



GREEN INITIATIVES FOR UMBC:
AN EIGHT POINT PLAN FOR A MORE SUSTAINABLE
CAMPUS

CAPSTONE IN PUBLIC POLICY
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EXECUTIVE SUMMARY

As one of four university missions, environmental sustainability has become paramount for the University of Maryland, Baltimore County (UMBC) as it strives not just to save money, but to reduce its carbon footprint and promote sustainable practices and lifestyles for faculty, staff, and students. In the 2008 fiscal year, UMBC incurred approximately \$12 million in energy and utility costs, accounting for 61 percent of its carbon footprint.

In 2007, UMBC joined more than 330 colleges and universities in forming the American College & University Presidents Climate Commitment (ACUPCC). UMBC has declared its commitment to take action to achieve a climate neutral campus while mitigating the detrimental effects of global warming and its potential for large-scale, adverse health, social, economic, and ecological effects.¹

In September 2009, eight graduate students in the UMBC Public Policy Department discussed promising areas for university sustainability policy, as part of a final capstone course. Several key themes emerged:

- Re-thinking the understanding of “green”—Students often think being environmentally sustainable is an unaffordable luxury where the costs outweigh the benefits.
- Designing green initiatives to focus on behavioral as well as monetary outcomes—Sustainable solutions to environmental problems can be achieved by a combination of long-term behavior modification, or nudging, as well as short-term fixes that can save money immediately.
- Capitalizing on the university setting—Universities are uniquely positioned to educate and produce the next generation of green-minded students and leaders who will tackle future environmental challenges.
- Conveying that nothing is for free—Students, faculty and staff share in the responsibility for environmental costs.

We developed the following eight broad recommendations to encourage sustainable activity across the campus community:

- Every Day Green— We recommend implementing a new paper ethic on campus by using formatting technology to reduce paper usage in offices and academic departments, incentivizing reusable coffee cups and bags, and limiting napkin consumption.
- Green Machine Ethic— We recommend implementing a new machine ethic focused on energy reduction. Specifically, we recommend switching to energy-efficient vending machines,

computers, and monitors, widely using computer hibernation settings, and removing light bulbs from all 85 vending machines on campus.

- Green Retrofits— We recommend a comprehensive light and water retrofit that would reduce energy demand in existing buildings. Lighting retrofits include occupancy sensors, dimmer switches, and ambient light sensors. Lavatory fixture retrofits include automatic faucets and low-flow showerheads.
- Green Parking and Transportation— We recommend implementing a \$175 parking surcharge to nudge students to consider sustainable transportation and reduce UMBC’s commuter carbon footprint. We also recommend creating a “green permit” to encourage the use of fuel-efficient vehicles, establishing commuter-only parking spots to encourage residents to walk more frequently, and starting an online carpool matching system to encourage ride-sharing.
- Green Life— We recommend that the Office of Residential Life commit to on-campus residential energy reduction by promoting sustainable student behavior within the residential community. We recommend training student staff to role model green behavior in residential communities and provide educational programming to residential students about the benefits of sustainable living.
- Green Land Use— We recommend creating a central green wall to visibly green the campus, enhance environmental awareness, and reduce the campus carbon footprint by natural means. We also recommend establishing a voluntary tree-planting program to offset student and faculty carbon emissions.
- Cultivating Green Minds— We recommend incorporating an environmental sustainability seminar into freshmen orientation to educate and nudge students both on and off-campus.
- Revolving Green Fund— We recommend developing a Revolving Green Fund in which 90 percent of sustainable project savings are re-invested as long-term financing for continued greening initiatives at UMBC.

These recommendations make a commitment to campus climate neutrality and environmental sustainability.

INTRODUCTION

There is a global rise in environmental consciousness that is prompting both large institutions and small households to change the way they consume and dispose of resources. The environmentally conscious community has branded these behavioral and policy changes as "green." However, green is not just a symbolic color for environmentalism and sustainability, it has become a universal shorthand description of efforts to reduce the impact of modern human life on the rest of the natural world.²

Colleges and universities, which are uniquely positioned to serve as experimental settings for green policies, have already taken aggressive steps to reduce their carbon footprint and raise environmental awareness.³ College campuses are self-contained communities that have the ability to act quickly—to harness the energy, creativity, and activism of environmentally conscientious students, faculty and staff who can help devise, implement, and sustain green initiatives.

Colleges and universities are beginning to promote these efforts to green their campuses. The College Sustainability Report Card allows parents and students to compare green efforts of 300 North American universities.⁴ And, in July, the Princeton Review released its second annual Green Honor Roll, highlighting 15 schools for their top sustainability rankings.⁵ UMBC did not make either of those lists.

However, UMBC is taking some action to be greener, by joining the Association for the Advancement of Sustainability in Higher Education and becoming a member of the American College & University Presidents' Climate Commitment in August of 2007. To date, 655 American colleges and universities (who educate one third of all U.S. college students), signed this commitment pledging to take immediate and long-term steps to make their campuses climate neutral.⁶ For example, UMBC has already installed high-efficiency chillers and boilers for heating and cooling, retrofitted lighting, and switched to water-saving plumbing devices.⁷

But technology and retrofits can only take UMBC so far. No amount of florescent light bulbs or low-flow shower heads will convince people to flip off that light switch when they leave the room, or take a shorter shower. And it is especially difficult to change behavior when there is no incentive to do so, when there is no cost associated with one's actions.

Consider that on the UMBC campus, it is free to take 20 napkins when two will do. It is free to park on campus when all students must pay a transportation fee, regardless of whether they need to drive to UMBC or not. It is free to leave the lights on all day in a dorm room when the electric bill is already included in residency fees. But nothing is truly free. Paper waste is clogging landfills. Driving habits are polluting the air, and increasing reliance on foreign oil. Electricity requires the burning of harmful fossil fuels.

While technology can change and help mitigate these harmful effects, people must change too. They must be nudged by well-crafted policies into becoming more environmentally aware. The act of “nudging” means that human behavior can be changed, or guided in a different direction, simply by altering the choices presented to people. Given its commitment to climate neutrality, and the green initiatives already taken, UMBC is poised to tackle the next generation of green policies—those that are aimed at nudging students, faculty, and staff in their everyday life into making more environmentally-friendly decisions.

As graduate students in the Department of Public Policy, we conducted an analysis of options to green UMBC’s campus. Here, we discuss the behavioral, cultural, and operational modifications necessary to generate a green and sustainable UMBC, review reasons for university intervention, present supporting data, recommend options to green and/or sustain resources at UMBC, and evaluate those options through a set of criteria. Ultimately, this document presents small and large scale options that can be implemented immediately or in the long term. Here, we demonstrate that nothing is free at UMBC: all students, faculty, staff and administrators share the responsibility for the environmental costs of daily habits and activities.

The recommendations focus on the following themes:

- Every Day Green—Promote a new paper ethic by reducing paper consumption, encouraging the use of reusable products, and limiting napkin consumption;
- Green Machine Ethic—Promote a new machine ethic by limiting computer and vending machine energy consumption;
- Green Retrofits—Reduce on campus energy demands by modifying existing campus lighting and lavatory fixtures;
- Green Parking and Transportation—Change driving habits to support campus climate neutrality by implementing an additional surcharge, designating parking

lots for commuters only, encouraging carpooling and the use of environmentally friendly vehicles;

- Green Life—Encourage sustainable student behavior by training residential life staff to role model and promote green student behavior in the residential communities;
- Green Land Use—Support campus climate neutrality by creating a central green space and instituting a voluntary tree-planting program;
- Cultivating Green Minds—Encourage sustainable behavior by educating incoming freshman during orientation;
- Revolving Green Fund—Finance future green initiatives by creating a financially stable revolving fund.

Some of these recommendations are more easily doable than others, some will take longer to implement than others, and the costs, savings, and benefits of these recommendations are not all easily quantifiable. But they are all meant to widen the angle of vision as to what's possible. Indeed, policies that seek to alter student and faculty behavior may not result in an immediate, dramatic reduction in waste, or carbon emissions. But if sustained, they will change the trajectory of environmental damage. What's at stake for UMBC is not just its own carbon footprint, but its own "green" image that has implications for everything from student and faculty recruiting to fundraising.

EVERY DAY GREEN

This group of initiatives is aimed at promoting a greener behavior among the UMBC community by promoting a new paper ethic and using fewer resources. These proposals are based on behavioral economics principles. Also known as “architectural choice” or “libertarian paternalism,” the main principle states that it is possible to change human behavior by affecting the way choices are presented to individuals.⁸ Overall, the initiatives presented in this section are highly feasible, have low costs, and are aligned with university policies. The following initiatives are practical techniques developed and implemented by students, faculty and staff in other university campuses across the country. The proposed policies involve using recyclable products more efficiently, using and consuming less, and using recyclable products longer.

- **INCENTIVIZING THE USE OF REUSABLE COFFEE CUPS, WATER BOTTLES AND TOTES⁹**

This initiative is aimed at reducing waste and costs by incentivizing a more efficient use of reusable cups and plastic bags.¹⁰ Different university campuses and retail stores such as Giant Food Stores have been incentivizing the use of totes or recycled bags in order to reduce plastic bag consumption. This has been achieved by selling low-price totes and by discounting 20 cents when consumers use them.¹¹ We recommend that UMBC implement these initiatives in places such as the bookstore, the market store, and dining/coffee areas.

Actions: Cashiers in dining and service areas such as the bookstore and the market store would be instructed to give a discount in the price when the client uses reusable cups and totes. The UMBC community at large would be informed of small discounts and the positive effects on the environment. Moreover, as a positive externality, UMBC could increase revenue by selling reusable totes and cups.

Costs: This initiative would have minimal costs attributable to time spent in training and instruction to cashiers.

Benefits: By offering a 25 to 30 cent discount on refills in reusable mugs, the University of Wyoming decreased purchasing costs by \$950 and waste by 185 pounds in six months.¹²

Similar savings could be expected at UMBC. Moreover, this initiative would potentially reduce UMBC's costs for cups and plastic bags, not to mention a reduction in waste management.

Feasibility: This alternative could be easily implemented as long as implementation costs are generally low and do not conflict with other UMBC programs in place.

There are some possible consequences of implementing this initiative. For instance, disposable paper products (i.e. coffee cups) are supposed to be protective against diseases/bacteria that spread through the repeated use of the same objects by different people. Even though this proposal does not imply repeated use of the same objects by different people, a repeated use by the same person without appropriately washing them, could increase the risk of health related problems. Similarly, UMBC may have to incur administrative costs because people may refill without paying.

- **ESTABLISHING A NEW PAPER ETHIC ON CAMPUS**

Paper consumption represents a global problem and has significant environmental impact.¹³ Paper manufacturers are the largest industrial users of water.¹⁴ The average college student in the United States produces 640 pounds of solid waste each year, and half of that waste is produced by paper consumption.¹⁵ The environmental impact of producing waste and depleting natural resources deserves special consideration and calls for effective and efficient initiatives to reduce paper consumption on campus.

In order to counteract the environmental impact of paper consumption, people can adopt measures for a new paper ethic. These measures involve major changes in paper consumption and broad efforts toward sustainable paper use. UMBC has already introduced such measures by implementing programs such as Recyclemania.¹⁶ However, additional efforts could be made. The basic idea is to reduce the negative impacts from consuming vast quantities of paper. Ways to reach this goal include reducing consumption and promoting the usage of technologies to reduce paper usage (i.e. electronic mail, digital storage, etc).¹⁷

Actions: UMBC would reduce paper consumption by promoting and initiating the use of paper to its fullest. UMBC would set computers and copiers to default to smaller margins and print double-sided.

The university also would promote a paperless campus through the use of technology instead of paper. This can be achieved by moving documents to electronic files. Blackboard would facilitate this action by providing a forum for discussion and file sharing. UMBC would also reduce the number of course catalogs, phone directories and class schedules printed each year, and make more documents available online or by request only. And finally, UMBC would encourage faculty to use electronic textbooks.

Costs: These initiatives can be implemented at a low cost. For instance, IT staff can change the default options of printers in computer labs and offices in the university. By doing so, UMBC would incur minimal administrative costs for setting up the computers.

Benefits: The University of Tennessee has implemented a paperless payroll system, with online-only paystubs, across the campus. Under this program, the university estimates it saves \$153,000 a year. Similarly, the Tennessee Institute for Public Service has made some of its publications paperless, including an online version of its employee newsletter, saving about \$7,000 and about 19,200 sheets of paper a year.¹⁸ Similar savings could be expected at UMBC.

Other benefits of going paperless are reported from Northwest Missouri State University. This university has implemented a program that replaced traditional textbooks in some classes with electronic versions. It is estimated that students are able to save half of the cost of their books, or an average of \$700 per year.¹⁹ Other universities have implemented similar initiatives, such as Washington State University, which has found the initiative largely symbolic and harder to quantify. But Washington State believes it sends out a message that the university is taking measures for environmental sustainability.²⁰

Feasibility: Although highly feasible, the goal of going paperless has some important pitfalls. Although electronic files would be good for sharing information in every-day situations, it could impair UMBC office efficiencies; not all offices have the same objectives and procedures. For instance, some offices require more hard copy records than others. Finally, although paperless offices may reduce paper usage, they would increase use of other resources, such as electricity from computers or electronic devices.

- **REDUCING NAPKIN CONSUMPTION**

This initiative is aimed at reducing waste by incentivizing a more efficient use of napkins. Students at colleges and universities generate 3.6 million tons of waste a year, or about 2 percent of the country's total waste stream. Food and food-related items may account for 10 to 20 percent of this waste at some schools, the largest component of waste after paper.²¹ In most common areas on campus, an unlimited supply of napkins is available. Since it is possible to take as many napkins as one wants without any cost, there is no incentive to use less. This situation can potentially lead to an inefficient use of napkins and increase waste on campus.²²

One alternative that would reduce waste and napkin consumption is placing napkin dispensers at dinner tables in The Commons dining areas.²³ The University of Michigan developed a pilot study in which they found that when students take napkins in the cafeteria line, each student used an average 3.3 napkins per meal. However, when the napkins were placed on tables, each person used an average of 1.4 napkins per meal.

Actions: UMBC would have to supply napkin dispensers at each dining table in The Commons, Dining Hall, cafeterias, etc.

Costs: Minimal costs include the time spent by staff refilling and cleaning the dispensers. It is possible that issues such as complaints related with aesthetics may arise. If students, staff or others do not find the design, color or appearance of napkin dispensers agreeable, they could complain. Another possible factor to consider is that the dispensers could be stolen.

Benefits: Florida Atlantic University saved around \$6,000 per year in napkins costs by implementing this initiative.²⁴ Similar savings could be expected at UMBC.

Feasibility: The initiatives presented in this section could be easily implemented and it would be difficult to find opponents since it is aligned with broad university policies and will not raise inequality issues. Similarly, these initiatives are highly feasible insofar as the implementation and maintenance costs are low and benefits offset minimal costs.

GREEN MACHINE ETHIC

Vending machines and computers are highly visible machines that students, faculty, and staff use on a daily basis. To be sure, both machines could benefit from a change in the campus machine ethic—or a change in the way individuals perceive and use these resources.

Among computer labs, the library, and staff and faculty offices, there are approximately 2,500 computers in the active UMBC directory. Currently, UMBC does not require that these computers use an energy efficient setting. Therefore, it is possible that when a faculty member leaves his or her office the computer is left running as if it were currently being used. We recommend that these computers require a new energy setting. By making a small change in computer settings, UMBC will be fostering a new computer ethic—or reducing the energy consumption of computers while they are not being used.

UMBC has 85 vending machines on campus—34 snack machines and 51 cold beverage machines—all of which have bright lights inside of them to entice hungry students to stop and purchase a snack. These machines, as well as the lights in them, stay on throughout the night, even in buildings that are closed after the last student has gone home. It is unnecessary for these machines and lights to remain on when the building is closed. By making small changes with vending machines, UMBC could see significant cost reductions in its vending machine energy consumption.

Here, we recommend some initiatives that could assist the university in achieving a green machine ethic.

- **ENERGY EFFICIENT COMPUTERS**

The EPA recommends setting computers to enter sleep mode or hibernate after 30 to 60 minutes of inactivity.²⁵ We recommend that the university Information Technology (IT) department promote a specific energy-conservation setting.²⁶ Other universities across the country have changed their campus computer ethics. For example, the facilities department at Yale University started shutting down their computers at night and experienced \$40 in savings per year per desktop computer. Over an entire year, the department saves \$4,700—enough electricity to power 34 homes, and the equivalent of planting eight acres of trees.²⁷ Additionally, the University of Wisconsin at Oshkosh set computer lab computers to sleep mode overnight.

The university found that activating the sleep settings reduces energy use by 75 percent, with savings of up to \$50 per computer per year.²⁸

Actions: We recommend that the university follow the EPA's standards and promote a policy that requires most faculty and staff to set their computers to enter low-power sleep mode after 15 minutes of inactivity. Some exceptions would have to be made. For example, many faculty members run research on their computers that take multiple hours, such as STATA or MatLab. A computer that was set to enter sleep mode after 15 minutes of inactivity would not detect the data batch being run and would ruin the current progress.²⁹ Therefore, not all faculty and staff computers can be set to enter sleep mode. However, the IT department can implement a policy that requires all faculty and staff who do not run large data batches to set their computers to a enter sleep mode after 15 minutes of inactivity. To be sure, sending emails about this new policy to busy faculty and staff may be futile. Therefore, IT staff can manually change the energy savings setting for each computer. Feasibly, IT undergraduate or graduate students could change the energy profiles, in exchange for extra credit or another incentive. To further save costs, these changes can be made at the same time as the changes recommended by the previous section on the new paper ethic. By having students do the work, the actual labor and time costs of implementation would be significantly reduced.

Cost: Most computers have energy management or power management technology that allows the user to customize when the computer should be set to sleep mode. By utilizing these existing computer settings, UMBC would not have to purchase any existing software. The only cost would be the labor costs of having the IT department change computer settings across campus. (However, as noted, by giving IT students extra credit to perform these changes, labor costs would be virtually free).

Benefits: The Energy Star Computer Power Management savings calculator estimates savings of energy-efficient computers, hibernate sleep mode software, and usage patterns.³⁰ This calculator estimates that with this new computer ethic, UMBC could save approximately \$214,000 and 1.7 million kilowatt hours (kWh), per year. These monetary savings are equivalent

to 1,341 tons of carbon dioxide pollution, 276 acres of trees planted, or 222 cars removed from the road for a year.

Feasibility: The biggest hurdle to overcome in terms of changing computer energy settings is that computers require updates that often occur overnight. By shutting down computers overnight, the IT department would not be able to perform critical updates and security checks. This recommendation, however, does not require computers to be shut down, or turned off. Instead, we recommend that computers are placed in sleep mode after 15 minutes of inactivity. Computers in sleep mode can be “awakened” in minutes. This compromise allows IT to keep the university’s computer network up to date and safe, while also cultivating a greener computer ethic. Since there is little cost and few interruptions associated with this policy, we believe that administrative approval will not be difficult. One possible consequence of altering computer power settings is that faculty and staff may become frustrated that beginning work on their computer after a break requires the simple step of “waking” the computer. However, despite this small inconvenience, the low cost and potentially high savings of this policy make it attractive.

- **LIGHTLESS VENDING MACHINES**

The lights in vending machines are always on and often superfluous; the hallway and room lighting surrounding the vending machines is sufficient enough to allow the consumer to view the options available. We recommend that the university remove all the lighting from the vending machines on campus. Both Louisiana State University and the University of Tennessee have taken the light bulbs out of all vending machines and placed stickers on the machine telling students about the new green initiative.³¹ The University of Tennessee had noteworthy savings when the campus turned off the lights in all 295 vending machines on the Knoxville campus. This change alone saved the university \$13,000 per year. Removing the light bulbs from almost 300 vending machines kept 130 tons of carbon dioxide out of the air, which is the equivalent of keeping 25 cars off the road for a year.³²

Actions: This initiative requires that facilities/maintenance staff remove the light bulbs from all vending machines and place a sign on the machine informing customers of the new

machine ethic on campus, and that the machine is still on. Since this option requires few resources, it could be implemented by facilities/maintenance staff as soon as possible.

Cost: There is little cost associated with this initiative; the only cost would be the labor hours required to remove all light bulbs.

Benefits: By taking this simple step, the university could save significantly on its energy costs. Based upon the savings experienced by similar programs, UMBC could save approximately \$3,740 annually.³³ Removing the light bulbs from all vending machines is also a visual reminder to the UMBC community that the campus is committed to a greener, more sustainable lifestyle. Students and faculty would be reminded daily that UMBC has instilled a new machine ethic on campus.

Feasibility: This option is entirely feasible. It requires no cost outside of labor costs. Since the action is not controversial, it is likely that the UMBC administration will support into the idea. It is possible that potential vending machine customers may interpret a dark vending machine as one that is off and therefore, not purchase a product. This could decrease the revenue the school makes from vending machine sales. However, the signs placed on the machines informing customers of the change should counteract this effect.

- **ENERGY STAR VENDING MACHINES**

The U.S. Environmental Protection Agency and the Department of Energy have created a stringent certification process that labels energy efficient appliances as Energy Star appliances.³⁴ Unfortunately, there is currently no Energy Star certification process for snack vending machines. However, cold beverage vending machines are rated. UMBC's cold beverage vending contract is held by Coca-Cola Enterprises, Inc. and is set to expire in August of 2010. Across the nation, other universities have required the use of Energy Star vending machines. The State University at Buffalo replaced 132 older vending machines with Energy Star rated machines and saved over 250,000 kWh of electricity and \$20,000 a year.³⁵ The University of Michigan experienced comparable savings when it replaced 132 machines.³⁶

Actions: Upon the expiration of our cold beverage vending contract with Coca-Cola Enterprises in August of 2010, we recommend that UMBC require Energy Star compliant appliances in the next Request for Proposal (RFP).

Costs: Energy Star vending machines are comparable in cost to the current machines, so the cost of a contract that requires the new machines should be comparable to previous contracts.³⁷

Benefits: Each Energy Star machine saves approximately 1,700 kWh of electricity and \$150 per machine per year.³⁸ According to the Energy Star cost calculator, by replacing our current fleet of 51 cold beverage vending machines with Energy Star rated machines, the university could save \$10,407 a year.³⁹

Feasibility: The feasibility of this option depends upon the contract negotiations between the university and the vending machine supplier. It would require that UMBC request Energy Star appliances in the next RFP. By requiring Energy Star vending machines in its next cold beverage vending machine contract, UMBC would be making another small, yet meaningful step in reducing its carbon footprint and in signaling to the community that the university is making responsible environmental decisions.

GREEN RETROFIT TECHNOLOGY UPGRADES

This group of initiatives would reduce the demand for energy using modifications and additions to the current building designs of UMBC. The phrase “Green Retrofit Technology” (GRT) will represent all improvements to an existing building that improve the sustainability or resource management of the building by conveniently rationing and enhancing resources already in use. This section explores the main academic buildings of the campus as well as the residence halls. Benefits associated with GRT include financial savings, a reduced carbon footprint, and precedence for future innovation. These initiatives focus on light energy management and water resource management.

The Information Technology and Engineering (ITE) Building at UMBC could serve as an example for planners. The building is highly efficient, boasting green lights and green use of water. Implementation would take place following an audit of need.⁴⁰ A comprehensive audit is being conducted during the writing of this paper by a company known as Noresco LLC, which will provide more accurate findings on energy and resource use at UMBC.⁴¹

- **GREEN LIGHTING IN ACADEMIC AND RESIDENTIAL BUILDINGS**

The actions listed here are low-cost alternatives to a total replacement of light bulbs, which has been determined to not be feasible in all areas.⁴² Campuses such as Stanford and Vancouver Island universities are known for using GRT in lighting systems to reduce energy usage and reduce cost. This is a common green building practice.⁴³ Lighting retrofits include occupancy sensors, dimmers, and ambient light sensors in conjunction with daylight and built in timers. These retrofits are not perfect in every situation but a proper combination of these measures produces the desired environmental result while allowing adequate light, a safe environment, cost effective plans, and more energy efficient lighting.⁴⁴ We recommend a strategy to carry out a comprehensive green light-switch retrofit.

Actions: Implement a comprehensive retrofit that would include a strategic combination of occupancy sensors, dimmer switches, and ambient light sensors. Occupancy sensors or motion sensors reduce energy consumption by turning lights on or off depending on if the room is occupied. Occupancy lights would be best for faculty/student offices, classrooms, mail/copier

rooms, study rooms, machine rooms, storage rooms, restrooms, and kitchens. Dimmers allow the light to be modified if full illumination is unnecessary. Dimmers work well for lights that are on continuously. Rather than consuming maximum light energy, this allows the university to adjust and set levels that are suitable with proportionate energy savings. Ambient light sensors can tell if an adequate amount of natural light is in a room and conserves energy by not coming on. These are best used in areas that receive adequate lighting on a typical day but require additional lighting at night. The Commons and some meeting rooms have sufficient daylight.

Costs: Occupancy sensors cost about \$65 per unit. Ambient lights are often combined with motion sensors and cost about \$100 each. Dimmers are usually \$20.⁴⁵ The cost to UMBC could range from \$48,205 to \$71,900, according to an informal walk-through audit by one of the authors of this analysis. That is based on upgrading lighting in the major academic buildings on campus and the work areas of the residence halls, and the broad range of costs reflects whether the most basic or the most expensive permutations are used.⁴⁶ A vast majority of lighting retrofits would be motion sensors, but there are some areas that would specifically benefit from ambient light sensors, but rarely from dimmers.

Benefits: The total amount of energy savings from these devices is highly variable and dependant on actual energy use patterns specific to UMBC. Based on the typical savings derived from comprehensive light retrofits, UMBC could reasonably expect a 30 percent electricity reduction, or a 1 percent electric energy reduction for every \$2,396.70 invested in the program.⁴⁷ If UMBC invested an annual \$14,380 for five years into these upgrades, we could expect a 6 percent energy reduction every year. In five years, energy consumption at UMBC will be 30 percent less than it currently is.

Feasibility: This plan would assure that the best strategy is utilized and the right combination of units is employed. Given the affordability and proven effectiveness of this option, feasibility is high. The program pays for itself in energy costs savings in the first year even at the highest cost estimate.

- **GREEN USE OF WATER IN ACADEMIC AND RESIDENTIAL BUILDINGS**

By making upgrades to water fixtures, the university could reduce water usage and minimize the environmental and financial costs of water treatment.⁴⁸ Much like the green lighting, Stanford University and many other green institutions use GRT in water resource management.⁴⁹ There are many GRT upgrades for water resource management but this plan targets the most common water users in residence halls and items unique to academic buildings such as public faucets, public toilets, and urinals. Upgrade items include lavatory faucets with flow restrictors of .5 gallons per minute (gpm) with shut off sensors, efficient toilets of 1.1 or 1.6 gallons per flush, and waterless urinals. Residential upgrades include low-flow showerheads and toilet modifications to be efficient (1.6 gpf). Each fixture conserves water by eliminating inadvertent waste. We recommend upgrading the water fixtures in the academic and residential buildings where appropriate.

Actions: Conduct comprehensive lavatory fixture upgrades. This would include automatic lavatory faucets with flow restrictors, waterless urinals, and efficient toilets in academic buildings as well as toilet and showerhead upgrades in residential buildings. Ideally, some strategic combination of all of these devices would maximize efficiency while minimizing cost and water usage for the entire campus.

Costs: Automatic faucets with restrictors cost about \$170. Waterless urinals cost between \$350 to \$700. Efficient 1.6 toilets cost about \$325. Low-flow showerheads cost about \$20. In residence halls, toilet modifications rather than replacements are being explored. Such modifications tend to cost \$135.⁵⁰ The informal walk-through audit revealed a cost range of \$229,210 to \$310,060 if the units were added to the major academic and residential buildings at UMBC using the least expensive and most expensive permutations.⁵¹ This cost could be broken into five smaller payments in five years (\$62,012/year). The most widespread need for the main campus is for lavatory faucets with motion sensors and flow restrictors. A prime example of this need is the Albin O. Kuhn Library, where all lavatory faucets should be upgraded.

Benefits: The benefits for water conservation are worth pursuing. A rough total daily estimate for UMBC's 12,000 students yields at least 105,200 gallons of water saved per day

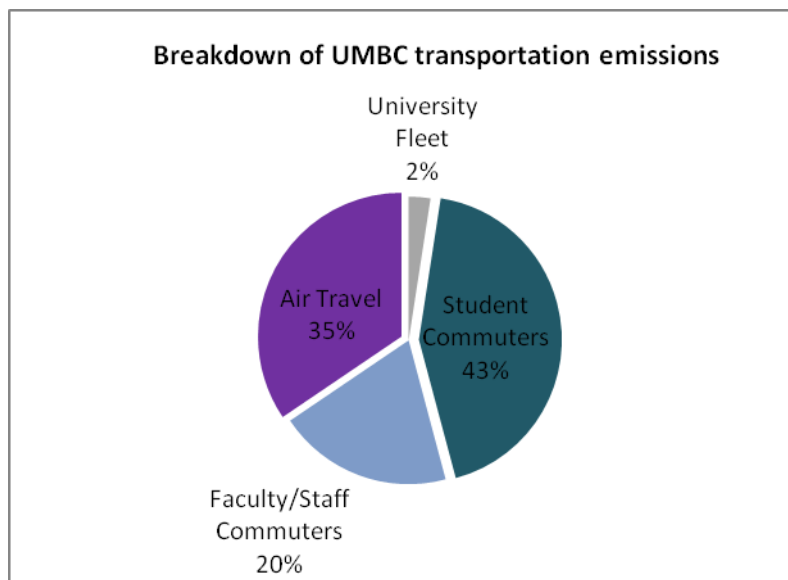
using retrofits. This plan essentially saves UMBC 101.80 gallons of water per one dollar invested in the program.⁵² If UMBC invested in a 5-year plan of \$62,012 per year, the university would save 6.3 million gallons each year. After 5 years, UMBC would use 31.6 million fewer gallons of water per year than the university currently does now.

Feasibility: The feasibility of this option is medium because it has a large cost but with highly quantifiable savings in water consumption. The program is palatable because there is considerable flexibility in the timeframe of its implementation.

GREEN PARKING AND TRANSPORTATION

Twenty-three percent of UMBC's carbon footprint comes from commuter vehicles. And the problem is only going to get worse. Based on enrollment growth trends, UMBC will see a 3.7 percent growth in the number of students by 2013, leading to increases in the university's carbon footprint. The majority of growth is attributed to an estimated 6 percent increase in the number of graduate students⁵³—who will be most likely driving to campus. What's more, next summer UMBC will lose 700 prime parking spots near the main academic buildings, or about 10 percent of all spots, to make way for a new fine arts center.⁵⁴

As seen by the chart below, student commuters are most responsible for UMBC's transportation-related carbon footprint.



Since parking fees are included as part of mandatory transportation fee assessed to all students, there is little to no incentive to forgo driving to campus. For many students and faculty, public transit is simply unrealistic or impractical, so parking must remain an available, and relatively affordable, option. However, altering how much students, faculty, and staff pay for parking, and where they can park, can be an important policy lever to change driving habits and reduce the university's carbon footprint.

Already, UMBC is taking steps to change driving habits by promoting car-sharing. UMBC will introduce four to five Zipcars on campus, which will be parked in the Commons Garage,⁵⁵ which should encourage students who are only occasional drivers to leave their cars at

home.⁵⁶ However, UMBC should take more steps to use parking and transportation to help green the campus, and so we recommend UMBC adopt the following initiatives:

- **PARKING SURCHARGE FOR ALL STUDENTS WHO WISH TO PARK ON CAMPUS**

Currently, a mandatory transportation fee is charged to all students, regardless of whether they drive to campus or not. In one sense, parking on campus is free. There is no incentive for students to forgo driving to campus since drivers and non-drivers are charged the same transportation fee. Simply increasing the cost of parking has been shown to change people's driving habits—from what mode of transportation they use to how many trips they make in a given day.⁵⁷ In simple terms, charging students a fee puts them on notice that there is indeed a cost to the privilege of parking on campus.

Actions: UMBC would establish a surcharge, in addition to maintaining the current transportation fee, for any vehicle that students would like to park on campus. The Student Government Association (SGA) would have to approve it, as it does for all proposed fees. The revenue would be placed in the new Green Revolving Fund (explained later in this document). The parking surcharge should fall within the range of other colleges and universities in Maryland: Towson University charges \$250 annually⁵⁸; Loyola College charges \$350⁵⁹; Johns Hopkins University charges \$700 for garage parking⁶⁰; and, the University of Maryland charges \$412 for residents and \$213 for commuters.⁶¹ We recommend a surcharge of \$175, which is approximately the price of Loyola's parking fee (which falls in the middle of the examples given) minus UMBC's existing transportation fee (or \$176 for full-time students.) The surcharge would need to be pro-rated for students only here for one semester. In addition, UMBC would need to decide whether to charge two different permit prices—one set fee for commuters, and one for residents.

Costs: Since UMBC already has a permitting system in place, adding a surcharge per permit would be a low- to no-cost option for the university since the existing parking management software can handle a new fee.⁶²

Benefits: This is a highly cost-effective way to prompt students to realize that driving to campus is not free, perhaps nudging their driving habits. The surcharge would generate revenue for UMBC, which could be placed in the new Green Revolving Fund. If UMBC decided to charge \$175 per permit, and if 6,000 student permits are issued, then this would generate \$1.1 million for the university.

Feasibility: Because the permitting system already exists, this could be implemented relatively quickly once UMBC officials and the SGA approve it. A target start date could be set for Fall 2010. In economic terms, a parking surcharge would establish a “fixed cost” for the ability to park a car on campus, but would not encourage students (or faculty, who already pay a parking surcharge) to make fewer trips once they purchased a permit. And, in an era of rising higher education costs and a sluggish economy, raising fees is never a popular option. However, a surcharge would eliminate the burden on non-drivers, who under the current system, indirectly pay for parking, even though they don’t use it.

- **PREMIUM PARKING SPACES AND PARKING DISCOUNTS FOR STUDENTS, STAFF AND FACULTY WHO CARPOOL, OR DRIVE HIGHLY FUEL-EFFICIENT VEHICLES AND OBTAIN “GREEN PERMITS”**

This initiative sends a message to students and faculty that UMBC is doing its part to influence environmentally friendly behaviors by providing incentives to students and faculty to “green” their driving habits. By using financial incentives and the convenience of close parking spaces, drivers could be swayed into forming carpools, or buying a hybrid or other fuel-efficient vehicle for their next car purchase. By rewarding students and faculty who drive hybrids and fuel-efficient models, the environmental benefits are not limited to those enjoyed by the campus, but the benefits reach everywhere that hybrid is driven.

Actions: UMBC would designate several choice spots near key buildings on campus (dorms and classroom buildings) for vehicles with “green permits” that are registered as carpools, hybrids, or highly fuel-efficient cars. These drivers would also receive a discount off of their parking surcharge. Hybrids could be those that are classified by the federal government as such (for 2010, there are 18 models that are defined as hybrids).⁶³ Highly fuel-efficient cars

could be those designated by the federal government as posting combined highway-city miles-per-gallon rates that exceed 30. Currently, for 2010, there are 8 non-hybrid models that meet this definition—including Honda Fit, Smartcar, Mini Cooper, Volkswagen Jetta, and Toyota Yaris.⁶⁴ The selection of eligible vehicles could also be modeled after the University of Maryland, College Park’s “Green Permit” program, which recognizes 51 vehicles from model years 2001 to 2010 based on information from the Environmental Protection Agency.⁶⁵

Costs: UMBC would incur administrative costs for setting up special permits for these vehicles, and enforcing the initiative. This could be problematic for the small, three-person staff that makes up the university’s parking department. However, it’s important to note that parking services contracts out parking enforcement duties. Costs would also be incurred for signage for the specially designated spots. UMBC would also lose revenue by granting discounts.

Benefits: A study of UMBC carpooling behavior showed that reducing parking fees and reserving premium parking spots for carpoolers could result in an additional 1,200 students who give up driving solo to campus.⁶⁶ This initiative, particularly the carpooling component, would complement UMBC’s decision to introduce Zipcars on campus, which gives carpoolers an alternative in an emergency.

Feasibility: UMBC would have to establish a mechanism for verifying the vehicles that would qualify as hybrids, fuel-efficient vehicles, and carpools, and determine how many students would have to drive together to constitute a carpool. Many campuses do this, and Boston College⁶⁷, the University of Delaware⁶⁸, and the large and small campuses of the University of California⁶⁹ could serve as models. UMBC could also consider designating tiers of carpooling, such as Seattle University does⁷⁰, with its “maxi pool” program, and reward those with especially large carpools (of, for example, four students) with a greater financial reward, such as free parking. To deal with the few occasions in which carpoolers must drive separately, UMBC could model its program after the State University of New York at Buffalo, in which each carpooler is given a set number of day permits for use throughout the academic year.⁷¹

There are a number of concerns to address, including fraud and enforcement, and equity. Protecting against fraud would be a major concern. Enforcement, especially when it comes to

carpooling programs, is especially difficult, and most universities rely on the honor system, a fraud hotline, and parking patrols.⁷² Also, enforcement of an even larger carpool program would be difficult with existing staff.⁷³ An initiative that encourages students and faculty to buy hybrid vehicles raises issues of equity, as these are usually more expensive cars that may be out of reach for some students, staff, and faculty. In fact, when De Anza College in California set aside choice spots for hybrids, the college newspaper wrote a critical editorial declaring the policy was unenforceable and benefited students who could afford pricier cars.⁷⁴ However, by also rewarding carpooling and other less pricey fuel-efficient vehicles—which are undoubtedly less expensive alternatives to buying a hybrid—this could mitigate some of the concerns about equity.

With an aggressive timetable, this program could be up and running by Fall 2010. Currently, the UMBC commuter services office administers a program in which five priority spots are set aside for carpoolers, but parking services reports that this is poorly executed.

- **COMMUTER-ONLY AND RESIDENTIAL-ONLY PARKING LOTS**

UMBC parking services reports that one problem contributing to the lack of choice parking lots available on campus, and a bigger carbon footprint, stems from residents who drive across campus from their dorms or apartments so they can park closer to their classes.⁷⁵ By establishing residential parking permits, and then designating lots closest to living quarters for students, this will free up spaces for commuters and eliminate short trips around campus that add to the UMBC carbon footprint.

Actions: UMBC would implement a dual permitting system, in which one type of permit is issued for commuters, and another type for residents (of which there are about 4,000). UMBC would have to designate specific lots for resident parking, erect signage, and ensure there are enough spaces to meet demand.

Costs: UMBC would incur minimal administrative costs in implementing the two-tiered system, but the existing permitting software could handle this.⁷⁶ UMBC would also incur costs for erecting new signage designating lots that are residential, and for commuters. The parking

services enforcement staff would have to bear an additional burden of checking to make sure the right permit is associated with the right type of parking lot.

Benefits: This is a highly cost-effective and simple way to reduce carbon emissions from cars. Parking services reports that resident students are making needless short-distance car trips around campus so they can park closer to their classes.

Feasibility: This could be implemented relatively quickly, by the Fall 2010, and inexpensively given there's already a permitting plan in place. Existing parking meters on campus would allow students to pay for a different spot if the need arises.

- **ONLINE CARPOOL MATCHING SERVICE**

According to a U.S. Congressional report, changing and increasing parking fees can promote carpooling.⁷⁷ So this policy is intended to complement the previous ones by implementing a web-based application or software that allows students and staff to facilitate carpooling. Since driving cars is inevitable, this policy would make driving more environmentally efficient.⁷⁸

Actions: UMBC would be implement a web-based carpool matching system that would allow students and staff to share a ride by posting the date, time, and destination of their trips online. The system would be programmed to find similar trips and notify students looking for a ride. The carpooling system could be easily incorporated into the Blackboard system as an additional application.

Costs: If the system is implemented through Blackboard, costs would be minimal, because the technical infrastructure already exists.⁷⁹

Benefits: For car owners and drivers, this policy provides benefits in terms of savings on gas and car depreciation. Estimating the savings is difficult, as it depends on the specific characteristics of the population involved and their travelling patterns. However, some approximation can be given. Assuming a gallon of gas is \$2.61, a car gets 21 miles to the gallon,

and carpooling reduces 2,907 miles traveled in one year,⁸⁰ we estimate a savings of \$361 per person in one year.

In addition, this policy also impacts non-drivers who take advantage of a carpool since it frees up time they would otherwise be spending behind the wheel. The value of saved time could be greater than the savings from fuel, illustrating that this incentive could not only result in monetary savings, but time savings as well.

In addition to creating a safe and regulated carpool matching system on Blackboard, this initiative also reduces emissions. Considering that emissions cost \$0.161 per mile for an average car, and the same assumptions are made as above, then taking one car off the road implies an environmental savings of \$468 per person over one year.

Feasibility: There are already some websites dedicated to promoting carpooling, which are especially successful and attractive for people who drive a lot (at least ten miles in a trip or whose trips take at least half an hour).⁸¹

Consider Stanford University as one example. Since April of this year, Stanford University has been operating Zimride, a carpooling program that matches drivers to people who need a ride.⁸² In addition, Okanagan College in Canada implemented a carpool database that allows staff and students to enter their ride needs.⁸³ Finally, at Anniesland College in the United Kingdom, a car-share scheme software is being incorporated into the college's intranet.⁸⁴

The main disadvantage of this policy is that drivers may not be willing to share rides. In this case, to counteract this, it is important to disseminate information about the advantages of carpooling. Thus, the effectiveness of the program is expected to be medium.⁸⁵ Finally, as this program involves students and staff who both own cars, and don't own cars, this program promotes equity.

GREEN LIFE

Residential Life remains one of the largest contributors to on-campus energy usage.⁸⁶ The department of Residential Life (RL) is responsible for operating and maintaining nine residential facilities as well as coordinating programs and services for approximately 3,900 students who live on campus.⁸⁷ In 2008, 39 percent of all undergraduate students and 74 percent of incoming freshmen students chose to live on-campus.⁸⁸ We recommend that RL adopt a series of small policy changes to promote environmentally sustainable lifestyles within the residential communities. The actions listed under this policy aim to nudge student behavior towards environmental sustainability principles that will benefit the UMBC community as well as students' lives beyond the institution.

- **NUDGE SUSTAINABLE RESIDENTIAL STUDENT BEHAVIOR**

Actions: We recommend two specific actions aimed at nudging residential student behavior to promote environmentally sustainable practices both on campus and off. First, we recommend educating and training RL student staff to properly role model green behavior in residential communities. According to the work of psychologist Dr. Lawrence Kohlberg, college students seek social acceptance through adherence to socially approved behavior.⁸⁹ Establishing student staff as authority figures and role models for “good” behavior will allow the development of sustainable norms which will appeal to students. Students will desire to live up to communal expectations. We recommend including an educational component centered on sustainable living and role modeling into fall and winter student staff training cycles. This educational module would be created by current RL staff members. Additionally, as approximately 200 RL student staff live on-campus and receive a reduction in their housing expenses as compensation, we recommend sustainable life practices be included as employment expectations.

Second, we recommend the Department of Residential Education utilize student staff members and resources to educate residential students about environmental sustainability and green practices. We suggest this can be accomplished through social and educational green-focused programs and activities. Currently, within the RL department, Resident Assistants (RAs) are required to host two to three education and social programs in their respective communities per month. To highlight sustainability as a critical community focus, we recommend the

inclusion of a sustainability category into the residential education learning matrix. The learning matrix is a guide for supervisors and student staff during the development of their community curriculum. The inclusion of sustainability as a category in the learning matrix would result in more than 100 programs on green initiatives and sustainability efforts planned, developed, and implemented by current undergraduate student leaders.

Costs: The costs associated with nudging student behavior are minimal, and would not contribute any additional monetary costs not already incurred by RL. Additional training of student staff would result in little to no monetary costs, as fall and winter training sessions are facilitated by current staff and are included in the annual budget. Incorporation of sustainability as a topic in the learning curriculum would have little to no impact on the current departmental budget.

Benefits: The monetary savings resulting from this policy are best estimated in a long-run trajectory, and are difficult to quantify now. However, social and behavioral changes could be seen more immediately within residential communities through better recycling practices, reduced water consumption, and less energy usage. Behavioral changes could be assessed within the communities, such as through focus groups and an annual departmental survey. Data showing residential water and energy usage could be used as an indicator as to whether Green Life policies are successful in nudging student behavior to reduce the negative RL outputs.

Feasibility: As in the goal-setting initiative, this is also highly feasible since RL has already established environmental sustainability as a priority. The actions listed within this policy are specific RL departmental changes to be facilitated by department leadership, including Director Katie Boone, Director of Residential Facilities John Wisher, and Residential Education Area Directors David Clurman and Amy Sine.

GREEN AND SUSTAINABLE LAND USE

While it is not possible to offset today's carbon emissions by planting trees or creating green space that will absorb carbon a decade from now, tree planting and the development of a central natural space is a meaningful and useful tool to encourage students, faculty and staff to recognize the impact of their day to day actions that impact our environment, including their energy consumption and usage.

- **PLANTING TREES FOR TRAVEL PILOT PROGRAM**

UMBC estimates that 23 percent of its annual carbon footprint is a result of student, faculty and staff commuting.⁹⁰ Estimates also suggest that the average UMBC student, faculty or staff member drives 150 miles to and from campus each month. We recommend a one-year pilot program to plant trees to offset half of the carbon emissions produced by commuting to and from campus.

Actions: For every 150 miles driven to and from campus each month (student, faculty and staff), the driver would be asked to pay the following annual recommended plantings, watering and maintenance costs (approximately \$100.00 for each assumed tree) as shown in Table 1.⁹¹

Table 1: Vehicle Efficiency and Number of Trees per Individual

<i>Vehicle Efficiency</i>	<i>No. Trees/Cost per Individual</i>
Equal to/more than 40 miles/gallon	½ [3 trees (at \$100/tree)] =\$150
16-39 miles/gallon	½ [5 trees (at \$100/tree)] =\$250
Equal to/less than 15 miles/gallon	½ [7 trees (at \$100/tree)] =\$350

The pilot program would be managed through the parking office based upon the registered vehicle information. Each year every campus commuter would be provided with a questionnaire assessing their expected driving practices. Following the survey's completion, the commuter would be provided with a summary of his or her anticipated usage and estimated carbon emissions. Additionally, the student would receive information about their anticipated driving, estimated impact on the campus carbon footprint, and the benefits of offsetting carbon

emissions. Individuals would have the opportunity to voluntarily opt into the program as well as explore other carbon reducing options such as carpooling, public transportation, biking or walking. At the one year mark, the program would be evaluated for overall outcomes and possible continuation.

Costs: This pilot program would bring no new additional cost to the university. Although administrative costs to the parking office would increase, this cost is built into the \$100 offset costs for each tree, its planting and maintenance. As such, there would be cost savings to the landscape and grounds office for its annual tree maintenance, as these costs are also built into the offset cost per tree. However, there would be additional costs to student, faculty and staff commuters who choose to opt into the program. The average commuter, driving a 21 mile/gallon vehicle would incur an additional cost of \$250 for commuting in the calendar year (\$125/semester). Figuring 8,368 commuters, the collective cost to students could be about \$2 million.

Benefits: Through this pilot program, UMBC would be able to physically green its campus, resulting in an almost immediate outcome of decreasing its urban heat island effects and run off impacts in the short term, and contribute to carbon offsets for the long term.⁹² Depending on student interest, in one year, UMBC would be able to plant and maintain (for a projected time frame) 13,000 trees, of various species and sizes (13,000 students, faculty and staff x one tree).⁹³ Additionally, this pilot would change student, faculty and staff behaviors as they pertain to transportation, urging an ethic that nothing is free when commuting, and that all costs must be accounted in an equitable offset. In turn, this pilot would physically green the UMBC campus and create a campus culture more focused on sustainability.

Feasibility: This program would be controversial due to its high cost of the tree planting offsets (see additional costs to commuters, above). However, if this additional cost is compared to similar institutions high parking fees, this program becomes much more feasible. These fees are comparable to University of Maryland, College Park (UMCP), which assumes an annual parking fee of \$412 per student. While parking is more plentiful at UMBC, as discussed in this paper's segment on green parking initiatives, the argument could easily be made that UMBC

students should pay similar fees to their colleagues at UMCP. Finally, with opportunities for students, faculty and staff to be involved in the tree selection and/or naming, process of “their” trees, sentiment may turn more positive.

- **CENTRAL GREEN WALL**

UMBC’s Environment and Sustainability Sub-Committee placed priority on moving the campus towards climate neutrality. One proposal from the Office of Architecture and Planning is called Central Green. This proposal aims to create additional green space, and bring additional plant life to the core of the university campus, thus encouraging environmental awareness.⁹⁴ We recommend the incorporation of a green wall into an appropriate structure on campus as an additional element to the Central Green proposal.

Actions: As currently proposed, the Central Green is a parcel of green space bounded by the Commons, Erickson Hall, Albin O. Kuhn Library, and Center Road for essential green space for student, faculty and staff outdoor use and also as the center and embodiment of environmental sustainability on campus.⁹⁵ The proposal includes a formal garden with an honors wall, a wooden arcaded pathway that would stretch from the Public Policy Building to the Library, and a variety of trees and shrubs for year-round color and vegetation.⁹⁶ This recommendation includes incorporating a green wall into the Central Green proposal.

A green wall is the construction of a vegetative surface on side of a building that greens the surface area otherwise displaced by the building itself.⁹⁷ Major considerations for constructing a green wall include the structural integrity of an existing wall, timing of construction and the cost of renovation, should it be necessary.⁹⁸ However, green walls are also a suitable alternative for older buildings with suboptimal integrity due to smaller payload. A prime candidate for green walling would be the northern and western-facing walls of the Administration Building. Adding a green wall to the Administration Building would be an aesthetic centerpiece for visitors to the campus and would appear to be an extension of the surrounding garden at the base of the western wall. This proposal is inspired by the California Academy of Sciences Building, a Leadership in Energy and Environmental Design (LEED) Platinum building, the highest ranking in sustainable and green buildings.⁹⁹

Costs: Estimates suggest that the consultation, construction and education on how to maintain a green wall would cost approximately \$500,000 (\$80/square foot + costs to design, implement). This cost decreases for future green wall projects, as UMBC staff no longer need the maintenance training.

Benefits: There are a number of benefits to green walls, which include enhanced awareness of the natural environment, increased biodiversity, and a reduction of energy usage, all of which are consistent with the overall direction of the UMBC campus community and specifically the greening of the environment. Green walls decrease peak summertime temperatures of buildings by up to 35 degrees Fahrenheit.¹⁰⁰ Similarly, this yields a lower cost in HVAC energy usage and less storm water runoff mitigation. In addition to these benefits, green walls provide insulation, improve visual aesthetics, and filter greenhouse gases and decrease pollution.¹⁰¹ While the current proposal of Central Green promotes a green focal point for the campus, the incorporation of a green wall into one or more buildings further would demonstrate UMBC's commitment to meaningful sustainability efforts.

Feasibility: A green wall works to "soften" building exteriors, which is a goal of the UMBC Master Plan. This green wall would be an extension of the Central Green project because it is likely to be managed and maintained using the same resources. If cost is a major barrier, implementation could take place in multiple stages, making the project more feasible. A controlled experiment could be performed on a smaller wall of an administrative building while a larger wall could be left bare. This way an assessment could be made of whether additional greening should be pursued and data could be collected on how effective the project is while keeping short-term costs low.

CULTIVATING GREEN MINDS AND BEHAVIORS AT UMBC

- **UMBC “INCOMING INITIATIVE”:** NEW STUDENT ENVIRONMENTAL SUSTAINABILITY SEMINAR

UMBC’s environmental sustainability cannot be comprehensively addressed without the inclusion of an initiative focused on sustainability education and how to make the necessary behavior changes needed to positively impact our environment.

We recommend UMBC adopt a new student environmental sustainability seminar or, “Incoming Initiative.” This educational orientation is necessary to promote a culture of environmental sustainability for generations of students to come. Specifically, UMBC should place a strong emphasis on creating the campus knowledge and modifying behaviors to promote and achieve environmental sustainability.

Actions: By Spring 2010, we recommend that UMBC organize a team comprised of administrators, faculty, staff, professionals, and students to craft a 20 to 30 minute environmental sustainability seminar. This seminar would be presented within the routine undergraduate and graduate fall new student orientations beginning Fall 2010.

The same team would develop the content and mechanisms for delivering the environmental sustainability seminar to students. We recommend that the content focus directly on UMBC’s role as a contributor to the environment, as well as address the wider scope of environmental sustainability on a global scale. We also recommend that the content of the seminar be restricted to a 20 to 30 minute time period. Time slots for both undergraduate and graduate student orientations are severely limited.

We suggest that the team presenting the environmental sustainability seminar focus on the savings and benefits that could be obtained by a student who practices “green” behavior versus a student who is more wasteful and does not embody social responsibility for his/her actions. For example, the presenters could convey calculations showing the following: Costs associated with purchasing bottled water daily versus using a reusable water bottle; costs associated with carpooling; and, costs associated with buying a cup of coffee versus buying coffee in a reusable mug

Additionally, we recommend the team emphasize that while UMBC can foster a culture of “green” behavior, mainstream efforts are needed to perpetuate this culture. The concepts and practices presented in the seminars do not have to halt at a single presentation. Rather, with the involvement and interest of the UMBC community there is greater potential for future growth in environmental sustainability at UMBC. For example, the University of Michigan hosts a “Sustainability Speaker Series” which evolved out of the community interest and occurs multiple weeks out of the year.¹⁰²

Finally, educational and behavioral efforts to promote “green” behavior do not have to wait to be rolled out until the incoming students begin their attendance at UMBC. As Montreal’s Concordia University emphasizes, a strong and lively community is as an essential component to effectively institute change.¹⁰³ Even starting with small modifications – such as how Emory University utilizes electronic communication to connect with students and their families regarding fall orientation – introduces a more sustainable behavior by eliminating paper-based orientation materials.¹⁰⁴ We recommend that UMBC place a strong emphasis on what first-year undergraduate and graduate students can expect to encounter in the environmentally sustainable culture, behavior and lifestyle of UMBC.

For other examples of small modifications and educational opportunities, the Office of Sustainability at the University of Maryland, College Park created an interactive module for sustainability and climate change and how both influence students, students’ studies, and future career outlooks.¹⁰⁵ This endeavor was geared to make the module a central part of new student education, and assist in ensuring that students at the University of Maryland “have a basic understanding of the fundamental issues of sustainability.”¹⁰⁶

Costs: The two major actions of this policy include the development of content for the environmental sustainability seminar and its 20- to 30-minute presentation given by members of the Climate Change Taskforce during the fall orientations for undergraduate and graduate students.

Since members of the Climate Change Task Force are already in place, asking them to develop and present the content for fall orientation sessions would pose no monetary costs. There would be expenditures of time, experience, and knowledge on behalf of the members of

the task force, but these would not exceed the duties and responsibilities already expected of them.

The enrollment of new students would have no effect on the cost or implementation of the seminar. This can be asserted given that orientation seminars for both undergraduate and graduate students are established by UMBC administrators; this means that location(s), equipment, materials, and various other variable resources (i.e. food/refreshments) are already prioritized by administrators in the Office of Undergraduate Education and The Graduate School, and no additional costs would be imposed by the addition of the environmental sustainability seminar. The bottom line is that this policy does not require financial resources to make it happen.

Benefits: The minimal price tag serves as a positive attribute of this initiative. We recommend that the content developed for the environmental sustainability seminars vividly display the difference in savings that is produced by exhibiting “green” vs. non-“green” behavior. Highlighting such savings permits students to tangibly comprehend how their individual actions have larger implications.

The environmental sustainability seminar’s effectiveness should be gauged over a long-term trajectory, as it is geared to have a direct impact on incoming undergraduate and graduate students and grow from that point forward; this begins with the first cohort of undergraduate and graduate students entering UMBC in Fall 2010. It should be recognized that providing a thorough awareness and knowledge-base is only a stepping stone on the longer path to environmental sustainability. For example, the University of California Berkeley has taken similar actions to those laid out here, but has gone one step further. Beyond educating students at Berkeley, the university is creating opportunities for their well-educated students to re-invest themselves into the university through positions and assistantships.¹⁰⁷

Educating each incoming cohort of undergraduate and graduate students from Fall 2010 onwards would help to heighten the awareness and provide students with the knowledge and realization of their impact on the environment. While the environmental sustainability seminar would be specifically geared to address incoming undergraduate and graduate students, it would promote equity by inviting and encouraging all members of the UMBC community to take part in these mainstream efforts and become “ambassadors” to promote social responsibility.¹⁰⁸

Feasibility: The feasibility of adding the fall environmental sustainability seminars to the routine fall orientation schedules for undergraduate and graduate students most notably concerns the additional time the seminars will add to the fall orientation schedules.

Fall orientation schedules are prepared well in advance by UMBC administrators, and have strict structures that are dictated by stringent time slots. In order for the environmental sustainability orientation seminars to be added to the routine undergraduate and graduate orientation schedules, the seminars must be able to be presented in a 20- to 30-minute time frame. Fall orientation schedules are subject to approval by the Office of Undergraduate Education and The Graduate School. The addition of the seminars to the orientation schedules should not meet any opposition from UMBC administration, faculty, staff, or other professionals; rather, this should be viewed as a small addendum with large-scale, long-term effects to be carried into the future.

The orientation seminars may be devised as a pilot program to begin with in order to test their initial strengths and weaknesses. However, any desired or anticipated results are not likely to be visible until after the seminars have occurred for approximately two consecutive academic years (i.e. Fall 2010 – Spring 2012). It is likely that there will be immediate results and reactions from the seminar's debut in both student orientations, but given the difficulty in assessing the relationship between the initiative and behavioral outcomes of the UMBC community, intervening variables may alter or produce the short-term outcomes. The long-term trajectory of student behavior changes will best gauge the effectiveness of this initiative in cultivating environmentally sustainable behaviors for the UMBC community.

GREEN REVOLVING FUND

One major roadblock to campus greening initiatives is the high initial costs necessary to finance significant sustainability measures. A revolving fund, by its nature, provides the financing necessary to make many of these projects feasible, and also encourages the long-term profitability (and thus feasibility) of the fund by securing return for future initiatives.¹⁰⁹

This green goal recommends the formulation of a Green Revolving Fund (GRF) to support new ideas in green technology, sustainability, building, and civic engagement at the UMBC campus. The GRF would serve as a modern financing tool to fund environmental projects and modifications through the cost savings that they generate. One highly successful nationwide university model for greening through cost savings is Harvard University's Green Campus Loan Fund, which since 2002 invested \$8 million in 160 projects.¹¹⁰

Actions: This goal recommends the creation of a revolving fund where 90 percent of the estimated cost savings from funded projects are paid back to the fund annually until 110 percent of the project cost, adjusted for inflation, has been repaid.

The GRF is an innovative method of financing a range of environmentally sustainable projects. Essentially, the GRF would provide grants to any UMBC department, division, or organization. In turn, the grant recipients would develop high-priority greening initiatives that save UMBC money. As money is paid back into the revolving fund, new loans would be made to other departments, divisions, or organizations that need start up funding to develop green initiatives.

There are many formulas to maintain a constant pool of money available for future use. University financial advisors and investment experts would recommend the best strategy. However, funding individual projects would be considered according to their short-term and long-term estimated savings. After a one-time initial investment of \$1 million (fundraising options discussed below), a revolving fund would provide sustainable, long-term financing for greening initiatives throughout the university. The fund would be overseen and actively managed by a new university GRF committee (consisting of administrators, faculty, students, and staff), or a new Office of Sustainability, that would design and implement a request for proposals (RFP) process to attract proposals for efforts to green the UMBC campus.¹¹¹

Additionally, the committee would work with departments and divisions to coordinate funding for replication or expansion of proven initiatives or new initiatives related to resource conservation, energy efficiency, sustainability, environmental quality, or green civic engagement.

Costs: A one-time initial investment of \$1 million would be needed to create the fund (fundraising options discussed below). After the initial investment, the fund would finance projects that have quantifiable monetary savings or return (such as energy efficiency). A portion of these returns would be reinvested into the fund until the project itself has been paid off. Then, the money would be reused for more projects. Simply put, this revolving fund would provide cost savings and long term financing for greening initiatives throughout the university for many years to come.

Benefits: The GRF would provide a number of positive outcomes for both the UMBC operations and civic/environmental concerns. First, the fund, by its nature, would remove institutional barriers to cost savings between capital and operating budget comparisons. Because the cost savings from financed projects would be returned directly to the fund for future initiatives, the cost savings would be accounted for, and reviewed, rather than passed over as a capital or operational expenditure. Additionally, the fund would allow faculty, students, staff and partner organizations to replicate and expand upon sustainable solutions and invest in supporting new methods for greening the UMBC campus (such as projects in renewable energy, energy efficiency and energy conservation). Finally, the committee would serve as a clearinghouse for information on best practices resulting from initiatives supported by the grantees (both for future projects and funders) that can serve as models for green changes throughout campus.

Feasibility: During these difficult economic times, the greatest barrier to implementing this goal would be the \$1 million recommended start up investment. However, there are a number of ways through which initial funding can be generated.

First, funding could come from the cost savings already generated by the goals within this document (see: reductions from promoting a paper and computer ethic, green retrofit

technologies, and green parking surcharges, etc.) Second, start up funding for an entrepreneurial venture, such as this fund, is available from local and national foundations based in Baltimore. Specifically, possible sources include: The Annie E. Casey Foundation, The Goldseker Foundation, and International Youth Foundation. Each of these foundations fund projects with sustainable outcomes. This initiative might be particularly attractive as it facilitates social entrepreneurship among young people (UMBC students) for the innovation of sustainability.¹¹² Furthermore, current energy efficiency dollars are available from the U.S. Department of Energy and stimulus funds focused on weatherization and energy efficiency are available from the Maryland Department of Aging.

Finally, on a smaller scale, investments and partnerships may be available from the UMBC Student Government and Graduate Student Association. Specifically, there are opportunities to team up with the Student Government's *Prove It!* campaign which offers \$50,000 to an individual or group with the best new innovation to the UMBC campus.¹¹³ Also, there are avenues through alumni funding initiatives and through already existing campus administration funds dedicated to similar greening initiatives.

CONCLUSION

To summarize and compare these initiatives, we created four matrices. A matrix allows the reader to compare all of the initiatives based upon a few criteria.

We rated each initiative (on a scale of low to high) based on the following criteria: cost, benefit, nudge factor, equity, and feasibility. Cost addresses the actual monetary cost of implementing the initiative. Benefit refers to the monetary benefits, or savings, that the initiatives would produce. Nudge factor measures the degree to which the initiative will alter behavior toward adopting a greener lifestyle. Equity assesses the fairness of each initiative. Finally, feasibility measures how difficult the initiative will be to implement, based upon administrative support and administrative burden.

The next few pages display four tables that present the initiatives and the five criteria with different overall strategies and goals. We will take the paper ethic as our example. Table 2 displays the information in the order in which it appears in the document. The paper ethic initiative is thus one of the first items to appear in the table because it is one of the first to appear in the document. Table 3 ranks the initiatives by their timeline of implementation. The initiatives with the shortest implementation timeline, i.e., those that can be done in a relatively short period of time, appear at the top of the table and are highlighted in light green. The table then lists the initiatives with a medium timeline, followed by those with a longer timeline. The paper ethic in this table remains near the top of the listings because it can be implemented within six months. Table 4 displays the initiatives according to their monetary benefit. The initiatives with the greatest benefit are at the top of the table. In this table, the paper ethic is located further down the list because it has a relatively low monetary benefit. Finally, Table 5 displays the initiatives in terms of nudge factor. The initiatives with the highest nudge factor are at the top of the table. Here, the paper ethic initiative can be found at the top again because its nudge effect is among the highest. Taken together, the tables allow our initiatives to be assessed across a variety of different goals and strategies.

In conclusion, this document contains an eight point plan for a more environmentally sustainable campus. The focus has been on generating green ideas and plans with less emphasis on bureaucratic mechanisms to enforce them. On this point, the creation of an office of sustainability to support UMBC's efforts in becoming and remaining green appears to be a

worthwhile consideration but is beyond the scope of this paper. The purpose of this report is to show students, faculty, staff, and administrators that our activities have environmental costs. Nothing is for free. The benefits of implementing green policies that nudge behavior are too great to ignore.

Table 2: Initiatives in Order of Document Appearance

Initiative & Goal	Cost	Benefit	Nudge Factor	Equity	Feasibility
Incentive the use of reusable items: To reduce waste production on campus	Low	Low	High	High	High
Paper Ethic: To encourage a more efficient use of paper	Low	Low	High	High	High
Napkins: To reduce inefficient napkin consumption at dining areas	Low	Low	High	High	High
Energy Efficient Computer Use: To put computers in low-energy mode when not being used	Low	Medium	Low	High	Medium
Lightless Vending Machines: to reduce energy consumption of vending machines	Low	Medium	Medium	High	High
Energy Star Vending Machines: To reduce energy consumption of vending machines	Low	Medium	Low	High	High
Green Lighting: Retrofitting lighting for energy savings	Low	High	Low	High	High
Green Water Use: Retrofitting water usage for savings	Medium	High	Low	High	Medium
Parking surcharge: To make students aware of the costs of driving to campus	Low	High	Medium	High	High
Premium parking spaces: To encourage students to carpool or drive fuel-efficient cars to campus	Medium	Low	Medium	Medium	Medium-High
Residential permits and lots: To discourage students from taking short-distance trips	Low	Low	High	High	Medium-High
Carpooling: To reduce the number of cars on campus	Low	Medium	-	Medium	High
Green Life Initiatives: To reduce on campus energy consumption (in residential communities by encouraging behavior modification)	Low	Low	High	High	High
Innovative Green Revolving Fund: To use cost savings for future green initiatives	High	High	High	High	Medium
Planting Trees for Travel: To offset carbon emissions	Medium- High	Medium	Medium	Medium-High	Medium
Central Green Wall: To create a central green wall space on campus	Medium	High	Medium	High	High
Incoming Initiative: Educating Incoming Students	Low	-	Medium-High	Medium-High	High

Table 3: Initiatives Ranked by Implementation Timeline

Initiative & Goal	Cost	Benefit	Nudge Factor	Equity	Feasibility
Incentive the use of reusable items: To reduce waste production on campus	Low	Low	High	High	High
Paper Ethic: To encourage a more efficient use of paper	Low	Low	High	High	High
Napkins: To reduce inefficient napkin consumption at dining areas	Low	Low	High	High	High
Energy Efficient Computer Use: To put computers in low-energy mode when not being used	Low	Medium	Low	High	Medium
Lightless Vending Machines: to reduce energy consumption of vending machines	Low	Medium	Medium	High	High
Green Life Initiatives: To reduce on campus energy consumption (in residential communities by encouraging behavior modification)	Low	Low	High	High	High
Incoming Initiative: Educating Incoming Students	Low	-	Medium-High	Medium-High	High
Green Lighting: Retrofitting lighting for energy savings	Low	High	Low	High	High
Parking surcharge: To make students aware of the costs of driving to campus	Low	High	Medium	High	High
Residential permits and lots: To discourage students from taking short-distance trips	Low	Low	High	High	Medium-High
Carpooling: To reduce the number of cars on campus	Low	Medium	-	Medium	High
Energy Star Vending Machines: To reduce energy consumption of vending machines	Low	Medium	Low	High	High
Green Water Use: Retrofitting water usage for savings	Medium	High	Low	High	Medium
Premium parking spaces: To encourage students to carpool or drive fuel-efficient cars to campus	Medium	Low	Medium	Medium	Medium-High
Innovative Green Revolving Fund: To use cost savings for future green initiatives	High	High	High	High	Medium
Planting Trees for Travel: To offset carbon emissions	Medium- High	Medium	Medium	Medium-High	Medium
Central Green Wall: To create a central green wall space on campus	Medium	High	Medium	High	High




-  0-6 months for implementation
-  6-12 months for implementation
-  More than a year for implementation

Table 4: Initiatives Ranked by Benefit

Initiative & Goal	Cost	Benefit	Nudge Factor	Equity	Feasibility
Green Lighting: Retrofitting lighting for energy savings	Low	High	Low	High	High
Green Water Use: Retrofitting water usage for savings	Medium	High	Low	High	Medium
Innovative Green Revolving Fund: To use cost savings for future green initiatives	High	High	High	High	Medium
Central Green Wall: To create a central green wall space on campus	Medium	High	Medium	High	High
Parking surcharge: To make students aware of the costs of driving to campus	Low	High	Medium	High	High
Energy Efficient Computer Use: To put computers in low-energy mode when not being used	Low	Medium	Low	High	Medium
Lightless Vending Machines: to reduce energy consumption of vending machines	Low	Medium	Medium	High	High
Energy Star Vending Machines: To reduce energy consumption of vending machines	Low	Medium	Low	High	High
Carpooling: To reduce the number of cars on campus	Low	Medium	-	Medium	High
Planting Trees for Travel: To offset carbon emissions	Medium- High	Medium	Medium	Medium-High	Medium
Incentive the use of reusable items: To reduce waste production on campus	Low	Low	High	High	High
Paper Ethic: To encourage a more efficient use of paper	Low	Low	High	High	High
Napkins: To reduce inefficient napkin consumption at dining areas	Low	Low	High	High	High
Premium parking spaces: To encourage students to carpool or drive fuel-efficient cars to campus	Medium	Low	Medium	Medium	Medium-High
Residential permits and lots: To discourage students from taking short-distance trips	Low	Low	High	High	Medium-High
Green Life Initiatives: To reduce on campus energy consumption (in residential communities by encouraging behavior modification)	Low	Low	High	High	High
Incoming Initiative: Educating Incoming Students	Low	-	Medium-High	Medium-High	High

Table 5: Initiatives Ranked by Nudge Effect

Initiative & Goal	Cost	Benefit	Nudge Factor	Equity	Feasibility
Innovative Green Revolving Fund: To use cost savings for future green initiatives	High	High	High	High	Medium
Incentive the use of reusable items: To reduce waste production on campus	Low	Low	High	High	High
Paper Ethic: To encourage a more efficient use of paper	Low	Low	High	High	High
Napkins: To reduce inefficient napkin consumption at dining areas	Low	Low	High	High	High
Residential permits and lots: To discourage students from taking short-distance trips	Low	Low	High	High	Medium-High
Green Life Initiatives: To reduce on campus energy consumption (in residential communities by encouraging behavior modification)	Low	Low	High	High	High
Incoming Initiative: Educating Incoming Students	Low	-	Medium-High	Medium-High	High
Central Green Wall: To create a central green wall space on campus	Medium	High	Medium	High	High
Parking surcharge: To make students aware of the costs of driving to campus	Low	High	Medium	High	High
Lightless Vending Machines: to reduce energy consumption of vending machines	Low	Medium	Medium	High	High
Planting Trees for Travel: To offset carbon emissions	Medium- High	Medium	Medium	Medium-High	Medium
Premium parking spaces: To encourage students to carpool or drive fuel-efficient cars to campus	Medium	Low	Medium	Medium	Medium-High
Green Lighting: Retrofitting lighting for energy savings	Low	High	Low	High	High
Green Water Use: Retrofitting water usage for savings	Medium	High	Low	High	Medium
Energy Efficient Computer Use: To put computers in low-energy mode when not being used	Low	Medium	Low	High	Medium
Energy Star Vending Machines: To reduce energy consumption of vending machines	Low	Medium	Low	High	High
Carpooling: To reduce the number of cars on campus	Low	Medium	-	Medium	High

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²² Another alternative to reduce waste and napkin consumption is making napkins unavailable in The Commons service stations. For instance, when a person buys a meal, the employee will give them a fixed number of napkins; if the person needs extra napkins she/he will have to request them. This situation places a burden on the consumer to request more napkins, and probably the consumer will chose to use the napkins provided more efficiently. Actions: All napkin dispensers that are located in the cafeteria line would have to be placed next to cashiers. It would be also necessary to instruct the cashiers to provide the costumer with a fixed number of napkins. Costs associated with this initiative include the time and labor of removing the existing dispensers and placing them next to the cashiers. As a consequence of not having napkins available, costumers may be tempted to leave more mess behind, causing an increase in costs associated with cleaning.

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²⁶ We don't want any of our recommendations to injure UMBC's reputation as a leader in the research field. We understand that some faculty run data that takes many hours. Of course, exceptions would be made for faculty who are running data on their computers.

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²⁹ Michael, Carlin, e-mail message to author, November 12, 2009.

³⁰ Estimates were made using the Energy Star Power Management Savings Calculator available at http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_management under the "estimate your savings using our online savings calculator" link. Estimates were based upon average commercial energy costs for Maryland (\$0.123 \$/Kwh) and upon setting 2,500 computers to the following energy savings profile: entering sleep after 15 minutes of inactivity and entering hibernate after 15 hours of inactivity.

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⁴⁶ All of the academic buildings on the main campus were considered. The staff areas of the Residence halls were included. A simple walkthrough of each building evaluated a single floor's typical design and an estimate was computed by multiplying by the number of floors. Typical building designs were replicated if appropriate. The low estimate assumes 677 basic motion sensors and 42 ambient light sensors. The high estimation assumes all ambient light sensors (719) which is a highly unlikely scenario but produces a cost safety window. The low cost of dimmers was simply estimated at the cost of a more expensive motion sensor in the interest of overestimating.

⁴⁷ This is a 30 percent reduction in electricity. This estimate is conservative estimate using the following facts: UMBC spends \$12,000,000/per year on energy and utilities. \$8,000,000 of this figure is electricity according to Jim Donlan. Comprehensive light retrofits have been shown to reduce energy consumption by over 50 percent according to Leon Glicksman. Because it is unknown without a light behavior audit of UMBC how often lights are left on, a conservative estimate of a 30% reduction was used here just for illustration This was also calculated using the highest possible cost for installation (highest cost for lowest returns). This figure can show whether such a program is worth pursuing given that savings could be substantially more.

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⁵¹ All of the academic buildings on the main campus and residence halls were considered. A simple walkthrough of each building evaluated a single floor's typical design and an estimate was computed by multiplying by the number of floors. Both estimates contain 100% installation of motions sensor faucets with flow restrictors in public restrooms as a fixed cost. Residential showerheads and toilet converters were considered fixed costs as well. Waterless urinals and toilet replacements would be used in strategic combinations and are considered variable. The low calculation assumes roughly 50% of the variable cost using the cheaper supplier. The high estimate assumes the expensive supplier and 100% of the variable costs as appropriate.

⁵² This is a conservative estimate based on student behavior. Anticipated water savings are approximately 38,400 gallons per day if residents each flushed 4 times, 1.1 gallons per minute in the shower. 1 gallon per flush at each urinal, 1.7 gpm at each faucet. It assumes 4 flushes per student living in residence halls, 3 flushed per day on the main campus, and a 7 minute shower for residential students. This estimate considers 4 students live in each dorm and 1000 units. This estimate does not add the lavatory faucet daily savings to the total however because it is extremely difficult to estimate. This estimate captures student use but not faculty or staff. Savings could be considerably more.

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- ⁵⁶ Will Toor et al. *Transportation & Sustainable Campus Communities*. Washington, D.C.: Island Press, 2004.
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- ⁶⁰ Homewood Parking Office. “Johns Hopkins University, Parking & Transportation, Student Parking.” Johns Hopkins University (2006). http://www.parking.jhu.edu/parking_students.html (accessed October 11, 2009).
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⁷⁸ As EcoTravelling recognizes, an organization formed to offer reference points on environmentally friendly travel, avoiding using the car and walking is not a realistic option, there are ways to make this form of transport less environmentally damaging. Especially when the distances are large or lack of public transportation, the usage of cars is inevitable. This organization claims that “the emphasis has often been on either driving in a more energy-efficient way to minimize petrol use – and emissions – or changing fuels or your type of car to more eco-friendly forms. Often overlooked, car pooling – also known as lift-, ride- or car-sharing – offers a flexible method of travel which can dovetail into everyday life while reducing individual carbon footprints”. <http://www.ecotravelling.co.uk/CarPooling.html> (accessed October 9, 2009)

⁷⁹ Based on pricing by carpoolworld.com, a group service that provides low-cost carpool group solution for organizations, we can estimate that the cost per trip record for managing a carpool matching system would be around \$0.02. For example, assuming a high demand scenario in which all residents on campus make a trip record per day during a year, total cost of the system would be \$29,200. For major details see: www.carpoolworld.com/groups.html (accessed November 16, 2009)

⁸⁰ Based on the Contra Costa SchoolPool Program. See Toor and Havlick (2004).

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