Examining the Feasibility of Installing a Greenwall in the Dalhousie Life Science Centre

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Abstract

This study took place at Dalhousie University on Studley Campus; the purpose of this feasibility analysis was to determine if Indoor Air Quality (IAQ) and aesthetics issues are present in the Life Science Centre (LSC) and to determine the usefulness and benefit of a greenwall in addressing these issues. The study used the triangulation technique of research, which included interviews, case studies and a survey. Based on research and information gathered we determined that there were IAQ and aesthetics issues negatively affecting the LSC, and that benefits derived from the implementation of a greenwall would help to mitigate these issues. However, due to lack of information concerning possible economic costs or benefits derived from a greenwall, we were forced to conclude that further study is necessary.

1. Introduction

1.1 Background and Setting

With the average urban-dwellers spending approximately 80-90% of their time indoors (Abbritti and Muzi, 1995; Krzyanowski, 1999; Carpenter, 1998), the issue of Indoor Air Quality (IAQ) and indoor aesthetics affects us all. The benefits of indoor plant life are well documented ranging, from decreased anxiety, increased productivity, to improving indoor air quality (Orwell R.L. et al., 2004; Darlington A. et al., 2000; Dingle P. et al., 2000; Lohr I. et al., 1996; Shibata S. et al., 2002). In order to keep out the cold many of today's modern buildings are becoming increasingly air tight. (Darlington A. et al., 2000). However, these practises unfortunately reduce IAQ, leading to the accumulation of pollutants and contaminants to dangerously high levels. The Environmental Protection Agency has recognized this problem and refers to IAQ as one of the top five public health concerns. The main concern is from the build-up of volatile organic compounds (VOC's) which come from building and cleaning materials, and even our own clothes (Darlington A. et al., 2000). VOC's are therefore a health risk to all those exposed.

In the context of Dalhousie University, the Life Sciences Center (LSC) has both IAQ and aesthetic issues that need to be addressed. With air quality at times being described by Dr. Louch as "nightmarish" (personal communication, Winter 2006) and with over 80% of students and staff rating the LSC's indoor aesthetics as poor, these issues regarding the LSC need to be addressed.

A previous ENVS 3502 problem solving group attempted to address these concerns, however, they failed to offer any direct problem solving recommendations. Therefore, we undertook a study to discover whether the unexplored option of a greenwall biofiltration would be a feasible option to address the concerns in the Dalhousie LSC.

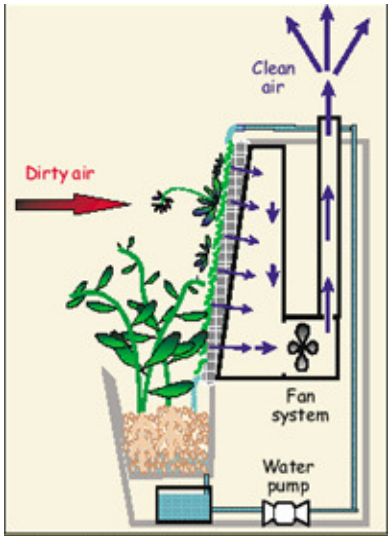
A greenwall is a plant-based biofiltration device in the form of a vertical surface containing a large variety of plants growing out the front of the wall and imbedded in a porous medium kept continually wet by re-circulated water. The wall draws air through the plants, and the microbes living in the root system of the plants, capture and breakdown harmful compounds thus using biological processes to remove airborne pollutants and thus producing cleaner air.

(i) Air is drawn through the wet wall material

(ii) Contaminants in the air are transferred to the water in the wall

(iii) Microorganisms that live among the roots of plants breakdown the contaminants

(iv) Air is recirculated devoid of most or all the airborne contaminants.



Guelph University, 2001

Dalhousie University, as a world class educational institution, has the ability to be a leader and example for the world community. Dalhousie University values environmental sustainability and has signed the Talloires (1990) and Halifax (1991) Declaration (Johnston, 1990) indicating a commitment to sustainable initiatives. Greenwall bio-filtration is a perfect example of a leading edge environmental concept that would not only showcase Dalhousie University as a leader in Environmental sustainability, and also offer a solution to help resolve the aforementioned concerns regarding in the LSC.

1.2 Problem Statement

Previous studies on greening the LSC have revealed that the two main concerns that the student wished to address were improving indoor air quality issues with 24.6% student support, and incorporating living aspects with 13.8% support (Dalhousie University, 2005). Furthermore 80% of students and staff consider the LSC to be an uninviting and poor place to socialize, with over 65% of those considering it an extremely uninviting location.

Every year the LSC has at least 13 air quality concerns that are reported to the Dalhousie University Department of Health and Safety according to William Louch (personal communication, 27 March 2006). The current solution to air quality issues is the “dilution solution to pollution”, in which more outside air is pumped into the building in an effort to dilute and displace the poor quality air. This outside air used is often too cold or too hot be pumped directly into the building, and therefore must be heated or cooled, before it can be used. This conditioning is an extremely energy-intensive process and therefore compromises the energy saving attempts from increased insulation and sealing of the building.

Furthermore, as stated by Louch, Dalhousie University's policy for maintaining the current air ventilation systems is reactive, in that a problem is identified by "waiting for air quality complaints to arrive" (personal communication, 27 March 2006) before attending to the issue at hand.

Student dissatisfaction affects all aspects of Dalhousie University, ranging from the possibility of decreased enrolment to decreased student achievement. Therefore, it is time that Dalhousie University addresses these issues as they can no longer be ignored. A new solution to these problems must be brought forward.

Dalhousie University has made a commitment towards greening the campus and encouraging environmentally sustainable initiatives. We propose that the construction of a greenwall biofiltration system would go beyond being merely an initiative, as it would address current concerns on campus. Therefore we wish to research the question, is the construction of a Greenwall in the Dalhousie University Life Sciences Centre a feasible project to address indoor aesthetic and air quality concerns in the LSC?

1.3 Objectives

The objectives are to assess the feasibility in four fields; Technological, Environmental, Social, and Economic Feasibility.

1.3.1 Technological

Technological feasibility will assess whether currently available technologies can meet the requirements set out for a greenwall and requirements which Dalhousie University holds. We will also assess whether the current greenwall technologies have any issues of concern (e.g. safety.) Finally, we assess whether the technology can easily be retrofitted into the LSC.

1.3.2 Environmental

The greenwall must meet current performance targets for the Life Science Centre along with reducing the environmental impact of the current Heating, Ventilation and Air Conditioning (HVAC) system. The proposed greenwall must provide an environmental benefit to the building. As such, the construction of a greenwall or use of one must be done in a sustainable way which has little or no negative impact on the environment.

1.3.3 Social

In order for the greenwall to meet our criteria it must not contribute to ill health affects with regards to the occupants of the LSC. Therefore, added bacteria or fungal growth must be strictly limited and controlled. There must not be any toxic pollutants added by the instillation and operation of a greenwall. All materials and practices must meet the applicable safety codes.

Occupant comfort must be improved by the addition of the greenwall along with providing aesthetic benefits. Therefore it cannot have a negative impact on humidity, significant change in odour, or the addition of a significant amount of pests.

It must also provide a platform for research and education in alternative practices which positively affect the environment. The greenwall must further Dalhousie University's mission in providing educational resources on sustainability and providing sustainable and environmentally friendly methods.

1.3.4 Economical

The greenwall must demonstrate competitive costs for the economic benefits it will provide in the long-term. It must also have a reasonable payoff time for the University. The greenwall must also reduce energy consumption for the LSC which will provide added economic savings.

Economic feasibility is difficult to measure due to the inability to accurately measure the true costs associated with many of the systems due to the current economic dogma which does not favour a natural capitalistic view towards economics.

1.4 Definition of Terms

BIOFILTER: Air pollution control technology that uses biological processes to breakdown down airborne pollutants and thus clean (or filter) the air. Living organisms such as plants, bacteria, and microorganisms are used to facilitate the desired biological processes.

CLER: Canada Learning Environmental Room

CONTAMINANT: any aerosolized substance, which reduces indoor air quality, usually an unwanted airborne constituent.

EXPLANATORY RESEARCH: research that "aims to investigate causal relationships or other patterned conduct that is thought to characterize social processes." (Palys, 2003, p.72)

EXPLORATORY RESEARCH: research that "aims to gain familiarity with or to achieve new insights into a phenomenon." (Palys, 2003, p.72)

HVAC: Heating, Ventilation, and Air Conditioning.

GREEN WALL: biofiltration system in the form of a vegetated vertical surface. Also see Biofilter. Also known as living wall, breathing wall, biofilter, etc.

IAQ: Indoor Air Quality. IAQ is a term used to describe the gaseous composition, relative humidity, temperature, and airborne contamination levels.

LSC: Life Sciences Centre at Dalhousie University

POLLUTANT: See Contaminant.

SICK BUILDING SYNDROME: a phenomenon whereby occupants of a building experience acute comfort or health effects due to exposure to poor indoor air quality.

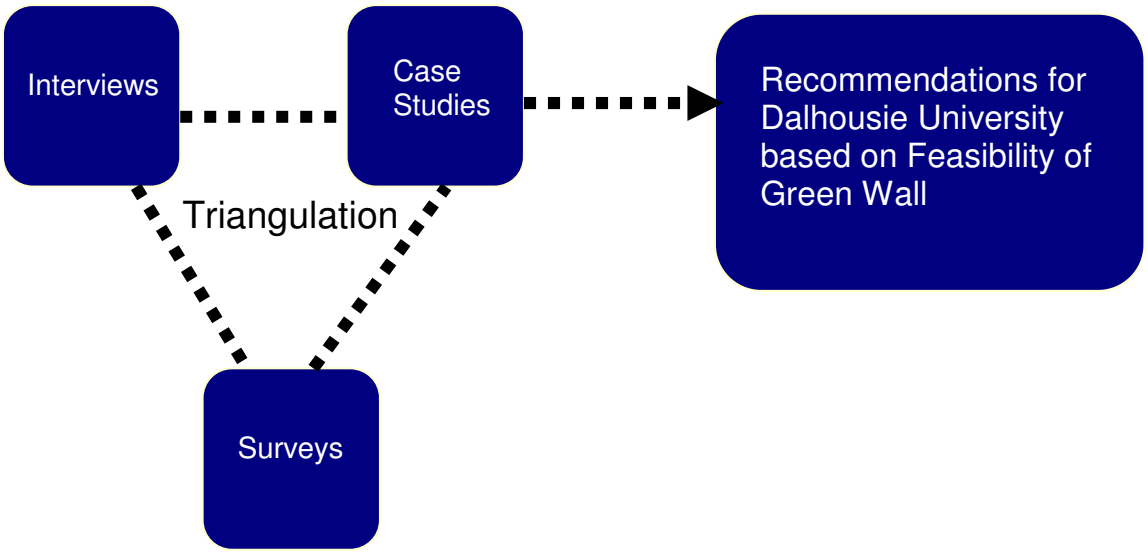
SUSTAINABILITY: "A sustainable society is one that can persist over generations, one that is far-seeing enough, flexible enough, and wise enough not to undermine either its physical or its social systems of support." (Meadows, Meadows, & Randers, 1992, p.209).

VOC: Volatile Organic Compound. This group of chemicals are found in various plastics, clothing, and household items and are known to off-gas toxic gases over time.

2. Methods

2.1 Design of the Study

To maximize the reliability and validity of our study we chose the triangulation method of research and information gathering. Our triangulation strategy followed a "model [which employs] two [or more] different methods in an attempt to confirm, cross-validate, or corroborate findings within a single study." (Creswell, 2003) Therefore, we use it as a means "to offset the weaknesses inherent within one method with the strengths of another method." (Creswell, 2003) This materialized in our study by incorporating three different information gathering strategies; interviews, surveys, and case studies.



This method of separate collection data allows us to "integrate the results … during the interpretation phase," (Creswell, 2003) and compare and contrast data that may not be consistent with other data gathered. This method also allows us to use the funneling technique, in which we begin with a broad scope of research, and subsequently narrow our focus allowing us to pin-point the exact information sought after.

2.2 Interviews

For the interviews we chose 'Purposive Sampling' and Snowball sampling (Palys, 2000) methods for the interviews we conducted. We chose these non-probabilistic sampling methods because we were looking for specific information that only a selective group of those familiar with the area of proposal could speak to. The interviews were designed to gain specific data regarding mainly qualitative information allowing us to further funnel our research. Interviews were done in person as "direct contact can

greatly enhance the quality of data, as any questions the respondent may have can be clarified on the spot, as well as the researcher may encourage a respondent to elaborate on a short answer" (Palys, 2003). The face-to-face interview was conducted following the funnel technique, beginning with open-ended questioning, and then further focusing the field of questions, to gain further insight to specific information sought after. This method of open ended question is particularly indispensable and constructive in exploratory research when interviewers are not "clear about… [the] range of responses [that] might be anticipated" (Palys, 2003: 176). This method of questioning did however contain drawbacks as it allowed the interviewee to depart from the intended field of questioning.

2.3 The interviewees

Dr. Louch was identified in our preliminary research as the Director of Dalhousie's University's Environmental Health and Safety Office. Dr. Louch was selected to uncover current health and safety concerns found with in the LSC, as well as the role which facility management could play in installation and maintenance of a greenwall. The interview consisted of a handful of open-ended questions in an attempt to better visualize the problem areas in the LSC from a health and safety standpoint and see if there is any interest in the project from the H&S Office along with gauging Dr. Louch's opinion on the prospect of a greenwall in the LSC.

Carman Mills was also identified in the preliminary research as being the Biology Greenhouse Manager. He was targeted as an interview candidate due to his extensive knowledge of plants which are a key component of greenwalls. He was probed with open ended questions to determine; what plants may work the best for a Greenwall in the LSC, what problems he thinks may come about if a greenwall is installed, the possibility of the Green House helping with growth of the plants, along with any possible research opportunities a greenwall could present.

The interviews were completed by Kyle Sharpe, who recorded information gathered by taking notes. The introductory questions were wide-ranging and broad. Once a general understanding was achieved the questions were narrowed to gain specific information. Secondary interview data was gathered from William Louch by Kristina Luus who conducted an interview to gain information for Campus Sustainability Assessment Framework (CSAF) indicators, and then relayed the relevant data to us.

2.4 Survey

The use of a survey was chosen to gain a basic understanding of the views of students and staff in response to selected closed questions. This method of a structured questionnaire was chosen for several reasons; the ease of data gathering and comparison, the allowance for a broad range of questions, a potentially higher participation rate. Considering the nature of information we were seeking, this method of surveying was appropriate.

The survey had two overarching purposes; to determine whether there is perceived problem with IAQ and aesthetics in the LSC, and if stakeholders believe that a greenwall would be a good addition for LSC to address these perceived problems. The stakeholders input is valuable for our study to gauge whether or not there is in fact a problem within the LSC building, whether they believe a greenwall would contribute positively to the social and environmental atmosphere of the LSC, and ultimately whether there was stakeholder support for the installation.

2.5 Pilot Survey

We developed a pilot survey based on the questions we wished to have addressed. Next we pilot tested this version on our fellow classmates in ENVS3502 (Environmental Problem Solving) to attest to the validity and to mitigate possible concerns relating to clarity, ease and the available options provided within our survey questions. We administered this test during the Environmental Problem Solving Class on Thursday, February 16th with our fellow classmates. We chose this setting because it allowed a fairly large sample size (n=20), it provided a simple and effective in-class setting for the test, with a class that has more nuanced experience with survey validity, giving us very relevant feedback. However there are potential reliability issues with using the ENVS 3502 students, as their values are likely skewed to be in support of green alternatives to indoor air quality solutions.

The survey developed was short, concise and limited to 10 questions for simplicity. At the top of the survey was a short objective explanation of greenwalls, this was done to provide basic understanding of the term greenwall used within the survey for those who may have been unfamiliar with the term. The survey used closed-ended questions to keep it brief, encourage a high response rate (Palys, 2003) and minimize confusion.

After piloting our survey, we refined questions to what we hoped would be a final product. We then had it reviewed by the Stats help center, were we again refined questions to remove biases and leading questions. Finally we completed a finished expanded survey to a final product of 12 questions.

2.6 Survey data

The sampling was random based in the LSC taken over the course of three weeks at various times in an attempt to create the most random and representative sample. Surveys were administered by Roger Fage, Sophia Horwitz, Ninna Luus, and Amber Mitchell.

We administered surveys on an individual basis; the participants were introduced to the topic and subsequently were offered answers to any possible questions for clarification, a weakness to this method is that it could be perceived as lowering anonymity. In order to minimize surveyor influence, the surveyor stood away from the participant. Data was collected and analyzed with the statistical program SPSS data Editor.

See Appendix A for survey.

2.7 Case Studies

As the third step in our triangulation method, we conducted an in-depth analysis of two case studies, using the inductive method of examining these case studies. "Case study is an ideal methodology when a holistic, in-depth investigation is needed." (Feagub, Orum, & Sjoberg, 1991) This method was useful in figuring out the overall concerns, costs and benefits associated with greenwall implementation as well as uncovering other factors involved to help lead us to our grand theory (Palys, 1997, p47). We focused on how a greenwall was implemented to mitigate indoor air quality concerns, as well as the psychological and aesthetic benefits plants provide for people.

2.7.1 Canadian Life Environmental Room Case Study

For our primary case study we considered the Canada Life Environmental Room (CLER) where a greenwall was implemented and monitored by Dr. Darlington, colleagues, associates and students at the University of Guelph, Ontario. This case study was chosen since it had the most extensive scholarly sources, documentation and this greenwall bio-filtration system was the first one implemented. The greenwall at the

University of Guelph has been implemented long enough that significant monitoring, evaluation and research has been conducted.

2.7.2 University of Waterloo Case Study

We chose to look at University of Waterloo's feasibility study for a living wall in their Student Life Centre. This case study provided us with the unique opportunity to discuss and analyze the processes and methods that another university has undertaken. This helped delineate the roles of staff, student and faculty as well as other possible constraints they faced and key information which they retrieved from then key interviews with the leaders in greenwall biofilter innovation who did not manage to communicate with.

2.8 Reliability and Validity

We considered both reliability and validity in our study. According to Palys "reliability can be seen as synonymous with consistency"(Palys, 1993, p.411) which essentially means that results would be very similar or the same if another researcher studied the same thing. One way we have attempted to guarantee reliability is by detailing our process and explicitly outlining the interviewers, the questions and techniques used, and the reasons for choosing the interviewees; the surveyors, the actual surveys administered and the corresponding dates; and analyzing both the case studies in a consistent manner. Our method of triangulation helps show that we are "build[ing] a coherent justification for themes" (Creswell, 2003, p.196) which provides validity. Validity is also ensured as our research responds to our proposed problem (Palys, 1993, p.73). As earlier discussed our problem is that there are perceived IAQ and aesthetic concerns regarding the LSC. Our research attempts to outline the student's perception, opinions and support as well as; faculty and facilities management's conception of the problem and our proposed solution. Our research also included the case studies which have previously attempted to mitigate similar concerns using the greenwall as a solution. The inclusion of our biases (see below) also helps with validity. The two case studies we used provide ecological validity as they incorporate existing projects. Though we made attempts to ensure that we overcame some threats to validity, external threats to validity might have occurred. For example; when we assume that our sample of survey participants represents students of Dalhousie University (Creswell, 2003, p.170). Threats to internal validity could have existed if the survey participants felt compelled to

appeal to our proposed project. Additionally, the people who agreed to take our survey might have been more willing if they were already concerned with the LSC and/or with environmental issues.

2.9 Biases, Limitations and Delimitations of the Study

2.9.1 Biases

As environmentally concerned students, we acknowledge that we bring certain biases to our report stemming from; 1) our environmental values and the weight we give the pillars of sustainability, 2) our belief that plant life in our surroundings has positive direct and indirect effects, and has intrinsic value in itself, 3) our assumption of how the LSC is perceived based on our own negative views of the LSC, in so far as IAQ and aesthetics are concerned. This bias is reflected in the very nature of our decision to undertake this feasibility study.

2.9.2 Limitations

In our work we faced many limitations, including restrictions on the project that were outside of our control as researchers (Palys, 2003). These restrictions impeded our study in several factors, some more detrimental then others, they included;

Time: The limited timeframe in which we had to operate created many difficulties which permeated the entire study. These ranged from limiting the amount of stakeholders surveyed affecting quality and size of sample population, number of interviewees, and number of case studies reviewed.

Lack of Expertise and Knowledge: We chose a field of study in which our group members had minimal familiarity with greenwalls and IAQ. This also affected our group members in the very nature of the study, in which none of our group members had created a feasibility study of this nature. This lack of Knowledge and Expertise regarding greenwalls was also a limiting factor in the response received from stakeholders as well, as 80% had no prior knowledge of greenwall technology. This issue may have also permeated our interviewees response as the information and concerns gathered from the interview process was shown to not reflect information from case studies, and may reflect deficient knowledge.

Loss of group member: Unfortunately, due to personal reason one of our group members was forced to drop the class mid-way through the project. This offered many

challenges including; a smaller than expected group to work with, logistical challenges of re-organizing work, and lost information which the group member had.

Limited group size: We had a smaller group which restricted the scale of work we could take on. However it did allow some benefits such as ease of coordination, and we also received some supplemental aid with information from facilities management and some survey administration.

Lack of response from interviewees: We attempted to contact several interview candidates to no avail; this limited the ability of researchers to gain important information due to inability to consult the relevant experts.

2.9.3 Delimitations

To aid in our study we selected several delimitations, which are restrictions on research design purposefully chosen by researchers. (Palys, 2003) These delimitations were chosen for the sake of simplicity. They included;

Spatial: We chose to restrict our feasibility study to the LSC as this reflected the area of most concern and need of improvement.

Greenwall bio-filtration: We chose to analyse only the bio-filtration option of greenwall technology.

3. Results

3.1 Questionnaire for Stake Holders in the LSC

The sampling size was 46 students and staff surveyed. We had hoped to achieve a higher sampling size but due to limitations on time and limited number of surveyors we were forced to reduce our sampling size. Much of the timeframe for surveying varied greatly, as the surveyors randomly sampled before or after their classes in the LSC.

Question #1

What year of study are you currently in?

a. First
b. Second
c. Third
d. Fourth
e. Fifth and beyond

We chose to ask this question because we thought it would help us determine what who frequented the LSC, as well as gain perspective on who perceived aesthetic and IAQ issues at the LSC.

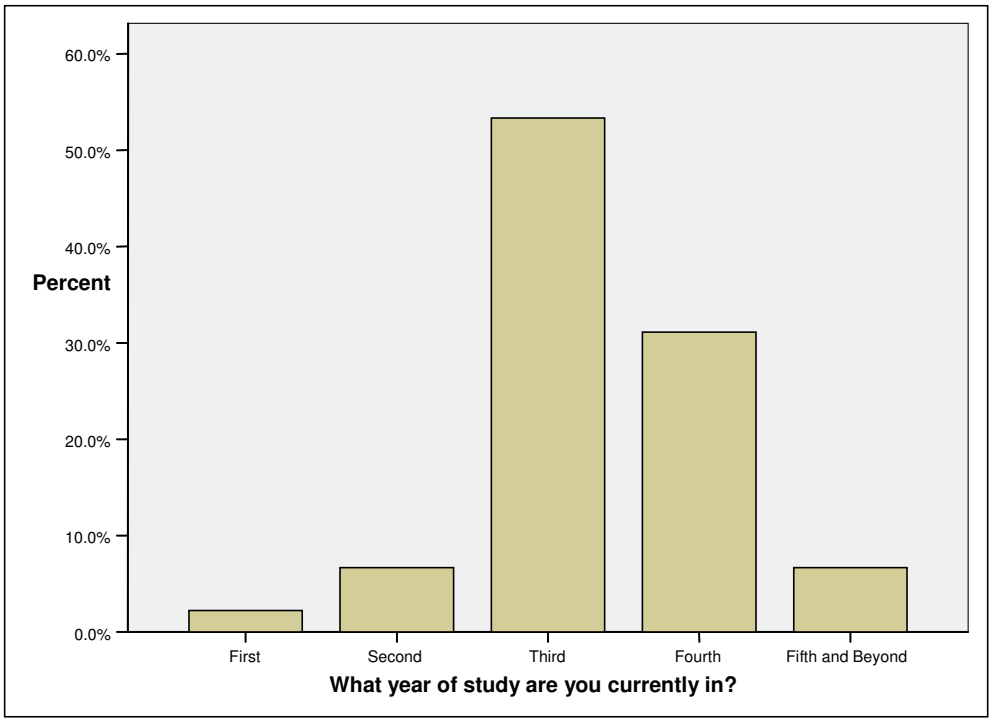


Table 1. Survey results for Year of study

We see a skew towards third and fourth year students surveyed. This possibly reflects that third and fourth year students are more likely to spend much of their time on campus. Further, it could also reflect timeframe of surveys administered, for

example, when the surveyors as senior students are more likely to share class time and rough schedules approximate with other senior students.

Question #2.

How would you rate your knowledge of environmental problems and issues?

a. Excellent
b. Good
c. Fair
d. Poor

We asked this question to so that we could gain knowledge as to the general environmental literacy of respondents. This could help validate survey results by showing prior knowledge surrounding environmental issues and concepts that are congruent with greenwall technology. We also cross tabulated this information with Question #8, concerning the LSC's IAQ, as this would help determine if those more familiar with environmental issues would have more or less concern with the IAQ of the LSC, perhaps helping to validate the perceived concerns over air quality.

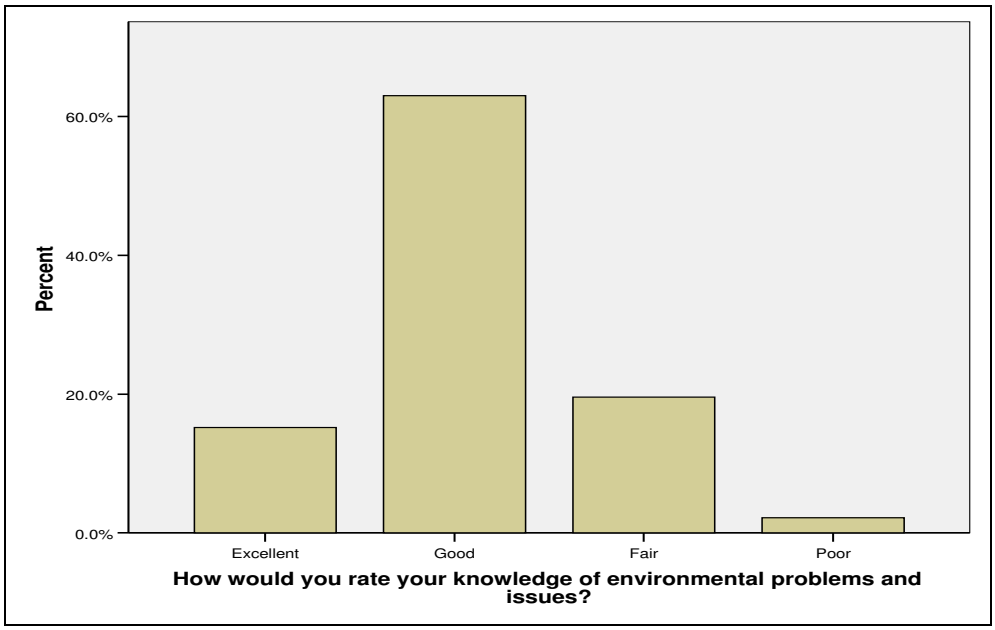


Table 2. Survey results of knowledge of environmental issues

Question #3.

Do you have prior knowledge of Greenwalls?

a. Yes
b. No

We asked this question to gain information regarding how familiar people generally were with the concept of a greenwall. This helps us determine how relevant peoples concerns with greenwalls may in fact be, and helps to validate information gathered in surveys, and therefore we cross tabulated this information with this question with Question #9, about concerns with greenwall construction. We wanted to see if those more familiar with greenwalls had more concerns with implementation.

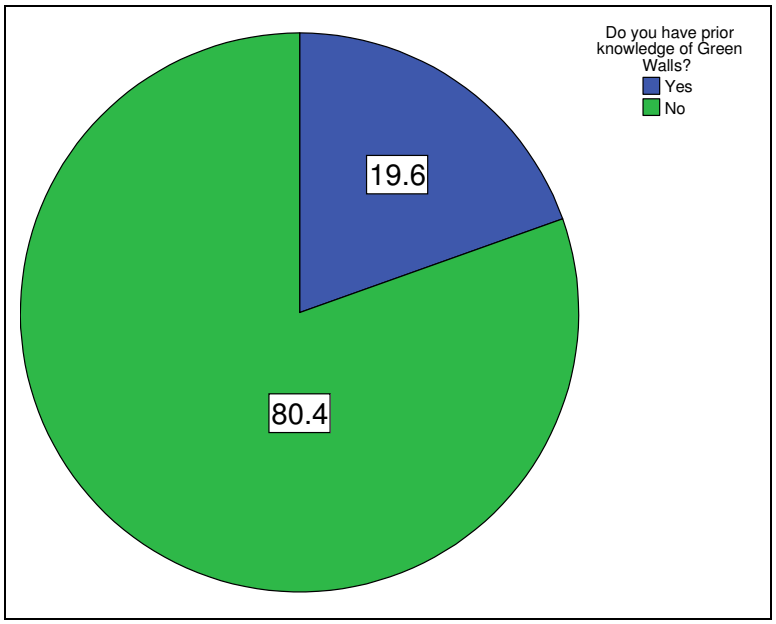


Table 3. Survey results for prior knowledge of greenwalls

Question # 4

How often do you frequent the Life Science Centre?

a. More than once a day
b. Once a day
c. More than once a week
d. Once a week
e. Less than once a week

This question was included because it helped us gauge how often people frequented the LSC, and determine whether students would get use of the greenwall.

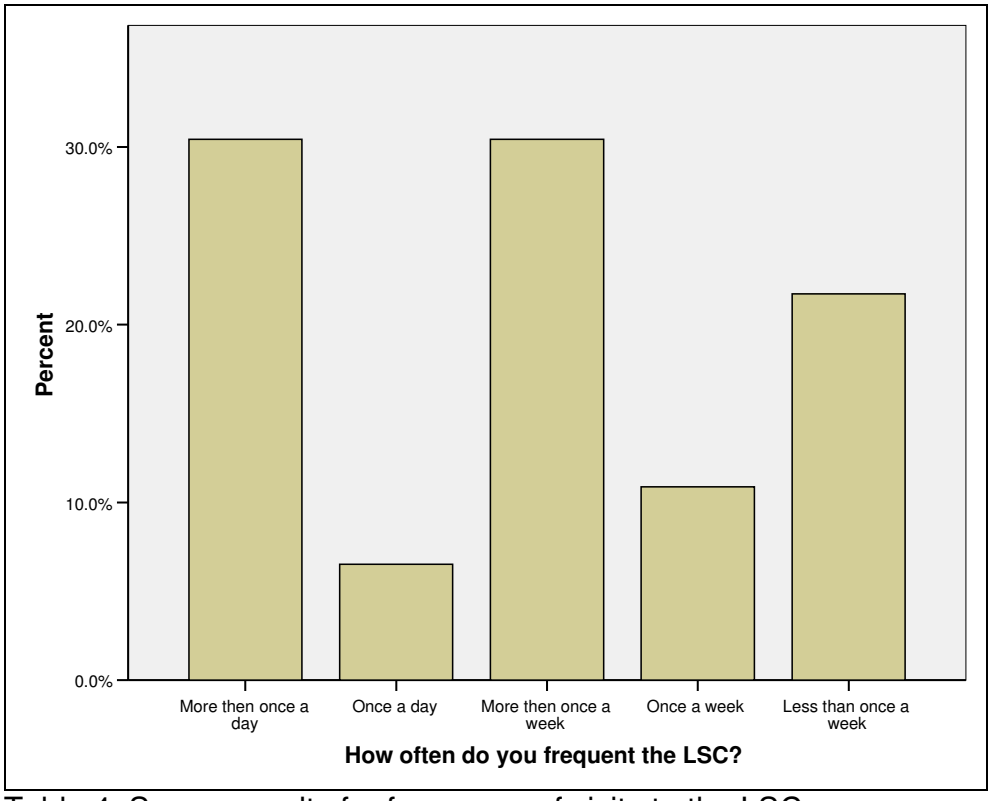


Table 4. Survey results for frequency of visits to the LSC

Question #5

How would you rate the indoor aesthetics of the LSC?

a. Excellent
b. Good
c. Fair
d. Poor

This question was designed to help determine whether or not there were perceived problems with the indoor aesthetics of the LSC, and help to determine whether or not action towards improvement was needed.

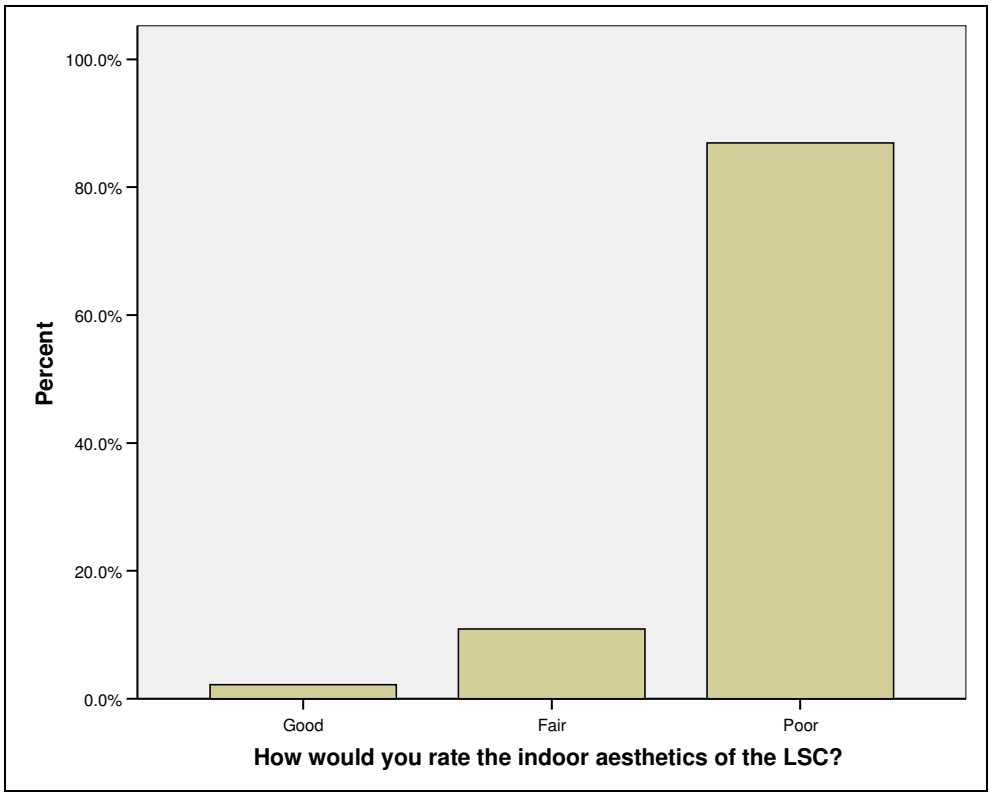


Table 5. Survey results for perceived indoor aesthetics of the LSC

Question #6

Do you think a greenwall would enhance the aesthetics?

a. Yes
b. No

This question was asked to help determine whether or not stakeholders would perceive the implementation of a greenwall as an improvement in aesthetics. Thus, we could determine whether or not a greenwall would improve an indoor aesthetic problem if present.

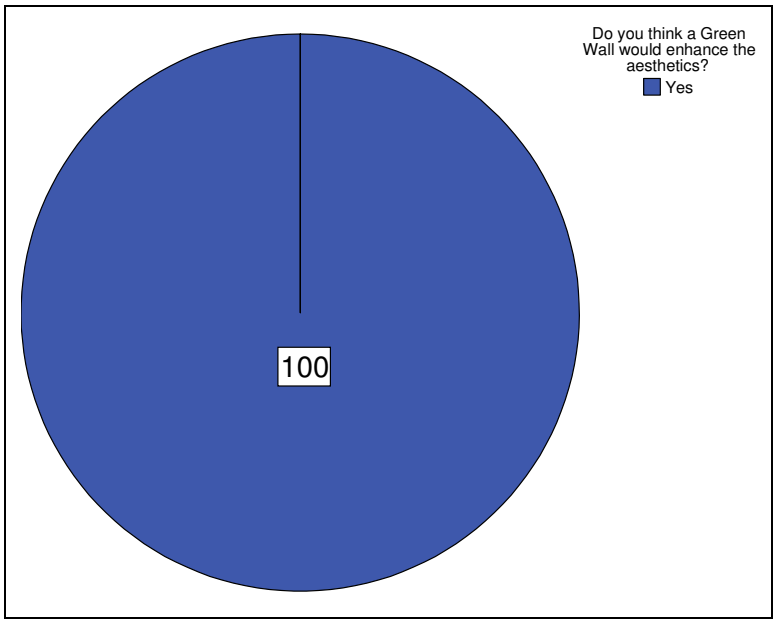


Table 6. Survey results for greenwall improving aesthetics

Question #7

Is the inside of the LSC inviting and a good place to socialize? i.e., would you consider the LSC when choosing a place to have group meetings?

a. Extremely Inviting
b. Inviting
c. Neither Inviting nor Uninviting
d. Uninviting
e. Extremely Uninviting

This question was designed to determine how stakeholders generally perceived the sociability of the LSC. This test directly relates to how the LSC is perceived and how it affects its use, we cross tabulated this information with Question #8, about perceived IAQ with in the LSC.

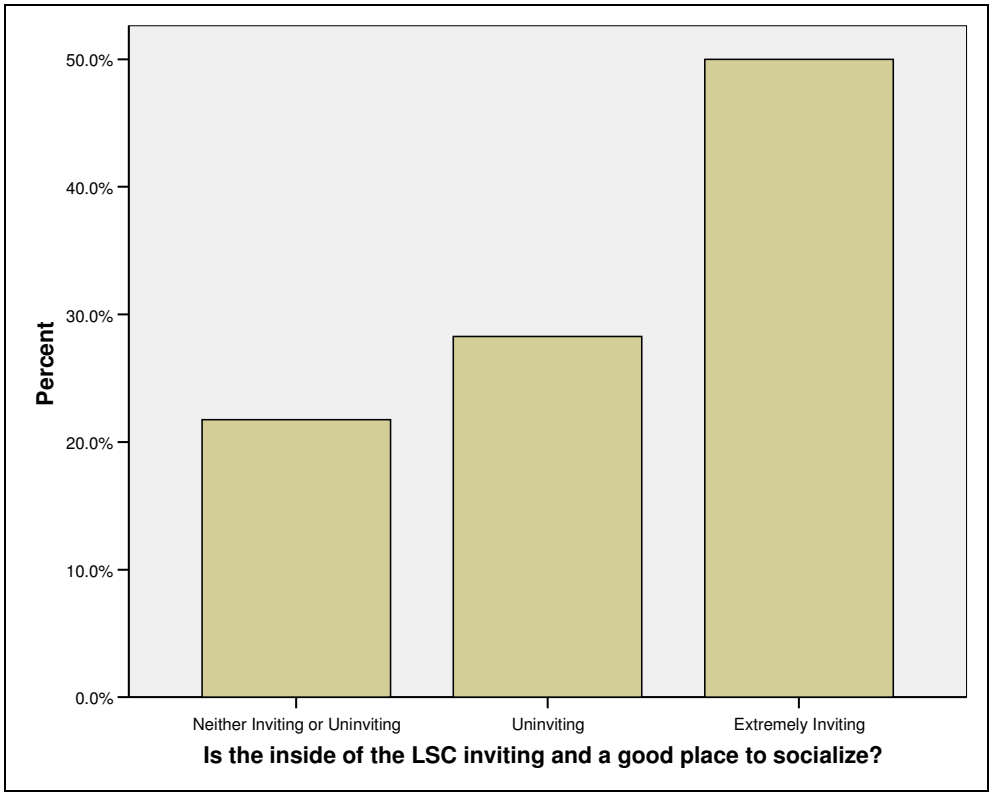


Table 7. Survey results for LSC sociability

Question #8

How would you rate the air quality at the LSC?

a. Excellent
b. Good
c. Fair
d. Poor

This question was designed to help determine whether or not there were perceived problems with the IAQ of the LSC, and help to determine whether or not action towards improvement was needed. This information was also cross tabulated with Question #7 which asked how inviting stakeholders found the LSC.

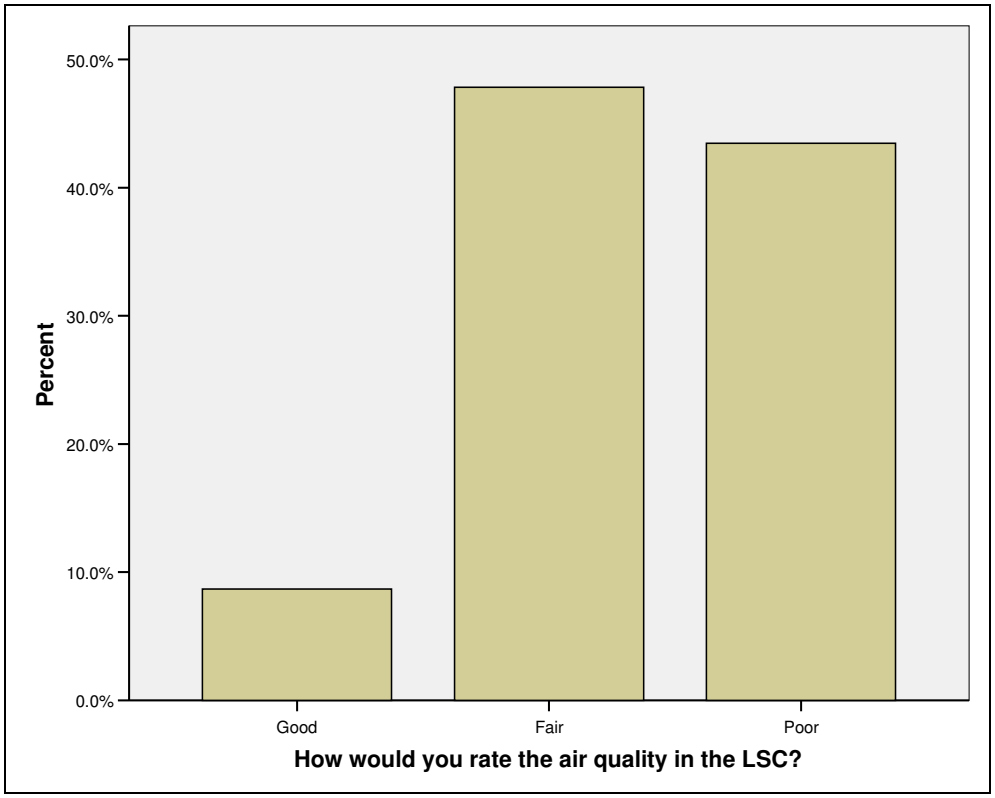


Table 8. Survey results for IAQ of the LSC

Question #9

Do you have any concerns with the installation of a greenwall in the LSC?

a. No concerns
b. Insects
c. Associated Costs
d. Allergies
e. Humidity
f. Maintenance
g. Smell
h. Use of space

This question was asked to help determine stakeholder concerns with greenwall installation within the LSC. This information was cross tabulated with Question #3 regarding prior knowledge of greenwalls. As well this information was cross tabulated with Question #10, regarding stakeholder support for greenwall installation, this helped determine whether those with concerns were still in support of the greenwall, or if these concerns were enough to eliminate support.

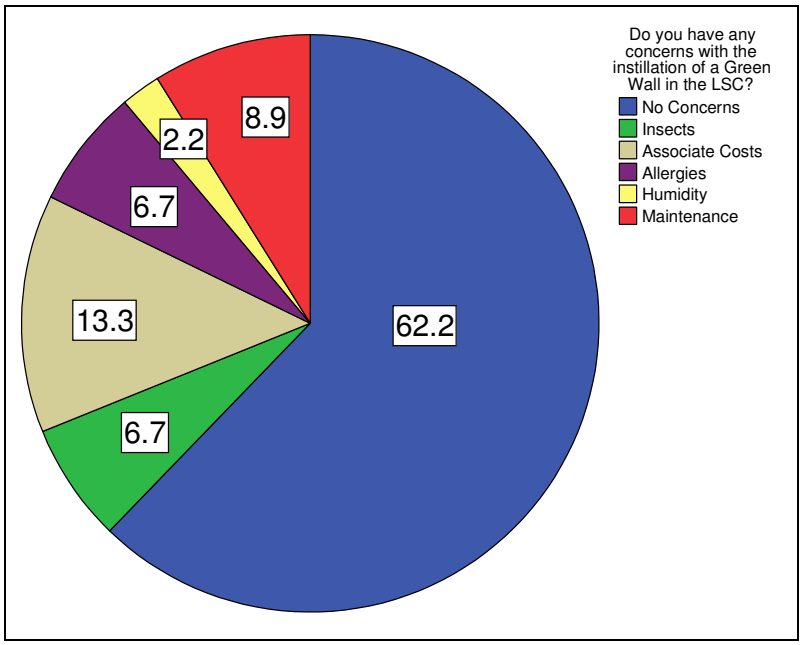


Table 9. Survey results for concerns of greenwall instillation

Question #10

How would you categorize your support for the installation of a greenwall in the LSC?

a. Strongly in favour
b. In favour
c. Neutral
d. Somewhat opposed
e. Strongly opposed

This is the most important question as it determined stakeholder support for greenwall installation. This question answered some over-arching concerns of feasibility such as stakeholder support. This information from this question was cross tabulated with Question #9, asking concerns of greenwall installation.

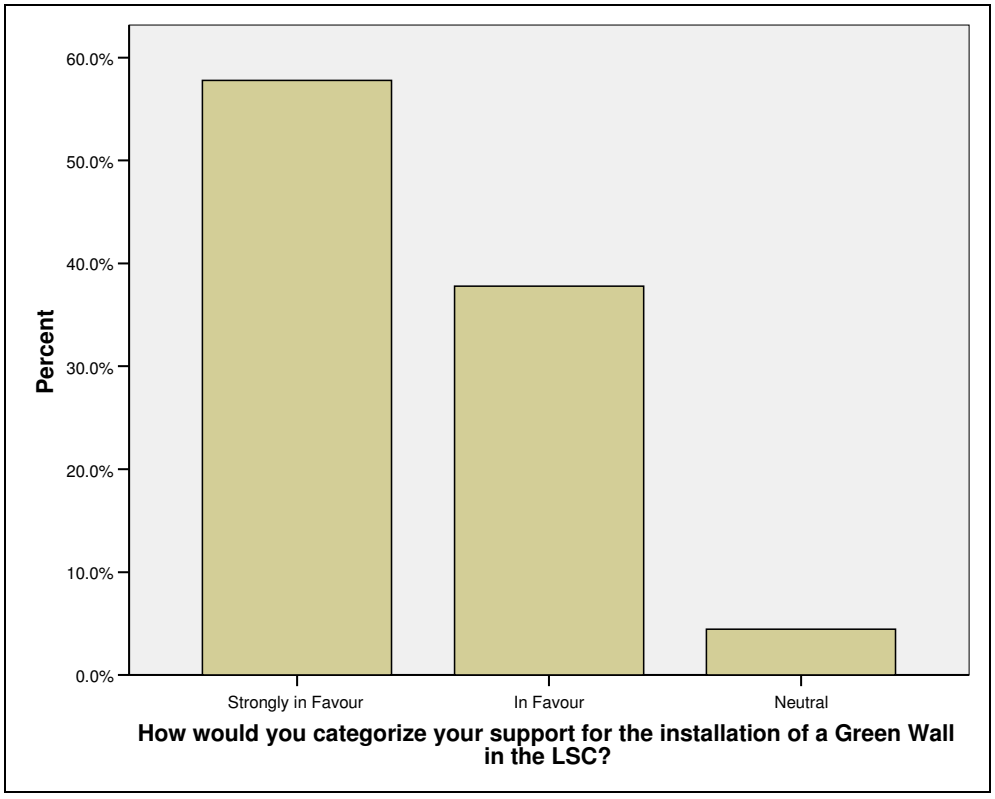


Table 10. Survey results for greenwall support

Question #11

What benefits do you perceive will come about if a greenwall is installed?

a. No foreseeable benefits
b. Environmental
c. Improved Air Quality in the LSC
d. Research possibilities
e. Improved aesthetics

This question was designed to determine what benefits stakeholders perceived to occur from the installation of a greenwall.

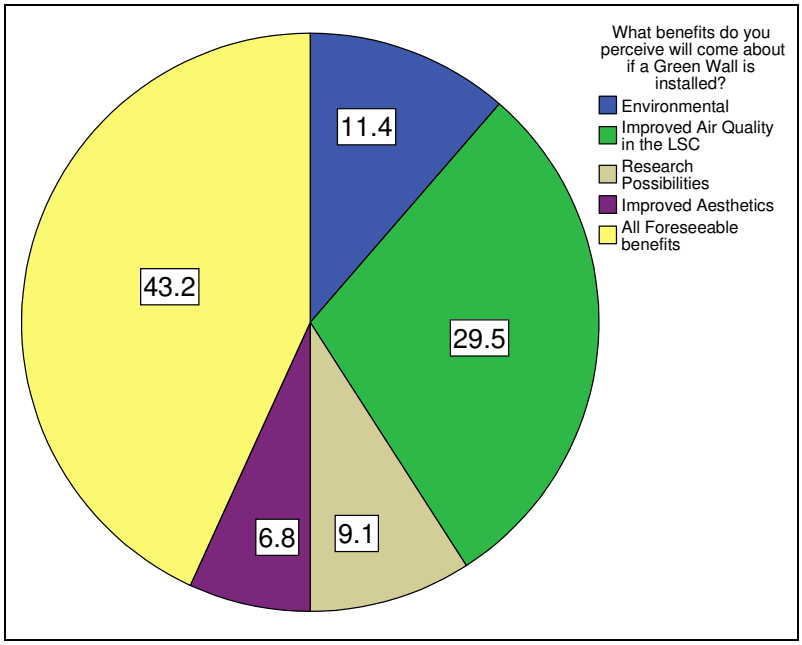


Table 11. Survey results for perceived benefits of greenwall

Data Cross Tabulation

How would you rate your knowledge of environmental problems and issues? * How would you rate the air quality in the LSC?

Count

		How would you rate the air quality in the LSC?			
		Good	Fair	Poor	Total
How would you rate your knowledge of environmental problems and issues?	Excellent	0	3	4	7
	Good	2	15	12	29
	Fair	1	4	4	9
	Poor	1	0	0	1
Total		4	22	20	46

Table 12. Crosstab for environmental knowledge and IAQ rating

We found a small positive correlation between higher environmental knowledge and decreased perception of the LSC's IAQ. This may reflect environmentally literate

students having more familiarity with environmental issues such as “sick building syndrome” or other environmental health issues.

Do you have any concerns with the installation of a greenwall in the LSC? * How would you categorize your support for the installation of a greenwall in the LSC?

Count

		How would you categorize your support for the installation of a Greenwall in the LSC?			
		Strongly in Favour	In Favour	Neutral	Total
Do you have any concerns with the instillation of a Greenwall in the LSC?	No Concerns	21	6	1	28
	Insects	0	2	1	3
	Associate Costs	1	5	0	6
	Allergies	1	2	0	3
	Humidity	0	1	0	1
	Maintenance	3	1	0	4
Total		26	17	2	45

Table 13. Crosstab for greenwall support and instillation concerns

We fount that the less concerns you have with greenwall instillation the more likely you are to be in support of greenwall implementation. This is as may be expected.

Do you have any concerns with the instillation of a Greenwall in the LSC? * Do you have prior knowledge of Greenwalls?

Count

		Do you have prior knowledge of Greenwalls?		
		Yes	No	Total
Do you have any concerns with the instillation of a Greenwall in the LSC?	No Concerns	7	21	28
	Insects	0	3	3
	Associate Costs	0	6	6
	Allergies	1	2	3
	Humidity	0	1	1
	Maintenance	1	3	4
Total		9	36	45

Table 14. Crosstab for prior knowledge and instillation concerns

We found that if you have prior knowledge of greenwalls you are more likely to have no concerns with greenwall installation; this is interesting if you consider the prior cross tabulation, and we find that those with prior knowledge are more likely to be in support. Therefore, the more knowledge concerning greenwall present, the less concerns and greater support for greenwall instillation if found.

Is the inside of the LSC inviting and a good place to socialize? * How would you rate the air quality in the LSC?

Count

		How would you rate the air quality in the LSC?			
		Good	Fair	Poor	Total
Is the inside of the LSC inviting and a good place to socialize?	Neither Inviting or Uninviting	1	7	2	10
	Uninviting	2	6	5	13
	Extremely Inviting	1	9	13	23
Total		4	22	20	46

Table 15. Crosstab for IAQ rating and LSC sociability

In this cross tabulation we find a relatively large negative correlation between IAQ and perception of how inviting the inside of the LSC is. Therefore, the more we perceive poor IAQ the less inviting a space we find an area to socialize.

3.2 Interviews with Carman Mills, Biology Greenhouse

Carman Mills was interviewed on 27 March 2006. His answers to a number of questions will be discussed. The questions used to guide the discussion are present in Appendix F.

The plant types of a proposed greenwall in the LSC are highly dependant on the location of the wall. In order for the plants to be successful they must flourish in the conditions presented by the location. There are a few factors dictating what types of plants can be used such as humidity and lighting. Therefore, without a proposed location of a greenwall, Mills found himself unable to recommend any specific type of plants.

Mills stated that the greenhouse would be willing to give cuttings of plants to students but would be unable to grow them for the project or donate a large portion of space in the greenhouse to grow the plants for a greenwall.

Grasses should not be used as there is a high proportion of individuals who are allergic to them, flowering plants also present the same threat; however, the conditions in the LSC would likely not produce flowers. The main concern would be contact allergies as airborne allergies are unlikely to materialize.

Maintenance for the plants would include, weekly watering, misting, insect control, fertilization, etc. The estimated time for watering is a minute per plant or less and would likely need to be done once to twice a week.

All the required research of plants that takes place is contained to the Greenhouse which provides adequate facilities; therefore, the addition of the greenwall would not provide any unmet need for plants to use in research. The Ecology and Nature Conservation classes may be able to use it for research.

The biggest difficulty to overcome in the installation of a greenwall would be the low humidity in the LSC along with the vandalism; such as coffee being deposited in the soil of plants.

3.3 Interview with William Louch, Environmental Health and Safety

Dr. William Louch was interviewed on the 27 March 2006 and was questioned about the feasibility of installing a greenwall in the LSC. The questions used to guide the discussion are present in Appendix F.

When asked about maintenance concerns, Louch's main worry was with water leaking from the system and the potential of mould caused by the water.

Louch said there are no spots with recurrent air quality concern in the LSC where a greenwall could be used to rectify the IAQ issue. The building has more than enough air supply to keep healthy air quality. It has 26 local air units which can change the volume of air delivered to any area, and generally if there are any concerns the air circulation system is looked at and the amount of air to the area is adjusted.

Maintenance concerns would mostly have to do with water and mould caused by the water. Along with humidity, anytime you have pipes and flowing water you must be careful of leaks and such. Another concern would be having to deal with conditioning the water and replacing it, as it cannot re-circulate forever.

Money that the University or Province has for funding a project such as this exsists in the "Alterations and Restorations" fund provided by the government of Nova Scotia. This money is generally around $2 million a year for Dalhousie with about $12 million a year of requests from various groups within Dalhousie for the money. Therefore it is unlikely that such a project would get any funding this way as there are more critical requests for the 2 million. Louch identified installing different indoor lighting or double-paned windows as a better alternative to dealing with indoor aesthetics or energy concerns.

Maintenance of the greenwall would have to be carried out by professional, trained staff as a concern would be that complex systems within it would not be properly maintained, and would lead to problems such as leaks. According to Louch, having students' or faculty doing any of the maintenance was out of the question as they are seen as unreliable.

3.4 Case Study

3.4.1 CLER green wall case study

The research in greenwalls and biofilters has been led by two Canadian researchers at Guelph University, Allan Darlington and Michael Dixon. Along with their research team from the University of Guelph, their Indoor Air Quality Solutions research and implementation company for biofilters found a niche to implement projects and solve the problems that they were already researching about indoor air quality, such as

issues associated with sealed buildings and the "Sick-building" phenomenon. This project resulted in the construction of a greenwall in the CLER room which we will look at in terms of its structure, function and effectiveness. This example will help us determine the benefits and steps to implementing a greenwall of this type, size and nature. The bulk of information for this wall and its research came from the website the available links to publications at www.ces.uoguelph.ca/research/envweb. As earlier described the greenwall will be examined under the categories; structure, function, participants and results.

Structure of CLER Greenwall :

The wall is situated in a "160 square metre 'air tight' room in a recently constructed office building in downtown Toronto." (Darlington "Biofiltration of Indoor Air: Implications for Air Quality (U. Guelph Controlled Environment, 2002).

The wall's biofilter contains 3 main parts:

i) vertical bioscrubber = 10 square m

ii) plantings = 30 square m

iii) aquarium= 3,500 litre

The cost of the wall has been documented as being

10m2 x $1500 = $15, 000

(Knowles et al., 2002)

Function of CLER Greenwall:

The monitoring and evaluation of this greenwall's effectiveness found that it was fairly successful at removing Volatile Organic Compounds (VOC). The VOC levels of formaldehyde were significantly lowered; toluene became nearly undetectable while trichloroethylene (TCE) was only found to be able to be partially removed. Aerial spore levels were slightly higher but the study found that it was still within the 'healthy' indoor space guidelines. This study found that large amounts of biomass cannot in itself lower IAQ. Nonetheless the CLER testing site which used no other form of air filtration was as effective if not more than the advanced air filtration system in other rooms of the building. (U. Guelph Controlled Environment, 2002) While humidity levels in the room were slightly above average there was no reported problem with mould spores (Ledger B. 1999). It can provide educational benefits through high school biology/environment classes/ tours/ university research/ studies and co-op work. Additionally it will boost innovation and enhance corporate public image (Darlington, et al., 2001).

Participants in CLER Greenwall:

Numerous parties were involved in CLER's installation of a greenwall biofilter. A range of participants contributed to its installation and upkeep such as the Controlled Environment Systems Research Facility (CESRF) at Guelph University; Canada Life Assurance Co. and its subsidiary Adason Properties, Genetron Systems, Northern Centre for Advanced Technology; the Space Agency(Ledger B. 1999) and The Centre for Research in Earth and Space Technology and the Ontario Ministry of Agriculture, Food and Rural Affairs(Fernandes and Rankine 1999). The CESRF group was studying the effects plants can have on tightly sealed spaces and their interest was in finding solutions to the problems they were witnessing with IAQ. Through further developments it is clear that this first capital venture by Dixon involved a leap out of the research and academia into creating efficient systems for the home and the workplace. Therefore it is important to note that the researchers and their documented articles prove that, their technology is functioning. The Canada Life Assurance Co. was most likely interested in pursuing this trial technology to enhance corporate image by being a leader in green technologies.

Results found for CLER Greenwall:

From a cost-benefit analysis completed by Darlington, it is worth the capital inputs even just considering the benefits from reduced absenteeism, increased productivity, and decreased utility bills over a 2-5 yr schedule.

(Knowles et al., 2002)

3.4.2 University of Waterloo Case Study

"Living Wall, A Feasibility Study for the SLC"
http://www.adm.uwaterloo.ca/infowast/watgreen/projects/library/f02livingwall.pdf
within the following case study section referred to as (Knowles et al., 2002)

A student group from the University of Waterloo's environmental programs class conducted a very comparable research feasibility study for the implementation of a green wall. They explored the possibility for a green wall in their Student Life Centre (SLC). They chose to frame their project as bringing an option to improve IAQ and aesthetics in the SLC, as well as expand knowledge base for academia; however, they did not demonstrate that these were prior issues at the university that needed addressing.

Like ours, Waterloo's student project included the triangulation method, using a literature review, a questionnaire and interviews, as well as using qualitative and quantitative research methods. They had two main objectives; to determine feasibility and recommend the technological elements such as size, and location, which were proven viable according to the study. The key actors involved in the study were the student group who created the study and represented the University of Waterloo Federation of Students (FEDS), as well as the University of Waterloo represented by the SLC Board members, whom the researchers were attempting to appeal to have the wall constructed.

The FEDS had put forward a proposal for a greenwall in the SLC building; subsequently the researchers were operating from a perspective that the construction of a greenwall had viability in that it was supported to some extent by those with political power. It seemed they created the study to further enforce the notion, and give particulars of how, and where the greenwall could be implemented.

Questionnaires were applied with a sampling size of n=90, and attempted to rate the current student perception of SLC, support of Green Wall, and location students supported for greenwall construction. They found students generally perceived the SLC as a having fair aesthetics, were in support of greenwall construction, and deemed the SLC location preferable to all others.

For their literature review they chose to consider the Canadian Life Environmental Room (CLER), Northern Centre for Advanced Technology (NORCAT), and Niagara Under Glass. All literature reviews supported their goal citing improved air quality with VOC removal, improved aesthetics and learning opportunities.

Furthermore, they conducted six interviews, including with Alan Darlington, one of the candidates we had hoped to interview. In sum, the interviewees gave encouraging feedback, and said "it would make a positive overall contribution" (Knowles et al., 2002, p.36).

Through the analysis and interpretation of the information gathered by the triangulation method, they brought together several recommendations and conclusions. They found that; the construction of a greenwall *would be feasible* in the SLC, that the green walls do provide benefits and are a more sustainable option than traditional ventilation methods, IAQ is improved, and the greenwall provides economic advantages derived from savings such as reduced utility costs, reduced absenteeism and greater

productivity. Furthermore, they found that the greenwall would improve aesthetics; the reputation of the University, (by demonstrating that they are leaders in environmental innovation) and lastly that it would provide an important learning tool. In conjunction with these benefits they also identified areas of concern. The leading concerns determined were maintenance and costs with more minor concerns including insects, humidity, smell, allergies, and vandalism. However, they found that most of these concerns could be mitigated and resolved by use of the triangulation method, as many were found to be negligible or not applicable.

They researchers ultimately concluded that benefits well outweighed "the limited and manageable concerns" (Knowles et al., 2002, p. 57), and that the green wall was indeed feasible in the SLC. Included were recommendations on several factors, such as scope, how to mitigate many of the concerns and the recommendation for further research.

4. Discussion

Through literature review of pervious projects undertaken for Environmental Science it was discovered that there is a perceived air quality problem at the very least, and aesthetic problem with the Dalhousie Life Science Centre. Our research wanted to further frame this problem and provide an analysis of the feasibility of installing a greenwall to mitigate any real and perceived problems in the LSC using an environmental friendly and sustainable solution.

4.1 Surveys

All information is gathered from our statistical analysis, for detailed results see table list in Appendix E.

In analyzing the surveys which were conducted in the LSC, we found a number of convincing trends. To begin, we found that there is very high student support for the installation of a greenwall within the LSC. This is represented by 57.8% surveyed being strongly in favour of greenwall implementation, 37.8% being in favour, and 4.4% being neutral to the idea. No survey participants showed any opposition to the idea of a greenwall in the LSC. This answers the over-arching question of whether stakeholder support is present, and indeed the stakeholders are in favour of greenwall implementation.

Furthermore, we gained important insight into other important factors, such as whether there were perceived problems with the LSC IAQ and aesthetics and whether this affects how the LSC is used. We determined that 87.0% of those surveyed perceived the indoor aesthetics of the LSC as poor, 10.9% as fair, and only 2.1% as good, clearly demonstrating discontent with the aesthetics of the LSC. Similar discontent was shown with perceived IAQ within the LSC, with, 43.5% of respondents rating IAQ of the LSC as poor, 47.8% as fair, and 8.7% as good. Perceived IAQ and aesthetics are evidently very poor within the LSC.

This discontent further affects stakeholders in how they view the sociability of the LSC. We theorize that with poor aesthetics and poor IAQ stakeholders were more likely to find the LSC as uninviting and a poor place to socialize. To demonstrate this, we began by directly addressing the question of whether the LSC is inviting and a good place to socialize. We found that 50.0% of participants rated the LSC as extremely uninviting, 28.3% as uninviting, 21.7% as neutral and we found that none of the participants

considered the LSC as inviting or extremely inviting. Next, we cross tabulated this with perceived aesthetics, and found a negative linear relationship in which 52.2% of participants rated aesthetics as poor, and the LSC as extremely uninviting, thus showing a correlation between these two factors. Similar results were found when cross tabulated with IAQ, showing a similar negative relationship, with 28.9% of participants rating the IAQ as poor, and the LSC as extremely uninviting.

Next we considered whether a greenwall would improve aesthetics, and 100% of participants stated that indeed a greenwall would improve aesthetics.

Survey participants were also asked if they had any concerns with the installation of a greenwall in the LSC. We found that 62.2% of participants had no concerns with the implementation of a greenwall, and the next leading concern was associated cost with just 13.3%. We cross tabulated this information with prior knowledge of greenwalls to see if those who were familiar with greenwalls were more likely to have informed concerns, and interestingly enough we found that of those with prior knowledge, a greater percentage had no concerns then those without previous knowledge of greenwalls.

The survey clearly reflects some very important information concerning stakeholder's perceptions and views with regards to greenwalls and the LSC. We found strong evidence to suggest that stakeholders are not satisfied with the IAQ and aesthetics within the LSC, and that this is negatively affecting their use of the LSC. Furthermore, we found that stakeholders had minimal concerns, and that those more informed about greenwalls were less likely to have concerns over implementation. Ultimately we found that there is strong stakeholder support for the implementation of a greenwall within the LSC.

4.2 Interviews

For the list of questions used to guide the discussion please see Appendix F.

In the interviews we tried to address a number of the feasibility criteria. To this end, we sought to identify the support that the interviewees have for a greenwall, funding or economics of the endeavour, concerns which they hold along with the actual process required to install and maintain a greenwall.

On the whole the participants did not appear to be highly in favour of the idea. Specifically, Louch believed that the money could be better spent on other initiatives

which would provide more environmental benefits and Mills did not see a need for it from an educational perspective. Furthermore, Louch was highly concerned with the maintenance of piping that would provide the water and other such infrastructure as he believed it would be costly to upkeep and could present problems such as mould if ill-maintained.

Mills stated that the biology greenhouse would not be equipped to provide plants for the project as it is already close to capacity. He did express his willingness to let a group come in and take cuttings of plants in order to grow the plants for the project; this would still present a problem of where to grow said plants for the project. There was also a mention that perhaps Ecology and Nature Conservation classes may be able to use the greenwall for studies and research projects.

When questioned about what plants should be avoided due to allergy concerns, Mills stated that this should be of little concern as most allergies are caused by grasses which would likely not be included in a greenwall. The remaining concern would be flowering plants; however, the LSC does not lend a good environment for plants to reproduce, thus flowering would likely not occur.

Funding for the project would not come from any easy or traditional sources as Louch pointed out that the only possible place this type of project would fall is under the "Alterations and Restorations" funding which is not enough to meet all the requests put out by various departments at Dalhousie. This makes the funding for a greenwall hard to come by and the greenwall would therefore require alternative methods of funding.

In summary, the interviewees did not believe that there would be a high level of support for the project or the necessary services at Dalhousie to bring the project to fruition. However, there were no public health concerns that they could see with the addition of the biomass to the LSC along with possibly being a place of future research. These comments solidify the social feasibility of the greenwall.

4.3 Case Studies

The results from examining greenwall case studies provided an overwhelmingly positive response. Both of the studies' implementation projects were of significant help in finding solutions to our problem by showing the technical and environmental feasibility.

The CLER greenwall project demonstrated the numerous benefits that the greenwall had for the stakeholders. According to its scholarly sources the site has managed to increase IAQ, lower VOC's in the room, decrease absenteeism from workers, increase well being, increase productivity, decrease utility bills, enhance corporate public image of Canada Life Assurance, and increase educational benefit.

The Waterloo student feasibility project found through their method of triangulation that while there were some duly noted "minor" concerns they encountered they were "limited and manageable concerns" in comparison to the broad benefits of aesthetics, improved University reputation, economic advantages, improved IAQ, etc.

It is important to note that while the former study found maintenance and results to be useful and the latter study provided examples of why it would be feasible in the institution, they both rely heavily on two researchers work: Darlington and Dixon. While these leaders in the field are crucial in the development of the biofilters they also hold a certain bias/interest in seeing their greenwall biofilter product succeed.

Even considering the possible ulterior interests of the main researchers, their scholarly accreditations and Waterloo's appropriate referencing cannot be devalued. In sum, the studies exemplify the great assets a green wall can provide both technically and environmentally.

5. Conclusion

We have created a table to add up and weigh different aspects of our proposed greenwall to quantify whether or not it is a feasible project. This method also helps to identify strengths and weaknesses within our methodology.

Factor:	**Weighting:**
Improved IAQ:	(0.8)(20%)
Improved Aesthetics:	(0.6)(20%)
Environmental Friendliness:	(0.9)(20%)
Economic Support:	(0.0)(20%)
Student Support:	(0.8)(10%)
Interviewee Support:	(0.3)(10%)
Total:	**57%**

Table 16. Quantified factors weighted for conclusion

Indoor Air Quality improvements were worth 20% when trying to assess feasibility. This is because improvements of IAQ were one of our main concerns to address with a greenwall. Improved aesthetics was also seen as a key component of our greenwall along with having to be environmentally friendly in order to be feasible. The economic support of our greenwall is also a key component to its implementation. The secondary concerns which are worth 10% versus the 20% for the primary criteria are Student Support of the project and support of our interviewees as they both have interest in the building and are users of the building.

Improved IAQ was rated to be 0.8 between 0 and 1 for its effectiveness; this rating was reached by reviewing a number of articles which state that greenwalls and plants indoors have an influence on the IAQ of the building. Plants have also been found to improve the aesthetics and enjoyment of indoor space thus giving it a 0.6 rating since the greenwall would likely be located in only one portion of the LSC. The Environmental Friendliness was seen to be a 0.9 as most of the materials are natural plant and soil. Economic support was ranked at 0.0 as we have been unable to find any sources of funding for a project of this type or any conclusive cost-benefit analysis. Student support was pegged at 0.8 as it was found through our surveys that 80% of students are in

support of a greenwall. Finally, interviewee support was set to 0.3 as there was minimal enthusiasm from the individuals interviewed.

Although there were a lot of low scores our final percentage for the feasibility of a greenwall was 57%. This indicates that there is some potential for a greenwall, though at this point it needs to be more thoroughly researched and a better cost-benefit analysis performed to provide a more in-depth feasibility analysis.

In our study we were lacking the timeframe and resources to perform a proper cost-benefit analysis and compare it with conventional HVAC systems. In the future it would be beneficial to fully cost out several different designs of a greenwall and assess their feasibility for installation within a specific site the LSC.

Currently we do acknowledge that the greenwall would provide numerous environmental, health, and social benefits to the stakeholders of the LSC. However, we are currently unable to provide a complete solution and firm recommendations on what should be created. At this point our comfort level only allows us to state that more research must be carried out to better account for the costs associated with installing a greenwall and address any economic concerns so that the health and social benefits can be realised by the occupants of the LSC.

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Appendices

Appendix A: Administered Survey

Greenwall Questionnaire

This is a quick survey to gage your opinion on the LSC and an idea for a Green Wall. This is in association with the course Environmental Problem Solving (ENVS3502) the results will be published in our final report but all data and any identifying data will be strictly guarded and kept confidential.

A Green Wall is an indoor air pollution control technology in the form of a vegetated surface that uses biological processes to breakdown down airborne pollutants and thus clean (or filter) the air. Living organisms such as plants, bacteria, and microorganisms are used to facilitate the biological processes.

1. What programme are you currently in and are you an undergraduate student or a graduate student?

   _____
2. What year of study are you currently in?
   a. First
   b. Second
   c. Third
   d. Fourth
   e. Fifth and beyond
3. How would you rate your knowledge of environmental problems and issues?
   a. Excellent
   b. Good
   c. Fair
   d. Poor
4. Do you have prior knowledge of Green Walls?
   a. Yes
   b. No
5. How often do you frequent the Life Science Centre (LSC)?
   a. More than once a day
   b. Once a day
   c. More than once a week
   d. Once a week
   e. Less than once a week
6. How would you rate the indoor aesthetics of the LSC?
   a. Excellent
   b. Good
   c. Fair
   d. Poor
7. Do you think a Greenwall would enhance the aesthetics?
   a. Yes
   b. No

8. Is the inside of the LSC inviting and a good place to socialize? i.e., would you consider the LSC when choosing a place to have group meetings?
    a. Extremely Inviting
    b. Inviting
    c. Neither Inviting nor Uninviting
    d. Uninviting
    e. Extremely Uninviting
9. How would you rate the air quality at the LSC?
    a. Excellent
    b. Good
    c. Fair
    d. Poor
10. Do you have any concerns with the instillation of a Green Wall in the LSC? (Circle all that apply)
    a. No concerns
    b. Insects
    c. Associated Costs
    d. Allergies
    e. Humidity
    f. Maintenance
    g. Smell
    h. Use of space
    i. Other (please specify):_____
11. How would you categorize your support for the installation of a Green Wall in the LSC?
    a. Strongly in favour
    b. In favour
    c. Neutral
    d. Somewhat opposed
    e. Strongly opposed
12. What benefits do you perceive will come about if a Green Wall is installed?
    a. No foreseeable benefits
    b. Environmental
    c. Improved Air Quality in the LSC
    d. Research possibilities
    e. Improved aesthetics

Thank you for your time! If you would like to receive the final report please leave your name and email.

Name:_____

Email:_____

Appendix B: Letter to Interviewees

The individual letter to participants was customized to reflect the expertise and knowledge sought after, and the nature of interview we wished to conduct.

Hello Sir or Madame (fill in name here)

First let me introduce ourselves, we are a group of students representing Dalhousie University, and are conducting a feasibility test of a Greenwall or other Biofiltration methods within one of the campuses buildings in the hope to improve indoor air quality and aesthetics. We are writing you regarding a request for a (phone/in person) interview pertaining to this subject. It would be a short maximum twenty minute interview regarding (the interviewees area of expertise). If you would be interested in helping our investigation, we would request that your respond to this message so that we can set up a time (and place/phone number) in which to do that interview. If you are not interested simply respond to that effect. Thank you very much for your time, and we hope to hear from you.

Your truly,

Roger Fage
Kyle Sharpe
Sophia Horwitz

Appendix C: Thank you letter

Hello Sir or Madame

We would like to thank you for your time and support in conducting our (interview/survey). You have helped us gain critical insight towards the Feasibility of Green Wall infiltration in the Life Sciences Centre, and without your support our work would not have been possible. The final report can be accessed at http://environmental.science.dal.ca/pages/envs3502_projects.htm under the section "Winter term 2006", heading "Green Wall Feasibility".

Thank you very much.

Your truly,

Roger Fage
Kyle Sharpe
Sophia Horwitz

Appendix D: Ethics Form

ENVIRONMENTAL PROGRAMMES
FACULTY OF SCIENCE
DALHOUSIE UNIVERSITY
APPLICATION FOR ETHICS REVIEW OF RESEARCH INVOLVING HUMAN PARTICIPANTS
UNDERGRADUATE THESES AND IN NON-THESIS COURSE PROJECTS

GENERAL INFORMATION

1. Title of Project:

Green walls, Biofilters and Lost Opportunities? A Feasibility study for possible applications at Dalhousie University

2. Faculty Supervisor(s): Gregor Macaskill **Department:** ENVS Programs **Ext:** Unknown

e-mail: gregormacaskill@eastlink.ca

3. Student Investigator(s) Department e-mail: Local Telephone Number:

Sophia Horwitz

Kyle Sharpe

Roger Fage

4. Level of Project:
Non-thesis Course Project [**X**] Undergraduate [ ] Graduate Specify course and number: ENVS 3502

5. a. Indicate the anticipated commencement date for this project: January 31st/06

b. Indicate the anticipated completion date for this project: March 20th/06

SUMMARY OF PROPOSED RESEARCH

1. Purpose and Rationale for Proposed Research

Briefly describe the purpose (objectives) and rationale of the proposed project and include any hypothesis(es)/research questions to be investigated.

Problem Statement: Is the Construction of a Green Wall at the Dalhousie Life Science Center (LSC) a feasible solution to existing concerns for indoor air quality?

Objectives:

- Determine environmental feasibility; in greater context, in Dalhousie context, environmental advantages and disadvantages.
- Determine technical feasibility; of construction, maintenance, siteing, and/or integration of HVAC systems.
- Determine political feasibility; proper student support, faculty support, and role of administrator/decision makers.
- Determine economic feasibility; can Dalhousie afford the technology, cost versus traditional solutions, and maintenance costs.

2. Methodology/Procedures

a. ***Which of the following procedures will be used? Provide a copy of all materials to be used in this study..***

[ ] Survey(s) or questionnaire(s) (mail-back)
[X] Survey(s) or questionnaire(s) (in person)
[X] Computer-administered task(s) or survey(s)]
[X] Interview(s) (in person)
[X] Interview(s) (by telephone)
[ ] Focus group(s)
[X] Audio taping
[ ] Videotaping
[X] Analysis of secondary data (no involvement with human participants)
[ ] Unobtrusive observations

[ ] Other, specify

_____

b. ***Provide a brief, sequential description of the procedures to be used in this study. For studies involving multiple procedures or sessions, the use of a flow chart is recommended.***

Participants Involved in the Study

a. ***Indicate who will be recruited as potential participants in this study.***

Dalhousie Participants: [**X**] Undergraduate students
[**X**] Graduate students
[**X**] Faculty and/or staff
Non-Dal Participants: [ ] Children
[ ] Adolescents
[ ] Adults
[ ] Seniors
[ ] Persons in Institutional Settings (e.g. Nursing Homes, Correctional Facilities)

[ ] Other (specify) _____

b. ***Describe the potential participants in this study including group affiliation, gender, age range and any other special characteristics. If only one gender is to be recruited, provide a justification for this.***

Listed Interviews
- Voluntary
- Sought for interview because they are professionals in respective their fields.

Survey
- Random Sample
- Will be Students, Faculty and Staff found in the LSC
- (ie Stakeholds in Indoor Air Quality at the LSC)

b. ***How many participants are expected to be involved in this study?*** *111*

Survey – 100 (This is an estimate that may be refined depending on statistical information found regarding relevance and sample sizes)

Listed Interviewees - 11

4. Recruitment Process and Study Location

a. ***From what source(s) will the potential participants be recruited?***

[ ] Dalhousie University undergraduate and/or graduate classes
[X] Other Dalhousie sources (specify): Students, faculty, and Staff

[ ] Local School Boards
[ ] Halifax Community
[ ] Agencies
[X] Businesses, Industries, Professions
[ ] Health care settings, nursing homes, correctional facilities, etc.
[ ] Other, specify (e.g. mailing lists)
_____

c. *Identify who will recruit potential participants and describe the recruitment process.*
Provide a copy of any materials to be used for recruitment (e.g. posters(s), flyers, advertisement(s), letter(s), telephone and other verbal scripts).

Survey
- Random Volunteers
- Found at the LSC
- Recruitment occurring during normal operation hours

Interviewees
- Selected for expertise in desired fields, and all participations on their part is voluntary.

5. Compensation of Participants

Will participants receive compensation (financial or otherwise) for participation? Yes [ ] No [X]
If **Yes**, provide details:

6. Feedback to Participants

Briefly describe the plans for provision of feedback and attach a copy of the feedback letter to be used.

Wherever possible, written feedback should be provided to study participants including a statement of appreciation, details about the purpose and predictions of the study, contact information for the researchers, and the ethics review and clearance statement.

Note: When available, a copy of an executive summary of the study outcomes also should be provided to participants.

Survey
- No Individual feedback as confidential random study.
- Results will be displayed publicly as project summary poster
- Complete study available publicly online, accessed by the Dalhousie Environmental Science Department Website

Listed Interviewees
- No Individual feedback unless specifically requested.

- Follow up with thank you letter with information and how to access completed research study
- Including Dalhousie and researcher contact information

POTENTIAL BENEFITS FROM THE STUDY

1. Identify and describe any known or anticipated direct benefits to the participants from their involvement in the project.

No direct benefits

Collective benefits: educational contribution to Indoor Air Quality issue in LSC, as well as potential benefit derived from instillation of Green wall in the form of improved Indoor Air Quality.

2. Identify and describe any known or anticipated benefits to society from this study.

- Education and Awareness of Indoor Air Quality issues and alternative solution approaches (ie Green Wall and Biofilters)
- Contribution to CSAF and DISI initiative(Greening campus movement)
- Improving Indoor Air Quality and knowledge of its applications

POTENTIAL RISKS TO PARTICIPANTS FROM THE STUDY

1. For each procedure used in this study, provide a description of any known or anticipated risks/stressors to the participants. Consider physiological, psychological, emotional, social, economic, legal, etc. risks/stressors

[X] No known or anticipated risks
Explain why no risks are anticipated:

- Voluntary Survey
- Research is exploratory and confidential

[ ] Minimal risk
Description of risks:

[ ] Greater than minimal risk
Description of risks:

2. Describe the procedures or safeguards in place to protect the physical and psychological health of the participants in light of the risks/stresses identified in Question 1.

- Survey will be confidential
- Data stored securely through ENVS department

- Exhibit politeness and candor at all times
- Once transcribed, tape recordings will be destroyed
- Results/Findings will be publicly available

INFORMED CONSENT PROCESS

Refer to: http://pre.ethics.gc.ca/english/policystatement/section2.cfm

1. What process will be used to inform the potential participants about the study details and to obtain their consent for participation?

[ ] Information letter with written consent form; provide a copy
[X] Information letter with verbal consent; provide a copy
[ ] Information/cover letter; provide a copy

[ ] Other (specify)

_____

2. If written consent cannot be obtained from the potential participants, provide a justification.

Interview from geographical distance will render written consent non-feasible

ANONYMITY OF PARTICIPANTS AND CONFIDENTIALITY OF DATA

1. Explain the procedures to be used to ensure anonymity of participants and confidentiality of data both during the research and in the release of the findings.

Survey
- Anonymous and Random

Interviewees
- Will not be anonymous
- Consent will be sought for use of their contribution

2. Describe the procedures for securing written records, questionnaires, video/audio tapes and electronic data, etc.

- Audio tapes destroyed
- Data and Questionnaires stored according to ENVS 3502 protocol

2. Indicate how long the data will be securely stored, the storage location, and the method to be used for final disposition of the data.

Specifics unknown at this time, but storage will be done according to ENVS 3502 protocol.

[ ] Paper Records
[ ] Confidential shredding after _____ years

[ ] Data will be retained indefinitely in a secure location
[ ] Data will be retained until completion of specific course.

[ ] Audio/Video Recordings

[ ] Erasing of audio/video tapes after _____ years

[ ] Data will be retained indefinitely in a secure location
[ ] Data will be retained until completion of specific course.

[ ] Electronic Data

[ ] Erasing of electronic data after _____ years

[ ] Data will be retained indefinitely in a secure location

[ ] Data will be retained until completion of specific course.

[ ] Other

_____

_____

(Provide details on type, retention period and final disposition, if applicable)

Specify storage location:

_____

ATTACHMENTS

Please **check** below all appendices that are attached as part of your application package:

[ ] **Recruitment Materials**: A copy of any poster(s), flyer(s), advertisement(s), letter(s), telephone or other verbal script(s) used to recruit/gain access to participants.
[ ] **Information Letter and Consent Form(s)**. Used in studies involving interaction with participants (e.g. interviews, testing, etc.)
[ ] **Information/Cover Letter(s)**. Used in studies involving surveys or questionnaires.
[ ] Parent Information Letter and Permission Form for studies involving minors.
[ ] **Materials**: A copy of all survey(s), questionnaire(s), interview questions, interview themes/sample questions for open-ended interviews, focus group questions, or any standardized tests used to collect data.

SIGNATURES OF RESEARCHERS

_____ _____
Signature of Student Investigator(s) Date

_____ _____
Signature of Student Investigator(s) Date

_____ _____
Signature of Student Investigator(s) Date

_____	_____
Signature of Student Investigator(s)	Date
_____	_____
Signature of Student Investigator(s)	Date
_____	_____
Signature of Student Investigator(s)	Date
_____	_____
Signature of Student Investigator(s)	Date

FOR ENVIRONMENTAL PROGRAMMES USE ONLY:

Ethics proposal been checked for eligibility according to the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans

_____

Signature Date

Appendix E: List of Tables

Appendix F: Interview Questions

1) Facilities Management - Dr. Louch
    a. Maintenance Concerns
    b. Data on air quality at LSC/ Complaints voiced/ Hot spots
    c. How current HVAC system operates- Operational information
    d. What they do to address air quality issues
    e. How would Green Wall fit into budget, How would fit into timeframe of improvements, fund for special projects
    f. What they believe political response- How will be received
    g. What is needed to make case for implementation
    h. What would your be about maintenance if student volunteers, faculty involvement
2) Biology Department Greenhouse – Carman Mills
    a. What plants would work best at Dalhousie
    b. Do they have resources to grow plants/ willingness to grow plants
    c. Concerns over certain plants (allergies)
    d. Maintenance- Manpower
    e. Costs
    f. Could they use Green Wall for research

g. Possible problems with green walls as per plants
h. What king of lighting would be needed
i. Integration with curriculum?

Green Wall Summary

- Consistent package of information on what a green wall is and how it works
- Basic condensed slideshow
- In attempt to keep consistency/ all on same page/ talking about the same thing throughout. Prevent interviewee from having wrong mental image
- Benefits over conventional air purification
- What it takes: manpower, costs, space, light, water
- Pictures and diagrams
- Look for company advertisement
- What would company give us if we were perspective buyers