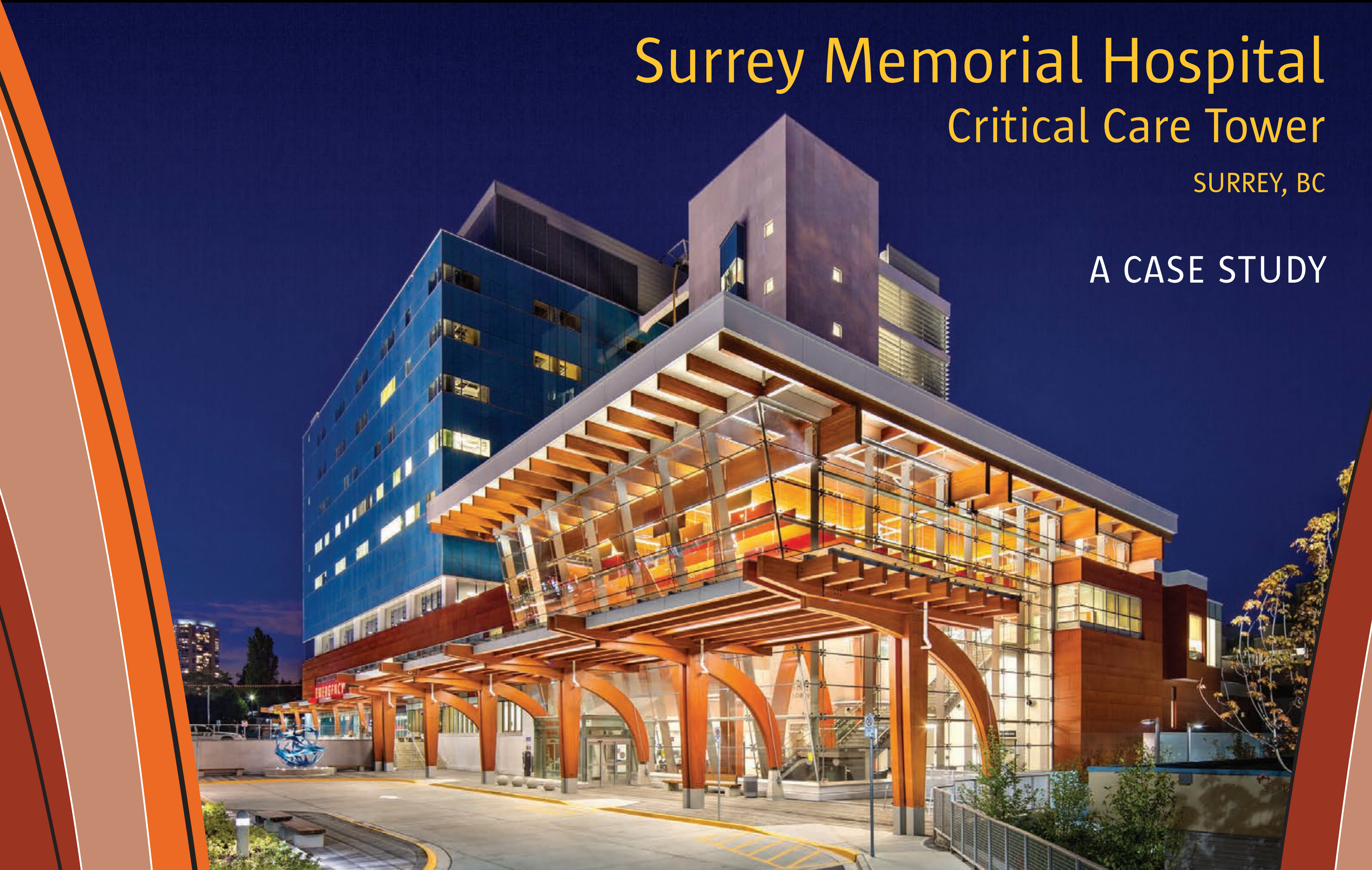
Surrey Memorial Hospital
Critical Care Tower

SURREY, BC

A CASE STUDY



wood WORKS!
Program of the Canadian Wood Council

Canadian Wood Council
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Photo by Jerald Walliser, courtesy Fraser Health

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Project Credits .... Back cover

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Introduction: Wood and Human Health

The completion of the Critical Care Tower (CCT) at Surrey Memorial Hospital provides the strongest evidence to date that Canada's healthcare sector now recognizes the important role that can be played by wood in the creation of healing environments.

Psychological and Physiological Benefits

Just as our definition of green building has expanded with time so has our understanding of human health expanded to include not only our physical condition but also our psychological well-being. We have known intuitively for a long time that humans have an affinity for nature, and being in a natural environment—a forest, a park or simply our own garden—can make us feel more relaxed. The term 'biophilia' has been coined to refer to this phenomenon.

Scientists have now confirmed that this sensation of relaxation in the presence of nature is the result of a physiological change, a reduction in the level of stress-related hormones produced by our body's sympathetic nervous system (SNS). Using an approach known as 'evidence-based design' (in which detailed analyses of occupant responses to a building's physical characteristics are used to inform the design of future projects), healthcare architects have begun to explore the physiological benefits of biophilia in the design of indoor environments. This has led to the greater use of natural daylight, access to views of nature, and the introduction of wood and other natural materials into healthcare facilities.

Courtesy Ed White Photographics

Wood in particular is visually warm and contributes to a socially positive experience for building occupants. People respond emotionally to wood and are attracted to its visual variety and natural expressiveness. A study carried out by the University of British Columbia and FPInnovations[1] confirms the value of these attributes. The joint research project found that the visual presence of wood in a room lowers SNS activation in occupants, further establishing the positive link between wood and human health.

[1]Fell D.2002. Consumer Visual Evaluation of Canadian Wood Species. FPInnovations, Vancouver, Canada.

Physical Benefits

Among the physical requirements for human health, wood contributes naturally to humidity control by absorbing moisture from the air when the humidity level in a space is high and releasing it when the humidity level is low. Wood products and finishes can also contribute to the control of air-borne contaminants as they are durable, easily maintained, dust-free after installation and emit few, if any, harmful vapours.

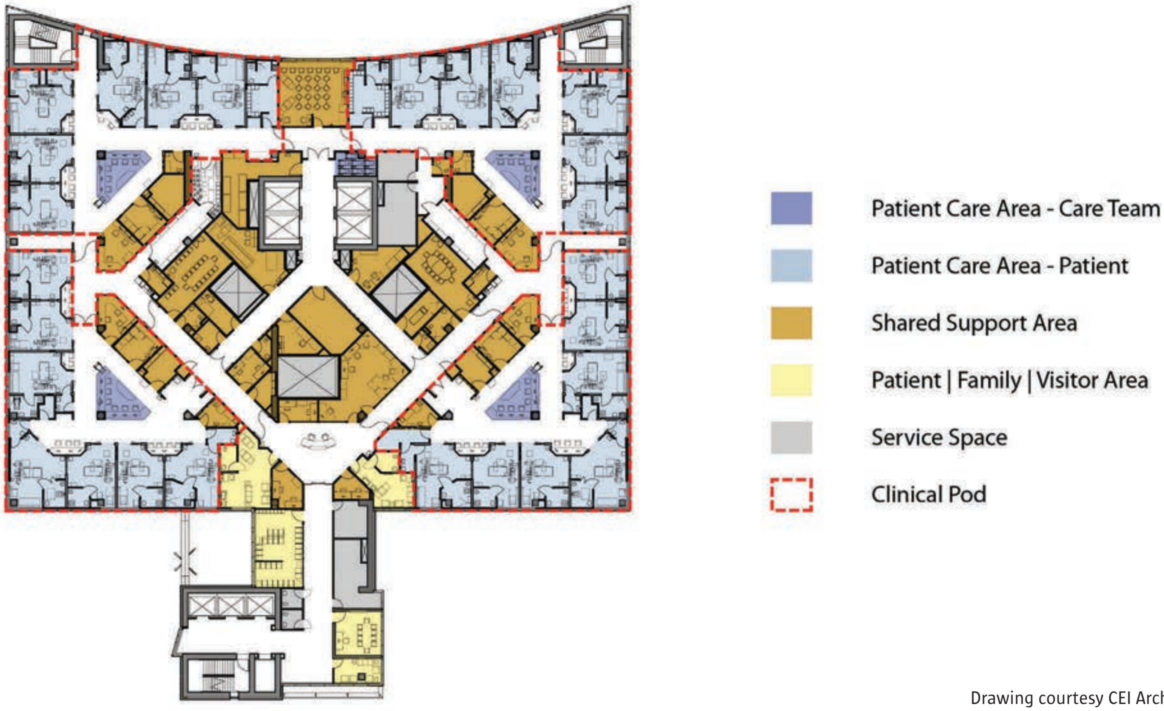
Courtesy Ed White Photographics

Overview of Critical Care Tower

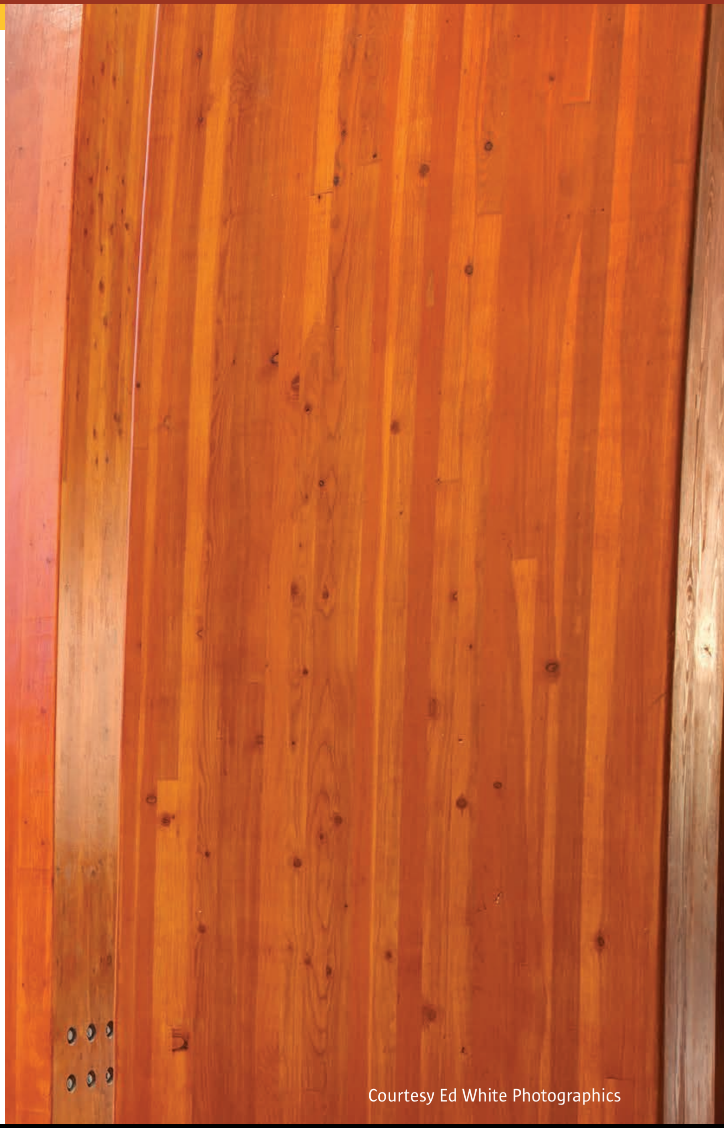
Surrey Memorial Hospital serves the metropolitan area of Surrey, BC—one of Canada's fastest growing communities. Surrey is a vital and vibrant city that is home to many diverse cultural groups, including a large proportion of new Canadians. The Surrey Memorial Hospital is the largest acute care site for the Fraser Health Authority, which serves approximately 1.6 million people, or 35 per cent of British Columbia's population. Its Emergency Department is the busiest in the province.

With an area of 39,250 m^2 (420,000 ft^2), the Critical Care Tower is the largest healthcare project in the history of British Columbia. This expansion to the existing hospital will provide the community with world-class family-centred care, with a goal for it to be a Centre of Excellence. An evidence-based design approach has been implemented to ensure that the facility will support the highest standards of care.

The project adds acute care beds, and a new emergency department (the biggest in Canada) with specialized mental health and pediatric areas. Other elements include adult and neonatal intensive care units, more space for the clinical academic campus of the University of British Columbia School of Medicine, and a laboratory with the latest medical technology, specially designed to meet the needs of the region.



Drawing courtesy CEI Architecture

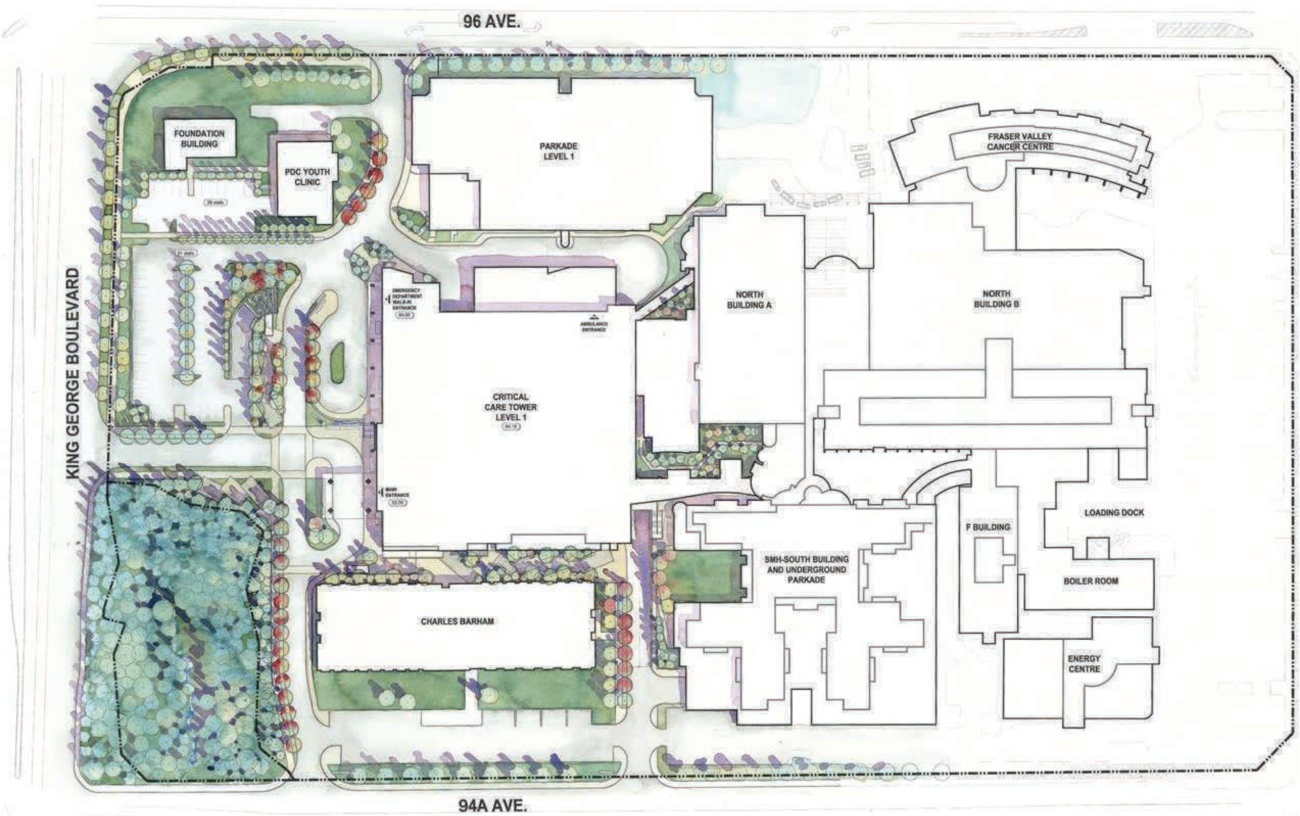


Courtesy Ed White Photographics

Architectural Approach

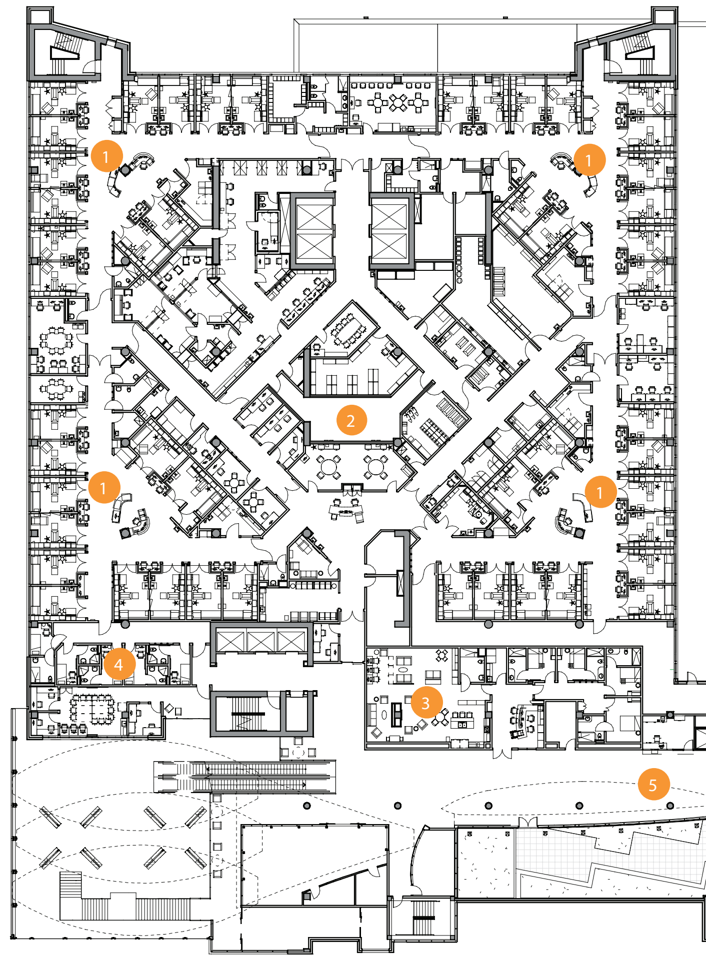
The Surrey Memorial Hospital Critical Care Tower is fully integrated with the existing hospital and within the neighbourhood. When all phases are complete, treed boulevards, landscaped walkways and bike paths will form a connection with the surrounding cityscape and neighbourhoods.

The Critical Care Tower was conceived as the new front door to the hospital campus. On approach, visitors are presented with a clear and calming image of the building that announces a state-of-the-art healthcare facility; one that responds and is sympathetic to its surrounding community in all its cultural diversity.



Drawings courtesy CEI Architecture

Site Plan

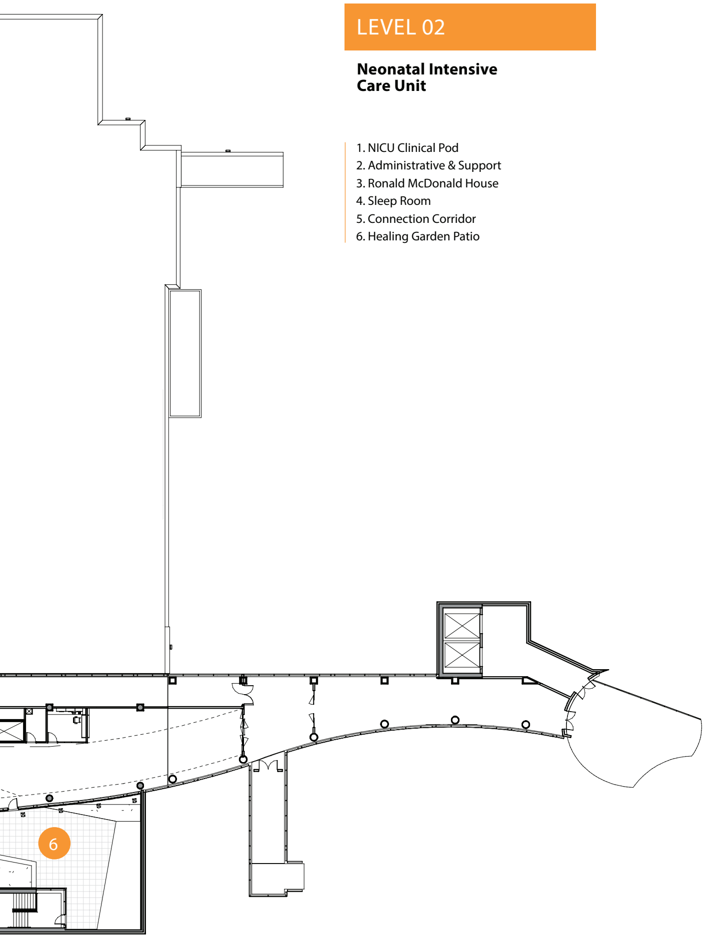


Typical Floor Plan

LEVEL 02

Neonatal Intensive Care Unit

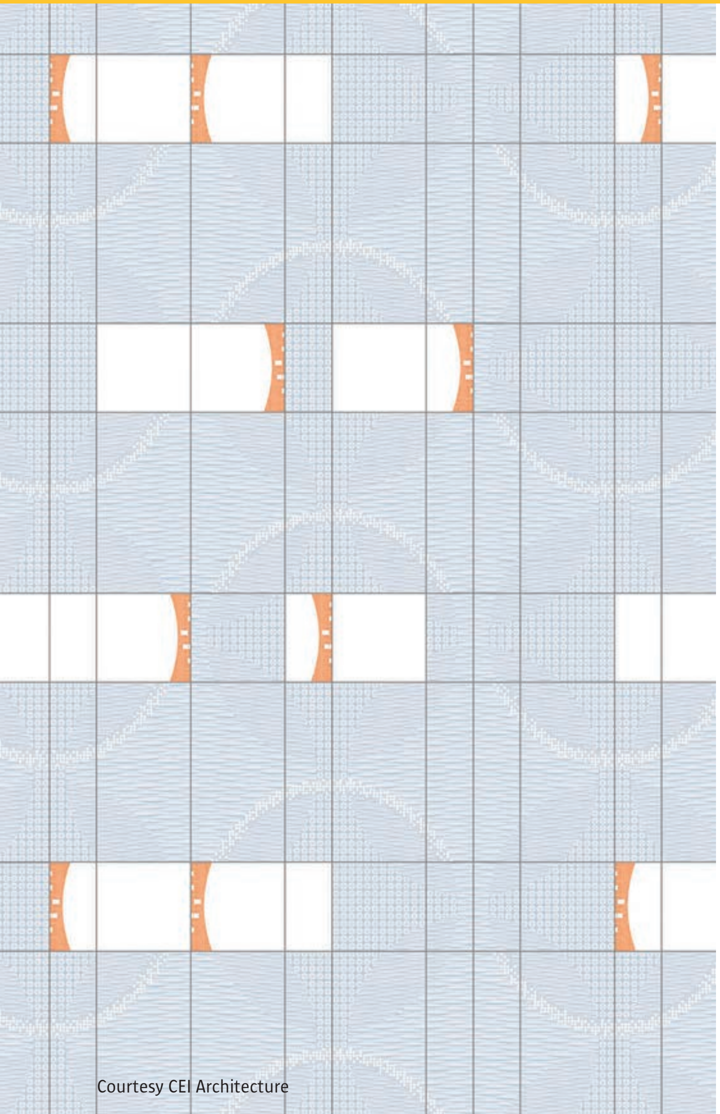
1. NICU Clinical Pod
2. Administrative & Support
3. Ronald McDonald House
4. Sleep Room
5. Connection Corridor
6. Healing Garden Patio



Courtesy Ed White Photographics

A Cultural Veil

The six-storey glass in-patient tower is veiled by a three-dimensional ceramic frit pattern that has been applied to the glass. This frit pattern was the main design catalyst for the project. The concept of the “healing veil” is woven from a cultural tapestry, representative of the diverse population of the City of Surrey. This theme is also expressed throughout the interior design, and provides the context for the hospital’s wayfinding system.



Courtesy CEI Architecture

The massing of the building is strong and simple, combining four durable natural materials —wood, glass, ceramic and stone.

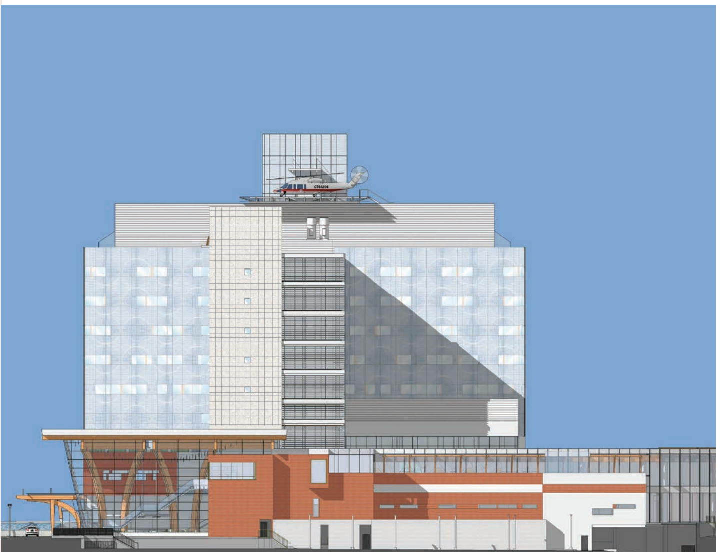
> WOOD – The two-storey base of the Critical Care Tower is clad in a wood composite panel system that embraces the Emergency Department and Neonatal Intensive Care Unit. The panelling is continued into the interior of the atrium to create a metaphoric “nest”.
>
> GLASS & CERAMIC – Rising above the wood base, the six-storey in-patient tower is clad in glass that takes on the quality of a veil with the addition of a three-dimensional ceramic frit pattern.
>
> STONE – The glass in-patient tower is complemented by the stone-clad circulation tower, which is connected to the main tower but articulated as a separate element.

Wood, glass, ceramic and stone are united in a transparent and inviting public entry pavilion. The 27-metre-square roof of the entry pavilion is supported by two internal tree structures, each consisting of four glulam wood branches. The use of wood is carried from the main entry through to all connective links and throughout all of the hospital floors so the warm influence of wood is pervasive throughout the Critical Care Tower.

The new processional drive axis from King George Boulevard leads visitors past an exterior wood canopy to the entry pavilion. Rising overhead, the expression of wood is continued by a three-dimensional wooden double helix inspired by the form of genetic DNA. The double helix delicately weaves along the surface of the glazing façade between the glass in-patient tower and the stone circulation tower, and is visible both on approach to the hospital and to visitors inside the waiting rooms on each floor of the glass tower.

As visitors enter the hospital, the finely woven details of the wood, glass, ceramic and stone become more prominent and complex. In contrast to the conventional institutional nature of a hospital, these textural details engage users and help forge a personal connection to the hospital that emphasizes a caring and healing relationship.

West Elevation



South Elevation

Drawings courtesy CEI Architecture

Sustainable Design

The nature of this public-private partnership project (design, build, finance and operations) demanded that it be conceived and realized through an integrated design process. Fraser Health required that the project achieve LEED Gold, an exacting standard for a building of this scale and complexity.

The design team used LEED as a starting point and established goals for environmental, economic and social sustainability to influence the 30-year model used as a framework for the sustainable design approach.

It is anticipated that the building's energy consumption will be reduced by 47 per cent when compared to a standard design. Flexibility is ensured by a flat-plate structural design with minimal walls and bracing. This provides flexibility in the floor plans and will support future renovations and reconfigurations.

Energy efficiency efforts began by carefully considering the integration of the hospital's existing physical plant (which includes provision for future retrofits and upgrades to higher efficiency boilers) while maximizing the energy efficiency of the new mechanical systems. Ample use of natural daylighting for energy efficiency will also support a healing, healthy and welcoming environment while minimizing the need for artificial lighting.

Materials have been selected that emit low amounts of volatile organic compounds. To promote the health of patients, staff and visitors, materials used in interior spaces were reviewed to ensure they contain either reduced levels of volatile organic compounds (VOCs) or no VOCs at all. Approximately 20 per cent of the materials used in construction were extracted and manufactured locally. Wood was specified where possible for both interior and exterior applications, not simply for its physical and psychological benefits, but as a sustainable resource.

A storm water management system will capture runoff and discharge it into a groundwater infiltration system. The water-efficient landscaping will not require the use of potable water for irrigation. A secure bicycle storage area with space for 72 bicycles and two separate shower facilities will encourage staff to use alternative methods of transportation.

Courtesy Ed White Photographics

Program Innovation

Patient and family care are at the core of the design, along with staff safety. All patient rooms have access to natural light and dedicated family space. Infection control, universal design and disaster preparedness were also key priorities for the project, which will help to ensure expanded access to world-class healthcare for communities across the province. As a new, modern facility designed according to the latest evidence-based healthcare research, this facility is truly a model for future healthcare projects.

Extensive user consultation processes, evidence-based design strategies, and lean principles[2] have been implemented to support clinical staff in providing the highest possible level of care. The emergency department is designed in pods. These take the form of universally designed self-sufficient zones that have centralized access to supplies and services. Within these pods, the treatment areas will support staff in providing intuitive patient care while reducing unnecessary travel time. The pod zoning also enables isolation of areas in the event of a communicable disease outbreak or acts of violence.

The Critical Care Tower's in-patient areas provide clearly delineated on-stage and off-stage spaces with patient and visitor areas clearly separate from core staff areas. Universal design and same-handedness supports staff familiarity and efficiency as they move around and between floors. Lean principles are also applied to reduce walking distances for clinical staff and strategically locate core service rooms that are most frequently accessed by caregivers.

Family-centred care is integrated with state-of-the-art technology by providing dedicated clinical and family zones within patient rooms.

[2]Lean design emphasizes efficiency and reducing wasted time, effort and materials by analyzing how patients, visitors and staff interact with a facility. In a healthcare setting, the ultimate goal is improved patient health.

Courtesy Ed White Photographics

Wood Use and the Wood First Act

Reflecting the requirements of British Columbia's Wood First Act, the project has been designed to embrace innovative and appropriate uses of wood. The design features many visible wood elements—structural and decorative—resulting in a warm, natural aesthetic that supports the function of the building as a facility dedicated to healing.

Courtesy Ed White Photographics

Wood has been showcased in areas where it makes practical sense to use materials that respond well to rigorous maintenance procedures, require superior resistance to weather and UV damage, or contribute to infection control. These applications include structural components for canopies and cladding, and interior use for millwork, interior wall treatments and acoustic panelling.

Wood use is concentrated in the areas of public interface, including the exterior covered walkways and waiting areas, drop-off area, new west entrance and the link connecting the Critical Care Tower to the existing hospital. This use of wood is designed to reinforce the connection to nature and the outdoors, helping to reduce stress and anxiety. The lobby, where families and loved ones will spend significant amounts of time, features exposed structural timbers, panelling and millwork.

Exterior

The use of wood is most predominant along the west elevation, which is the most visible aspect of the building. It culminates in the two-storey entrance atrium at the southwest corner, where two massive glulam tree columns support a cantilevered wood lattice roof made up of two layers of glulam beams.

Outside the entrance atrium, wood elements remain a prominent feature with a reduction in scale to frame the pedestrian walkways down the west façade connecting to the walk-in entrance of the new Emergency Department. The Emergency Department walk-in entrance and ambulance canopy also showcase glue-laminated beams.

Wood finishes are also featured in the link between the new Critical Care Tower and the existing hospital to reinforce the connection to the new main entrance. Wood is used extensively in exterior soffits in prominent areas. Wood composite exterior cladding is used along the lower podium of Levels 1 and 2, to soften the appearance and to differentiate this public area from the patient tower above, and to link the various entry points of the building together.

Courtesy Ed White Photographics

Interior

In addition to prominent exterior elements, wood is used extensively in the interior of the new facility. It is concentrated in feature public spaces, reception areas and nurse workstations to act as both a humanizing and a wayfinding element.

Wood is also incorporated in interior ceiling panels, acoustic wall panels and decorative wall panels throughout the facility, with a focus on the Main Entry Lobby, second floor and link areas and the UBC Lecture Theatre. In some instances, laminate has been used in place of real wood veneer on solid core wood doors where durability and the integrity of the finish are paramount.

Wood is also used for the built-in cabinetry, for the ceilings above the team care stations and the front of reception desks where it can be properly protected and maintained.

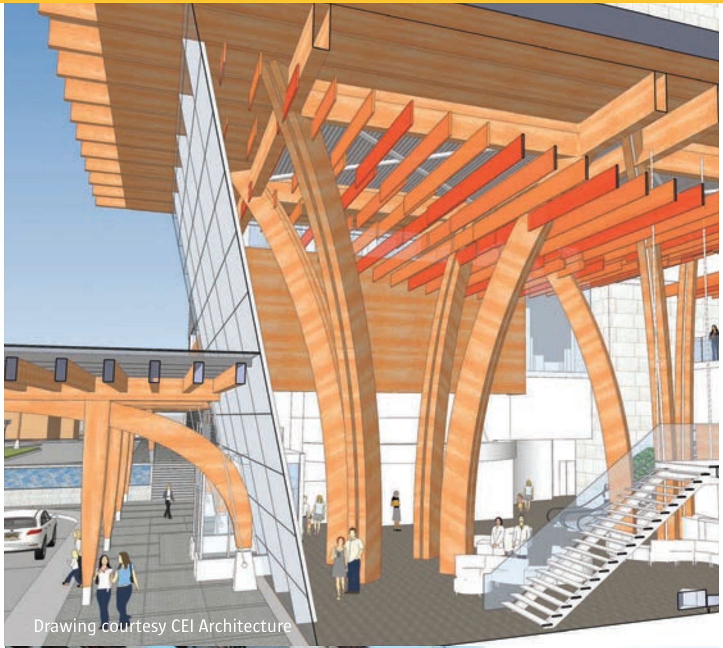
Building Code Considerations

Codes currently limit the use of heavy timber structural elements in large and tall buildings, which makes the use of wood a challenge in projects such as this. As a result of the occupancy and size of the building, combustible construction would typically not be permitted based on the prescriptive requirements of the Code.

However, because the lobby projects from the base of the tower, it has been possible to design it so that from a fire safety perspective it is considered a separate structure. This portion of the building does not contain any patient rooms, thus heavy timber was permitted on an alternative solution basis for up to two storeys in building height for the roof and its supporting structure.

This particular interpretation was achieved on account of the sloping grade along the west elevation. The heavy timber structure was permitted at the south of the building where only the second and third storeys are technically above grade. The following code analysis was performed to address this situation:

- A two-hour fire separation was provided to separate the area containing heavy timber from the remaining B2 occupancy.
- The principal firefighting entrance and the fire access route are at the second storey. This provides direct access for firefighters for the two storeys above the access route at the west side of the site.
- Firefighting access is also provided in the southeast corner of the building and will provide direct access to Level 2 in this area.
- The building is sprinklered.
- A roof connection for the standpipe was provided for additional firefighting ability.



Drawing courtesy CEI Architecture

Sectional perspective through the glazed curtain wall of the lobby, showing the relationship between the interior glulam tree column structure and the exterior glulam canopy structure

Photo by Jerald Walliser, courtesy Fraser Health

Fast-track Construction Challenges

To facilitate the fast-tracking of several aspects of the project, the design at the outset of the project was focused on enabling the design-builder to begin construction on site as soon as possible. Construction commenced in February with the installation of excavation shoring piles and site services.

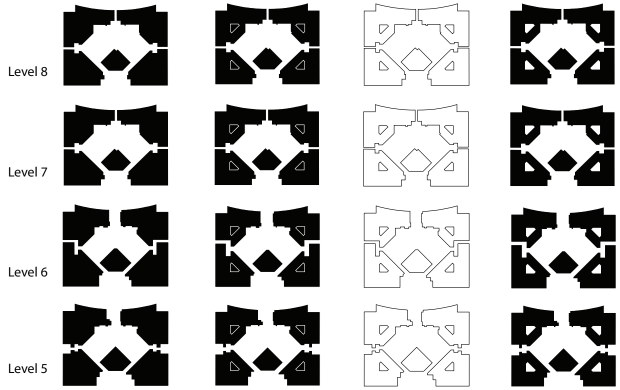
By working closely with the City of Surrey, the design team was able to submit a foundation permit while design development was still underway.

Collaboration with the design-builder established key design milestones relating to fast-tracking. For example, by the end of June 2011, the locations of floors and walls were frozen to allow the mechanical and electrical consultants to complete their designs with construction to follow.

Peer reviews, checklists and regular consultant coordination meetings were part of a quality control program that was necessary for the continuing success of the fast-track process.

Because of the restricted area of the site, the new tower had to be constructed directly against the existing building. Special surveys were required and monitors were installed to ensure that the existing building did not settle more than 10mm.

Special construction techniques were required to reduce the amount of vibration and noise resulting from construction work. The design team addressed the complex issues relating to constructing adjacent to existing structures such as building code issues regarding exiting from the existing building (both during and after construction).



Drawing courtesy CEI Architecture

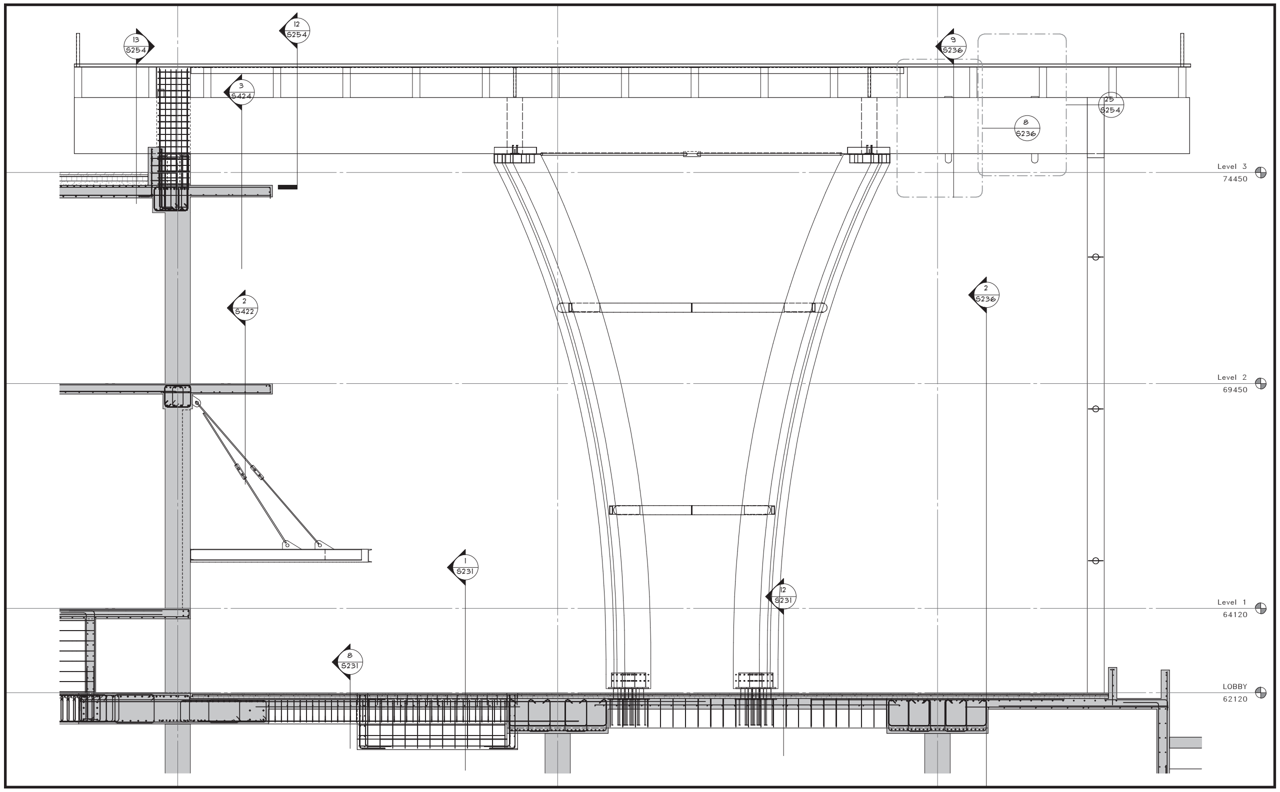

Photos courtesy Stephanie Tracey, Photography West

Structural Design of Wood Components

The main body of the Critical Care Tower is a 10-storey reinforced concrete frame structure with an interstitial service floor. Noncombustible construction is required by the BC Building Code for institutional occupancies of this size and height, so the use of structural wood is predicated on the creation of a fire separation between combustible and noncombustible portions of the building.

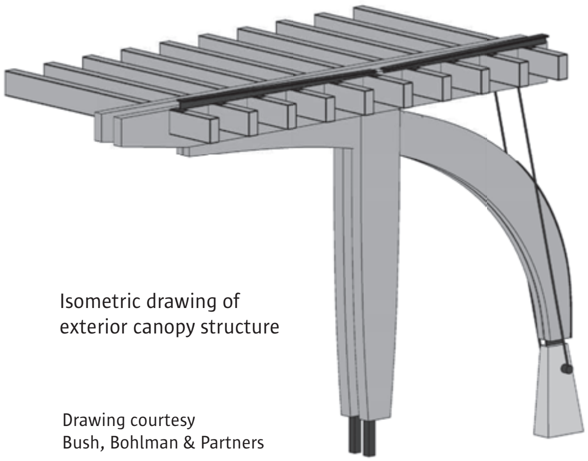
Thus the two-storey lobby with its glulam tree structure sits adjacent to the base of the main tower and is structurally distinct from it. The heavy timber roof structure consists of an upper layer of glulam purlins that run east to west, supported on a lower level of glulam girders that run north to south. Both layers of this structural lattice cantilever six metres beyond the line of the exterior curtain wall to provide weather protection for arrivals and departures. The roof deck is profiled metal and is exposed to view on the underside.

This structural lattice is supported on two massive glulam tree columns that define the character of the lobby space. Each tree consists of four composite glulam and steel curved elements, closely spaced at the base and spreading out like branches as they rise through the lobby. Each element consists of a pair of glulam beams, anchored to a steel base plate at floor level, and held apart at intervals throughout their length by four-inch (100-mm) steel spacers.



Drawing courtesy Bush, Bohlman & Partners

The curvature of the beams and the cantilevering roof were the determining factors in the sizing of members and the design of connections. The four curved elements are connected at two points by horizontal steel rings and again at the top by diagonal steel tension rods. This arrangement stabilizes the tree structure, resisting the natural tendency of its individual elements to buckle or spread apart.



Isometric drawing of exterior canopy structure

Drawing courtesy Bush, Bohlman & Partners

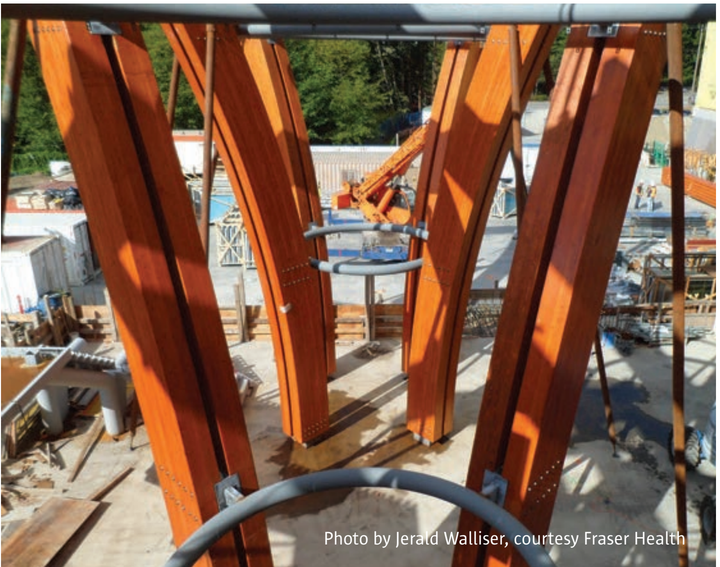


Photo by Jerald Walliser, courtesy Fraser Health

Courtesy Ed White Photographics

“With wood structures, it is always the connections that drive the design and often this can lead to interesting and unique solutions.”

Clint Low – Bush, Bohlman & Partners

The DNA were constructed from 130-mm x 228-mm (5 1/8-inch x 9-inch) cedar glulam material. The typical connection utilizes a through-bolted knife plate and a screwed back plate. Epoxy is injected to fill the space around the knife plate.

Courtesy Ed White Photographics

The potential for large deflections to occur in the cantilevered portions of the roof, and most particularly the anticipated 65mm (2.5-inch) deflection at the double cantilevered southwest corner, informed the design of the connections between the roof beams and the top of the exterior curtain wall. The weight of the curtain wall is borne by the steel plate mullions, so the roof is required only to resist the lateral loads. A plate connection with a slotted hole was used to ensure that no vertical roof loads would be transferred to the steel plate mullions.

The tree column and roof structure was modelled using Revit software that provided three-dimensional views of the connections, and permitted the detailing and appearance of the steel to be optimized to meet both structural and architectural requirements. Detail drawings were produced by the structural engineers at Bush, Bohlman & Partners LLP, and the glulam fabrication carried out by StructureCraft Builders Inc.

In comparison to the atrium roof structure, the design of the exterior canopies was straightforward. The biggest challenge was to design the canopy to resist seismic and lateral loads. For most of its length, the canopy could be tied back to the main structure of the building, but this was not possible where it passes in front of the multi-storey glazed curtain wall of the entry atrium.

Although the roof of the canopy is at a consistent height along the length of the west wall, the section in front of the atrium is a taller structure, on account of a five-foot (1.5-metre) change in grade. The taller structure adds to the grand appearance of the lobby but presented additional challenges for lateral design.

In the longitudinal direction, it is tied into the upper level canopy where the seismic loads are dragged into the building by drag rods. The cantilevered canopy is made stable in the other direction through the use of vertical tie rods that connect the beams to a concrete pilaster at each bay.

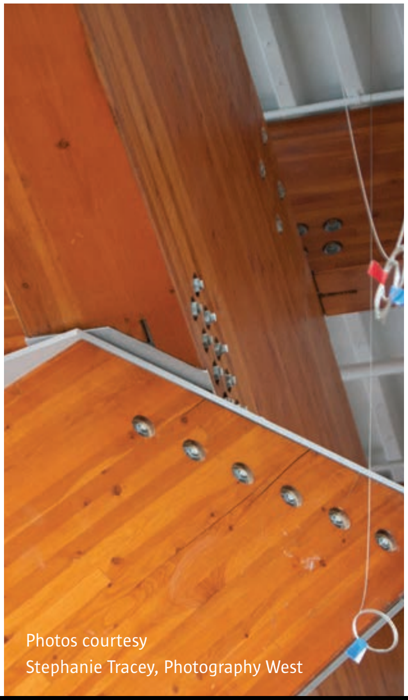
Constructability: Installing the Wood Elements

For the Critical Care Tower, StructureCraft Builders Inc. was the successful bidder on a subcontract package for wood fabrication and erection. At the time of tender, the structural engineering and drawings had been completed by Bush, Bohlman & Partners.

Although the connections for the various structural elements had all been designed, StructureCraft spent time refining some aspects to make them more economical, efficient and more constructible. On the low and high canopies, which included a large number of glulam purlins, they chose not to install these piece by piece, but rather to prefabricate 9.1-metre-square (30-foot-square) elements on site, then lift them into place as a single unit.

Curved columns

The original design for the curved columns of the canopy included a continuous steel knife plate sandwiched between paired glulam elements, a system in which the steel was doing most of the work. To simplify prefabrication and reduce the overall cost, the company suggested increasing the size of the glulams and eliminating the knife plate. The shadow gap between the columns, which was an aesthetic requirement of the architect's design, was created instead with plywood spacers.



Photos courtesy
Stephanie Tracey, Photography West

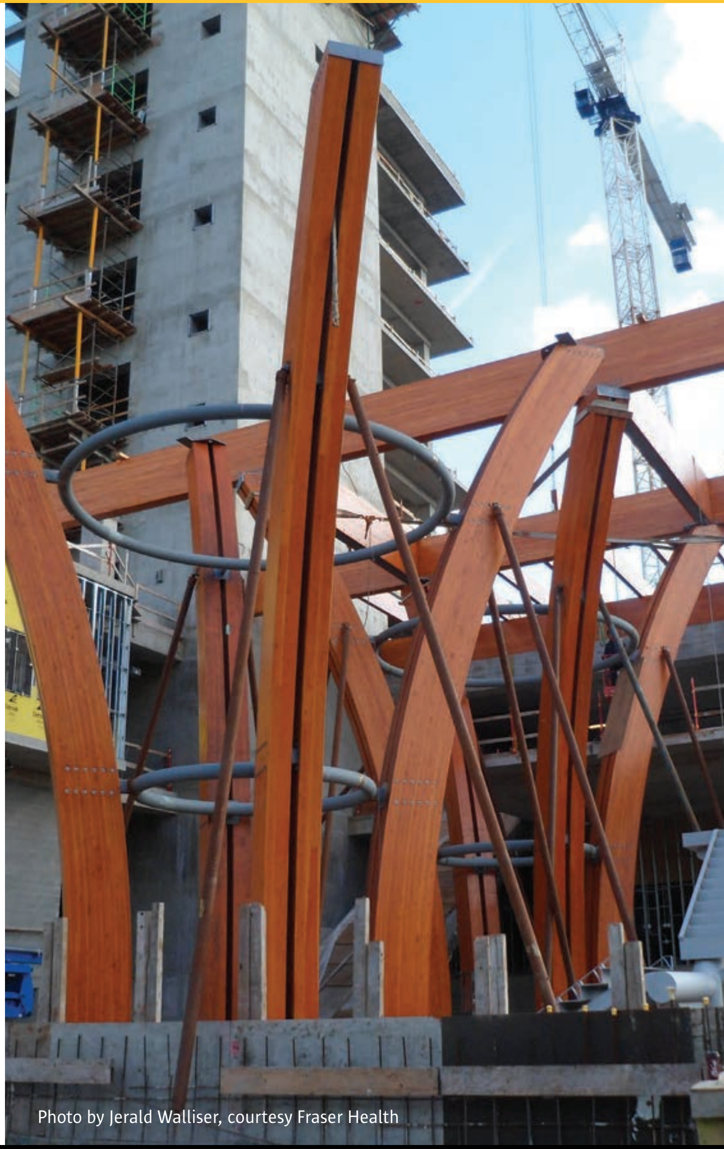


Photo by Jerald Walliser, courtesy Fraser Health

"It has been proven through evidence-based design that creating connections with nature helps facilitate healing. Specifically, natural environments can help restore a body's balance and expedite the healing process. The use of exposed wood in a project is one of the ways that we can improve conditions for our patients. Wood conveys a sense of warmth and comfort that supports the healing environment and improves the overall patient experience. The Surrey Memorial Hospital Critical Care Tower, with its unique use of wood, is a good example of a facility designed with patient care in mind."

Peter Goldthorpe, Vice President, Capital Projects, Real Estate & Facilities – Fraser Health | Providence Health Care | Provincial Health Services

Straight canopy columns

For the straight canopy columns, again the original design was a composite construction with a Hollow Steel Section (HSS) sandwiched between two glulam elements. Again, by redesigning the connection details top and bottom to make them moment connections, StructureCraft was able to eliminate the HSS while maintaining the space between the glulams to conceal rainwater leaders.

Large tree columns

For the large tree columns, StructureCraft was primarily concerned with constructability. Although the four column tree configuration, tied together by steel rings and connected to the glulam lattice roof, was designed to be stable in its final configuration, finding a way to erect it safely piece by piece was a considerable challenge. One theoretical option would have been to redesign the ring connectors, but the aesthetic requirement for an invisible connection precluded this possibility.

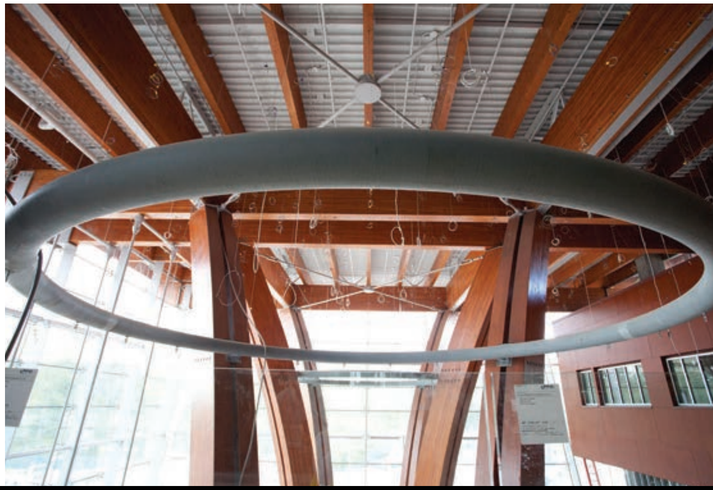
Instead, StructureCraft decided to use adjustable tilt-up shoring to stabilize each prefabricated paired column unit as it was manoeuvred into place. Secured to its base plate, and with shores essentially creating a temporary tripod structure, it was possible to erect all four columns independently and then to install the ring connectors.

Courtesy StructureCraft Builders

Cedar glulam DNA

To install the cedar glulam DNA economically also required considerably ingenuity. Although the pieces themselves were not particularly heavy — about 300 pounds (135 kg) - neither a conventional crane nor scaffolding were viable options. In the end, StructureCraft chose to utilize a “man basket” of the kind used to evacuate workers from high up a building in the case of an emergency. Two installers and the DNA beam could be accommodated in the basket and lifted by the tower crane to the appropriate position on the building façade. This option was by far the most economical, but required the submission of an erection safety procedure to WorkSafe BC for approval.

All photos courtesy Stephanie Tracey, Photography West



Conclusion: The Case For Wood

Surrey Memorial Hospital Critical Care Tower represents the most significant application of structural and non-structural wood products in a healthcare facility in British Columbia. Health authorities and healthcare architects continue to show leadership in the use of wood, having confirmed its psychological and physiological benefits through evidence-based design. The presence of wood in the built environment has been found to promote faster recovery times and reduced lengths of stay in hospital for patients, and an elevated sense of well-being for staff.

Courtesy Stephanie Tracey, Photography West

In addition to these proven benefits to human health, wood also has significant broader environmental benefits. Research conducted independently in several countries concludes that the use of wood helps to reduce the environmental impact of buildings. This research draws on sophisticated environmental impact criteria such as life cycle assessment (LCA) and the measurement of carbon footprint, both of which are beyond the scope of the most popular green building rating systems currently used in North America.

Life cycle assessment is accepted worldwide as a means of evaluating and comparing the environmental impacts of building materials, products and complete structures—from resource extraction through manufacturing, transportation, installation, building operation, decommissioning and eventual disposal. LCA studies consistently show that wood products yield clear environmental advantages over other building materials in terms of embodied energy, air and water pollution, and greenhouse gas emissions. A comprehensive review of scientific literature looked at research done in Europe, North America and Australia pertaining to LCA of wood products. It applied LCA criteria in accordance with ISO 14040-42 and concluded, among other things, that:

- Fossil fuel consumption, the potential contributions to the greenhouse effect and the quantities of solid waste tend to be minor for wood products compared to competing products.
- Wood products that have been installed and are used in an appropriate way tend to have a favourable environmental profile compared to functionally equivalent products made out of other materials.

Source: Werner, F. and Richter, K. 2007. Wooden building products in comparative LCA: A literature review. International Journal of Life Cycle Assessment,12(7): 470-479.

Trees and forest products play a critical role in helping to tackle climate change and reduce greenhouse gases. Using wood products that store carbon, as well as responsibly managing forests in a way that balances harvesting and replanting, can minimize our carbon footprint over the long term.

As trees grow, they clean the air we breathe by absorbing carbon dioxide from the atmosphere, storing the carbon in their wood, roots, leaves or needles, and surrounding soil, and releasing the oxygen back into the atmosphere. Young, vigorously growing trees absorb the most carbon dioxide, with the rate slowing as they reach maturity. When trees start to decay, or when forests succumb to wildfire, insects or disease, the stored carbon is released back into the atmosphere. However, when trees are harvested and manufactured into forest products, the products continue to store much of the carbon. In the case of wood buildings, this carbon is kept out of the atmosphere for the lifetime of the structure—or longer if the wood is reclaimed and manufactured into other products. In any of these cases, the carbon cycle begins again as the forest is regenerated, either naturally or by planting, and young seedlings once again begin absorbing carbon.

Surrey Memorial Hospital
Critical Care Tower

Project Credits

OWNER: FRASER HEALTH AUTHORITY

CONSTRUCTION MANAGER: ELLIS DON

ARCHITECT: CEI ARCHITECTURE AND PARKIN ARCHITECTS

STRUCTURAL: BUSH, BOHLMAN & PARTNERS

MECHANICAL: MMM GROUP

ELECTRICAL: MMM GROUP

CIVIL ENGINEERS: MMM GROUP

TRAFFIC PLANNING: MMM GROUP

ACOUSTIC AND NOISE CONTROL: DANIEL LYZUN

CODE: CFT ENGINEERING

GEOTECHNICAL: LEVELTON

LANDSCAPE: PHILLIPS FAREVAAG SMALLENBERG

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