Vienna House Innovative Affordable Housing Demonstration Project

Study on Building Form Decision

VIENNA HOUSE

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Disclaimer

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1. Vienna House is an Opportunity for Innovation

Vienna House is an affordable housing project in Vancouver that is a model for innovation in sustainable, multi-family construction. The development aims to showcase low-carbon emissions design, resilient building strategies, and prefabrication strategies to industry, policymakers and the public.

A parallel research project funded by federal and provincial governments is being conducted to aid, study, and report on low-embodied carbon construction. Vienna House is a high-profile project with a substantial research program that is organized on a dedicated website – www.viennahouse.ca. The project is intended to serve as a model for new technologies in construction and social housing for application to future projects in BC and across the country.

Vienna House realizes the vision of a Memorandum of Understanding signed between the Cities of Vancouver and Vienna in 2018 to share best practices in innovative low-carbon affordable housing. Two building projects represent the commitment of each City to demonstrate leadership in pressing global issues. Vienna House in Vancouver and a sister project called Vancouver House in Vienna will showcase world-leading standards of living for residents while addressing challenges of climate change and creating economic opportunities.

Staff from both cities and the two project teams have been exchanging ideas over the past two years, informally and through a series of four integrated design workshops. These reports are available on the Vienna House website.

The Vienna House project demonstrates how innovation in design and construction can be combined with advancements in social housing. This combination creates sustainable homes capable of withstanding the stresses of climate change while also providing comfortable, affordable and meaningful places to live for a diverse community. The design and construction team are guided by the owners of the project via a Project Steering Committee (PSC) comprised of representatives of BC Housing, the Vancouver Affordable Housing Agency (VAHA), More Than a Roof Housing Society (MTAR) and the City of Vancouver Sustainability Office.

In the spirit of sharing insights into the development of the Vienna House project as the project proceeds, this report summarizes the considerations and decisions that resulted in the configuration of the project. The project is at the schematic design stage and much work is still to be done. The findings in this report are distilled from interviews with key members of the Project Steering Committee and the design team. The authors are grateful for their participation.

2. Priorities of the Project Steering Committee

All the Project Steering Committee members have a commitment to provide high quality affordable housing to the residents who will occupy the building. In 2020, the PSC developed a Charter that set out the project goals and objectives.

Project goals set forth by the Charter include:

- Increase the supply of safe, accessible, sustainable, and affordable housing to support the well-being of the residents of Vancouver.
- Reduce greenhouse gas emissions by building efficient and high-performance buildings in the City.
- Explore opportunities to accelerate the development and construction process.
- Maximize quality performance design.
- Increase knowledge and awareness of the capabilities of the prefabricated construction industry.

Project objectives listed in the Charter that affect building form include:

- Near zero emission building[1]
- Climate resilient design
- Off-site prefabrication
- Knowledge sharing with Vienna
- Improved affordable housing supply and availability
- Maximized capital investment to ensure the project is financially feasible and sustainable
- Use of renewable construction materials, as much as possible, such as wood, which also helps support the local lumber industry

In addition to the charter, each Project Steering Committee member seeks to achieve specific project outcomes. For example:

- BC Housing manages and administers a wide range of subsidized housing options across the province. Their mandate from the Attorney General and Minister Responsible for Housing to the Board of Commissioners for 2021-2022 is based on the five principles of putting people first, lasting and meaningful reconciliation, equity and anti-racism, a better future through fighting climate change, and a strong, sustainable economy that works for everyone.[2]

  In Vienna House, they are seeking solutions that demonstrate equity and a pathway to a low-carbon economy while keeping costs for this project manageable.

1 Near-zero emission buildings are defined by the City of Vancouver ("COV") as a highly energy-efficient building that uses mostly renewable energy.
2 https://www.bchousing.org/about/governance#mandateletter

- The City of Vancouver's Greenest City Action Plan has a vision to create opportunities today while building a strong local economy, vibrant and inclusive neighbourhoods and an internationally recognized city that meets the needs of generations to come.[3] This Plan sets goals that include reducing greenhouse gases emitted through building energy use, targeting carbon neutral operations, and developing a green economy that is essential to a healthy and sustainable future.

  The Vienna House project creates a pathway for strengthening the sharing of knowledge with Vienna on best practices in green buildings and low-carbon construction for both embodied and operational emissions. In choosing a building form, the City is interested in providing a comfortable occupant experience in a building that the operator would appreciate.

> *"...ensuring that the building that we we're selecting, designing, building was going to be one that the operator really felt was their ideal or close to their ideal."*
> *- Chris Higgins, City of Vancouver Sustainability Office*

- More Than a Roof Housing Society (MTAR), the operator of Vienna House, has a mission and purpose to break the cycle of poverty and homelessness in the lives of their tenants through transformative affordable housing.[4] They believe safe, affordable housing is a key factor in bringing stability, security and an improved quality of life to many individuals and families who by circumstance are vulnerable. They encourage residents to contribute to a community that is supportive, respectful and caring.

  MTAR's focus for Vienna House is a building that helps to build that community and a form that creates the most livable structure, one that contributes to the health and well-being of its residents.

- The Vancouver Affordable Housing Agency (VAHA) has a vision for all Vancouver residents to have access to affordable, safe, quality homes. Using innovative building techniques and unique partnerships, VAHA is focused on building high quality rental housing for individuals and families on low to moderate incomes across Vancouver.[5]

  In the Vienna House design, VAHA is prioritizing optimizing the development potential of the site to provide as many homes as possible, as well as cost certainty while providing energy efficient, highly livable spaces.

> *"We specifically brought the not-for-profit partner in very early… because we knew we were doing a design-heavy research-oriented project… and the operator's perspective early in the design, especially for this project, is really critical. And I think that that will make for a more livable building, and also one where design decisions that might impact operational costs can be better understood and considered."*
> *- Heather Oland, Vancouver Affordable Housing Agency*

The priorities of high quality, affordable housing, built sustainably to be energy efficient and with low emissions, in a manner to maximize livability, at a reasonable cost were shared by all members of the committee despite their varying focus.

3 https://vancouver.ca/green-vancouver/greenest-city-action-plan.aspx
4 https://morethanaroof.org/who-we-are/
5 https://vaha.ca/

3. Vienna House Research Agenda

The project team also coordinates with the research team via a Technical Research Committee comprising the research team (UBC, FPInnovations, WoodWorksBC, Summit BIM, BIMOne, BC Housing Research Centre, Scius Advisory, Glave Strategies). Through this committee, the project team and project steering committee interact with experts in a wide range of fields with a view to incorporating those that are technically and economically feasible. To date, these include the following and reports can be found on the Vienna House website:

- Affordable strategies and technologies to achieve Passive House performance
- Prefabrication and the use of advanced engineered wood products such as mass timber
- The use of Building Information Management (BIM) and Virtual Design and Construction (VDC) from design to hand-over to improve the efficiency and productivity of the project delivery process
- Envelope design to minimize thermal bridging
- Enhancing sociability through building design
- Acoustics
- Heat pump technology evaluation
- Investigation into social and economic housing models in Vienna
- Design for disassembly approaches for multi-family residential buildings

Strategies for building adaptation and resilience in response to anticipated impacts of climate change are also being developed whereby the building is designed to accommodate extreme weather events (flooding, high temperatures), poor air quality because of wildfires, etc.

The project is also paying close attention to social considerations and how the building can be designed to improve health and quality of life of residents and neighbours. Exploration into acoustical design, designs for residents with cognitive issues, designs that maximize the opportunity for social interactivity are under way. Other studies have explored design for disassembly and social and economic housing models in use in the City of Vienna and their application to Vancouver.

All of this background work has informed the planning and configuration of Vienna House. This report documents and examines the process to choose the building form for Vienna House, the priorities of the Project Steering Committee, and the reasoning behind the decision. It is compiled from information from meeting minutes, participation in meetings, and interviews with Committee members.

4. Site Location and Building Form Design Options

The site on which Vienna House will be built is located on five city-owned lots at 2009-2037 Stainsbury Avenue where it intersects Victoria Avenue and is bordered to the north by Sky Train tracks. The factors that played a key role in the choice of building form include:

- The project Charter goals targeting passive house certification, off-site construction, maximizing quality performance design, and increasing the supply of affordable rental housing stock in Vancouver.
- Neighbourliness and urban fit.
- Construction efficiency. The Victoria Drive and Stainsbury Avenue area is currently experiencing a high level of development. This makes a prefabricated solution appealing as it results in a faster, cleaner, and quieter project than traditional construction and is kinder on neighbours but requires a standardizable configuration to simplify constructability and control cost.
- Proximity to the Skytrain line raising noise issues.
- Maximizing the development potential of the lot to deliver at least 101 units in a range of sizes and configurations.
- The creation of a meaningful, identifiable, and inclusive housing complex that encourages social interaction and meets the needs of a diverse community.

Figure 1. Future location of Vienna House

Eleven options were initially developed and evaluated by PUBLIC and the consultant team[6] using common criteria such as

- Solar access to the north side of the site
- Length of façade along Stainsbury for neighborhood fit and scale
- Lot coverage
- Quantity of cores (stairs/elevator) to control cost
- Efficiency of a typical floor
- Surface area ratio to minimize heat loss
- Daylight to public corridor
- Per cent of single aspect units facing SkyTrain – negative metric reflecting noise and air quality
- Per cent of dual aspect units – positive metric for natural ventilation and daylight

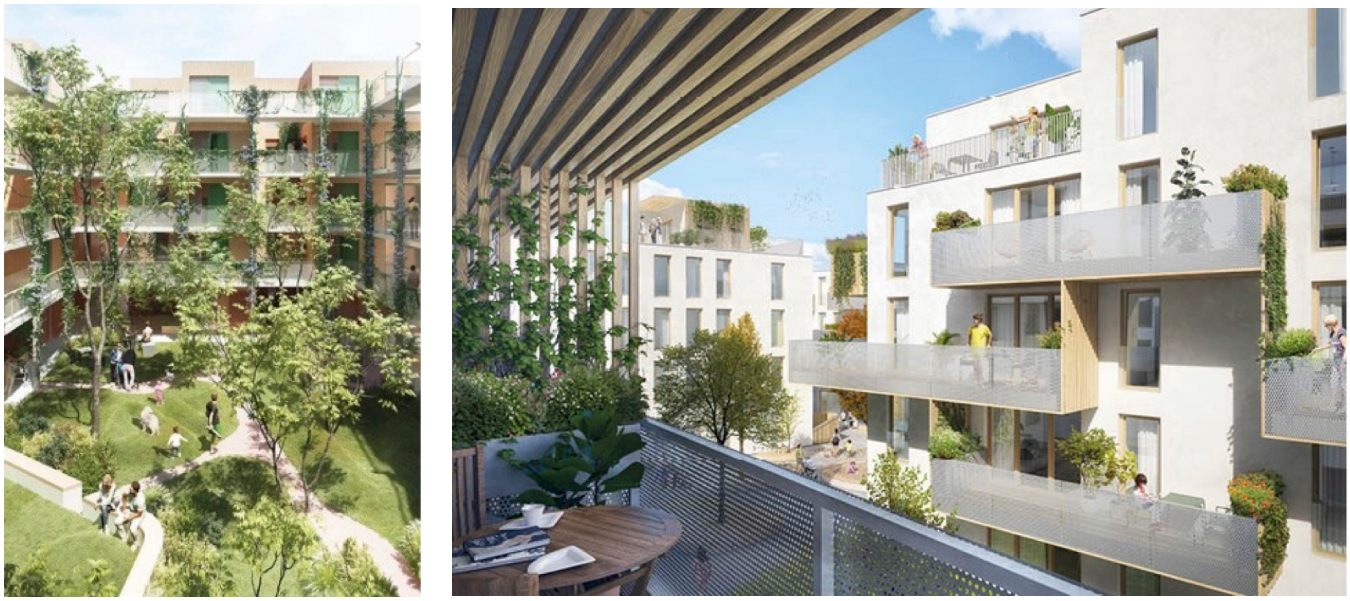
Examples of building forms in Vienna were also considered as part of the knowledge-sharing activities of the project. Two options were shortlisted for further examination. These came to be known as the 'J' and 'O' options.

Figure 2. Approximate footprint of potential building forms 'J' and 'O'

The 'J' option represents a common mid-rise residential building typology for Vancouver, with a double-loaded corridor down the center, providing units on either north- or south-facing sides. The 'O' option is more unusual. It is organized around a central courtyard with wide walkways open in the center and windows on both north- and south-facing sides. While common in Vienna, this type of configuration is less usual in Vancouver. Indeed, the Vienna House project team were able to review the ten competition design submissions developed for the Vancouver House counterpart in Vienna – the majority of which pursued a courtyard configuration.

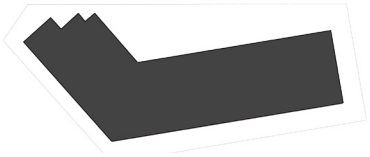
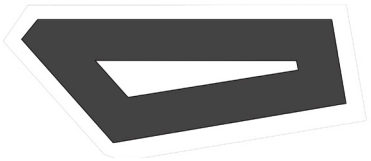
6 Consultant team: Wicke Herfst Maver, Integral, Morrison Hershfield, Core Group Consultants, Matthew Thomson Design, Steven Winter Associates, BKL, Gunn Consultants)

Figure 3. Examples of courtyard designs from the design competition for Vancouver House in Vienna (left ©einsundzwei architectur, right ©expressIvat)



The examination took the form of qualitative (via engagement with key members of the project team) and quantitative (e.g., cost analysis and Passive House modelling) reviews, recognizing the early stage of the project development process. In summary, both options had the potential to provide high-quality affordable housing. However, both also came with potential performance trade-offs. Overall, the 'O' scored better than the 'J' scheme. The evaluation is summarized in Table 1 and discussed on the following pages.

Table 1. Summary of the analysis of the built form options

Criteria	'J' Scheme	'O' Scheme
		
1. Livability	✓ Meets BC Housing Design and Construction Standards ✓ Acceptable livability	✓ Meets BC Housing Design and Construction Standards ✓ Greater potential for social interactions ✓✓ Better overall livability
2. Cost and value to owner and residents	✓ Lower capital cost	X Higher capital cost ✓✓ Greater overall value to owner and residents
3. Energy and GHG efficiency	✓ Meets PH performance ✓ Low embodied carbon timber structure ✓✓ Better overall surface area to volume ratio X Greater reliance on active HVAC	✓ Meets PH performance ✓ Low embodied carbon timber structure X Less efficient form ✓ Less reliance on HVAC
4. Climate resiliency and lifecycle considerations	✓ Acceptable operational cost performance	✓✓ Better overall climate resiliency due to greater potential to function passively ✓ Acceptable operational cost performance ✓ More opportunity for future flexibility
5. Acoustics	✓ Meets code requirements for sound transmission between adjoining suites X 35 per cent of units exposed to SkyTrain noise	✓ Meets code requirements for sound transmission between adjoining suites ✓✓ Better overall acoustical quality

5. Livability

Livability is a difficult parameter to measure as tolerances and preferences may vary from person to person. However, it is the most important consideration for the Project Steering Committee and will underline the success of the project. Livability frames the conditions of a decent life for all inhabitants of cities, regions and communities, including their physical and mental wellbeing. It often includes long-range measurements that are dependent more on location than on the shape of the building such as access to transportation and services. For the comparison of the 'J' and 'O' options, livability is understood to mean that it meets BC Housing's Design and Construction Standards[7] plus the provision of a safe, inclusive, affordable and resilient community.

Both options would be able to meet BC Housing's Design Standards and provide a highly livable building. The quality of the resilient community was a defining consideration of the decision-making process.

> *"We live in a city where approximately 70 per cent of the people go home alone, so isolation is a big deal. By working with the courtyard design we have the opportunity to foster true, genuine community interactions. As an organization that excels at community building, that is incredibly important to us."*
>
> *-Lee-Anne Michayluk, More Than a Roof Housing Society*

The not-for-profit operator, More Than a Roof Housing Society, has significant experience in operating multi-family affordable housing buildings and provided valuable insights into the decision for the building form. This experience includes situations which encourage community cohesion and help to limit isolation which can lead to a variety of health and social concerns. A sense of community belonging and interaction has been shown to improve both physical and mental health.[8]

In July, the Vienna House Technical Research Committee had an opportunity to explore a new software simulation project called FLUID Sociability[9] being developed by Human Studio. The goal of the project is to create a way for architects and designers to comparatively analyze their projects based on quantitative social health measures. Human Studio is creating an agent-based simulation tool to measure the potential of architectural design options to support the frequency of interactions and sociability.

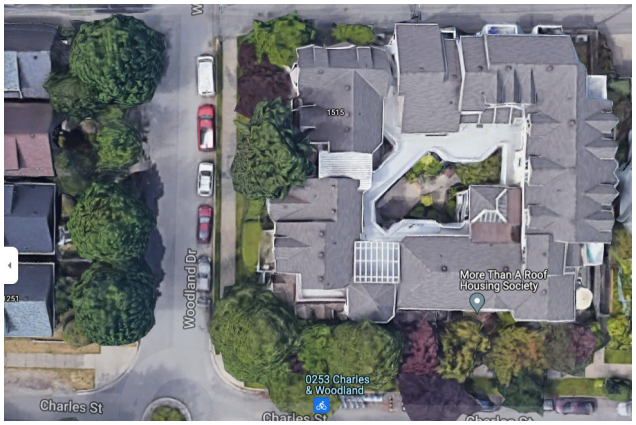
Simulations for the 'J' and 'O' options were conducted to assess which one better supported social interaction between residents according to the model. The simulation favored the 'O' option, indicating a greater than 30 per cent improvement in 'Greetings' which indicate familiarity. More details are given in Appendix A. This simulation supports the experience of More Than A Roof Housing Society, who operate another courtyard property. It is among their most popular and where they have noticed a particularly strong sense of community.

7 https://compositedesign.ca/doc/bchousing/BCH-Design-Guidelines-Construction-Standards.pdf

8 Camilla A. Michalski, Lori M. Diemert, John F. Helliwell, Vivek Goel, Laura C. Rosella, (2020) Relationship between sense of community belonging and self-rated health across life stages, SSM - Population Health, Volume 12, 2020

9 https://fluidsociability.circle.so/c/introduction

Figure 4. Charleswood Court is More Than A Roof's existing courtyard property on Charles St., Vancouver



The findings were reinforced with insights from the Vienna project team. Sixty per cent of Vienna's population live in municipal housing and the city has some of the most innovative and successful social housing models in the world.[10] These have been studied in detail as part of this project by Dunefield Consulting in partnership with UBC School of Community and Regional Planning and published in a report "An Exploratory Review of Social Housing Models in Vienna".

Criticism has been offered that suggests courtyard-style buildings are not suitable for everyone, as it can "enforce neighbourliness" on those who value their privacy. However, the benefits far outweigh the shortcomings. In addition to the points cited above, courtyard schemes provide

- improved solar access
- improved natural ventilation and passive cooling compared to a double-loaded corridor option
- improved Crime Prevention Through Environmental Design solutions
- strong cultural significance for many immigrants.

Courtyards have been shown to temper environmental conditions by obstructing the cold winds.[11] In this situation, with the experience of the operator, the intent to build community, and the interest in learning from the Vienna experience, the 'O' option was strongly favored when considering livability.

Figure 5. The proposed Vancouver House in Vienna will include courtyard spaces

10 Article by Professor Patrick Condon, the James Taylor chair in Landscape and Livable Environments at the University of British Columbia's School of Architecture and Landscape Architecture and the founding chair of the UBC Urban Design Program. https://thetyee.ca/Solutions/2018/06/06/Vienna-Housing-Affordability-Case-Cracked/

11 Mohammad Taleghani, Martin Tenpierik and Andy van den Dobbelsteen, "Environmental Impact of Courtyards— A Review and Comparison of Residential Courtyard Buildings in Different Climates", Journal of Green Building https://www.scienceopen.com/document_file/e1ff5e24-e02f-4772-92e8-aad9ab72dbc0/API/i1943-4618-7-2-113.pdf

6. Acoustics

Acoustical quality contributes to overall livability. Given the proximity to the SkyTrain, this quality was deemed an important criterion to evaluate in its own right. The impact of long-term exposure to noise is known to adversely affect health in a variety of ways, including sleep impairment, hearing loss, and cardiovascular and psychophysiological effects.[12] Limiting the exposure to SkyTrain noise for future residents of Vienna House is a priority for all members of the committee. The tracks pass the lot on the north side and curve to the west, closest to Victoria Drive. There is also a station not far to the east, which results in additional noise due to braking as the train approaches the station.

Figure 6. Skytrain tracks curving past lot

The 'J' building form option poses acoustical issues for the tenants who would reside in the units to the north side of the building (35 per cent of total occupants). They would have the central interior corridor to the south and windows to the north facing these SkyTrain tracks, with other units to the east and west. Opening a window for fresh air would result in exposure to that noise.

Although both schemes will meet code requirements for sound transmission between adjoining suites, the 'J' option has greater potential for suite-to-suite noise and noise from the central corridor. The 'O' option provides windows in the courtyard for all units, limiting the direct impact of the train noise as well as that from the street. Selection of landscaping in the courtyard can also contribute to reduction in noise levels and provide a more comfortable acoustical environment. With an external walkway and a sealed exterior door, there is less exposure to noise from immediate neighbours[13].

12 https://www.who.int/docstore/peh/noise/Comnoise-1.pdf

13 Acoustic analysis courtesy BKL Consultants

7. Cost and Value

Efficiency of design not only supports energy efficiency but also cost efficiency and speed to build. An initial high level cost analysis indicated that the 'O' design would be significantly more expensive than the 'J' design due, in large part, to the additional insulation and cladding requirements of the additional exterior walls. This difference could have been prohibitive. However, the strength of the 'O' design in the acoustical performance, livability and climate resiliency prompted the Project Steering Committee to conduct more detailed costing for both designs. The Class D costing was completed[14] for the 'O' design with a gross floor area of 9,571 m^2 and 104 residential units and the 'J' design with a gross floor area of 9,973 m^2 and 101 residential units. The Class D estimate is considered to have an expected degree of accuracy of ±20-30 per cent; resulting bids might vary by this amount.

"The marginally higher cost for 'O' design was immaterial, really, at that point. It's important to recognize that we're still going to have to commit to value engineering throughout the project."

-Heather Oland, Vancouver Affordable Housing Agency

The mechanical ventilation approaches were further analyzed, taking into account the City's requirements to limit overheating and achieve Passive House standards. These approaches also considered the building's energy performance being modelled using 2050 climate data. With the 'J' design, full air conditioning would be required due to the lack of cross ventilation available with windows. For the 'O' design, the mechanical systems could be reduced while achieving the same occupant comfort and energy efficiency goals. Without full cooling, the savings for the 'O' design brought the estimate into a more reasonable range and result in a more climate resilient building that would be easier to operate.

The intention is for the project to leverage the efficiency benefits of prefabrication where possible for greater predictability and speed to completion. The construction manager – Kindred Construction – joined the project early to advise on options.

In July, the Technical Research Committee convened a session with several experts to discuss best practices and options for prefabrication. In addition, a research project led by the project's structural engineering consultant WHM in partnership with Timber Engineering Inc. is underway to explore the potential for an innovative hybrid CLT-CFS[15] (structural steel stud) system. This system has been shown to deliver up to 10 per cent project cost savings over a concrete or structural steel building and up to a 50 per cent reduction in structure weight. The decrease in weight results in a lighter foundation, reductions in lateral systems, and the ability to build in challenging soil conditions. Other systems are also being evaluated, including a hybrid system of CLT floors on conventional light wood frame walls.

14 Costing courtesy Hanscomb Limited

15 Cross Laminated Timber - Cold Formed Steel

Figure 7. CLT-CFS hybrid structural option

The costs for the 'O' design are modestly higher, however the benefits offer significant value to the owner and result in a higher quality, more comfortable building for residents.

8. Energy and GHG Efficiency

Both design options can meet Passive House standards as set out in the project charter.[16] Both schemes will also incorporate a low embodied carbon timber structure.

From an operational efficiency standpoint, minimizing the surface area on the exterior of the structure reduces the heat loss and the insulation requirements to achieve desired air tightness and thermal performance. The 'J' scheme offers a better overall surface area to volume ratio but may require more active HVAC systems to compensate for the proximity of the SkyTrain and the lack of natural ventilation through the suite. Residents on the north side of the building (~35 per cent of the units) would be unlikely to open their windows.

The 'O' design has more walls facing the exterior of the building than the 'J' meaning that the envelope costs will be higher. However, all units would have access to ample natural ventilation thereby reducing HVAC costs and offering greater overall occupant comfort.

16 In 2016 the Vancouver City Council voted to build all new City-owned and VAHA projects to be certified to the Passive House standard https://council.vancouver.ca/20160712/documents/rr2.pdf

9. Climate Resiliency and Lifecycle Considerations

Consideration is being given to aspects of the building lifecycle as they will be affected by the changing climate. The design of the building can have a significant impact on operational costs, future flexibility and resiliency. Mobilizing Building Adaptation and Resilience (MBAR) is a multi-year, multi-stakeholder knowledge and capacity building project[17] led by BC Housing that encourages designers to consider future impacts of climate change and/or major disasters on their project. A series of four workshops were hosted by BC Housing using the Integrated Building Adaptation and Mitigation Assessment (IBAMA) framework[18] to identify and investigate climate resiliency and what factors will inform the project design.

"Extreme temperature changes, both in observations and future projections, are consistent with warming. Extreme warm temperatures have become hotter while extreme cold temperatures have become less cold. Such changes are projected to continue in the future, with the magnitude of change proportional to the magnitude of mean temperature change."

- Canada's Changing Climate Report, 2019

As the climate changes, residents of Vancouver are being exposed to an increasing number of excessively hot days as well as periodically high levels of smoke from wildfires in the province. Vienna House is being designed for resiliency, with projections of 2050 climate data in mind. Climate impacts were reviewed by Integral and PUBLIC to ensure that both options include mechanical systems that will maintain comfortable interior temperatures at times when windows must stay closed. However, the 'O' scheme is expected to perform better from a resiliency standpoint as it has the greater potential to function passively (e.g., in the event of power outages). At this stage of the design development, the 'J' and 'O' options generally performed equally well on operational cost performance. The 'O' scheme may offer more opportunity for future flexibility in terms of suite configuration.

"The people in [the O] building are in a far better position if there is a power outage or if there is an air conditioner failure."

– Chris Higgins, City of Vancouver Sustainability Office

17 https://www.bchousing.org/research-centre/library/residential-design-construction/MBAR

18 https://pics.uvic.ca/sites/default/files/IBAMA%20Primer_FINAL_v1_0_rev.pdf

10.Conclusion

Overall, the 'O' scored better than the 'J' scheme. Both schemes have the potential to provide high-quality affordable housing, yet both also come with potential performance trade-offs. The 'O' design for the building form offered the best solution for livability in terms of enhanced thermal and acoustical comfort and social interaction. The Project Steering Committee and project team's preference for this configuration was reinforced by its climate resiliency and relative ease of operation due to less reliance on active systems (notably the use of passive cooling). The operator's positive experience with a courtyard-oriented social housing project was also an important factor.

Although the 'J' option is very familiar to the B.C. market, the courtyard configuration is not without precedent. Based on insights gained from successful housing models found in Vienna, the 'O' scheme is deemed by the Project Steering Committee and project team as the best choice for providing a highly livable building that builds a strong, inclusive and diverse community.

Vienna House is one of ten projects from across Canada selected to be included in CMHC's 2021 National Housing Demonstration Program. The project aims to explore and implement best practices and serve as a case study for policymakers and industry every step of the way. The innovations incorporated into the Vienna House project and the decision-making processes that support them are being documented and published on the project website (www.viennahouse.ca) on an ongoing basis to inform best practices for future projects.

Appendix A – FLUID Sociability Simulation

To compare how building design can influence social interactions, Human Studio is developing an agent-based simulation tool called FLUID. Using a combination of video game technology and building designs, simulations predict frequencies of interactions, specified by encounters, greetings and conversations. Encounters occur when an agent sees another and there is an opportunity for voice and eye contact. Greetings are interactions between agents and can include a short "hi", a wave, or eye contact. Conversations are interactions where agents stop to talk to one another. This simulation was done on the two potential designs for Vienna House, with the results displayed in Figures 8-10 (results supplied courtesy of Human Studio).

Figure 8 shows the occurrences of encounters (orange) and greetings (green) in the 'J' option based on a 30-day simulation. Figure 9 shows results for the 'O' option.

Figure 8. FLUID Sociability simulation of 'J' option, flags for Encounters and Greetings (left) and closer view (right)

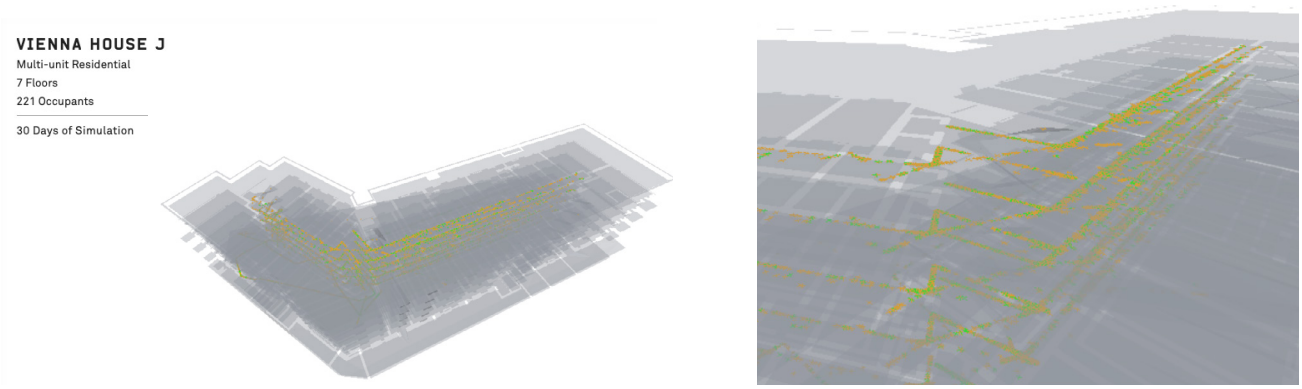


Figure 9. FLUID Sociability simulation of 'O' option, flags for Encounters and Greetings (left) and closer view (right)

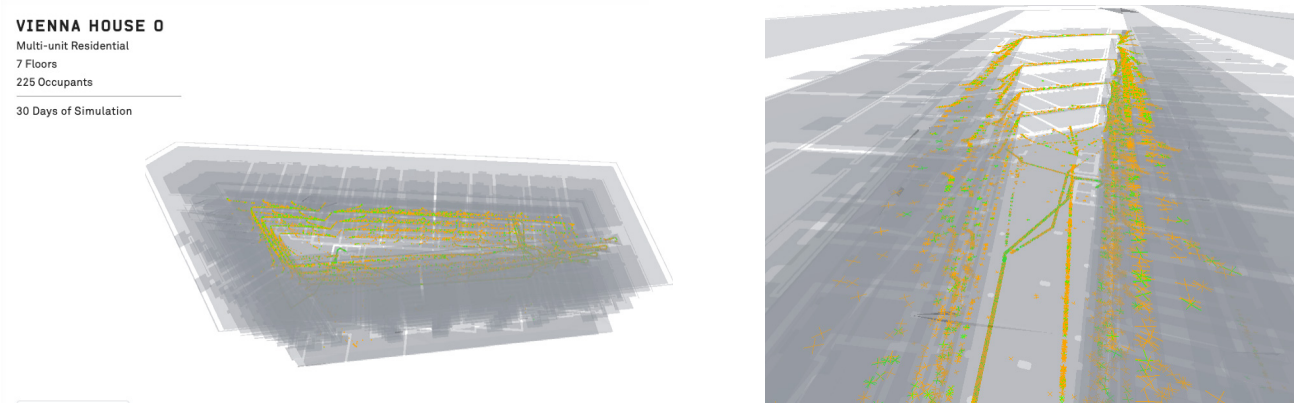
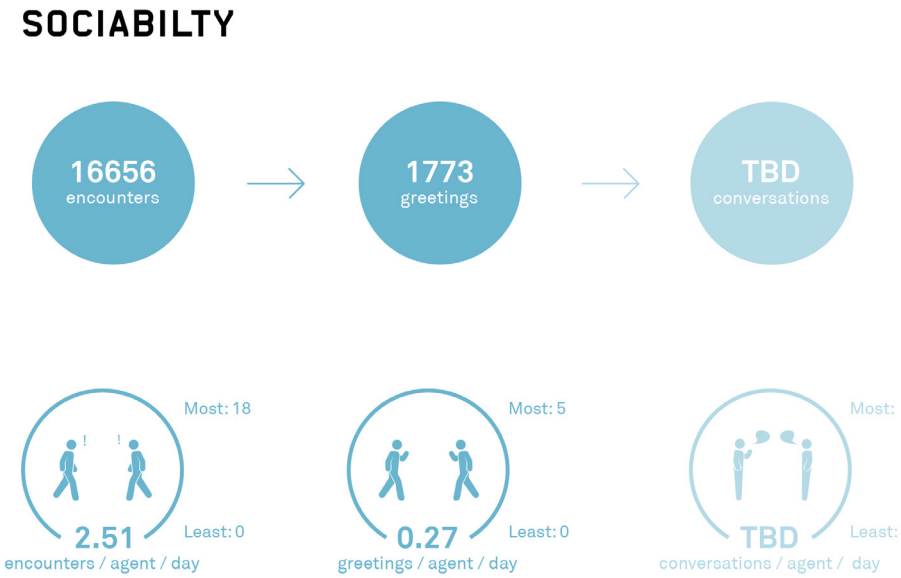


Figure 10 provides numerical simulation results for both options. The 'O' option provides 26,192 simulated encounters and 2,398 greetings, while the 'J' option provides 16,656 simulated encounters and 1,773 greetings. These results indicate that the 'O' design may have a 57 per cent greater likelihood of encounters and a 35 per cent greater likelihood of greetings. Many factors go into the sociability of a community, and this is only a simulation. But with all factors being equal other than the layout of the building, this simulation supports the theory that the 'O' layout greatly contributes to the sense of community through increased capacity for interaction of the residents.

Figure 10. FLUID Sociability Simulation estimated number of encounters and greetings

'J' Option



'O' Option

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