Feasibility Study | 3 Over 3 Chimo«Project_Number»

Architectural Report – for BCNPHA

To BCNPHA
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Provided as a part of the whole feasibility report.

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1 Zoning and Code

1.1. Existing Condition and Zoning

Rezoning is required when either the density increases or the occupancy changes from what is allowed by the site's zone. Density is measured by Floor Space Ratio (FSR), which is the ratio between the total floor area of the buildings on site and the site area.

As demonstrated in section 2.2 above, the City allows increased density for social housing projects. The increased density allowance may allow housing providers to effectively double the site's FSR with the addition of 3 extra floors above the current 3 storey building. Confirming whether a rezoning application for density is required will be determined on a project-by-project basis. The occupancy is not anticipated to change; the building area is simply adding residential occupancy to the existing residential occupancy. This may change if the housing provider wishes to add a commercial occupancy during the future redevelopment.

It would appear that rezoning will not be required at Chimo. The FSR calculation will include the 4 existing buildings on site and will be finalized in future design phases.

However, the zoning bylaws also prescribe the form of buildings. This includes limitations on building height, setbacks, massing and describes articulation requirements. The 3 over 3 overbuilding form and siting is inextricably linked to the existing building. The size of the overbuilding's supporting structure is the generator of the form and building location. In all cases the smallest rectangular exo-skeleton structure, that can circumscribe the existing building is used. This structural layout results in a simple box form perched on top of the new surrounding structure and the existing building.

Variances will be evaluated in the next phase of design and will require input from the City. Extra architectural consideration of façade composition (colours and cladding types) and façade articulation (to break up the massing) will be required. Consideration of the affordability of the project will inform the design decisions in this future phase.

The following are some variance challenges that the project may face:

Setbacks – Generally the exit stair and elevator shafts are outside the footprint of the exo-skeleton surrounding the existing building. The existing buildings were likely built close to the required setbacks. This means that these elements may be non-conforming and may have to apply for a setback variance.

Massing – Chimo's massing is quite large. The existing building has a level change in the middle at the fire wall, that breaks up the massing. However the new building is one continuous box over top. The current design uses a large bank of windows to provide a point of interest on the street facing façade. The rear is broken by the vertical stair and elevator shaft volume.

Height – The interstitial space between the existing building and new floors, will add height to all 3 over 3 buildings. The design team may have to reevaluate the function of this space, if the building height is too high to vary.

Parking – All three buildings will lose parking stalls, the extent of which will be determined in the next design phase. A traffic study may need to be procured to support the parking stall reduction, compounded by the added population from the new building above.

1.2. **General Code Analysis and Commentary**

For an in-depth code analysis, please see the Code Report in the Appendices.

One of the basic project principles is to touch the existing building as little as possible, so that the existing building can remain occupied during construction and to avoid costly and more disruptive structural upgrades to the older building. The existing building was reviewed to identify preexisting life safety conditions that would be compounded by adding the new floors or might affect the safety of those new floors.

In general, bigger buildings are less safe than smaller buildings of the same occupancy, due to there being more people who need to travel longer distances and spend more time exiting the building. This project effectively doubles the building size and therefore doubles the number of people who need to use the exits in an emergency. There are several challenges with modifying the existing exits to accommodate the new floors above, not the least of which is the requirement that the building stay occupied during the long duration construction phase. As such a common design feature for all the buildings is to provide new and completely independent exits that only serve the new floors. These independent exits also provide the required exiting for the construction workers during Mass Timber construction. By providing these two additional exits, 3 over 3 buildings provide larger exiting capacity than a 6 storey building with the same number of exits.

The project team has assumed that the existing building was constructed with 45 min. fire separations and structural fire ratings. The existing building is also not sprinklered. The current code requires 6 storey buildings with this classification to have 1 hour fire ratings and to be sprinklered throughout. To consider 3 over 3 buildings as a single building, sprinklers need to be added to the existing building. A 2-hour horizontal fire separation between the new floors and the existing building at the underside of level 4, help address the lower ratings in the existing building. The idea is that if a fire in the existing building, isn't suppressed by the new sprinklers, the increased rating at the horizontal separation and the supporting structure adjacent and exposed to the existing building, will be safer for the occupants of the new floors, while not posing any additional risk to the occupants of the lower portion of the building. This is achieved by way of encapsulating the mass timber structural floor panels, wrapping the supporting steel structural elements, exposed to fire from the existing building, in fire resistive layers and providing 2-hour shafts through the building above. 2-hour fire stopping at penetrations through level 4 and a building wide fire alarm system will also be required.

All 3 over 3 projects have a service or interstitial space between the existing and the new portions of the building. The interstitial space will be accessed by way of the existing roof top hatches, and will provide mechanical cross over space; the sanitary lines from the building above will be collected and conducted to shafts that run vertically outside the existing building, the existing plumbing stack vents and suite exhaust ducts will also be collected and run up through the new building within 2 hour shafts to the roof level. There is an opportunity for some mechanical equipment to be placed within this space; central HRV systems and cooling systems could be hung from the ceiling of this space, attached directly to the new structure to avoid imparting loads on the existing building. The interstitial space will be sprinklered throughout and the existing roof drains maintained to avoid flooding events for the building below.

The sprinklers in the existing building will be surface mounted, to avoid disruptive demolition activities. GHL recommends that the concealed spaces in the existing building be sprinklered as well. The extent of the work associated with sprinklering will be determined in future phases.

The VBBL, per Part 11, requires seismic upgrades for the existing structure. The extent of these upgrades will be determined in a future phase. However, the exo-skeleton structure provides a way to brace the existing structure from the outside, thereby reducing the impact to the tenants during construction.

Chimo does not have elevators and has limited numbers of suites that can be considered accessible. To remedy this, Chimo has been designed to accommodate two elevator shafts outside the existing building footprint. Chimo's elevators are combined with a third exit stair, which is placed adjacent to the existing building close to the floor level change, so that with some modifications to the existing building a ramp can be used to access the split levels. The elevator and exits stairs will be separated from the rest of the building by a fire separation.

Energy compliance in 3 over 3 buildings will be achieved through an 'enclosure first' design paradigm. The new portion of the building will have highly insulated exterior wall assemblies, floor and roof assemblies complete with triple pane windows. A high airtightness rating will be achieved partly due to the simple form of the building. Window to wall ratios will be minimized without negatively affecting occupant comfort. Chimo is targeting Step 4 as a minimum.

2 Architectural Concept

2.1 Overview

In general, the 3 over 3 architectural concept was driven by the structural concept and by the desire to use modular construction systems. An exo-skeleton, complete with new foundations, surrounds the existing building. Crane installed long span elements or systems span over the existing building and transfer the new floor loads to the exo-skeleton. The first of the new floors becomes a staging ground to complete the construction of the rest of the new floors above. Simplicity of the architectural form was dictated by primary structural principles, ease of construction and energy efficiency.

The smallest rectangle that encompassed the existing building defined the size of the exo-skeleton and therefore the depth of the floors above. The vertical members of an exo-skeleton structure can either respond to the existing building or not.

Chimo's vertical structure was positioned to avoid the existing windows and doors. Chimo's structural design also necessitates the removal of the balconies, to allow the horizontal members to span between the vertical members, and to help brace the existing building's floor. During design development balconies and solar shading panels could be reincorporated and attached to the rectilinear exo-skeleton structure. However, there is an opportunity to provide a common roof top space to provide semiprivate access to the outdoors for the tenants. These spaces can be quite engaging and could help support community activities.

Parking will be affected by the new structures. Attempts were made to avoid this, but the transfer structures were seen as too expensive and complex to be worth pursuing. Chimo will lose a number of at grade parking stalls directly under the building, due to the exo-skeleton's columns. The elevator core and stairs will need to be modified to provide vehicular access to the upper parking lot area. When the structure is finalized, the number of bylaw compliant parking stalls can be determined and evaluated.

When foundations are designed the location of the subgrade services will be taken into account. Some foundation systems may be better suited to avoid the services. Chimo's foundation caissons are in discreet locations and may avoid conflicting with the services. There may be an opportunity to move the services to avoid the foundation.

Other disciplines will be engaged for the next design phase, including Civil, Mechanical and Electrical. They will help define the rest of the project scope; site servicing, HVAC and plumbing systems, emergency power and distribution systems. For this feasibility study, the cost consultant has estimated these costs based on a cost per area.

2.1. Unit Layouts

The unit layouts have been generated by the following factors:

1) BC Housing Design Guidelines for the minimum clear width for bedrooms and
2) The structural system proposed by the design team

BC Housing requires certain building efficiencies depending on the type of housing being provided, And minimum spatial design requirements to promote the design and implementation of livable units. In a 3 over 3 project the upper floors' depth and therefore the suite's depth is dependent on the structure below. It will always be deeper than the existing building below. The width of the new suites can be either dependent or independent of the structure below. Chimo's unit width is independent, as the exo-skeleton creates a 'table top' at level 4 which is able to transfer any building configuration above down to the supporting structure. This means that there is some control over the unit sizes as the suite separation walls are not dependent on the structure or the building below.

The Design team made every effort to conform to the maximum unit areas prescribed by the BC House Design Guidelines;

		NET UNIT AREA	
Unit Type	**Bedroom**	**Sq. Metres**	**Sq. Feet**
Apartment/Single Storey Apartment (Motel Type)	Studio	33 m^2	350 ft^2
	1	49 m^2	525 ft^2
	2	67 m^2	725 ft^2
	3	86 m^2	925 ft^2
	4	112 m^2	1200 ft^2

Unit areas per BC House Design Guidelines

However, the unit areas generated in this design exercise are almost always more than the unit areas specified by the Design Guidelines. Different unit types have been proposed to use the excess space within the unit; dens don't require windows and are perfect for utilizing excess internal space.

Chelsea	Studio	36 m^2	+3m^2
	1 Bedroom	57 m^2	+8m^2
	2 Bedroom	81 m^2	+16m^2
	3 Bedroom	101 m^2	+15m^2
Chimo	1 Bedroom	57 m^2	+8m^2
	2 Bedroom + Den	85 m^2	N/A
Building 5	1 Bedroom	55 m^2	+6m^2
	1 Bedroom + Den	69 m^2	N/A
	2 Bedroom	76 m^2	+9m^2

Comparison of Unit areas per 3 over 3 Design Documents

Detailed design will determine the exact wall placement and room dimensions. It is worth noting the BCBC Adaptable unit requirements will be in place when these buildings are designed, as such BC Housing may have to increase the prescribed unit areas, thereby making the 3 over 3 areas closer to the acceptable standard.

2.3. Enclosure

An ‘enclosure first’ design process is envisioned for the new portions of the building. This means that the exterior wall, floor and roof assemblies will have a high level of thermal and airtightness performance. In order to achieve Step 4 it is recommended that 6” of exterior mineral wool insulation be used in conjunction with a lower window to wall ratio. High performance triple pane windows have been specified. This type of enclosure reduces the energy required to heat and cool the building and allows the mechanical team to ‘right size’ the mechanical equipment. To avoid disrupting the tenants the exterior walls will be made up of modular prefabricated panels, installed by crane (similar to the structural framing systems).

Modular facade construction offers several benefits, making it an increasingly popular choice in modern architecture. One of the primary advantages is speed; since the facade components are prefabricated off-site, they can be quickly assembled on-site, significantly reducing construction time. This method also enhances quality control, as the controlled factory environment allows for precise manufacturing and thorough inspections. Additionally, modular facades are cost-effective, minimizing labor costs and material waste. They also provide flexibility in design, allowing for easy customization and future modifications. As an additional secondary benefit, modular panels help to mitigate moisture issues during construction, by shielding the mass timber from wind driven rains. Overall, modular facade construction promotes efficiency, sustainability, and constructability in building projects.

Example of prefabricated cladding panel installation [Brock Commons]

2.4. **Summary**

3 over 3 projects provide a way to gently densify areas of the City that may not be able to support new high density development. By using the unclaimed density allowances above existing 3 storey buildings, housing providers can keep their at-risk tenants housed, while building new capacity into their housing portfolios to accommodate the growing need for this type of housing.

3 over 3 is a wholly new way of developing housing and will need the active participation of the City to secure the necessary approvals to proceed to construction. There are characteristics of 3 over 3 projects that are simply non-negotiable, the building's conformance to bylaw requirements, its shape, size and siting, are defined by the existing building's footprint and siting, the new exo-skeleton structural system and best practices in building and energy efficiency design. Funders will also have to review the design and understand and accept the fact that these types of buildings may not be able to achieve all the prescribed design metrics that are key to meeting the funding requirements. Open and direct communications with approving entities, that can accept justifiable deviations from the norm, are necessary to the success of a 3 over 3 building project.

Site restrictions will also play a role in determining whether a 3 over 3 building project is feasible. Construction sequencing and crane limitations will inform if modular construction can be used for both the structure and the enclosure elements. Lay down areas for the project may also be problematic for sites with very little open site area. These considerations will need to be taken into account early in the design stages to help determine the best systems to use.

Next phase design discussions and decisions will be required to refine the design, create a more accurate construction budget, test the acceptability of these sorts of projects with the approving authorities and to find out if there are any other barriers to project success.

To help make this future project more feasible the following should be considered when picking a building to add upper floors to:

1) The building should be rectangular in shape, have exits at the ends of the internal corridors and be adjacent to an exterior wall, with the possibility of direct exit discharge to the outside.
2) The building should have a good amount of space around it to accommodate the new structure and vertical circulation elements. The site may have extra space because it either has large setbacks from the property line, or is located on a campus that has no internal property lines, where the only limiting factor is the code defined separation of buildings from one another.
3) The building ideally would have no underground structures that extend out past the face of the existing building. This includes underground parkades and service areas.
4) The length of the building is important as this defines the maximum travel distance to the required exits for the floors above. The goal is to provide only 2 new exits for the floors above. A third exit complicates the building design and makes the project less feasible. The existing building may be separated into two buildings by a fire wall. However, once the existing building is sprinkled, the building may not need the fire

wall, as long as the travel distance is less than or equal to the distance stipulated by the code.

5) Depending on whether the existing exits are configured to allow access to the existing floors at the landings, an existing elevator may be required, unless the approving authority accepts the existing non accessible condition.
6) A potentially more feasible project to consider first, would be a variant of the 3 over 3 theme. Perhaps a 4 over 2, or a 5 over 1 should be considered first, as the shorter exo-skeleton structure is much easier to design and construct.

The project team considers this new typology as a great way forward to address the critical housing supply shortage. The concept leverages the modular construction industry and focuses gentle growth on low to medium density areas within cities. The new market created by this type of development could be quite large and span many geographic locations. In fact, some locations with less risk of seismic activity may be better suited for this type of construction, as the supporting structural system is where most of the extra project costs are found.

Prepared by Tim Judge, for inclusion in the draft report compiled by BCNPHA.

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