UBC Social Ecological Economic Development Studies (SEEDS) Student Report

An Investigation Into Composting Alternatives at the New Student Union Building

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Technology and Society – APSC 261

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ABSTRACT

The new student union building is to be built to as an example of sustainability for British Columbia and the world. As such, all aspects of sustainability, including how food waste is handled must be considered in detail. Nearly 48% of the total waste from the SUB is compostable. This represents about 46 tonnes annually. It is expected that after the new SUB is constructed, this figure will rise and more composting will be required. Composting at the current SUB building is mostly done offsite in a process that takes 21 days.

This report will look in detail at an alternative method of composting using Black Soldier Fly (BSF) larvae. This is a new approach to vermicomposting and represents a significant advantage in both waste process time and overall composting ability. This report also examined the current operation of composting at the current sub, as well as the use of worms to improve overall food waste processing. Information was gathered to examine alternative composting methods from many sources, including interviews with UBC staff, industry professionals, academic journals, and online literature. As information was gathered, the possibility of utilizing BSF Larvae was examined and the requirements for such a configuration at the new SUB were examined. Interviews with LEED industry professionals and UBC Staff were also used to confirm our results and the overall result it would have on the project.

Utilizing BSF Larvae to quickly digest food waste is a viable and environmentally friendly alternative to traditional composting methods. This reports shows that BSF Larvae harvest food waste much faster than worms or traditional composting with minimal human input. Labour costs would be significantly cut while fertilizer and agriculture feed outputs would be maximized. Additionally, one point towards the LEED Platinum certification could be obtained if this composting strategy was implemented. It should be noted that such a project requires more space than provided in the current SUB plans for composting.

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GLOSSARY

Prepupae: The stage directly following the larva and just before the pupa stage. As a larva finishes eating and growing, it begins the prepupa stage by looking for a place to hang itself and become a pupa.

Vermicomposting : The breakdown of organic material that, in contrast to composting, involves the joint action of earthworms and micro-organisms and does not involve the generation of high heat as is with composting.

LIST OF ABBREVIATIONS

BOM – Bill of Materials

BSF – Black Soldier Fly

CaGBC – Canada Green Building Council

LEED – Leadership in Efficient and Environmental Design

LEED-AP – LEED Accredited Professional

LEED-NC – LEED New Construction

SUB – Student Union Building

UBC – University of British Columbia

1.0 INTRODUCTION

As the new Student Union Building (SUB) building is constructed at UBC, special attention to sustainability and the environment will be taken. This report will look at sustainability as it relates to food waste at the new SUB building and will offer an alternative method of composting food waste to be considered in the construction of the new SUB.

1.1 BACKGROUND

Composting at the current SUB building is mostly done offsite in a process that takes 21 days (Refer to Appendix A). The composting takes place on the south of campus and requires 3 full time workers.

As it stands now, nearly 48% of the total waste from the SUB is compostable (see Figure 1). This represents about 46 tonnes annually. It is expected that after the new SUB is constructed, this figure will rise and more composting will be required.

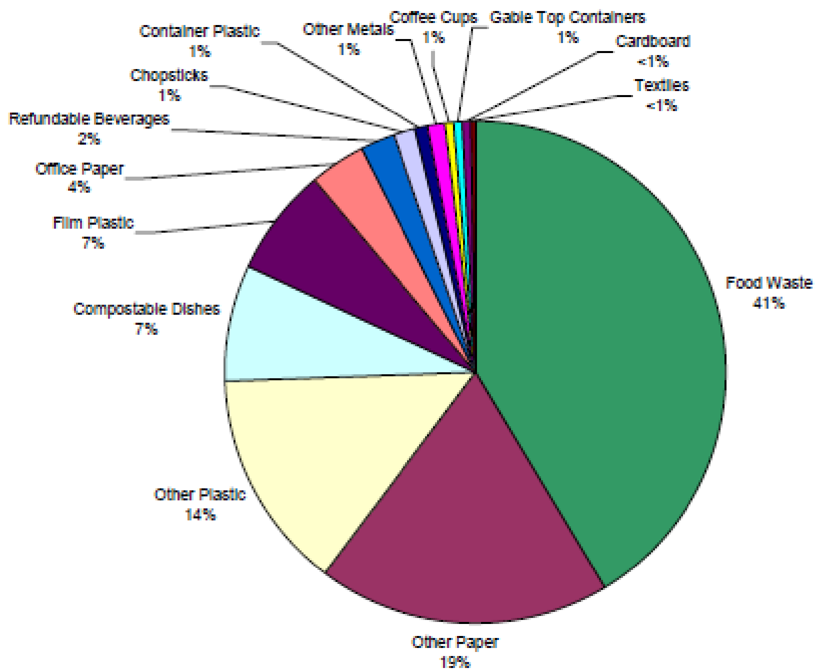

Figure 1 - SUB Waste Production Breakdown [2]

1.2 SCOPE

This report will look in detail at an alternative method of composting using Black Soldier Fly (BSF) larvae. This is a new approach to vermicomposting and represents a significant advantage in both waste process time and overall composting ability.

This report also examined the current operation of composting at the current sub, as well as the use of worms to improve overall food waste processing.

2.0 ALTERNATIVE COMPOSTING METHOD: BLACK SOLDIER FLY LARVAE

As an alternative to traditional vermicomposting with red worms, a relatively new form of composting is becoming more prevalent throughout the world in the past 5 years; the use of BSF larvae (see Figure 2 below) to digest organic material. The BSF larvae are voracious digesters of organic material, and can process 3-5 kg of organic scraps per metre2 of the organic material with a 40% rough conversion rate. [1]. This means that the BSF larvae would be able to process roughly 40% of all of the organic material generated by the SUB each year, or about 15,200 kg [2]. The remaining 22,800 kg of residue remaining would still need to be either processed on site by traditional vermicomposting, or trucked offsite to the South Campus as is done today. Vermicomposting will be discussed later in this report.

Figure 2 – Images of the Black Soldier Fly and its Larvae [6]

2.1 BLACK SOLDIER FLY BACKGROUND

The BSF adult fly, and its larvae are non pathogenic, and pose no health threats. The adult flies, have no mouths, and only live for 5 days to mate and lay eggs, living only on their reserves. As long as there is a supply of decaying organic material, the cycle of egg laying, new larvae to adult flies will continue unabated. Food scraps in and harvested larvae out, is the pared down result. The BSF fly is not commonly found in the metro Vancouver area, so there needs to be some sort of room, or enclosure to keep the flies in the general area of the food scraps. There is a liquid by-product of the larvae's processing of the organic material. This is a major attractant to the egg laying female, so any flies that pupate to adults from this area, would naturally want to stay in the area to lay their eggs in this prime location. The adult BSF fly needs sunlight for successful mating, so the enclosure would have to account for this as well.

2.2 SUB WASTE REDUCTION OF FOOD BY BSF LARVAE

The conversion rate of food scraps to actual BSF larvae, at an optimal feeding rate of 0.100 kg of scraps/larvae, yields roughly 10% of the entire 38,000 kg of food scraps being turned into 3,800 kg of BSF larvae per year. Weekly, this is 76 kg of BSF larvae per week that can be harvested. BSF larvae, in either live form or dried form, are an excellent feed for chickens, fish, or lizards. Andrew Rushmere, of the UBC Farm, has indicated the UBC Farm would be able to take all of the harvested BSF larvae to feed their chickens. As they deliver food on campus every week, a 5 gallon pail exchange could take place every week to take the harvested BSF larvae to the farm.

2.3 DESIGN OF THE BSF COMPOSTER AND SUB LAYOUT

The BSF larvae, when ready to pupate, leave the composting area, and try to find a dry area to transform into an adult BSF fly. This natural ability to leave the composting area, is used to build a BSF composter, where these prepupae can be channelled and collected into harvesting bins (see Figure 3 below for sketch of a BSF Composter). There would also be an open bin with dry wood chips and sawdust for some of the prepupae to escape to hatch to adult BSF flies to keep the cycle going. On the inside of the roofs of the BSF Composter lids, would be layers of plastic cardboard to allow easy egg laying by the females into the plastic channels, to have the hatchlings drop onto the waiting food scraps. The entire composter is made modular with a bottom, top and the lid. The materials are regular plywood coated with fibreglass resin, SCH80 PVC pipe and fittings, aluminum 10 mesh, and grey PVC for the harvester bins. The area of the composter, where the food scraps would be placed by SUB workers, has aluminum 10 mesh as the table, and is 3 m^2. The mesh allows the liquid from the larvae's processing to fall through to the bottom collecting area, where a maintenance worker would need to drain from time to time. This liquid is a natural organic fertilizer, and can be diluted to spray onto any area needing fertilizing. The number of BSF Composters required for the entire SUB's food scrap output is 11. The calculation is:

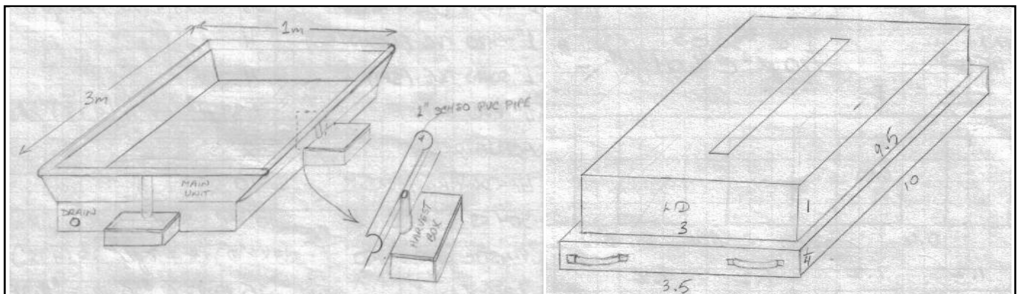

Figure 3 Sketch of BSF Composter

Showing 3 m^2 food scrap area, harvester bins, and hinged lid (separate). Lids to have 2 spring actuators, to facilitate easy opening. Dry, open bin with wood chips and sawdust in the rear of the unit to facilitate pupation to adult flies.

$$\frac{38{,}000\ kg\ of\ food\ scraps}{280\ SUB\ days\ of\ operation} = \frac{136\ \frac{kg\ scraps}{day}}{4\ \frac{kg\ processed\ by\ larvae}{m^2\ of\ scraps}} = \frac{34\ m^2\ total\ composter\ area\ required}{3\ m^2\ for\ each\ composter} = 11$$

The square footage to house the BSF Composters, with area to move equipment unobstructed within the enclosure is 1200 ft^2, as seen in Figure 4 to the right. The allotment of square footage given to compost on site at the new SUB building is 480 ft^2, as laid out in the Roof Garden Program Area document distributed to interested parties. The stakeholders will need to make a decision whether to expand this area to include this BSF composting proposal.

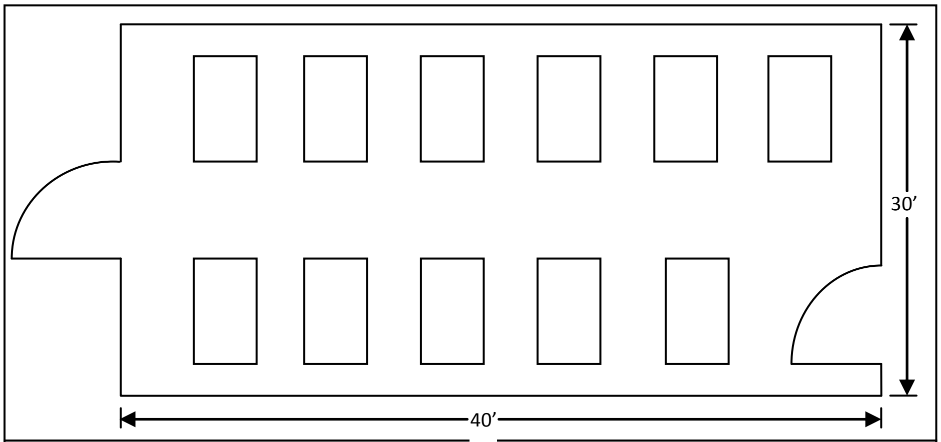

Figure 4 -Suggested layout of BSF Composters within an enclosure

Shown with 1200 ft^2 footprint. Right side door would lead into SUB, and left side door to loading dock area.

2.4 COSTS OF BSF COMPOSTING

The cost to build each of the BSF Composters has been tabulated in the bill of materials (BOM) in Table 1 below. It shows the breakdown of the different components required. These BSF Composters could be built on campus by students, or could be shopped out to a millwork shop, and then to a boat builder in the lower mainland area to bring the costs down. A project for the Capstone 45x project in the mechanical engineering department is another possibility for this undertaking.

Table 1 - Bill of materials and rough costs for SUB BSF Composters.

SUB Project: On Site Composting BSF Single Unit							
Material	**Amount Needed**		**Price**			**Total**	
3/8" Plywood	190	ft^2	$	0.78		$	148.44
1" SCH80 PVC Pipe	35	ft	$	1.50		$	52.50
1" SCH80 PVC Elbow (SW)	4		$	4.09		$	16.36
1" SCH80 PVC Tee (SW)	4		$	7.33		$	29.32
Actuators	2		$	35.00		$	70.00
Hardware	1		$	15.00		$	15.00
Fibreglass Mat	190	ft^2	$	1.04	ft^2	$	197.60
Fibreglass Resin	190	ft^2	$	30.00		$	30.00
1/4" PVC Sheet (Grey)	7.5	ft^2	$	3.44		$	25.80
Miscellaneous	1		$	20.00		$	20.00
Plastic Cardboard	8	ft^2		0.625	ft^2	$	5.00
Aluminum 10 Mesh	33	ft^2	$	2.25		$	74.25
Labour	25	hrs	$	25.00		$	625.00
	Grand Total Per Unit:					**$**	**1,309.27**
							↓
	Rounded Up Cost Per Unit:					**$**	**1,325.00**
Grand Total For 11 Units Needed For SUB:						**$**	**14,575.00**

2.5 MAINTENANCE AND OTHER CONSIDERATIONS

The maintenance for the compost area would involve recovery of any uneaten material from the BSF Composters, emptying the composter bins to a 5 gallon pail, draining the liquid from the bottom of the BSF Composters, and to keep the area generally clean and safe for the SUB workers. A 5-6 hour estimate of work to achieve this per week is an estimate. A grad student from the Zoology Department could oversee the area, as it involves entomology, and could be used on a resume as direct work experience. The new SUB would need to be equipped with sorting bins throughout, with 4 bins, one of which would be solely used for uneaten food only, and nothing else (no liquids). This is one of the recommendations of the Waste Audit Report to do away with stand alone garbage bins, and replace with the multi-bin alternatives [2]. All food related scraps from the SUB could be directly dumped into the BSF Composters on a daily basis by SUB employees. A short demonstration of the composting procedure to all SUB employees who would be emptying the food scraps into the BSF Composters would need to be implemented. The BSF Composters work the same way as a normal garbage bin, just larger in size, with an easy open lid, with actuators like a car trunk.

3.0 VERMICOMPOSTING

Vermicomposting is a method of recycling waste which uses worms. This is generally considered an easy way to compost since the requirements are quite simple and the worms don't require a lot of attention. Vermicomposting is relatively fast, does not require a large space, and the odour produced is not significant. Although various kings of earthworms can be used for vermicomposting, generally Red Wigglers (Eisenia Foetida) are used due to their ability to eat satisfactory amounts of organic waste.

3.1 ENVIRONMENT

Red Wigglers can survive a good range of temperature (4-27C), but the optimal temperature for them to process the waste is 25C [3]. Since this temperature is higher than the average winter temperatures in Vancouver, the worm bin would have to be kept inside a building. They tend to breed quite rapidly assuming the environment is appropriate. The environment of a worm bin is the kind of environment they enjoy, after all there are large amounts of waste and they are densely stored in the bin. The worms need some kind of damp bedding in the bin such as paper or cardboard. They are sensitive to lights so they should be kept in the dark. There must be ventilation in the bin in order to get oxygen in the bin. When the bin is open to add more waste, the air in the bin will be recycled.

3.2 FOOD

The worms will eat vegetable, fruits, tea bags, crushed egg shells, paper, coffee grounds, cardboard, and yard waste. Meat, fat, dairy products, and starch should be avoided. The food should be placed on a different section of the bin every week or have different bins for various weeks.

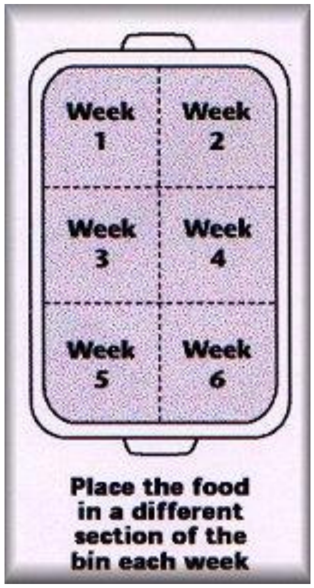

Figure 5 – Placement of Food in Bin [4]

Red Wigglers can consume up to 2 lbs of organic waste per day making them able to process one pound of waste per week for every square foot of worms.

3.3 NUMBER OF WORMS

For every person we need about 0.5kg of worms and a bin size of 45 x 60 x 30 cm. The worms can eat up to their weight in waste every two days. It is necessary to have one pound of worms per cubic foot of volume of the bin.

Number of Pounds of Food a Week = Surface Area sq ft x 0.5 lb/ft sq/day x 7 days/week

3.4 MAINTENANCE

The waste should be covered with a layer of damp bedding. The liquid which forms on the bottom of the bin needs to be removed. The waste should be spread out in the bin to encourage growth in the worm population. Every three months new bedding needs to be put in, at this point the worms and finished compost product should be moved to the other side of the bin. The worms tend to slowly move to the other side of the bin looking for new food.

3.5 REPRODUCTION

The worms will take three months to start breeding since an egg takes about three weeks to develop. When the egg is hatched, up to twenty worms can come out. The worms themselves will keep the population growing constantly as long as the environment is appropriate.

4.0 COST COMPARISON

The costs of implementing the alternative method of composting were compared to current food waste management at UBC. These costs were estimated assuming that future production of food waste does not significantly vary from the present consumption and production.

4.1 CURRENT COSTS

The following table is a summary of the current operating costs for the SUB composting program.

Table 2 - Current Composting Cost

	Monthly Cost
3 Full Time Employees – 40 Hours/week	$10,400
Maintenance	
Gas ($0.42/km, 4 km/day)	$51
TOTAL	$10,451

4.2 COSTS WITH BSF COMPOSTING

The following table is a summary of the expected initial costs for the proposed BSF composting program.

Table 3 - BSF Program Initial Costs

	Initial Costs
Worms	$36,000
Construction – 11 units	$14,575
TOTAL INITIAL COSTs	$50,575

The following table is a summary of the expected monthly costs for the proposed BSF composting program.

Table 4 - BSF Program Monthly Costs

	Monthly Costs
20 hours/week labour	$ 4,800

4.3 COST COMPARISON

The operating costs for a BSF Composting system on site are much lower than the current composting costs. The following table outlines the differences in costs and shows the simple payback (in months) for implementing the new strategy.

Table 5 - Cost Comparisons and Payback

Strategy	Initial Costs	Monthly Costs	Simple Payback
Current Composting Strategy	-	$10,451	9 months
BSF composting Strategy	$50,575	$4,800	

5.0 LEED ACCREDITATION IMPACT

The new SUB is attempting to gain LEED accreditation at the Platinum level in accordance with CaGBC (Canada Green Building Council) guidelines for new construction (LEED-NC). In order to achieve LEED Platinum, the SUB must achieve at least 80 of the 110 possible points according to the LEED-2009 reference guide.

Unfortunately, the LEED rating system does not attribute standard points for post construction waste management plans and facilities in new buildings [5]. However, it is possible for the project to achieve a point in the Innovation Category for dedicated food composting system located on site. According to Brian Derkash, an accredited LEED AP, an innovation credit may be earned for this project if the intent of the project is clearly defined and the project has a significant impact on building sustainability. As 40% of the waste exiting the building would be diverted, it is expected that if this strategy was implemented, a LEED innovation credit would be obtained (refer to Appendix C).

6.0 CONCLUSION

The BSF Larvae composting technique, presented in this report, is a very effective way to sustainably process food waste. Not only would the increased rate of food waste processing improve fertilizer and agricultural feed output, but labour costs and labour requirements for processing the waste would be minimized. In addition, 40% of the food waste produced on site could be diverted and be processed to be used in local agricultural products.

A LEED Innovation Credit would also be obtained if the BSF Compositing Strategy was implemented.

However, it should be noted that such a project requires substantially more space than provided in the current SUB plans for composting. As a result, recommendations have been made to address these issues.

6.1 RECOMMENDATIONS

The following is a list of recommendations for the new SUB Food Waste Management System:

- Increase space for composting
- Consider vertically stacking composting units
- Consider doing a portion of composting offsite (to allow for overflow)

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APPENDIX A - INTERVIEW WITH DARREN DUFF

As part of our research project, we focused on the benefits of composting at UBC to comply with UBC's pledge to be the most sustainable campus in North America. Clearly, the data and statistics change from year to year; we, to comply with the scope of the project, have used rough estimates from the last year. Our group interviewed, Mr. Darren Duff, the manager of UBC Waste Management for collecting valuable statistical data and his insight on this topic. A synopsis of this interview is as follows.

Organic waste material is picked up every day at UBC using a pick-up truck with a tailgate. It carries 12 rolling bins per trip, each bin being able to hold up to 150 lbs. The Student Union Building produces on average about 30 to 35 bins per week. This fluctuates during the school year with class sessions being lower in the summer.

Although an exact breakdown the cost of hauling compostable waste (labour/ gas/ equipment/ other expenses) alone wasn't given to us, we were told that UBC employs one full time employee hauling the compost and another 2 full time employees working on the composter. This includes loading the machine, washing the bins, running the machine, piling the compost in the bays and turning the compost piles. In addition, each year, when the final product of the composting is screened it takes about 5 weeks for 1 person to work full-time on the backhoe. The operating expenses vary depending on the maintenance required each year, on the composter the bin washer the trucks and other related items.

UBC Waste Management uses an "In-Vessel" compost processing method that composts organic waste within 17-21 days. Leaves and grass clippings from the UBC campus is also collected. All the waste composted on campus is used by our landscaping crew on campus. UBC does not sell its compost but provides some of it to small community projects on campus upon request.

We wish to thank Mr. Darren Duff for his time and effort in making our research project successful.

APPENDIX B – INTERVIEW WITH JUSTIN RITCHIE

As part of our research project, we focused on the benefits of composting at the Student Union Building (SUB) to comply with UBC's pledge to be the most sustainable campus in North America. Clearly, the data and statistics change from year to year; we, to comply with the scope of the project, have used rough estimates from the last year. Our group interviewed, Mr. Justin Ritchie, the Sustainability Coordinator for the Alma Mater Society (AMS) of UBC to collect valuable statistical data and his insight on this topic. A synopsis of this interview is as follows.

Organic waste material is generated every day at the SUB. The amount of this waste fluctuates during the school year with class sessions being lower in the summer. Last year, the SUB generated about 47 metric tonnes of compostable waste.

The AMS provides information to the vendors as well as students to promote composting. In the past, the SUB did not engage in such activities and has come a long way. About three years ago, it didn't have any specific bins for recyclable containers, compostable food waste etc. but just one "multi-purpose" bin. Today, the SUB has many tri-bins – one bin each for recyclables, food waste and other garbage. The AMS has also got vendors to recycle and compost their waste on a regular basis. It has also moved from using Styrofoam dishes and cutlery to compostable ones.

Last year the AMS, in total, composted and recycled over 91 metric tonnes. This was explained to us as just enough to save about 9 metric tonnes of carbon emission had this waste been sent to a landfill. The number of persons using the SUB will only increase in the years to come and the AMS is proud that this step will help them save more emissions in the years to come.

We wish to thank Mr. Justin Ritchie for his time and effort in making our research project successful.

APPENDIX C - LEED INNOVATION CREDIT

INNOVATION IN DESIGN

	ID
NC	Credit 1
CS	Credit 1

	NC	CS
Credit	ID Credit 1	ID Credit 1
Points	1-5 points	1-5 points

INTENT

To provide design teams and projects the opportunity to achieve exceptional performance above the requirements set by this rating system and/or innovative performance in Green Building categories not specifically addressed by this rating system.

REQUIREMENTS: NC & CS

Credit can be achieved through any combination of the paths below:

PATH 1. INNOVATION IN DESIGN (1-5 points)

Achieve significant, measureable environmental performance using a strategy not addressed in the *LEED Canada for New Construction and Major Renovations 2009* and *LEED Canada for Core and Shell Development 2009*.

One point is awarded for each innovation achieved. No more than 5 points under ID Credit1 may be earned through PATH 1—Innovation in Design.

Identify the following in writing:

- The intent of the proposed innovation credit.
- The proposed requirement for compliance.
- The proposed submittals to demonstrate compliance.
- The design approach (strategies) used to meet the requirements.

ID	
NC	Credit 1
CS	Credit 1

PATH 2. EXEMPLARY PERFORMANCE (1-3 points)

Achieve exemplary performance in an existing credit that allows exemplary performance as specified in the *LEED Canada Reference Guide for Green Building Design and Construction*. An exemplary performance point may be earned for achieving double the credit requirements and/or achieving the next incremental percentage threshold of an existing credit in LEED.

One point is awarded for each exemplary performance achieved. No more than 3 points under IDc1 may be earned through PATH 2— Exemplary Performance.

POTENTIAL TECHNOLOGIES & STRATEGIES

Substantially exceed a *LEED Canada for New Construction and Major Renovations 2009* or *Core and Shell Development 2009* performance credit such as energy performance or water efficiency. Apply strategies or measures that demonstrate a comprehensive approach and quantifiable environment and/or health benefits.