GREEN BUILDING GUIDELINES

Submitted to
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EXECUTIVE SUMMARY

The “Green Building Guidelines” was developed to establish guidelines for the construction and operation of new buildings on UW’s campus. The goal was to develop a policy that would enhance UW’s commitment to environmental practices on campus with respect to erecting new facilities. Upon developing construction approaches and practices that adopt the principles of sustainability, the “Green Building Guidelines” could prove to be a valuable tool for increasing public awareness of UW’s initiative to preserve the natural environment and at the same time for reducing costs to UW over the long term.

The green building policy guidelines, will be a tool for use to ensure that more environmentally sustainable buildings can be developed. The creation of such a policy enables us to be a leader in the community for acknowledging environmental responsibility. As, such, it is hoped that our project may be used as an example in other educational institutions and their buildings be equally or even more environmentally friendly.

We recommend that environmental awareness with regards to buildings be encouraged. Also, courses involving green building guidelines could be created, and increased student involvement and input would be beneficial in this quest for a greener building. Lastly, the adoption of the green building guidelines could propel UW to higher levels of consciousness and innovative environmental design. With this, UW would not only be known for its academia, but also, for our initiative in commitment to our natural environment.
1.0 INTRODUCTION

The University of Waterloo (UW) is one of Canada’s leading comprehensive universities, with undergraduate and graduate programs in Applied Health Sciences, Arts, Engineering, Environmental Studies, Mathematics and Science. UW includes among its major strengths programs that are dedicated to innovative technology regarding the management of the environment. UW pioneered the Faculty of Environmental Studies twenty-seven years ago and now has the largest faculty devoted to environmental issues in Canada. Waterloo has a reputation in applying their excellence in academics to contribute to society through innovative programs that benefit both the community and the natural environment. UW has forty-five teaching and resources building on campus and the Environmental Science and Engineering buildings is expected to be redesigned and constructed on campus soon (UW Facts and Figures, 1997).

2.0 POLICY BACKGROUND

Currently at the University of Waterloo, there is no comprehensive policy on the design of campus facilities. There is also no requirement that new buildings consider environmental issues or innovative technologies in the design, although such policies exist at other institutions (refer to Comparative Analysis section). The development of “Green Building Guidelines” might include requirements with respect to minimizing long-term costs of operating any new facility. The policy will also consider specific attributes that use innovative technologies that address environmental issues. The University has committees designed to make recommendations on campus planning and development, but there are no standardized policy procedures to ensure the incorporation
of environmental considerations or long term costs. Accompanying the University committees, there are also local municipal requirements enacted through various by-laws.

The Building and Properties Committee (BPC) makes recommendations to the Board of Governors on “campus planning and development, including the acquisition or disposal of land or buildings; the use of land, buildings and facilities; the siting of buildings and roads” (UW Building and Planning Committees, 1997). The BPC also makes recommendations to the Board of Governors regarding “construction projects exceeding $500,000, including the appointment of architects and consultants; the budget; the design; and the award of general contracts” (UW Building and Planning Committees, 1997). For all site work, new construction, alterations and major repair, the BPC ensures that the University has in place appropriate procedures for:

- cost estimating
- competitive tendering of bids
- awarding of contracts
- contract administration
- cost control
- payment to contractors

The BPC also is responsible to ensure that the University complies with all building codes, fire codes, safety regulations, and other government regulations in its buildings and grounds program. Finally, it is the BPC duty to ensure that the University has appropriate maintenance programs in place for buildings and grounds (UW Building and Planning Committees, 1997).
In addition to the Building and Planning Committee, the Long Range Planning Committee was created to have the following powers and duties:

- “To make recommendations to the Senate in all matters pertaining to the coordination of the planning of the academic, physical, and operational development of the University and the achievement of a planned rate and scope of such development.

- To receive from the President, for consideration, study and review, on behalf of the Senate, plans for the development of the University and to make recommendations to the Senate thereon.” (Long Range Planning Committee, 1997).

The one other procedure at UW is the President’s Advisory Committee on Design, which is chaired by Dennis Huber, Associate Provost, General Services and Finance, which oversees the design aspects for major construction to land and buildings.

These mechanisms will be enhanced through the development of a “Green Building Guidelines” to adopt a standard for the planning, construction and operation of sustainable buildings on campus in the future.

3.0 OBJECTIVES

A “Green Building Guidelines” should be developed to create guidelines for the construction and operation of new buildings on UW’s campus. Our goal is to develop a policy that would enhance UW’s commitment to environmental practices on campus with respect to erecting new facilities. Upon developing construction approaches and practices that adopt the principles of sustainability, we believe that the “Green Building Guidelines” could prove to be a valuable tool for increasing public awareness of UW’s
initiative to preserve the natural environment and at the same time for reducing costs to UW over the long term.

4.0 LIMITATIONS

Our research scope was limited to present technologies provided by the companies that responded. Additionally, our status as undergrad students limited the interest in companies to aid us in our pursuit of environmentally sound technologies. Resulting from the time constrains; our level of analysis of this project was relatively limited. The main areas of building design were covered and included water technologies, energy-efficient methods and interior design however; an additional section was added to encompass the applicable holistic approach of the functioning system.

Financial constraints limited our mobility to visit the facilities at McGill University as well as other green facilities in the region.

5.0 METHODS

For the development of the “Green Building Guidelines”, we gathered information form a variety of sources. Patti Cook, was the main source for our preliminary investigation into building requirements and environmentally friendly technologies. From the information provided by Patti, we followed up on the “Green on the Grand Project” and in turn contacted several companies that provided cutting edge technologies for the first sustainable office building in Canada. These companies were contacted and information was received, via e-mail or through mail delivery.
Additional information was received from McGill University regarding the “Eco-residence” located on the campus in Montreal. Other institutions that have environmentally sound buildings were access via the Internet.

The information was then divided into three sub-groups for analysis (Water, Energy, and Interior Design). The analysis was conducted and the “Green Building Guidelines” was developed to reflect areas for improvement.

Our group submitted the initial draft for comment and improvements were made based on Jim Robinson’s recommendations.

A survey was produced to determine the feasibility of the “Green Building Guidelines” as viewed by the attendees of the presentation given on Thursday July 29, 1999. The survey was interpreted and the results are offered in Appendix A.

6.0 ACKNOWLEDGEMENTS

We would like to thank Patti Cook for her guidance and direction in the initial stages of this project. In addition, we would like to recognize the following companies and institutions that provided us with the information necessary to construct the “Green Building Guidelines”:

- Trus Joist MacMillan
- Nepitek
- Enermodal Engineering
  - Los Alamos National Laboratory
- McGillUniversity- Macdonald campus
- Ian Cook Construction
- Oberlin College
Furthermore, we would like to thank Susan Sikes, Director Research Ethics and Grants, for her assistance with the survey. Finally, we would like to thank Jim Robinson for his contribution to the development of the University’s “Green Building Guidelines”

7.0 SCOPE

In the development of a “Green Building Guidelines”, the main areas for concern are water conservation, energy conservation and interior design to aid in the development of sustainable buildings on campus.

7.1 Water

The University of Waterloo obtains water from the City of Kitchener-Waterloo as well as two campus pumps and several small wells located on campus (Churchill and Zalagenas, 1999). Resulting from the installation of several campus wells and pumps along with the implementation of various water conservation programs, the amount of water purchased by the university has decreased (amount of decrease not available) (Churchill and Zalagenas, 1999). During the 1997-98 academic year, UW purchased 860,000 cubic metres of water from the City of Waterloo (Churchill and Zalagenas, 1999). The University does not currently have a formalized water conservation plan on campus. However, some methods of conservation include leak detection and repair, and installation of low flow plumbing fixtures and a closed loop cooling system which re-uses cooling water instead of pumping new water into the system (Churchill and Zalagenas, 1999). Nonetheless, it should be noted that reclaimed water is not currently being harnessed on campus (Churchill and Zalagenas, 1999).
A Campus Ecology Audit previously conducted calculated the total cost savings from the implementation of water conservation technologies were $3,000,000 for the Central Plant and $1,000,000 for the Biology building during the 1994-95 academic year alone. These cost savings exhibit the utility of developing policies to ensure that water conservation programs are incorporated into the design criteria of new facilities on UW’s campus.

7.2. Energy

The University acquires its energy from Waterloo North Hydro who get their power from a variety of sources such as hydro, nuclear, coal and natural gas (Churchill, 1999). UW does not have an official energy-efficiency program; however, efforts to reduce energy consumption include replacing standard light bulbs and old motors with energy efficient versions, and fans in the ventilation system have been modified to have variable speed drives (Churchill, 1999). It has been determined that these efforts have significantly reduced the levels of energy consumed annually (Churchill, 1999).

These existing methods are excellent examples of how to decrease energy consumption on campus; however by incorporating these techniques into a policy it would ensure the mandatory compliance with these methods in the planning and construction phase of the project.

7.3. Interior Design

No information was available on the existing conditions of the interior design of buildings on campus. After an investigation of alternative interior design methods
(see below), a sustainable building would need to incorporate technologies that decrease the long-term environmental and financial operating costs.

8.0 ADVANCED WATER TECHNOLOGIES

Water has become an area of great concern in today’s society. With decreasing water levels, water restrictions have become common. These restrictions prohibit the use of water for outdoor activities on certain days. Rainbarrels are an ancient method of water collection, which were to be used for most purposes, such as watering the garden. This is an example of one alternative solution to a growing environmental problem of water shortages. With the goal of sustainable buildings in mind, many alternative methods for water, collection, treatment and use, such as the rainbarrel, have been investigated. The main concerns addressed are reduction of water consumption, cost savings and decreasing the need for chemical treatment of wastewater.

The alternatives considered are rainwater collection, ecological water treatment, grey water, low-flush toilets and self-regulating faucets and showerheads. Although it is common for initial costs of environmental technologies to be high, the long term benefits and sustainability will reduce overall cost.

8.1. Collection and Treatment

8.1.1 Rainwater Collection and Distribution

Rainwater collection is a system, which incorporates the natural hydrological cycle and human water consumption. Through ancient methods of water collection, rainwater can provide for landscaping, showers/tap water, and drinking and cooking needs. This system is user friendly and cost effective once it is in place.
The rainwater collection system consists of trapping rainwater on the roof in order to avoid the absorption of the salts and minerals in the soil. All roof types are acceptable, with the exception of tar and gravel. However, metal is most efficient for rainwater collection due to its durability and smoothness. The amount of water that can be collected is dependent on the roof size. One inch of rain on 1000 square feet of roof can yield approximately 550 gallons of rainwater (Banks, 1999).

The water collected is then stored in a cistern to be treated and distributed. For landscape use, no treatment is usually required. For showers and tap water, ultra-violet light and disinfectant filters are required to treat the water. Finally, for drinking and cooking water, carbon filters, reverse osmosis and ultra-violet light, in combination, removes all but radioactive particles (Banks, 1999). Rainwater collection accounts for all water needs and uses. The cisterns are attached to the city’s main water line for emergencies in extensive dry periods.

8.1.2 Ecological Waste Water Treatment

The ecological wastewater treatment system is increasing in popularity as people are beginning to understand the importance and cost effectiveness of independent water treatment facilities. This ecological system uses living plants, animals and micro-organisms to clean wastewater. This system is a designed application of what exists in the environment. Natural processes of ecosystem cleansing are used for water treatment.
Ecological wastewater treatment avoids costs by transforming waste into resources. The end product of the cycle is plant biomass, evaporated water, CO2 and heat. The plant biomass can then be sold for profit (Ecological Engineering, 1999). This system also avoids the problem of reliable wastewater disposal and treatment, for the system is sustainable within itself. There are no additional costs once the system is in operation, not including operation and maintenance of the accessory systems.

The end product, water, can be used for all intents and purposes, with the exception of drinking. Finally, the system is an aesthetically pleasing recreation of a natural ecosystem.

8.1.3 Grey Water Recuperation

Grey water recuperation is a system that reuses household wastewater. Grey water consists of water used from sinks, showers and washing machines; therefore the most common contaminant found is soap (Watgreen, p78). Grey water systems treat and reuse 85-90% of household wastewater (Global EnviroScience Technologies Inc., 1999). Treatment occurs through carbon absorption or through settling tanks. In the settling tanks, all contaminants are decomposed by bacteria. These tanks require annual cleaning due to the build up of sludge on the bottom (Watgreen, p76). Grey water recuperation extends the water supply through drought and eliminates wastewater discharge.
8.2. Use

8.2.1 Low Flush Toilets

When considering washroom fixtures to be placed in a new building, it is important to look at water saving fixtures. Toilets use a great deal of water resources. On average, a toilet consumes 20-25 litres of water per flush. The new low flush toilets reduce the water consumed to 6 litres per flush (Natural Resource Defence Council, 1998).

The water being saved reduces costs of consumption and extends water supply in time of drought. However, the most beneficial result of using low flush toilets is the prevention of excessive dam and reservoir construction.

8.2.2 Self-Regulating Faucets and Shower Heads

It has been determined that the electronic sensor faucets are most effective to reduce water consumption. The electronic faucets produced by Nepitek contain a 30-second auto shut off function. Additionally, the water will shut off with the removal of hands from the sensor stream. These shut off functions will eliminate the habit of unused running water (Nepitek, 1999).

The electronic faucets will also reduce costs as a result of the reduction of bacterial health concerns. With the electronic faucets, there is no hand contact with the faucets and therefore, there is no spread of bacteria.

Another great consumer of water is the shower. An average five-minute shower consumes 125 litres of water with the conventional showerhead. With the low flow showerhead, an average of a five-minute shower will consume 45
litres of water (Watgreen, p78). The low flow shower is relatively inexpensive to buy and has long term cost benefits due to reduction of water consumption.

9.0 ENERGY-EFFICIENT TECHNOLOGIES

Energy efficiency makes economic and environmental sense. Energy-efficient buildings:

- cost less to operate than other buildings.
- are more comfortable, have better indoor air quality and reduce noise and dust infiltration. These factors can combine to make energy-efficient buildings more attractive to potential buyers.
- offer more opportunities to use innovative, new products and techniques. This flexibility encourages developers and designers to explore alternative approaches to keep construction costs down while maintaining energy efficiency.
- create market opportunities for new products and technologies, which result in new jobs for Canadians and economic growth in communities. (Natural Resources Canada)

9.1. Heating and Cooling

An alternative to the standard heating and cooling systems would be to use radiant heating and cooling. This system encompasses space heating and cooling provided through water-based radiators. This method offers 3 main advantages. Firstly, water is a more efficient heat transfer medium than air. Therefore, the motor energy required to
move heat through water-based radiators is less than that required to move heat through air-based duct. Secondly, it provides even warmth to occupants. Lastly, a more effective zone control of temperature can be achieved with control valves than through air-based registers (Green on the Grand, p. 7).

The panels used for the heating and cooling system can be the same colour as the ceiling therefore making it less obtrusive. Dehumidifying ventilation air prevents condensation on radiant panels as they carry hot water in the winter and cold water in the summer. The water is heated and cooled by the same efficient appliance: a natural gas fired boiler/absorption-chiller, which operates at 85% efficiency (highest level).

The advantages of this system are:

- it takes up less space indoors as installation occurs outdoors;
- natural gas is used to supply building cooling making it is less expensive to operate; and
- the refrigerant used is water and absorbent lithium bromide, which has no ozone-depleting or toxic substances (Green on the Grand, p. 7).

The only disadvantage is that it is less efficient compared to an electrical air conditioner. However, this disadvantage is compensated by the lower cost of natural gas and the two-stage operation process that reduces cycling losses.

9.2. Heat Recovery and Ventilation

An air handling unit containing two heat exchangers, two fans and a heating/cooling coil can be applied as an alternative system. This unit provides a
continuous flow of air at a comfortable temperature and humidity. The fresh air is delivered via a displacement ventilation system, which operates without air recirculation. This encourages greater energy efficiency, cost effectiveness and it provides a more superior indoor air quality.

9.3. Lighting

As a result of development in technology in the lighting industry, improvements in lighting efficiency and reductions in energy consumption and costs have occurred. The new alternatives reduce energy consumption by 65% or more, and a payback is seen within 1-3 years after upgrade.

Improvements in lighting efficiency can be viewed from 7 categories (Cook, B. 1998):

1. Lamps • replacing inefficient lamps with the most efficient lamp for the purpose, taking into account size, shape, colour and output of the lamp.
2. Ballasts • replacing standard choke ballasts with high frequency electronic ballasts.
3. Luminaries • retrofitting standard luminaries with high-efficiency spectral reflectors or replacing standard luminaries with high-efficiency luminaries.
4. Automatic control systems • installation of
   (a) timer circuits that switch lamps off during room vacancy times,
(b) photoelectric sensors that sense the amount of daylight in the room and either switch lamps on or off or adjust the lamp brightness accordingly and
(c) occupancy sensors that switch lamps off when work stations are unoccupied.

5. Localized switching - installing localized switches near workstations to control local lighting.

6. Lighting design -
(a) designing lighting systems that maximize the use of daylight, such as the PSALI system (permanent supplementary artificial lighting in interiors); and
(b) introducing local task lights (e.g. desks lights), allowing a reduction in general overhead lighting.

7. Maintenance schedule - setting up a maintenance schedule to clean and replace lamps on a regular basis.

Fluorescent lamps seem, at a first glance, to be environmentally friendly because they are three to four times more efficient than incandescent lamps at converting electricity to visible light. However, the advantages of fluorescent lamps are greatly diminished by their dependence on mercury, which the federal EPA classifies as toxic and hazardous (Los Alamos National Laboratory, 1997). The excessive disposal of 500 million spent lamps yearly poses a serious threat to the environment and to human health.

The mercury-free lamp, instead of using mercury (or any other toxic substance) as the excitation source relies on field emitters (Los Alamos National Laboratory, 1997). In
the new lamps, a field emitter discharges electrons through a vacuum in the bulb. In conventional fluorescent tubes, gas discharge ions eventually destroy the cathode in the lamp’s power supply (Los Alamos National Laboratory, 1997). Without the damage caused by these ions, the Los Alamos lamps can last considerably longer, and the power supply would be much smaller and cheaper. In addition, the new lamps, unlike their predecessors, can be controlled by simple dimmer switches.

Lighting controls play a large part in energy efficiency as well. Daylighting, can provide a cheap alternative to turning on the actual lights. Energy-efficient light fixtures and task lighting also exist to aid in the same manner.

9.4. Windows

There are many different methods in which to reduce energy costs. Simple factors of consideration would include the direction the windows in the building face (north, southeast, west, etc.); the size of each window; their exposure to direct sunlight (winter or summer, morning or afternoon) and shading from trees, surrounding buildings (Loewen, 1999).

Other possible alternatives to the existing window systems would be those which are triple-glazed with two low-e coatings. Low-E is better known as Low Emissivity technology. This technology works by reflecting heat back to its source. Argon gas can also be injected into one or more of the air spaces between the glass panes along with two silicone edge-spacers (Loewen, 1999). This inert, environmentally safe gas significantly reduces the conduction of heat. These windows have a total U-value under 1.0 W/m²C.
The outside light of spectrally-selective glass maintains high visible light transmission (0.53) and minimizes solar heat gain.

These fibreglass frames are better because they are environmentally friendly, excellent insulators, have low embodied energy and have few noxious emissions in manufacturing. With the recent technological revolution, it is now possible to have lower heat loss, less air leakage and warmer window surfaces that improve comfort and minimize condensation (Green on the Grand, p. 6).

9.5. Doors

One of the most energy-efficient commercial door systems in the world is shown to have a 13 mm thermal break (Green on the Grand, p. 6). This minimal thermal break prevents the leakage of precious heated air, or the transferal of cold air from the exterior. The glazing used for the doors is similar to that of the triple-glazed windows. Another method with which heat loss is reduced is by an insulated steel door, which has a wood (not steel) edge. Along with this, a high-performance glazing unit can be used to aid in the reduction of the prevalent heat loss during the cooler seasons.

10.0 INTERIOR DESIGN

Building materials should be selected carefully when designing the interior of new campus buildings. Careful selection of wall and ceiling coverings, flooring, paints and furniture will enhance indoor air quality and provide inexpensive and environmentally sound designs. Paint and flooring will be the focus of this section since persons entering a building first come in contact with these materials. The goal is to
choose the best paint and flooring alternative that is both environmentally and economically feasible.

10.1. Flooring

Flooring materials available for building use include carpeting, resilient flooring, and concrete.

The top two flooring systems that appear to be the most economically and environmentally feasible is linoleum and concrete flooring. Both are relatively inexpensive because they are easy to install; they are irreplaceable and finished coatings only need to be applied occasionally. Concrete has an excellent life span and maintenance is good though concrete tends to crack after many years. Linoleum is also very durable and is excellent to maintain. Both flooring materials also pose little damage to the environment. They use non-renewable resources in their production and are harmless once they are in place. In addition to linoleum flooring, production waste is reused by feeding it into a production process. As well, at the end of the life cycle of linoleum, the material can be composted or incinerated. Linoleum is biologically degradable and does not release harmful substances or gases (Forbo Resilients, 10).

At present most buildings are composed of synthetic tiles such as vinyl, asphalt, cork or rubber. These materials are relatively inexpensive however long term costs of linoleum, terrazzo and concrete outweigh the long term costs of synthetic tiles. Also, synthetic tiles are rated as poor for environmental impact due to the chemicals that are released during their lifetime and the inefficient methods of disposing waste.

Carpeting is inexpensive in the short run, however, the long-term cost seem to be economically inefficient. This is because of the maintenance needed to uphold carpet.
Carpets require proper cleaning with shampoos and equipment that can be very expensive. Furthermore, carpets have a short life span and therefore must be replaced sometime in the future. In addition, carpeting is rated poor in environmental standards because it is a great source of irritants and chemicals. Carpets are susceptible to mold and bacteria because of the huge amount of dirt collected in the fibers. Carpets are then treated with toxic chemicals such as pesticides (Watgreen, 37). Other chemicals found in carpets, as well as synthetic tiles and concrete are found in table 3.0.

10.2. Paints

Paints available for building use include conventional and organic paints. In comparison, these two types of paints rank very similarly in all categories. Long-term costs are higher for organic paints than conventional paints though it is cheaper to use conventional paints in the short run. Organic paints are better in the long run because disposal is inexpensive. Since organic paints are made from natural products and use no environmentally harmful synthetic elements, they can be disposed by pouring paint onto compost heaps. Conventional paints however, are hazardous wastes composed of toxic chemicals and petroleum based products (Watgreen, 50). The cost of proper disposal therefore, is needed. Both paints are durable products and each has to be repainted periodically.

In regards to availability, conventional paints are more readily available than organic paints. This is because organic paints are still relatively new. Like other environmentally sound methods however, organic paints have become more widespread in Canada and the United States. The major differences between these two paints are the environmental impacts. As mentioned, conventional wastes are hazardous. Many of the
substances used in conventional paints are carcinogenic and once these chemicals are released, they cause indoor air pollution (Watgreen, 50). Chemicals found in conventional paints are listed in table 3.0. Organic paints however do not release chemicals and do not contribute to indoor air pollution.

Most buildings use conventional paints to coat their interiors. Since the long-term costs are feasible and the impact on the environment is reduced, organic paints are recommended in the campus building policies.

11.0 COMPARATIVE ANALYSIS

Analyzing the implementation of environmental strategies throughout North American University campuses, and accounting for their benefits and efficiency levels.

11.1 McGill University

The courtyard was transformed into a communal garden, which served as a lab for horticultural research projects, and provided a common area used for lectures, gatherings, or research related tasks (EcoResidence Project, 1998).

The objectives included a demonstration for sustainable living in a concrete and educational context. This was created as a research project, with which the sharing of information with other parts of the world involved in similar projects, was encouraged. A permanent teaching facility was produced and this aided and developed new curricula in environmental and scientific areas.

The main areas of focus included (EcoResidence Project, 1998):

- waste management reduction
- reuse and recycle of non-toxic materials
- durability
- maintenance
- life cycle costing
- manufacturing

Specific environmental technologies and methodologies were implemented. Initially, passive solar heating came from greenhouse where sunlight scoops were introduced. Greenhouses were built from old windows and plants were used in the greenhouse to improve the indoor air quality (EcoResidence Project, 1998). Vents were used at the bottom and top of trombe wall to control the air circulation between the greenhouse and the interiors, along with the recycling and reuse of dismantled components: including re-use of external components. Reused items would include, items such as: exterior doors and windows, concrete blocks, plumbing pipes, dimensional lumber, electrical wiring, wood stair, etc.

Rainwater collection/distribution for laundry and landscape irrigation was practiced. The implementation of sump pits that connected the storm drains to the main campus sewage connections allowed rainwater to be pumped into new reservoirs or cisterns. The roof membrane was also tested to ensure that there is no contamination of rainwater (EcoResidence Project, 1998).

Ecological waste water treatment facility was created, where there was a natural purification process. This facility was used for teaching and demonstration purposes and provides opportunities for residents to participate in wastewater treatments. It was
required that new sewers, water and electrical lines be built prior to the completion of landscaping.

There was active solar energy heating of hot water, which was a way of reinforcing their original heating system. Incorporating solar heating on the roof reduced the energy consumption. The solar power was used to reduce energy consumption in the building, however the building is not fully dependent on solar power. The original piping system was recycled in this process (EcoResidence Project, 1998).

A PVC-Free project was carried out, where there was the use of alternative products that contained no PVCs. Alternatives were explored and tested.

Innovative organic gardening and landscaping became a forum for horticultural research. This served as a laboratory for horticultural research and as a model for community living. It also stored rainwater supplies water conserving irrigation system and salvage material used as fill for fences and furniture, etc (EcoResidence Project, 1998).

Improved energy efficiency was promoted by the use of alternative heat sources, improved air-tightness of building envelope and energy efficient lighting. Along with which, there was innovative environmentally friendly furniture where recycled or reused furniture was utilized. Students also participated in the design and fabrication of furniture.

11.2 Oberlin College

New Environmental Studies building at Oberlin College in Ohio is the most advanced example of ecological architecture and designed to improve ecological
competence and increase energy efficiency. The environment is a priority in purchasing decisions, landscaping, architectural designs, investment designs and operations. There are no waste products as a result of construction along with no use of toxic materials and maximum usage of natural material (The Earth Times/Environment, 1998).

Students were employed students to work closely throughout the process of this construction. Solar power technology was implemented, as well as a waste water purification system (same as ecological waste water management), and the flooring and carpeting material was reused.

11.3 Princeton Universit

Princeton has been attempting to implement a new building policy with environmental considerations. Although no building has been constructed, there are currently six projects being planned. Therefore, they wish to implement new environmental building guidelines with which these six projects will be following.

There are four recommendations stated by the board (Princeton University, 1995):

1. Hiring the architect

The architect has control regarding the construction process, building design, materials used and methods utilized. Therefore, and architect with environmental knowledge or priorities would be more beneficial to the implementation of these guidelines.
2. *Reduction of solid waste produced by the building industry.*

This could be achieved with recycled or reprocessed contents. This will be a requirement in the future, as disposal costs are increasing as a result of decreasing landfill space. Examples of reconstructed materials include: carpeting made from recycled plastic bottles and flooring made from old tires and waste glass.

3. *Implementation of more efficient and ecologically friendly lighting and air-conditioning systems, cleaning processes and waste management practices.* Firstly, the removal of halogen lamps by implementing more powerful overhead lights and replacing existing windows with one *paned* windows. Secondly, ensure that proper insulation and air circulation methods, which reduce energy consumption and costs. Thirdly, use natural light by special positioning of windows.

4. *Environmental Impacts resulting from building operations.*

Primarily, there is an important health and environmental concerns with the use of chalkboards. Therefore, dry-erase boards should be utilized. Also, dry-erase boards are a good form of communication and reduce the need for flyers. The development of practical and efficient solid waste recycling systems allows for the ease of recycling. This allows the university to comply with increasing stringent waste disposal regulations.
12.0 GREEN BUILDING GUIDELINES

Cost-effectiveness considering long-term operating and environmental costs has to be taken into account. Direction from the Board of Governors is required to avoid primarily focusing on capital costs.

Consider use of advanced technologies beyond cost-effectiveness. This should be consistent with UW's image as a technologically advanced university. Environmentally appropriate technology and materials should be employed.

One means of pursuing this is to have a group of students develop a set of building guidelines, perhaps during the Fall term 1999. Theses students could be from many faculties including Engineering and Environmental Studies.

Specific measures to be taken within the buildings:

1. Consider integrating a closed loop water system into the design of all campus facilities.

2. Use the most efficient technologies available in the following sections:
   a) Lighting - Consider adopting mercury-free or the most energy efficient bulbs
   b) Windows and Doors - Consider triple glazed panes, and minimal thermal breaks
   c) Heating and Cooling - Consider radiant heating and cooling systems

3. Interior Design: make use of linoleum and concrete materials for flooring.

4. Use of non-toxic paint in addition to organic paints that require little long-term maintenance.
13.0 CONCLUSION

There are many benefits of the introduction of environmental policies into the University of Waterloo building guidelines. It allows the University to operate more efficiently, to promote increased ecological sensitivity and raises the University’s status as an ecologically aware institution.

Considering the large architecture, engineering and environmental faculties at the University, it would not be an awkward step to implement additional environmental awareness into our building policies. Also this would provide an impetus for future educational experiences for the students as well as for the faculty members. Supplementary knowledge of ecological processes will be imparted on willing minds and this may encourage and enhance environmental appreciation.

Aside from the formal environmental guidelines, everyday practices of menial tasks, such as switching off lights when leaving rooms, etc., should be encouraged as common routines. This can be accomplished through the increased awareness of both the on-campus and K-W recycling programs.

As we enter the 21st century, with this new green building guidelines, the University of Waterloo will establish itself as a leading player in this quest for increased environmental standards. We will hopefully be able to set the precedent for future Canadian universities to follow.
Appendix A

Survey Results: sample space was ten people.

1. To what extent did you find the presentation informative

   10% - Very Informative
   80% - Informative
   10% - Not Informative

2. Did you find that the presentation influences your perception of new environmental technologies

   10% - Strongly Influenced
   80% - Moderately Influenced
   10% - Not Influenced

3. Did you feel that environmental technologies are a concern for the future of the University and of society?

   80% - High Concern
   20% - Moderate Concern

4. Would you be willing to invest in alternatives with higher start up costs in order to provide long term economic and environmental sustainability?

   60% - Yes
   30% - Unsure
   10% - No

5. Based on technologies mentioned in the presentation, which would you be most willing to implement

   40% - Rainwater Collection
   40% - Ecological Waste Water Treatment
   100% - Low-Flush Toilets
   70% - Showers and Faucets
   
   70% - Paints
   40% - Flooring
   
   100% - Windows and doors
   60% - Lighting
   60% - Heating
   60% - Cooling
6. Do you feel that the implementation of new environmental technologies would enhance the University of Waterloo’s reputation

100% Yes

Comments:
- Recommendation to coordinate with architecture students as they also construct new technologies.
- Environmental technologies are currently implemented where applicable in all renovation and construction now.