed and classified into the following categories:

1. **White Paper** (relatively clean & dry): This is the most valuable version of paper which can be recycled back into white paper.

2. **Colored Paper** (relatively clean & dry): This category is identified by tearing to determine base color.

3. **Newspapers, Magazines, and Journals** (relatively clean & dry): Categories belonging to numbers 2 and 3 are not as valuable as white paper but it is still important to recycle them.

4. **Non-Recyclable Paper (paper towels, napkins, tissues, food wrappers, wet or soiled paper)**

5. **Paperboard or Chipboard like cereal boxes, gift boxes etc.**

6. **#1 & #2 Plastic Containers:**

#1 PET or PETE (Polyethylene Terephthalate): This type of plastic is usually clear or green in color; shiny and rigid and generally used for soft drink bottles, peanut butter containers, water and beer bottles, salad dressing and vegetable oil containers and microwavable food trays etc.

#2 HDPE (High Density Polyethylene):

These plastics have milky or solid colors and are rigid containers; they are used in making detergent bottles, pens and shampoo bottles etc.

7. #3-#6 Plastic Containers:

#3: PVC (Polyvinyl Chloride): This plastic is semi-rigid, used as dashboards, clear food packing, cables etc.

#4: LDPE (Low Density Polyethylene): It is a flexible plastic, used in squeezable bottles, tote bags etc.

#5.PP (Polypropylene): This plastic is semi-rigid, it is generally solid white or colored, it is used in yogurt containers, ketchup bottles etc.

#6.Polystyrene: This plastic is brittle and glossy, used in medicine bottles, CD cases etc.

8. **#7 Plastic Containers & PLA** (corn starch plastic): PLA is Poly lactic acid made from corn starch; lactic acid is the fermentation product of Dextrose which is made from corn starch. PLA can be formed into a variety of products. Corn plastic products have the look and feel of traditional petroleum-based plastics, but they are compostable and biodegradable. These plastics

biodegrade in a commercial scale composting facility, where they are first shredded. The corn based resin from which PLA is derived is non-toxic and renewable resource.

9. **Plastic Bags/Films:** a thin sheet of plastic material used to cover or wrap things, it is usually transparent

10. **Styrofoam:** Styrofoam is a brand name product. It is expanded polystyrene plastic called **EPS**. It is a petroleum byproduct and does not biodegrade, though it is recyclable the process is time consuming and expensive. Thus it is encouraged avoid using Styrofoam as it is not designed for reuse.

11. **Other Plastic Containers & Plastic Container lids**

12**.** **Glass**:

13. **Aluminum**: Aluminum cans be identified by their concave surface at the bottom. Aluminum sheets and foils which are not soiled or contaminated with food can be sorted and recycled.

14. **Metals (Non-Aluminum):** Steel or Tin cans which have a flat bottom and other metals like brass, copper belong to this category.

15. **Drink boxes (like milk cartons):**

16. **Corrugated Cardboard:** Cardboard with waffle-like construction that makes up the walls of a piece of cardboard is corrugated cardboard.

17. **Food Waste**

18. Household batteries (both rechargeable and regular)

19. Trash

20. Other (Things very out of place like toilet seats or tires)

21. Hazardous Waste: Waste that is potentially harmful or dangerous to our health or the environment is called a hazardous waste, they can be liquids, solids, gases etc. Cleaning fluids or pesticides or the by-products of manufacturing processes are some of the examples of hazardous wastes.

After characterizing the waste, a final audit was conducted in which 6 bags of waste from each building was collected and sorted into their respective categories. Each category was weighed and the results were interpreted to bring out some valuable suggestions for improving existing programs and implementing new programs.

LITERATURE REVIEW:

The United States is facing a huge solid-waste disposal problem, especially in urban areas. According to EPA, in 2010 Americans produced 250 million tons of trash and the waste generated per person in the United States is twice that of any other country. The amount of refuse being produced is increasing year by year but the landfills the facilities into which the waste is disposed are filling fast in some parts of the country. In the United States the number of landfills has declined from over 7,300 in 1989 to fewer than 1,800 in 2007, cities in New Jersey have to ship 11 million tons per year which is 50% of its total waste to nearby states. In 2001, Fresh Kills Landfill in New York City was closed; this facility accepted over 12,000 tons of trash each day, but now NYC exports 20% of its trash to other parts of New York, Pennsylvania, Virginia, and other states. Most landfills are within 5 to 10 years of closing unless current facilities are expanded or new landfills opened. Urban areas don't have enough space for new landfills and the costs of municipal solid waste disposal into landfills have hit the roof in recent years, which indicates that parts of the nation are facing a waste crisis [1]. The landfilling option of waste management gives rise to environmental pollution due to the seepage of harmful leachate, methane gas formation, increased costs associated with disposal and the land, particularly in densely populated areas where land space is scarce, thus integrated solid waste management practices like recycling and composting have to be considered, which have many benefits in terms of reducing money for managing waste. An economic analysis shows that "recycling can generate three times as much revenue per ton as landfill disposal and almost six times as many jobs." [2].Recycling and using those materials reduce the pressure on existing natural resources that are required in the process of making new products. Composting is a another effective solid waste management method that is a natural process of recycling decomposing organic materials

into a rich soil known as compost; this method is beneficial to the environment by mitigating global warming, reducing the amount of toxicity in soils exposed to pesticides or fuels (that is if composted soil is added to the mix of the soils that have been exposed to toxic matter, such as pesticides or fuels, they regenerate faster into healthy soil) reducing the water pollution and enabling healthy growth of trees and plants etc. According to the EPA 2010 fact sheets, of the 250 million tons of trash generated, about 85 million tons of waste is recycled, a 34.1 percent recycling rate. On average, Americans have recycled and composted about 1.51 pounds of individual waste generation from 4.43 pounds per person per day [3]. Thus techniques like reduce, reuse, recycling and composting not only help in reducing the costs involved in waste disposal but also lessen the ill-effects on environmental health. By recycling, the amount and pressure on limited precious natural resources can be minimized: composted materials can be used as natural fertilizers in agriculture and save limited landfill space, which could be utilized for other more useful purposes. Owing to the importance of these alternatives of waste disposal it is essential to quantify and analyze the composition of solid waste generated These assessments can be used to learn the effectiveness of existing programs and also design methods for improving current and future programs. Findings from waste audits can help in determining the waste generator's ability to reduce, reuse, recycle and compost materials from the existing waste streams, strengthen recycling initiatives, and also set a stage for taking up new waste reduction work plans. Thus by waste auditing, an efficient waste disposal program can be devised, which can increase the amount of paper, plastic, and metals that could be recyclable and organic materials that can be composted, which in turn, can reduce air and water pollution, conserve natural resources and energy, and help curb global warming.

Many institutions have benefited by conducting waste audits. Illinois State University has been conducting waste audits of its campus every year since 2002. In that year recyclable material accounted for 40 percent of the total; the audit conducted in 2011 found that nearly 20 percent of the audit sample was recyclable. This decline in the recyclable percentage is attributed to the effective decisions that were drawn from the audits that were used for the implementation and improvement of recycling programs on the Illinois campus [4].Portland Community College conducted an audit on November 4th, 2009. The audit results report that 43% of the material sorted, by weight, from the garbage could potentially be recycled. Of the total, 18% was compostable and 25% recyclable. These audits helped the campus in making recommendations like: placing a recycling bin next to every garbage can; implementing a central recycling station; introducing a composting system on campus etc. [5]. In 2006, Boston University performed a waste audit on the Charles River Campus to lay the groundwork for a recycling program and discovered a waste diversion rate of 3%. In 2012 the waste diversion rate had improved from 3% to 32%. These improvements in waste reduction and recycling can be attributed to new programs that were formulated like tray-less dining, food waste composting, etc., which were possible through proper waste auditing [6].

The waste auditing process for an institution can be divided into four parts: Planning, Collecting, Sorting and Analyzing. In the planning part, the study area that is to be audited and the audit objectives are defined, all the arrangements for the audit (i.e. getting equipped with all the safety materials for handling the waste like gloves, first aid kits etc.) is done. Also all the materials required for the process are obtained (supplies, sorting tables, tongs, bags, plastic sheeting, recruitment of volunteers etc.) during this phase and safety training for the volunteers involved in the audit is provided prior to starting the work. The next step is the Collection of waste; in this

phase all the waste is collected and the bags are labeled appropriately with their locations, time and date of the day it was collected and the waste is transported to the area where sorting takes place. The collection process should be carried out confidentially, personal and private information found during the waste sort is also kept confidential. The timing of a waste audit should be kept secret because if the building occupants are informed about the audit there is a possibility they may change their behavior (such as improving recycling efforts, etc.) which can affect the composition of the waste stream that is being analyzed. The next step is sorting the waste. This step involves thoroughly examining the waste and sorting it into categories of waste such as recyclables (white paper, magazines, aluminum, metals, plastics etc.), compostable material (food and yard waste etc.), hazardous waste, trash etc. After placing all the sorted wastes into their respective categories they are weighed. The last step in the process of a waste audit would be the analysis of the results and making recommendations. The data are entered onto spreadsheets and calculations are done. An audit report is prepared that includes findings and recommendations. Several institutions have successfully conducted waste audits and reported usefulness in estimating the effectiveness of their recycling programs.

RECYCLING AND COMPOSTING IN OKLAHOMA STATE UNIVERSITY:

Paper recycling:

The Stillwater campus of Oklahoma State University recycles white paper, which is the most valuable version of paper and mixed paper (colored paper, journals, phone books, and newspaper/magazines etc.). The school provides white rectangular boxes, into which both white paper and mixed paper can be thrown, which is sorted later by OSU employees at the OSU

Recycle Center. Paperboard and chipboard can also be tossed into the paper recycling boxes on the campus. The campus also recycles Old Corrugated Cardboard (the cardboard with waffle-like construction that makes up the walls of a piece of cardboard). Flattened corrugated cardboard boxes can be stacked next to paper recycling boxes or placed into one of the thirteen huge green single slit dumpsters available on the campus [7].

Fig 1: Single slit green colored dumpsters for disposing cardboard

Fig 2: Bins labeled ‘trash only’ and ‘plastic’ in the Student Union

Plastic recycling: There is no facility on the campus to recycle #1 and #2 plastics but the school provides many bins labeled either “plastic” or “bottles” or “#1 & #2” into which bottles or plastics belonging to PETE or HDPE categories can be disposed ,this is sent to Oklahoma City for recycling . PepsiCo and Waste Management encourage recycling on campus, with their blue PepsiCo recycling “Dream Machine” reverse vending kiosks at seven campus locations, into which anyone can throw plastic bottles and aluminum cans and earn points in return for coupons to use at local businesses [8].

Fig 3: Separate bins for (bottles and cans) and trash placed all over the campus

Aluminum recycling: The campus provides plenty of bins labeled as "bottles and cans" next to "trash only" bins, also there are blue PepsiCo bins installed at many places on campus.

Apart from recycling paper and providing facilities for recycling plastics and aluminum, OSU also provides ways to dispose of electronics. One just needs to take their old cell phones, mp3 players, laptops, cameras, GPS systems, gaming equipment etc. to the Orange Tech Team in the Student Union and get free gift cards in return [9].

The Orange Tech Team in the Student Union refills and exchanges ink cartridges belonging to either individuals or departments.

Fig 4: Pepsi-co dream machine for collecting plastic bottles and aluminum cans

Partners:

Departments like the Physical Plant, Dining Services, Energy Conservation Program, Parking and Transit Services, and organizations like ECO-OSU, SGA Sustainability Committee, the Environmental Science Club, Net Impact, the Association for the Advancement of Sustainability in Higher Education, Oklahoma Recycling Association, and Sustainable Stillwater support the recycling programs conducted by OSU on campus

UDS (University Dining Services) at Oklahoma State University has introduced 'Tray less Tuesdays' at three of its dining units – Scott-Parker-Wentz, Blair Dining and the Adams Market. The program is aimed at eliminating unnecessary waste by abstaining from cafeteria trays.

OKRA (Oklahoma Recycling Association) a non-profit organization is one of the partners that aims at improving recycling by providing education and referral services about integrated solid waste management, including reduction, reuse and recycling [10].

Composting:

At present OSU has a very small composting program conducted by the Grounds Dept. The Grounds team collects landscape waste, transfers it to the composting area, and mixes it with horse manure from the nearby Rodeo Club. The finished compost is used as a fertilizer and mulch in OSU landscaping.

INTRODUCTION:

A waste stream analysis was conducted for six buildings by the Waste Audit and Sustainability Management Team during spring 2013 on the Oklahoma State University campus. The six buildings represent offices, classrooms, residential and mixed use space. The buildings selected for the project were the Student Union, Classroom Building North, Physical Sciences, Ag Hall, Kamm-Peterson-Friend residence hall and Family and Graduate Student Housing (FGSH). The selected buildings represent distinct waste generating sources like office rooms, dining services, conference halls, laboratories, classrooms and living quarters, which best represent the various types of waste streams found on campus. This project aims to enable the reduction of current waste and chemicals that are generated by buildings operations. The waste stream analysis gives valuable information about the quantity and quality of the wastes generated. The results obtained from the assessment of the waste stream will help identify the effectiveness of possible and potential diversion techniques and practices such as reduction, reuse, recycling and composting, which could reduce a huge portion of solid waste that finds its way to the landfill. The project also aims at bringing about awareness among the occupants of the buildings by providing them with the amounts and type of the wastes produced so they could become more careful and selective in using and disposing materials, which not only saves valuable money related to operating costs for the materials but also for discarding waste.

METHODS:

The spring 2013 Waste Audit and Sustainability Management team analyzed the type and quantities of waste from six campus buildings, namely the Student Union, Classroom Building North, Physical Sciences, Ag Hall, Kamm-Peterson Friend residential hall and FGSH by conducting a waste assessment for each building. The waste assessment was carried out in two steps. The first step of the waste assessment was the pre-audit. The pre-audit included a team of about six student volunteers participating in sorting out the waste. All the required supplies, such as the sorting containers, plastic sheeting, bags, tape, litter grabbers, sorting tables, scale, and hand-sanitizers were provided for the sorting process. An Environmental Health and Safety training by EHS personnel was given prior to the sorting process and equipment for safety, such as nitrile gloves, first aid kit, safety glasses, tongs etc. were provided. The sorting area was set up by spreading plastic sheeting on the floor; sorting containers were lined with bags and labeled with the names of categories assumed before the pre-audit. For the pre-audit one bag of waste was collected from each of the selected building before the audit day. The waste bags were labeled with details about the collection times and the date of collection. The pre-audit process helped in providing a better idea of waste characterization. Through the pre audit, 21 categories of wastes were identified. After characterizing the wastes, the second and important step of the waste assessment -the final audit was performed.

For the final audit, six bags of waste were collected from each building and their details were marked similar to the pre-audit process. All six bags of waste for each building were thoroughly sorted into their respective categories and after the sorting process was completed all the sorted categories were weighed and the percentage of each of the category's weight of the total weight was determined by deducting the sum of the tare weight of the bucket and liner from the total

weight of the waste material measured. The results from the data showcased what might have been recycled or composted for each building and also presented some recommendations for the improvement of existing programs for effective management of solid waste on campus.

DATA ANALYSIS:

Approximately 302.48 lbs of waste collected from the six buildings was sorted, weighed and analyzed. Analysis was carried out for each building and also in terms of each category's weight compared to the total weight from all the buildings.

Data for the each of the six buildings mentioned below is calculated

1. Classroom Building North

2. Family Graduate Student Housing (FGSH)

3. Agricultural Hall (Ag Hall)

4. Student Union (SU)

5. Physical Sciences Building

6 Kerr-Peterson Friend Residence Hall

Classroom Building North:

A total of 44.56 lbs. of waste was sorted from Classroom Building North. Food waste constituted the highest percentage for about 30.18% of the total waste from the building. This shows a great potential for food waste to be composted and diverted from the trash. The next highest percentages are taken by PLA and #1 and #2 plastics, which accounted for about 15.03% and 13.15% respectively.

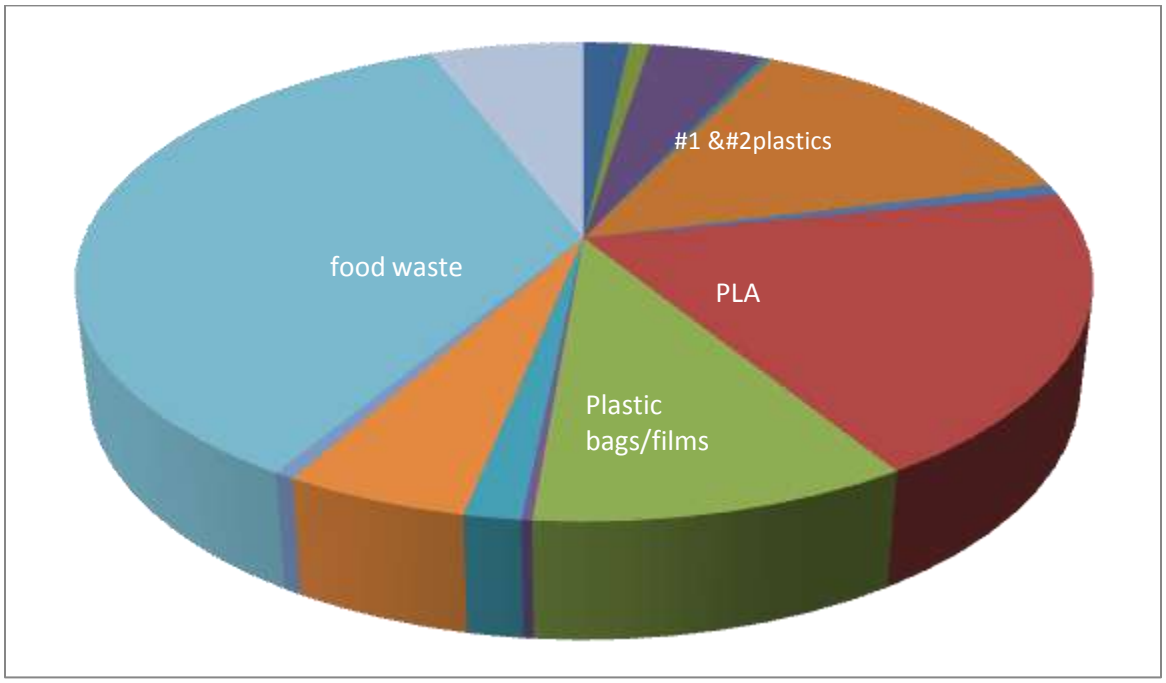

Figure 5: Pie chart representing the % of weight of each category of waste for the Building: Classroom Building North.

Table 1: Table showing the % of weight of each category of waste for the Building: Classroom Building North

No	Waste category	% Weight of the category
1	White paper	3.14
2	Colored paper	0
3	Newspaper, magazines	1.95
4	Non-recyclable paper	6.55
5	Paperboard & chipboard	0.40
6	#1 & #2 plastics	13.15
7	#3-#6 plastic	1.17
8	#7 plastic and PLA	15.03
9	Plastic bags/films	8.43
10	Styrofoam	0.8
11	Other plastic containers & lids	1.97
12	Glass	6.86
13	Aluminum	1.39
14	metals	0
15	Drink boxes	0
16	Corrugated cardboard	0
17	Food waste	30.18
18	Batteries	0
19	Trash	8.93
20	Others	0
21	Hazardous material	0

Family and Graduate Student Housing building (FGSH) :

A total of 51.4 lbs of waste was sorted from several apartment buildings namely X2, X3, N-10, N-25, S-80 within FGSH. Food waste constituted the highest percentage at about 43.67% of the total waste from the buildings. This shows great potential for food waste to be composted and diverted from the trash. The next highest percentages are taken by #1 and #2 plastics and plastic bags/films which accounted for about 9.18% and 4.04% respectively.

Figure 6: Pie chart representing the % of weight of each category of waste for the Building: FGSH

Table 2: Table showing the % of weight of each category of waste for the Building: FGSH

No	Waste category	% Weight of the category
1	White paper	0.95
2	Colored paper	0
3	Newspaper, magazines	0.33
4	Non-recyclable paper	2.76
5	Paperboard & chipboard	1.12
6	#1 & #2 plastics	9.18
7	#3-#6 plastic	1.24
8	#7 plastic and PLA	0
9	Plastic bags/films	4.04
10	Styrofoam	0.62
11	Other plastic containers & lids	0.58
12	Glass	0
13	Aluminum	0.13
14	Metals	1.125
15	Drink boxes	0.2
16	Corrugated Cardboard	1.55
17	Food waste	43.67
18	Batteries	0
19	Trash	28.92
20	Other	2.25
21	Hazardous material	0

Agricultural Hall (Ag Hall):

A total of 59.56 lbs of waste was sorted. White paper and newspaper/magazines constituted the next highest percentages for about 13.73% and 21.7% respectively of the total waste sorted from Agricultural Hall. This shows that a high percentage of waste that could be recycled is disposed as trash. The next higher percentage is taken by the plastic bags/films which accounted for about 11.21%.

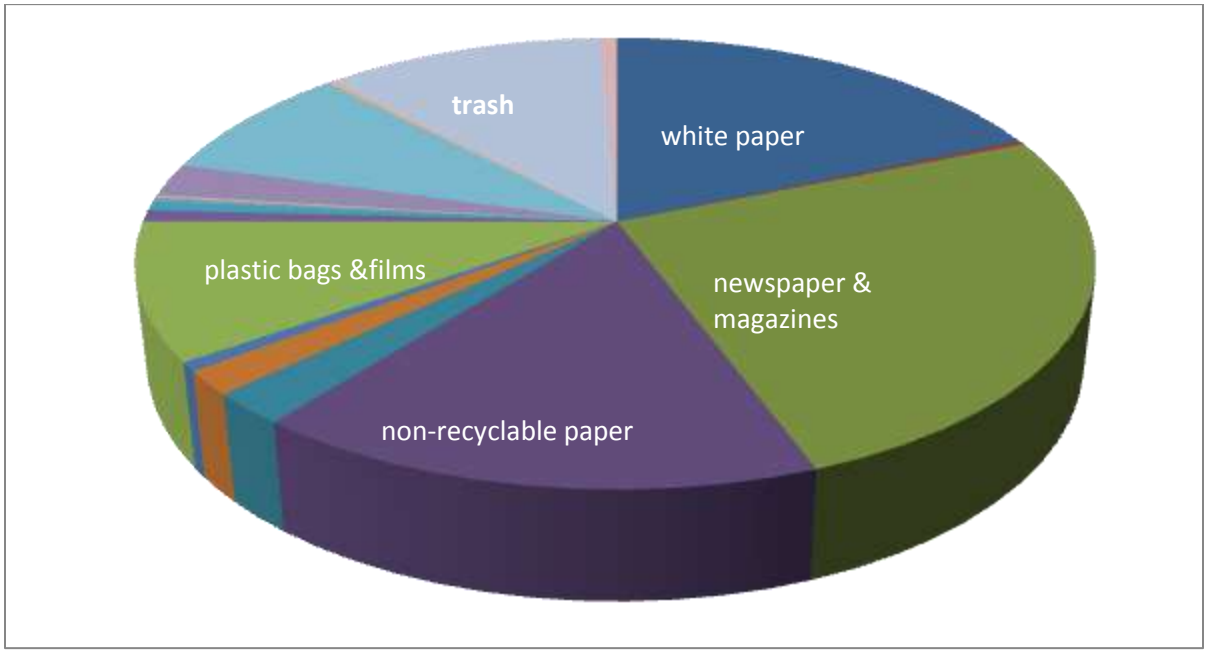

Figure 7: Pie chart representing the % of weight of each category of waste for the Building: Agricultural building

Table 3: Table showing the %weight of each category of waste for the Building: Agricultural building.

No	Waste category	% Weight of the category
1	white paper	13.73
2	colored paper	0.3
3	Newspaper, magazines	21.7
4	non-recyclable paper	18.53
5	paperboard & chipboard	2.58
6	#1 & #2 plastics	1.94
7	#3-#6 plastic	0.87
8	#7 plastic and PLA	0
9	plastic bags/films	11.21
10	Styrofoam	0.94
11	Other plastic containers & lids	0.73
12	Glass	0
13	Aluminum	0.33
14	Metals	0
15	Drink boxes	0.4
16	Corrugated cardboard	2.71
17	Food waste	9.67
18	Batteries	0.23
19	Trash	12.89
20	other	1.07
21	Hazardous material	0

<u>Student Union</u> (SU): A total of 52.23 lbs of waste was sorted. Food waste constituted the highest percentage at about 24.31% of the total waste from the building. This shows a great potential for food waste to be composted and diverted from the trash. Plastic bags/films and corrugated cardboard took the next highest percentages which accounted for about 17.76% and 13.15% respectively. It should be noted that one of the 13 large green dumpsters for cardboard is located at the Union.

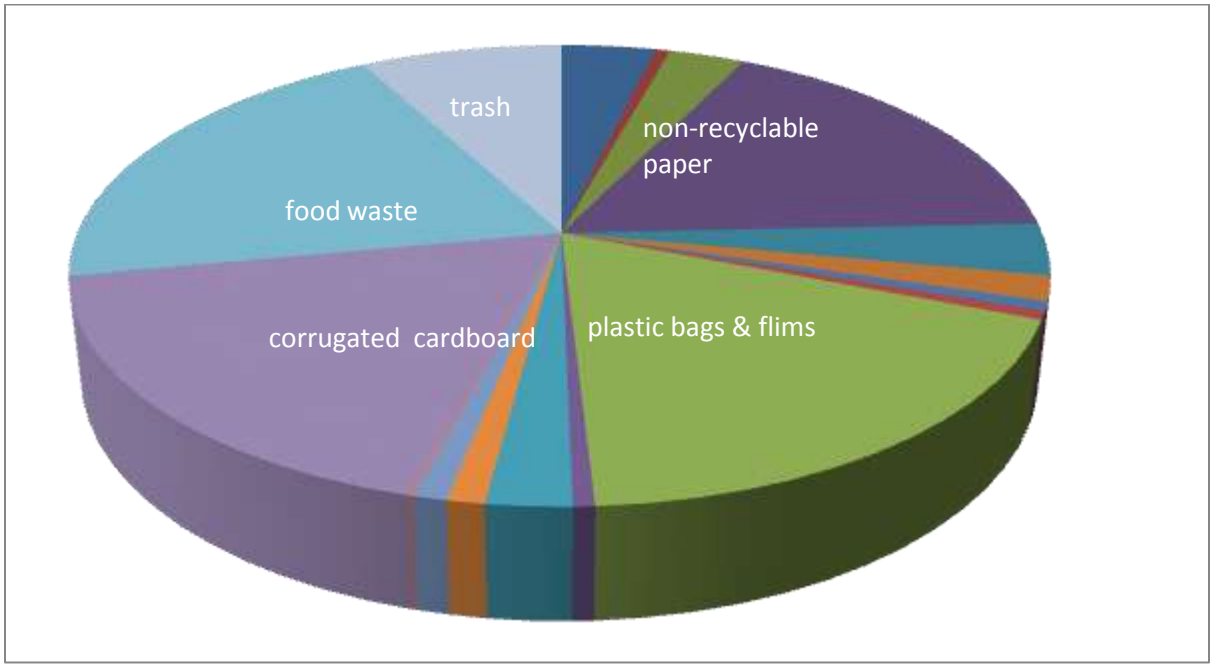

Figure 8: Pie chart representing the % of weight of each category of waste for the Building: Student Union

Table 4: Table showing the % of weight of each category of waste for Student Union

No	Waste category	% Weight of the category
1	White paper	4.48
2	Colored paper	0.68
3	Newspaper, magazines	3.59
4	Non-recyclable paper	12.25
5	Paperboard & chipboard	4.40
6	#1 & #2 plastics	2.10
7	#3-#6 plastic	0.76
8	#7 plastic and PLA	0.72
9	Plastic bags/films	17.76
10	Styrofoam	0.72
11	Other plastic containers & lids	2.87
12	Glass	1.26
13	Aluminum	1.14
14	Metals	0.15
15	Drink boxes	0
16	Corrugated cardboard	13.15
17	Food waste	24.31
18	Batteries	0
19	Trash	9.57
20	Hazardous material	0

Physical Sciences building:

A total of 48.3 lbs of waste was sorted. Food waste constituted the highest percentage at about 27.37% of the total waste sorted the Physical Sciences building. This shows a great potential for food waste to be composted and diverted from the trash. Both PLA and #1,#2 paper share the next highest 10.31% followed by corrugated cardboard which could be recycled. The high amount of food and food packaging waste at the Physical Sciences building may be attributed to dining waste from Newton's Café, which is located in a nearby building.

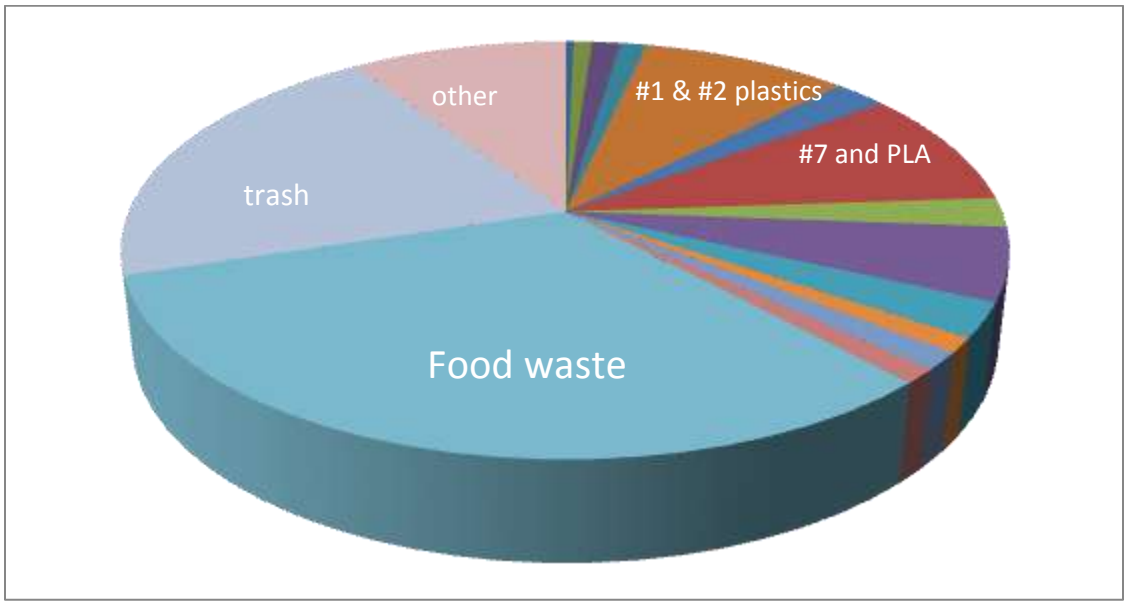

Figure 9: Pie chart representing the % of weight of each category of waste for the Building: Physical Sciences

Table 5: Table showing the % of weight of each category of waste for the Building: Physical Sciences.

No	Waste category	% Weight of the category
1	white paper	0.31
2	colored paper	0
3	Newspaper, Magazines	0.86
4	non-recyclable paper	1.40
5	paperboard & chipboard	1.28
6	#1 & #2 plastics	10.31
7	#3-#6 plastic	2.60
8	#7 plastic and PLA	10.31
9	plastic bags/films	2.60
10	Styrofoam	6.41
11	other plastic containers & lids	3.02
12	glass	1.28
13	aluminum	1.55
14	metals	1.28
15	drink boxes	0
16	corrugated cardboard	0
17	food waste	27.37
18	batteries	0
19	trash	18.67
20	other	10.68
21	hazardous material	0

KPF (Kerr-Peterson-Friend) residence hall:

A total of 45.6 lbs of waste was sorted. Number1 and #2 plastics constituted the highest percentage by weight of the total waste sorted from the Kerr Peterson-Friend residence hall at about 20.53%, which means that recyclables are being dumped as trash into landfills. Newspaper and magazines account for about 20.51%, which could also be recycled. Food waste accounted for about12.4%

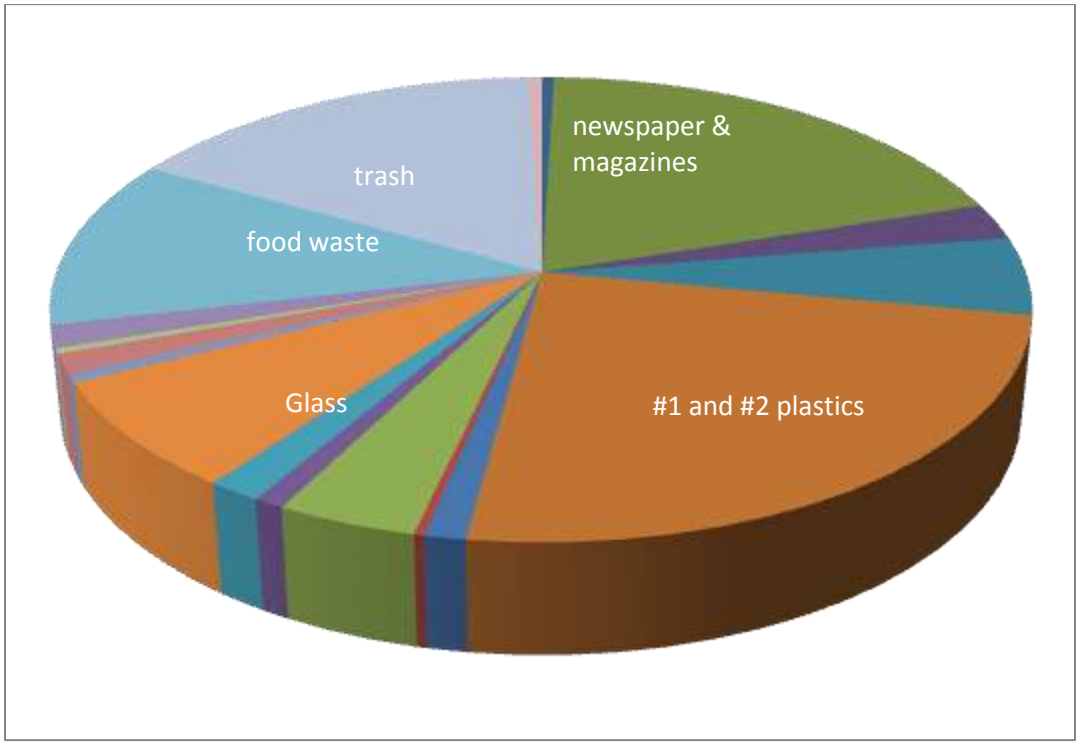

Figure 10: Pie chart representing the % of weight of each category of waste for the Building: KPF (Kerr Peterson Friend) residence hall.

Table 6: Table showing the % of weight of each category of waste for the Building: KPF (Kerr-Peterson-Friend) residence hall.

No	Waste category	% Weight of the category
1	White paper	0.43
2	Colored paper	0
3	Newspaper, Magazines	20.51
4	Non-recyclable paper	2.670
5	Paperboard & chipboard	5.65
6	#1 & #2 plastics	20.53
7	#3-#6 plastic	1.22
8	#7 plastic and PLA	0.30
9	Plastic bags/films	4.20
10	Styrofoam	0.92
11	Other plastic containers & lids	1.62
12	Glass	7.93
13	Aluminum	0.56
14	Metals	1.40
15	Drink boxes	0.39
16	Corrugated cardboard	1.62
17	Food waste	12.4
18	Batteries	0
19	Trash	17.0
20	Other	0.56
21	Hazardous material	0

Six buildings analyzed by category of waste:

A total of 302.48 lbs of waste was sorted from the six buildings. Food waste constituted the highest percentage at about 24.21% of the total waste from the six buildings. This shows a great potential for food waste to be composted and diverted from trash. Paper (white paper, colored paper and newspaper or magazines) constituted about12.89% and#1 and #2 plastics accounted for about 8.99%.

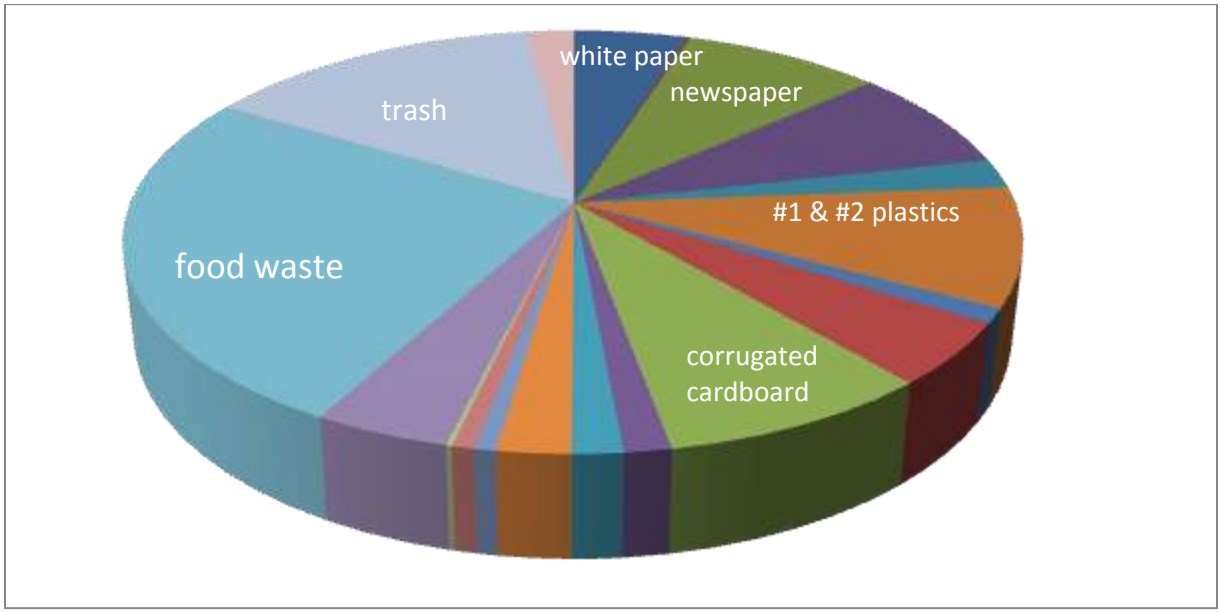

Figure 11: Pie chart representing the % of weight of each category of waste to the weight of the waste sorted from all the six buildings.

Table 7: Table showing the % of weight of each category of waste to the weight of the waste sorted from all the six buildings

Categories of Waste	Total Weight	% Weight of each category	Products generated in the municipal waste stream, EPA 2010
White paper	12.76	4.22	Not available
Colored paper	0.54	0.18	Not available
Newspaper, magazines	25.68	8.49	5.0
Non-recyclable paper	23.68	7.82	1.4
Paperboard & chipboard	7.8	2.58	15.1
#1 & #2 plastics	27.19	8.99	1.4
#3-#6 plastic	3.9	1.29	Not available
#7 plastic and PLA	12.2	4.03	Not available
Plastic bags/films	24.98	8.257	1.6
Styrofoam	5.14	1.69	Not available
Other plastic containers & lids	5.32	1.75	1.8
Glass	7.96	2.63	7.5
Aluminum	2.55	0.84	0.53
Metals	2.36	0.78	1.1
Drink boxes	0.68	0.22	Not available
Corrugated cardboard	10.03	3.31	11.6
Food waste	73.24	24.21	13.9
Batteries	0.14	0.04	1.3
Trash	48.31	15.97	Not available
other	7.22	2.38	Not available
hazardous material	0	0	Not available

Recommendations:

- Food waste constituted the highest percentage at about 24.21%, non-recyclable paper accounted 7.82%, PLA made-up 4.03% and corrugated cardboard consisted of 3.31%, all these categories summed up to a staggering 39.37% which is almost half of the total weight sorted from the six buildings. This number strongly implies a need for setting up a commercial-scale composting facility which can divert a great portion of waste from being dumped into the landfill.

- **Reduce, Reuse, Recycle:**

  Reduce- From the Student Union data we can see a high percentage of non-recyclable paper which may be due to the paper towels from the rest rooms. In this case an electric hand dryer could be considered as an alternative to reduce paper production. Production of waste from offices can be reduced by making documents double-sided instead of printing on only one side.

  Reuse – Disposable cups in the waste stream can be replaced by durable cups that can be washed and used over and over again; reuse of packing materials that are used for shipping should be encouraged. Cloth bags should be used instead of plastic bags, which are very harmful to the environment.

  Recycle –Implementing recycling programs for items that can be recycled such as water bottles, office paper, aluminum or steel cans should be done even more actively.

- **Education:**

  The school provides plenty of bins separately for bottles and cans, in spite of this there is a high percentage of #1 and #2 plastics, which accounted for about 8.99% of the total weight sorted from all six buildings. This calls for active departmental and peer-to peer education programs on campus. An aggressive commitment to education of faculty, staff, students and visitors to the University on why and how to recycle using different educational methods and outreach tools like social media, presentations, flyers, posters, movies etc. is very critical. Employer education especially in University Dining Services on the campus is essential so that they can supervise the activities of the employees. Periodic inspections of employer and employee activities by the leaders of the recycling programs would improve the results of recycling programs.

- The existing signage of the bins in the Student Union is ambiguous, presently ‘plastic only’ labeled bins are placed next to ‘trash only’ bins, but the plastic only bins receive all kinds of plastics. Hence it is recommended to adopt better and clear signage. It is also

important to educate people about different plastics that exist which can be identified through the 'Plastic Identification Code' (the number inside the recycle symbol).

- Separate bins with a single slit opening should be placed so that corrugated cardboard is flattened before disposing and not mixed with trash.

- Conducting special events like Earth Day (April 22) or contests, awards for best recycling department etc. would motivate people to engage more and more in recycling activities.

AUDIT IMAGES

Volunteers sorting the waste collected from the six buildings

Weighing and recording the sorted wastes

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