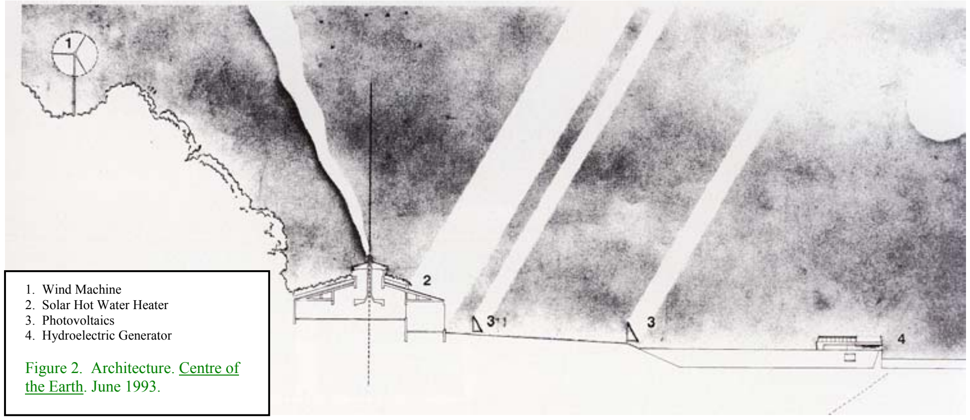
Boyne River Ecology Centre Case Study

The Boyne River Ecology Centre was intended to be a theory in practice representation of Environmental Design. Built by architect Douglas Pollard, it marked a standard to design by and the ideal mentality of sustainable architecture. A 517 square meter educational facility, it is located in Shelburne, Ontario. The Toronto Board of Education financed the project after the decision was made to turn an existing ecology facility into an outdoor educational centre for students and teachers within the school system. Classes were organized weekly throughout the year for students to learn about vitality and sustainability and their integration with the building process. The project was most successful at providing examples to learn by, both for students and architects in the future. The Ecology Centre embodies sustainable and economical practices in its construction, employing resource conservation, off-grid power supplies, efficient materials, renewable design and a waste water treatment system.

The Ecology Centre was conservative with its use of resources. Beavers had cleared the site so destruction of trees was minimal. The earth that resulted from excavating was reused in the sod roof, where local plant life (fescue grass, wildflowers, Queen Anne's Lace, and wild mustard[i]) grew on a volunteer basis from the seeds already implanted in the soil (fig 1). The circular, sixteen-segmented envelope was the most efficient organization of space as the central fireplace radiates heat outward like a drop of water into a pool. This minimized the use of material and decreased the surfaces for heat gain and heat loss. The lack of corners introduces less thermal breaks and allows for wind to sweep across the façade without turbulence. The backside of the building is burmed into the earth to take advantage of the temperature of the ground. As the central fire is not always needed it becomes more ceremonial, but when it is lit (during the winter months) it warms water pipes in a radiator heating system which circulates through the building, accelerated by thermo siphoning and storing itself in an insulated tank.[ii] The windows are triple glazed, argon filled, low E coated with silicon edge spacers.[iii] Air enters the building from the cupola where a heat exchanger is employed to warm the incoming fresh air. Fans then force the air downwards where it is diffused through ducts into the classroom floors.[iv] The fireplace was problematic, the flue was not properly designed and it was difficult to continuously be tending to the fire. A wood pellet furnace that proved more useful, but required monitoring of the carbon monoxide levels and new ductwork installation eventually replaced it[v]. The Ecology Centre was successful in conserving the resources on site while embracing the challenges put forth by the environment

Figure 1. The Canadian Architect. Eco Building at the Boyne. June1994

The building, since sited in an area conducive to off-grid power was able to use three separate types of alternative energy (fig 2), a feat not usually achieved due to the available surroundings of most buildings. In the winter months a wind machine, placed on the crest of the hill that overlooks the site, generates 9.3 kWh/day, which accommodates 60-70% of the building's electrical requirements. However, if the wind machine fails it is a considerable burden to fix. In the summer, photovoltaics placed behind the building generate an average of 2.3 kWh/day and are easily maintained and added to. In the spring and fall a micro hydro generator, affixed to the existing dam on site, generates 3.7kWh/day. This process is also cumbersome as there are often leaf and debris clogging the turbine. The other down side of these types of power generation is that the surplus, or overhead that is not needed to supply the building is wasted, as the building typically only uses 5 kWh/day. [vi] As an afterthought the building implemented a device to sell power to Ontario Hydro so as not to waste the excess. The power is stored in on site battery packs, but the problem remained that were there to be a 'dry' spell then the batteries could discharge. As a result the school elected to connect to the utility electrical grid.[vii] While having these difficulties with the off-grid power systems they still allow an alternate means of energy consumption that is neither wasteful nor depleting.



1. Wind Machine
2. Solar Hot Water Heater
3. Photovoltaics
4. Hydroelectric Generator

Figure 2. Architecture. Centre of the Earth. June 1993.

The materials chosen for the Ecology Centre were done so on a basis of durability, limited off-gassing, low embodied energy and ease of maintenance. Terra Cotta clay brick, concrete, linoleum and the main frame columns are in their original states, and all lumber that was used was untreated (fig 3). Wood was selected based on its rate of renewal, and a British Colombian species was chosen.[viii] Linoleum was made with wood flour, linseed oil and natural pigments and the cleaning methods involved mild soaps and water, as powerful cleaners are both hazardous to the staff and to the material itself.[ix] The interior wood siding is finished with beeswax, paints are non-toxic and all exterior stains are water based. [x] Metals were avoided when possible because of their embodied energy, although by using B.C. timber rather than local suppliers they would have incurred a larger embodied energy for the wood. To make up for this the interior walls were

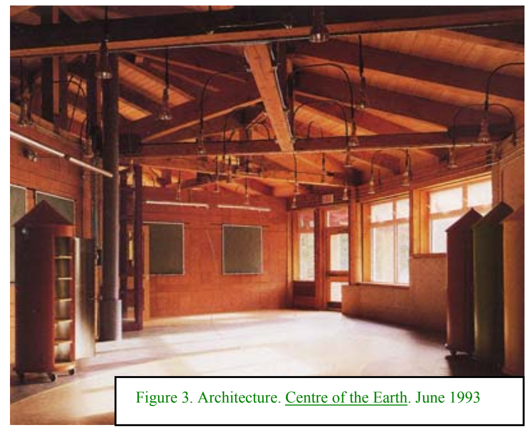


Figure 3. Architecture. Centre of the Earth. June 1993

finished with a local cedar, also capable of quick renewal. These materials represented the conscious choices of the design team to make a building both structurally and aesthetically efficient.

The design of the Ecology Centre is relying heavily upon passive heating and cooling in order to keep the building at a comfortable interior temperature, without having to use fossil fuels or electricity to do so. The building has several thermal heat sinks: the uninsulated basement, the sod roof and the large surface of exterior walls. The basement has no insulation below it with the intention of staying at the same temperature of the earth. The walls of the foundation are insulated only on the exterior so that they can be a part of the heat sink as well. The sod roof acts both on its absorption and its reflection of radiation. When damp, the soil dissipates any absorbed heat through evaporation, or can create a 9-hour temperature time difference so that it can re-radiate the heat gained during the day. When the sun beats down on the plants, they reflect 20-30% of the radiated heat, while the rest is taken care of by absorption.[xi] The exterior walls are able to allow radiating heat in through the circular forms, which are south facing but well insulated with a collective R-value of 34.7.[xii] Daylighting comes from clerestory windows, light shelves and from a multitude of angles from the curved southern façade (fig 4). One problem was that the central hearth, covered by a massive concrete shelf, remains a dark core when the fire is not in use. Skylights could solve this but they are not used, presumably because of the complexity of the sod roof. There is one particular classroom on the interior that is in a great deal of darkness comparatively because it is near the backside of the building, which is burmed into the earth. There is a glycol solution that flows through solar collectors on the roof and feeds down into the storage tank where it heats the water for the radiator system. The fireplace itself is another method to heat the water for the radiator system, as the pipes pass around the backside of the hearth.[xiii] Ventilation provides for passive cooling. The partition walls in the Centre do not reach the ceiling so air is free to circulate. The issue with this is that there is a significant loss of acoustic separation and the class rooms quickly become noisy, also in part to the hard surfaces that make the walls.[xiv] All windows are operable, and the metal screens outside of the building foster cooling as well. The main elements of cooling come from the equalization of the basement and the back wall with the earth. Although no legitimate records exist to show that these techniques are successful, due to budget cuts at the last minute. The caretaker kept record of the temperature trends during the changing seasons. In July, when the temperature outside was 36°C, the temperature inside the building was at 26°C. In December, over Christmas break when there was no one in the building the

Figure 4. Architecture. Centre of the Earth. June 1993

temperature outside was –20°C and the temperature inside was 10°C.[xv] These are quite impressive differences, showing that the building is successful in using the passive heating and cooling processes.

The most ambitious of the methods towards sustainable living comes from a biologist by the name of John Todd. His Living Machine is designed to recycle 800 gallons per day.[xvi] The system is made up of 17 cylindrical canisters, sitting upright in a spiral pattern, so that waste starts at the top and gravity takes it to the next cylinder where another process takes places in the purification of the waste (fig 5). The first group of tanks is an anaerobic environment where bacteria consume nutrients, reducing the amount of suspended solids and biochemical oxygen. The next group are closed aerobic tanks using bacteria to nitrify ammonia into nitrite and finally nitrate. Following this the tanks are open with algae, duckweed, snails, flat worms, catfish and other organisms to consume the remaining nutrients in the water. The water then flows to the next tank, which is an indoor marsh. The final tank is an indoor pond, with fish and plant life living in it, as proof of its cleanliness.[xvii] Because the Boyne River Ecology Centre suffered budget cuts during its completion there is not the proper monitoring system to prove the recycled water fit to reuse in the building's water system. This is a shame because this water could be used to sustain the building completely, instead it acts solely as a teaching aid.

Figure 5. Architecture. The Centre of the Earth. June 1993.

It could be presented that because of this weakness, the political mind sees this not as an opportunity or investment, but a very expensive teaching aid which has yet to pay itself off. Ernie Eves and his government decided that it would be better to remove the building from public hands-the Toronto Board of Education-and privatize the land in an effort to turn a profit. Trustee Cary-Meagher states, "This is nothing but asset stripping by a dying government. Some would call it vindictive politics." If Premier Eves thought that it was worthwhile to keep this educational centre functional he would keep it in the hands of the Toronto Board of Education. Privatizing the land it rests on will make selling the property easier, and the building will be torn down. . It is more reasonable to believe that the action of the government is based more on finances than on the facility's effectiveness. The 2002 funding report made no mention of outdoor education, and Boyne River's closing is a result of that. Helen D. Gault, Manager of Education at the Federation of Ontario Naturalists (FON), has stated that, "these closings are the most visible evidence of a systematic move away from environmental and outdoor education happening across Ontario."[xviii] The efficiency of the passive heating and cooling, as well as the lack of dependency on the power-grid suggest that operating costs of the facility are reasonable considering how valuable an asset it has proven to be as a educational center. The issue of public and government awareness of environmental and sustainable building need be raised. It should not be only those willing to invest in environmentally responsible architecture. In its actions, the provincial government is giving the wrong message to the public about this issue.

The Boyne River Ecology Centre was designed and built before the implementation of the Leadership in Energy and Environmental Design (LEED) program. Because of this the building was never properly rated or accredited. However, this environmentally driven design would undoubtedly achieve certification. Of the 69 available points in the LEED program, there is evidence suggesting that the Ecology Centre accounts for between 26 and 35 of the points. These arguments are found in the LEED Appendix. Insufficient information was available to argue for the other 34 points but it is quite probable that many would be awarded, based on the building's directive. There are four points awarded for Innovation & Design Process that require, in writing, the intent, requirements, submittals, and design approach strategies of the project. An environmentally aware architect would surely submit these. It is reasonable to assume that a project addressing so many environmental concerns and principles would achieve at least LEED Silver Status.

The Boyne River Ecology is a building that embodies sustainable practices by employing resource conservation, off-grid power supplies, efficient materials, renewable design and a waste water treatment system. The Centre should be an example for future sustainable practice. The building does not wholly complete the task set before it to become completely self-sufficient as the building is not set up to monitor its methods. However it far exceeds the hopes of an educational centre teaching people about sustainable practice in architecture, and the design sensibility of environmentally friendly building. Although it is currently not in use it still represents the right direction of architecture and is a stepping-stone to the acceptance of sustainable practice.

LEEDS Appendix

Sustainable Sites

5.1 Reduced Site Disturbance: Protect or Restore Open Space
There is little to no built areas beyond the building perimeter, walkways or parking lot. Also, the area on which the building is located had no major vegetation to take down. "The building snuggles into the south side of a small wooded hill in a clearing made by beavers."[1]

5.2 Reduced Site Disturbance: Development Footprint
As a rural site the area has no zoning requirements highlighting criteria for open space, it is likely that this credit applies to the mainly undeveloped site.

7.1 Heat Island Effect: Non-Roof
There is no paving onsite. The gravel parking lot is a permeable open-grid pavement system.

7.2 Heat Island Effect: Roof
A point is award because the roof is vegetated on well over 50% of its area.

8 Light Pollution Reduction
Night sky access is virtually unaffected as there are very few night lights outside the building.

Water Efficiency

1.1, 1.2 Water Efficient Landscaping: Reduce by 50% & No Irrigation
No landscape irrigation is employed as it is left to all natural vegetation. The area around the building is indigenous fescue grass.[2]

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[1] Canadian Architect p. 17
[2] Canadian Architect p. 17

2 Innovative Wastewater Technologies
100% of wastewater is treated on site, in the front room.

3.1, 3.2 Water Use Reduction: 20% Reduction & 30% Reduction
"The building can also treat its own sewage and waste water naturally in its own front room."[3] The intention of the living machine is to make the building's waste water available for greywater uses.

Energy and Atmosphere

1 Optimize Energy Performance (1-10 points)
Heating and cooling use entirely passive systems, water is heated through a solar heating system, and interior lights use renewable energy and are "controlled with timers and motion sensors."[4]

2.1, 2.2, 2.3 Renewable Energy: 5%, 10%, 20%
The combined renewable energy systems produce up to 15 kW/day and the building only uses 5 kW/day.[5]

6 Green Power
All of the project's power is off-grid renewable. It is only linked to the power grid for backup purposes.

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[3] Canadian Architect p. 15
[4] Canadian Architect p. 19
[5] Canadian Architect p. 18

Materials and Resources

2.1, 2.2 Construction Waste Management: Divert 50% From Landfill, 75%
"The earth roof not only replaces the biomass which the building has displaced, it increases it."[6] Measures were taken to refrain from being wasteful in construction.

5.1, 5.2 Regional Materials: 20% manufactured regionally, 50% extracted regionally
"The walls were finished in locally available 1" thick cedar boards in smalls sizes that can be regrown quickly."[7] Local materials were used whenever possible.

6 Rapidly Renewable Materials
The local and British Columbian lumber products have short regrowth times.

Indoor Environmental Quality

4.1, 4.2, 4.3 Low-Emitting Materials
"Material finishes were kept to a minimum, and environmental factors as well as costs were considered…substances had to 'look good, feel good, and smell good.'"[8] Because of their toxicity materials with solvents were avoided.

6.1 Controllability of Systems: Perimeter Spaces
All regularly occupied areas have windows and lighting controls.

8.1, 8.2 Daylight and Views
Sunlight is available directly to all regularly occupied rooms.

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[6] Canadian Architect p. 17
[7] Canadian Architect p. 19
[8] Canadian Architect p. 19

References:

[i] The Canadian Architect. Eco Building at the Boyne. June 1994. p.17
[ii] Architecture. Centre of the Earth. June 1993. p. 52
[iii] Elena Chernyshov. Boyne River Ecology Centre. Shelburne, Ontario. p. 4
[iv] Architecture. Centre of the Earth. June 1993. p. 52
[v] The Boyne River Ecology Centre. http://www.fes.uwaterloo.ca/architecture/faculty_projects/terri/findings.html
[vi] The Canadian Architect. Eco Building at the Boyne. June 1994. p.15
[vii] Elena Chernyshov. Boyne River Ecology Centre. Shelburne, Ontario. p. 6
[viii] The Boyne River Ecology Centre. http://www.fes.uwaterloo.ca/architecture/faculty_projects/terri/findings.html
[ix] The Canadian Architect. Eco Building at the Boyne. June 1994. p.19
[x] Architecture. Centre of the Earth. June 1993. p.56
[xi] The Canadian Architect. Eco Building at the Boyne. June 1994. p.17
[xii] The Canadian Architect. Eco Building at the Boyne. June 1994. p.17
[xiii] Emily Maemura. Boyne River Ecology Centre. Shelburne, Ontario. p. 4
[xiv] The Boyne River Ecology Centre. http://www.fes.uwaterloo.ca/architecture/faculty_projects/terri/findings.html
[xv] The Canadian Architect. Eco Building at the Boyne. June 1994. p.15
[xvi] Architecture. Centre of the Earth. June 1993. p.56
[xvii] The Boyne River Ecology Centre. http://www.fes.uwaterloo.ca/architecture/faculty_projects/terri/findings.html
[xviii] Ontario Nature. http://www.ontarionature.org/news/template.php3?n_code=140