STARS SUSTAINABILITY ANALYSIS FOR THE UNIVERSITY OF VIRGINIA SCHOOL OF ARCHITECTURE

Climate / Energy / Water

Global Sustainability, Fall 2011
Prof. Phoebe Crisman
Workshop Leader: Michael Britt
Team Members: Jasmine Amanin, Ghilan Golzar, Annie Hovland, Barbara Porada, Stephanie Montenegro
Community Partner: Dean Kim Tanzer

TABLE OF CONTENTS

PROJECT STATEMENT

This project will assess the School of Architecture's Energy, Water, and Climate expenditures according to the Sustainability Tracking Assessment and Rating System (STARS). It will also offer several sustainable alternatives the school could implement in order to increase it's STARS score. We used the 2010 version of the STARS rating system to calculate the current STARS rating for Campbell Hall. The school's final rating was reached by calculating data accumulated from the school's energy, water, and climate activities within the last five years. We then proposed and performed a detailed analysis of several different best management practices (BMPs) that the school could implement in order to improve its rating.

We worked closely with Andrew Greene, the Sustainability Planner for Campbell Hall, to formulate a skillfully planned metric system, which we used to rank each BMP. The system was designed to easily show which BMPs have the largest effect on the STARS rating system, are the least costly, require the least amount of outside resources, and are the most feasible for the school to implement. The BMP with the highest score would be the most effective BMP to implement, and the BMP with the lowest score would be the least effective to implement. In our conclusion we provided the top ranked BMPs for each category (energy, water, and climate) that would be most beneficial for the school to implement and several ways in which the school could approach implementing them.

The main goal of this project was to find out what Campbell Hall was doing to promote sustainability in the areas of energy, water, and climate. The second goal was to discover new ways to approach reducing the school's energy, water, and climate dependence. Our community partners were Andrew Greene, the UVA Sustainability Planner, and Dean Tanzer, Dean of the School of Architecture. The Dean was a contact and stakeholder in the project and Andrew Greene functioned as our main liaison throughout the project. Each team member worked diligently together with our community partners to compile the necessary data to perform the analysis and achieve our goals. We hope that the findings of our research will be made accessible to all the faculty members of Campbell Hall and placed on the School of Architecture's website to raise awareness about how the school could be more sustainable.

In order to improve sustainable practices, levels of sustainability need to be quantified. STARS has allowed our team to evaluate which departments of the Architecture School are lacking in sustainable practices. Our team has specifically performed an in depth investigation of the metrics of energy usage, water consumption, and green house gas management. We collected data, conducted research, and compared the STARS standards to other similar schools. In doing so, we have determined the infrastructure's least sustainable practices, and furthermore made recommendations for the School of Architecture to pursue to improve their STARS rating and increase their level of sustainability.

TIMELINE

This project timeline for our gives an overview of when various parts of the project occurred.

Task Description	Due Date	Team Participants	Completed/Notes
Project Definition	09/21/11	All	Yes.
Draft email to stakeholders	09/30/11	Jasmine Stephanie	Yes.
Contact Stakeholders	10/01/11	Ghilan	Yes. Andrew Greene and John Quale provided data.
Obtain all necessary documented data on Campbell Hall	10/03/11	Ghilan	Yes. Andrew Greene provided us with carbon emissions and energy and water usage data for Campbell Hall for 2005-2011.
Formulate BMPs for Energy	10/05/11	Jasmine	Yes.
Formulate BMPs for Water	10/05/11	Stephanie Barbara	Yes.
Formulate BMPs for Climate	10/05/11	Annie Ghilan	Yes.
Conceptual Design	10/05/11	All	Yes. Now we need to interpret the 5 years of existing data for the UVA Architecture School to evaluate current sustainability and rank each BMP by the Indices of Performance suggested in the Conceptual Design to determine which would be the most practical and successful.
Rank each BMP by Indices of Performance- Energy	10/30/11	Jasmine	Yes.
Rank each BMP by Indices of Performance- Water	10/30/11	Stephanie Barbara	Yes.
Rank each BMP by Indices of Performance- Climate	10/30/11	Barbara Annie Ghilan	Yes.
Meeting with Andrew Greene	11/01/11	Annie Ghilan	Yes. Went over each BMP in the Conceptual Design to find out which have already been implemented and which have not. Several implemented but very sparsely, so expanding upon these ideas must be considered. Also went on a tour with Andrew around the Architecture School to analyze current infrastructure and to see sustainable and unsustainable systems already in place.

Determine a scale for the Indices of Performance	11/01/11	Annie Ghilan	Yes. Each number represents a specific score for each Index of Performance: 1 being the least advantageous and 5 being most advantageous. A specific range enables us to effectively rank each BMP and avoid ambiguity about what each number stands for.
Compare the A School's STARS points before and after the (hypothetical) implementation of our BMPs	11/01/11	Annie Ghilan	Yes. We will continue this comparison as we collect further data and information.
Reformat BMPs and add in the scores based on the Indices of Performance	11/01/11	Annie Ghilan Stephanie	Yes.
Adjust the Approach section of our Conceptual Design	11/01/11	Stephanie Annie	Yes. We are no longer comparing to other schools or using the AASHE calculator.
Update and adjust the calendar	11/01/11	Barbara	Yes.
Address the project's budget	11/01/11	Barbara	Yes.
Dissemination	11/01/11	Jasmine	Yes.
Interpret and organize UVA Architecture School data from the past 5 years	11/01/11	Annie Ghilan	Yes.
Preliminary Report	11/02/11	All	Yes.
Find missing data in the STARS rating calculator Excel sheet	11/07/11	Annie Ghilan	Yes.
Review/Revise Report	11/07/11	All	Yes.
Final Project Due	12/10/11	All	Yes.
Final Report Presentation	12/12/11	All	Yes.

BUDGET

There is no budget for our project because it is only a proposal that will be carefully considered by the University of Virginia Architecture School. When the Architecture School evaluates our best management practices and decides to implement some of them in the future, then a budget will have to be created.

RANKING

In this section we determine and explain our indices of performance. See aforementioned Indices of Performance table in Executive Summary for determinants. The following tables detail each BMP, its score for each Index of Performance, and the reasoning behind said scores.

Climate BMPs

1. Partner with Local Landfill Gas (LFG) collection and usage programs		
Capturing the methane produced at landfills and using it to generate electricity and/or heat can decrease the GHG emissions impact of landfills. Landfill gas, largely methane, is a much more powerful GHG than carbon dioxide; hence why it is important to harness it. Unregulated, the gas pressure from the breakdown of materials in buried waste builds within a landfill and ultimately releases into the atmosphere. An LFG collection system would utilize this otherwise very harmful gas for power generation and prevent releasing it untreated into the atmosphere. The collection system is comprised of collection wells, connections to headers, condensate traps and a pumping station, as well as an LFG compressor system and an enclosed flare. Additionally, there is a treatment and conditioning system prior to pipeline injection. **Currently, there are no landfills in close proximity to Campbell as Ivy landfill closed 5 years ago. Thus this BMP is not feasible presently, but could be in the future.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	2	The possible affect on the STARS rating system is 0.5 points under credit OP T2-2.
Cost	1	The cost of implementation would be about collection wells, connections to headers, condensate traps and a pumping station, LFG compressor system, an enclosed flare, treatment and conditioning system. A new large project can cost millions of dollars. For example; a 40-acre (160,000 m^2) landfill gas collection system with a flare designed for a 600 ft^3/min extraction rate is estimated to cost $991,000 (approximately $24,000 per acre) with annual operation and maintenance costs of $166,000 per year at $2,250 per well, $4,500 per flare and $44,500 per year to operate the blower.
Feasibility	3	This would require no student or faculty participation, only sustainability coordinators and outside agencies would be involved.
Infrastructure	5	No changes would need to be made the Architecture building as this is an off-site offset program.
Total Score	**11**	

2. Implement a reforestation program		
This program would include planting more trees and vegetation around grounds and surrounding areas. Furthermore, it would include support for the protection of current forestation in Albemarle County, such as the forestation surrounding the Rivanna River Reservoir. Trees and plants have great CO_2 absorption abilities, so increasing forestry significantly reduces the amount of CO_2 emission into the atmosphere.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	2	The possible effect on the STARS rating system would be 0.5 by credits OP 5 and OP T2-2.
Cost	2	The cost would depend on how many trees are purchased, species of tree, and whether they are planted by paid professionals or by volunteer. Assuming 500 bur oak trees at 150 each, volunteer planting, no landing clearing or new soil needed, the reforestation program would cost: 150*500 = $75,000 http://www.tytyga.com/product/Live+Oak+Tree http://www.tree-land.com/tree_price_list.asp
Feasibility	2	There would be significant student and faculty participation in planting trees around the A school.
Infrastructure	4	There would be some infrastructure change in clearing the land to make it fertile for trees, and then the space required for when the trees grow.
Total Score	**10**	

3. Implement a strong compost collection system for the Fine Arts Cafe		
Composting helps prevent pollution; diverting organic materials away from landfills prevents the production of methane and leachate in those landfills. Using compost can also reduce the need for water, fertilizer, and pesticides. Composting can help regenerate poor soils and prevent the erosion and silting on water embankments. Depending on the extent of the system a pulper may be needed A pulper processes food scraps and converts it into pulp/compost that can be used for fertilizer.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	2	The possible affect on the STARS rating system is 0.5 under credits OP T2-7 and OP T2-8.
Cost	4	The cost depends of the extent of the composting system. Simple systems versus more complex systems can range from $200 - $2,000, either way; the overall cost would be very small.
Feasibility	4	There would be a significant impact for the workers at the Fine Arts Café, however it may not necessarily be more work to increase composting, but just different responsibilities. For example, instead of taking out the trash, an employee would take food products to the composting location. Students and faculty would not be affected by this system.
Infrastructure	4	If the composting system is on site there would be small infrastructure changes to accommodate composting bins and their shelter. If the composting system is off site there will be no infrastructure changes.
Total Score	**14**	

4. Implement a recycling co-location program		
A co-location program involves placing recycling bins with every trash bin in order to give people the option to recycle every time they dispose of waste. Easy to understand and accessible recycling bins can increase recycling participation.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	2	The possible affect on the STARS rating system would be 1 point in guidance of credit OP 20.
Cost	4	The cost would be very minimal. A potential budget of $5,000 may be needed for more recycling bins, advertisement, and an instructional program.
Feasibility	3	This would require significant student and faculty participation. Everyone would need to participate by recycling regularly according to provided recycling instructions. However, a lot of student and faculty already recycle regularly so this would not be much of a change to their daily lives.
Infrastructure	5	There would be no necessary infrastructure changes.
Total Score	**14**	

5. Reduce the use of paper products		
To do this, set the double sided printing option as the default on all printers, administer online quizzes and assignments through Collab, and purchase only recycled paper products. This reduction in paper will protect the lives of more trees, so they can absorb more CO_2 and reduce carbon emissions.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	1	The possible affect on the STARS rating system would be 0.25 under credits OP T2-39 and OP T2-40
Cost	4	The cost would be very minimal. Recycled paper products versus non-recycled paper products is on average only a 3$ difference (recycled is more expensive). However, the price increase will be negated by the reduction of paper usage, thus the overall cost is trivial.
Feasibility	2	This would require significant faculty and building administrator participation. Faculty would have to be conscious of their paper usage, and utilize electronic communication whenever possible (i.e. Collab/Email). Building administrators would be in charge of ordering only recycled products, changing double sided printing as the default on all printers/copiers, and enforce paper reduction efforts.
Infrastructure	5	There would be no necessary infrastructure changes.
Total Score	**12**	

6. Installation of a green roof.		
Green roofs are beneficial to Climate, energy, and water concerns. The vegetation from green roofs reduces the emission of green house gases. The green roof structure provides insulation for the building so less energy is required for heating and cooling needs. Green roofs are not impervious surfaces, so water can filtrate through the soil at a more natural rate, and thus regulate a healthier water cycle that reduces storm water run-off, which alleviates receiving waterbeds and sewage systems. Additionally water captured in the green roof system can be reused for other purposes (such as water the lawn) and the green roof creates a natural habitat for animals, such as birds, squirrels, etc.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	5	This would allow for a great change in the STARS rating system up to a possible 2 points.
Cost	1	This would be one of the most costly Best Management Practices for Campbell Hall to implement. Costs for green roofs in the United States are estimated to average between $15 to $20 per square foot. This means that it would cost the Architecture school between $82,000 and $110,000 to implement a green roof on its west roof that is 5,500 square feet. With the use of the attached source we could estimate an even more accurate estimate. http://www.glwi.freshwater.uwm.edu/research/genomics/ecoli/greenroof/roofinstall.php - costs
Feasibility	2	The feasibility of a green roof actually being installed is very low. There would need to be an additional work for staff members that would be responsible for maintaining and care for the new living roof. However, with the implementation of a 'living machine' that was discussed earlier in the report the roof should be able to somewhat maintain itself.
Infrastructure	1	The installation of a green roof would require a tremendous change in infrastructure and appearance. This would completely change the functionality and structure of the entire roof system. Furthermore, there would need to be an implementation of a watering system to maintain the roof garden. The different plants grown on the roof could include edible vegetation that could be used in the fine arts Café. It could also become an 'outdoor classroom' for students and a great teaching tool for faculty.
Total Score	**9**	

7. Increase the number of bike racks.		
More bike racks around the building to encourage visitors to ride bikes instead of driving cars. This is a direct way to reduce harmful green house gas emissions from motorized vehicles. Additionally, the reduction of cars leads a smaller demand for impervious surfaces, creating a healthier environment.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	1	An reduction on commuting CO_2 emissions could result in a change in .25
Cost	4	Implementation of new bikes racks around Campbell Hall would be relatively inexpensive. A 13- Bike Wave rack to a 21-Bike Wave rack would range from about $600 to $1000. The total cost would be relative to how many we install but should be less than a few thousand dollars.
Feasibility	4	Any student that rides their bike to Campbell Hall would be inclined to use these new and more conveniently placed bike racks. With the addition of more bike racks we might be able to promote more biking to Campbell Hall while consequently reduce CO_2 emissions from less people driving.
Infrastructure	4	There would be fairly light construction on the current infrastructure. The installation of these bike racks would only require a few holes drilled into the current brick or pavement.
Total Score	**13**	

8. Reduce coal consumption by means of a coal substitute		
Replace part of coal consumption with torrefied wood fuel, the CO_2 emitted during the wood burning process is typically 90% less than when burning fossil fuel and wood can be used for cogeneration (simultaneous production of heat and electricity). **This project would be very extensive and may not be in the scope of Campbell Hall.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	5	The possible effect on STARS would be 2.
Cost	1	This would be a hugely intensive project requiring a multi-million dollar budget.
Feasibility	1	Only building management would be responsible for this.
Infrastructure	1	Significant changes would need to be made to infrastructure offsite and minimal changes to Campbell Hall.
Total Score	**8**	

Energy BMPs

1. Utilize power save mode on all electronic devices		
Turning off idle computers and electronic devices when not in use would greatly reduce the schools energy and electricity usage. This could be done through regulating the power save mode on computers, printers, vending machines, and other electronic devices. Or by setting an automatic shutdown option after several designated minutes of inactivity. The implementation of this would reduce energy by an estimated 10%.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	4	This is an Energy management system that accounts for 0.25 points in the STARS rating system; additionally this would decrease consumption, so its total affect would approximately 1.5 points.
Cost	5	Instituting the power save modes on all electronic devices within Campbell Hall would be of zero additional monetary cost to the school.
Feasibility	2	It would also be supported by students who after using these devices would then shut down the idle computers or printer.
Infrastructure	5	It would not require aid from outside taskforces. It would only require additional time from faculty and the computer technician to select the power save modes on all electronic devices
Total Score	**16**	

2. Use energy efficient light bulbs throughout the building		
Energy efficient light bulbs require less power than incandescent light bulbs. Depending on the amount of money that the school would like to allocate towards efficient lighting there are several viable options. The most efficient light bulbs are the LED (light emitting diode). These light bulbs shine brighter and last longer than most CFL (compact fluorescent lamp) bulbs. They are also the most expensive option. Other options include the Compact Fluorescent Light bulbs and the Halogen light bulbs.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	1	LED lighting accounts for 0.25 points in the STARS rating.
Cost	2	It would cost the school roughly $2556 to purchase 64 LED light bulbs. Depending on the number of light bulbs needed on each floor purchasing light bulbs alone could cost the school between $3000 and $10,000. It would then cost the school between $20,000 and 50,000 to rewire the entire building and install all of the LED light bulbs.
Feasibility	4	This would require a small team to install all new lighting fixtures.
Infrastructure	4	Installing LED light bulbs would require the rewiring of the building which could result in minor infrastructural changes
Total Score	**11**	

3. Use motion sensors for lighting and vending machines throughout the building		
Many light fixtures and all vending machines are constantly running 24 hours a day at Campbell Hall. The implementation of motion sensors would greatly reduce the amount of energy consumed to power these devices.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	1	Motion sensors also account for 0.25 points in the STARS rating and Vending machine sensors account for 0.25 point in the STARS rating. However, some classrooms already have light sensors implemented that portion of the STARS rating points would already be accounted for, allowing for an additional 0.25 STARS points to be gained for this BMP.
Cost	2	Installing the motion sensors would not require the hiring of a professional team, however, for the expanse of Campbell hall a professional team may be more efficient. It would cost the school an estimated $65,000 to install the motion sensors. This depends on the number of light bulbs and vending machines per floor, and the relative cost of labor.
Feasibility	4	This would require a small team to install all the sensors.
Infrastructure	4	Motion sensors would require minor infrastructural changes.
Total Score	**11**	

4. Implement solar water heating system		
There are two major types of commercial solar water heaters which are collector devices in which fluid is heated by the sun. The first is a liquid based system which works on an antifreeze solution to heat water. The second is an air based system which heats air in an air collector. Tankless water heaters are another sustainable option that only heats as much water that is being used. Tankless water heaters do run on gas but they use substantially less energy than normal water heaters.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	3	The system accounts for Energy Metering Systems for 0.25 points and would account for part the Clean and Renewable Energy Category which encompasses 7 points; however this system would only effect up to .75 of these 7 points. So the total for this BMP would be 1 point.
Cost	2	Purchase of water heaters, installation, maintenance, and infrastructure alterations costs would total to about $80,000.
Feasibility	3	This system would require a medium size expert team to install the new system.
Infrastructure	3	This would alter the infrastructure of the building due to the need for the water heaters to be located on a portion of the building that receives enough solar energy to support the system.
Total Score	**11**	

5. Proper and effective insulation will reduce the schools reliance on heating and cooling		
Heat and air conditioning is lost through building entryways as students come and go throughout the school day. Campbell Hall has over six major exit and entryways that can be used at any time during the day. This accounts for much of the school's heating and cooling loss. In addition, a lot of energy is used in the process of heating and cooling a building. If the building is not properly insulated, it requires far more energy to maintain the temperature of the building. Therefore, it is imperative for the school to be properly insulated.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	5	This is a part of the schools Building and Energy Consumption that accounts for 8 point in the STARS Rating. The BMP could potentially have an effect of 2 points in this category.
Cost	1	The cost of re-insulating the entire building would gross well over $20,000 per floor thus a budget of at least $100,000 would be required.
Feasibility	1	This would require a complete shutdown of the Architecture School until the insulation work is complete and require an extensive team of professionals to install proper insulation.
Infrastructure	1	Changing the school's current insulation would require major infrastructural challenges. All of the exterior walls of the buildings will need to be removed in order to re-insulate the building.
Total Score	**8**	

6. Alternative energy sources		
The school could make strives to power certain parts of the building from wind or solar energy. With wind and solar there are many opportunities to create renewable energy. Wind and solar energies produce no greenhouse gases and are renewable alternatives to fossil fuels. The school could look into the possibility of installing photovoltaic cells on the flat roof of Campbell Hall. They could also look into wind turbines as a means for generating electricity and wind mills for generating mechanical power.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	5	This is a form of Clean and Renewable Energy which accounts for 7 points in the STARS rating. Depending on the extent of alternative energy use the potential points would be anywhere from 1-4.
Cost	1	One implementation could be a solar energy system which according to an article published in 2007 a two–Kilowatt (KW) solar energy system costs about $45,000. In the past five years the School of Architecture has consistently consumed over 2,000,000 kwh of electricity per year. If the school were to receive all of its electrical energy through a solar energy system it would need to implement at least 17 two-Kilowatt solar panels throughout the building. At $45,000 each purchasing 17 solar energy systems would cost the school $765,000 Another possible solution is a wind energy system. UVA is a great area for wind power. It has an annual wind rating of 4.55 m/s or 10.2 mph. If the Architecture School were to purchase and install one 50 KW wind turbine it would cost roughly $225,000. If the school were to produce 96 percent of its electrical energy by wind energy systems it would have to purchase 30 fifty Kilowatt wind turbines. This would cost the school roughly $6,750,000.
Feasibility	1	This would require extensive work and a very large team of experts in order to implement either of these systems in Campbell Hall. Furthermore it would be difficult to locate areas to install wind turbines or solar panels in order to optimize wind and solar energy, respectively.
Infrastructure	3	The presence of wind turbines or solar panels may alter the buildings outward appearance but would require changes to the immediate infrastructure.
Total Score	**10**	

Water BMPs

1. Installation of permeable pavement		
Permeable paving meets today's need for environmentally sustainable resources for it not only creates a water permeable surface that is lightweight and easy to install but also eliminates mud, prevents soil compaction, does not rot, crack or splinter (maintenance free and long lasting), and is resistant to chemicals. Permeable pavements will have the positive effect of allowing the planting of trees. Porous pavements give urban trees the rooting space they need to grow to full size. This integrates healthy ecology and thriving cities. It is important to note, however, that permeable pavements are designed to replace Effective Impervious Areas (EIAs), not to manage stormwater from other impervious surfaces on sit. Therefore, permeable pavements must be part of an overall on site management system for stormwater, and is not a replacement.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	4	It could have a possible effect of 2 since under storm water management.
Cost	2	Costs vary with site activities and access, porous asphalt depth, drainage, curbing and underdrains (if used), labor rates, contractor expertise, and competition. The cost of the porous asphalt material plus the insulation beneath the pavement is about 10$ per square foot (NCHRP, 2005). So to install permeable pavement around Campbell Hall (about 2,500 sqft) would be at least $25,000.
Feasibility	5	This would require no student or faculty participation, only sustainability coordinators and outside agencies would be involved.
Infrastructure	4	Slight change to the current infrastructure in replacing certain pavement areas located outside of the building.
Total Score	**15**	

2. Install low- flow faucets as well as dual- flush or 1.28 gallon flush toilets		
Low-flow plumbing technologies have a great potential to decrease water consumption at Campbell Hall. Research has shown that low flow toilets can save a family of 4 more than 22,000 gallons of water yearly (http://www.lowflowtoilets.net/) and in 2011, the San Francisco Chronicle reported that low-flow toilets save the city 20 million galls of water per year. Installing low- flow water fountains and faucets as well as dual- flush or 1.28 gallon flush toilets will significantly decrease amount of water used throughout Campbell Hall. The implementation of these fixtures would reduce overall water consumption by approximately 25%.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	4	It will have a possible effect on the STARS rating system of .25 since it falls under waterless urinals. This BMP would have a significant effect on total water consumption which is a category that accounts for 7 points. This has the potential to affect a total of 1-2 points.
Cost	3	A new low flow technology fixtures (low flush toilet and low flow faucet) can be purchased and installed for about $300 http://www.nytimes.com/2002/04/14/realestate/your-home-reducing-water-use-in-the-home.html Assuming about 50 fixtures in Campbell Hall, the cost of this BMP would be an estimated 15,000 – $20,000.
Feasibility	4	This would require no student or faculty participation, only sustainability coordinators and outside agencies would be involved.
Infrastructure	4	This would require a quick installment of the new toilet systems. There would be very light construction in each restroom.
Total Score	**15**	

3. Investing in “living machines”		
The cost of reclaimed water exceeds that of potable water in many regions of the country, where a fresh water supply is plentiful such as Charlottesville. Using reclaimed water for non- potable uses saves potable water for drinking and reduces the school’s cost on potable water. Reclaimed water can sometimes even contain higher levels of nutrients such as nitrogen, phosphorous, and oxygen that may help fertilize garden and agricultural plants. It will be necessary to educate the school of architecture that reclaimed water is highly engineered for safety and reliability even more so than that of existing surface and groundwater sources. http://athirstyplanet.com/real_life/valuable_research/reuse_safe		
Index of Performance	**Score**	**Reasoning**
STARS Rating	1	It will have an effect on the STARS rating system of .25 if it falls under non- potable water usage.
Cost	1	The University of North Carolina paid the entire cost to build the reclaimed water system, excluding State and Federal grants received for the project. To date, the University’s total system investment is over $10 million. http://www.energy.unc.edu/reclaimed-water-system-celebration
Feasibility	4	There is expected effort needed to the faculty and students on board due to the controversial fact that some of the reclaimed water eventually becomes part of the drinking water. Otherwise, this would require no student or faculty participation, only sustainability coordinators and outside agencies would be involved.
Infrastructure	1	Intensive infrastructure changes would be needed to the outer perimeter of Campbell Hall.
Total Score	**7**	

4.Utilize rainwater collection system		
Catch, filter and reuse run-off during inclement weather and harvest rainwater by catching it and storing it for later use. This is the most natural way to allocate water for the Architecture School and makes use of water that would otherwise go to waste.		
Index of Performance	**Score**	**Reasoning**
STARS Rating	3	The possible effect on STARS would be 1 point.
Cost	1	This BMP would require the purchase of rain cisterns and installation of a dual plumbing system and permeable pavement, adding up to over $100,000.
Feasibility	3	Only building management would be responsible for this.
Infrastructure	2	Could alter the infrastructure of the building and the surrounding landscape. May require a pond or basin for filtration.
Total Score	**9**	

STARS RATINGS

In this section we used operational building data and expert information for Campbell Hall and a STARS calculator programmed in Excel given to us by our community partner, Andrew Green. The following information shows the current STARS rating based on data from 2005-2010 and a potential STARS rating assuming the implementation of our BMPs from the section above. Scores in red refer to data that encompasses much more than just the Architecture School, such as air travel reduction programs and local offset programs in which the entire University participates. Thus we cannot accurately assess these point values.

Additionally the potential scores may vary from what they would realistically be because we cannot gather data for the effect that every BMP would have. For example, we cannot properly assess the reduction of Greenhouse Gas Emissions resulting from composting at the Fine Arts Café. A composting system would need to be implemented, and then Greenhouse Gas Emissions would need to be recorded for the next 5 years in order to accurately assess the system's impact and consequent STARTS point rating.

Climate				
Credit Number	Credit Title	Points Available	Current Score	Potential Score
OP Credit 4	Greenhouse Gas Emissions Inventory	2	1	1

There is no change from current score to potential for this credit because it encompasses much more than just Campbell Hall; it requires the entire University's involvement, thus we cannot accurately assess this STARS score.

OP Credit 5	Greenhouse Gas Emissions Reduction	14	1.726	2.476

A composting program for the Fine Arts Café and a recycling co-location program would reduce waste, which would in turn reduce the emission of Greenhouse Gases, resulting in a gain of 0.75 points.

Tier Two	*Climate Tier Two Credits*	0.5	0	0.25

The implementation of a composting program fulfills the aforementioned tier two credit, resulting in a gain of 0.25 points.

The best option for improving Climate scores are the creation of a Fine Arts Café Composting Program and a Co-Location Program.

The Composting Program BMP scored a total of 14 points. This BMP recommends installing a composting system for the use of the Fine Arts Café. This system would reduce the Café's contribution of methane gas emissions by diverting waste to useful practices. Depending of the desired scope of the project Campbell Hall can choose to install a pulper that converts food scraps into usable compost or they can simply collect the food waste and then send it to an offsite composting location.

The Co-Location Program BMP also scored a total of 14 points and recommends placing recycling bins adjacent to every regular trash bin throughout Campbell Hall. This would give building occupants the ability to recycle every time they dispose of their waste. This would significantly reduce the amount waste thrown away when it should be recycled.

Energy				
Credit Number	Credit Title	Points Available	Current Score	Potential Score
OP Credit 7	Building Energy Consumption	8	2.824	4.39

Power save modes will reduce energy consumption by 10% and thus will increase the STARS Rating score by an estimated 1.5 points.

OP Credit 8	Renewable Energy	7	0	0

This credit cannot be accurately assessed because it encompasses much more than just Campbell Hall, it involves the entire University's operations and programs.

Tier Two	*Energy Tier Two Credits*	1.5	1	1

No additional points will be awarded for this category.

The Power Save Mode BMP scored a total of 16 points. This BMP recommends the use of regulatory power save modes on all electronic machines such as computers, printers, vending machines, etc. Automatic shut down options could prove to be beneficial. Lastly, we believe that posting signs encouraging students and faculty to turn off lights or a computer when they are finished will further foster the effectiveness of this BMP.

Water				
Credit Number	Credit Title	Points Available	Current Score	Potential Score
OP Credit 22	Water Consumption	7	7	7

**The scores are very high for the water category; we believe the water usage data may be incorrect, therefore highly skewing the results to a nearly perfect score.

Low flow plumbing fixtures will decrease water consumption by 25%. Although, according to current data Campbell Hall has already received all available points in this category; however, if water meters were correct the decrease in water consumption would attribute to 1 or more points.

OP Credit 23	Stormwater Management	2	2	2

Permeable pavement will improve the stormwater management system for Campbell Hall. Although, according to current data Campbell Hall has already received all available points in this category; however, if water meters were correct the improved management system would attribute up to 1 point.

Tier Two	*Water Tier Two Credits*	1.25	0.75	1

Low-flow plumbing fixtures account for tier two credit and thus attribute to 0.25 points.

The Permeable Pavement BMP scored a total of 15 points. The BMP recommends the installment of more permeable pavement in areas surrounding Campbell Hall, such as the patio area outside of the Fine Arts Café. This will allow for a more integrated ecosystem and would improve the stormwater management system at Campbell Hall.

The Low-Flow Plumbing Fixtures BMP also scored a total of 15 points. This BMP recommends the installation of low flow fixtures throughout all the bathrooms and any additional plumbing fixtures in Campbell Hall. This simple solution will allow Campbell Hall to reduce their water usage while maintaining their current water usage habits.

FUTURE WORK / DISSEMINATION

Future work of this project consists of the implementation of our recommended BMPs. Strengthening bonds with community partners is crucial in securing sufficient monetary funding in order to follow through with our project objectives. The University of Virginia, however, has yet to take the appropriate steps to commanding a long-term sustainability system. UVA can only participate in the Sustainability Tracking Assessment & Rating System as an entire school, not just as Campbell Hall. Thus, we hope this project can act as a catalyst to spark a school-wide STARS rating.

Our main approach to raising awareness about our data will be to advertise the most riveting findings of our research. The data will be made available in a multiplicity of ways including: stall seat journals in bathrooms, flyers posted outside of lecture halls in Campbell Hall, and flyers posted in studio, the place where most Architecture students spend most of their time. Another avenue that we will explore is virtual advertising by making our flyers available via the internet. There are several ways in which we will approach this. Firstly, we will try to appeal to different student organization that focus on sustainability within the Architecture School and then move to larger sustainable initiatives across grounds including groups such as Sustain-a-Unity. Secondly, we will try to make the findings from our project available via a link on the Architecture School's Website. Also, a shortened version of this project should be distributed to each faculty member at the beginning of each new academic year so that the faculty and staff can discover ways that they can be more active in the Architecture School's sustainable efforts. Their knowledge and actions will also serve as an example for students and visitors who enter the school thus raising awareness of the importance of sustainability in Campbell Hall.

The flyers that we post will concentrate on both the positive and negative aspects of our research. For instance, a flyer could potentially discuss how much money the school is currently spending to keep the building at its current temperature and how much money it could be spending if it were to implement certain sustainable best management practices. Also these flyers will include some of the best management practices that students can perform individually and how the effects of those actions will help to improve the school's sustainability. For example, a potential flyer could discuss how much the school is currently spending on electricity. The flyer would then state the economic and environmental benefits of turning off the lights after use. From this a student will have a better understanding of how a simple action of turning the lights off after use could affect the school's electricity consumption.

The purpose of popularizing our data is to create a level of awareness in the School of Architecture about sustainability: its importance and what we can do to improve it. By utilizing the sustainable practices that our project suggests the Architecture School can be a model for the entire university. In a school full of forward thinking students and faculty and a budget that could support many of the suggestions made in this study, there is no reason why the school should not make strides towards more groundbreaking sustainable practices. If more of the faculty, staff, and students are made aware of the details of Campbell Hall's sustainability levels, then they would have more incentive to assist in sustainability efforts.

LESSONS LEARNED

Our group faced a few barriers to success when composing our initial project design. First we had to find raw data for the UVA Architecture School's climate, water and energy uses in order to be as up to date as possible on the building's existing technologies. To resolve this, we sent several emails and held meetings with Andrew Greene, the Sustainability Planner in the Office of the Architect for UVA, who provided us with relevant data on Campbell Hall. We further toured the building Andrew to identify which sustainable technologies are currently in use. Andrew Greene's expert knowledge on the School's sustainability was a great asset to our research and helped us better understand where the School is in terms of sustainable practices and where there is room for improvement.

Another barrier that our group faced was determining which best management practices (BMPs) would be more beneficial than others. To resolve this, our group came up with a ranking system that rated different Indices of Performance. We applied this ranking system to each BMP in order to quantitatively calculate each BMP's effectiveness. We took into consideration cost, change in infrastructure, the ease of faculty and student participation, number of staff needed to implement or manage a BMP, and the effect on the STARS rating system. Thus, we were able rate each BMP's effectiveness and compare them to each other in order to pinpoint the most advantageous options.

We were unable to fulfill some of our goals from the beginning of the semester due to time and resource constraints. Our team intended to provide more in-depth and exact research on each of our recommended BMP's for the use of the Architecture School, such as very precise costs and payback values, but due to lack of professional resources, our research was mostly internet-based and therefore slightly less informed. However, we still believe that our report provides a solid introduction to each BMP and will help the School decide on which BMP's to pursue. Another goal we did not achieve was speaking with representatives of the Delta Force. We reached out to them via email on multiple occasions, but never received a response, so we could not use them as an informed resource in our research. If we were to do this project over again, we would love to have more time to explore each BMP in more depth and to learn as much as possible from our community partners to provide the Architecture School with a more thorough report.

As the project progressed, our team became more aware of how complicated the process of change is and how it is much more than simply having a great idea. The process of developing and supporting our ideas was long and complex, requiring copious amounts of precise data, careful interpretation, and hours of research. Although we have developed our ideas and they are now much closer to implementation, our team realizes that there is still a long road ahead to actually bringing more sustainable practices to fruition in the Architecture School. Through our data analysis, we have learned that all change depends heavily on financial support and that every good idea comes with a price tag, which can often be a large barrier to an idea's manifestation. Additionally, our team has learned the complexity and interconnectedness of the effects of change. Changes not only affect the environment but can affect all other stakeholders involved such as, the Architecture School's faculty, staff and students, and the greater UVA community. Due to its far-reaching consequences, significant change often requires extensive cooperation between many different kinds of institutions with many different goals and limitations, which proves to be the biggest obstacle to overcome.

APPENDIX 1: COMPARISON TO OTHER SCHOOLS

To determine the best approach for Campbell Hall, we assessed similar platforms already implemented at the University of North Carolina at Chapel Hill and Arizona State University. The decisive criteria for our selection of universities entailed comparable size, geography and high performance in the STARS Rating. Regarding the climate category, the University of North Carolina's project portfolio contains complementary off-set projects such as fuel switching and transportation efficiency. Specifically for greenhouse gas emissions reduction, approaches mainly consist of managing refrigerant leaks and waste management. These practices allow for the University of North Carolina (UNC) and Arizona State University (AU) to score a 5.19 and 7.16 out of a possible 16.50, respectively.

With respect to the energy category, UNC and AU have applied temperature control timers, lighting sensors, LED lighting, vending machine sensors, and an energy management system. These practices give UNC and AU 3.05 and 2.30 out of 16.50, respectively.

Concerning the water category, the universities implemented a reclaimed wastewater system to reduce water consumption; this resulted in the accumulation of 2.00 points out of 2.00. In addition, using reclaimed wastewater for irrigation and using harvested rainwater for human waste disposal have awarded AU and UNC 3.39 to 3.60 points out of 10.25, respectively.

Arizona State University received a gold rating from the STARS rating system with a total score of 66.97, scoring particularly higher in reducing greenhouse gas emissions while scoring slightly lower in reducing water consumption. The University of Carolina received a silver rating from the STARS rating system with a total score of 53.11.

APPENDIX 2: WORKS CITED

"Arizona State University ." *Sustainability Tracking Assessment & Rating System*. Version July 29, 2011. AASHE, n.d. Web. 2 Dec. 2011. <https://stars.aashe.org/institutions/arizona-state-university-az/report/2011-07-29/#ec_2_9>.

Find Solar Wind Contractors FindSolar Installers: Largest Directory of Solar and Wind Professionals. Estimate Solar and Wind Cost and Run Solar and Wind Financial Analysis. Find Solar and Wind Customer Reviews of Local Professionals Contractors. Certified Prescreened Qualified Solar Installers Wind. Web. 05 Dec. 2011. <http://www.find-solar.org/index.php?verifycookie=1>.

"Global Institute of Sustainability." *ASU*. Arizona State University , n.d. Web. 1 Dec. 2011. <sustainability.asu.edu/index.php>.

Great Lakes WATER Institute. Web. 05 Dec. 2011. <http://www.glwi.freshwater.uwm.edu/ErrorDocs/404page.php>.

"How Safe Is Reuse | A Thirsty Planet." *A Thirsty Planet | Sustainable Solutions for a Thirsty Planet*. N.p., n.d. Web. 2 Dec. 2011. <http://athirstyplanet.com/real_life/valuable_research/reuse_safe>.

"Low Flow Toilets." Save Water Project. Web. 1 Dec. 2011. <http://www.lowflowtoilets.net/>.

"Product News & Information." *Hunter Industries - The Irrigation Innovators*. N.p., n.d. Web. 3 Dec. 2011. <http://www.hunterindustries.com/Resources/Library/product_news.html>.

"Project Portfolio — UNC Climate Action." *Climate Action Plan Home — UNC Climate Action*. N.p., n.d. Web. 2 Dec. 2011. <http://www.climate.unc.edu/CAP/portfolio/near-term-portfolio>.

"Reclaimed Water System Celebration — The Energy Behind UNC." *The Energy Behind UNC*. UNC Energy Services, 11 May 2009. Web. 05 Dec. 2011. <http://www.energy.unc.edu/reclaimed-water-system-celebration>.

"Recycled Water: Putting the Risk into Perspective." *A Thirsty Planet | Sustainable Solutions for a Thirsty Planet*. Sustainable Solutions for a Thirsty Planet. Web. 05 Dec. 2011. <http://athirstyplanet.com/real_life/valuable_research/reuse_safe>.

Romano, Jay. "YOUR HOME; Reducing Water Use In the Home - New York Times." *The New York Times - Breaking News, World News & Multimedia*. New York Times, 14 Apr. 2002. Web. 05 Dec. 2011. <http://www.nytimes.com/2002/04/14/realestate/your-home-reducing-water-use-in-the-home.html>.

"Tree Price List - Tree Land Nursery - Dallas, Texas." *Tree Land Nursery - Dallas, Texas - Guaranteed Lowest Prices*. Treeland Nursery. Web. 05 Dec. 2011. <http://www.tree-land.com/tree_price_list.asp>.

Ty Ty Nursery. "Live Oak Tree Prices." Web. 1 Dec. 2011. <http://www.tytyga.com/product/Live+Oak+Tree>.

"Understanding the Cost of Solar Energy." *Green Econometrics — Information and Analysis on the Economics of Solar and Alternative Energies*. 13 Aug. 2007. Web. 05 Dec. 2011. <http://greenecon.net/understanding-the-cost-of-solar-energy/energy_economics.html>.