A CASE STUDY OF INNOVATIVE SUSTAINABLE DESIGN

Jim Pattison Centre of Excellence in Sustainable Building Technologies and Renewable Energy Conservation

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The Jim Pattison Centre of Excellence in Sustainable Building Technologies and Renewable Energy Conservation—on the campus of Okanagan College in Penticton, British Columbia—is a shining example of what integrated design and sustainable innovation can be: a custom solution shaped by its site, the curricula it teaches, and those for whom it was designed. Conceived to meet the urgent need for tradespeople, site managers, and construction workers who are skilled in sustainable building practices, the structure itself is used extensively as part of the teaching curriculum and is highly-adaptable to future changes in technology and education.

The inspired, ambitious design of the LEED Platinum building broke new ground as one of the largest ever to pursue the Living Building Challenge—the most rigorous sustainability standard on the planet. To achieve net-zero energy and water consumption, a three-pronged approach to energy and water use was adopted: conserve, capture, and create. Passive strategies, which aid in optimizing active and renewable strategies, were prioritized and “bundled” together to ensure synergistic efficiencies.

Since opening in 2011, the Jim Pattison Centre has received numerous awards and accolades recognizing its achievements in innovative, sustainable design. It was one of three buildings, in North America, cited by the New York Times Knowledge Network as a leading example of carbon-neutral campus architecture; and has received honors from the Canadian Green Building Council, the Green Good Design Awards, and the Applied Science and Technologists and Technicians of British Columbia. Additionally, the Centre received top honors, among university and college buildings, in a recent ranking of Canada’s greenest buildings by the 2016 Green Buildings Review.

A FOCUS ON SUSTAINABLE EDUCATION AND DISCOVERY

The Centre was designed to not only provide teaching spaces, but also to serve as a living laboratory for sustainable building and alternative/renewable energy technologies, processes, and education. To that end, the structural, mechanical, and electrical systems are exposed throughout the building. Students studying these systems have complete access to them and experimentation is encouraged. Live building data is available on a web-based interface and the accessible rooftop allows for study of experimental technologies, including solar chimneys, solar tubes, wind turbines, and photovoltaics. The green roof is also equipped with a viewing gallery so visitors to the facility can see sustainable technologies up close.

The highly adaptable design easily supports new technologies to ensure relevance and currency with a changing curriculum. Start-up companies can prototype new green technologies in the synergistic environment of the embedded Okanagan Research Innovation Centre. Flexibility for change in program and space use is accommodated by using an open plan configuration for all office space and a standardized module for future classroom needs

COMMUNITY INTEGRATION

It could be said that the Jim Pattison Centre was born in a spirit of community integration and input beginning with a three-day design charrette involving over 60 stakeholders including: the design team, college staff and students, municipal and provincial government representatives, city planning and engineering, community groups, and local residents and businesses. Day 1 of the charrette focused identifying participants' needs and concerns, and Day 2 was dedicated to implementation strategies. During an open house on Day 3, the design team stepped back, allowing local representatives to answer questions and lead discussions. Participants were impassioned and empowered in their conversations supporting the design, attesting to the success of this inclusionary process.

Local sports groups, non-profits, and community groups use the Centre on a weekly basis. It is a celebrated gathering place for the community and was recently selected by Canada's National Women's Hockey Team for its summer training camp.

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A Closer Look at Performance

In 2015, the International Initiative for a Sustainable Built Environment (iiSBE) Canada—an independent, nonprofit group of Canadian engineers, architects, and researchers who seek to promote sustainable environments—published the results of a building performance evaluation conducted at the Jim Pattison Centre (Chu et al., 2015). The aim of the evaluation was to compare actual building performance with predicted performance, and identify and report lessons learned to the sustainable building industry. The findings of the iiSBE research are uniquely valuable because current green building rating systems (e.g., LEED and GreenGlobes) typically focus on predicted performance established during design. The goal of this case study is to describe the sustainable design features used in the Centre and to provide insight as to how the features performed, in practice, based on the iiSBE research. While not part of the iiSBE evaluation, the Centre's impact on community integration, and sustainable education and discovery are also discussed.

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Energy Reduction Strategy

DESIGN SOLUTIONS

To conserve energy, a super-insulated building envelope; consisting of R28 walls, an R40 roof, and triple-glazed, argon-filled windows was created in the Centre. Additionally, brise soleil enabled the Centre to utilize more efficient, low intensity HVAC systems, such as radiant slabs with a dedicated outdoor air system (DOAS) and CO2 controls for ventilation.

Energy capture is facilitated by vacuum tube solar panels, which satisfy the building's domestic hot water needs and supplement the radiant floor heating. An open-loop, ground source geothermal system provides heating and cooling throughout the floors and in the walls of the gymnasium. Daylight is optimized throughout the building and is supplemented by high efficiency lighting, controlled with both occupancy and daylight sensors. Solar ventilation chimneys improve airflow for natural ventilation, enhancing the stack effect with glazing on the south side for increased solar gain.

The 300 kWh/year grid-tied photovoltaic (PV) array was installed on the roof of the Centre to generate energy. A nontraditional flat installation decreased panel efficiency by 10%, but allowed 40% more panels to be installed on the roof. Surplus energy, generated from the PV array during the summer, is either transferred to adjacent campus buildings or exported to the local electric grid to achieve a net-zero balance. The system was believed to be the largest non-utility array in Western Canada, at the time of installation.

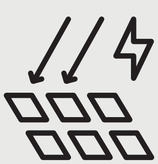
RESULTS

According to the iiSBE Canada performance evaluation, the building outperformed typical multiuse buildings in the area. Analysis of energy consumption data (for the two years included in the study) revealed the actual energy use intensity (EUI) of the building was 74% lower (76 kWh/m2 per year) than a typical academic building in this location, and 22% lower than energy modeling predicted for the building during design. Possible explanations for the results include less than predicted electricity consumption during winter and spring, and occupancy patterns that were different than expected. According to iiSBE Canada researchers, "Occupancy values are difficult to predict and record for multiuse buildings with changing occupancy numbers throughout the year."

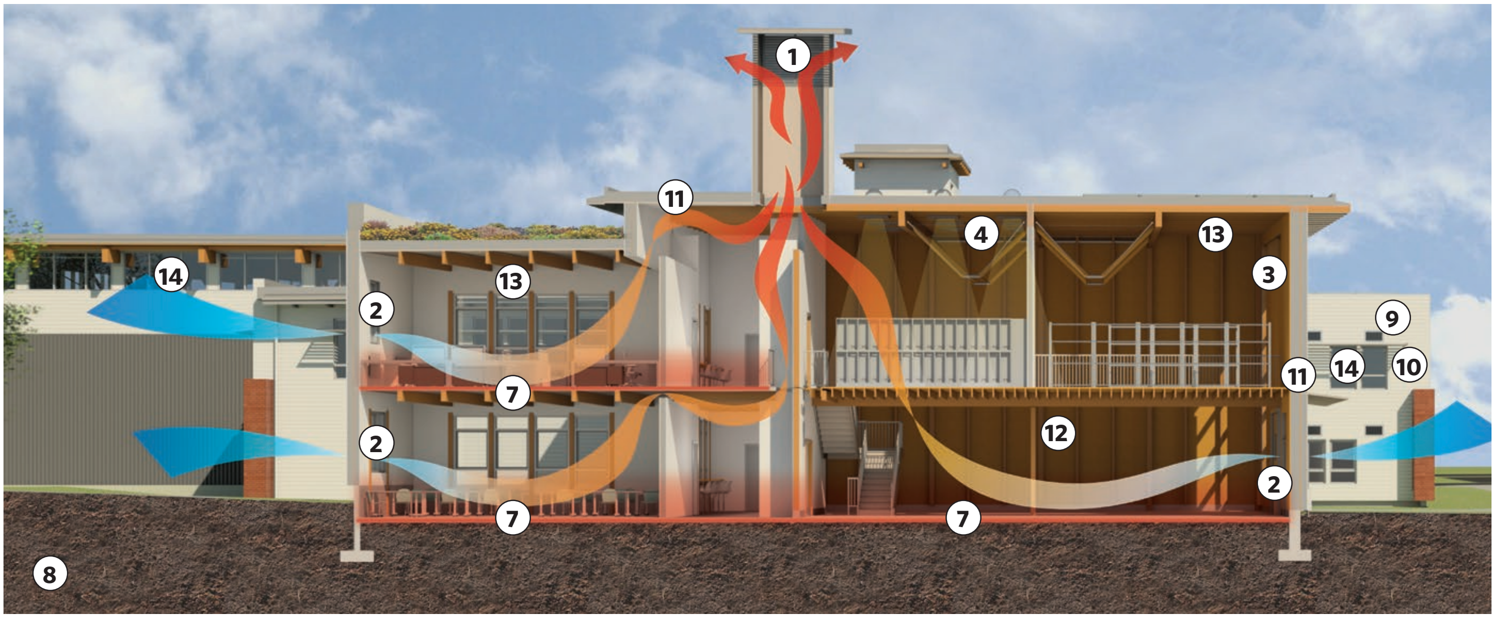
While the building is outperforming predictions, an interview with the facility manager revealed that opportunities for energy performance improvement still remain. For example, fine-tuning the automated schedules and algorithms for the heating and cooling pumps, to reflect the actual hours of operation of the building, could save electricity during weekends when the building is unoccupied. The building performance evaluation concluded: "In general, the implementation of innovative systems has been successful in this building."

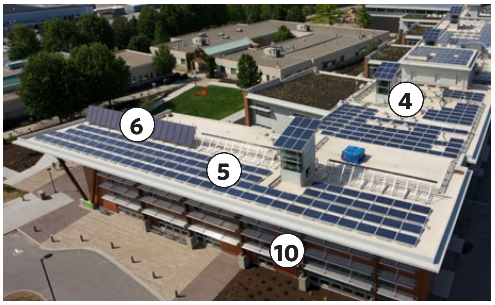
95%
predicted EUI reduction from national baseline

92%
actual EUI reduction from national baseline



24%
energy supplied by photovoltaics





1. Ventilation chimney to improve stack effect for natural ventilation
2. Operable windows with red/green lights to indicate when outside conditions are best
3. Clerestory windows with light shelves in larger spaces
4. Solatube® daylighting system
5. Photovoltaic panels
6. Vacuum tube solar panels
7. Radiant in floor heating and cooling
8. Open loop ground source geothermal system
9. Sun tracking light panels for Suncentral® lighting system
10. Brise soleil
11. Super insulated walls and roofs
12. Occupancy and daylight sensors
13. High efficiency lighting to supplement daylight as required
14. Triple glazed, argon filled windows

Water Reduction Strategy

DESIGN SOLUTIONS

The Centre's strategy to reduce water use is comprised of three main components:

1. The City of Penticton's wastewater treatment plant (located approximately 600 m from the Centre) provides chemical-free, treated effluent water (TEW) to the Centre for sinks, showers and kitchen use. Grey water is exported back to the treatment facility and an equivalent volume of treated effluent is returned for toilet flushing, green roof, and site irrigation. In the winter, transfer from the treatment facility is not available as the water line is too high and freezes; therefore, water from the open-loop geothermal system is diverted for toilet flushing.
2. Low-flow fixtures have been installed throughout the building.
3. The use of xeriscaping principles in the landscape design (e.g., drought-tolerant indigenous plants, mulch) reduced the need for supplemental irrigation. Subsurface drip irrigation is provided where irrigation is needed.

RESULTS

Overall, heavy reliance on local recyclable water sources has facilitated a significant reduction in the use of potable water from the municipal water system. Evaluation results confirmed the actual municipal water use intensity for the Centre was very low (0.03 m3/m2 per year) because water for toilet flushing, the mechanical system, and irrigation came from well groundwater and treated effluent water provided by the City's wastewater treatment plant. Since the building only requires potable water for sinks, showers, and kitchen uses, the actual potable water use intensity per occupant was 67% lower than expected.

However, occupancy predictions (used to determine water use intensity) were higher in modeling estimates than measured in practice and did not account for very low occupancy (nearly zero) during the summer months.

Additionally, the facility manager estimated water usage could be reduced by 15% to 30% with the installation of submetering systems (e.g., for irrigation and toilet flushing). Having more information about water flows would provide building operators needed information to improve conservation solutions.

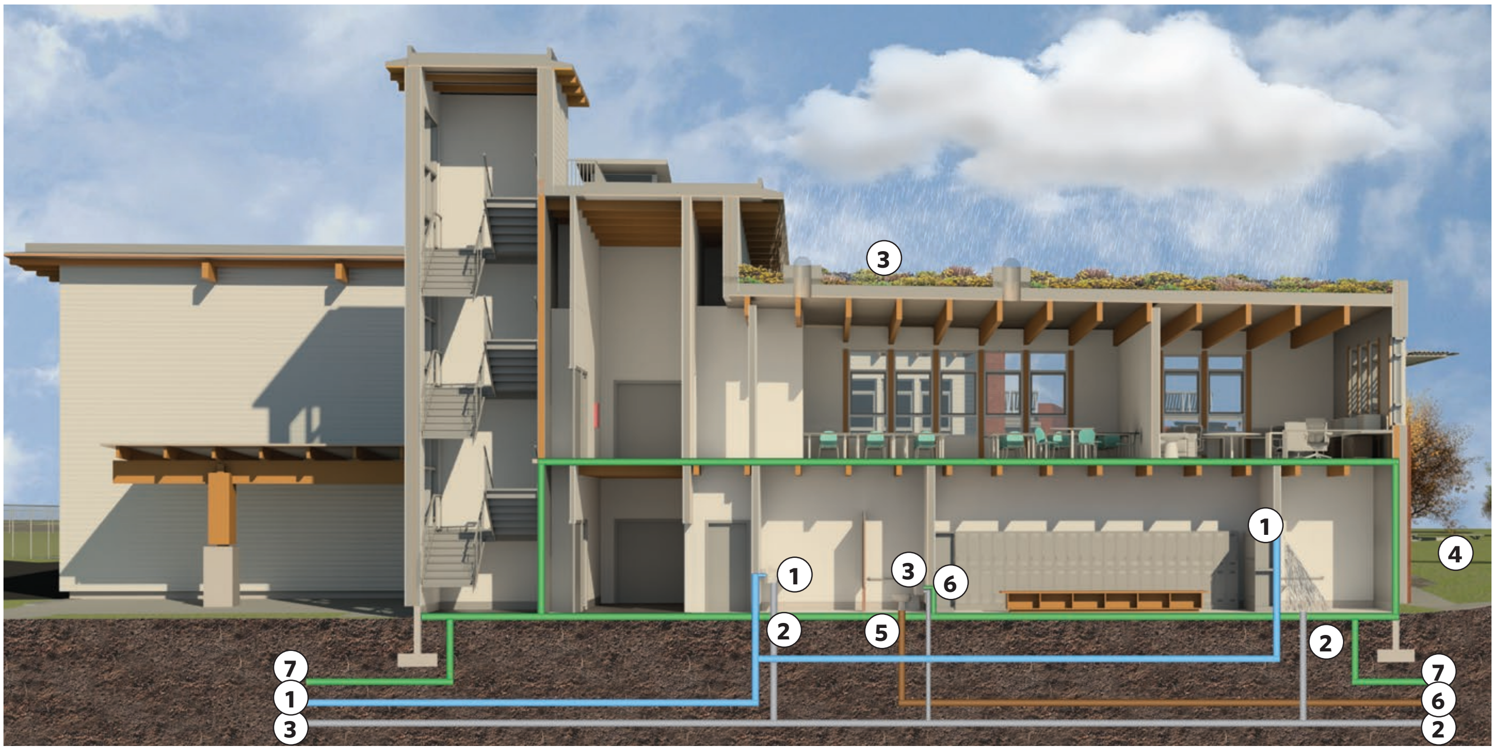
0%
potable water used for irrigation

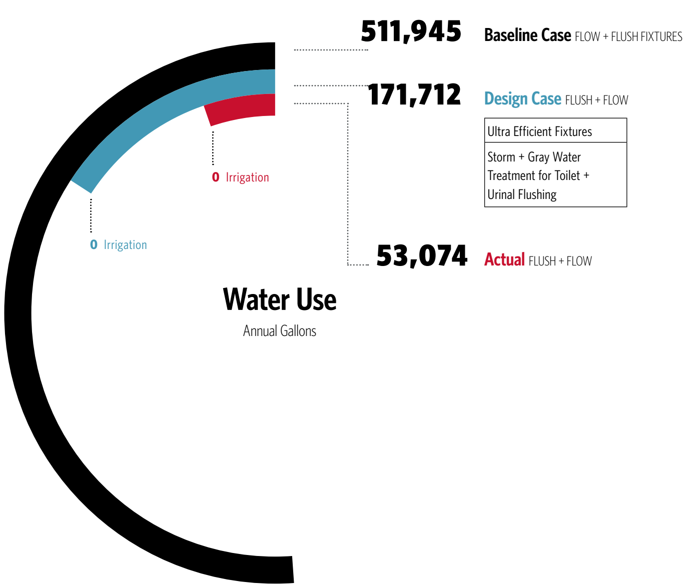
89%
water use reduction

100%
wastewater generation reduction

81%
water consumption from greywater

100%
rainwater managed on site





1. Potable water is supplied for sinks, showers and kitchens
2. Greywater from sinks, showers and kitchens is exported to the advanced wastewater treatment plant (AWWTP)
3. Treated effluent is imported from the AWWTP for flushing toilets and irrigation
4. A corresponding volume of biomass is imported from the AWWTP for fertilizer
5. Blackwater from the toilet flushing is returned to the AWWTP
6. In the winter, groundwater from open loop geothermal system is diverted for use in toilet flushing
7. Process water for the open loop geothermal is drawn from a groundwater well and returned through an infiltration well

Preservation of the Surrounding Ecosystem and Site

DESIGN SOLUTIONS

The site for the Centre had been previously developed and was used mainly for access to two existing buildings to the north; including an access road, walkways, and a parking lot. Due to the large amount of existing paving, the project team was able to add the building to the site without increasing the amount of hardscape. When the building footprint is subtracted, 50% of the remaining site area has been protected or restored with native and adaptive vegetation. The remaining pavement, on the other 50% of the site, was repurposed for 268 parking spaces and two plazas in front of and alongside the building.

Efforts to reduce the heat-island effect included a vegetated green roof covering 10% of the roof area and a high-reflective membrane covering another 72% of the roof. The accessible green roof has been planted with local flora creating a natural, pesticide-free habitat for indigenous fauna, such as the Sandhill Skipper—a butterfly on the local Red List of at-risk and threatened species.

The project was designed to capture, store, and return to the ground 100% of the storm water that falls on the site using a complex system of drywells, perforated pipes, bio-filtration swales, and surface storage (i.e., ponding on grass covered areas and the green roof). The bio-filtration swale, built between the parking areas, cleans storm water before it enters the municipal storm drain.

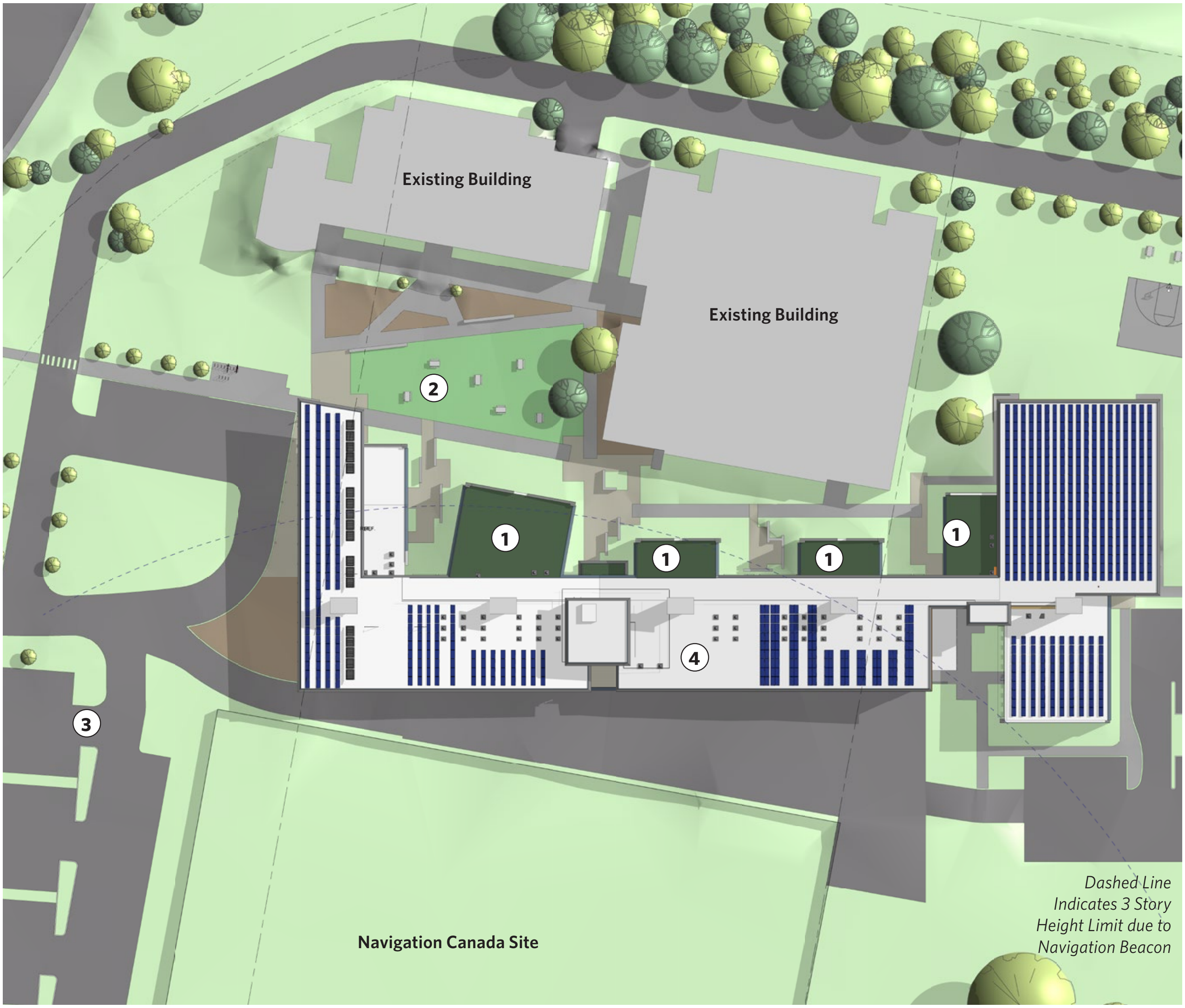
RESULTS

According to the iiSBE Canada evaluation, taken together, these efforts significantly reduce impacts on the surrounding ecosystem: “This building aimed to be highly adapted to its site, climate, and context.”

36%
amount of landscaped area before and after addition of new building

50%
of the site area was protected or restored (building footprint not included)

94%
amount of landscaped area with the native or climate-appropriate plants



1 Green roofs support local fauna such as the sandhill skipper butterfly on the local endangered species list

2 Irrigation limited to college green area: high efficiency sub-surface drip irrigation

3 Biofiltration swale

4 Highly reflective roof

Indoor Environmental Quality

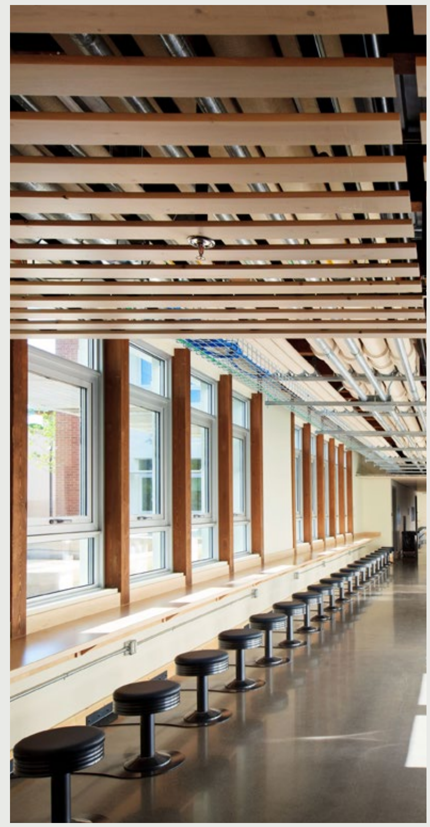
DESIGN SOLUTIONS

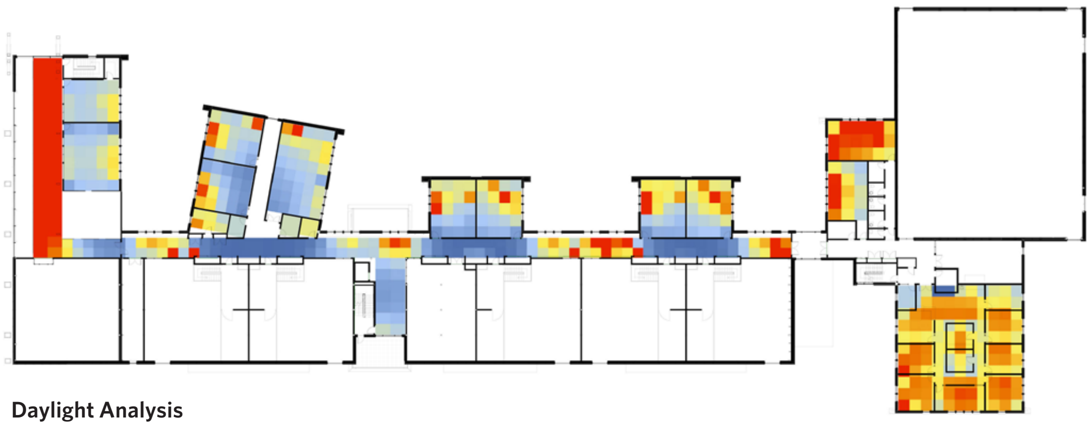
A key design goal for the Centre was to create a healthy environment for students, staff, and visitors. To fully realize this important goal, shallow floor plates were included throughout most of the building allowing for natural cross ventilation and daylighting. Operable windows, with light indicators showing when to open/close for optimal heating and cooling, also were utilized in the facility. In larger shop and classroom spaces, clerestory windows with internal, high-level opaque glass light shelves help bounce light further into the space. Since the Centre is designed to help advance new sustainable technologies, two types of daylighting—Solatubes and sun tracking light pipes—were included. For the few areas of the building where it was not possible to achieve daylighting, LED lighting was designed into the walls to create the illusion of natural light reflecting off the surfaces.

RESULTS

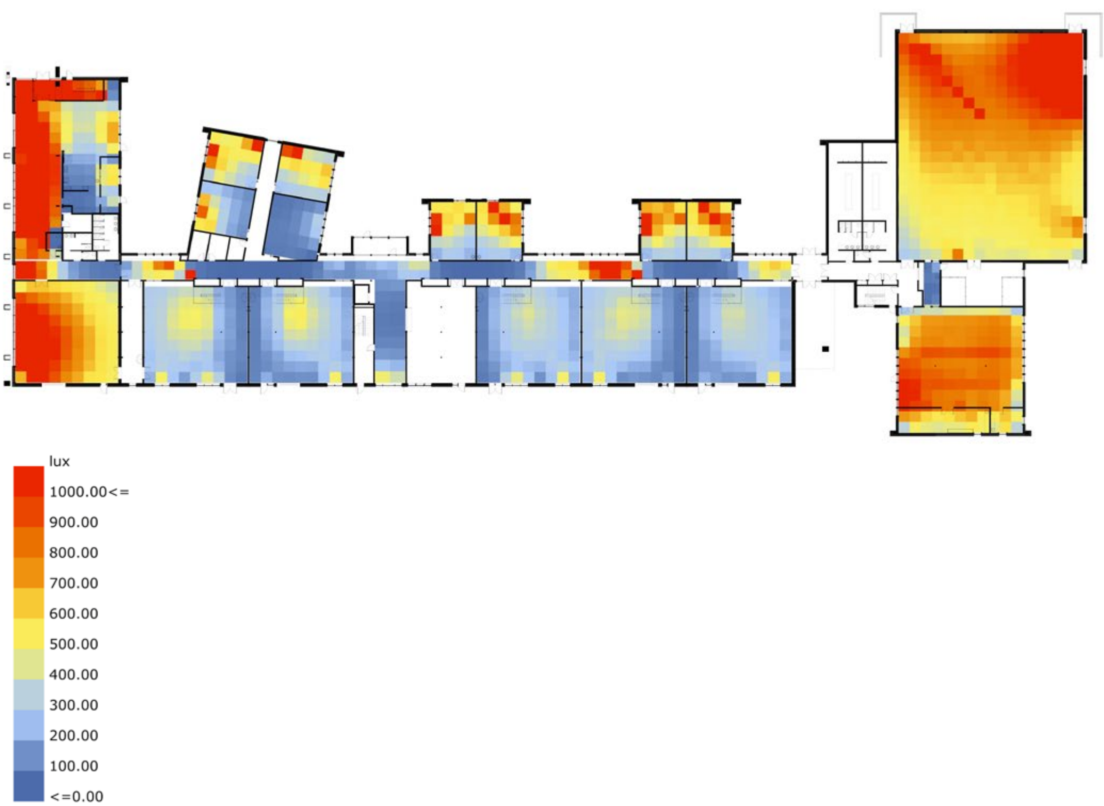
Occupant satisfaction with indoor environmental quality was assessed in the iiSBE Canada building performance evaluation. Survey results indicated that 85% of respondents were satisfied with the building environment, as a whole. Occupants were satisfied with lighting, temperature, and air quality, but were dissatisfied with speech noise and privacy. More specifically, survey results indicated:

- 71% rated lighting favourably. The majority of the complaints were about inadequate lighting on overcast days and in winter months, and excessive glare in the summer months. Some occupants also felt they had little control over lighting, although this may have been due to a preference for daylight versus artificial lighting.
- 72% of occupants were satisfied with indoor temperatures. Dissatisfaction came from being slightly too warm or feeling cold drafts, as well as a perceived lack of control over thermal conditions.
- Air quality was rated positively by respondents.





Daylight Analysis



Reducing Carbon Impacts through Materials Selection

DESIGN SOLUTIONS

Careful attention was given to reducing the carbon footprint for the project through materials selection. As part of pursuing the Living Building Challenge, research was conducted to find materials available within the region (high-density materials within 500 km, medium-density within 1000 km, and light materials within 2000 km). Timber frame, made with FSC wood from British Columbia's Kootenay Region and local pine beetle killed wood, was chosen as the main structural system.

While pine beetle kill wood is often used in ceiling treatments, the project's structural engineer was able to take it one step further and successfully incorporate it into the overall structure. Additionally, the design team was successful in advocating for the use of pine beetle-kill wood as an alternate to FSC wood, allowing for support of the local forestry industry, and thereby helping to alleviate some of the economic hardship that the beetle infestation had caused.

In the gymnasium, a pioneering system of composite wood and concrete panels was designed to accommodate the need for radiant heating, which could not be in the floor due to the sprung wood system. The panels were much lighter and used less material than traditional panels, which also helped reduce the carbon footprint.

Wireless switches were incorporated into the project, as part of the electrical design. These innovative switches are self-powered, converting kinetic energy—from each button push—into power for the wireless signal. There is no installed wiring or conduit, resulting in less material and lower embodied energy for the project.

The Living Building Challenge Red List (the worst-in-class materials commonly used in the building industry) was used to assess materials to be included in the Centre's construction. A significant amount of time went into researching locally available, Red List-compliant materials. This proved to be difficult for electrical products, especially PVC-coated conduit products. In the end, fiberglass-reinforced epoxy conduit was used.

RESULTS

The iiSBE Canada reported that the building incorporated regional materials (23% by cost), as well as recycled materials (8% by cost). Design documents indicated that 79% of the construction waste was diverted from landfill.

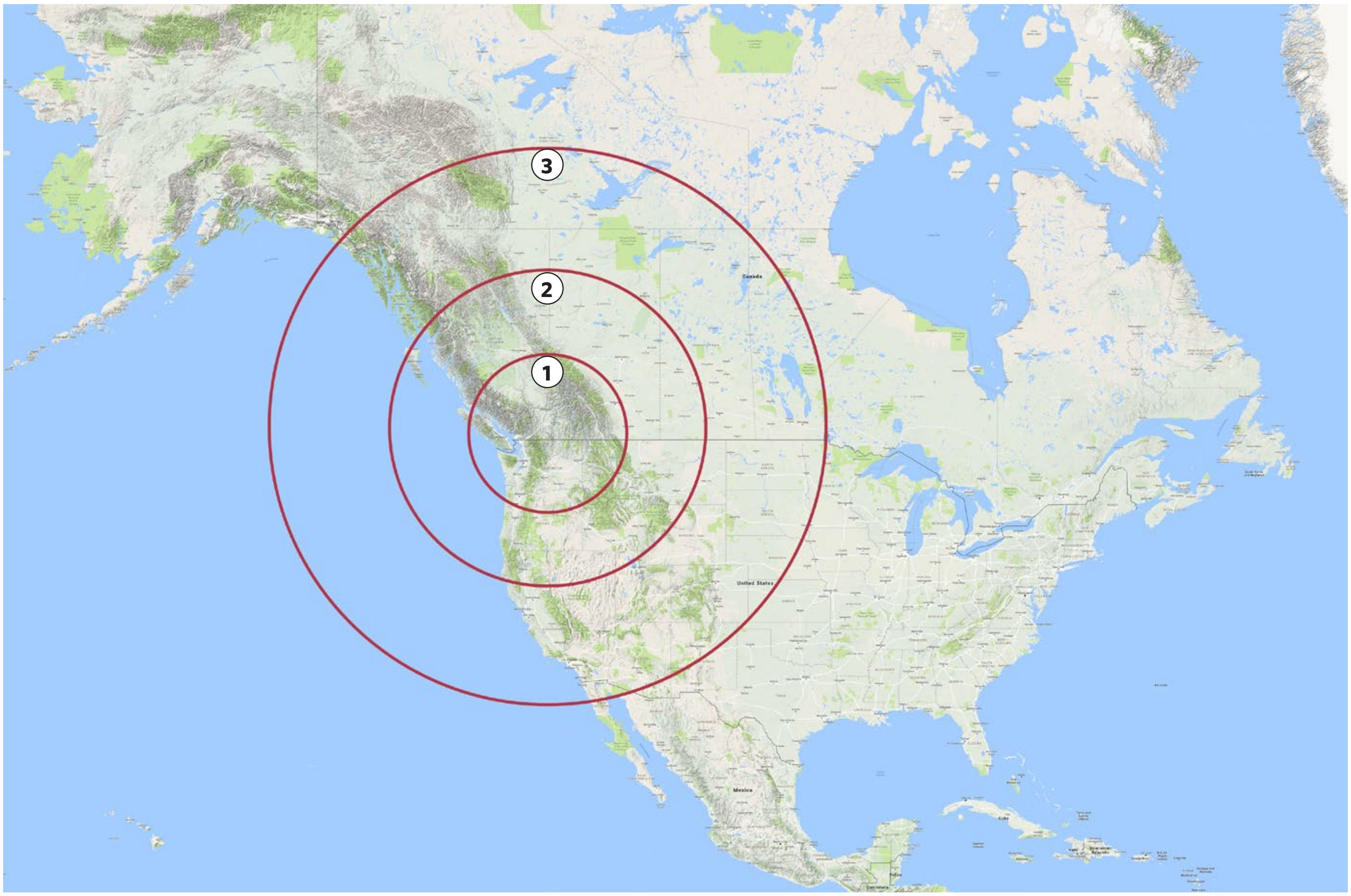
79%
construction waste diverted from landfill

53.5
lbs/ft^2 CO_2

10%
recycled content

386
$\$/ft^2$

23%
materials extracted and manufactured within 540 km



1 500km radius for sourcing high-density materials

2 1000km radius for sourcing medium-density materials

3 2000km radius sourcing light materials

Informing the Future of Sustainable Design

Since its opening the Centre has received visitors from the U.S., Brazil, Columbia, India, China, Germany, Scotland, Kenya and South Korea. Okanagan College also hosted the Annual Conference of Canadian Community Colleges during which 600 delegates visited the facility. Numerous conferences have been hosted within the building including the first TED Talk in the region.

The design team has been able to share this project with the design and construction industry both locally and on the world stage, presenting the project at conferences in Helsinki, Finland and China. Recently, the College signed a New Memorandum of Understanding with the British Columbia Institute of Technology (BCIT) to create joint programming and research opportunities in building sciences, sustainability education, and energy management.

"We could not be more pleased with the way the building has attracted people here to learn, work, and collaborate—from students and staff, to members of the community, to visitors from all over the world. This is a building that students love to learn in, that staff enjoy working in, that the community loves to use, a building that continues to impress visitors," says Donna Lomas, Okanagan College's Regional Dean of the South Okanagan-Similkameen. "And it's doing all that with a tiny footprint on our environment."

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With over 500 LEED Accredited Professionals, HDR has been at the forefront of the movement to implement an industry standard for green buildings and was the first architecture firm to join the USGBC in 1994.

For more than 20 years, we've championed the belief that sustainability isn't just about achieving a solitary target or end goal, it's about changing values, culture, and processes. Using a "whole building" approach to design, we have adopted high-performance sustainability requirements for all of our projects and have endorsed the Architecture 2030 Challenge to achieve dramatic reductions in greenhouse gas emissions. We explore and challenge long-held assumptions to find new ways to reduce energy demand by 50 percent and more in the complex buildings we design.

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We practice increased use of sustainable materials and reduction of material use.