Final Project Report

Green Codes: Alternative Means of Approval when Building Green

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Final Project Report

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Executive Summary

Introduction

Green building is a vital step towards a healthy, sustainable built environment. In North America, the green building movement has swelled in recent years with the proliferation of third-party rating systems, technologies and strategies to achieve high performing, sustainable buildings. Regulators are recognizing the promise of better building performance for mitigating environmental impacts like carbon emissions while also realizing human health benefits through improved indoor environmental quality in green buildings. However, policy and market factors are effecting widespread implementation of green buildings in Canada. These factors include a lack of high performance standards and financial incentives, low energy and water prices, and an unfavourable political climate over the past decade.

Regulation of our buildings can enable or hinder the adoption of green building practices. Building codes and standards are among some of the policy tools at a government's disposal to incentivize green building in the construction sector. While there is steady-growth of green buildings in Canada, exemplified by the rise of LEED certified buildings and local governments promoting or mandating third-party certification in their jurisdiction, codes and standards have been slow to incorporate technologies and systems that have been applied in European jurisdictions for decades. With a focus on public safety and risk management, Canadian building codes and standards tend to be conservative in adapting new technologies and standards in construction. However, cutting-edge green buildings like the UniverCity Childcare Facility, targeting Living Building Certification, are being realized. How are green building projects faring in this regulatory climate?

Project Objectives

Under the National Building Code, building projects can demonstrate code compliance through acceptable or alternative solutions. The alternative solutions pathway is permissible so long that the technology, product or system can be proven to comply with prescriptive or non-prescriptive elements of the code. This project seeks to understand the regulatory experience of green buildings in the building permitting process especially experience using alternative solutions pathway for code compliance.

The project tested the following assumptions:

1) Regulatory barriers are creating obstacles to the widespread implementation of sustainable technologies and practices in Canada's new, large, complex building stock;
2) Green buildings may be using the alternative solutions to demonstrate code compliance of emerging technologies or practices not yet addressed by Canadian building codes and standards;
3) Buildings seeking third-party certifications like LEED, Living Building Challenge or Passivehouse are more likely to use the alternative solutions pathway in this way, and;
4) On the edge of innovation, green building projects teams will have knowledge of alternative solutions and be willing to share them.

Methodology

The project used a mixed methodology of primary and secondary research to test the assumptions outlined above. Primary research took the form of twenty-two semi-structured interviews with project team leads to discuss the regulatory experience with a specific green building project. Several building code officials were interviewed for their perspective as well. Secondary research consisted of document analysis from reports, case studies, related legislation as well as attending lectures on the topic. The secondary research served to confirm and contrast the themes found across the interviews. Limitations to the project include the focus on new building stock and Part 9, large, complex buildings as well as the national scope. This broad scope made for generalized findings due to variation in codes and standards across jurisdictions and the areas covered from energy, water, and materials. The

researcher was also inexperienced in the area of technical building research and building codes, creating an ongoing learning curve through the project.

Results

The results of the alternative solutions pathway were inconclusive. The alternative solutions included approval of a composting toilet in Kelowna, fire resistance for heavy timber and mass timber products in the Centre for Interactive Design and MEC Headquarters in Vancouver. There were also alternative solutions concerning fire safety and fire exists in the Mosaic Centre constructed in Edmonton, Alberta. Vancouver Convention Centre had novel solutions such as a desalinization plant for non-potable water and allowances for wood use in a non-combustible building. However, these alternative solutions reports were not received. While the alternative paths provided were interesting and illustrated that they can be undertaken and approved, the core take-away was that after contacting approximately 45 building owners/designers/approval authorities, a non-statistically valid sample of solutions was not attained due to the deemed intellectual property (IP) of the solutions. Therefore a study of these alternative solutions and the preparation of an alternative code solution list was noted as inconclusive.

Discussion

The assumption that green buildings were using the alternative pathway proved inconclusive. There was too small a sample and variety among the alternative solutions to draw any definitive conclusions. The regulatory experience of green buildings also proved contradictory in many cases. Some projects had no trouble approving the building they designed and others faced greater regulatory hurdles. The interviews pointed to key lessons and themes across the projects. In the building permitting process, projects found significant value in the integrated design process for collaborating design solutions, integrating code officials throughout the approval process and sharing risk among professionals. The parallel approval process was a mechanism that streamlined a fragmented building permitting and approvals process typical of local governments, as well as increasing education and awareness among regulators.

No patterns were revealed through the identification of alternative solutions in those green building projects that provided response to the research queries. This was due to a small sample size, limited sharing of solutions and variability among the solutions found. Though the results were inconclusive, some of the solutions correlated with trends in construction. The alternative solutions regarding fire resistance of wood mirrored a growing use of wood in green buildings, with innovative examples coming out of BC. The high incidence of decentralized water and water treatment systems also reflects a shift towards onsite treatment of water. However, the regulatory system is remains biased toward centralized systems and a highly fragmented approval process with multiple organizations having authority. This often created a challenging environment for project teams to navigate.

Experience in the materials section caused a complicated sourcing and procurement process for project teams, especially those seeking Living Building Challenge certification. While this is outside of the regulatory process, LEED could impact product standards in the future with greater detail in credits on sustainable materials.

While there were no alternative solutions in energy efficiency and a largely positive experience implementing energy efficiency strategies and renewable energy technologies, project teams felt that code could set much higher standards in this area. A look at the evolution of energy efficiency standards in BC reveals that meeting net zero energy will take almost forty years at the current pace of adoption despite the know-how and ability to meet net zero energy today. BC has also tabled new legislation to improve consistency of the building code across the province that will eliminate all local by-laws dictating requirements for construction. This will be an interesting process, as it should act to raise the level of performance across code-only jurisdictions, but may cause for recessive energy requirements among progressive jurisdictions that will no longer be able to require higher standards. Recognizing a need to replace local programs on energy efficiency that it will displace, the province engaged a working group in the development of optional, harmonized ‘stretch codes’. The impact of this legislation for SFU Community Trust is worthy of further investigation. Further research is also needed to fully understand the implications of building codes and regulations for green building in Canada especially the role of intellectual property in design.

Introduction

Sustainable building design and construction has the potential to dramatically change the quality of our environment; both inside and out. Constructing and operating buildings has well-known environmental, social and economic impacts. Buildings are immense users of resources and the quality of the materials used can have long term impacts on water and energy cycles, air quality, local vegetation and wildlife, and patterns of land-use (Commission on Environment, 2008). In Canada, building construction and operations account for over one third of our carbon emissions and energy production, indicating ample opportunity for improvement (Canadian Green Building Council, n.d.). As we grapple to mitigate the impacts of lifestyles and the built environment, green building[1] is a logical solution as a key source of emissions and resource use.

Improved building performance is not just a matter of social urgency; it is also better building design. Architects and designers can minimize negative environmental and human health impacts through sustainable technologies and systems. Elements of green building include energy efficient options including the use of renewable energy sources, water conservation strategies, and efforts to maximize daylight and ventilation for improved indoor environmental for example (BC Wood Council , 2015). Many Canadian projects are taking on this imperative to build 'green' with an increasing use of certifications like LEED, BOMA Best, Passive House and Living Building Challenge, with LEED pulling ahead as the most popular and widely understood. With the capacity to transform the environment and human health, our building stock holds both promise and peril for a sustainable future.

Regulators have a variety of policy tools at their disposal to encourage green building including building codes and standards, research, funding, education and training programs or market-based incentives (Frappe-Seneclauze & MacNab, 2015). Building codes and related standards are particularly important mechanisms for as mandatory requirements and standards of performance will result in widespread change among new and potentially, old building stock. However, building codes and standards and their implementation at the local level can present challenges to adoption. A study on regulatory barriers to green buildings identified problematic assumptions in the regulatory approach in the Cascadia region. These barriers included a reactive policy approach to addressing risk; an assumption that minimum standards in regulation will protect the public from human health and environmental impacts, and that risks can be addressed independently through the policy cycle (Eisenberg, Persnam, Spataro, & McLelland, 2009). Building codes and standards, or an absence of these guidelines for new technologies, can enable or obstruct market transformation towards green building. On a five year policy cycle, the Canadian building code has taken a conservative approach to new standards and emerging technology. For example, the national standard addressing energy efficiency introduced in 2010 the *National Energy Code for Buildings*, made incremental change compared to available technology in energy efficiency and building envelope. Are the codes and standards regulating our buildings hindering widespread adoption of green building practices?

This project will examine regulatory experience of leading green building projects across Canada to better understand if Canadian codes and standards are facilitating or hindering green building practices. This includes the building codes as well as other regulation impacting building construction. Specifically, we hope to identify whether projects are using the alternative solutions pathway as a means to approve green technologies and solutions and if there is potential patterns among the application of alternative

[1] The US Green Building Council defines green building as, "the planning, design, construction, and operations of buildings with several central, foremost considerations: energy use, water use, indoor environmental quality, material section and the building's effects on its site.

solutions. Is there a consistent application of alternative solutions or patterns in their use for broader application?

Through the research process, I have identified several assumptions to test in the research:

5) Regulatory barriers are creating obstacles to the widespread the implementation sustainable technologies and practices in Canada's new, large, complex building stock;
6) Green buildings may be using the alternative solutions to demonstrate code compliance of emerging technologies or practices not yet addressed by Canadian building codes and standard;
7) Buildings seeking third-party certifications like LEED, Living Building Challenge or Passivehouse are more likely to use the alternative solutions pathway in this way, and;
8) On the edge of innovation, green building projects teams will have knowledge of alternative solutions and be willing to share them.

The research strategy has been devised with these assumptions in mind using primary and secondary sources. The results of this project aims for a catalogue of alternative solutions in green building projects to share with the green building community for potential application or policy influence.

Methodology

The project used a mixed methodology to synthesize knowledge on alternative solutions in green buildings. This mixed methods approach includes primary research consisting of interviews with green building practitioners and secondary research using document analysis. Interviews are the primary source of data for the study to identify and collect alternative solutions and discuss the regulatory experience of green buildings. The goal set for the number of interviews was approximately 15 practitioners, planners or green building project managers. Key informants include project managers or planners of green buildings who are familiar with details of building code variances for building code, fire code or plumbing code requirements and were identified using the following criteria:

- Projects located within Canada
- New build projects, not building retrofits
- Projects with a certification like Living Building Challenge, LEED Platinum, Passive House
- Preference for large, complex buildings (Part 9 of the Code)

Several approaches were taken to Identifying and selecting participants and projects for inclusion in the study based on the purposeful sampling outlined above. I compiled a list of the certified Platinum CaGBC LEED Project database of projects in Canada, added all non-residential projects targeting Living Building Challenge projects as well as all the passive house projects from Passive house Canada. In order to prioritize projects using the most innovative technologies or approaches, I read about some of the technologies used on the projects website, consulted awards listings for innovation in green buildings and tried to add projects outside of Charter cities like Vancouver or Toronto. The project list was also reviewed by Trust staff to help prioritize projects.

All interviews were recorded using an electronic recorder, transcribed and analyzed for primary themes. Once an interview was transcribed, the document was sent back to the participant for edits or

additional clarifications. This process gives the participant control over the interview as well as the opportunity to elaborate or clarify areas. It is an important mechanism for building trust and participants.

This project was subject to the terms of the Office of the Research Ethics at Simon Fraser University. After preparing the MITACS proposal, the essential ORE documents such as the study details, participant consent forms, participant invitations and preliminary interviews questions were initiated and submitted for review. I received ORE approval on June 12, 2015.

Limitations

With every research project, there are factors that pose limits on the research. First, the unwillingness of the project to share their alternative solutions report impeded the ability to conduct the research. The scope of the project was challenging at times including the national scope requiring a broad understanding of the building codes and standards and the exclusion of retrofits and residential projects from the study were all limitations. Ultimately, Ontario and British Columbia is over-represented in the sample due to of a higher incidence of the leadership of green building projects and policies in the Cascadia region and my position at a Western university. Lastly, my knowledge base on building code also posed limitations throughout the research process.

Building Regulation in Canada

There are a number of codes and standards that regulate the construction sector in Canada. The primary purpose of our building codes and standards is to ensure public safety, accessibility and quality in our building stock. There are five national codes that outline published by the Canadian Commission on Building and Fire Safety (CCBFS) and the National Research Council of Canada. The codes are:

- National Building Code of Canada (NBC)
- National Fire Code of Canada (NFC)
- National Plumbing Code of Canada (NPC)
- National Energy Code of Canada for Building (NECB)
- National Farm Building Code (NFBC)

The building code is geared towards new buildings and does not apply retroactively to old buildings in its requirements for health, safety, accessibility. On the other hand, the fire code applies to both new and existing buildings to regulate fire hazards concerning fire safety equipment, the storage or use of combustible goods and safety plans in case of fire (National Research Council of Canada, 2015). For the purpose of compatibility, the building and fire codes are developed in parallel to ensure they do not conflict (National Research Council of Canada, 2015). The national codes run on a five year policy cycle and standing working groups conduct ongoing research related to different areas of work (e.g. earth quakes, energy efficiency, hazardous materials) and may develop policy based on their findings and expertise (National Research Council of Canada, 2015).

Canada's building code provides alternative compliance avenues beyond of the requirements in the code. The 2010 National Building Code[2] and its companion guidelines for Plumbing and Fire Safety are an objective-based code. Objective-based code uses both prescriptive and non-prescriptive requirements as acceptable solutions in the design and approval of a building (National Research Council Canada, 2015). Alternative solutions are also permissible so long as the equipment, system, design or component is proven to meet or exceed the acceptable functions and objectives outlined in the code (National Research Council Canada, 2015). Previously known as variances or equivalencies, alternative solutions are submitted by designers and engineers in the building permitting process and are evaluated by the local jurisdiction having authority on their merit as an acceptable alternative.

Spotlight on British Columbia: The British Columbia Building Code

Through their provincial authority, the BC Building Code (BCBC) regulates the construction and renovations of buildings in the province in conjunction with the national code (last updated 2012). The BCBC sets standards and guidelines for building construction for fire and life safety, health, accessibility, energy and water efficiency based on the Model National Building Code and includes the BC Plumbing Code and the BC Fire Code, which apply after occupancy (Government of BC, 2015, pg. 8). The BCBC applies in all municipalities with the exception of some Federal Lands and the City of Vancouver, which has its own building by-laws through a City Charter (Government of BC, 2015, pg.3).

The province has modified the National Codes to the region. Some of the main differences between the National Construction Code and BC Building are the use of wood in the construction of mid-rise construction up to six-storeys and letters of assurance, mandatory documents that outlines the responsibilities of professionals in a building project (Government of BC, 2015, pg.3).

The Role of Local Governments in Building Regulation

Provincial legislation provides local governments the authority to plan land use and development. Through provincial Local Government Acts, municipalities are given the authority to enforce building codes in their jurisdiction through zoning, development and building permit processes (Canadian Mortgage and Housing Corporation, n.d.). Local government use these approval mechanisms to implement building codes and relevant by-laws in their municipality to ensure the safety, durability and reliability of buildings in their community (Canadian Mortgage and Housing Corporation, n.d.). As code compliance is examined in the building permitting process, it is also the area where design and engineering professionals propose alternative solutions in the building design.

[2] While the most recent version came into force in December 2015, the 2010 version is more relevant for our discussion since all projects were constructed to the 2010 Building Code or an earlier iteration.

Results

Since technologies and approaches used in green building exists on the leading-edge of innovation in many cases, this project hypothesized that green buildings are using the alternative solutions pathway more than conventional buildings to achieve the desired design and performance. Over the course of the project, twenty-two people in the construction industry were contacted to explore the regulatory experience of their green building. The most prominent of those were architects and designers associated with green building projects. A large selection of projects was invited to participate with ultimately eighteen projects taking part in an interview and four building code officials and regulators participating as well. Table 2 (next page) provides a summary of the projects included in the study and a list of respondents has also been included in the Appendix.

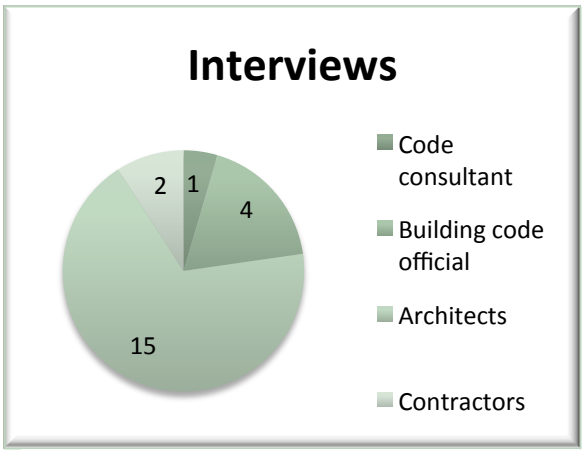

Figure 1 Project interviews by type

The buildings considered in our study were large, complex buildings (Part 9) with primarily commercial or institutional occupancies with a few exceptions: the Vancouver Convention Centre, a passivehouse MURB and a single-family residential building, given the expertise of the respondents. Participating projects had been certified from many of the voluntary third party rating systems in Canada. LEED Platinum was the most common certification with more than half of those projects also targeting the Living Building Challenge. Unfortunately, no BOMA Best buildings made the list of projects selected as outreach to several well-known BOMA Best projects yielded no result (ie. unable to reach a project manager or no alternative solutions were used).

Alternative Solutions

Alternative solutions were used in a number of the projects surveyed. Of the eighteen projects in the sample, six projects used the alternative solution pathway for compliance with an estimated total of fourteen alternative solutions. Table 3 (next page) provides a summary of the alternative solutions identified. There were several novel systems (e.g. desalinization plant) approved through the alternative solutions pathway, in many cases the reports describing the systems were not received by the researcher most often due to the IP of the designer or their team. Without the specifics of these solutions, comparisons are challenging if not impossible. As a result, the summaries of the alternative solutions are based on the best information available such as project case studies though they often lack detail.

Table 1 Participating Projects

	Project_Name	Authority	Certification
1	Upper Thames River Watershed Conservation Centre	London, ONBC	LEED Platinum Certified 4/24/2014
2	Centre for Green Cities, Evergreen Brick Works	Toronto, TBBL	LEED Platinum Certified 6/17/2014
3	Vancouver Convention Centre Expansion	Vancouver, VBBL	LEED Platinum Certified 2/8/2010
4	MEC Head Office	Vancouver, VBBL	Undergoing LEED Platinum Certification Salmon-Safe building
5	York Region Forest Stewardship & Education Centre	Regional Municipality of York, ONBC	LEED Platinum Certified Aiming for LBC
6	Dockside Phase 1 - Synergy	City of Victoria, BCBC	LEED Platinum Certified 6/20/2008
7	VanDusen Botanical Garden	Vancouver, VBBL	LEED Platinum Certified 7/8/2014 Aiming for LBC 1.3
8	The Mosaic Centre for the Conscious Community and Commerce	Edmonton, ABBC	Undergoing LEED Platinum Certification Aiming for LBC
9	Jim Pattison Center of Excellence, Okanagan College	Penticton, BCBC	LEED Platinum Certified 6/3/2015 Aiming for LBC Petals
10	Centre for Interactive Research on Sustainability	UBC, BCBC	LEED Platinum Certified 9/12/2013 Aiming for LBC 2.0,
11	Vale Living with Lakes Centre	City of Sudbury, ONBC	LEED Platinum Certified 3/18/2014
12	Univercity Childcare facility	City of Burnaby, BCBC	Aiming at Living Building Challenge
13	Arctic House	Fort Simpson, ABBC	LEED Platinum Certified
14	Glenmore Landfill Administration Building	City of Kelowna, BC Building Code	No certification
15	Bedford Roadhouse Passive House	Vernon, BCBC	Passive House
16	Wood Innovation Design Centre, UNBC	BCBC	No certification
17	Austria Passivehouse	Whistler, BCBC	Passive House
18	Institute Agroalimentaire	Montreal, QC	LEED Gold

Alternative Solutions in Plumbing Code

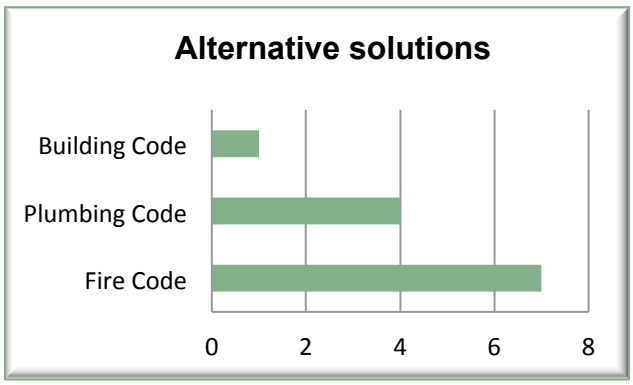

Figure 2 Alternative solutions by type

For Plumbing code, there was one alternative solutions report received for composting toilets. The Glenmore Landfill Administration Building considered connection to the municipal sanitary system, although its location outside of the city would make connection to the municipal sanitary system costly (McLellan, 2013). Since there was precedent of composting toilets at the landfill facility, the design team proposed use of composting toilets as a solution for the administration building as well. The report shows that the requirements of toilet design met the BCBC (2006) requirements in terms of shape, backflow mechanisms which separates liquid waste to be diverted into a sump and treated by an on-site pond, and the solid waste to a composting unit meet the BCBC (2006) requirements (McLellan, 2013). The toilets met the BCBC code requirement that fixture's conform to CAN/CSA-B45 series by showing certification to a comparable standard, Standard 41 of the National Sanitation Foundation (McLellan, 2013). The toilets also were compliant in terms of shape for accessibility purposes.

Two other alternative solutions were mentioned that related to the plumbing code. The desalinization plant and water reuse system in the Vancouver Convention Centre likely required alternative solutions though we are unable to confirm the details. Also, the MEC headquarters had an alternative solution for piping for recycled water, though we can only speculate on its application.

Alternative Solutions with Building & Fire Codes

There were several alternative solutions that related to fire code in the jurisdictions of Vancouver, University of British Columbia and Edmonton. These alternative solutions are concerned with life and safety issues such as fire rating of materials, adequate exits and barrier-free exits. The Centre for Interactive Research Centre at University of British Columbia used the alternative solutions pathway to build a four-storey building using heavy timber wood structure. The CIRS building uses glulam beams and columns, a floor system of dimensional lumber along with cast-in-place concrete structure below the auditorium and is fully sprinklered (Canadian Wood Council, n.d.). It appears as though CIRS sought three alternative solutions related to the wood elements of the building. First, the interconnected floor space in the four-storey atrium proved had adequate safety with the, "combination of alternative measures, including fire suppression and smoke management systems" through modelling and simulation (Canadian Wood Council, n.d.).The fire suppression systems also supported the other two alternative solutions. The floor assembly was not rated under code so analysis was completed on similar assemblies to demonstrate the necessary 1-hr fire rating (Canadian Wood Council, n.d.). Second, the auditorium heavy timber and solid wood assembly roof was facilitated by an alternative solutions through acceptable safety in the 1-hr rated concrete wall, sprinklering and smoke management systems and a direct exit to the exterior (Canadian Wood Council, n.d.).

Under the Vancouver Building By-Law, the MEC Headquarters in Vancouver also required alternative solutions for the amount of wood with its glulam post and beam system and the mass timber panel floors (Canadian Wood Council, 2015). The building followed the requirements in the VBBL as Group D, four storey, sprinklered building. The floor assemblies needed fire separation with a minimum one hour fire rating and a heavy timber construction was required due to the four-level interconnected space

(Canadian Wood Council, 2015). In the end, consultants and the architects found a solution using nail laminated timber floor assemblies that satisfied the bylaw fire resistance requirements to make the largest wood building of its kind in the City of Vancouver (Canadian Wood Council, 2015). Another alternative solution under the VBBL is for wood used in the floors and walls beyond what is permissible in a non-combustible building at the Vancouver Convention Centre (Beaudrault, 2015). Unfortunately, no further information about this solution is available.

Switching gears to Alberta, the Mosaic Centre for the Conscious Community in Edmonton used the alternative solutions pathway for various aspects of wood and other design considerations in a three storey building (Manasc Isaac, n.d.). The building uses glulam post and beam and heavy timber structure for the three floors interconnected by stairs and an elevator, not unlike the interconnected floorspace of the MEC Headquarters and the CIRS building. The Mosaic Centre also uses heavy timber for the elevator structure (Manasc Isaac, n.d.) The first of three alternative solutions concerns the limited use / limited application elevator which does not provide enough space to use a mobile patient stretcher in case of emergency as required by the Alberta Building Code, Division B, Appendix A – 3.5.4.1 (1) (Manasc Isaac, 2014). Given that for the size and distribution of the occupants, the elevator does not require emergency power, so the stairs connecting the upper floors and main level have been designed to accommodate, “safe, non-impeded and negligibly delayed option for moving a patient in a patient stretcher to a care-giving location (Manasc Isaac, 2014). A stretcher path analysis was completed where they simulated the actual movement of emergency responders with the stretcher to ensure adequate and safe exit (Manasc Isaac, 2014).

The second alternative solution concerned exits. AB Code requires that every floor be served by at least two exits in order to ensure the safety of emergency responders and occupants should one of the exits be blocked in a fire (GHL Consultants, 2014). The Centre proposed to use the exit at the stairs for the second and third floors as the stairs provide adequate exit in the interconnected floor space to the ground floor (GHL Consultants, 2014). Performance based analysis like occupant evacuation analysis and fire modelling were the used to demonstrate how this alternative solution meets the code (GHL Consultants, 2014).

Lastly, an alternative solution was written to accommodate the inclusion of the third storey as interconnected floor space to the second, for the safety of first responders and the occupants in case of emergency. Provided certain mitigating features are met, ABC Division B, Sentence 3.2.8.2 allows for interconnected floor space to be exempt from Article 3.2.8.3 and 3.2.8.9. Since the interconnected floor space was more than half what was permitting under code, the alternative solution proposes low occupant loads, additional exiting, smoke venting and additional access the department to meet the requirements (GHL Consultants, 2014).