Environmental Practicum 301

Changing the Landscape at Denison: Envisioning Sustainability

Final Report

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I. Introduction

This report is written with the intent of facilitating the newly established Campus Environmental Task Force in determining steps that can be taken immediately – as well as over the long term – to increase Denison's leadership in environmental sustainability. During the course of the Fall 2007 semester, the Environmental Studies 301 class conducted an audit of Denison that determined some of the areas in which we could improve our environmental sustainability. What follows is the result of this research. In order to better understand the process that led to our final recommendations, we will first begin with a brief summary of the semester's activities.

At the beginning of the academic year, there were two impetuses that led to our focus on campus sustainability. The first was the creation of the Campus Sustainability Venture Fund. The Venture Fund began as a result of the donation of $100,000 by John R. Hunting '54 to the Denison University Environmental Studies Program in 2005. A portion of this funding has already been applied to the installation of solar panels on Howard Doane Library, but over $50,000 of this money has been stipulated to go toward establishing a sustainability venture fund that would serve, "…to cover costs of experimental projects dedicated to promoting sustainability/conservation and resulting savings on the Denison campus" (Schultz and Chonko 2005). The information gathered from this assessment became the basis for conducting several small-scale projects in order to determine the overall feasibility and efficacy of those ideas. During the implementation of these projects, we developed an application system for the Venture Fund. Our project divided into three distinct phases: "reconnaissance," "implementation," and "presentation" (our final report), for which further explanation is provided below. All actions taken and recommendations made are based with the message of the Mission Statement for the Fund in mind:

> "The Campus Sustainability Venture Fund serves to help establish a campus sustainability plan for Denison's campus. This fund exists to help Denison become an innovative leader in campus sustainability, through working to implement changes in the way that our community uses its resources. This fund supports students and organizations that wish to improve the environmental state of Denison's campus, but who lack the financial means to do so. Students, faculty, and organizations are encouraged to submit proposals for projects that range from $100 to $5000 in capital and/or operating costs."

The second reason for the semester's focus was the recommendation of a campus sustainability committee by Denison's Finance Committee in early 2007. With this recommendation, we felt that our timing for campus sustainability research was very appropriate. Throughout the semester, the idea of a committee has been debated by University Council and then the Faculty Senate, resulting in the creation of an Environmental Task Force. Based on the knowledge that has been gained throughout the course of this semester, our class has compiled this report in order to help assist the newly formed Environmental Task Force. The following are summaries of each phase that has led to the information and recommendations found in this report.

Phase I: Reconnaissance

During this step, over the course of four weeks, our class investigated the present state of sustainability at Denison University. Divided into four groups – energy/utilities/appliances, food, heating, and purchasing – we discovered where Denison's strengths and weaknesses lay with regard to environmental sustainability. This involved finding out pertinent information about aspects of the school's operation, including: total paper used at Denison; present availability of recycled products; food waste disposal; composition of food supplies (including disposal of dining products such as napkins and utensils); energy used by lights, appliances and computers; and the efficiency of the campus HVAC (heating, ventilation and air conditioning) system. We proceeded in this phase with the intention of procuring information about the status quo – how things presently work on campus – in order to see which areas are the most important for advancing sustainability and what implementation of the necessary changes might entail. While the four groups had to approach our topics from different angles, the final set of data was comprised of quantitative and qualitative data and collected through an assortment of relevant methods and measures.

Phase II: Implementation

After gathering requisite information in Phase I, our class decided to conduct "pilot projects." The purpose of these small projects was to test the feasibility and efficacy of sustainability projects suggested in Phase I, as well as to determine the most efficient application process for Venture Fund grants. Based on the outcomes of Phase I, we divided into the following groups: Biodiesel (which worked on further researching how dining hall waste cooking oil could be turned into biodiesel); student recycling (more recycling on Academic Quad); faculty recycling (more recycling bins within academic departments); and water/utilities (reducing Mitchell Athletic Center's water consumption through laundry services). All groups conducted a pre-test before starting their project. That is, we measured what the baseline data was for a given topic – such as recycling on Academic Quad – before we made changes. This enabled us to have quantitative data available to determine if our projects did indeed help increase campus sustainability. After several weeks of work obtaining the necessary resources for our projects and implementing those projects, we conducted a post-test for comparison. Through these pilot projects, we were able to further our knowledge of current campus sustainability and future steps that should be taken.

Phase III: Final Report

This final report is the summation of the previous two phases. We have compiled the most pertinent information into a final report, highlighting the most important areas in which Denison can improve its environmental sustainability. Our hope is that the following will serve as a catalyst for the greening of Denison's campus and help us to demonstrate leadership in the area of environmental sustainability.

II. Energy

Perhaps the largest adverse environmental impact created by a university is the air pollutants and carbon dioxide emissions that are produced by heating and cooling and also the use of electricity. Even though much of the energy is generated off campus, the implications of the mining, transport, and combustion are serious. Such activities contribute to poor air quality, water pollution, climate change, and ozone depletion (Creighton 2007). By reducing our consumption and making our technology more efficient, Denison can decrease its impact on the surrounding environment.

Heating, Ventilation, and Cooling

College campuses use large quantities of off-site energy and consume fossil fuel resources at their own production facilities to provide for buildings' heating, ventilation, and cooling (HVAC) systems. In the 2006-2007 academic year alone, Denison spent $761,238 million burning coal for heat production (Chonko 2007 a). More specifically, over three million pounds of coal were burned to heat buildings on campus in a period of only three months from March to May (Chonko 2007 a). With such a high rate of consumption of coal, not to mention natural gas and fuel oil or the energy used for cooling, the carbon output from Denison's HVAC systems is staggering.

The large degree of variation between Denison's HVAC systems in both age and specific operation make effective control difficult and this is only exacerbated by the actions of students, staff, and faculty who live and work in campus buildings, opening doors and windows and resetting thermostats to meet their comfort wants. Additionally, the height of many campus buildings, especially some academic buildings, is such that "stacking" can occur, which is a process by which the upper portion of the building reaches a higher temperature and pressure and forces air flow out of the building enclosure while the opposite occurs at the base of the building (Lstiburek 2007). This process can make heating and cooling highly inefficient. It is especially prevalent in buildings with very open vertical air-mass connections such as large stairwells, and elevator shafts. However, if the HVAC systems operating in these buildings are well designed and properly managed, their efficiencies can be kept high and the overall campus environmental impact can be greatly reduced. The following sections provide details on ways this can be accomplished.

Methods of Cooling

There are a number of different means by which Denison buildings are cooled in the summer and fall months, concentrated most heavily among the Academic buildings and the apartment style residential buildings.

Eighty-three percent of the academic buildings on Academic Quad receive their cooling from a loop that runs through each building. It is produced at two central production locations near Academic Quad, augmented by smaller chillers in some of the buildings. All production units feed into the loop and the system is designed to run only the minimum number of units necessary at any given time.

North (with the exception of Taylor and Ash), East, and West quads are minimally air conditioned, some partially, some with window units in the public lounge spaces only, and some on a split system typical to a residential house system that includes an exterior and interior component to the production. Taylor and Ash on the North quad, and Burke Hall on South Quad are air conditioned by a chilled water system that is exclusive to each respective building (Pearson et al. 2007).

Methods of Heating

Heating and Cooling Methods:

- Heat—steam, gas, hot water
- Cool—chilled water, individual chillers

Denison employs several different methods of heating, most of which rely on steam produced at the central heating plant in Granville or individual boilers in the basement of some older buildings. The central plant steam is produced by the combustion of coal, natural gas, and fuel oil and then distributed through a network of underground pipes from the plant to each of the buildings it serves (~65% of buildings analyzed). The steam is used to heat water or fan coils (for forced air), after which the steam or water can be pumped through finned-tube and radiator units in individual rooms. The forced air is sent through the ductwork through ceiling vents in rooms. Ideally, an efficiency study of the steam line network should be completed in the near future by determining the temperature and pressure at the point of entering each building (Pearson et al. 2007).

Some notable exceptions to the steam line network are the North quad buildings, which each have their own boilers for heating by radiant or forced air. This independence allows opportunities for more site-specific heating practices, but many of the systems date back to the building's original construction, lending doubt to their efficiency. This is another area that merits further investigation.

Another variation from the steam line system is those buildings with Air Handling Units. These units are located in the on the roof and in the attic space and provide forced-air heating to their respective building. These units, not unlike air conditioning units, require a great deal of energy and are susceptible to faults and inefficiency in the ductwork used to move the air through the building. The duct joints can loosen and open and improperly insulated sections provide an area of high heat loss and should be checked for structural integrity, heat transfer efficiency, and flow volume at source and output.

<u>Steam Use</u>

The steam line network feeds some buildings for uses other than driving their heating systems. Forty-three percent of campus buildings produce hot water by means of the steam, some in addition to general heating. A small percentage (10%) use the steam as is and pipe it directly into their heating units.

<u>Gas Use</u>

As mentioned above, 100% of the North Quad buildings draw their heat from gas-fired boilers in the basements. The "summer" classification in physical plant records refers to two Academic

quad buildings that possess large, gas-fired boilers used during the summer on a loop system supplying certain academic buildings on an on-demand basis.

Hot Water

Hot water is produced in 63% of buildings by gas-fired boilers that are not the primary building heat source (with the exception of North quad). Thirty-five percent use electric systems involving immersed electric heating coils or elements in the tanks or pipes, and 29% use steam (Pearson et al. 2007).

General Building Construction Effects

Generally speaking, Denison's buildings can be split into two categories of construction: masonry and brick, and wood structure. Each type of construction affects HVAC performance in different ways and care must be taken to tailor the design and management of those systems to account for these characteristics. The design and construction of a building's "enclosure," which is any part of the system of structural walls, air/vapor barriers, air spaces, insulation, and exterior cladding, have a profound effect on the function of any HVAC system operating within. A building's enclosure can be a large source of heat loss.

The ability of a material to store and transfer heat increases with its structural strength and density, so those buildings built primarily of masonry and brick will require either much thicker walls or more insulation than buildings constructed primarily out of wood (Straube 2007). Buildings such as the Sunsets, Elm, Maple, Beth Eden, Gilpatrick, and other houses on campus are constructed with wood framing. Most other buildings on Academic, East, West, and North Quad are masonry or brick buildings. Many masonry buildings on campus are also framed with steel studs, which will allow more heat loss than wood studs. When not insulated, the air cavities between the studs offer a minimal heat barrier while also providing opportunities for heat loss through the space.

With such a large number of tall buildings that, according to Art Chonko, the director of Facilities, are "largely not insulated", it is very probable that a good deal of energy and money is being spent to make up for heat lost through the building enclosures (Chonko 2007 a). Installation of any sort of insulation is obviously better than none, but in recent years, an insulation material known as Spray Polyurethane Foam (SPF), or simply "sprayfoam," has been quickly taking over the market (Schumacher 2007). As the name implies, the foam is sprayed on and expands to fill the cavities between studs, blocking heat loss and actually serving as a vapor/moisture barrier at the same time. This new method of insulation comes at a higher price, but engineers who work to improve HVAC and water-shedding efficiencies of buildings around the country are recommending it as worth the extra cost (Durston 2007).

Window and Door Efficiency

Entry and exit points and windows are also areas in which heat loss is high. However, there are several of efficiency boosting measures, such as double-paned windows and two-stage and/or revolving doors. Each contributes to increased efficiency by reducing the volume of air that is transferred to and from the outside environment.

Double-paned windows are described as a window unit composed of two panes of glass with an evacuated air space between the frames. This design aspect is important due to its ability to reduce heat transfer by conduction. A single pane will readily pass on the heat from the inside in winter and the heat from the outside during summer, allowing 20 times as much heat loss than double paned windows (Snell et al. 1976). The evacuated air space between the two panes creates a thermal gap due to the fact that heat cannot pass through a vacuum.

As learned from Mr. Chonko, Denison has made a conscious effort to replace the single-paned windows in buildings across campus as they are renovated. Those efforts are strongly reflected in that 75% of the buildings on campus have double paned windows. Remaining single-paned windows are concentrated on the South residential quad and main academic quad (Chonko 2007 a).

Two-Stage and Revolving doors are another significant contributor to building heating and cooling efficiency, as they can prevent the exchange of large volumes of air between the interior and exterior environments. Every time a door is opened, warm air escapes in the winter and cool air escapes in the summer, reducing the efficiency of the HVAC systems by requiring extra output to manage the temperature swings. A two-stage or double door is an entrance/exit point that has two doors with a closed air space in between, allowing a person to open one door, enter the space, and open the second door after the first has shut. By doing this, only the air in the closed space is affected by a temperature difference between the interior and exterior, and a great reduction in heat transfer will occur. These exist in many locations on campus, but are somewhat inconsistent within buildings in that they are often located only at the main entrance and exit point (47% of buildings surveyed possess two-stage doors) (Pearson et al. 2007).

Another door style that works towards the same end as the two-stage door with a diminished efficiency is a revolving door. While these do reduce the heat loss through direct air mass exchange and flow, some of the air from the outside is brought in as the door revolves. Because of this fact, it is a less efficient door system than the two-stage door, though it remains well above the efficiency of single doors. A mere 6% of the buildings studied were installed with revolving doors, but those were accompanied by two normal doors to either side, which observation revealed to be used more frequently by students and faculty than the central revolving door, despite signs urging its use. One potential way to force people to use the available revolving and two-stage rather than the adjacent single doors would be to leave the single doors locked so they can only be used as exits. Though this is still not ideal, the need to have easy exists for safety reasons would prevent these doors being locked both ways (Pearson et al. 2007).

Recommendations

Denison makes use of a wide range of sources for its heating and cooling needs, many of which offer potential opportunities for improvements. The central steam system is itself a large red-flag due to the fact that the combustion and steam production occurs nearly one half of a mile away from the buildings it serves and even then the steam is run through a great deal of pipe distance traveling around campus. Physical Plant data indicates that the buried pipe may be 20

years old and has never been checked for failures or leaks (Chonko 2007 a). Input and output comparisons combined with aerial infrared analysis of the network would yield great insight how much heat loss is occurring between the production plant and the campus.

It is difficult to run an integrated, efficient, and responsive HVAC system on a campus with a broad range of building ages and types and within them a great deal of variation in the type of output methods. Given the age of many systems, boilers, and thermostats, an investigation into the feasibility of renovating and replacing certain systems is necessary to begin any large scale renovations. Denison has made efforts towards reducing sources of heat loss in its buildings, but there are a number of buildings with remaining single-pane windows and no two-stage or revolving doors. Another window type that was not studied but is highly effective in increasing HVAC efficiency are "high performance" windows with a low Solar Heat Gain Coefficient which, in large "boxy" buildings like most of Denison's academic buildings minimize solar energy transmission and can allow for little to no heating in sub-freezing conditions during occupied hours (Straube 2007).

Recommendations:

- Improved efficiencies to reduce resource use and lower heating bills.
- Building efficiency and system integrity
- User controllable thermostats

In order to more accurately and completely determine the specific conditions and needs of campus buildings, a Forensic Analysis should be commissioned for all buildings on campus and the steam line network. An existing conditions survey utilizing visual inspection, infrared thermography, moisture intrusion detection, building enclosure integrity and HVAC systems efficiency testing will yield a detailed report of the exact conditions of the buildings studied and serve inform the most effective and feasible actions available to improve the function of the buildings.

As for actual renovations to the HVAC system, installing user-controlled thermostats in highly used buildings would greatly increase the efficiency of the system on an individual user basis. This system allows each individual room to determine an approximate temperature by controlling the amount of heating or cooling that enters the room. The buildings that do not have such a system include Beta (leased), Chamberlin, Kappa Sigma (leased), Morrow, Preston, Beaver, Crawford, East, Huffman, Sawyer, Shepardson, Gilpatrick, Curtis East, Curtis West, Shorney, Smith, King, Stone, and Mulberry House. This represents 59.4 % of the dormitory buildings. Most of the academic buildings do not have user-controlled thermostats either: 72.2 % (Pearson et al. 2007).

It is a common complaint among students that these dorms waste a lot of heat because they do not have control over their own room temperature. This means that windows are often left open to cool an overheated room, thus requiring extra output to compensate for cooler temperatures.

Retrofitting HVAC systems in dormitories to provide students with user controllable thermostats would have a couple of benefits. First, it would provide students with their optimum level of comfort, which many students would welcome. Second, retrofitting HVAC systems to be more individualized would save a substantial amount of energy. Heating systems that cause students

to open their windows for optimum comfort are extremely wasteful because much of the heat is lost.

Because retrofitting the HVAC system to one that contains only user controllable thermostats has high opportunity costs, a step-by-step implementation plan might be the most opportune approach toward making this change. This includes prioritizing buildings by age, for example, or combining the retrofitting process with other sustainability projects or renovations. Students could be an effective source for feedback; for example, conducting a survey on which dorms have the lowest level of comfort in terms of heat. A project such as this is an excellent first step in increasing the efficiency of Denison's HVAC system because it is so highly visible. It will affect many members of the community directly and so will highlight Denison's new efforts to be more environmentally sustainable. This consideration is an important aspect of engaging the Denison community in transforming their campus toward higher degrees of sustainability. Overall, an HVAC retrofit such as this could provide a good stepping stone for future change, and could provide many benefits to the community as a whole.

Lighting

As a university, Denison requires a lot of power for heating, appliances, and lighting, as well as other various activities. Lighting systems can be responsible for up to 35% of the electricity costs in a typical commercial building (Alliant Energy). It is one of the significant uses of power on Denison's campus as some lights are left on 24 hours a day, both inside and outside. These lights vary in size and type of bulb and total use (time used during the day). Outside lights for the most part are turned on when the sun goes down and are either timed to turn on at a certain time or have sensors to turn on when there is so much light left in the day. Inside, however, is an area that could be improved in terms of sustainability as some lights are left on when the building or room is not in use (Chonko 2007 c).

Denison does not have a specific light policy for the lighting, indoor or outdoor. The most commonly used interior lights at Denison are incandescent and fluorescent, although fluorescent bulbs are more common in hallways and large open areas. An incandescent bulb uses filament resistance to emit light and wastes a lot of energy through heat loss (Lights of America). A fluorescent bulb emits light by forcing electrons in a tube filled with ionized gas from one electrode, or side, to the other, which then collide with mercury atoms to produce light (Alliant Energy). As a result fluorescent bulbs are more efficient, not getting nearly as hot as the other incandescent bulbs.

Building Use

A sample audit was done on the Academic Quad (Knapp Hall and Fellows Hall) by students to determine the kinds of lights used and which of these lights are turned off at night. The students found that at night lights are left on in the hallways and main entrances for security and safety. For these reasons, these lights are not turned off. Also, Fellows Hall contains a 24-hour computer lab and therefore, lights are left on at all times. However, there were also times that lights in classrooms and student/faculty lounges were left on after classes were over for the day (Carter et al. 2007).

The majority of lights in these buildings are overhead 4ft 8in fluorescents. Typically there are two bulbs per fixture with 112 watts. As an example for energy use and costs, here are some figures for a sample hallway in Fellows that contains 12 light fixtures, each with typically 2 bulbs and an input wattage of 112W per bulb. This translates to 2.68kW per hour per hallway, which means that for the 12 hours at night that the building is not in use, Denison uses 32 kWh of unnecessary energy. The current cost of electricity is $0.05 per kWh. That is a cost of approximately $0.13 per kWh per hallway, which over 12 night hours, is a cost of approximately $1.61. Over a period of a month, Denison spends an additional $582.40 on energy in just Knapp and Fellows Hall because lights are carelessly left on at night. While this is only a sample of lighting in buildings, it shows major implications both for energy use and costs at Denison (Carter et al. 2007).

However, Denison's Physical Plant has been working to change light fixtures to be more efficient. According to Mr. Chonko, interior incandescent bulbs are being replaced with screw in fluorescent ones, which are also known as compact fluorescents (CFLs) (Chonko 2007 c). Compact fluorescents use about 75 % less energy than standard incandescent bulbs and can last up to 10 times longer. This efficiency and longer lifespan save about $30 in electricity costs over each bulb's lifetime (Energy Star 2007 a). Therefore, changing incandescent bulbs around campus to CFL bulbs would result in a large energy and cost savings.

Current fluorescent bulbs are T8, 8 referring to the diameter of the bulb (8 times $1/8^{th}$ of an inch) and T referring to the tube (NLPIP). Physical Plant currently use T8 in new buildings and renovations, but they hope to replace T8 fluorescents with the T5 model when that technology improves (Chonko 2007 a). Both models are highly energy efficient, although the T5 model has a higher light output (Alliant Energy). It is probably not feasible to replace the T8 fixtures with T5 at the moment because the T5 lights are not compatible with the T8 fixtures, which means that if the Physical Plant wants to convert, they will have to replace the fixtures. Replacing fixtures is not cost effective at this point because the technology is not that improved. The replacing of the fixtures is expensive and they have to make budgetary considerations before upgrading in the future.

Recommendations

Even if replacing these fluorescent models is not feasible at the moment, lighting technology continues to develop. As old lights burn out and need to be replaced, newer, more efficient models become more and more available. These newer technologies can be reduced from 39 to 83 % of its prior demand (Creighton 1998). One example of this technology is compact fluorescent bulbs. The Physical Plant does replace some incandescent lights with these bulbs, but there should be an explicit policy of doing so. It is important to note that although CFL bulbs are more efficient, they do contain a small amount of mercury and must be disposed of in a proper manner (Energy Star 2007 a). This should also be taken into account in replacing bulbs on campus.

Other technology that Denison has used in recent renovations, including Slayter Union, is light dimmers that sense the amount of daylight in the room and will adjust accordingly. Therefore, they use less energy in the daytime when the sun is out. Another similar tool is light sensors that automatically turn on when motion is sensed and will also automatically turn off after a period of inactivity. These also decrease the amount of energy used because they reduce the amount of time a light is left on when not in use.

Efficient lighting technologies:

- Light dimmers reduce demand during the day
- Sensors turn lights off when no one is around
- Efficient bulbs reduce demand and replacement costs

While these lighting upgrades may be expensive in terms of initial cost, they will also translate to savings on electricity costs. As stated above, CFL bulbs save about $30 during their lifespan. Similarly, reduced energy use through dimmers and sensors will also save on electricity costs. Another added benefit to cost savings is that improving lighting efficiency and upgraded technology can also mean a reduction in the cooling load, or the amount of waste heat removed by air-conditioning of a building. Energy from lights is transferred into heat as well as light, inefficient lighting results in waste heat. This means that because inefficient lighting increases the energy required to cool the building, upgrading the lighting can reduce cooling needs as well as costs (Creighton 2007).

Appliances

While there are some changes that can be made at the producer-end of generating electricity, one of the most important responsibilities at the consumer-end is maximizing the efficiency of use. Appliances, such as washing machines and computers, are large consumers of energy, especially on the scale that is necessary for Denison to operate. Energy management can be effective in reducing waste and therefore costs.

Benefits of Energy Star Appliances:

- Improved energy efficiency
- Savings on utilities cost

Energy Star is a fairly recent initiative jointly run by the U.S. Environmental Protection Agency and the U.S. Department of Energy. This program certifies products the agencies find to be highly energy efficient to help American consumers protect the environment and save money (Energy Star 2007 b). Essentially, an appliance has two price tags: one is the initial cost and the other is the cost of the energy and water it takes to run the appliance. Recognizing this, Energy Star is a program that allows for top performance and energy efficiency in over 60 certified appliances (Energy Star 2007 b). The products that are the most used at Denison include washing machines, computers, printers, refrigerators, as well as light fixtures (Carter et al. 2007).

Denison owns both Energy Star-certified products and non-Energy Star products. There is no specific policy to purchase solely Energy Star-certified products when this is available. Mr. Chonko has stated that appliances purchased by the Facilities department are often Energy Star because of the cost benefits that are associated with certification (Carter et al. 2007). However,

even though certified appliances can save money through energy and utilities costs over its lifespan, many of these appliances have a higher initial cost than those that are not certified. The Physical Plant often considers this fact when making purchases. Below is a list of some of the most heavily-used appliances and their implications for energy use.

Washers and Dryers

Many of the commercial washers and dryers used in residential buildings are Energy-Star certified. The most prevalent model is the Maytag Commercial Energy Advantage Front-Load High-Efficiency Washer, which has a 32 % greater capacity than regular top loading models and can potentially save up to 50 % a year on water and energy (Maytag Commercial Laundry). One savings estimate from Energy Star states that one washer could save $1,200 in utilities costs over a span of 10 years. In addition to monetary and energy savings, Energy Star washers reduce water consumption. A non-Energy Star commercial washer can use up to 40 gallons per load, while a certified commercial washer uses only about 18 gallons per load (Energy Star 2007 b). As these washers are in high demand by students, these savings could potentially be much more than these conservative estimates.

Dryers, on the other hand, are products that are not certified by Energy Star because there is little difference in energy use between models. However, the most common model is the Maytag Commercial Single-Load Stack Dryer, which does seem to be more efficient than other possibly models. It has a diagonal airflow feature that enabled for faster and more efficient drying with a lesser amount of energy consumption (Maytag Commercial Dryer).

Computers

Computing Services, which purchases computers for public computer labs on campus, also does not have an explicit policy of buying Energy Star computers and printers. Many of the computers and printers Denison owns are certified, however, as Computing Services seems to have a de facto policy of Energy Star purchases. There are several different models of computers in the labs, only two of which are currently certified. However, this is because standards for certification just increased in July 2007. When the computers were initially purchased, they met the former Energy Star qualifications (Energy Star 2007 b).

Computing Services also is responsible for the energy-saving settings on Denison owned computers. In the public labs, the settings are dependent on the model of the computer. PCs have settings that will turn the monitor off after either 10 or 20 minutes of inactivity. All Macs will turn off the monitor after 10 minutes of inactivity. Also, all of the computers labs are scheduled to automatically shut down at 3 am after a period of inactivity. This includes 24-hour labs as well. Printers are also subject to power-saving settings in public labs. Neither computers or printers are manually turned off or unplugged when labs are closed; however, the computers automatically shut down as stated before and most printers have a power-save function that goes into effect after 30 minutes of inactivity (Carter et al. 2007).

The reasons for these settings are demand and usability. The ease of use of public computer labs is important in determining power-saving settings. For example, classroom computers are not turned off after classes or at night because there is a 10 minute wait for the computer to turn on

when it is needed, wasting class time (Carter el al. 2007). Likewise, while public lab computers have a scheduled shutdown time of 3 am, they are not manually turned off by staff when labs are closed. This is because that the labs are not staffed at night to allow for such a job. These issues have been the typical response when Computing Services has tested more aggressive energy settings in public labs and classrooms (Carter et al. 2007).

However, in Barney-Davis, Computing Services is experimenting with more aggressive settings because of the environmental concern. These computers are set to go into sleep mode after about 5 minutes of inactivity. The current settings in other public labs have been put into place more for user convenience, which is a priority consideration, as opposed to environmental awareness. We think that it is important to have a standard setting for both PCs and Macs taking into account the amount of energy that is used in power mode and sleep mode (Carter et al. 2007).

Our recommendation for computer use is to expand the more aggressive settings such as those of Barney Davis. Computing Services states that when these settings have been tested, the results are usually general confusion with how to use the computer and an increase in complaints. If the new settings were advertised by flyers in public computer labs, for example, there would be less confusion.

Refrigerators

Every residential hall has a kitchen containing appliances such as refrigerators, microwaves, and stoves. Many of the refrigerators were built prior to 2000 standards for energy consumption. We recommend that these older models be replaced with Energy Star models with higher efficiency compressors, improved insulation, and more precise temperature and defrost mechanisms to improve energy efficiency. These models use 15% less energy and use 40% less energy than the conventional models sold in 2001 (Energy Star Refrigerators). Figure 1 shows the potential energy savings for newer more energy efficiency refrigerators.

Upgrading a fridge made in this year to a modern EnergyStar fridge...	...Will likely save about this much
1976-86	$106 / yr.
1987-89	$57 / yr.
1990-92	$51 / yr.
1993-00	$29 / yr.
2001+	$9 / yr.
Assumes electricity rate of $0.11 per kWh	

Figure 1. Provided by Saving Electricity Homepage

Many of the refrigerators in the dorms were made to less stringent energy consumption standards. On average these refrigerators made from 1993-2001 had a kilowatt usage between 700-500 kWh while newer energy star models use around 475 kWh per hour (Bluejay 2007). It

should also be noted that top freezers are the most efficient types of refrigerators, with side-by-side models using 55% more energy (Bluejay 2007).

Other Appliances

There are several other appliances that have Energy Star standards similar to the appliances listed above. These include microwaves, ice makers, individual air conditioners, and televisions. While these may also be in every dorm building, they are not as large or frequently used as the above appliances. However, buying Energy Star certified appliances in these categories can also conserve a large amount of energy. For example, an Energy Star television uses 60 % less energy to operate than a regular television (Energy Star TV). An Energy Star certified ice maker can potentially save 1160 kWh, which adds up to an average of $100 per year on utility bills. They can also save around 2700 gallons and $10 a year on water usage (Energy Star Ice Maker).

Non-Energy Star Appliances

There are also many appliance models that are not available with Energy Star certifications. As mentioned above, dryers are included in this type. Others are especially found in large, industrial size machines, such as dish washers in the dining halls or washing machines in the Mitchell Athletic Center. Efficiency is also important for these types of appliances as well. For example, one Mitchell washing machines may be used to run 49 loads per week, which consumes a significant amount of water as well as electricity (Ehrhart et al. 2007). In such cases that Energy Star certification is not available in order to ensure efficiency, Denison should still consider environmental benefits in addition to economic factors.

III. Green Building

A green building is marked by energy efficiency and environmental sustainability. This is attained by using fewer resources, such as non-renewable power sources and water, using recycled materials, minimizing and recycling waste, and improving indoor air quality (USGBC 2007 A). As growth is a part of a college campus, it is important to be responsible in the way we grow—both in new construction and renovation.

Current Status of Green Building at Denison

Denison has approximately 120 buildings on campus and in 2006-2007, spent $1,246,320 for electric, $1,391,122 for natural gas and coal, and $386,000 for water and sewage (Chonko 2007 b and Appendix B). The electric alone is probably about 22-24 million kilowatt hours (kWh) (Chonko 2007 b). This translates to more than 16,500 tons of carbon dioxide for electric energy at Denison (Bloch 2007). It is important to take responsibility for the pollution that we emit. As buildings are the largest contributor to greenhouse gas emissions on campus, green building and renovation is an important step we can take to make Denison more sustainable.

Denison currently has no policies on green building; however, Barney-Davis was renovated in 1997-1998 with green design in mind. The construction “re-used” the existing structure and

restored many of the characteristics of the building, such as the floors and large windows, recycled many of the items used in construction, and used non-toxic materials in the building (Second Nature 2002). Barney-Davis also uses its own natural gas boilers, which work more efficiently than the central heating plant on campus, which burns coal (Second Nature 2002).

While Barney-Davis was a great step forward for the University, the creation of the senior apartments in the late 1990s to early 2000s and then Burton Morgan and Sampson Talbot in 2003 proved that Barney-Davis was the exception and not the rule. These buildings were not constructed with green building in mind. The campus is currently considering green building once again in the current restoration of Cleveland Hall, which will be completed in 2009 and will be built to the LEED Silver level.

Importance of Green Building

Buildings are an integral part of our economy, lifestyle, and society. The building construction industry provides jobs and generates between 5-10% of a country's gross domestic product (UNEP 2007). In the United States, over $800 billion was spent on new construction in 2004 alone (UNEP 2007). Buildings in the United States account for 37% of primary energy and 68% of all electricity use (OFEE). Furthermore, the construction of buildings in the United States uses 60% of non-food/fuel raw materials, produces approximately 136 million tons of construction and demolition debris per year, and uses 36 billion gallons of water per day. In addition, buildings also emit 35% of the country's carbon dioxide emissions and 49% of sulfur dioxide emissions (OFEE). As these statistics depict, buildings under the status quo are energy and resource sinks.

College campuses are no exception. Institutions of higher learning within the United States spend $18 billion annually for energy and operations, which equates to approximately 19 million metric tons of carbon dioxide (National Wildlife Federation 2007). Fortunately, colleges have the unique opportunity to act as a model for society in green building and renovation. Every year, between $15 and $18 billion is spent on new construction and renovation projects on college campuses (Eagan et al. 2007). If these projects are constructed according to green standards, the amount of carbon dioxide entering the atmosphere can be greatly reduced. Green buildings can use less than half of the energy a conventional building uses—some buildings, like the Adam Joseph Lewis Center at Oberlin College, have even been constructed to be net exporters of energy (Eagan et al. 2007)! It takes determination and commitment to the environment to plan and institute such projects, but in the end, green buildings save money, energy, and resources.

To follow green building standards, colleges as well as companies and institutions across the country look to the United States Green Building Council (USGBC), a third party certifier for green buildings. The USGBC designates green buildings by their LEED program, which stands for Leadership in Energy and Environmental Design. Even if the building does not go through the LEED certification process, building to these specifications is a baseline for sustainable building projects.

New Construction and Existing Building Components

The two types of LEED certification standards are New Construction (including major renovations) (LEED-NC) and Existing Building (LEED-EB) Projects. They are similar in many ways, but have some definite differences, depending on whether a new building is constructed or an existing building is renovated. Buildings qualify for certification based on pre-existing conditions, known as prerequisites, and new green features to which credits are given. These credits are compiled in six main categories, which are sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation. The categories are the same for LEED-NC and LEED-EB, although the possible credits vary between the two. Both standards have explicit conditions for every potential credit in each category. Points are then given according to the credits that have been earned, resulting in a rating system. The detailed rating systems for LEED-NC and LEED-EB are accessible through the Green Building Council (USGBC 2005 B and USGB 2005 C) (Appendix A). They include intent, requirements, and potential technologies and strategies for each criterion in each category.

Buildings can be given Certified, Silver, Gold, or Platinum status. Points are earned for each criterion that is met in the six categories as long as the prerequisites are also met. The following table summarizes the point system for certification.

	New Construction	Existing Building
Certified	26-32	32-39
Silver	33-38	40-47
Gold	39-51	48-63
Platinum	52-69	64-85
Maximum Points	69	85

The six categories where credits may be earned are described below. Each category is summarized with an example feature design; the full list of credits is in Appendix A.

Sustainable Sites

This category is meant to take account of impact on and around the site of the building. Criteria aim to minimize impact to the surrounding habitat by redeveloping an area rather than destroying new habitat and by reducing outside light, heat, and debris pollution. Alternative transportation credits can also be included for efficient transportation capabilities to and from the site.

Example: Stormwater Management:

Decreasing stormwater runoff by 25% is required to attain this credit. There needs to be a plan or system to lessen runoff and increase the quality of the water to eliminate pollutants.

Reduction of runoff could be attained by using permeable alternatives such as porous concrete or green roofs. Stormwater runoff may be treated with a wetland or filtering system. Also, stormwater could be retained for landscape irrigation or toilet usage.

Water Efficiency

This category is meant to minimize water use in and outside the building as well as maximize the water that is used. This can be done through technologies to reduce consumption, higher efficiency of water use, and landscaping techniques.

> Example: Water Efficient Landscaping
>
> The credit may be attained by eliminating irrigation through natural subsurface or surface waters. Water sources need to be at least 50% eliminated and there should be no permanent irrigation system for landscaping.
>
> This can be done by only using captured rainwater or recycled water for irrigation purposes and landscaping with plants that do not need as much water.

Energy and Atmosphere

The Energy and Atmosphere category is aimed at reducing harmful air pollutants and greenhouse gas emissions. These criteria are all meant to reduce atmospheric pollution, particularly ozone, and monitor the performance of the building. Higher energy performance and green energy sources are also included.

> Example: Additional Ozone Protection
>
> Additional protection may be achieved by operating the HVAC and refrigeration systems of the building, so harmful chemicals that break up the ozone layer, like CFCs, HCFCs, and Halons, are not emitted. The systems also need to be analyzed and documented.

Materials and Resources

This criterion is meant to decrease material use and waste. Permanent recycling becomes important in this category, as does recycling of products during construction. Other important criteria include where materials come from in order to reduce fossil fuel consumption and the efficiency of the use of those materials.

> Example: Construction Waste Management
>
> This credit may be attained by diverting 50% of the construction waste from disposal. Waste can be recycled, reused, and donated to other sources. An example of this would be to recycle all of the wood and metal scraps from construction.

Indoor Environmental Quality

Indoor Air Quality (IAQ) is important for the well being for those that use the building. These criteria stress the importance of clean air through ventilation, removal of harmful chemicals, and

plans for healthy air. There are also criteria regarding the heating of the building and the amount of daylight it receives, as these make the area more hospitable.

> Example: Low-Emitting Materials
>
> Low-emitting materials include adhesives and sealants, paints and coatings, carpet systems, and composite wood and agrifiber products. To attain one of these credits, these materials must be used throughout the building. They all decrease the amount of harmful chemicals like volatile organic compounds (VOCs) that can often be found in paints to extend their lifetime.

Innovation

The innovation category is included in order to push the envelope and work to create new ideas and higher performance than is required by the standards. Also, having a LEED accredited professionals help to speed up all aspects of a building project and help teach those around them about LEED certification standards.

> Example: Innovation in Design
>
> Points may be given for exceptional new designs that are not addressed in the Rating Systems.

Other Green Projects

There are many green, innovative ideas that should be kept in mind when a building is renovated or constructed. All of these ideas do not necessarily need to be included in a building's design, but they should be seriously considered as possibilities. They include, but are not limited to:

- Geothermal heating systems
- Rainwater catchments to gather precipitation, which can then be used as toilet water and landscape water
- Stormwater management
- Green roofs, such as gardens, which increase the energy efficiency of a building
- Solar and wind powered energy sources
- Stand-alone heating systems and changing the central heating plant so that it runs more efficiently
- Retrofitting buildings to allow for individual room temperature control
- Temperature control system to turn down the heat or air conditioning when buildings are not in use (e.g. academic buildings at night)
- Permeable paving options, such as Grasscrete
- Alternative transportation options, such as improving bike rack storage, implementing a community bike program, and switching campus vehicles to hybrids

Benefits of Green Buildings on Campuses

There are many benefits for an institution that builds green besides helping the environment. These benefits include monetary savings, a better learning atmosphere, and a selling power for recruiting potential new students.

Monetary Savings

The capital costs of building green can vary from 0 to 30% above the costs of a conventional building or restoration, but the majority of projects have increases of less than 8% (Lucuik et al. 2005). Many studies even suggest that cost increases can frequently be less than 2% (Lucuik et al. 2005). Once the projects are complete, it only takes a few years for the benefits to be realized economically. One study in California showed that LEED buildings had an average payback period of three years, with annual return on investments of 25-40% (USGBC 2005 A). While California may have higher than normal averages because of the warmer climate, green building is economically beneficial in any climate, even in Ohio as showcased by the successes of Oberlin College.

These financial incentives come from reduced utility and water bills. Green buildings have been shown to use 30% less energy, 30-50% less water, and generate 50-97% less waste than conventional buildings (USGBC 2005 A). For example, The University of South Carolina's West Quad is the largest green residence hall in the world and saves $40,000 annually on utilities and $40,000 on water. West Quad did not cost any more than a conventional building to construct, but will continue to save the University money every year (Dowell 2005). .

Educational Benefits

Studies have shown that green buildings provide a better learning atmosphere for students. For instance, green buildings have better moisture, ventilation, indoor air quality, noise control, and lighting than conventional buildings (National Research Council 2006). These positive characteristics have outcomes such as improved student learning, student and teacher health, and teacher productivity (National Research Council 2006). A study that surveyed executives at organizations who are involved with Green K-12 facilities found that 74% believed the building improved the institution's ability to attract and retain teachers, 72% believed that student absenteeism was reduced, and 71% believed that student performance increased (Turner Corporation 2005). For green college buildings, 71% of executives working with the buildings believed that there was improved ability to attract and retain teachers, 70% believed it had improved ability to attract students, 59% believed it improved student performance, and 48% believed it reduced student absenteeism (Turner Corporation 2005). Overall, improved conditions appear to improve the learning space.

Green buildings can:

- Improve attractiveness of a school to students and faculty
- Improve attendance rates
- Improve student performance

Not only are green buildings able to improve the educational environment, they can also be valuable learning tools. Green buildings would offer research opportunities and an immeasurable educational opportunity for students to experience sustainability in practice. For example, Denison students have already been involved with the solar panels on the library and have designed class research projects based on their efficiency (Pearson 2007). Students will also be able to retain this knowledge of sustainability after Denison in order to become more socially and environmentally aware citizens—qualities that will be necessary to cope with the challenges surrounding global climate change.

Public Relations

Green buildings also provide a publicity opportunity for college campuses. Green initiatives are gaining more and more attention, including books, articles, and websites dedicated to publicizing campus sustainability projects. Not only would green building and design place Denison among other prestigious schools that are combating global climate change by making their campuses sustainable, this would also be a selling point for perspective students. Colleges that are socially responsible attract more socially-aware and responsible students. Green buildings and ecologically-designed buildings will enhance perspective student tours and add to the national publicity regarding green campuses.

Recommendations for Building Green at Denison

We recommend that Denison adopt a green building policy that incorporates our values and commitment to the environment. It is time to build green and consider the environment in our campus decisions. Denison has already decided to build Cleveland Hall to the LEED silver level. Silver certification for this new construction requires at least 33 out of 69 points, which is completely reasonable for Denison. This is a great first step for our campus; however, we cannot simply abandon this green initiative after Cleveland Hall has been completed. Future plans for Denison include renovating the Ebaugh chemistry laboratories and classrooms, which should especially follow LEED standards because they are science buildings in which new technology is very important. Other renovation plans for Denison includes changes to the Mitchell Athletic Complex and Shorney Hall. These renovations should adhere to LEED standards because residential halls and athletic buildings are some of the largest consumers on a college campus.

Changes to the status quo:

- LEED Silver Policy
- Hire contractors with LEED expertise
- Creative thinking in design plans
- Educate the Physical Plant on LEED.

We believe that Denison should immediately enact a policy that states that all future new construction and major renovations shall follow LEED silver standards. Eventually, Denison should look into building at the gold level, which will take more planning and dedication. As green building continues to gain popularity, it should be easier to find contractors and designs to fit these standards. However, Denison should not wait for green building to become the

construction norm. For many schools, the biggest barrier to implementing new and efficient techniques in new construction and renovation is unfamiliarity with the technology. Therefore, Denison should send out requests for proposals for construction projects (Creighton 1998). It is important to find a company that is experienced with LEED design to contract with and there are several construction companies that are familiar with LEED design operating in Ohio. Designs for renovation and new construction should be forward-thinking and utilize green techniques rather than following the status quo.

The policy that is created for Denison should also be adaptive. While it may use silver standards as a baseline, it is reasonable to re-consider this policy with time and experience to push Denison to build to gold standards. We should not simply be satisfied with reaching one goal, but continue to push ourselves to do more toward our commitment to the environment. Cost-benefit analyses and long-term payback periods should be considered in the future because although building green may cost more initially, it could perhaps be more cost-effective over the next twenty or so years.

We also suggest that Denison provide at least one Physical Plant staff member an opportunity to take a course in LEED certification or attend the annual Green Building conference. We believe it would be very beneficial for at least one staff member to learn more about techniques and strategies in order to help Denison continue and expand our Green Building efforts. There are different levels of courses that are offered based on previous experience and knowledge. Courses are available through the U.S. Green Building Council and may even be taken online (USGBC 2007 B). There is also a large Green Building conference held every year to learn about the many aspects of LEED called the Green Build International Conference and Expo. Many colleges and universities attend this conference in order to connect with green building peers and leaders (USGBC 2007 C). In order to be a leader in sustainability and continue to hold a prestigious standing among colleges and universities, Denison needs to adopt policies such as these that strive for sustainability.

III. Waste Management

Introduction

Many universities throughout the country, in their efforts to become more sustainable, are addressing how waste is managed on their campuses. One of ways through which this is occurring is by increased infrastructure for recycling. As Sarah Hammond Creighton notes in *Greening the Ivory Tower,* recycling is, "…the most common institution-wide environmental strategy at colleges and universities" (Creighton 1998). As the word implies, recycling returns already used products back into the production cycle so they may be made into new products instead of contributing to landfill waste. Recycling also means that fewer new products need to be made, lessening the use of resources. What follows is a list of questions that the task force should ask when attempting to reduce Denison's generation of solid waste. These have been adapted, with slight alterations, from the University of Colorado's own Zero Waste approach to solid waste (University of Colorado 2007):

1) What policies on sustainable resource management are already required at colleges and universities?
2) What subsidies for waste and pollution should be avoided on campus?
3) What products should be boycotted from campus?
4) What green practices should be "procotted" on campus and around town?
5) What products on campus (beyond basics) are recoverable through reuse, recycling or composting?
6) What staff and student opportunities are ready for consumer education and product take-back?
7) What campus and/or community centers are needed for total recovery-reuse, recycling and composting, material exchange and education?

Current Practice

Recycling Bins

During Phase II of our project, the class addressed the lack of recycling bins on Denison's campus. Several students worked with the Physical Plant, reused recycling bins from the DURP barn, and then placed them by Fellows and in front of Slayter, bought three multi-use recycling bins and placed them around Slayter Student Union. The amount of recyclables thrown in trash bins around Slayter was measured before and after the bins were installed, which showed that the amount of solid waste generated was reduced considerably after the bins became available. Within a couple of weeks, Denison bought more of the bins and placed them in several additional locations around campus, including between Fellows and the library, and in front of Higley; all together, there were 20 new receptacles purchased (Comisford 2007).

Plastics Recycling

Right now, Denison only recycles types one and two plastics. There are seven different types of plastics, which can be differentiated from each other by the number within the three-arrow recycling symbol printed on the plastic. According to many who have worked at the Denison recycling barn, there are often large amounts of plastic brought to the barn that have to be thrown away simply because they are another type of plastic. Right now we use SBC Recycling, which handle all types of plastic, to take our plastics (Barbara Burgess, personal communication, December 6, 2007). There would be little issue with having them take the other types of plastics if we so chose to begin sorting them as well.

Recommendations:
- Contract with a recycling company to process all types of plastics.
- Upgrade the current recycling barn through improved safety precautions and increased student employment.

100-percent Recycled Paper

Another group of students, also during Phase II, worked with recycled paper. Since their research began, much community interest has initiated campus-wide transition to 100-percent recycled paper. For more information on this project please see the section V: Purchasing of this report.

Computer Reuse

According to Lisa Bazley (Personal Communication, November 29, 2007), Director of Computing Services at Denison, nearly 90-percent of computers and computer parts are recycled or given to charity. This is an encouraging fact, and an area of environmental sustainability in which Denison may be applauded. As a result of the current policies already in place, the following suggestions are directed for personal computers from students, faculty and the general community surrounding the University, in addition to the other 10-percent of computers that are not recycled through Denison.

Recycling

There are many different recyclable materials throughout Denison that are thrown away instead of being properly recycled:

Toner Cartridges

Toner cartridges contain petroleum-based plastics that are not biodegradable, yet 80-percent of these ends up in landfills (eCycle Group 2007). Tonerbuyer.com will purchase printer, copier and fax cartridges for up to $22 each and pay for all shipping (Tonerbuyer 2007). eCycle Group is another company that purchases printer cartridges and pays for shipping but offers a much lower price than that offered by Tonerbuyer (eCyclegroup 2007).

Batteries

Batteries are one of the most overlooked sources of pollution, as they contain many types of heavy metals and acids. More than two million household batteries are sold every year in the United States, producing around 83,500 tons of discarded batteries. Unfortunately, many students do not recognize the toxicity of batteries or the reality that they should not be thrown away. Universities can help to improve this situation by offering recycling (Creighton 1998). Best Buy, RadioShack, Batteries Plus and Staples all take old batteries for recycling and fortunately, there are eight of these stores around Granville (Earth 911 2007). For national programs, there is Air Cycle Inc., Battery Mart, Battery Solutions Inc., Call to Protect (a division of Verizon), Charitable Recycling Program, Complete Recycling Solutions, LLC, Earth Protection Services Inc., Intercon Solutions, Lighting Resources, LLC, Northeast Lamp Recycling Inc, ReCellular Inc., USA Lamp & Ballast Recycling Inc., and WeRecycle! Inc. (Earth 911 2007). Several of these national organizations also take other electronic equipment, from cell phones to computers. Presently, the Environmental Studies Program offers battery recycling; however, most students are unaware of this; there is a need for a University level program for recycling old batteries.

Foam Peanuts

Unfortunately, foam peanuts (often found in packaging and made of styrofoam) are usually not recyclable; however, they can be reused. Faculty, staff and students should be encouraged to save foam peanuts that come in received packages for future use in outgoing packages. Denison

could also provide a service that takes foam peanuts from the campus community and uses them in the many packages that are sent out by Denison every day. This service could be a division of the computer reuse program or could become another service operated by the mailroom in Doane.

Fluorescent Tubes

Fluorescent tubes contain many harmful chemicals, including as PCBs (polychlorinated biphenyls), and should be disposed of as soon as possible. Upon the writing of this report, the recycling barn had several barrels full of burnt-out fluorescent tubes; to our knowledge there is not a specific plan for disposable of these tubes, and we wonder how this waste will be properly disposed of. One possible suggestion for disposing of them would be to use the Easypak system. Easypak containers can hold up to 67 pounds of waste per container and are available through LampRecycling for approximately $75. Once filled, the containers can be shipped free of charge back to LampRecycling where they are properly disposed of (LampRecycling 2007). Another site has a list of 16 fluorescent lamp recycling companies and several handlers who will transport fluorescent bulbs to recyclers (Lamp Recycle 2007). A partnership with one of these companies would be a simple task for Denison and would provide more room in the barn.

Envelopes

Envelopes may also be reused, pending they are in good enough condition. The University of Michigan, for example, has adopted the practice of reusing all envelopes that enter faculty and staff offices (University of Michigan 2007). Denison could do the same, as well as place a "used envelopes" box in Slayter next to the mailboxes. This would allow students who would otherwise throw envelopes away, to place them into the box where they will instead be reused.

One-sided Paper

DURP has created one-sided paper notebooks for several years now and this practice could be expanded to the whole campus. Almost all paper thrown away or recycled is one-sided; meaning that only half of the paper's potential has been used. At the recycling barn, paper that has only been written on one side could be separated and sent to Doane for binding into notebooks that can be distributed for free in computer labs around campus and in the library.

Recyclemania

Recyclemania is a ten-week long event held every year that challenges schools around the country to reduce waste by increasing recycling (Recyclemania 2007). The school with either the largest amount of recyclables per capita, the largest amount of total recyclables, the least amount of trash per capita, or the highest recycling rate wins the competition (these are separate categories so there are actually four different winners per year). The main point of the event is to raise awareness and get people excited about recycling. The competition has been continued for six years and in 2007 alone over 35 million pounds of materials were recycled. For several years, Denison has been trying to join the approximately 80 colleges participating in

Recyclemania; support from the University administration would likely help to facilitate making this a reality.

America Recycles Day

America Recycles Day (ARD) is every November 15th and many schools throughout the country, such as the University of Michigan, celebrate by setting up recycling tables throughout campus and at sporting events (University of Michigan 2007). These tables have recycling information, free reusable mugs with hot cocoa, America Recycles Day pledge signing, recycled content giveaways and anything else supporting recycling. The pledge is made up of five steps:

1) I pledge to find out what materials I can and cannot recycle in my community.
2) I pledge to lead by example in my neighborhood by recycling.
3) I pledge to recycle batteries, cell phones and other electronic wastes.
4) I pledge to email my elected officials to ask them to increase funding for my community's recycling programs.
5) I pledge to tell five friends that recycling is the easiest thing they can do to slow global warming (National Recycling Coalition 2007).

Denison should also participate in America Recycles Day, thereby supporting recycling and educating the community of its benefits. While DURP does already participate in this event (it is called National Recycling Day here at Denison), it is our recommendation that the University as a whole become involved in it, not just student organizations.

Website

The schools with the greatest commitment to recycling have websites that document all of their efforts as well as educate site visitors on how to recycle in their own communities. When the word "recycle" was searched on Denison's own website, the first mention of recycling was not until the third hit (the DURP link, which has not been updated in five years). As such, the only mention of recycling comes from a student organization – there is no discussion as to the commitment of the University as a whole to recycling. Denison should create and continually update their own website about the how, why and where of recycling on our campus.

Recommendations:

- Establish a recycling program for toner cartridges, batteries, foam packaging peanuts, fluorescent tubes, envelopes and one-sided paper.
- Update the recycling page on Denison's website to educate on the benefits of recycling.

Running Counter at Miami University

Miami University of Ohio has a running counter on their website that keeps track of how many pieces of paper, aluminum cans and plastic bottles have been recycled, as well as the amount of money (around $206,000), kilowatt hours and tones of greenhouse gasses saved by their recycling program (Miami University 2007). Such a counter builds excitement about recycling, shows how much can be saved, and encourages people to help reduce their negative impact on the environment and financial resources. This is something that Denison could look into as a way to boost recycling efforts on campus.

Biodiesel

Definition of Biodiesel

Biodiesel is a renewable, non-toxic, biodegradable, alternative fuel source that can be used in any unmodified diesel engine. Compared to conventional fossil fuels, studies have shown that biodiesel emits 75-percent less PAH compounds (polycyclic aromatic hydrocarbons), which are potential cancer-causing compounds, and reduces net CO_2 emissions by 78-percent (National Biodiesel Board 2007). Biodiesel is made from a variety of used cooking oils, also known as 'yellow grease.' The grease and other ingredients are put into a processor that converts it into a fuel that can be used in any diesel engine. Thousands of government fleets, businesses and universities are beginning to transition to using biodiesel as a beneficial alternative to petroleum-based diesel (National Biodiesel Board 2007). In 2006, according to The National Biodiesel Board, 250 million gallons of biodiesel were purchased in America.

Benefits of biodiesel:

- Reduce emissions of cancer-causing agents and CO_2.
- Compatible with all diesel engines.
- Save $600 monthly on waste grease removal.

Presently, 250 gallons of waste cooking oil are produced from Denison's dining services in Huffman and Curtis Dining Halls, as well as Slayter Student Union (Dickson et al 2007). Currently, all waste grease from dining services is removed and disposed of weekly by an outside contractor, Darling International Inc., to which Denison pays $600 per month for its services; however, this waste grease could instead be converted into biodiesel and used as fuel. The development of a biodiesel conversion program at Denison would reduce the amount of waste generated on campus, while also reducing carbon emissions, and as a result, manufactured biodiesel would replace conventional, carbon emitting fossil fuels. This program could take two main forms: a) Denison could have our oil transported off campus for conversion and use or b) could establish its own biodiesel conversion system. Establishing a biodiesel production system off-campus might eventually lead to an on-campus production system, thus allowing Denison to make use of its waste grease to power its diesel-run vehicles and therefore making the campus more sustainable. What follows is a list of considerations that should be taken into account when investigating the options for turning our waste cooking oil into biodiesel.

Current Denison Practice

Denison produces approximately 250 gallons of waste grease every month. The grease is stored in two 55-gallon drums located outside each of the three dining locations on campus (Huffman, Curtis and Slayter). The oil in the fryers is changed everyday and the grease from the grills is also frequently emptied. It is picked up by Darling International for a cost of $600 per month and transported to Zanesville, Ohio, where it is turned into animal feed and other similar products. It is our opinion that this is not the most efficient way to dispose of our used cooking oil.

Severing contract with Darling International Inc

Denison's waste grease is picked up weekly by Darling International Inc. Sodexho, Denison University's food contract manager, is under contract with Darling International Inc. to pick up all used cooking oil on campus. The contract is negotiable and there would be no penalties to terminate it with a few weeks notice. The transfer station that works with Denison is located in Zanesville, OH which is about 40 miles east of Granville. The grease is transported to a plant to be processed into recycled materials, including animal feed, lubricant, explosives, shampoos, anti-freeze, inks, glues, emulsifiers, etc. Thus, while the waste grease Denison produces is not technically all "waste," as it can be recycled into different materials, using the grease for biodiesel production suggests that one day Denison might be able to use the grease from its dining hall for other campus purposes, such as fueling campus vehicles that already use diesel fuel.

Flying J Farm

Mr. Dick Jensen, who operates the Flying J Farm, currently uses about 1,300 gallons of diesel fuel annually. Given that Denison produces 250 gallons of cooking grease every month, he would not be able to use all of the biodiesel if he were to take all of Denison's cooking grease himself; however, he could sell any extra fuel to his neighbors, who are also interested in using biodiesel. He believes that he would be able to produce about 100 gallons over a span of two to three days and could use the fuel for a number of machines on his farm. He utilizes four diesel tractors, a diesel-powered combine and a diesel car, all of which he would like to run on the biodiesel he would produce. Additionally, he plans to trade in his gasoline-powered truck for a diesel truck, and would also like to purchase a diesel-powered electric generator for use in remote structures located on his farm, including one near his lake, where he hosts events, and from where he pumps water for his pastures.

Financial Implications

Six storage containers for waste grease (complete with pumps and filters for transferring oil from the containers to tanks on the back of Mr. Jensen's truck) would be the only immediate cost for the University to begin a new system of waste grease removal with Mr. Jensen. If no filters were applied to the pumps, the pumps would have to be large enough not to clog from meat particulates in the grease. Ideally for Mr. Jensen, the meat particulates would be filtered at the source (i.e. at Curtis and Huffman dining halls and Slayter Student Union) at the time of transfer to the storage tanks.

Additional Costs

Aside from two to three transport tanks for his truck, Mr. Jensen would need to purchase two large storage tanks for the grease at his farm, one to contain the grease from campus, the other to contain the fuel he produces. He has already purchased two conical-shaped tanks, each with the capacity to hold 110 gallons. He is not currently prepared to produce biodiesel during the winter months because he cannot provide heat to the barn, where he plans for production to take place (a heated room is required for successful conversion). During the warmer months of the year,

Mr. Jensen would produce the grease at his horse barn, which is currently not heated; however, during cooler months, Mr. Jensen could still pick up Denison's waste grease and store it in much larger containers on his property until the weather is warm enough for production to occur.

If Mr. Jensen (or Denison) wanted year-round waste grease conversion into biodiesel, Mr. Jensen would need to construct a new room off of this barn, which could be heated off of some of the fuel he would produce. Mr. Jensen would need to buy heating equipment, including a furnace, in order to begin processing during cooler months. If no fuel was produced during the winter months, even larger containers would have to be purchased to store grease collected during the winter. To being production now would require converting his greenhouse, which is currently heated, into the biodiesel production room; however, this would still necessitate eventually building another structure to replace the greenhouse.

The cost of constructing a biodiesel production room, two large storage tanks, pipes, valves, pumps, a renderer's license (required by law if Mr. Jensen sells the fuel he produces) as well as inputs into the fuel production process (e.g. lye) are all within Mr. Jensen's budget; however, any and all financial assistance that Denison could would assist Mr. Jensen in developing his own refinery. He would hope to recoup some of the costs of the equipment needed by selling the fuel over time, and feels that even if Denison purchased storage tanks and pumps, that this would greatly help him in the project's development. Mr. Jensen is willing to incur all of the costs associated with establishing a biodiesel production system on his farm, including the purchases required for either scenario (i.e. year-round biodiesel production, or storage of grease during cooler months and production during warmer season).

Legal Considerations

Biodiesel production carries with it some risks for those involved in the production process, as it involves adding methanol and lye and requires careful monitoring of temperature when mixed. The University has begun reviewing Mr. Jensen's insurance policy to verify that it qualifies for establishing a biodiesel program with Denison. Mr. Jensen thinks that anyone involved in the production process would need minor training. As such, if he had other people responsible for picking up and transporting the grease, additional individuals would likely need approval from the University in order to be able to transport the cooking grease from Denison to Flying J Farm.

Educational and Marketing Purposes

Involving Denison in the production of biodiesel could go beyond simply making use of the cooking grease it generates, but could act also as a learning demonstration for Denison students. Denison could become a model for other schools in the Midwest that produce large quantities of cooking grease, but which do not make use of it to produce biodiesel fuel. Additionally, student involvement in the conversion process, particularly on his farm, would help educate students about the importance of biodiesel to reduce reliance on fossil fuels and reduce waste, in addition to helping in making his farm more sustainable.

On-campus Biodiesel Production

A biodiesel conversion system on Denison's campus would be an alternative option for the disposal of waste grease from campus by Darling International Inc. or through a separate contract with Mr. Dick Jensen. This effort would essentially create a new recycling system that would show immediate benefits for the school on many fronts. While there are initial costs that would be incurred by its establishment, the payback period is short (this is discussed in more detail below). It would stimulate positive marketing for the University and attract a progressive range of students and faculty. This system would provide biodiesel for campus vehicles used by physical plant workers, security officers, and any other vehicle or machine that is compatible with diesel fuel.

New System in Waste Grease Disposal

Waste grease would be picked up at each of the three dining locations on campus and taken to an on-campus biodiesel converter. The oil would be converted into biodiesel that can be used in any engine that takes regular diesel fuel. As security vehicles are replaced, new diesel engine vehicles could be purchased. Another possibility would be to contract with local farmers who could use the fuel to run their farm equipment, and with local residents who may have use for the extra fuel we would produce. Essentially, we could create a community biodiesel pump station (as is the case at Oberlin College, please see below).

Benefits of off-campus biodiesel production:

- Support a local organic farm while reducing waste from Denison's campus.
- Lead to an on-campus biodiesel production system.

Benefit of on-campus biodiesel production:

- Use of fuel produced from dining halls in campus vehicles.

Financial Implications

More drums would need to be used as fuel storage containers for the biodiesel fuel produced. Just as required for a new waste grease disposal system with Mr. Jensen, six storage containers would need to be purchased, two for each dining location. The 55-gallon drums from the New Pig Corporation cost $60 each, so the cost of 12 drums in total would be $720. An on-campus biodiesel conversion system would require the purchase of a biodiesel processor. We propose the purchase and use of the biodiesel processor from Home Biodiesel costing $2,995. This processor has an automatic processing system with an operating time of 1.5 hours. It is capable of producing 83 gallons of bio-diesel fuel per batch (Home Bio-Diesel 2007). This processor comes with all necessary processor implements, testing, and safety equipment. The purchasing of necessary equipment for a biodiesel processing system would cost about $3,715, excluding the possibility of a small housing facility. The project would be projected to pay for itself within seven months. The selection of the processing location and the purchase of the necessary equipment would be the next steps towards establishing an on-campus biodiesel conversion system.

Future Prospects in Biodiesel: Programs at Other Schools

Oberlin College

A recent graduate of Oberlin College founded one of the first alternative fuel pumping stations. Full Circle Fuels, the pumping station, sells biodiesel/petroleum mixtures and ethanol-85, as well as straight vegetable oil, to the local community. They receive all of the vegetable oil from local establishments. The pumping station is also auto repair shop that converts diesel vehicles to run off vegetable oil (Oberlin College 2007). This project positively affects the entire community in Oberlin, Ohio including the college. It has made the college and town more sustainable, efficient and educated about environmental issues.

Duke University

Beginning in the summer of 2003, Duke began using a 20-percent blend of biodiesel and petroleum diesel in its bus fleet. Although they have not employed a biodiesel processor on their campus, they have recognized the benefit of utilizing a cleaner alternative energy source. The Duke Environmental Alliance co-wrote a $30,000 grant in order to facilitate the purchasing and use of biodiesel on campus (Duke University 2007).

Conclusion

The implementation of a biodiesel pump station on campus would create financial, environmental and advertising benefits for Denison University. The entire payback period would be short and ultimately, would prevent excess payment of $6,000 per year, not including the amount of money that is spent for fueling of all campus vehicles (Dickson et al 2007).

This program would serve many purposes including increased student and campus awareness of environmental issues such as the use of green fuels compared to fossil fuels, and waste reduction. This system would benefit the entire Granville community, enhance the reputation of the University, increase environmental awareness, decrease the amount of waste that is produces on campus, and give the community a greater sense of independence. The implementation of a biodiesel processing system on campus would be relatively easy for the University, and the benefits would outweigh the costs on every front.

Composting

Definition of Composting

Composting is the transformation of organic waste (food scraps and yard debris) into simple, nutrient-rich organic matter through decomposition by soil microbes. The nutrient-rich organic matter which results from composting is able to improve soil health and productivity, thus reducing the need for pesticides and chemical fertilizers. Composting is the most productive and ecological method of recycling organic waste, which accounts for 30-percent of all the waste in landfills in the US (Endowment Institute 2007).

Residential universities are in an especially unique position to carry out composting on a large scale as their dining halls serve thousands of students and as a result, produce tons of pre- and post-consumer food waste every year. Denison University's two Dining Halls (Huffman and Curtis), for example, produce around 113 gallons of food waste per day, which adds up to between 800 and 1000 tons of food waste each year. Until the initiation of a composting program on Denison's campus in the fall of 2007, all of this waste went directly to landfills. Today, more and more universities all over the country are realizing the importance of composting. As of 2007, 42-percent of the top colleges in the country have instituted composting programs (Endowment Institute 2007).

Benefits of composting:

- Reduce waste from dining halls and landscaping.
- Create nutrient-rich soil for local farmers or landscaping purposes.

Current Denison Practice

Denison University's composting program was spearheaded in 2006 as part of a class project by then-first year student, Meredith Atwood (2009). She conducted a pilot project that measured how much food waste generated by Denison's dining halls every day could be composted. Additionally, she also publicized the need for a composting program at Denison through pamphlets and articles in student publications and eventually managed to gain the assistance of the Physical Plant to start a permanent composting program at Denison University. As a result of these efforts, in the fall of 2007, Denison University constructed a composting facility on its grounds, directly behind the Denison University Physical Plant.

All pre-consumer food waste from the dining halls – except those which would take too long to be composted (meat, dairy, liquids and acidic fruits) – is now collected and placed in the composting unit instead of being thrown away with other garbage. Usable compost will be created every few months (it takes six to eight weeks to compost, and then there is a one-month stage where it is left to cure) from the food waste and will be used as fertilizer on the campus grounds in place of commercial fertilizer. Denison's dining halls currently only compost pre-consumer food waste, as a permit from the Ohio Environmental Protection Agency is required in order to compost post-consumer food waste. Steps ought to be taken to apply for a permit to enable dining halls to dispose of post-consumer food waste as well as pre-consumer food waste.

Future Prospects in Composting: Programs at Other Schools

Middlebury College

Started in 1996, Middlebury's on-site composting program was initiated by staff and students, who researched composting, made the collective decision to build an on-site composting plant and personally helped to build, maintain and improve the plant. It also had great success in collecting food for composting at special events by having facilities managers separate trash, recycling and leftover food into separate containers. As a result of its efforts, the college manages to compost 24 tons of food every month and save an average of $95 per ton by avoiding having to pay for food waste directed to a landfill (Middlebury College 2007).

Bates College

Bates College won an award for Best Management Practice for Colleges and Universities from the Environmental Protection Agency for its composting program, its reduction of food disposed of in its sewer system and reduction of its general impact on the environment. Students in the college's dining hall scrape food off their plates onto a scrim line which collects it to be sent to a nearby pig farmer, while pre-consumer waste is sent, along with unbleached napkins, to a nearby farm which composts it and sells the compost back to the college. Dining hall employees also have the opportunity to present information on composting, recycling and waste management to the students (Bates College 2007).

Berea College

Berea College started a composting program to provide compost for its own use in its greenhouse and garden program**,** the horticultural component of its 500-acre educational farm. It collects 35 tons of pre-consumer food residuals each year and employs around 12 students who work on the educational farm to help manage the compost pile. Compost is turned by a tractor, rather than by hand, on a monthly basis. The compost is partially processed by worms and free-range poultry on the farm and the finished product is used as fertilizer and as part of a greenhouse potting medium. Research is constantly being done to assess the richness and productivity of the compost produced, as well as ways to improve it (Bates College 2007)

Carleton College

Working alongside its dining services, Carleton College initiated a composting program which includes pre- and post-consumer food waste from its dining halls and special functions. It sends its food waste to a professional company, Resource Recovery Technologies (RRT) of Bloomington, Minnesota, the largest processor of organic materials in the Midwest that processes, cures and analyzes the compost to ensure that it meets the state's pollution control standards. It also switched to using corn-based disposable plates and utensils in spite of a 15-40-percent increase in cost, as these may be composted alongside food and other organic waste (Carleton College 2007).

Recommendations:

- Purchase biodegradable plates and cutlery for campus events (i.e. items that may be composted).
- Establish composting programs for residence halls and Slayter dining services.

Further Action

Reduce Overall Food Waste

Efforts should be made to educate students on how much food is wasted and discarded every day as well as the importance of wasting less food. As noted, the websites of many other colleges' composting programs have reminders to students to waste less food.

Sell Compost to Local Farmers

If the composting project is successful and productive enough, Denison could potentially sell some of its excess compost to the Granville community to build relationships and increase

awareness of its environmental initiatives. Denison could also sell some compost to local farmers around Licking County, or even sell it in exchange for local produce.

Biodegradable Plates and Cutlery

Denison's Dining Services could also cut down on the amount of trash it creates by switching from plastic to biodegradable plates and cutlery made of recycled materials or corn. This would make it possible for utensils, plates and even food packaging to be composted alongside food waste. The Dining Services at Carleton College, which, like Denison University, has a contract with Sodexho Food Services, only uses biodegradable sandwich packaging, salad containers, napkins, coffee cups and drink cups in its snack bar and at all its functions.

Expand Composting to Apartments, Residence Halls and Slayter Dining Services

Although Denison's dining halls produce the majority of the University's food waste, it would also be greatly beneficial to Denison's sustainability to also take into consideration food waste that is produced in students' personal kitchens and in the Slayter Snack Bar. Given that nearly 25-percent of students at Denison are not on meal plans and do not eat in the dining halls, Denison could expand its composting program to student apartments with private kitchens and kitchens in residence halls. Compost bins could be distributed to senior apartments, residence hall kitchens and off-campus satellite houses, and large compost bins could be placed alongside the dumpsters to collect individual food waste. This would have to be implemented together with an education program for students that explains what kitchen waste they can and cannot compost. It would spread awareness of Denison's composting efforts to the campus as well as make Denison students more aware of the environmental impact of their personal habits, that they may realize their individual responsibility to the environment.

Student-run Computer Refurbishing Effort

At Clark College, a program exists that pays students to take old computers (that would otherwise discard) to a center that refurbishes them so that they are in operating condition (Steven Stryker 2007). The computers are then sent to the Salvation Army to be distributed throughout the area to those in need. All recyclable materials that are left behind are recycled. It is the recommendation of the ENVS 301 class that Denison should investigate the feasibility of creating a similar program. This could be run by Computing Services, and employ students to refurbish computers. These computers could then be given to the Salvation Army, or to similar programs such as the Cristina Foundation (Christina Foundation 2007) or Redemtech, Inc (Redemtech 2007), for distribution to needy families.

Computer Recycling

Computers and related electronics that are unable to be used again should be recycled at the recycling barn. Amherst College provides a list of recyclable computer components: computer equipment, monitors, printers & plotters, electronic equipment, 3.5-inch diskettes, CD ROM's, data cartridges, computer reel tapes, VHS tapes, and audio tapes (Amherst 2007). The Denison

University recycling barn should begin taking computers and electronics, where they can then be sorted and sent to the closest processing plant.

Computer Collection

Colorado University created a three-day event titled "Computer Round-Up," where over 17 tones of computers and peripherals were collected and donated to national and international community development organizations (Colorado University 2007). Denison could implement a similar program. A large, public event could serve as a way to advertise the new program to students and faculty. In the future, people could bring their used electronics to computing services (or whatever location is ultimately determined to house the program). Alternatively, if the electronics are too difficult for students or faculty to carry, a collection service could also be implemented, and student workers could collect the equipment.

Community Outreach

Colorado University also created a program for the community around the university, called the Colorado Materials Exchange, or COMEx (Colorado University 2007). This organization has a branch titled "The Colorado Computer Reuse Project," which provides information and opportunities for computers and associated electronics to be reused within Colorado. Denison could follow CU's lead and reach out to Granville and the surrounding area to allow them to bring their electronics and computers to Denison's campus for refurbishment. If this is deemed too large a responsibility for Denison to handle, the University could research existing programs in Licking County and donate money or pay students to work with these programs when needed.

Plastic-recycling Organizations

There are many companies, mostly national, that process all types of plastic and Denison could easily become clients of these organizations, allowing the University to process all types of plastic. Plastic Recycling is an 80-year old international company that processes every type of commercially-used plastic, regardless of whether it is clean or contaminated (Plastic Recycling 2007). The Association of Postconsumer Plastic Recyclers represents hundreds of recycling companies in the U.S., Mexico and Canada which process over 90-percent of the recycled plastic in all three countries (Plastic Recycling 2007). This Association could undoubtedly connect Denison to a plastic processor that takes all seven types of commercial plastic.

Recycling Barn Upgrade

The current Denison University Recycling Barn is (according to members of the class who have worked in the barn), "cramped" and a "difficult place to work." If Denison expands its recycling capacity, the barn will have to be upgraded to accommodate these changes. Beyond simple increases in size, there will also have to be changes to issues involving safety. Many of the materials handled by workers can be harmful to their health and, while there is an eye-washing machine in the barn, it is not connected to any kind of water flow and therefore would not be helpful in the event of an emergency. Also, goggles and masks for eye and lung protection are

not sufficiently available. As such, while Denison does currently have a safety course that is mandatory for everyone who works in the barn, the training provided is seen as inadequate by students who have taken the course and work in the recycling barn. These are improvements that Denison needs to make if it plans to increase its recycling capabilities and provide a safe working environment for its employees.

The issue of recycling barn employment is another area that needs improvement. Currently, there are very few students employed at the barn and a large portion of Denison's campus is entirely unaware of the existence of the recycling barn. In order to implement the changes suggested within this report, more employees would have to be hired. One way to increase the workforce of the recycling barn would be to hire student workers. To increase student interest, the task force should help DURP (Denison University Recycling Program) in advertising the recycling barn, either through posters at the beginning of the year, radio spots on 91.1 WDUB, Denisonian articles or a combination of these and other media outlets.

V. Purchasing

Introduction

The products and services that a university chooses to use can have a significant environmental impact; as such, there are many opportunities within this arena to increase campus sustainability (Creighton 1998). With regards to the acquisition of goods including, but not limited to, office supplies, fertilizer, food, and cleaning supplies, we have determined a set of principals that should be taken into consideration before any purchasing decision is made. First, recycled or post-consumer products take priority in final decisions. Second, there should be an emphasis on local products. This emphasis should be heavily placed on issues such as dining hall food and supporting local businesses. In addition, whenever possible, dining hall purchases should include organic food products. Finally, environmentally friendly items should be taken into great consideration. 'Environmentally friendly' is defined here to include fertilizers, cleaning products that carry the approval of Green Seal, or another third party certifier (Creighton 1998). The following sub-sections shall go into further depth with relation to each of these three guiding principals.

Post-consumer Recycled Content Products

The term "post-consumer recycled content" is differentiable from the term "recycled content" and has different implications for a given product's process of manufacturing. Pre-consumer waste refers to leftover waste from processing and production methods before end-use by a consumer (State of Oregon: Department of Environmental Quality 2005). Post-consumer waste refers to products that have been disposed of by a consumer. Products with post-consumer recycled content refer to those that contain material from "end-cycle" products that have been disposed of as waste by the consumer, separated from waste material and recycled (State of Oregon: Department of Environmental Quality 2005). Some products report to contain

"recycled content," which can refer to recycled pre-consumer and/or post-consumer waste. The use of products that contain recycled post-consumer waste are beneficial in that they make use of materials that have been discarded by the consumer. It is important to note these differences in production and labeling when making decisions to purchase products with any form of recycled content.

In Phase I: Reconnaissance of the research process, some of the members of our class conducted research on departmental usage of post-consumer recycled paper. In correlation with the information about what type of paper was used there was also inquiry about the amount of paper used by the departments. The students surveyed 13 departments: Biology, Black Studies, Environmental Studies, Honors, Political Science, History, Religion, Admissions, Modern Languages, Math/Computer Science, Sociology/Anthropology, Education, and Psychology. All information gathered came from information reported by the departments. The data collected showed that the majority of departments do not use 100% post-consumer recycled paper (Figure 1). Specifically, the results from Phase I determined that:

> Of the 13 departments that responded to our requests, they use 112.5 reams of paper a week, 46.7-percent of which is virgin paper, 32-percent of which is partially recycled (30-percent post-consumer) paper, and 21.3-percent of which is totally recycled paper (Appendix C)

Furthermore, there is a good deal of printing done outside of the departments themselves in Office Services. In fact, Office Services used more than 15,000 reams of paper during the 2006-2007 school year (Appendix C). Because of the amount of consumption and the low usage of 100% post-consumer paper, we encourage implementation of regulations that require 100% post-consumer paper. For example if departmental orders are placed with Office Services, limits on the types of paper that are purchased could be set in place.

Benefits of purchasing of post-consumer recycled content products:

- Reduce use of virgin stocks (i.e. trees).
- Reduce overall generation of waste.
- Make use of discarded materials and products.

Our Phase II results evidenced a receptiveness of departments to in fact make the shift to 100% post-consumer paper. In Phase II, we conducted a project that provided the Office of Service Learning and the Psychology Department (which admittedly uses over 900 reams of paper annually) with 10 reams of 100% post-consumer paper (Appendix C). This project served two purposes: 1) to determine pre-conceptions about post-consumer paper and 2) to determine whether or not people noticed a significant difference between the currently used paper and 100% post-consumer paper. It was determined through surveys within the departments that there was no significant difference between the two types of paper. In fact, the Psychology department actually shifted to 100% post-consumer paper after the testing. This evidence further supports the willingness of departments to change their consumption patterns after exposure to the alternative options. In recent press, there has been a public statement issued which noted that Denison University has, in fact, shifted to 100% post-consumer paper (Bracken 2007). This is very encouraging information; however, as of yet, there has been no on-campus release stating the impending shift.

Purchasing of post-consumer recycled content paper and other products is essential to increase campus sustainability for numerous reasons. First, purchasing paper made from recycled material does not require the deforestation of virgin forests; therefore fewer trees need to be cut down. Second, use of post-consumer recycled content paper reduces the overall generation of waste. It should be noted, however, that purchasing recycled paper extends beyond the realm of printer paper; recycling should also be emphasized in the purchasing of napkins, paper towels, toilet paper, poster paper, used books, notebooks, other bookstore supplies, and carpeting. In short, use of products containing post-consumer recycled content should be prioritized in any institutional purchase at Denison.

Recommendations:

- Mandate use of post-consumer recycled content paper in all University departments and offices.
- Emphasize purchasing of other post-consumer recycled products such as office supplies, toilet paper, paper towels, etc.

Local and Organic

Phase I of our class research included an audit of Denison's Dining Services. As noted previously in this report, Denison's campus accommodates two buffet-style dining halls (Huffman and Curtis) and one a-la-carte dining service provided in Slayter Union (which includes Taco Bell, Pizza Hut, Strutters, Grill 151 and Substantials). Over the past few years, Dining Services has made small changes to accommodate Denison's students. For example, providing a "Smart Market" in both Curtis and Huffman dining halls that include vegan choices has allowed vegan students to enjoy more options. In addition, labeling vegan options with yellow containers has made locating and selecting vegan options easier. Lastly, purchasing and labeling local and organic food (i.e. locally grown apples and organic milk) has been implemented as a response to student demands for more local and organic food options. Although these changes take a step in the right direction, they are only the first few steps that Denison can take toward more sustainable dining options.

An interview with Becky Macheda, the General Manager of Campus Dining Services, provided information about Denison's contract with Sodexho, the University's food services provider. She stated that once Sodexho is contracted, they are responsible for hiring all food personnel, including managers and staff, as well as deciding menus, ordering food from vendors, cooking the food, and assuring that the dining process runs smoothly for students. Denison's contract with Sodexho dates back forty one years. According to Seth Patton, the Vice President for Finance and Management at Denison, Dining Service's annual budget is $4.3 million. Sodexho receives $3.5 million for management and food, while the rest is used for maintenance and utilities (Patton 2007). Of this annual budget, Ms. Macheda reported that approximately $1.54 million, of Sodexho's payment from Denison is used for purchasing food (Macheda 2007 a).

In Huffman and Curtis Dining Halls, the process for menu selection is pre-determined by the managers, and food is purchased on a weekly basis according to that week's menu. All purchases must be made from a list of about 20 Sodexho-approved vendors. This list includes

food prices and it indicates which are local and/or organic. Pressure from students a few years ago led Dining Services to begin purchasing only organic milk. Although this can cost up to three or four times as much student demand caused the change in purchasing. According to Ms. Macheda, Dining Services purchases as much local and/or organic food as can be allowed in the budget. Common local and/or organic foods in the dining halls include lettuce and a variety of fruits. One common question for Dining Services is why local and organic foods are not labeled. The interview with Ms. Macheda stated that the Sodexho staff does not think that it is honest to label local and organic purchases that are not 100% locally grown or organic. Vendors do not have an abundance of local or organic food available, so Dining Services purchases what they have available and then purchases the rest in conventional foods. Frequently, foods like lettuce and fruits are a mixture of local and organic products and conventional products. For this reason local and organic foods are not labeled in the dining halls since Sodexho employees believe it would be misleading to label products that are not 100% local or organic (Macheda 2007 a).

Benefits of Local Food:

- Requires less transportation and therefore less fossil fuel and less carbon emissions.
- Requires less packaging and less use of petroleum products for the production of plastics and Styrofoam.
- Supports local economy.

Benefits of Organic Food:

- No use of pesticides & insecticides, which is better for human health and the environment.
- No genetically modified organisms.
- No animal mistreatment or cruelty.

Although local and organic food products can be more of an expense, their benefits are still significant. Local food requires less transportation, and lighter packaging, resulting in fewer carbon emissions because of the long range transportation and extensive packaging with plastics and styrofoam that are necessitated by conventional foods. In addition, locally produced foods support the local economy and contribute to local business. Purchasing organic food options means buying foods that have not been exposed to pesticides and insecticides which can be harmful to human health. It also ensures that genetically modified organisms have not been used in food production, and that animal mistreatment or cruelty has not been used in the production of organic meats and dairy products. Unfortunately there are currently no Sodexho-approved vendors that offer organic meat options, however, if pressure is applied and Sodexho is encouraged to look for and add organic meat vendors to their approved list, local and organic meats and dairy products can be served as a healthier and more humane alternative than products of conventional methods (Macheda 2007 a).

A student survey conducted this semester included questions regarding student's attitudes towards local and organic foods. One question asked about student knowledge of the differences between local, organic, and conventional foods. These results concluded that a majority of students were aware of the differences between the two. In addition, students were asked how important they felt it was to have local foods in the dining halls, their responses showed that a majority of students felt it was moderately to very important to have local foods in the dining halls and the following question regarding organic foods in the dining halls showed that a majority of students feel that it is also moderately to very important that organic foods be served

in the dining halls. These three questions showed student support for local and organic foods in the dining halls. The full results to this survey can be found in Appendix C.

With student support and local and organic benefits in mind, it is recommended that Denison University's Dining Services reevaluate their contract with Sodexho food providers and require that local foods be purchased when possible, and that the maximum amount of organic foods be purchased in place of conventional non-organic options. These changes have been implemented in numerous other colleges and universities across the country as schools look for ways to increase campus sustainability and promote environmental causes. Two nearby examples include Oberlin College and Kenyon College. Oberlin College switched from Sodexho services to those of Bon Appétit, who proved to be more flexible and willing to work with student needs and requests. This new food provider sought ways to cook with fresh foods, provide vegan and vegetarian options, respond to student feedback, minimize negative impact of packaging, and commit to working with local vendors. With and initial goal of having "10 percent of all food purchases from local sources," Oberlin, over the past six years, has become home to a greenhouse that provides a local location to produce organic produce throughout the year. In addition, Oberlin's 2007 goal of 35 percent local food purchases indicates an increasing target for the purchase of locally produced foods. These new steps generate a financial boost for the local economy with purchases and significantly reduce food transportation costs and packaging costs and materials. Oberlin is an example of a college that responded to student demand and takes action to increase campus sustainability (Tibbitts 2007).

Kenyon College has also striven for more sustainable food options through their Dining Services. Their "Food for Thought" program is aimed at purchasing fresh, locally produced products to decrease negative environmental impact and invest in the local economy. Kenyon's labeling system for locally grown products also helps raise awareness about local purchases in the dining halls. Their food provider, Avi Foodsystems, Inc. has worked to meets the demands of students and has been flexible and accommodating to student suggestions (Kenyon College 2007). In the interview with Ms. Macheda, she shared that she has been in contact with Kenyon over the years and has learned a lot about their food provider and how they are incorporating local and organic products into their menus. She stated that as of a year and a half ago, about 15-20% of Kenyon's food was local and/or organic. Also, she believes that Kenyon has a vendor for local and organic meat, unlike Denison, which has no Sodexho-approved local or organic meant vendor. In addition, Becky stated that she believes Kenyon to have a specialized fund that aids Dining Services in purchasing local and organic food (Macheda 2007 b).

Recommendations:

- Apply pressure to Sodexho to provide more local & organic food sources, particularly local & organic meats.
- Increase budget to include purchasing of local & organic food.

After researching Sodexho and Denison's dining services, we recommend that the University put pressure on our food provider to establish additional vendors of local and organic food sources, mainly a vendor for local and/or organic meats. In addition, Denison should recognize the importance and positive impacts of local and organic foods and make it a priority in Dining Services budgets and contracting. The University should reconsider annual budgets and try to find a way to set aside funds or gain additional funds to aid in the purchasing of local and

organic foods. Organic products promote healthy and humane production practices, and local purchasing has a positive impact on the local economy as well as decreases transportation costs and emissions. We recommend that Denison's Dining Services support the local economy and local businesses when at all possible, and that organic food purchases be made a priority.

Environmentally Responsible Products

Yet another way in which Universities can decrease their environmental impacts and increase campus sustainability is through purchasing environmentally friendly and environmentally responsible products for cleaning supplies, chemicals, and fertilizers. Characteristics of products that are considered environmentally responsible or "green" might include: biodegradable, low-toxicity, carcinogen-free, chlorofluorocarbon-free, bioaccumulative toxin-free, heavy metal free, recycled post-consumer content, and locally manufactured or grown (Oberlin College Green Purchasing Policy 2007). One should consider the entire life cycle of a product from its manufacturing and use to its disposal (i.e. can it be recycled)when evaluating the environmental impact of the product. Furthermore, many third-party organizations certify products to distinguish those that are environmentally conscious, which aids in campus sustainable purchasing decisions. Examples of these green certifications include Green Seal, Energy Star, and Electronic Product Environmental Assessment Tool (EPEAT). Green Seal, an independent non-profit organization, is committed to promoting the manufacture, purchasing, and use of environmentally responsible products and services such as cleaners and paints through a green certification process (Green Seal 2007). Purchasing of Green Seal certified products are a good way in which Universities can make more sustainable campus purchasing decisions. Additionally, Green Seal certification standards can be used as a guide for purchasing other products in an attempt to increase use of environmentally responsible products.

Benefits of environmentally friendly products:

- Reduced negative impact on environment.
- Safer for humans.

Recently, Denison has made an increased effort to purchase environmentally friendly and Green Seal approved products for use on campus. According to Mr. Chonko, Denison purchases the majority of its cleaning supplies from Johnson, many of which are Green Seal certified. Mr. Chonko mentioned that one of the non-Green Seal certified cleaning products that is used on campus is a gum remover and degreaser. Furthermore, Mr. Chonko noted that the University currently uses organic fertilizer in addition to traditional pesticides and other chemicals in grounds keeping. Mr. Chonko explained that he has asked all University departments and storeroom operators to be aware of green alternatives to any purchased products that are currently used on campus (Chonko 2007).

Recommendations:

- Written mandate for purchasing of low-environmental impact products.
- Continue and increase use of Green Seal cleaning supplies and chemicals.
- Expand purchasing of Green Seal and low-environmental impact products to other types of products.

Purchasing of environmentally responsible, low-environmental impact products is an ongoing process, which must be increased and continued on Denison's campus. It would be advisable for the University to increase purchasing of Green Seal, low-environmental impact, and environmentally responsible cleaning supplies, detergents, chemicals, fertilizers, and other products as a means to increase campus sustainability. It would also be advisable for the University to refrain from purchasing and using harmful, polluting chemicals in house keeping, grounds keeping, and regular departmental use. Furthermore, a way in which the University can contribute to good environmental stewardship would be to commit to reduce consumption and purchasing of materials and products only to that which is necessary (Creighton 1998). It would be beneficial for the University to mandate the use of environmentally friendly products where possible and perhaps to formulate a written commitment to purchasing products with environmental benefits or decreased environmental harm. For example, Oberlin College has formulated a written policy outlining standards that will be followed in purchasing green products and materials on campus. Other college campuses have also made an effort to make purchasing of green chemicals, cleaning supplies, and other products easier, more accessible, and even mandatory. Campuses that have implemented such environmentally responsible, green purchasing programs and guidelines include: Oberlin College, Cornell University, Harvard University, Tufts University, and Yale University, among many others (van Schagen 2007). Denison should follow the actions taken by other college campuses and make a commitment to purchase all environmentally friendly products in order to increase campus sustainability.

Conclusion

Sustainability at Denison can be heavily influenced by the products that the University purchases. We believe that it is important to make it a priority for the University to purchase products and materials with recycled content. Also, purchasing local and organic foods for the dining halls instead of conventional products decreases negative environmental impact and has a positive effect on the local economy. Lastly, purchasing environmentally friendly products including detergents, cleaners, and fertilizers can reduce environmental impacts and contribute to sustainability on Denison's campus. A conscientious purchasing policy can be instrumental in making Denison aware of campus consumption, and may in fact lead to future progress on the path to sustainability. In short, implementing the guiding principals of purchasing can effect further change.

VI. Conclusion

Denison University can make significant positive changes toward becoming more environmentally sustainable. In the United States, institutions of higher learning are seen as places of progress and ideals, yet the fact that colleges and universities can be the largest polluters in their surrounding areas is often overlooked. However, it does not always have to be this way. This idyllic concept of the university as well as the university's obligation to educate students for the future should spur these institutions to embody the change their students want to see in the world.

Becoming a progressive leader does not happen overnight; in fact, it requires long-term commitment and action. The University must be dedicated to making changes like the ones suggested above. Initial steps must begin with the cooperation and participation of all levels within the Denison community, meaning that students, staff, faculty, and the administration must work together to create a "culture of stewardship" (Creighton 2007).

A Culture of Stewardship

Many of the actions throughout this report require improved operations, the installation of new and efficient technology, or the purchase of environmentally friendly products. These actions alone may accomplish the tasks set forth, such as decreasing energy consumption and cost, but they are not necessarily indicative of change. Environmental action must be coordinated with an increased awareness and understanding of the ways in which everyday choices have long-term consequences to the campus and its surrounding environment. This knowledge is part of creating a "culture of stewardship."

Individual effort is critical to the new culture. The choices that individual members of the community make are just as important to environmental change as larger, institutional decision. In fact, emphasizing smaller efforts often make the larger issues, such as reducing greenhouse gas emissions much easier to combat. Therefore, a campus-wide education campaign is essential to build support for institutional progress. Education should be based on everyday decisions that make a difference, including reducing personal waste, recycling, choosing to walk instead of drive, and eating sustainably. This is most important for students because they live on campus, and are thus in a unique position to influence and practice the University's environmental stewardship policies (Creighton 1998).

The educational campaign is also important for the publicity aspect. As stated before, institutional action does not generate change on its own. Therefore, publicizing the University's efforts raises awareness of both the issues and the actions that Denison is taking. While emphasizing Denison's active commitment toward a more sustainable campus, publicity also encourages and recruits motivated members of the community to get involved. An example of this is the recent installation of solar panels on the roof of the library. As mentioned in the Green Building section, these have already inspired several student projects on sustainability as well as awareness among students, faculty, and staff alike.

An excellent source for help regarding education and publicity is student campus organizations. Groups like the Denison University Recycling Program, Green Team, and Denison Progressive Alliance have run successful environmental campaigns to raise awareness about various issues, such as waste reduction and global climate change. Recently, Green Team conducted a month-long competition between residence halls to reduce their water consumption by the highest percentage called Water Wars. The competition turned out to be a great success; the winners reduced their consumption levels from September to October by over 50%! Student organizations have been very active on these issues and will be able to provide an additional support base for Denison's environmental initiatives.

Another example of student initiatives is the partnership of Denison's Physical Plant and Green Team to create stickers that will be placed on light switches in classrooms to remind people to turn off the lights. First, this will further help to create a culture of stewardship as people learn and remember to manually turn off the lights when a room is not in use. Second, this initiative also entails the collaboration of students and staff. We hope that many future projects will include this type of cooperation and unity.

Support for environmental initiatives is necessary so that they far-reaching and institutionalized. While student organizations are important, they are not the only support change will need. The implementation of a "culture of stewardship" requires the backing of faculty, staff, and administration as well.

Future Projects

The purpose of this report has been to emphasize the enthusiasm and support of students as well as to serve as a guide to the beginnings of environmental change on Denison's campus. We have given many recommendations in areas that are key to environmental sustainability. Building a culture of stewardship is the most important aspect in getting these changes implemented. That entails support of all the members of the Denison community. However, we realize that many of those supporters do not have the resources to devote themselves completely to implementation of a new environmental plan.

Future Project Recommendations

- Sustainability Coordinator
- Paid Student Positions
- Campus Audit
- Revolving Fund

For this reason, we advocate for the hiring of a new Sustainability Coordinator position at Denison. The University could benefit greatly by creating a staff position that focuses on energy and environmental management. This person will oversee the efficient operation of existing systems, the improvement of such systems, renovations and new construction. The coordinator should also be responsible for making sure that the University is able to meet and exceed its environmental policies. Many schools have already created such a position. For example, the University of North Carolina at Chapel Hill runs an entire Sustainability Office to implement sustainable practices, policies, and curricula (UNC 2007). At Cornell University, the sustainability coordinator is often an alumnus/a who reports to the Vice President for Finance and Administration. The first coordinator was charged with creating a plan for ecological responsibility that assessed the cost effectiveness and feasibility of difference environmental initiatives (Cornell 2005). Such a position at Denison would help define and implement the University's environmental commitment.

Another possible resource for implementation would be to create paid student positions that will serve several purposes. Much like the students that help to sort the recycling at the Recycling Barn, these positions will help staff to perform small, but important tasks. For example, these students could assist the Sustainability Coordinator in whatever tasks are necessary. Students can be effective extra hands to see that the research, testing, and implementation of environmental action take place (Creighton 1998).

However, in order for the solutions mentioned in the above report as well as future positions to be effective, we must make sure that data and research are part of the process of environmental improvement. Although we have provided a great deal of useful information for setting policies, we were unable to delve in detail into the nature of existing technology and infrastructure of the university. Therefore, we recommend that Denison conduct a detailed audit of the campus that quantifies its environmental impact. This should include the sections we have considered in this report: energy, green buildings, waste management, and purchasing. It should also include a detailed look into other topics such as grounds keeping and landscaping, investments, transportation and parking, and water (AASHE 2007).

One more concern for future projects and the recommendations we have made so far to be effective is the issue of cost. We understand that many of these initiatives will incur certain startup costs. For example, in order to create a biodiesel program on campus, the total cost of purchasing the necessary processing equipment would be $3,715 (Dickson et al. 2007). However, because the University would not be paying the $600 a month to have the kitchen grease picked up, the initial cost would be paid back. We found that the payback period would be seven months, after which the biodiesel program would be saving Denison money. To pay for initial costs of environmental initiatives such as these, Denison currently has set aside annual funds for environmental sustainability projects on campus through the administration. Besides that, the John Hunting Venture Fund also has funds to support such projects. We propose that the money saved from such projects as the biodiesel program be placed in a "revolving fund." This revolving fund contributes to the longevity of current funds and will be used to fund further environmental initiatives. The way in which this fund works is that Denison would continue to allocate the same amount of money for utilities as if the projects had not been undertaken. The money in the budget that now does not need to be spent on utilities will build up the revolving fund (Chonko 2007 e). Thus, the $600 that was originally spent to have the kitchen grease taken away that has been made unnecessary by the biodiesel program will instead be put into the fund.

President's Climate Commitment

Throughout this report, we have advocated for change within Denison's guiding principles to include environmental sustainability. To complement and maximize Denison's dedication, we strongly encourage the signing of the American College and University President's Climate Commitment (PCC). The document is sponsored by the Association for the Advancement of Sustainability in Higher Education (AASHE). The goal of the Commitment is to unite colleges and universities in confronting global climate change by reducing carbon emissions and eventually achieving climate neutrality, or reducing net carbon dioxide emissions to zero. The Commitment emphasizes the unique role that institutions of higher learning have to educate tomorrow's leaders and model to society tangible ways to eliminate global warming emissions. As of November 2007, 448 schools have signed the Commitment, pledging to become climate neutral. Many of Denison's peer

President's Climate Commitment

- 448 schools already signed
- Pledges to make strives to be climate neutral
- Creates environmental sustainability committee
- Addresses campus sustainability

institutions have signed this document to take responsibility for their emissions (President's Climate Commitment 2007).

The document itself requires that signatories take various steps to achieving climate neutrality (Appendix E). First, it requires schools to set up a committee to deal with environmental sustainability issues and to oversee the Commitment's implementation on campus. Secondly, a comprehensive greenhouse gas emissions inventory must be completed within a year of signing the document. We believe that this inventory is crucial in order to determine the status of our inefficiency and what buildings should be targeted for renovations and fitted for efficiency standards first. Within two years of signing, the campus must devise a comprehensive action plan to become climate neutral. The college comes up with its own date for climate neutrality and interim steps to that goal. Lastly, the college must choose two immediate action steps to take from a list of seven that can reduce carbon emissions. The list includes items such as creating a policy for green buildings, buying Energy Star appliances, and offsetting greenhouse gas emissions for air travel paid by the institution.

We recommend that Denison sign this Commitment and immediately begin planning a path to carbon neutrality. Signing the PCC will benefit the campus environmentally, financially, scientifically, and academically. Not signing the Commitment or making a plan for climate neutrality will leave Denison behind peer institutions and will reflect poorly on our campus. The science from the National Academy of the Sciences and the Intergovernmental Panel on Climate Change agree that greenhouse gas emissions must be reduced 80% by 2050 (Texas Tech 2007). We need to take responsibility for our emissions and educate our students on the importance of reducing the carbon footprint of our institution and of the individuals that comprise the institution. The actions of the PCC that we will pledge to are critical for our University and our planet.

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Appendix A

Sustainable Sites

New Construction	Existing Building
Prerequisite Construction Activity Pollution Prevention	*Prerequisite* Erosion and Sedimentation Control
Site Selection	*Prerequisite* Age of Building
Development Density and Community Connectivity	Plan for Green Site and Building Exterior Management
Brownfield Redevelopment	High Development Density Building Area
Alternative Transportation	Alternative Transportation
Site Development	Reduced Site Disturbance
Stormwater Design	Stormwater Management
Heat Island Effect	Heat island Reduction
Light Pollution Reduction	Light Pollution Reduction

Water Efficiency

New Construction	Existing Buildings
Water Efficient Landscaping	*Prerequisite* Minimum Water Efficiency
Innovative Wastewater Technologies	*Prerequisite* Discharge Water Compliance
Water Use Reduction	Water Efficient Landscaping
	Innovative Wastewater Technologies
	Water Use Reduction

Energy and Atmosphere

New Construction	Existing Buildings
Prerequisite Fundamental Commissioning of the Building Energy Systems	*Prerequisite* Existing Building Commissioning
Prerequisite Minimum Energy Performance	*Prerequisite* Minimum Energy Performance
Prerequisite Fundamental Refrigerant Management	*Prerequisite* Ozone Protection
Optimize Energy Performance	Optimize Energy Performance
Enhanced Commissioning	On-site and Off-site Renewable Energy
Enhanced Refrigerant Management	Building Operations and Maintenance
Measurement and Verification	Additional Ozone Protection
Green Power	Performance Measurement
	Documenting Sustainable Building Cost Impacts

Materials and Resources

New Construction	Existing Building

Prerequisite Storage and Collection of Recycles	*Prerequisite* Source Reduction and Waste Management
Building Reuse	*Prerequisite* Toxic Material Source Reduction
Construction Waste Management	Construction, Demolition, and Renovation Waste Management
Materials Reuse	Optimize Use of Alternative Materials
Recycled Content	Optimize Use of IAQ Complaint Products
Regional Materials	Sustainable Cleaning Products and Materials
Rapid Renewable Materials	Occupant Recycling
Certified Wood	Additional Toxic Material Source Reduction

Indoor Environmental Quality

New Construction	Existing Building
Prerequisites Minimum IAQ Performance	*Prerequisites* Outside Air Introduction of Exhaust Systems
Prerequisites Environmental Tobacco Smoke (ETS) Control	*Prerequisites* Environmental Tobacco Smoke (ETS) Control
Outdoor Air Delivery Monitoring	*Prerequisites* Asbestos Removal or Encapsulation
Increased Ventilation	*Prerequisites* PCB Removal
Construction IAQ Management Plan	Outside Air Delivery Monitoring
Lo-Emitting Materials	Increased Ventilation
Indoor Chemical and Pollutant Source Control	Construction IAQ Management Plan
Controllability of Systems	Documenting Productivity Impacts
Thermal Comfort	Indoor Chemical and Pollutant Source Control
Daylight and Views	Controllability of Systems
	Thermal Comfort
	Daylight and Views
	Contemporary IAQ Practice
	Green Cleaning

Innovation

New Construction	Existing Building
Innovation in Design	Innovation in Design
LEED Accredited Professional	LEED Accredited Professional

Appendix B

Personal E-mail between Meredith Atwood and Art Chonko, 27 November 2007

Cleveland is a LEED-NC new build project.

We spent the following in 2006-07 for utilities, I'll need to ask Scott for usage information:
$1,246,320 electric (which is probably about 22-25 million kwh)
$1,391,122 natural gas and coal
$386,000 water and sewerage

~120 structures, 1.7M sq. ft. - the list is below.

BUILDING NAME	NUMBER	SQ FT
116 East College (Sinnet)		1,456
12 Samson		890
124 East College		1,920
130 East College		1,700
130 N. Main		1,500
135 N. Main		1,500
138 N. Main		2,000
140 East College (Inskeep)		1,920
209 North Prospect		1,150
215 N Prospect		2,400
231 West Broadway		3,600
231 West Broadway Garage		
301 North Propsect		1,500
405 Burg Street		2,000
500 Burg Street		2,900
504 Burg Street		2,000
6 Samson		890
Ace Morgan		24,182
Alpha Chi Omega		
Ash House (ATO)		13,334
Bancroft		3,000
Barclay Thomson Rest Room		700
Barney-Davis		26,784
Baseball Rest Room		700
Beaver		22,000
Beta (leased)		14,880
Beth Eden		8,054
Burke Hall		32,397
Burton Hall		13,620
Burton Morgan		55,298
Chamberlin (Phi Gamma)		15,462
Chicken House		500
Chiller Plant		900
Cinema		3,005
Cinema Annex		1,001
Cleveland Annex		5,146
Cleveland Hall		28,204

College Town House	4,000
Crawford	54,000
Curtis Dining	33,598
Curtis East	24,568
Curtis West	22,700
Deed's Field Concession/RR	
Delta Delta Delta	
Delta Gamma	
Doane Admin	31,470
Doane Dance	10,822
Doane Library/Seeley Mudd LRC	94,399
Dustin Cabin	1,004
East	26,648
Ebaugh/Herrick	52,712
Elm Lower	10,712
Elm Upper	10,712
Fellows	46,038
Fieldhouse/Mitchel/Pool	171,418
Fire Pump House	320
Foster Hall	
Garage (Security)	42,800
Gilpatrick	4,417
Gilpatrick	2,000
Grounds Pole Barn	
Heating Plant	7,314
Heating Plant Pump House	
Higley Hall	34,311
Hobart House	3,600
Homestead 1	720
Homestead 2 down	0
Homestead 3	940
Homestead Bob/Straw	900
Huffman	17,856
Huffman Dining	31,296
Irvine Hill	2,960
Kappa Alpha Theta	
Kappa Kappa Gamma	
Kappa Sigma (leased)	11,900
King	12,120
Knapp	57,890
Lamson Lodge	1,314
Hayes - Maple Lower	10,712
Wright - Maple Upper	10,712
Middleton Stables	
Monomoy Annex	2,600
Monomoy House	14,774
Morrow (Lambda)	9,510
Mulberry House	4,686
Mulberry House	800
Nursery Cottage	1,292

Observatory - Swasey	2,826
Olin	56,541
Physical Plant	33,000
Pi Beta Phi	
Poly Anderson FH	1,748
Preston (Phi Delta)	13,170
Quonset Hut	4,000
Recycling Building	1,800
Richards House	2,176
Rose House	3,200
SAE	12,895
SAE (art)	
Samson Talbot	65,164
Sawyer	22,086
Shanon House	1,800
Shaw	26,080
Shepardson	39,073
Shorney	48,600
Sigma Chi	13,270
Slayter	44,026
Slayter Connector	1,224
Slayter Dining	10,000
Smith	25,110
Stone	22,500
Sunset A	18,500
Sunset B	18,500
Sunset C	18,500
Sunset D	18,500
Sunset House	6,600
Swasey Chapel	21,896
Taylor House	13,020
Warehouse	
Whisler	12,071
TOTAL	1,758,914

APPENDIX C

Department	Percent of reams of printing done in office	Percent post-consumer reams of recycled paper used in office	Reams of paper used reams per week in office
History	100	0	5
Religion	90	0	5
Math/Computer Sciences	95	0	2.5
Admissions	75	0	30
Modern Languages	95	0	10
Totals for departments that use -0-percent recycled paper	91	0	52.5
Sociology/Anthropology	100	30	1.5
Education	99	30	5
Black Studies	95	30	2
Psychology	95	30	27.5
Totals for departments that use 30-percent recycled paper	97.25	30	36
Political Science	98	100	10
Environmental Studies	99	100	3
Honors	70	100	2
Biology	90	100	9
Totals for departments that *report* use of 100-percent recycled paper	92.5	100	24

Figure 1. Reported Departmental Paper Habits

Student Behavior, Opinions, and Actions

Appendix D

A student survey was conducted for approximately one week in order to better understand student behaviors and opinions towards food and Dining Services. Out of roughly 2,200 students at Denison University, 383 filled out the survey, which was open to everyone. The survey contained information regarding all sorts of behaviors regarding environmental issues all over campus and not just dining. The following results, however, just look at the questions that we designed to help understand the current state of Dining Services.

The first question that we wanted to find out was how satisfied students were with the selection of foods in the dining hall (Figure 2). This graph shows that the sample of 374 students who answered this question, on average, 19.8% were dissatisfied with current dining hall food selections, 20.6 were slightly dissatisfied, 31.0% were neutral, 23.3% were satisfied and 5.3% were satisfied. Of the 383 students who took the survey, nine did not answer this question.

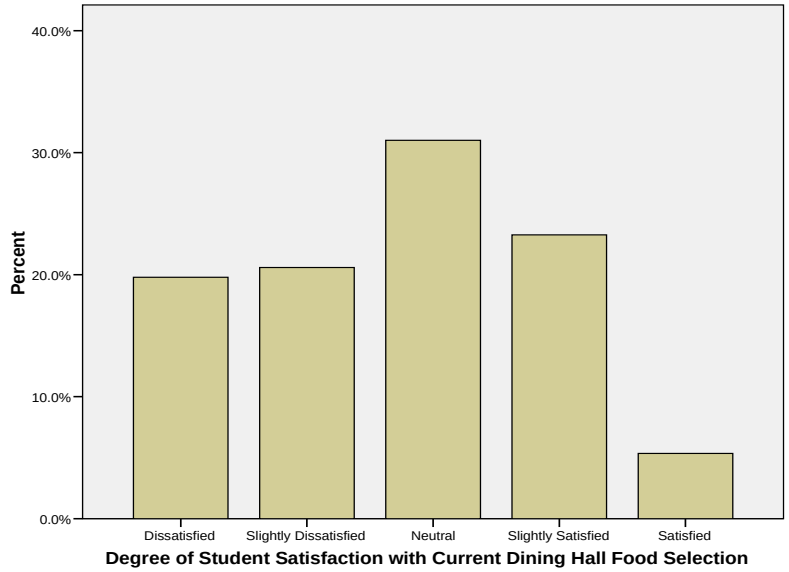

Figure 2. This graph visually represents the degree of student satisfaction with food selection in the dining hall.

Secondly, we wished to see how often students were wasting some portion of the food that they were taking during their meals. Figure 3 shows that out of the sample of 379 students who answered this question, on average, 2.6% of students never finished all the food on their dining trays, 12.1% rarely did, 20.8% sometimes did, 53.3% frequently did, and 11.1% of the responses answered that they always finished the food on their tray. Four of the students who took the survey did not answer this question.

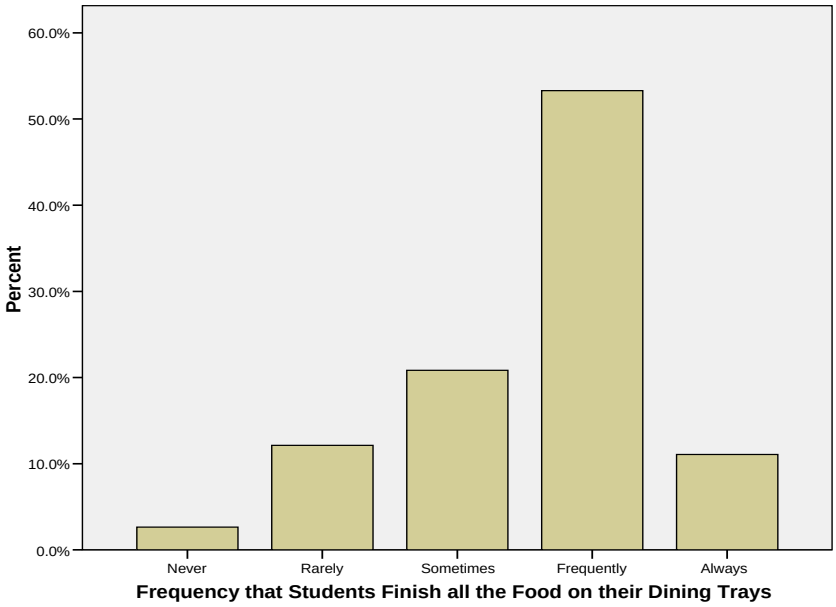

Figure 3. This graph visually represents the frequency that students finish all of the food they take in a meal.

We were also interested in finding out students' knowledge of local, organic, and conventional foods. If they didn't know much about the difference, then some of the other questions we asked would not have reliable answers. Figure 4 shows that out of the sample of 371 students who answered this question, 80.6%, on average, were aware of the differences between local, organic, and conventional foods, while 19.4% were unaware. The total survey sample consisted of 383 students and twelve did not answer this question.

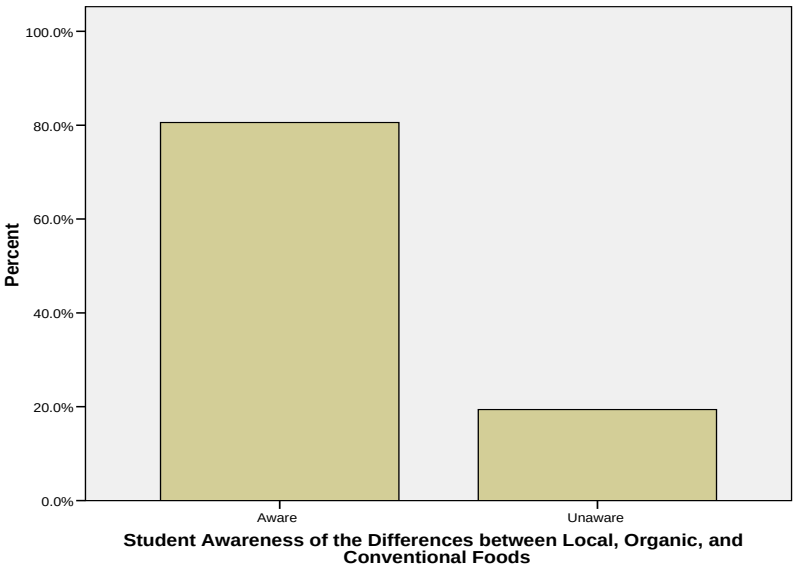

Figure 4. This figure compares the number of students aware of the differences between local, organic, and conventional foods with those who are unaware of the differences.

We also wanted to gauge how students felt towards having local foods in the dining halls. This graph (Figure 5) shows that of the sample of 380 students who answered this question, on average, 23.2% answered that it was most important to have local foods in the dining hall, 17.4% answered fairly important, 27.1% answered moderately important, 14.3% answered slightly important and 17.2% answered least important. The total survey sample consisted of 383 students and three did not answer this question.

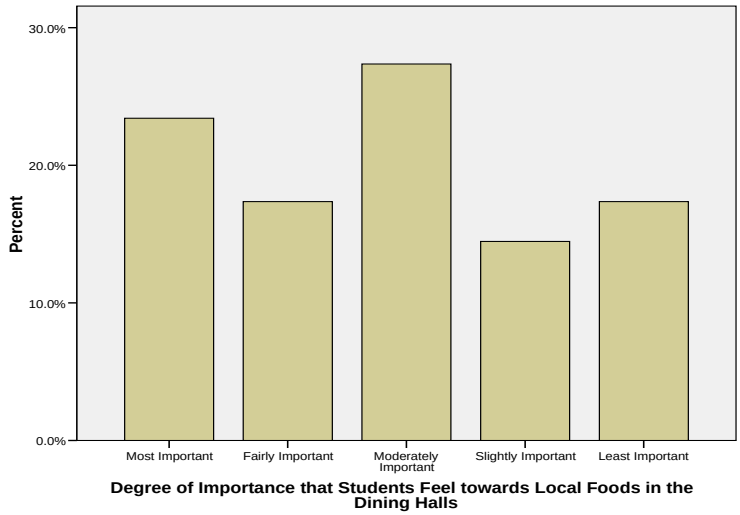

Figure 5. This figure shows how important students feel local foods are for the dining halls.

Next, we asked the same question as above (importance of local foods in the dining halls), but of organic foods. Figure 6 shows that of the sample of 380 students who answered this question, on average, 20.21% answered that it was most important to have organic foods in the dining hall, 20.6% answered fairly important, 28.4% answered moderately important, 16.1% answered slightly important and 13.8% answered least important. The total survey sample consisted of 383 students and three did not answer this question.

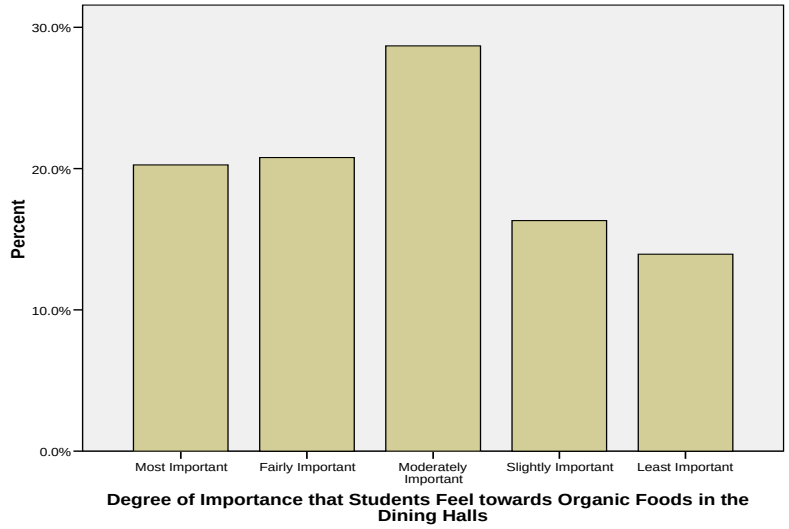

Figure 6. The degree of importance students feel towards organic foods in the dining halls.

Lastly, we were interested in gauging the knowledge of students about environmental actions that Denison is taking. We asked students if they knew about the compost program that

is supposed to take effect this fall. Figure 7 shows that of the 381 students who answered this question, 32.5% answered they were aware of the composting program and 67.5% answered they were unaware. The total survey sample consisted of 383 students and two did not answer this question. The data show, on average, that about two-thirds of the sample was unaware of the composting program Denison is going to start.

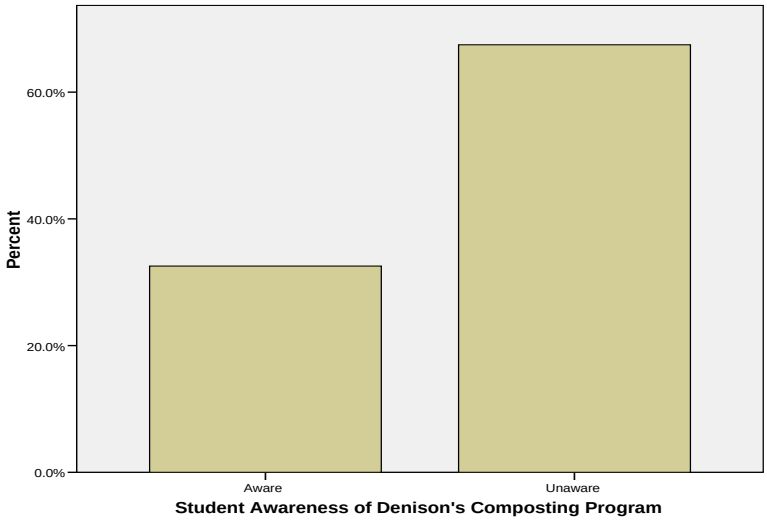

Figure 7. This figure shows the distribution of students' awareness to the upcoming compost program.

Appendix E

See attached document on Menu of Energy Star Offerings for Higher Education

Appendix F

See attached document of the Presidents Climate Commitment