

An Investigation into Implementing Biowall In the New SUB Project

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APSC 261 T1D

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ABSTRACT

Plants have always had a therapeutic effect on humans since time in memorial. Not only do plants serve as a great source of nourishment, clothing, and building material, but they also improve our living environments, our health, and mental well being by providing cleaner air and an aura of aesthetic beauty. Dating back to the time of the Ancient Babylonians the concept of the bio-wall has been used to display the beauty of plants in social infrastructural settings. The architectural excellence of the Hanging Gardens of Babylon has deemed it as one of the seven ancient wonders of the world. In the 1920s, the integration of the house with the garden or man with nature was promoted by a strong garden city movement in Britain and North America. It is in this same spirit that the construction and display of a bio-wall is being proposed as potential means of inspiring students and visitors of the new Student Union building (SUB). Bearing in mind the aim of the new SUB committee to promote sustainability awareness on campus, this proposal of a bio-wall seeks to address this goal directly by providing a functional art piece which is socially attractive and educative on matters of sustainability.

In order to investigate the feasibility of the proposal, it is necessary that an effective triple bottom line assessment be conducted to evaluate the environmental, social, and economic factors that pertain to the bio-wall. The evaluation seeks not only to present the benefits in these different areas, but also to present some of the shortfalls that come with the bio-wall's many advantages. The assessment provides the essential details and information needed to determine the feasibility of the proposal. Overall the analysis supports the implementation of this proposal because of the outstanding impact it will have on bolstering the awareness of sustainability on campus and on improving the experience of students and visitors of the new SUB. Socially the aesthetic value of the bio-wall will attract many viewers and the environmental impact of an improved air quality will also be a social and economic benefit. In addition the aim

of this proposal and project is to spark an interest in incorporating bio-wall designs and other vertical wall designs in campus infrastructure and beyond.

Table of Contents

ABSTRACT.....	2
LIST OF ILLUSTRATIONS.....	5
GLOSSARY.....	6
LIST OF ABBREVIATIONS.....	7
1.0 INTRODUCTION.....	8
2.0 ENVIRONMENTAL ASPECT OF BIOWALL.....	9
2.1 Improved Air Quality.....	9
2.2 Better Environment for Health.....	11
2.3 Noise Reduction.....	11
3.0 SOCIAL ASPECT OF BIOWALL.....	13
3.1 Community.....	13
3.2 Mental Health.....	14
3.3 Promotion of Sustainability at UBC.....	15
4.0 ECONOMIC ASPECT OF BIOWALL.....	15
4.1 Initial Cost.....	15
4.2 Economic Benefit.....	16
4.3 Funding.....	17
5.0 CONCLUSION.....	18
LIST OF REFERENCES.....	19
APPENDIX.....	22

LIST OF ILLUSTRATIONS

Figure (1) CO ₂ concentration level (ppm) versus different times (hours).....	10
Figure (2) VOC concentration (ppm) versus Sample time (hours).....	11

GLOSSARY

<i>AMS Lighter Foot Print Strategy:</i>	The AMS recognizes the ecological crisis that humanity faces and the special responsibility universities and university students have in finding and implementing solutions. For this reason, AMS Council passed an Environmental Sustainability Policy in January 2007 that called for the creation of a sustainability strategy for the AMS.
<i>AMS Sustainability Fund:</i>	A fund that unites sustainability efforts across campus while taking student engagement to a new and exciting level
<i>AMS Student Initiative Fund:</i>	A \$500 Fund given to sponsor student projects
<i>Volatile Organic Compounds:</i>	an organic compound that evaporates at a relatively low temperature and contributes to air pollution, e.g. ethylene, propylene, benzene, or styrene

LIST OF ABBREVIATIONS

HVAC.....Heating, Ventilation, and Air Conditioning

SUB.....Student Union Building

UBC.....University of British Columbia

VOC.....Volatile Organic Compounds

PPM.....Parts Per Million

1.0 INTRODUCTION

The proposal in this article is called a Bio-wall. A Bio-wall is a free-standing, mobile structure that houses a wall full of plants on either of its two large sides and acts as a wall within a room. It also is self sustaining, containing enough plant nutrients and enough water to last it for several weeks at a time, thus allowing minimal maintenance. The Bio-wall is an effective functional and inspiring “art piece” because it is socially inspiring for the public within the SUB to think about sustainability and think about nature within the middle of a very busy area. This inspiration is very inexpensive and can have a very positive effect per dollar spent. The Bio-wall contributes to the community and environment by creating cleaner air for and using and purifying less treated grey water. The Bio-wall is an important fixture to have in the SUB in order to promote effective sustainability and a positive triple bottom line analysis.

2.0 ENVIRONMENTAL ASPECT OF BIOWALL

A bio-wall is designed to bio-filter the indoor air and provides thermal regulation. Plant roots of bio-wall are sandwiched between two layers of synthetic fabric which supports microbes and a dense root mass. The root microbes reduce the volatile organic compounds (VOCs) and the foliage absorbs the carbon dioxide, carbon monoxides and heavy metal particles. The plants produce cool fresh air by absorbing the dirty air, drawing through the system by a fan and distributing throughout the building. The benefits obtained from a bio-wall are dependent on several design factors including leaf area, leaf density, site conditions and the scale of the project (Green Roofs for Healthy Cities, 2008).

There are significant advantages of using bio-walls in the public and private sectors. Some benefits of implementing a bio-wall are categorized as follows:

- Improved indoor air quality
- Better environment for health
- Noise barrier

2.1 Improved indoor air quality

Bio-walls are able to filter contaminants which are regularly flushed out of the building through traditional ventilation systems. They also absorb airborne pollutants such as dust, pollen, and heavy metal particles. They filter noxious gases such as carbon dioxides and carbon monoxides and VOCs due to carpets, furniture and other building elements ((CHBE Sustainable Club, (n.d.)).

Researchers at UBC conducted several preliminary air quality tests in a computer lab in Chemical and Biological Department to determine if the bio-wall can improve the indoor air quality (James et al, 2011). The computer boards and printers were a known source of VOCs. The result indicated that the bio-wall improved the indoor air quality by reducing both CO₂ and VOC concentrations. Figure (1) shows the CO₂ levels in the unit of ppm versus time. Based on the following figure, a considerable reduction in CO₂

concentration was obtained with both passive (with the presence of bio-wall, but fans off) and active (CHBE Sustainable Club, (n.d.)).

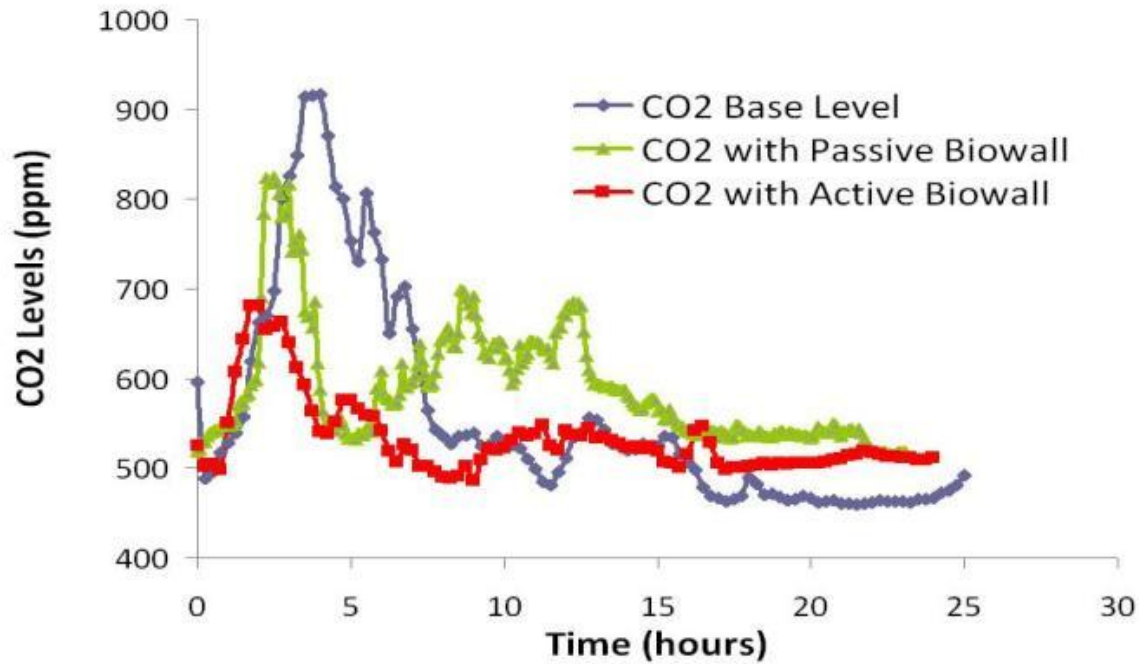


Figure (1): CO2 concentration level (ppm) versus different times (hours) (CHBE Sustainable Club, (n.d.)).

Moreover, Figure (2) indicates the VOC concentration in the unit of ppm versus sample times. The figure clearly showed that VOC concentration in the lab was greatly decreased with an active bio-wall filtration (CHBE Sustainable Club, (n.d.)).

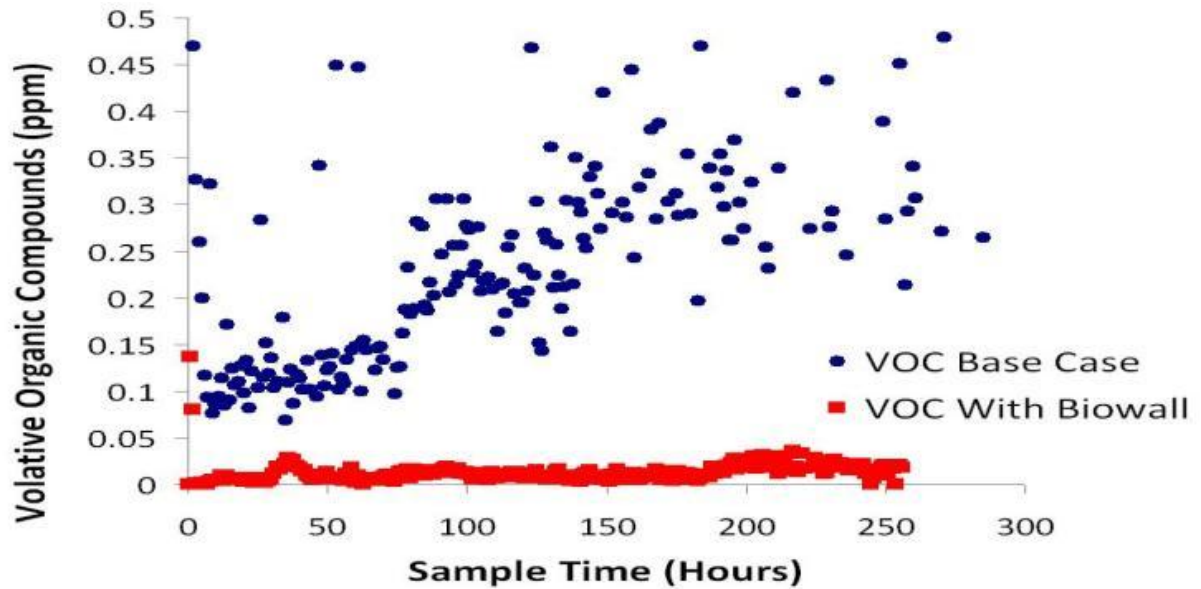


Figure (2): VOC concentration (ppm) versus Sample time (hours) (CHBE Sustainable Club, (n.d.)).

With the improvement of air quality, it is possible to achieve some future energy savings in connection with the HVAC system by omitting the process of taking fresh air from the outside of the building.

2.2 Better Environment for Health

VOCs concentration level is often found higher indoors than that of outdoors as much as five times. It is especially higher in newly constructed buildings because many VOCs off-gas a significant proportion of their volume in a relatively short time. Being exposed to VOCs, one can possibly suffer from both acute and chronic health effects, such as asthma (Jones, 1999). From the data shown in Figure (2), a significant decrease in VOC concentration has observed, which prevents from the aforementioned effects on people in new SUB building (CHBE Sustainable Club, (n.d.)).

2.3 Noise reduction

The growing media in the bio-wall system can also reduce the sound level which transmit through or reflect from the bio-wall. There are some factors that affect the

level of noise reduction including the depth of the growing media, the overall coverage, and the material used as structural components of the bio-wall (Green Roofs for Healthy Cities, 2008). A research shows that a wall as thin as 100mm is capable of 5 decibels noise reduction (Commonwealth of Australia, 2010). With the proposed modular design, a significant amount of soundproofing effect is expected, which can be utilized in separating certain areas for different purposes, a study area for example.

3.0 SOCIAL ASPECT OF BIOWALL

3.1 Community

The Bio-wall proposed has significant social benefits on the community and those that are involved with the project. The Bio-wall's most striking feature is the aesthetics that it provides for a room. The beauty of the green plants softens the busy atmosphere of the SUB providing the room with a spiritual connection to our environment. By using plants that are located within British Columbia, and more specifically some of the plants we can see within the forests in Vancouver, they promote a better sense of community and link to the natural environment. Simply by displaying the color green, the color recognized by many as the color of sustainability, the Bio-wall will promote sustainability and emphasize exactly what the SUB is trying to promote.

3.2 Mental Health

Aside from aesthetic, the Bio-wall is a large soft wall within a hard walled room that will help to reduce noise pollution caused by sound hitting a hard surface and bouncing back as an echo. The more plants we keep in a room the less noise pollution we can expect. The health benefits of plants in a room are beyond the physical health and also can aid in our psychological health. The significance of Plants in areas of work and study shown by Fjeld (1998) in his online journal highlights the mental and physical health benefits by comparing patient's reactions to having plants as opposed to not having plants within their office buildings. The results show that not only was physical health improved and positive changes noticed in the respiratory systems as well as the skin in many of the patients but also that morale and psychological health improved when plants were used. These changes were seen in energy of patients and overall well-being within the office setting. Although students are not working next to plants all day, this large effect on the few in the study mentioned would translate to a small effect on the many people that walk through the SUB every day.

3.3 Promotion of Sustainability at UBC

There is a new club at UBC labeled “The Sustainability club” which has taken the responsibility of maintaining the bio-wall, in exchange for using the wall to promote the club and promote sustainability on campus. By showing UBC’s commitment within one of the more public areas on campus, a positive message of sustainable development and community is sent to the students that pass it, and can be used as a centerpiece for future student projects. The wall is not permanent, and therefore can be moved from one area within the SUB to another, to a different building or can be put outside in order to aid the health of the wall. This mobility of the wall is important in order to find an area where the wall is most effective and properly displayed. After some time, the wall can be moved in order to cause an effect on people that otherwise would not have been able to see the wall. This type of initiative will use the bio-wall as a billboard and attract students from within the campus to join a club who is committed to benefiting the environment and creating more vehicles of sustainability for our campus. By helping to create the first project, the SUB will then be helping to inspire more projects and involve more people in the growth of their green vision. The plants used on the Bio-wall are effective for using grey water and reusing water as they will absorb dissolved nutrients, creating the possibility for another student project to find a suitable way to provide the wall with grey water to be reused. The usage of bio-walls such as this is not yet a popular means of using plants in a room and therefore there is no widely accepted method of building the wall. By experimenting with the design and creating better ways to construct the bio-wall this project will create the prototype for mobile bio-walls and will refine the construction to create a more effective and cheaper design that could be used to make many more bio-walls to be used across campus.

4.0 ECONOMIC ASPECT OF BIOWALL

An economic analysis of the benefits and costs of the bio-wall proposal is an important component of the triple bottom line assessment. The assessment will include an analysis of the initial costs and an analysis of the economic benefits to UBC and the society in general. There are two different projected costs mentioned below: the quotation of James Butler a graduate student in the Chemical Engineering and Biological Engineering department (CHBE) who has also constructed a successful and working bio-wall in the CHBE Atrium; and the quotation of the sustainability club.

4.1 Initial Cost

After contacting a number of companies who design bio-walls and other vertical gardens, James Butler, the CHBE graduate student, had the most affordable quotes of these professional contractors for the bio-wall construction, assembly and installation. Using similar design materials and parameters as he did for his Capstone Project, the quote was \$60 per square foot before labor. This cost includes the cost of materials, plants, tubing and the pump.

The dimension for one section of the proposed bio-wall design is:

6.23 ft in height x 4.37 ft in width.

Since the design will be 3 bio-walls the total width is multiplied by three and thus becomes $4.37 \text{ ft} * 3 = 13.123 \text{ ft}$. Considering that the bio-wall will have plants on both sides this brings the final dimensions to:

6.23 ft in height x 13.12 ft in width X 2 sides=163.48 square feet

With the proposed dimensions at cost of \$60 per square foot the total cost before labor is \$9,810.75. With the inclusion of labor costs of \$220 the total initial cost of contracting James Butler is \$10,030.75.

Recognizing that funding of the project at such cost would be difficult; it seemed more reasonable to do an independent research on resources and materials that were needed and tabulate the initial costs independently. An important difference in this scenario is that the labor work will be done by members of the Sustainability Club in the form of a club event. In fact the opportunity to get involved in this pilot project will be extended campus wide to other potential volunteers. This is great for the raising sustainability awareness because students get the opportunity to engage actively in a sustainability project and learn the issues involved. From an economic standpoint this means that labor costs are avoided and the only input costs are the input costs of the materials, plants, tubing, and the pump. With the same proposed dimensions of **163.48 square feet as mentioned above** This total comes to **\$3,138.35** for the input costs if the sustainability club were to independently acquire the needed material and plants and construct the wall (Appendix). The costs of the plants could be considerably reduced or even avoided by sponsorship from local botanical gardens such as the UBC Botanical Gardens.

4.2 Economic benefits

The improved air quality that the bio-wall generates has great social, environment and economic benefit to the users of the new SUB. The improved air quality, with dramatically reduced levels of VOC's and formaldehyde increases the health status of the SUB users and this has some indirect economic effects that will be highlighted. Studies have shown that steadily increasing rates of Asthma and allergies have been attributed to the increased concentration of artificial elements in our environment. Approximately 8.4% of the population has Asthma and it has been identified as the leading cause of absenteeism from school and the third leading cause of loss of work (Journal of royal college). Annually Asthma care in Canada costs between \$504 and \$ 648 million dollars annually. (Krahn, M.D., Berka, C.B, Langlois, P., & Detsky, A. S., 1990). Hence improving air quality boosts long-term productivity and health and thus generates long-term savings.

The scale at which this particular bio-wall is being constructed is not grand enough to provide any energy savings yet. However, as a pilot project, this could be the beginning of a larger scale project, which would reduce energy costs by reducing the necessary work of the HVAC systems.

4.3 Funding

A very important social dimension of the bio-wall project is the establishment of the Sustainability Club, which is intended to heighten the awareness of sustainability issues, particularly sustainability on campus. The vision of the club to increase the awareness of sustainability on campus by undertaking projects like that of the bio-wall ties in closely with the AMS Lighter Footprint Strategy. Thus a primary source of funding will be to get a grant from the AMS Sustainability Fund. An alternative source of funding is the AMS Student Initiative Fund. This fund supports students that undertake projects deemed worthy by the AMS Financial Commission. The remainder of the funding, after deducting initial costs, will be used to manage maintenance costs, which are estimated at \$30 annually. Alternatively, the Sustainability Club can manage the maintenance costs through club fundraising events and the Membership fees.

5.0 CONCLUSION

With the information and the analysis that has been presented through the triple-bottom line investigation thus far it can be inferred that the implementation of the bio-wall proposal would be a social, environmental and economic success for the new SUB committee. Thus in conclusion we recommend the implementation of the bio-wall.

The level of sustainability awareness that will be raised as a result of the bio-wall project and the affiliated Sustainability Club will be profound. Ultimately this the bio-wall project with its social Sustainability Club component is a creative solution to the challenge posed by the UBC new SUB committee: the challenge of designing an inspiring functional art piece that promotes campus-wide sustainability awareness. With the improved air quality and therapeutic aesthetic nature that the bio-wall provides, the students and visitors using the new SUB will have a unique experience in their social interaction within the space. Likewise their interaction with the building will be unique and active because of their awareness to the roll of the bio-wall in promoting sustainability. This heightened awareness will certainly be extended beyond the walls of the new SUB will continue to fuel the spirit of sustainable practices on and off campus.

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Appendix: Input Cost Table

Size (inches)	Material	Length (ft)	Price (\$)	Amount (units)	Total (\$)
2x6	Spruce	14	9	6	54
4x4	Douglas Fir	8	7	1	7
4x4	Appearance Cedar	8	18	2	36
(1/2)x2	plywood	8	25	2	50
(1/8)x4	Sheet Metal + Custom Work	8	100	1	100
(1/4)x35	Plastic Sheeting	15	20	4	80
63"x5 yards	Black Felt Fabric	Custom	22	8	176
				Total Materials	247
	Pump		520	1	520
	Irrigation Tubing	50	40	1	40
	Plants		1771.35		1771.35
				Total Irrigation	560
				Total Initial Costs	807
				Total Plant Costs	1771.35
				Total Initial Costs	3138.35