
UBC LIFE SCIENCES CENTRE

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1. INTRODUCTION/GENERAL INFORMATION

The Life Sciences Centre (LSC) at the University of British Columbia (UBC) is located west of Vancouver on a peninsula overlooking the Georgia Strait. An international hub for medical research and education, the centre was designed by the Canadian based architectural firm of Diamond and Schmitt Architects Incorporated of Toronto in joint venture with Bunting Coady Architects of Vancouver. The LSC achieved LEED® Gold certification from the United States Green Building Council (USGBC) in December 2005, and is currently the largest building in Canada to achieve LEED® Gold certification. This is regarded as particularly impressive, due to the building's significant laboratory component. Only a handful of laboratories in North America have achieved the LEED® Gold rating.

Built at a cost of \$125 million Canadian, the LSC opened in six phases starting in September 2004, only 29 months after breaking ground. The building is composed of three large five-storey blocks, connected by atriums, with two basement levels (Figures 1–3). It contains a range of different spaces including laboratories with Biosafety ratings of 2 and 3, two lecture theatres each seating up to 350 students, a 128-seat lecture theatre, and 42 classrooms of varying sizes. With an area of 52,165 square metres (561,521 sq. feet), the LSC is currently the largest building at UBC (Source: Yuill 2005).

The Life Sciences Centre was created to address the critical shortage of doctors and boost Life Sciences research in the province of BC. Before the centre opened in 2004, BC had had the lowest number of first-year medical-school spaces per capita of any region of Canada, reflecting a much deeper Canada-wide crisis where the country is currently training less than three quarters of the Doctors it needs (Source: Canadian Medical Association 2003). The LSC allows the UBC Faculty of Medicine to almost double its enrolment, graduating 224 new physicians every year by 2009 (Source: Office Of The Premier 2004).

The creation of the Life Sciences Centre also allows the province to train doctors in the north and on Vancouver Island for the first time, permitting the inhabitants of BC to be treated by physicians trained in their region of the province. Two new medical school facilities at the University of Northern BC (UNBC) in Prince George and the University of Victoria (UVIC) are linked to the LSC through state-of-the-art tele-learning facilities. All students will receive a UBC medical degree upon completion of their studies (Source: Office of the Premier 2004).

The UBC Life Sciences Centre currently accommodates a community of 2,654 people including researchers, graduate students, medical students, professors, and administrative staff (Source: Yuill 2005). It provides a forum to accelerate and strengthen learning and is helping to address the critical physician shortage in BC. Gordon Campbell is the Premier of BC: “The LSC takes medical education and research in BC to the next level, providing a setting where doctors and other health professionals of tomorrow will learn next to researchers who are discovering future treatments and cures” (Source: Office of the Premier 2004).

Sustainable Initiatives at UBC

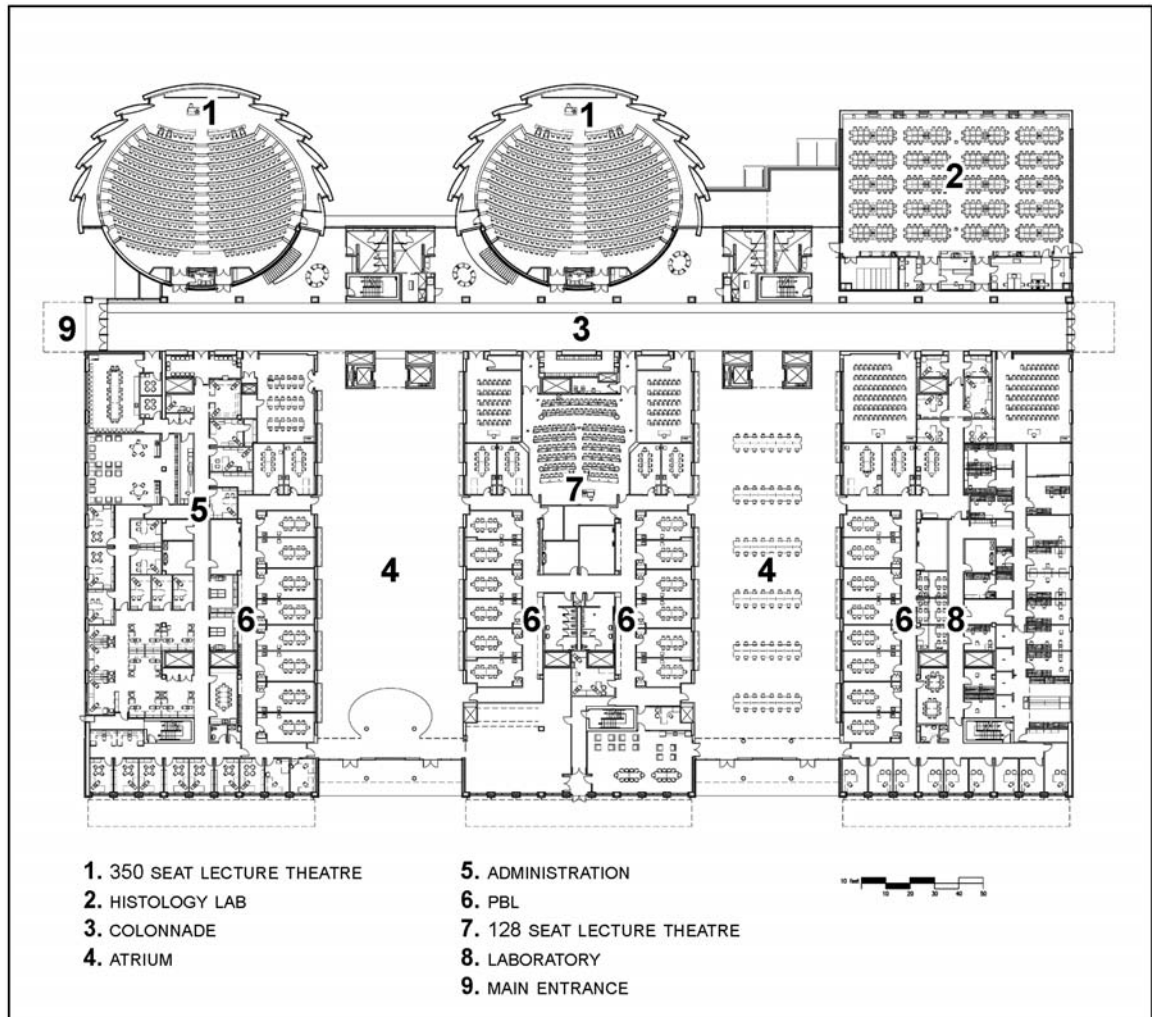
The University of British Columbia has become the first university in North America to create a comprehensive sustainability strategy. The university has identified 68 targets and actions for achieving nine major sustainability goals. These include reducing

pollution, conserving resources, and protecting biodiversity in order to create a model sustainable community (Source: UBC Sustainability Office 2006).

The Life Sciences Centre is seen as exemplifying UBC's commitment to sustainable development and is regarded as a model of environmental stewardship.

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FIGURE 1. Main floor plan. (Photo: BCA/DSAI.)



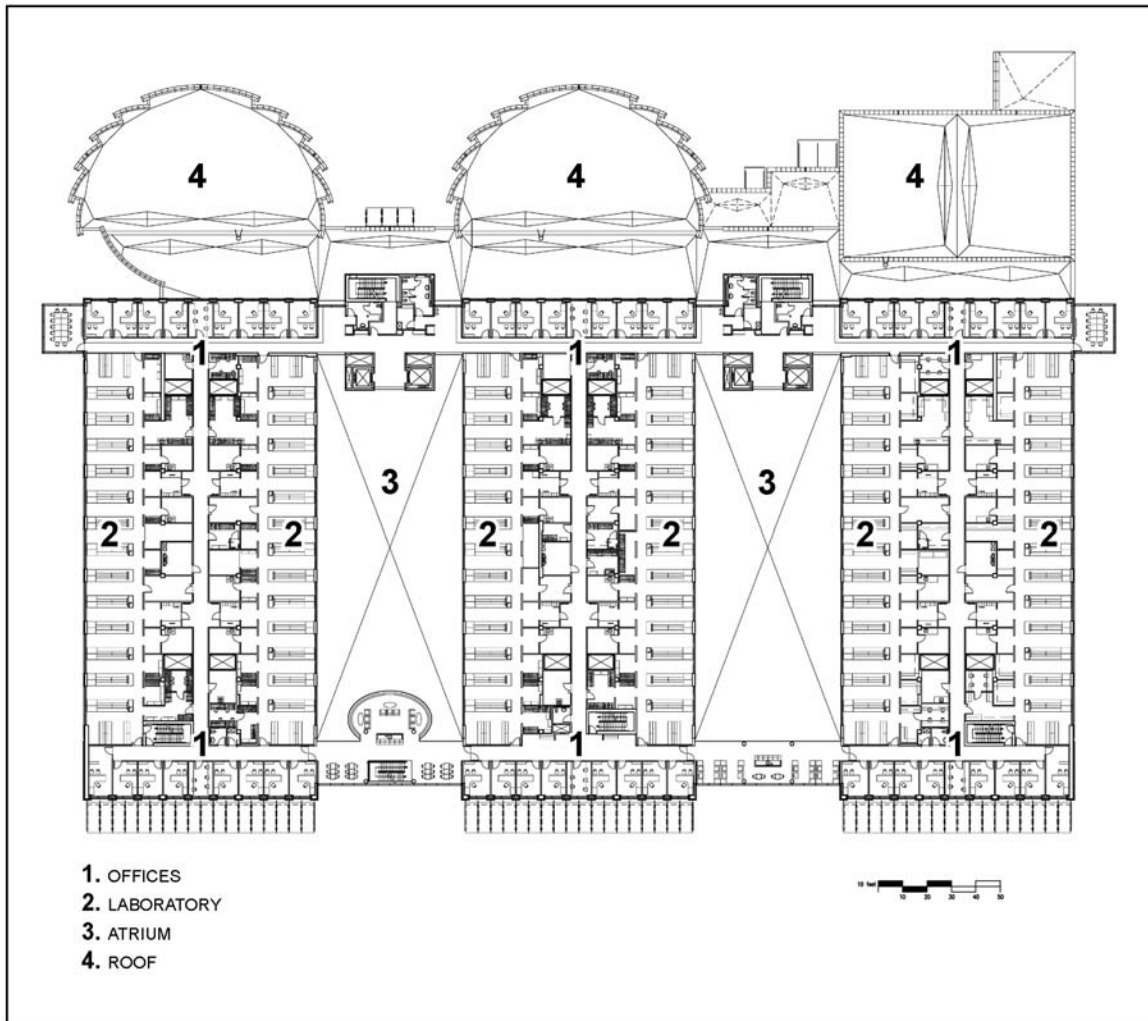
It is also the latest in a series of UBC buildings to achieve worldwide acknowledgement for its sustainable features. The University's first two green buildings, the C.K. Choi building and the Liu Institute for the Study of Global Issues, have won five awards including a listing on the American Institute of Architects' Top Ten Earth Day 2000 Green Buildings. The Technology Enterprise facility III (2004) also achieved LEED® Silver certification (Source: Yuill 2005).

The promotion of global citizenship and civil society is also a key facet of the university's sustainabil-

ity philosophy (Source: UBC Sustainability Office 2006). An example of this is the award-winning Sustainability Coordinator Program at UBC, which is a grassroots campaign to bring sustainability practices to UBC's 300 plus departments. The Sustainability Coordinators serve as educators and resources for building occupants on decreasing the consumption of materials, reducing the production of waste, effective energy usage, and alternative transportation (Source: Yuill 2005).

Occupants in many UBC buildings participate in a composting program that redirects food waste,

FIGURE 2. Typical (upper) floor plan. (Photo: BCA/DSAI.)



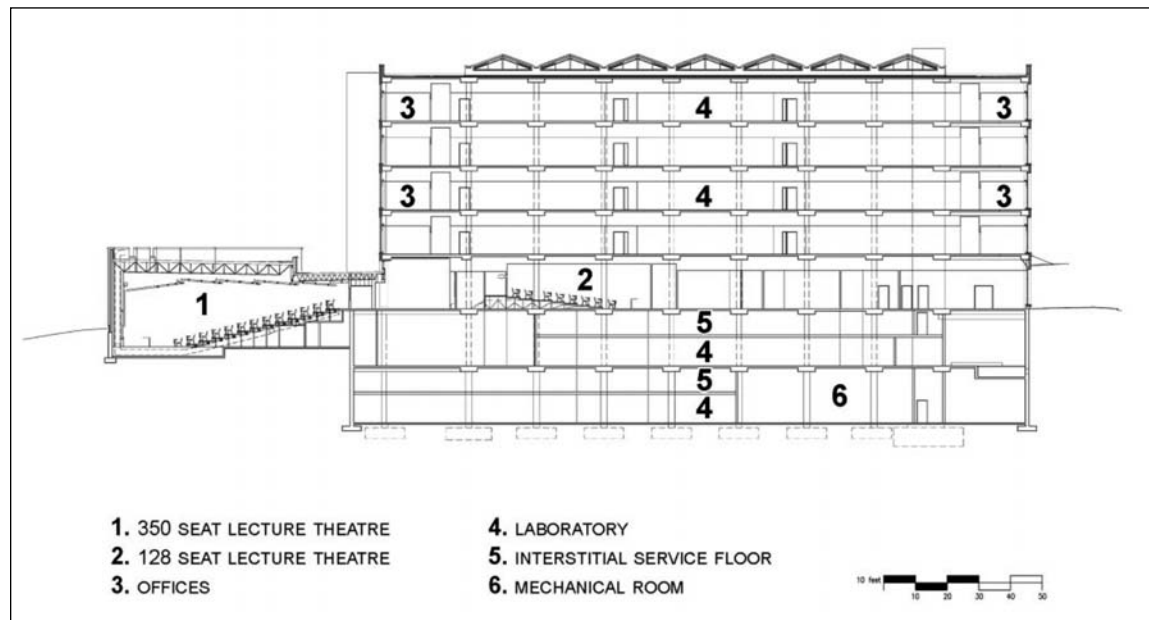
residual paper products, animal bedding, waste wood, and yard waste into an in-vessel compost system with a five ton daily capacity. The resulting compost is then applied in on-campus landscaping. In addition a campus-wide recycling program provides desk-side paper receptacles and centrally located bins for plastics, tin, glass, batteries, and electronic waste.

LEED® Certification

From its conception the design team worked towards LEED® certification for the LSC. This effort was enhanced by co-ordination with the construction

manager, Ledcor Construction Limited, achieving the multi-phased occupancy within the budget requirements and without losing sight of the teams' sustainability targets. Al Poettcker, President and CEO of UBC Properties Trust, paid tribute to the achievements of all parties in attaining the targets set: "It took a large amount of co-operation and energy on the part of user groups, consultants, the construction manager, and trade contractors to finish the project not only on schedule but according to everyone's original expectations" (Source: UBC Public Affairs 2006).

FIGURE 3. Section. (Photo: BCA/DSAI.)



The Life Sciences Centre is part of an established and successful green building program at UBC. Under the USGBC ratings system the LSC received LEED® Gold certification, regarded as a major achievement for a building with so many wet labs and so much energy consuming technology. The LSC is only the second facility housing research laboratories in Canada to receive the LEED® Gold designation as of the end of 2005 (Source: UBC Public Affairs 2006).

2. FACILITY OVERVIEW

Medical School

The medical training portion of the LSC contains two large lecture theatres each seating up to 350 students; a 128 seat lecture theatre; 42 classrooms of varying sizes; and two flexible, high-use, teaching labs. In particular, the large lecture theatres and the multi-purpose lab are fully IT/AV integrated to link to facilities at UVIC and UNBC. With one computer for every two students, the multipurpose laboratory can accommodate 256 students at a time providing interactive, simultaneous learning at all three medical program sites. This has revolutionized the way that

histology is taught at UBC. Instead of having to use a microscope and slides, students at all three campuses have access to a “digital slide box” so that each student sees the same image. This technology also allows staff to set computerized examinations for 100 students at a time, not only for undergraduates but also for board examinations for medical certification (Source: UBC Faculty of Medicine 2005).

Life Sciences Institute

The LSC research institute houses over 80 faculty investigators as well as approximately 600 trainees and research staff who conduct innovative research into many areas of biomedical sciences. 25,000 sq. metres of flexible lab space was specifically created for the evolving research programs of the Institute so that a unique collaboration of eight interdisciplinary research groups could be organized around biological systems as opposed to disciplines or faculties. Examples of research groups housed at the Institute include the Cellular Mechanism of Development Research Group, the Immunity, Inflammation & Infection Research Group, and the Centre for Blood Research. Finally, the LSI houses the Centre for Disease Modeling and supports ongoing

research in the fields of anatomy, biochemistry, cell biology, medical genetics, and micro-biology (Source: Yuill 2005).

The design for this landmark facility was also created with one eye to the future, to take into account new and developing trends. Interaction between oc-

cupants was encouraged both through an open plan concept for laboratories and through dynamic social spaces such as lounges and a bridge overlooking the atria. Adoption to future research needs was built into the design through modular layouts and laboratory spaces that can easily be rearranged.

3. FAST FACTS

Site Area	166,554 sq. ft.
Gross Floor Area	561,521 sq. ft.
Building Footprint	113,310 sq. ft.
Site Coverage	68%
Total Cost	CAN\$125 million
Project Delivery	Construction Management 6 phases of completion and occupancy
Site Condition	Previously developed; Brownfield; Remediation to Canadian Sites Regulation (CSR) Commercial (CL) Standards
Occupants	2654 staff, researchers, and students
Energy Use	28 percent less than standard building Annual savings: 6,400,000 kWh, 1000 tons of greenhouse gas emissions and \$180,000.00 at current utility rates
Building Envelope	R12 North and South façade R12 Metal walls East and West side R21 Roof
Air Flow Systems	40 total Air Supply Systems 31 systems – 100% Fresh air 9 systems – Recirculation Mode (with CO ₂ sensors)
Daylighting	2% Daylight Factor in 75% of regularly occupied space
Lighting Energy Density	0.94 W/sq. ft. for Laboratories 0.76 W/sq. ft. for Offices
Water Use	50 percent less than standard buildings Annual saving of 2.75 million liters
Building Materials	11.5% (by \$ value) recycled content 30% (by \$ value) locally manufactured materials
Parking/Alternatives	Only 2 automobile handicapped parking spots 140 secured bicycle stalls and 10 showers
Landscape	Restored 52.8% of the open site area with soft landscaping 87.5 percent of soft landscaping native and adaptive plants
Construction Waste	80% recycled or salvaged for a total of 1,300,000 kg
Indoor Environment Quality	Low VOC materials used 2 week building flush-out before occupancy

4. DETAILS OF SOME SUSTAINABLE INITIATIVES

The Integrated Design Process (IDP)

The Life Sciences Centre was the largest ever construction project at UBC, built in 29 months on time and under budget. A building of this type traditionally takes two years to design and two to three more years to construct. In this case, because of the building's key role in addressing the critical shortage of doctors in BC and the need to provide lecture facilities in time for the start of classes, the entire process was condensed considerably. This gave the design team just five months of planning time before the ground was broken.

The project team was able to speed up the design process through the use of The Integrated Design Process (IDP). The IDP is a defined eight-step process that deliberately sets up the building fundamentals to enhance the passive performance of the architecture. The project team believes it is this process which helped the LSC to achieve its LEED® Gold rating. The IDP approach used by the design team for this project included a formal set of steps rather than a vague commitment to work together. The specific steps of the Integrated Design Process as used in the creation of the Life Sciences Centre were: (1) Shape and orientation, (2) Site and water strategies, (3) Lighting and daylighting strategies and window configuration, (4) Envelope design including insulation and shading values, (5) Ventilation systems including natural ventilation strategies, (6) Heating and cooling systems, (7) Materials selection for low embodied energy, (8) Quality assurance (Source: Bunting Coady Architects 1996).

By bringing this rigor to the design process, the team was able to create a large, complex, well lit and well ventilated, high performance building.

Shape and Orientation

The Integrated Design Process calls for the Architect and the Energy Engineer to work closely together at the start of the project to develop the most appropriate form of the building. At this stage the building is modeled on a computer software program that analyzes its basic thermal and day lighting performance and simultaneously acts as a design massing tool. The goals for this phase are to meet performance criteria

for the site and building and for basic energy loads. The goals for active versus passive solutions are discussed and defined at this stage. Based on the results of these preliminary simulations, aesthetics and building program criteria, an optimal shape for the building and its location on the site are determined and finalised (Source: Bunting Coady Architects 1996).

The UBC Life Sciences Centre involved a number of very specific challenges with regard to Shape and Orientation. In particular the design team was faced by a constrained site with 561,521 sq. feet of program on 3.8 acres of land. Based on density and building depth requirements, the possible configurations involved blocks of building in letter shapes—an “O,” an “I,” an “H,” and an “E.” Each of these configurations allowed good daylight penetration into the spaces and optimal efficiency of the service to lab area ratios. However, the development of a detailed energy model revealed that the asymmetrical “E” shape was the best form overall. This permitted morning sun penetration into the atria between the legs of the “E,” yet successfully blocked the low hot sun in the afternoon by locating the auditoria along the “closed” west face. This shape also maxed out the north and south window exposures in order to provide the most comfortable and well lit space possible. An added benefit of the energy model approach to the shape was that the client gained two interior atria as free space on top of the program area by simply taking the savings from an interior versus exterior wall and transferring them into a skylight. In the initial sketches the atria were just open to sky spaces.

The “E” shape also allowed natural ventilation to flow through the exterior windows and vent into the atria and exhaust warm air through the vents at the top. This proved to be a smoke evacuation benefit as well. Some of the potential for natural ventilation was lost as the labs had to be contained and serviced with fume hoods. Providing openable windows in labs could risk contaminating other spaces and had to be avoided.

The LSC was built at a cost of \$210 Canadian per sq. foot versus \$300 Canadian per sq. foot for similar research teaching facilities—40 per cent less than the North American average (Source: UBC Faculty of Medicine 1995). The tight budgetary and scheduling limits were achieved by seeking low cost solutions

that did not compromise the performance of the building. For example, a pre-manufactured wood slat wall backed with acoustic insulation addresses sound levels in the atria and auditorium. The lab bench and support space module was designed to be flexible enough to support varied research programs but similar enough to gain the dollar savings resulting from economies of scale and repetition (Source: Yuill 2005).

Site Sustainability

Site Selection. UBC is presently constructing many new facilities to provide space for its existing and new departments (Figure 4). The volume of new building work is creating a huge demand for sites available for new construction. In this context, and consistent with its sustainable development policies, UBC considered several criteria for selecting the LSC project site.

- The project site is in close proximity to the existing medical school and research facilities to enable easy pedestrian movement between each location. The planning of the sidewalks around the building augments current pedestrian traffic patterns; the main (West) entrance is directly off Health Sciences Mall, which contains most of the existing health science research facilities including the Bio-Medical Library; the South entrances provide direct access to the campus parking lot,

and the East entrance provides easy pedestrian access to the UBC Hospital.

- The project site was a previously developed site, with a brownfield designation (defined as per U.S. Environmental Protection Agency criteria). UBC contracted the services of Seacor Environmental Inc. to conduct a preliminary site review and determine any environmental areas of concern. Tests of the soil and groundwater revealed areas with hydrocarbon and zinc in the soil exceeding the BC Contaminated Sites Regulation (CSR) commercial (CL) standards (Source: Seacor 2002). Seacor thereafter designed and supervised the implementation of a comprehensive remediation plan. Contaminated soil from the site was removed and taken for remediation to an off-site Bioremediation facility. Confirmatory samples were then collected from the remediation excavations to confirm all soil exceeding the CSR CL standards had been removed from the site and that the site was suitable for construction. By using the previously developed site, and performing bio-remediation, UBC was able to preserve existing green space on campus and enhance the environmental quality of the project neighbourhood.
- UBC has a successful Trek program to assist the campus community in finding alternative transportation choices including public transit, car-pools, vanpools and cycling options. In keeping

FIGURE 4. Aerial view of UBC Life Sciences Centre. (Photo: MCW.)



with the guidelines of the Trek Program, the LSC provides secured bicycle parking and shower space for 5% of the building's occupants (a total of 140 secured bicycle stalls and 10 showers). Except for two handicap stalls, no new automobile parking space has been provided. This is a significant achievement considering that a building of this size would typically need to provide parking for about one thousand cars, requiring around 400,000 sq. foot of paved space and resulting in a considerable negative impact on the micro-climate and surface water runoff.

Site Impact During Construction. Excavation for the project started in July 2002. The initial excavation was for the two basements (about 440' long, 240' wide and 36' deep). The entire excavated site lay exposed to the heavy winter Vancouver rainfall (October to March) as construction activity progressed. Water that drained off the excavation site, laden with sediments, needed to be filtered and tested before draining into storm sewers. Truck traffic (concrete trucks, recycling trucks, materials delivery) posed a constant problem of tracking sediments off the site and causing sedimentation of nearby storm sewers. There was also a need for large, clean and dry construction assembly space (for formwork, rebar, and other systems).

In designing a Sediment and Erosion Control Plan for the site that would address all the issues, the storm water management consultant's first task was to compare the relevant EPA standards (EPA 832/R-92-005) with several local standards to determine the more stringent standard, a requirement of LEED® Prerequisite SS-1 (Source: Aqua-Tex 2003). A number of local standards were reviewed. These included:

- Best Management Practices Guide for Stormwater (1999), developed by the Greater Vancouver Regional District (GVRD)
- Erosion and Sediment Control Program (Bulletin 2002-003-EV) developed by the City of Vancouver
- Water Quality Guidelines for the protection of Fresh Water by the British Columbia (BC) Ministry of Environment, Land and Parks (MELP)

The EPA document 832/R-92-005 was found to be more stringent, and the Best Management Prac-

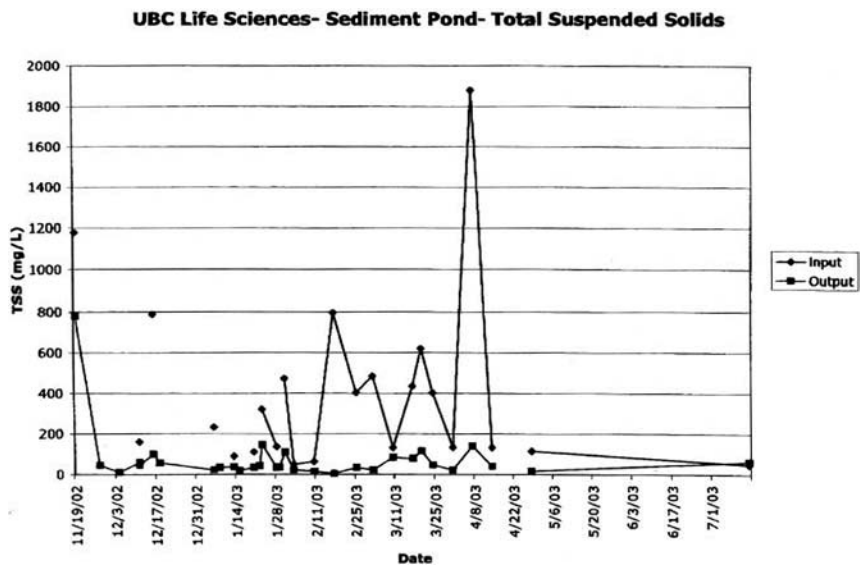
tices described therein were used to develop a Sediment and Erosion Control Plan for the site (Source: Aqua-Tex 2003). Key measures included in the plan were:

- A temporary sediment basin (15' wide, 75' long, with side slopes of 2:1) was installed and water from the excavated site was diverted into the basin (Figure 5). The basin was divided into three separate chambers using gravel and filters (cloth partitions) and had a storage volume of 3,700 cu ft. The filter partitions were regularly inspected, and sediments were removed when they reached 1/3 of the height of the partitions. Water from the basin was regularly tested for TSS, phosphate, pH, and turbidity before discharge into storm drains (Figures 6–7). The water quality testing criteria evolved from a need to meet LEED® and EPA requirements (TSS and phosphorus) and also local requirements of the BC MELP (Turbidity) and the GVRD (pH). The water testing criteria was therefore more stringent than that typically required in a LEED® project.
- Crushed rock was installed over drive lanes and all work/assembly areas to provide a clean, dry, and permeable work surface. A grass verge was left surrounding this work area to ensure surface water filtered across the bio-swale before draining into the storm drains.
- A temporary wheel wash (Figure 5) was installed, and all trucks leaving the site were required to drive through it to prevent their wheels and undercarriages from tracking sediments off-site. The

FIGURE 5. Temporary sediment basin and wheel wash. (Image: Aqua-Tex Scientific Consulting.)



FIGURE 6. Water quality test reports from the temporary sediment pond for the period that the excavated site was exposed to the rain. Nov 02–July 03 (Suspended Solids). (Image: Aqua-Tex Scientific Consulting.)



water was changed at intervals, and the turbid water was filtered in the sediment pond before discharge.

- Nearby storm drains were protected with filter bags that were inspected and cleaned regularly.

Site Impact After Construction

- **Soft Landscaping:** Due to the large building footprint (113,310 sq. ft. on a site area of 166,554 sq. ft., 68% site coverage) large areas of

the site were disturbed during the construction process. To provide habitat after the construction process had finished, the landscape design restored 53% of the open site area (i.e. site area excluding building footprint) with soft landscaping (Source: PFS 2005). 87.5% of the soft landscaped area is designed with native or adapted vegetation which requires no irrigation after the first year of establishment and very little maintenance (Figure 8).

FIGURE 7. Water quality test reports from the temporary sediment pond for the period that the excavated site was exposed to the rain. Nov 02–July 03 (Phosphorus). (Image: Aqua-Tex Scientific Consulting.)

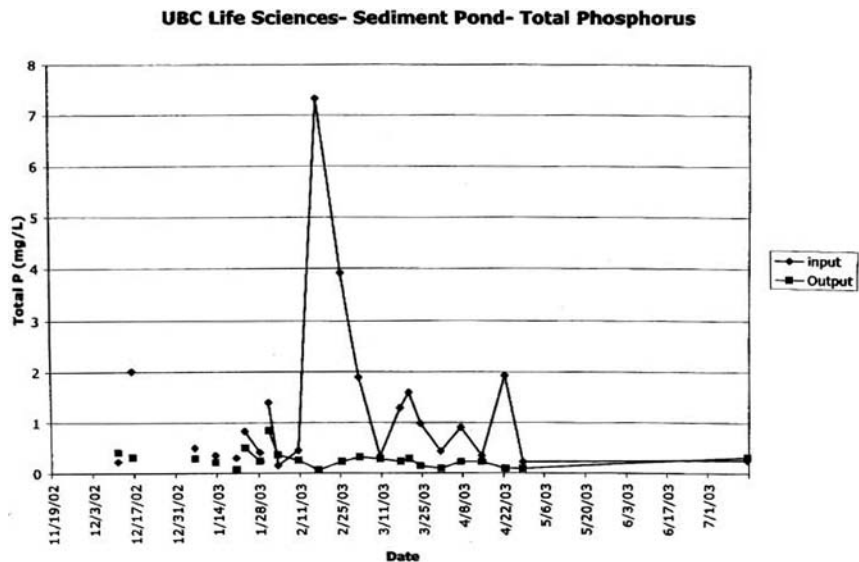
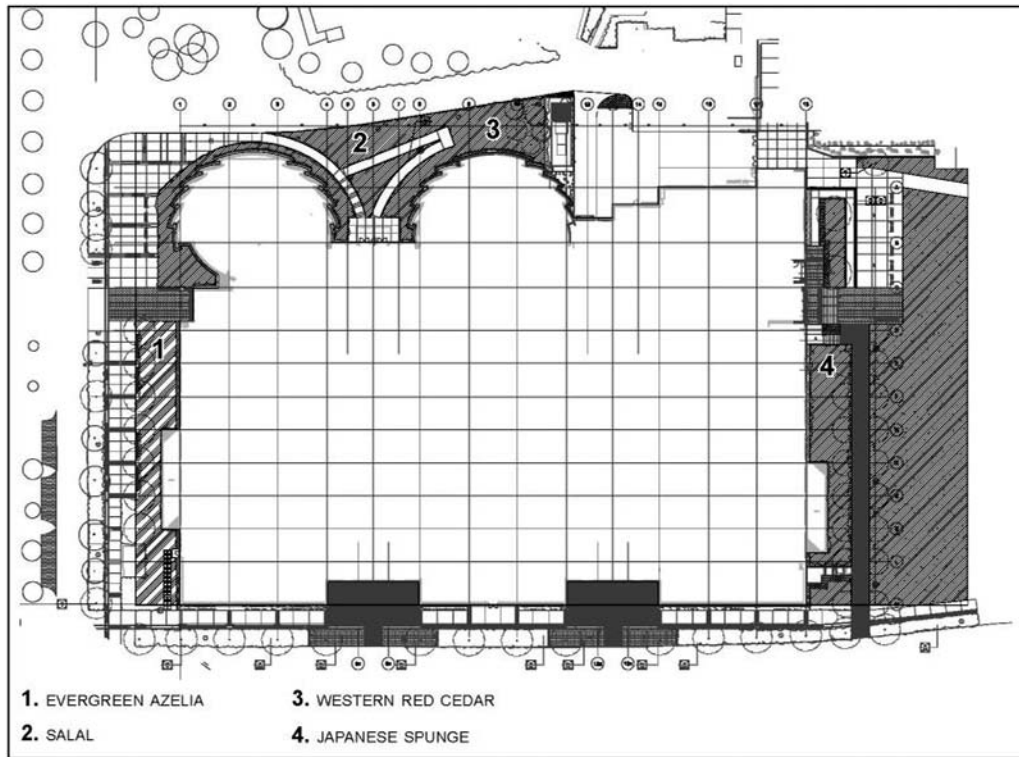


FIGURE 8. 53% of the open area of the site was restored with soft landscaping. (Image: Phillips Farevaag Smallerberg.)



- **Hard Landscaping:** The large building footprint also required extended lengths of sidewalks around the building to provide pedestrian access to the neighbouring facilities. The sidewalk area comprised 72% of the site's non-roof impervious surface. To minimize heat island effect due to the large areas of concrete sidewalk, the design team selected a high albedo (0.28) concrete mix (Source: Levinson 2001). In addition the landscaping design will provide shading to the concrete surface once the new trees are established.

(UBC LSC received 11 credits in the LEED® certification for initiatives relating to site sustainability.)

Water Conservation

The LSC uses 50% less water (for base building use, about 2.75 million liters less per annum) than a similar building designed compliant with the fixture performance requirements of the Energy Policy Act of 1992 (Source: MCW 2005). Water conservation fixtures are used throughout the building including wa-

terless urinals, low flow dual-flush toilets (0.8 and 1.6 gal/flush), self closing and sensor operated lavatory faucets (0.5 GPM), and low flow sink faucets (1.5 GPM).

Savings in irrigation also make a big contribution to the water savings at LSC. 53% of the open area of the site (site minus the building footprint) has been restored with soft landscaping. Of this landscaped area 87.5% has been planted with native or adapted vegetation which require no irrigation after the first year of establishment. Plants in the native category include *Gautheria Shallon* (Salal), *Thuja Plicata* (Western Red Cedar), and *Pachysandra Terminalis* (Japanese Spurge), while *Azalea Japonica* (Evergreen Azelia) comprises the remaining 12.5% of the ornamental variety (Figure 8). Calculations show a water use reduction of almost 73% (165,000 liters per annum) due to the water efficient landscaping design of the LSC (Source: PFS 2005).

(UBC LSC received 3 credits in the LEED® certification for initiatives relating to water conservation.)

Energy Savings

Laboratory buildings typically consume more energy than standard office buildings. Despite this fact the DOE 2.1E simulation program showed that the LSC performs 28% better than a similar building designed to the Ashrae 90.1 standard (Source: GF Shymko 2005). This results in an annual saving of approximately 6,400,000 kWh, 1000 tons of greenhouse gas emissions, and nearly \$180,000 (Canadian) at current utility rates. The following paragraphs describe the architectural, electrical, and mechanical design strategies that resulted in such significant energy efficiency.

Architectural Strategies. Typically at this stage of the Integrated Design Process the project team takes the agreed building shape and develops the envelope. This involves determining the best possible ratio of wall to window, glass and shading options, insulation values, and high performance building technology applications. The building assemblies are reviewed for thermal bridging characteristics. As-

sembly detailing and materials are also developed. The strategies usually explored during this step include increasing the performance of the glass to a reasonable cost effective level, investigating sun shading options that may be indicated by the first stage simulation exercise, and examining insulation values to optimize effectiveness (Source: Bunting Coady Architects 1996). For the design of the LSC, the project team addressed the challenges of the envelope in several ways:

- **Orientation:** The North and South side of the building contain offices (54 offices on each of the four upper floors) for the faculty and the research staff. Each office has a window for day lighting with a small openable portion for natural ventilation. The windows on the North façade (Figure 9) are flush with the exterior masonry wall to maximize the daylight penetration into the offices. The windows on the South façade (Figure 10) are recessed deep in the masonry opening to provide shading.

FIGURE 9. Windows on the North Façade are flushed with the exterior masonry wall to maximise daylight penetration. (Photo: Elizabeth Gyde, DSAI.)



FIGURE 10. Windows on South Façade are recessed in the Masonry opening to provide shade. (Photo: Elizabeth Gyde, DSAI.)



- **Envelope:** The building envelope was designed to optimize between summer cooling load and winter heat loss and gain. The north and south façades (Figures 11–12) have masonry brick veneer on concrete block wall backing (Figures 13–14) with spray foam insulation within (R value of assembly = R12). The East and West façades (Figure 15) have zinc panel cladding on concrete backing (Figure 16) with insulating panels within (R value of assembly = R12). The flat roof has SBS membrane roofing over rigid insulation (R value of assembly = R21). An innovative design feature of the envelope was the decision to

enclose the two open spaces between the three separate wings (5 storey towers) into large atria (each 60' wide, 140' long and 75' high, Figure 17) covered with full span skylights (glass U value

FIGURE 11. North Elevation. (Photo: Howard Waisman.)



FIGURE 12. South Elevation. (Photo: Elizabeth Gyde, DSAI.)



FIGURE 13. Brick veneer on north and south elevations. (Image: BCA/DSAI.)



FIGURE 14. Brick veneer on concrete block wall backing with spray insulation within (R-12 value). (Image: BCA/DSAI.)



FIGURE 15. Zinc cladding panel on West and East Elevation. (Photo: Howard Waisman.)



= 0.29). The savings by using interior type glazing and finishes on the walls of the atria more than offset the additional cost of the skylight and mechanical systems for the atria (Figure 18). The atria significantly reduced the area of envelope exposed to the elements and also allowed enhanced penetration of daylight into the laboratories. The atria are not air conditioned but utilize a reversible high-low de-stratification airflow system (Source: MCW 2005) to provide a comfortable environment at reduced energy levels.

Electrical/Lighting Strategies. Once the building shape and general window and sun shading strategies have been established, the amount of interior lighting required within the structure can be determined. It is important to reduce lighting loads as these are a significant portion of the energy consumption of buildings, both because of the power they consume and because of the cooling load they generate. Reducing the lighting load reduces both power consumption and cooling requirements (Source: Bunting Coady Architects 1994).

In order to achieve this at the LSC, maximizing daylight in the work spaces was an important goal in the design process. A 2% Daylight Factor is available in 75% of the regularly occupied space. The Lighting Design Lab of the Northwest Energy Efficiency Alliance was commissioned to test daylighting using scale models and a full size lab mock-up. Models of the labs and offices were studied in clear and overcast sky conditions to guide lighting design as well as ceil-

FIGURE 16. Zinc cladding panels on concrete wall backing with insulation in between (R-12 value). (Image: BCA/DSAI.)



ing and finish treatment (Figure 19). The 12' high windows in the labs enhance daylight penetration. Photo-electric sensors automatically dim the light fixtures in the perimeter areas in relation to the intensity of daylight penetrating the space. Most areas also have the lighting system controlled by occupancy sensors. The 8,800 plus light fixtures at the LSC are among the most ecologically responsible available. They are lead free, high efficiency, low mercury, low embodied energy, and contain minimal packaging. The lighting design resulted in the university's lowest lighting energy density for this type of building (0.94 W/sf. for the labs compared to 1.6 W/sf. per Ashrae 90.1-1999 and 0.76 W/sf. for the offices compared to 1.5 W/sf. per Ashrae 90.1-1999) (Source: GF Shymko 2005).

Mechanical Strategies. The LSC contains \$30 million Canadian worth of mechanical equipment for

FIGURE 17. The atria reduced the area of envelope exposed to the elements and enhanced daylight penetration into the labs. (Photo: Elizabeth Gyde, DSAI.)



the base building (excluding process equipment). This equipment is housed in a 3000 sq. m. mechanical room in the basement. There is also 6000 sq. m. of interstitial floor space for the labs in the two basement levels to service the mechanical, electrical, and plumbing distribution systems from above without breaching the containment protocols of the Bio-safety level 2 and 3 labs. The following are some of the innovative mechanical design features incorporated in the LSC.

- **Heat Recovery:** Laboratory space comprises the largest portion of the LSC (about 65% of gross floor area). The HVAC system for the labs requires 100% outside air supply to maintain a healthy indoor environment. Overall the building uses approximately 320,000 liters per second of outdoor air which is heated or cooled and humidity controlled (Source: MCW 2005). To capture heat from the outgoing exhaust air the LSC uses heat recovery coils in a glycol runaround

FIGURE 18. Savings in interior glazing and finishes of the atria offset the additional cost of the skylights. (Photo: Howard Waisman.)



loop. A second runaround loop recovers heat energy rejected from water-cooled process applications in the building.

- **Air Flow Efficiency:** Due to the large floor area and complexity of the program, a total of 40 air-supply units are used in the building incorporating several energy-saving technologies such as heat recovery, demand ventilation, variable speed drives, and direct digital controls (Source: MCW 2005). The lab exhaust systems are connected to

FIGURE 19. Daylight testing for Labs using scale model. (Photo: Lighting Design Lab, Seattle.)



the mixed-flow dilution fans (by Strobic Air) on the roof (Figure 20). Each exhaust fan system is connected to multiple fume hoods to economize on energy use and minimize roof penetrations. The Strobic fans make heat recovery economical and facilitate adequate dispersion of the exhaust by their high exit velocities. The standard laboratory fume hoods use a zone presence sensor to control occupied and unoccupied exhaust flow rates (regardless of hood sash position) to further conserve energy.

- **Displacement Ventilation:** The two large 350-seat lecture theatres use displacement ventilation. Air is delivered at extremely low velocity under the risers of the stepped rows of seating (Figure 21) and is returned through wood slats on the front wall. This system uses minimum fan energy, provides superior comfort level, and eliminates ambient noise generation, which is critical for the functioning of the broadcast quality audio-visual systems required for distance learning.
- **Heating and cooling:** For ambient temperature control the offices across the building (around 250 in number) use a four-pipe fan coil system to provide on-demand heating and cooling. For domestic hot water the LSC uses a steam-to-water instantaneous system that does not require storage tanks. A computer controlled hot water recirculation piping system balances pipeline heat losses, flow rates, and safe water temperatures.

FIGURE 20. Strobic fans on the roof facilitate adequate dispersion of the exhaust by their high exit velocities. (Photo: Howard Waisman.)



FIGURE 21. Air in the 350-seat lecture theatre is delivered under the stepped rows of seating at very low velocity. (Photo: Howard Waisman.)



- **Energy efficient chillers:** The LSC has a 1,200 ton chiller plant using three high pressure centrifugal chillers, with heat recovery on the primary unit. A low temperature chilled water system with a 16°F temperature differential is used to decrease pump energy, water flow rates, and chilled water pipe sizes. This strategy alone provides a 5% reduction in overall energy use (Source: MCW 2005).
- **Commissioning:** A commissioning agent was contracted to develop and implement a commissioning plan for the project. The commissioning process ensured that systems were installed and functioning as intended. The contract also required a review of building operations with UBC Operations and maintenance staff within one year of construction. For a project of the complexity of LSC, the commissioning process was crucial for the effective functioning of the mechanical and electrical systems leading to savings in energy and operational costs.

(The UBC LSC received 6 credits in the LEED® certification for initiatives related to energy conservation.)

Materials

Selection and application of construction materials can have a significant impact on the overall sustainable goals of a project, even more so in a project of the

scale and complexity of the LSC. Over 50 trades were involved in the construction process. The design and construction teams realized the challenge and significance of controlling the materials used on site (to conform to sustainable criteria) and of managing the documentation process required for LEED® certification. Sustainable criteria of the materials were incorporated into the construction documents, particularly the specifications, to ensure compliance during construction. Sections of the specifications outlined requirements for recycled content in materials, the priority for local sourcing, and the requirements for low volatile organic contents (VOC) in applicable materials. Management of the construction waste was also discussed with the construction team. To consolidate all this information and to act as a tracking tool, the design team developed a one-page Material Information Sheet (MIS) and included the same in the specifications. The MIS required information from the trades/material suppliers on the material cost of a building product, recycled content in the materials, place of its manufacture and/or raw material extraction, levels of VOC as per applicable standards, and methods of construction waste management practiced by the trade. The construction manager required each trade to provide the MIS information for their materials. The following paragraphs describe a summary of the materials information extracted from the MIS.

Construction Waste Management. The project specifications provided guidelines on the key materials for mandatory recycling and/or salvage. Based on these guidelines the construction managers prepared and implemented a Construction Waste Management Plan focusing on Reduction, Reuse, Recycle, and Recovery. This process resulted in 1.3 million tons of construction waste (78% of total) being diverted from the landfill. A recycling company was contracted to provide the necessary collection bins, monitor the process, and provide periodic manifests for the quantities reused, recycled, or salvaged. The recycling rates varied from 100% (for metals, drywall, concrete, and cardboard) to about 50% (mixed waste).

Recycled Content. The MIS facilitated the observation and documentation of levels of recycled content

(both post consumer and post industrial) in the construction materials as already called for in the specifications. Overall, the construction materials contained 11.5% recycled content (combined value of post consumer plus half of post industrial content as a percentage of total cost of materials) (Source: Ledcor 2005). The percentage of recycled content in the individual materials varied. Some examples are: Structural steel (78% post consumer, 12% post industrial), Reinforcing steel (69% and 29% respectively) Medite II medium density particle board (75% and 25% respectively), Acoustic tile (42% post industrial), and Zinc cladding panel (35% post consumer).

Local Materials. Vancouver's location on the Pacific coast poses an inherent disadvantage in trying to source materials within a 500-mile radius, as almost half the supply area within the radius is the ocean! Notwithstanding this difficulty, the design team included sections in the specification to give priority to local materials and the MIS documented locations whenever they were within the 500-mile threshold. In the final analysis 30% (by \$ value) of the materials used in the LSC were manufactured within a 500-mile radius, and raw materials for 16% (by \$ value) of the materials used were extracted within the same radius (Source: Ledcor 2005). The main building materials manufactured locally included site-cast/pre-cast concrete, block masonry, aluminium extrusions, drywall, and vision glass.

(UBC LSC received 6 credits in the LEED® certification for incorporating sustainable material in the project.)

Construction IAQ Management, Low VOC and Indoor Air Quality

Health and comfort of both the building staff during construction period and the final occupants upon completion was considered throughout the design and construction process. Strategies applied included selection and specification of material with low off gassing potential (low VOC content), the design of mechanical systems to provide required ventilation levels (per Ashrae 62-1999 standard), and the implementation of a rigorous Construction Indoor Air Quality (IAQ) Management Plan both during and immediately after construction (before occupancy).

Materials with Low VOC. A total of 29 types of adhesives and sealants were used in the project. MIS information for each was obtained during the shop drawing submittal stage and vetted for compliance with the VOC content limits of the South Coast Air Quality Management District (SCAQMD) Rule 1168. Maintaining sustainable criteria for paints was a bigger challenge, due to the need for several industrial class primers and coatings (e.g., epoxy) for which there are few alternatives. The selected paints complied with Green Seal Standard GS-11 as well as the included chemical component restrictions. The carpets were also selected for compliance with the CRI Green Label IAQ Test Program requirements.

Ventilation Rate. 40 different air supply systems were designed for the project to maintain the ventilation rate required (as per Ashrae 63-1999) and at the same time provide the 100% fresh air content. A key mechanical design strategy was to have air intakes at the ground level and exhaust with dispersion at the roof. The fresh air intakes are located in areas away from any garbage fumes, vehicle exhaust, building exhaust, or smoking. The building exhaust and intake locations were analyzed by completing a CFD (Computational Fluid Dynamic Modeling) of the intakes to ensure contaminant-free fresh air.

CO₂ Monitoring. Of the 40 air supply systems installed in the project, 31 systems are 100% fresh air and 9 have a recirculation mode. Each of these 9 systems has a CO₂ sensor located in the space to modulate outdoor air to maintain a level of CO₂ not to exceed 550 ppm above ambient background CO₂ levels, normally 350 ppm (Source: MCW 2005).

Construction IAQ Management. Maintaining a healthy air quality during construction is important not only for the health of the construction workers but also for the health of the occupants (after construction). Dust and other contaminants present in the air during construction can be absorbed by porous building materials such as insulation, furnishing, soft furniture, and carpet and prove detrimental to the health of occupants for long periods afterwards. An effective Construction Indoor Air Quality (IAQ) Plan was therefore necessary to prevent this contamination. The construction manager imple-

mented a Construction IAQ Management Plan based on the requirements of the SMACNA (Sheet Metal and Air Conditioning Contractors National Association) IAQ Guidelines, Chapter 3. All the five categories of control measures listed in Chapter 3—namely HVAC Protection, Source Control, Pathway Interruption, Housekeeping and Scheduling—were addressed in the IAQ plan (Source: Ledcor 2004). Due to the phased nature of the LSC project (Figure 22) the Pathway Interruption and Scheduling categories were implemented with more rigor than in a typical LEED® project. Upon completion of construction of each phase and before occupancy, a minimum two-week building flush-out was conducted with Minimum Efficiency Reporting Value (MERV) 13 filtration media at 100% outside air.

(UBC LSC received 11 credits in the LEED® certification for incorporating strategies to promote a healthy indoor environment quality.)

5. LESSONS LEARNED

When the project began in April 2002, the design team was faced with opening the facility for the first cohort of medical students in September 2004. Knowing that it would take at least 24 months to complete 560,000 sq. feet of construction, the team members realized that they had less than six months for design. Another source of additional pressure was that this ambitious timeline did not allow for a fit-out period, typically of about three months' duration. This meant that there was only three months for design if the team pursued a linear traditional process.

Everyone immediately got to work and decided to adopt a just-in-time approach of information flow for the construction manager. This approach allowed the design team additional flexibility by more effective management of the timelines for each stage of the project. By giving the contractor the basic outline of the facility and burying much of the building underground (needed to accommodate the research labs, the morgue, the gross anatomy labs, and the mechanical floor—all required to be temperature controlled secure and unlit spaces), the trades were effectively occupied with the excavation process allowing more time for design. We were in the ground by July 2002.

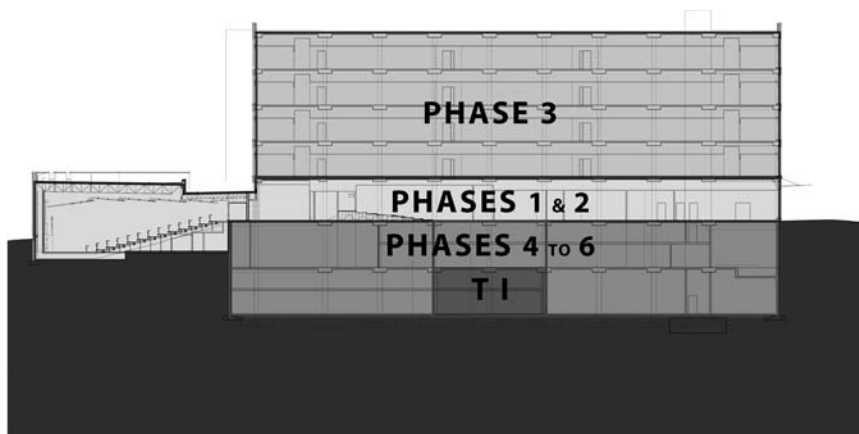
Within a matter of twelve weeks the team had managed to use the energy model to great advantage to inform and secure the shape of the building, ensuring that the building mass was energy efficient and able to support our land use sustainability goals. This holistic approach, employed from the very beginning of the project, combined with a desire to get every consultant involved in the design of the building shape, gave us great results.

In addition, the university responded well to the very real time pressures the design team found themselves under, appointing a representative team to provide feedback on behalf of the users. This approach was somewhat contentious, especially at the end of the project, when the users started to move in as they felt they had not always been individually and personally involved in the decisions regarding the development of the building. At times there was an inherent conflict between what the users actually wanted, which was very specific, and what the university wanted, which was a generic, universal layout that could be adapted to multiple future users. At times the university user representatives got caught in the middle of this debate and were under tremendous pressure and stress to provide a middle way to please all sides. On completion of the project, the design team recommended that the UBC Board should set up a strong communication protocol explaining the university's commitment to sustainability, how that translates to universal design principles, and how each individual will have to accommodate for this

new paradigm. However, once the users moved in, and especially when the facility started to win awards and attract tour groups, the users became very proud of the building and the complaints essentially stopped. In addition, having the contractor in place for two years after the initial completion of the building helped with the smooth running of the occupancy process. In particular, users felt that they could quickly get a timely and appropriate response to any operational queries.

This project involved eight separate occupancy dates, and it soon became clear to the design team that the code requirements for this approach in a laboratory setting were both complex and detailed. Nevertheless it was possible to overcome most of the obstacles with a clear action plan at the very beginning of the job. For this reason it was decided to generally complete the top floors first so that the fire, if any, would burn upwards towards the protected floors. The project team worked with the client and local authority having jurisdiction to establish the multiple occupancy stages and liaised with the owner to assist in their move coordination. The first occupancy took place in September 2004 and was followed by five more occupancy periods through May 2006 (Figure 22). It was undoubtedly a challenge for all concerned to measure the performance of a building that was being completed so organically, and it took a great deal of engineering discipline and contractor control of the site to keep the air quality, life safety systems, and heating and cooling systems pro-

FIGURE 22. The construction was completed in 6 phases. (Image: BCA/DSAI.)



tected and balanced for each phase of the project. In addition, the project could not be finally submitted for LEED® certification until completion of the final (base building) phase of construction, meaning that the contractor had a greatly extended period in which to collect information and provide documentation for the LEED® submission. In some ways, however, the constant pressure and need to document every single stage of the process ensured a very high level of quality control and led to a real sense of camaraderie on site as people rose to the challenge.

Finally, the design team also realised that the construction of a lab building came with its own unique set of challenges; the equipment had as many specific and individual requirements as the people. Although targets for the occupants were set in advance for fresh air, temperature control, and acoustics, often the governing parameters were in fact those required for the specialized laboratory equipment. This in turn involved lots of vibration separation and heavy loading requirements, meaning that a lot of the equipment had to be located on the ground floor slab. The ventilation strategy of the building was dramatically affected as well. In particular, it took all of the team's expertise to get the ventilation fume hoods in the labs not to have an adverse affect on the over-all ventilation energy use in the building. Another challenge to the team was the available equipment information based on the schedule for user space allocation and funding programs. Most of the future users had not been assigned to the building at the time of design. Indeed, a majority of the lab researchers were not assigned spaces until after the occupancy for the labs were reached. This made it extremely difficult to finalize plugs, gas, and water requirements throughout the building and meant that the team had to spend a lot of time anticipating future requirement options and generic service requirements. It also required a focussed effort at the end of the job to customize generic lab spaces before individual users were allowed to move in. A key element in this approach to customizing is the availability of building trades at the end of the job. In the end this worked out and resulted in an orderly serving approach for the customization requirements during occupancy.

6. CONCLUSIONS

The goal-oriented approach of this project was a recipe for success. The desire of all involved to

achieve third party certification through LEED® was also a positive experience through the adoption of the Integrated Design Process. Would it have been possible to have done things differently? Of course. In an ideal world the team would have had more time and more money combined with the luxury of a complete program if the users had all been in place. However, this is the new norm in our industry—as projects consolidate and owners become more fluid in their requirements, architects have to create a generic response. This ultimately leads to buildings that are more useful over time as they are more flexible. As labour and materials respond to increases in demand with extreme price upswings, there is a need to be more creative in the streamlining and in the speed of our work. Architects also need to design more efficiently and with greater emphasis on sustainability. Over the long term, the creation of a simpler system, using local materials or leading to the elimination of some elements altogether will ensure that costs are kept down.

The push toward sustainable design supports better use of sites and materials and healthier and more energy efficient materials in more flexible building forms, but the message regarding durability has not yet really got through to the market. In the case of the Life Sciences Centre, the project team created a brick and masonry building that will not only last through time but is also extremely durable. Too often disposable buildings are being created as a direct response to price increases and a lack of ownership of the building stock. The design team believes that the Life Sciences Centre will stand as an example of a quality based response to current building requirements that is architecturally elegant, reflective of advanced engineering design solutions, and built to meet society's needs for many years to come.

7. AWARDS RECEIVED

The UBC Life Sciences Centre has received the following awards to date (August 2006):

- 2006 IESNA International Illumination Design Award (Special Citation)
- 2006 USGBC LEED Gold (New Construction)
- 2005 Masonry Institute of BC: Masonry Design Awards; Merit Award—Institutional
- 2005 BOMA Earth Award

2005 NWCB Building of the Year (Commercial Interior)
 2005 CEBC Award of Merit
 2005 ASHRAE Chapter/Regional Technology Award

8. PROJECT TEAM (ACKNOWLEDGMENTS)

OWNER: University of British Columbia
 PROJECT MANAGER: UBC Properties Trust
 ARCHITECTS: Bunting Coady Architects and Diamond & Schmitt Architects Inc. (joint venture)
 CONSTRUCTION MANAGER: Leducor Construction Ltd.
 PROGRAMMING: Resource Planning Group Inc.
 STRUCTURAL: Read Jones Christoffersen Ltd.
 MECHANICAL & ELECTRICAL: MCW Consultants Ltd.
 ENERGY: G.F. Shymko & Associates
 DAYLIGHTING: Lighting Design Lab
 CIVIL: Aplin and Martin Consultants Ltd.
 LANDSCAPE: Phillips Farevaag Smallerberg
 STORMWATER: Aqua-Tex Scientific Consulting Ltd.
 LEED CONSULTANTS: Build Green Developments Inc.
 SPECIFICATIONS: E. W. Hamilton Ltd.
 BUILDING ENVELOPE: Read Jones Christoffersen Ltd.
 COMMISSIONING: CES Engineering
 GEOTECHNICAL: Trow Consulting Engineers Ltd.
 ELEVATOR: John W. Gunn Consultants
 CODE: CFT Engineering Inc.
 ROOFING: J. W. Wells Consulting Inc.
 ACOUSTIC: Aercoustics
 AUDIO VISUAL: MC2 Systems Design Group
 AIR DISPERSION: Rowan Williams Davies & Irwin Inc.

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