

Diving Into the Depths of the Desolate Dumpster 3.0

An Audit of Physical Waste and Energy Consumption on Furman's Campus

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I. Introduction

Because solid waste accounted for a mere 0.6% of Furman's carbon footprint during the year 2010, it is often disregarded as an issue that can be dealt with in the future as opposed to one that must be addressed immediately, such as that of unsustainable energy consumption in campus buildings—particularly in residence halls. Such energy consumption, on the contrary, accounted for 56% of the campus' carbon footprint. The energy and waste audit data collected here have the potential to aid in further improving the energy-efficiency of buildings on campus, one of eight strategic goals to reach carbon neutrality found in "Sustainable Furman," the university's sustainability master plan. The data will also create a foundation upon which to create a specific recycling and waste management master plan for campus in the near future.

The threat of global climate change associated with the unsustainable consumption of fossil fuels (particularly coal) has made its way via the media into the public sector as common knowledge; however, awareness of the environmental consequences associated with solid waste disposal is still quite limited. Such consequences include increased methane emissions and contamination of groundwater from leachate, not to mention the economic cost of the transportation, treatment, and disposal of the waste. Landfills contribute to global warming when municipal solid waste emits metric tons of methane as it decomposes in the ground. Methane gas has a global warming potential >20 times greater than that of carbon dioxide over a 100-year period. After being buried in a landfill for a century, mixed and white paper will emit approximately 616.6 m3/hr./yr. of methane. Cardboard will emit 282.87 m3/hr./yr., textiles 140.6 m3/hr./yr., putrescible items 78.52 m3/hr./yr., and composted sewage sludge 64.07 m3/hr./yr. (Pan et al 2007).

Furman's recycling program currently accepts both mixed paper and cardboard, in addition to plastic #'s 1-2 (PE, PET, HDPE), and aluminum cans; and numerous buildings on campus have obtained various levels of LEED certification. Despite the proactive efforts of the university, however, this data collection demonstrates a pressing need for a behavioral change in faculty, staff, and students, geared toward gaining an awareness of the implications of their personal energy consumption and waste production.

II. Literature Review

- Various factors influence the energy consumption of the residential sector, including the age of the dwelling, its type (terraced, double, individual, flat, etc.), the total floor area, the primary energy source, and whether or not it is centrally heated (Hens et al. 2001).
- Other independent variables include the location and orientation of the house/building; composition of the family group (inhabitants); the time spent at the home/building and activities of each resident; electric and gas equipment in each room; consciousness of energy saving; and income levels of residents (Lucas et al. 2001).
- Energy consumption appears to increase as time spent in the home/dormitory/apartment increases, as the number of residents increases, and as the perceived comfort of the residence increases (Lucas et al. 2001).
- Energy consumption appears to decrease as environmental awareness increases (Lucas et al. 2001).
- CO_2 emissions from residential energy usage can be reduced with the substitution of fuels with high emission per MJ by fuels with lower emissions per MJ, implementation of a well performing heat pump technology, substitution of fossil fuels by renewable energy, and enhancing the energy efficiency of buildings by retrofitting (Hens et al. 2001)
- An analysis of the waste stream at the Campus Mexicali I of the Autonomous University of Baja California (UABC) showed that out of the ton of solid wastes produced per day on the campus, 65% could have potentially been recycled. In academic buildings, 44% of the waste was attributed to mixed paper and cardboard. Organic wastes composed 80% and 54% of the waste streams of the garden and of the community center respectively (Armijo de Vega et al. 2008)
- At the Prince George campus of the University of Northern British Columbia (UNBC) during the 2007-2008 academic year, researchers found that 70% could have been diverted from the waste stream. Paper and paperboard made up the highest proportion of the campus waste stream (29.1%), followed by non-recyclable material (28.4%), and compostable organic material (21.6%) (Smyth et al. 2010).
- Suggestions to reduce paper waste include using electronic instead of print media, creating campaigns to promote the reutilization of brown envelopes and unused sides of paper, and the use of printers capable of duplex printing (Armijo de Vega et al. 2008).
- Organic waste can be significantly reduced by implementing composting practices on campus. Camosun College, in Victoria, British Columbia, established a food waste composting program in 2003 that diverts 51 metric tons of organic waste annually. In 2008, Northwest State Community College in Ohio installed the A500 Rocket composter, which has an in-vessel design that served to divert nearly 4,000 tons of food waste from landfills at the campus alone. It is capable of treating 80 gallons of food waste per week (*PRWeb Newswire*, 2010).
- Other strategies to divert recyclables from the campus waste stream include replacing poorly labeled, unevenly distributed recycling receptacles and strategically positioning these receptacles throughout campus, making them more noticeable and accessible to students, faculty, and staff (Smyth et al. 2010).

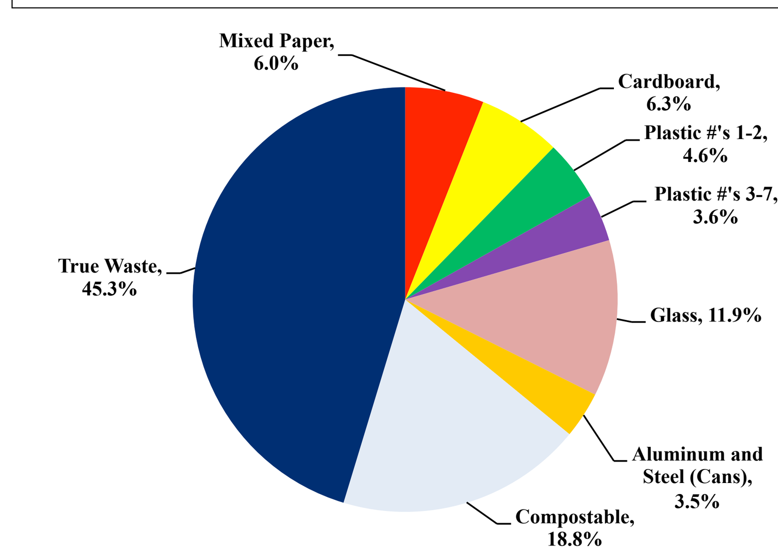


Figure 1 (left): Composition of the Total Campus Waste Stream by Weight

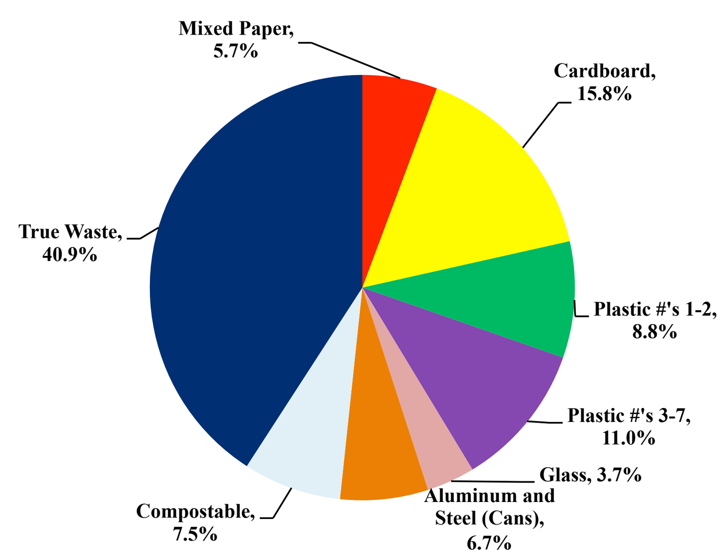


Figure 2 (right): Composition of the Total Campus Waste Stream by Volume

III. Methodology

Waste Audit:

- Audits took place on Tuesday and Friday afternoons from September 2010 until March 2011.
- Samples were extracted from fourteen waste collection sites on campus serving all residential buildings.
- At each site, 40-50 pounds of waste were extracted and then sorted into the following categories: mixed paper, cardboard, plastic #'s 1-2, plastic #'s 3-7, glass, aluminum and steel, compost, and true waste (waste not belonging to one of the previously mentioned categories). Weight and volume measurements for each category were recorded.
- Recyclable materials found during the audits were diverted from the waste stream to the proper receptacles for recycling.
- Materials required for the study included trash can liners, a standard household scale, measuring tape, several 2,211 in^3-volume plastic blue containers, calculators, latex gloves, Tyvek suits, and a golf cart to transport materials to and from waste collection sites.
- Point features were placed at all dumpster locations sampled to create a new data layer.
- Values for each point feature and fields containing all collected data were manually added to the dumpster layer attribute table.
- Dumpsters were represented with a graduated symbol scheme in order to represent the total percentage of recyclable materials found in each.

Energy Audit:

- Data were obtained from Facilities Services containing monthly energy usage in kWh and heated square footage for all residential buildings on campus (Lakeside Housing, South Housing, all North Village apartment complexes, and the Greenbelt Community).
- This data were cleaned in Microsoft Excel, and this spreadsheet was joined to an attribute table for a campus buildings data layer in an existing shapefile in ArcMap.
- Two new fields were added to this attribute table in which the field calculator was used to determine the total annual energy consumption for each building and the kWh usage per heated ft^2 per year.
- A polygon representing the Greenbelt Community was manually drawn over the four eco-cabins as represented in the aerial photo of campus serving as the base layer for all maps created; this value was manually added to the attribute table.
- A graduated color scheme was used to represent energy usage in kWh/ft^2 in which buildings were placed into four classifications using the quantile method.
- All maps were projected with the Lambert Conformal Conic projection.

IV. Data Collection

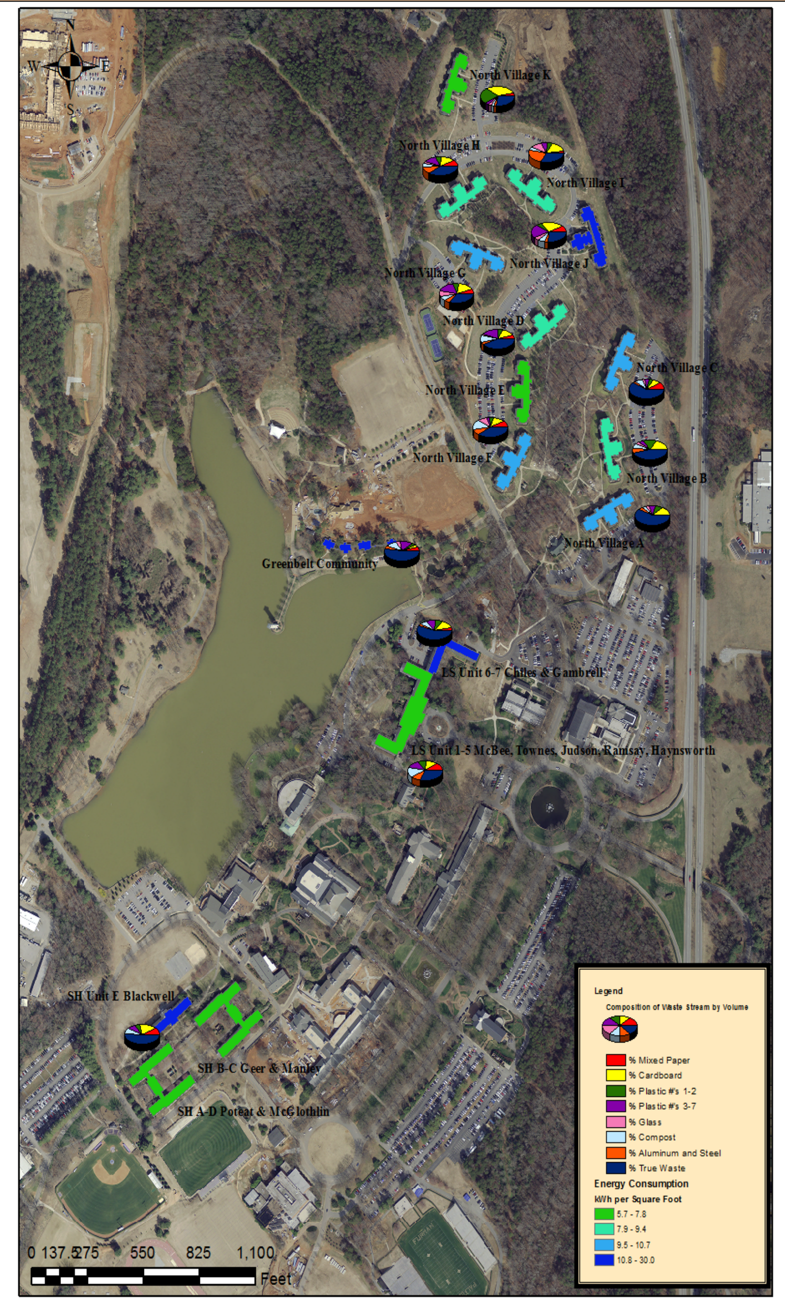
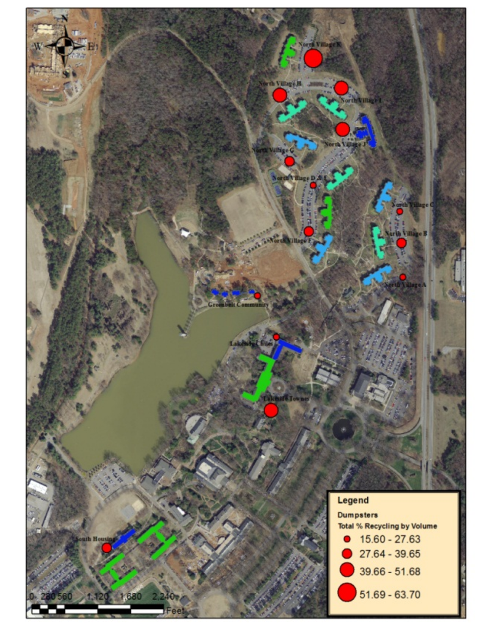
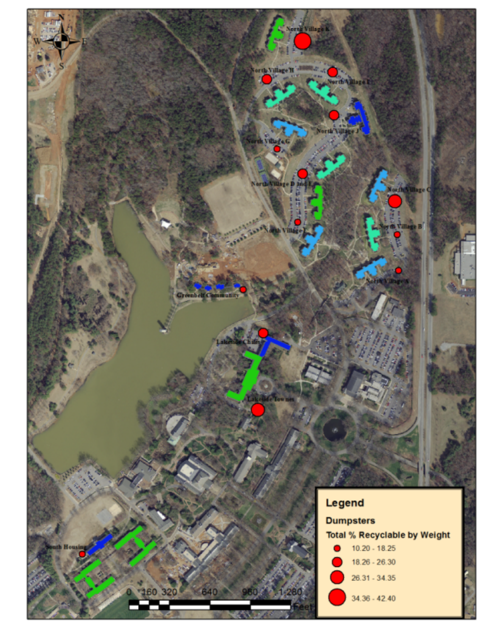


Figure 3: Composition of Residential Waste Stream by Volume

Figures 4 (above) and 5 (below): Percent Recyclables by Volume and by Weight (respectively)

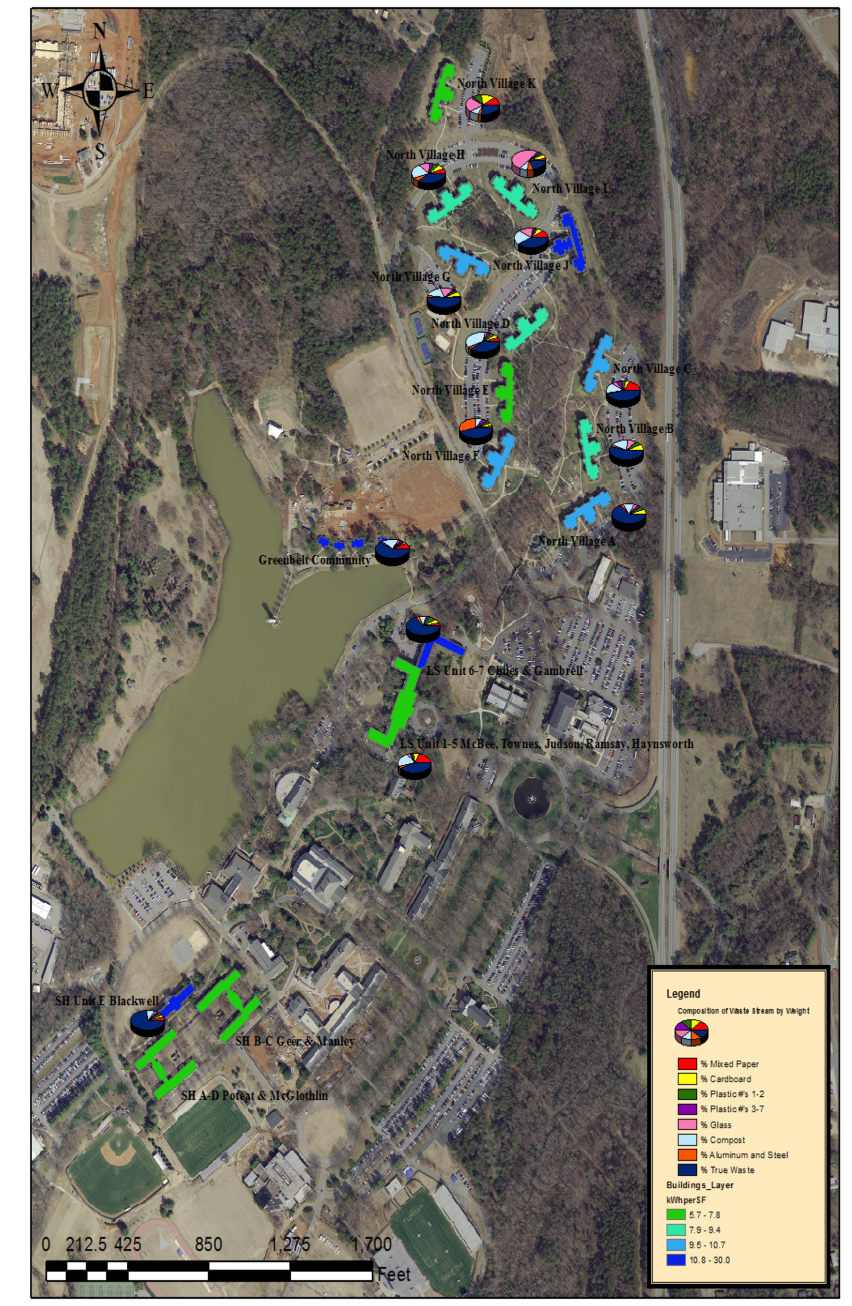


Figure 6: Composition of Residential Waste Stream by Weight

V. Discussion and Conclusions—Waste Audit

Pie charts were used to represent the composition of the waste stream of the entire campus (Figures 1 and 2) and of each individual residential building (Figures 3 and 6). Out of 633.5 lbs. of residential waste sampled, 128.5 lbs. (20.3%) could have been recycled with Furman's recycling program, and 346 lbs. (54.6%) could have been recycled at a typical recycling center. By volume, 227,573.1 in^3 (37%) of the total waste stream could have been recycled with Furman's program, and 363,626.9 in^3 (59.2%) could have been recycled at a typical recycling center. Compostable material made up the largest proportion of the recyclable waste stream by weight (18.8%/119 lbs.). Because food waste is not currently accepted by Furman's recycling program, with the exception of small post-consumer compost tumblers outside of the cabins in the Greenbelt Community and pre-consumer composting in the dining hall, these data imply a need to expand composting efforts on campus. Of all recyclable materials accepted by our current program, cardboard made up the heaviest proportion (6.2%/39 lbs.) and also the largest proportion by volume (15.8%/97,101.8 in^3). Cardboard also made up the largest percentage of the recyclable waste stream in the 2009-2010 academic year (7% by weight and 13% by volume). These numbers indicate the need for the placement of more recycling receptacles at or near residential buildings in response to the large volume of cardboard and paperboard found in and around the dumpsters. Students should also be reminded to break down and compact their boxes before disposing of them in order to decrease their volume, allowing more to fit into the recycling receptacles available.

Of all residential buildings on campus, North Village K contained the most recyclables by weight (18 lbs./42.4%) and by volume (28,050 in^3/63.7%) according to Furman recycling standards. North Village I contained the most recyclables by weight in its waste stream (44 lbs./81.5%) and North Village J contained the most by volume (34,924.2 in^3/74.5%) based on standards of a typical recycling center. These discrepancies can be explained by the significant amount of glass found in the North Village I dumpster (26 lbs./48.1% of waste stream), as glass is the heaviest category of waste classified by this study. A vast majority of this glass was attributed to alcoholic beverage containers, which experienced an influx in both weight and volume from the 2009-2010 academic year, most likely as a result of Furman's new alcohol policy, which allows students who are 21 years of age or older to consume alcohol in their North Village apartments. North Village J contained a large proportion of plastic #'s 3-7 in its waste stream—plastics that tend to compose large volumes at lighter weights.

Lakeside Townes contained more mixed paper by weight (7 lbs./18.9%) and by volume (8,800 in^3/10.5%) than any other residential waste stream on campus. This large proportion of paper could be attributed to the fact that both Johns Hall and Furman Hall occasionally use this dumpster. North Village K contained the most cardboard in its waste stream by weight (7 lbs./16.5%) and by volume (15,427.5 in^3/35%), followed closely by North Village J. Because J contains two additional meeting rooms that are often used by sororities, fraternities, and other campus organizations for meetings, Greek life formal recruitment, and Cultural Life Programs, large amounts of cardboard in the waste stream are to be expected, most likely as a result of packaging materials from food, equipment, etc. used in these meetings. North Village D and E contained the largest proportion of compostable material in its waste stream (20 lbs./34.8%), closely followed by the Greenbelt Community (9 lbs./21.4%). Most of this compost was attributed to food waste. These results from the Greenbelt Community may seem ironic, due to the composting efforts at the cabins. It should be noted that similar results were found during the 2009-2010 campus waste audit (10.5 lbs./27% of waste stream). These results can be justified, however, by factoring in the possibility that some unknown portion of the waste sampled here could have been attributed to visitors of Furman's campus, not the students residing in the Greenbelt Community, because as determined by the distance measuring tool in ArcMap, this dumpster is only 30 feet away from the walking/biking path encircling Furman Lake, which is often used by the public.

VI. Discussion and Conclusions—Energy Audit

No relationship was found to exist between the amount of energy consumed by each residential building and its waste stream. According to the data collected, the Greenbelt Community consumed the most energy (30 kWh/ft^2), followed by Blackwell Hall (12.6 kWh/ft^2), and North Village J (11.2 kWh/ft^2). In this case, the energy consumption of the Greenbelt Community can be considered an inconclusive outlier, as it was determined that the energy consumption of the streetlights around the Lake was also accounted for on this meter, and possibly that of other surrounding buildings as well (such as the Shi Center); however, specific numbers for the outside sources of consumption are not currently available. Because Blackwell Hall is home to the most students in the smallest amount of space, these results for energy consumption seem appropriate. It seems reasonable that North Village J would consume more energy than other North Village apartments because it contains two additional meeting rooms, kitchens, and a computer lab. Lakeside Housing (McBee, Townes, Judson, Ramsay, and Haynsworth) had the lowest energy consumption (7.8 kWh/ft^2), followed closely by South Housing. All North Village apartments, with the exception of North Village E, K, and J, have energy consumption levels ranging from 7.9 to 10.7 kWh/ft^2, all of which are higher than energy consumption levels in the dormitories. These results can be explained by the additional appliances found in the apartments, additional kitchens and bathrooms, increased time spent in the apartments, and an increased perception of comfort in the apartments, as they are more spacious and hospitable.

VII. References

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5. With the Launch of a Rocket(R) Composter, Northwest State Community College opens a new frontier in green technology in the US. (2010, March 2). *PRWeb Newswire*.