EARTH RANGERS FOUNDATION CENTRE
WOODBRIDGE, ONTARIO

BAUTECH DEVELOPMENTS INC.

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EARTH RANGERS CENTRE
WOODBRIDGE, ONTARIO

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# Quick Facts

<table>
<thead>
<tr>
<th><strong>Building Name</strong></th>
<th>Earth Rangers Centre</th>
</tr>
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<tbody>
<tr>
<td><strong>City</strong></td>
<td>Woodbridge, Ontario, Canada</td>
</tr>
<tr>
<td><strong>Year of Construction</strong></td>
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<td><strong>Client/Owner</strong></td>
<td>Earth Rangers Foundation in partnership with the Toronto Wildlife Centre</td>
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</table>
| **Architect**     | Bautech Developments Ltd.  
Project Architect: John Buttner |
| **Consultants**   | Civil Engineers: Marshall Macklan Moghnahan and Philips Engineering,  
Construction Manager: Internorth  
Construction, Electrical Engineer: MCW Consultants Ltd.,  
Energy Consultant: Transsolar Energietechnik,  
Landscape Architect: PMA Landscape Architects,  
Mechanical Engineer: Enermodal Engineering Ltd.,  
Structural Engineer: Internorth Engineering Inc. |
| **Program**       | Wildlife treatment, rehabilitation and education |
| **Gross Area**    | 60,000 square feet (5,800m²) on a 31 acre site |
| **Climate**       | Temperate-cold |
| **Site Conditions** | Located in an 800-acre natural area |
| **Aesthetics**    | Heavy concrete construction with curtain wall, E.I.F.S. stucco and field stone exterior finish |
| **Structural System** | Reinforced concrete with load-bearing concrete block and steel stud infill walls |
| **Mechanical System** | 100% radiant cooling and heating using 21km of tubing buried into the structural concrete slabs; “earth tubes” pre-condition incoming ventilation air allowing for high air exchange rates while minimizing energy consumption; outperforms the MNECB by 65% |
| **Ventilation**   | Both natural and mechanical ventilation – operable windows and ducted air supply through in-floor displacement ventilation system |
| **Special Construction** | Vegetated roof garden; saw-tooth roof profile combining north-facing skylights with solar panels for heating domestic hot water and producing electricity |
| **Day-lighting**  | All rooms save mechanical areas are at least partially naturally lit; north-facing sky-light bring additional lighting into the second floor office areas |
| **User Controls** | Individual thermostats and operable windows in office areas along with automated controls and occupancy sensors; laboratories and surgery theatres are mechanically controlled to provide for consistent air quality and high ventilation rates necessary for a “health care” facility |
| **LEED Score**    | 34 points – Silver |
| **Cost of Construction** | $23 million |
INTRODUCTION

While most people mindlessly concentrate on their intense daily schedules, our routine activities which otherwise occur without much thought, actually affect the lives and well being of others. Often, the most greatly affected by our activities are animals and wildlife. Humans affect their habitation, the food that they eat, and the air and water that they depend on. Each year, thousands of wild animals are injured, displaced or orphaned because of human activities. Animals are most threatened by human thoughtlessness and error as in the case of car accidents, oils spills and other environmental pollution. As human daily life intensifies, the number of endangered animals and habitats increase. Consequently, as humans we bear the responsibility to help both the animals and environment which are so profoundly affected by our activities.

As self-proclaimed “animal ambassadors,” the Earth Rangers Foundation realizes that in order to help improve the plight of both wildlife and the Earth, humans must undertake not only remedial efforts, but also educate future generations. According to the Earth Rangers mantra, changing human behaviour is a positive step towards creating a sustainable future. Since their foundation, this non-profit organization has concentrated their efforts on both animal rescue and youth education programs. As their organization and activities have grown, however, so has their need for space in order to realize their ambitions. As a result, in 2002 the Earth Rangers commissioned Bautech Developments of Newmarket, Ontario, to create a new home for their organization that would allow them to fulfill their two principle missions while exemplifying their tenet of building for a sustainable future. As a result, today the Earth Rangers Centre is considered not only one of the “most environmentally sustainable buildings in Canada,” but also a premier facility for animal rescue, rehabilitation and education.
SITE

The Earth Rangers Centre is located within an 800-acre natural area governed by the Toronto and Region Conservation Authority. The Earth Rangers negotiated a long-term lease of 31 acres within the Kortright Conservation Area of the site in order to build their new facility. Because of its sensitive surroundings, during the design stage special attention was paid to minimizing disruption to the local ecosystem while maximizing the views from the building. The siting of the building within a conservation area also helps fulfill part of the building’s programmatic requirements: resident animals stay in close proximity to their natural habitat which facilitates their transition back into the wild upon their release. The site also facilitates the Earth Rangers’ educational programmes by offering a contextual learning environment. As an added benefit of the building’s natural surroundings composed entirely of hearty, native plant species, the building’s landscaping does not require irrigation.

PROGRAMME

The 60,000 square foot (5,800 square metre) Earth Rangers Centre houses all aspects of the charity’s organization, including its administrative, rescue and educational functions. The building includes a small theatre, seminar rooms, administration offices, an area of interactive educational displays, a cafeteria, a kitchen specialized in animal food preparation, cage cleaning and storage facilities, as well as a world class veterinary hospital. The hospital’s rehabilitation rooms and treatment areas are designed according to the specific needs of different types of animals that vary according to size. For example, rooms and labs for deer differ from those for reptiles and birds because each has specific requirements – whether a wading pond or flight cage. The centre
also houses North America’s only adult deer treatment facility. For large animals such as deer, large predators, or even raccoons, the rehabilitation spaces were designed with durable walls and finishes. Rooms for smaller animals such as birds and small mammals were designed with out potential hiding places, or routes of easy escape.

The Earth Rangers Centre provides one of Canada’s only oil spill response units for wildlife. Statistically, one animal per week is involved in a chemical or oil spill. Consequently, the centre is equipped with a specialized area for decontamination. This crisis unit has a separate water cistern that collects all its wastewater so that it can be treated separately from the water used throughout the rest of the building.

For the public areas of the building, the overall design strategy was to provide opportunities for humans to interact with wildlife while at the same time educating them about the realities of human-animal interaction and their shared...
responsibility through the building’s architecture. In designing the centre, the architects strove to create one of the world’s most energy efficient buildings. Experts from different areas in the industry were recruited, ensuring the efficiency of all components of the building from the initial stages.

In addition to their youth education and summer camp programs, the new Earth Rangers Centre is expected to attract over 130,000 visitors from around the world each year. In their much smaller former home, more than 16,000 children visited their facilities, while over 750 kids enjoyed one of the Earth Rangers’ summer camps. While the new centre will draw many visitors because of their extraordinary facilities, educators and children are drawn to the Earth Rangers because of their programmes that extend beyond their property such as school-yard naturalization projects, waste and energy audits, and community clean-ups. With their expanded facilities, the Earth Rangers are now able to offer three levels of educational programs: professional, public and youth. Professional education includes veterinary internships which encompass research, medicinal, and surgical treatment of animals. As part of the Earth Rangers internship programme, a second building was constructed on the site to function as dormitory style residences. The second building, like the main Centre, was designed with energy efficiency and sustainability in mind, and meets the stringent standards of an R-2000 building.

The public and youth programs concentrate on more generalized educational themes, employing a wildlife hotline, interactive website, on-site lectures, interactive displays and demonstration gardens. Through these programmes and the location of the building, visitors are able to have close contact with wildlife in their natural environment while treating up to 5,000 animals per year. In addition, the building is open year-round to the public for the drop-off of injured or immature animals.²
LIGHTING/VIEWS

The building’s roof is lined with north-facing skylights that are used to provide and enhance the building’s natural day-lighting. The saw-tooth skylight roof filters north light into the second floor administration areas, dramatically reducing the building’s energy demand for lighting by half. On the opposite side of the skylights is an interconnected solar array of 16 panels that both generate electricity and heat the building’s domestic hot water by pumping it through black tubes integrated into the panels. The backs of the skylights are angled 30 degrees towards the south in order to maximize the solar gain. Reflected light that is bounced off of the solar panels into the skylights results in a diffuse ambient light without glare.

Artificial lighting is also used in the building. All systems are high-efficiency and operated by automated sensors and dynamic dimmers that either reduce lighting levels when sufficient day-lighting is available or turn them off when spaces are unoccupied.

In addition to maximizing the amount of daylight entering the building, designers sought to maximize the view to the surrounding natural landscape without greatly increasing heat loss via openings in the building façade. As a result, double-glazed windows with low-emissivity coatings are used for the office areas. The glazing units have a U-value of 1.1 W/m², a solar heat gain coefficient (SHGC) of 25%, and a VLT of 50%. The windows also have an argon gas fill between the panes and insulating frames with continuous edge spacers to avoid any air leakage. All windows in the office areas are also operable to allow building occupants to have direct control over their work areas and introduce natural ventilation into localized spaces.
HEATING/COOLING

Behind the exterior cladding constructed of a locally manufactured curtain wall and E.I.F.S. stucco system, the Earth Rangers Centre is a building of great substance. Made of structural reinforced concrete with load-bearing masonry walls, this heavy construction provides a durable structure while doubling as a damage and moisture-resistant interior finish. In addition to its durability, however, the concrete structure also plays a significant role in the building’s mechanical systems.

Approximately 3,400m² of exposed concrete is used as an interior floor finish. All of this concrete has a mass of approximately 1,570 tonnes, and a heat storage capacity of approximately 1,570MJ per degree of temperature change. This allows the building’s structure to act as a thermal heat sink, thus greatly improving the comfort and energy performance of the building. The excess heat gained by the building is dispelled at night through a radiant cooling system integrated into the structural concrete slabs. Overnight, the slabs are cooled to about 18°C using water supplied by an exterior cooling tower and supplemented by a back-up 113kW (32 tonne) chiller. The building’s radiant cooling system consists of 21km of polyethylene tubing within a 200mm- to 300mm-thick concrete slab. The area of radiant cooling – which represents the 3,400m² area of exposed concrete – accounting for approximately 70% of the building’s total floor area. This system allows the structure to warm up to 22°C during the day as it absorbs both direct heat gain and ambient energy from the interior spaces. This represents a total heat storage capacity of approximately 1,740kWh (500 Tonne-hours) – enough to provide much of the necessary cooling on a typical design degree day. Since the rest of the building’s cooling can be provided by a low-energy consuming cooling tower rather than a traditional electric chiller and air conditioning system, the electrical energy demand for the building’s cooling...
is significantly reduced. Consequently, the design cooling load for ventilation and space conditioning is only 64 Tonnes – approximately one half of that required for a similar building using more “conventional” mechanical systems. As a result, the supplementary chiller is half the conventional size, representing a significant capital cost and on-going maintenance savings.

The cooling capacity of the radiant slab system depends on the temperatures of both the cooled ceiling/slab and the un-cooled surfaces in the space. Cooled slabs have a lower specific cooling capacity, but compensate by their greater area. All slabs within the building are exposed from both above and below to ensure their cooling function. In the end, this results in an indoor environment with a more stable temperature. Through the use of radiant heating and cooling, energy efficiency and occupant comfort are easily achieved. The Earth Rangers Centre is one of the first buildings in Canada to be completely heated and cooled using this type of thermally activated radiant slab system.

The polyethylene tubing is installed midway in the slabs, seated on metal “chairs” atop a 150x150mm welded wire mesh and between two layers of reinforcing steel. This provides approximately 75mm of clearance between the tubing and fasteners drilled into the slab from below for pipe and duct hangers. Some threaded inserts were also set into the bottom form for mechanical anchors, but the designers still wanted to permit future drilling into the slab without risk of puncturing the tubing. Coordination was also required with the installation of electrical conduit and mechanical slab penetrations for the radiant slabs cannot be core-drilled after they are poured. In the end, the 21km of tubing was installed spaced at intervals between 150mm to 300mm on centre and distributed by 20 manifolds. The concrete work as well as the intricate detailing and coordination, were no small feat considering that the majority of the concrete work was done during -10°C to -25°C weather in January through March 2003.

Figure 15 (Above): Cast-in-place concrete was used throughout the Earth Rangers Centre and for all structural components - even the roof. Figure 16 (Bottom Left): Although the structure consists mostly of poured concrete, in-fill walls also contribute to thermal storage of the building such as those made of concrete masonry.
During warmer weather the building is cooled primarily through the radiant slab and cooling tower system. During the winter, however, a high efficiency natural gas condensing boiler located in the basement is used for heating water which is circulated through the same tubing in the floor slabs. Condensing boilers are up to 88% efficient in converting fuel into heat compared to approximately 72% for conventional types of systems. Incorporated into the boiler is a heat exchanger which reuses waste heat that would normally escape up the chimney. As a result, the temperature of flue gasses is greatly reduced to the point where water vapour is produced during combustion. This “condensation” gives this type of boiler its name.

In addition to the heat exchanger incorporated into the boiler, in regularly occupied areas of the building that are heated with the radiant slab, two secondary heat exchanger systems are used. The office area uses an enthalpy wheel heat recovery system, while the animal areas use a glycol loop. In the remaining 30% of the building that is composed of low-occupancy spaces such as vehicle storage and receiving bays, location-specific, gas-fired, infra-red radiant heaters are used in lieu of the radiant slab system.

Another advantage in using the active radiant slabs is an overall reduction in the amount of ductwork needed in the building. This is because the slab is used for cooling rather than a forced air system. In order to fulfill this function, however, the slabs are exposed, thereby eliminating dropped ceilings. This allows for a greater perceived ceiling height as well as minimizes the overall material use for the building in terms of sheet metal for ducts and ceiling finishes. These up-front savings from reductions in mechanical conveying systems and materials helped offset the cost of the complicated concrete structure.
VENTILATION

Indoor air quality became a crucial design factor for the Earth Rangers Centre. Since the building is considered a health care facility, it requires a significant amount of fresh/outside air to maintain healthy conditions for both “patients” and workers. The ventilation rate for the Centre is over 9,400 litres per second, averaging 2.5 air changes per hour in the office and educational areas of the building, and 6 air changes per hour in the hospital surgery and lab areas. Because of this requirement, the heating and cooling ventilation air could have been the single largest energy cost for the building. Consequently, in order to reduce the energy demand and cost of providing the necessary ventilation rates, the Earth Rangers Centre uses a network of underground concrete tunnels – or “Earth Tubes” – to temper fresh air entering the building’s ventilation systems.

“Earth Tubes” are a well-established technology originating in Europe. They allow all of the air used in the building’s ventilation systems to be 100% outside air with no recirculation. The technology is simple: outside air is drawn through a series of buried “tubes” allowing the surrounding earth to moderate the temperature of the incoming air so that it is either pre-heated or pre-cooled depending on the time of year. This ground-to-air heat exchange system consists of nine 900mm diameter, 20m long pre-cast concrete pipes buried beneath the frost line – or approximately 1500mm below grade. The “earth-tube” installation used for the Earth Rangers Centre is the largest of its kind in North America.

All of the concrete pipes are straight and large enough for inspection and maintenance. Once the air enters the building through a series of rain and snow proof louvers and dust filters, it is fed along a double-foundation wall providing further natural heating and cooling of the building’s structure before

Figure 19 (Above): The Earth Tubes supply the Earth Rangers Centre with pre-heated or cooled air depending on the time of year by a minimum of 3°C.
Figure 20 (Bottom Left): The entrance shaft to the Earth Tubes during construction, prior to the application of louvers and filtration media to ensure that little or no dust or particles are able to infiltrate the building’s ventilation system.
entering into the ventilation system. The second wall inside of the poured concrete foundation is constructed of insulated concrete masonry. The tunnels and double foundation wall provide a total of 1,500m² of thermally conductive surface between the ventilation air and the surrounding earth. Since the soil temperature below the frost line varies seasonally between 4°C and 17°C, while the entering air varies from -30°C to +35°C, the potential for beneficial heat transfer is great. As a result, air is pre-warmed or pre-cooled by as much as 15°C before entering the air handling system – without spending a dollar. This represents a 30kW reduction in the heating and cooling load, a 12% increase in ventilation heat recovery effectiveness over a conventional system, and an estimated $7,000 per year savings in operational costs.

These cost and energy savings as well as a heat transfer analysis to calculate the tunnel wall surface temperature based on the thermal resistance of the soil in the region of the tube wall was conducted using FRAME software. Further analysis is required to determine the long-term effects on the soil temperature in the vicinity of the Earth Tubes and the foundation, as well as the “real” costs of building operation in comparison to the computer generated models. Transsolar Energietechnik of Germany calculated the overall thermal performance of the system at the design stage, however, the extensive system of monitors and sensors incorporated into the building will now determine their accuracy.

After passing through the Earth Tubes, but before being distributed throughout the building, the incoming air passes through two levels of filtration. First, in the double foundation wall plenum a series of ultraviolet lights irradiate the air for mould and bacteria. Second, before entering the enthalpy wheel heat exchanger that is integrated with the radiant slab heating system, the air passes through liquid desiccant dehumidifiers to remove any remaining airborne contaminants. Although the tubes were designed to reduce pressure loss and the collection of condensate and dust through measures such as low-pressure
loss inlet filters, smooth sloped surfaces and sealed joints between the tube sections, as a necessary precaution, the Earth Tubes are constantly monitored by temperature and humidity sensors to ensure the quality of air entering the building’s ventilation system.

Once “cleaned,” the air is distributed throughout the building by a displacement ventilation system. It is argued that displacement ventilation provides superior indoor air quality and occupant comfort while requiring less fan power for air circulation. Although the science behind the technology is solid, one down side to displacement ventilation is that because air is introduced at floor level it allows for contaminants from occupants’ shoes to circulate within a given space – an unfortunate contradiction to the efforts taken to cleanse the air before it enters the system. With the use of Pedimats and other methods of indoor pollutant control, however, many of the disadvantages associated with the displacement ventilation system become negligible.

WATER

Potable water requirements for the facility are supplied by an on-site well. Sanitary and wastewater are treated on-site to better than tertiary levels of purity using a 98% closed loop wastewater system with a Zenon membrane bioreactor and UV light sterilization. A proprietary system, the Zenon membrane bioreactor was chosen for the Earth Rangers Centre for several reasons. First, because the series of ZeeWeed membranes are completely immersed within a constant water flow, the membranes are able to handle high levels of suspended solids and user-related “spikes” such as when a bus-load of school children arrive for the day. Second, because the filtration membranes operate within a slight vacuum created by a permeate pump and a subtle but regular air flow, the fibres

Figure 24 (Above): Formwork for the cast-in-place water cistern. Figure 25 (Bottom): Schematic of the Earth Rangers Centre’s wastewater recycling system.
of the membranes are constantly cleansed by the resultant turbulence. This allows the membranes to operate at a high flux.  

The Zenon ZeeWeed membranes also have an absolute pore size of 0.1 microns, ensuring that particulates and bacteria such as *Giardia* and *Cryptosporidium* are unable to pass through. The filters are also chlorine resistant up to concentrations of 1,000mg/L. As such, integrity of the system is not compromised by cleaning products. Despite this resistance, the filters are so effective at cleansing wastewater that pre-treatment and chemical usage in the system is greatly reduced. Consequently, because the Zenon system relies on the integrity and design of the membranes rather than chemicals for treating the building’s wastewater, it keeps with the overall aspirations of the Centre in minimizing its impact on the local ecosystem because little residue ever escapes from the building.

Once the water has been treated, it is reused in the facility for toilet flushing, animal ponds, irrigation, and maintenance such as floor washing. All of the building’s wastewater passes through this innovative treatment system, except that which is used for cleaning animals that have been contaminated with toxic chemicals. Wastewater from these areas is collected in a separate pre-cast concrete tank with a capacity of 50,000 litres for treatment and disposal off-site.

A storage tank collects the treated wastewater and mixes it with rainwater filtered through the green roof systems. The 310,000 litre cast-in-place concrete storage tank is large enough to accommodate all of the building’s needs as well as serve for fire protection because there is no municipal fire hydrant system available. By employing this cistern system that reuses wastewater for many basic building functions, the Earth Rangers Centre reduces its potable water use.
by approximately 60%, while dramatically reducing their wastewater discharge. This results in an annual savings of approximately $3,000. The concrete mix used for the cast-in-place cistern was the same as for the structural slabs: 32MPa C2 with 0.45 water/concrete ratio, 6 – 8% air entrainment, super-plasticizer, 20 – 25% slag plus silica fume as densifier in lieu of waterproofing. As a result, the cistern did not require any special liner or surface coating.\textsuperscript{21}

**CONSTRUCTION/MATERIALS**

The building is highly insulated to keep heating and cooling loads to a minimum. A minimum of R40 insulation (or about 180mm) is used in the roof and a minimum of R30 (or about 140mm) is used in all of the walls. Both the roof and wall assemblies exceed the insulation requirements of Canada’s Model National Energy Code for Buildings (MNCEB). By increasing the insulation in the building its mechanical systems were reduced, thus adding to the overall savings of the building. On top of the added insulation, flat portions of the roof are finished with a vegetated “green roof,” further contributing to the overall insulation value of the roof assembly. The structure did not require any additional strengthening to support the 150kg/m\textsuperscript{2} (30psi) design load of the roof soil and vegetation.

Table 1 details various building envelope assemblies, indicating their effective R-values as calculated by the EE4 software provided by Natural Resources Canada. These calculations account for parallel heat flow through composite assemblies such as structural steel walls.\textsuperscript{22} In addition, the EE4 software calculates the energy loss of the building envelope with the strict requirements of MNCEB to reduce thermal bridging through envelope assemblies.

In general, the use of materials in the Earth Rangers Centre corresponds with its need for energy efficiency and environmental sustainability. For example, concrete was chosen for the structure because of its invaluable properties as a thermal mass. Overall, where possible environmentally friendly materials were used such as carpets made with recycled content, and low-VOC emitting paints, sealants and adhesives. The roof is tiled with Enviroshakes, an engineered composite roofing material, 95% of which is made from post-industrial recycled plastics, fibres and crumb rubber from old tires.\textsuperscript{24} The roofing mimics cedar shakes, however, unlike wood they will not warp, crack, blister or attract insects. As such, the Enviroshakes are virtually maintenance free – a significant benefit for reducing operations and maintenance costs and increasing the building’s long-term durability and overall life-span.

| Table 1. Earth Rangers Centre Envelope Assemblies  \textsuperscript{23} |
|-----------------|-----------------|-----------------|
| **Component**   | **Construction**                        | **Effective R-Value** |
| Walls           | Masonry or steel stud w/rigid insulation, finished with stone masonry or E.I.F.S. stucco | R30 (RSI 5.3)         |
| Roof            | 200-300mm reinforced concrete slab w/ 200mm polyiso insulation. Flat roofs have white TPO membranes or vegetated “green roofs.” Sloped roofs are finished w/ Enviroshakes | R40 (RSI 7.0)         |
| Slab-on-Grade   | 200mm reinforced concrete slab on 50mm EPS insulation | R9 (RSI 1.6)          |
| Glazing, Skylights, and Curtain Wall | Double-glazed, low-emissivity, and argon-filled units w/ insulating edge spacers and aluminum frames w/ thermal breaks | \( U_{Si} 2.13 \) \( SHGC 0.32 \) \( VT 0.57 \)  |
Overall, the Earth Rangers Centre qualifies for an approximate 34 out of 69 points, landing it a low-Silver rating (see Table 2). In the Sustainable Sites category the Centre earns only 6 out of a possible 14 points. This poor score is reflected in part by the remote location of the building, where cars are necessary for full-time employees to arrive at work with no access public transportation to the site. Points in this category were earned primarily for measures employed to reduce storm water run-off and the heat-island effect by using a vegetated roof and cistern for storm water capture.

With all of the impressive measures used for recycling water, the building earns the full 5 points in the Water Efficiency category. Likewise, its second best showing is in the Energy and Atmosphere category earning 11 out of a possible 17 points. As modeled with the EE4 software, overall the Earth Rangers Centre uses 65% less energy than a reference building designed to meet the minimum requirements of the MNECB energy code. Table 3 shows various energy consuming building functions such as space heating and cooling and their energy consumption as percentages of the MNECB reference building. As a means of contextualization, Figure 28 shows the proportional energy consumption of the various building functions as percentages of the overall building energy usage. As shown by Figure 28, as a percentage of total building energy use, space heat, fans and lights still consume the most energy, even with the special measures used by the designers to reduce the overall consumption of the building.

The Earth Rangers Centre scores the worst in the Materials and Resources category of the LEED Rating System, receiving only 2 out of a possible 13 points for its use of concrete – a regional material. This is unfortunate because many points in this category are easily attained, however require additional administrative work on part of the design and construction staff. For example,

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<thead>
<tr>
<th>Table 2. LEED GREEN BUILDING RATING SYSTEM 2.1</th>
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<td>Sustainable Sites</td>
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<td>Water Efficiency</td>
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<td>Energy &amp; Atmosphere</td>
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<tr>
<td>Materials &amp; Resources</td>
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<tr>
<td>Indoor Environment Quality</td>
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<tr>
<td>Innovation &amp; Design Process</td>
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<tr>
<td><strong>Project Totals</strong></td>
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<tr>
<td><strong>Earth Rangers Centre Result</strong></td>
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</tbody>
</table>

**LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN**

Although currently the Earth Rangers Centre is pending accreditation under the LEED Canada NC version 1.0, at the time of writing the U.S. version 2.1 was used as the method of comparison with other buildings in Canada claiming to be environmentally sustainable. For the purpose of this case study, and to remain consistent with the other case studies produced as part of a research course conducted at the University of Waterloo under Professor Terri Boake, the older U.S. version of the rating system is used as means of evaluating the Earth Rangers Centre. This being said, in reality the differences between the older U.S. and current Canadian systems are minimal, allowing this discussion to remain valid.
although the building designers claim to have used low-e paints, adhesives and coatings, unless they were incorporated into the tender specification with their cut-sheets or material safety data sheets kept for submission to the Green Building Council at the time of certification, the building is unable to receive these particular LEED points. Unfortunately, the LEED certification process is documentation heavy, meaning that many buildings that comply with its criteria that lack supporting documentation do not receive credit where credit may be due.

In the Indoor Environment Quality category the Earth Rangers Centre earns nearly half of the possible points with a score of 7 out of 15. This is due to the attention paid to the ventilation systems with high air exchange rates, means of user control, and monitoring systems. Points that were lost in this category include day-lighting and views to 75% and 90% of indoor areas because of the deep floor plates on the main floor requiring highly controlled conditions such as those in the operating theatre. Despite this average scoring in the Indoor Environment Quality category due to programmatic constraints, the designers of the Centre feel that they will make up for it in the Innovation and Design category with 3 additional points for the Centre’s innovative use of concrete. Although 3 innovation points is unprecedented for buildings applying for LEED accreditation, the creative use of building materials that are integrated into the building’s mechanical system in the Earth Rangers Centre might make it a first.

<table>
<thead>
<tr>
<th>Mechanical/Electrical Function</th>
<th>Relative Percentage (%)</th>
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<tbody>
<tr>
<td>Space Heating</td>
<td>27%</td>
</tr>
<tr>
<td>Space Cooling</td>
<td>42%</td>
</tr>
<tr>
<td>Lighting</td>
<td>50%</td>
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<tr>
<td>Cooling Tower and Pumps</td>
<td>28%</td>
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<tr>
<td>Heating and Chilled Water Pumps</td>
<td>96%</td>
</tr>
<tr>
<td>Fans</td>
<td>59%</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>50%</td>
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<tr>
<td><strong>Total Building Energy Consumption</strong></td>
<td><strong>35%</strong></td>
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Figure 28: Relative Energy Consumption by Building Function

22% Ventilation Fans
8% Domestic Hot Water
13% Lights
10% Receptacles
7% Pumps and Miscellaneous
3% Heat Rejection
2% Space Cooling
35% Space Heating
CONCLUSION

To achieve a better environment, one must first possess a basic understanding of how one interacts with it. The Earth Rangers Centre, through both its youth education programs and its physical presence in the built environment, addresses this fundamental need for a greater understanding of our surroundings and the other beings with whom we share it. The Earth Rangers Centre embodies much of the same principles which they teach to the thousands of visitors that pass through their doors each year: a reduced impact on local resources and stewardship of our greater environment. The Centre demonstrates these principles by consuming approximately 65% less energy than a similar building designed to meet the Model National Energy Code - or the average building. This is also proven by meeting the criteria of a LEED Silver building according to the stringent criteria established by the U.S. Green Building Council. Furthermore, it is one of the first examples in Canada which has proven the possibility of achieving higher energy efficiency in a health care facility with a large ventilation demand. The simple strategy of using the structural concrete as part of the mechanical system proves that the use of common building materials rather than expensive “high-tech” systems, can provide first rate indoor air quality while at the same time dramatically reduce energy consumption. In the end, the Earth Rangers Centre demonstrates that architecture is one step closer to providing for a more sustainable future. In essence, the building embodies the Earth Rangers’ mantra that hopes to educate the youth of today, while also promoting a “legacy for our future.”
BIBLIOGRAPHY

Personal Interviews:

2. Dean, Nick: Manager, Marketing and Development, Earth Rangers.

Publications:


Internet References:

2. Earth Rangers Website. Source: http://www.earthrangers.ca/our_centre.html
6. Toronto and Region Conservation Website. Source: http://www.trca.on.ca/parks_and_attractions/places_to_visit/kortright_centre?load=earth_rangers

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ENDNOTES

1. Environmental Design + Construction Website.
2. Sources Website – Press Release.