FLUVIAL FORMWORK

CONTEXTUALIZING STANDARDIZED METHODS AND MATERIALS

BY TEAM ADJACENT BRICK ROWS

"River dolphins all over the world (in the Ganges and Amazon Rivers, for example) are not close genetic relatives. But they are remarkably physically similar. They have grown common forms due to their common circumstances.

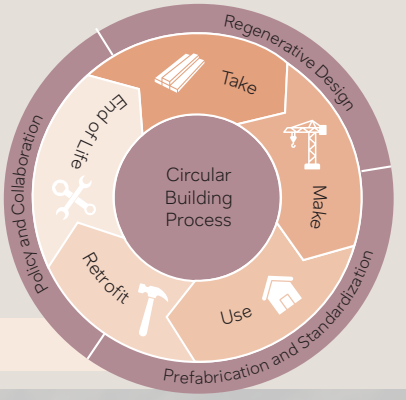
Have you grown that way, riverine? In a context that moves so quickly that looking at it tells you almost nothing. Are you evolving a deeper way of listening where you are? Could we become students of shape precise enough to move with the grace and flexibility our circumstance requires ***even though your river is not my river?****"*

Alexis Pauline Gumbs
Undrowned: Black Feminist Lessons from Marine Mammals, P.19

Shaping Our Common Future

This design competition asks us to consider how mass timber in residential construction can help mitigate climate change and improve housing affordability. Our response is that while mass-timber, prefabrication, and modular design are important tools in the toolkit for addressing these challenges, a broader systems-level shift is essential. We must move from a conventional linear building process to a circular one (where carbon is continuously cycled through our consumption patterns) rather than released into the atmosphere or sent to landfill. To support this goal, we propose Three Implementation Strategies intended to guide the project's design, ensuring that intergenerational equity is considered at every stage of the building and its components' lifecycle. All new construction should enhance intergenerational equity, not diminish it.

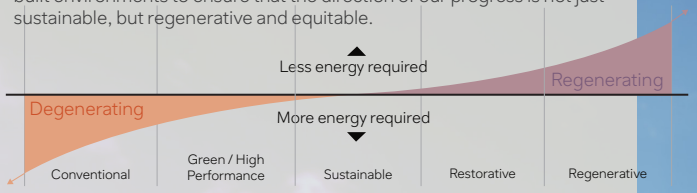
Conventional Linear Building Process



Intergenerational equity

- Carbon
- Affordability
- Opportunity

Time is running out to meaningfully address climate change and housing affordability, if it hasn't already. With a 1.5°C temperature rise likely inevitable due to past emissions, urgent and meaningful action is needed. As climate leaders, policy makers, and designers of the built environment, we have a responsibility to confront these intersecting crises. This demands bold, systemic change in how we use resources and a rethinking of our relationship with ecosystems and our role within them. Considering the passage above in the context of consumption and the built environment, it is essential that we reshape the "riverbanks" of our built environments to ensure that the direction of our progress is not just sustainable, but regenerative and equitable.



Credit: Bill Reed - "Shifting from Sustainability to Regeneration"

CONTEXT MAP (NTS)

Implementation strategies

Regenerative Design

Regenerative Design is a holistic design philosophy and practice that goes beyond sustainability to create systems, buildings, and communities that actively repair and regenerate ecological, social, and economic systems.

Prefabrication + Modular

Through efficiencies in manufacturing, prefabrication and modular construction have a singular potential to mitigate the economic and carbon cost of providing housing in the future while simultaneously providing a higher quality of construction and project outcomes.

Policy and Collaboration

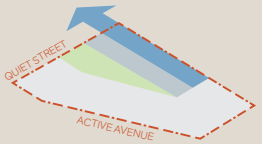
Regulation and policy are paramount in implementing this framework of consumption which posits the reframing of established processes of delivering housing. Collaboration and buy-in among all parties is critical for success.

Policy reformwork

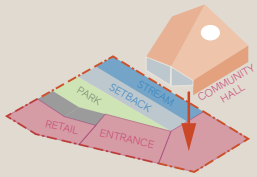
- **A** Daylighting streams should be encouraged and incentivized through density and height bonuses
- **B** Regulate embodied carbon alongside operational carbon with a lifecycle metric approach
- **C** Reward upcycle and deconstruction efforts through carbon targets. Provision of natural areas can contribute to meeting carbon targets.
- **D** Permit voids within mass timber slabs with acceptable fill materials and stringent safety testing
- **E** Require RFPs for publicly awarded projects to be evaluated on best-value outcomes from integrated teams at the proposal stage
- **F** Facilitate development of material standards for upcycleable or reusable materials

Parti Diagrams

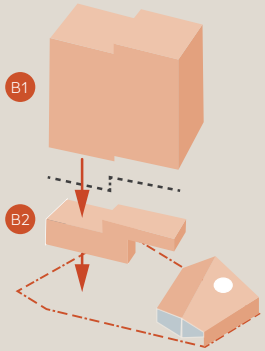
The culverted stream is brought to the surface starting one third of the length of the North property line, establishing a 10.0m setback on the subject site. The buildable area and ecological areas are established.



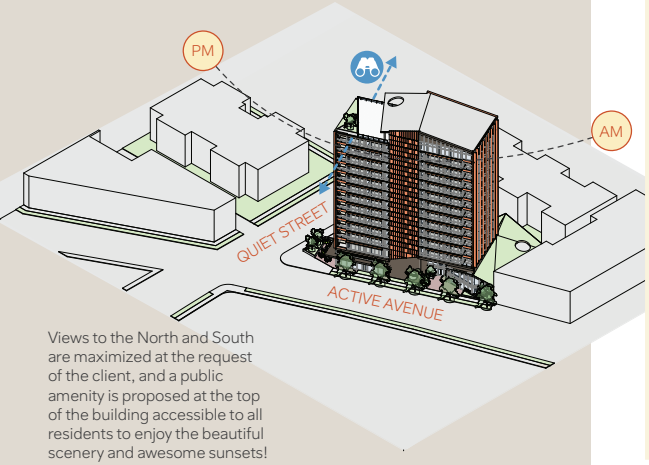
The site is programmed giving prominence to the KKS Nations Community Hall, from which the new stream emerges from underground. In exchange for daylighting the stream and providing a public park, **the project receives a density bonus** from the planning authority with jurisdiction.



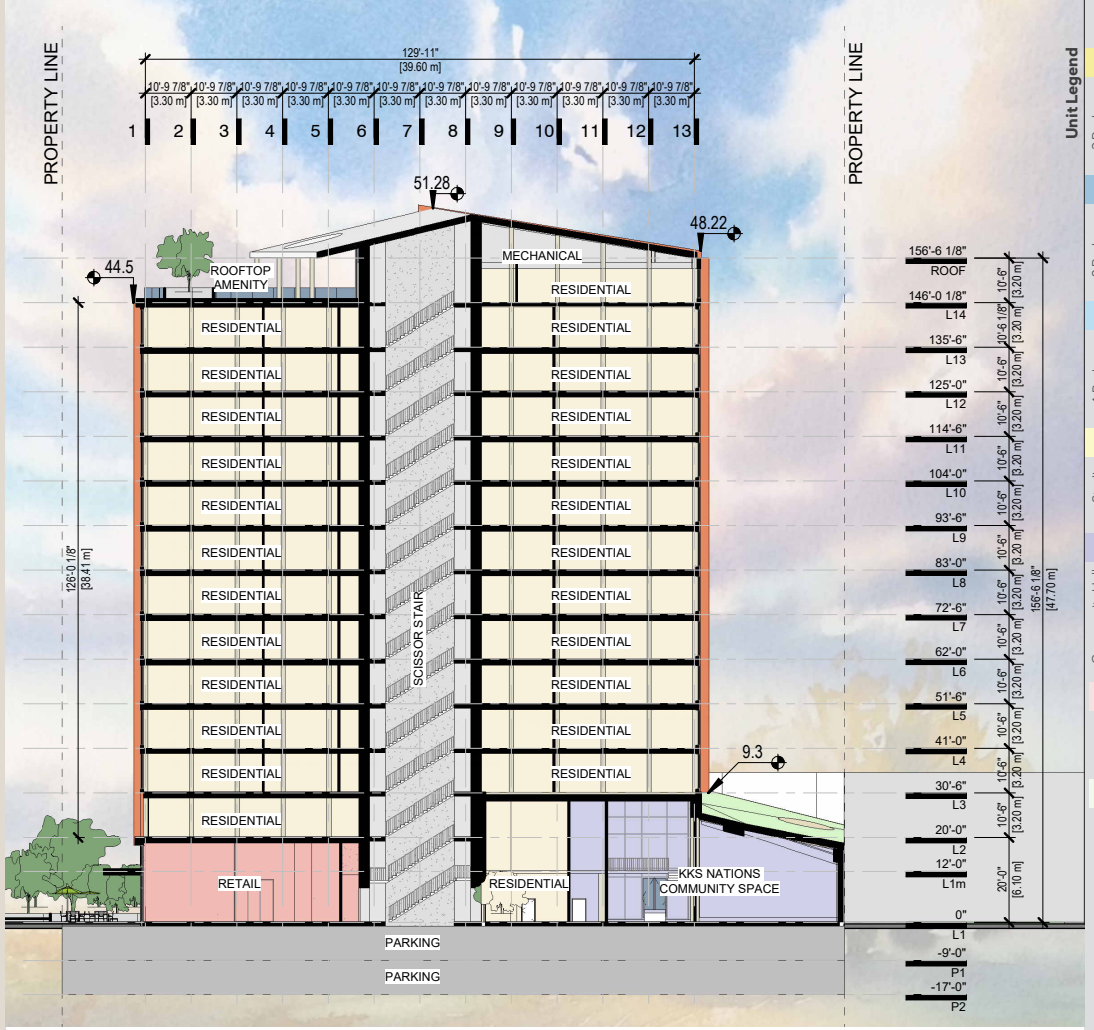
To accomodate the extra density on the site, the building is proposed at 14 storeys instead of the 12 as recommended by the TOA Tier 2 guidelines. Additional density is at the discretion of the AHJ. To permit the building to have exposed mass timber elements (max. 12 storeys), the building is split in two using an **Alternative Solution** which allows a fire rated floor to compartmentalize the two buildings from each other.

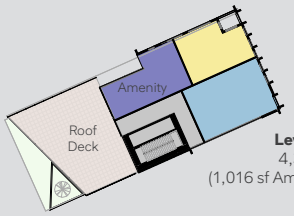


Solar shading devices are designed for the East, South, and West elevations to ensure a reduction in solar heat gain while ensuring the maximum amount of glazing in the liveable areas. The ration of glazed area to opaque is 70 / 30, which is above average at the request of the client.

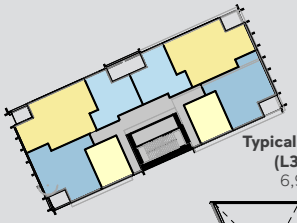


Views to the North and South are maximized at the request of the client, and a public amenity is proposed at the top of the building accessible to all residents to enjoy the beautiful scenery and awesome sunsets!

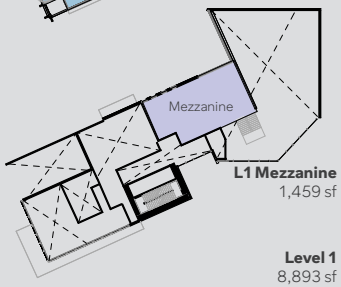




Level 14
4,323 sf
(1,016 sf Amenity)

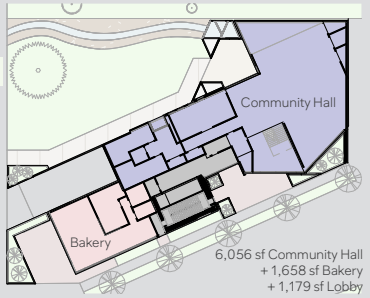


Typical Level (L3-L13)
6,983 sf



L1 Mezzanine
1,459 sf

Level 1
8,893 sf



6,056 sf Community Hall
+ 1,658 sf Bakery
+ 1,179 sf Lobby

Area Summary

	Permitted	Provided
Floor Space Ratio (FSR)	4.0 (+1.0)	4.8
Lot size (sf)	20,125 sf	-
Building area above grade (sf)	-	95,544 sf
Building efficiency (%)	-	84.3%
Non-leaseable area (sf)	-	15,956 sf
Leasable area (sf)	-	80,544 sf
Total stories above grade(#)	12	14
Total stories (#)	-	16
Base floor (#)	-	1
Above 1st storey (#)	-	13
Units (#)	-	96
Unit Mix (%)	25% 3-Bed, 25% 2-Bed, 25% 1-Bed, 25%-Studio	
Amenity space (sf)	-	1,016
Non-residential area (sf)		7,762 sf

Building Code Summary

Construction article: 3.2.2.93

	Permitted / Required	Provided
Building height (storeys)	18	14
Building height (m)	76 m	50.2 m
Building area (m2)	6000 m2	826.2 m2
Encapsulation (floors) (3.1.6.4.(9))	50 min	50 min
Encapsulation (all other)	70 min	70 min
FRR (Floors)	2 hr	2 hr
FRR (Columns)	2 hr	2 hr
STC (All construction)	47 (STC) 47 (ASTC)	47 ASTC

Alternative Solutions

AS1 - P1 to L2 / L3 (partial) are to be considered two separate buildings. Additional fire safety measures and compartmentalization required.

Zoning Relaxations

Tier 2 Minimum Allowable Density Framework

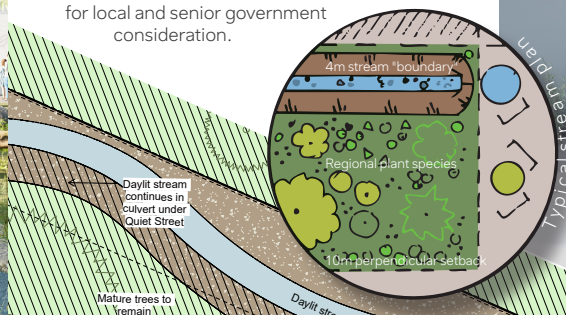
	Distance	Min. FAR	Min. Height
Prescribed	200-400m	4.0	12 storeys
Proposed	200-400m	5.0	14 storeys

As per the Ministry of Transportation and Infrastructure's guiding document "Provincial Policy Manual: Transit Oriented Areas" issued on May 29 2024, "local governments retain the zoning authority to establish densities and heights **greater than** those prescribed by Provincial regulations."

In this hypothetical project proposal, we imagine that in exchange for daylighting the culverted stream that exists along the North PL, the authority having jurisdiction will provide a density and height bonus as incentive to restore the ecological functions historically provided by these natural features.

Design for Nature

High land costs of urban areas paired with stringent legislation outcompetes incentives to open (daylight) piped streams and to reactivate their direct and indirect public benefits. To capture the economic, social, and ecosystem values that urban streams provide, this sheet indicates barriers and solutions that are recommended for local and senior government consideration.



Incentivize Carbon Sinks and Ecosystem Services

To address this issue, we are proposing the following relaxations to the Municipal and Provincial regulatory frameworks governing stream setbacks:

1. Relax municipal stream setbacks where they exceed Provincial minimums.

2. Formally recognize these projects under a WSA Notification and / or DFO request for review to alleviate permitting uncertainty and schedule delays.

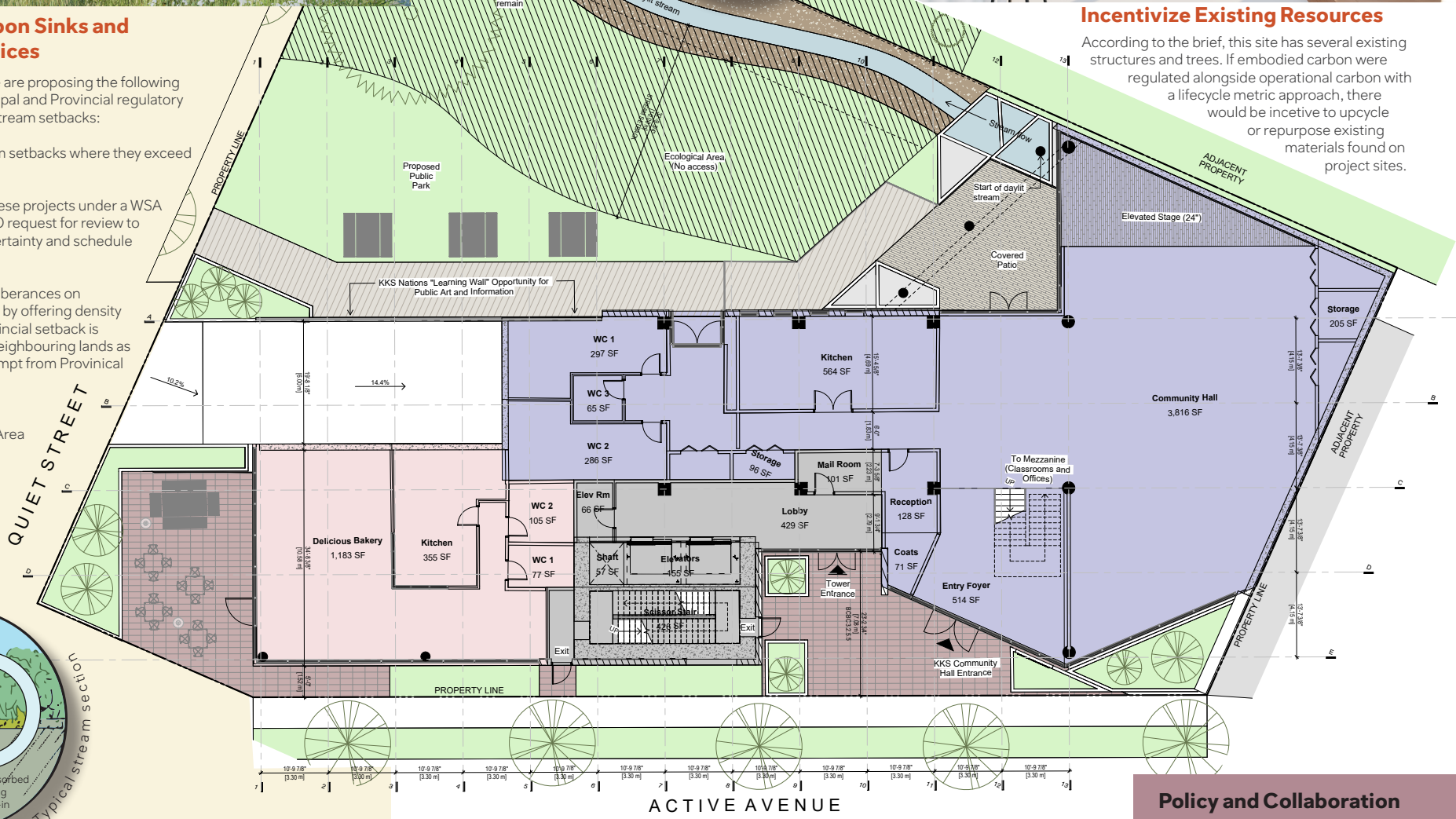
3. Offset setback encumberances on neighbouring properties by offering density bonuses where the Provincial setback is achieved or recognize neighbouring lands as legacied land use to exempt from Provinical setbacks.

4. Include the "Sensitive Ecological Area" in Site Area and density calculations.

5. Develop and promote density bonus programs for daylighting streams currently in catchments on private property.

Incentivize Existing Resources

According to the brief, this site has several existing structures and trees. If embodied carbon were regulated alongside operational carbon with a lifecycle metric approach, there would be incetive to upcycle or repurpose existing materials found on project sites.



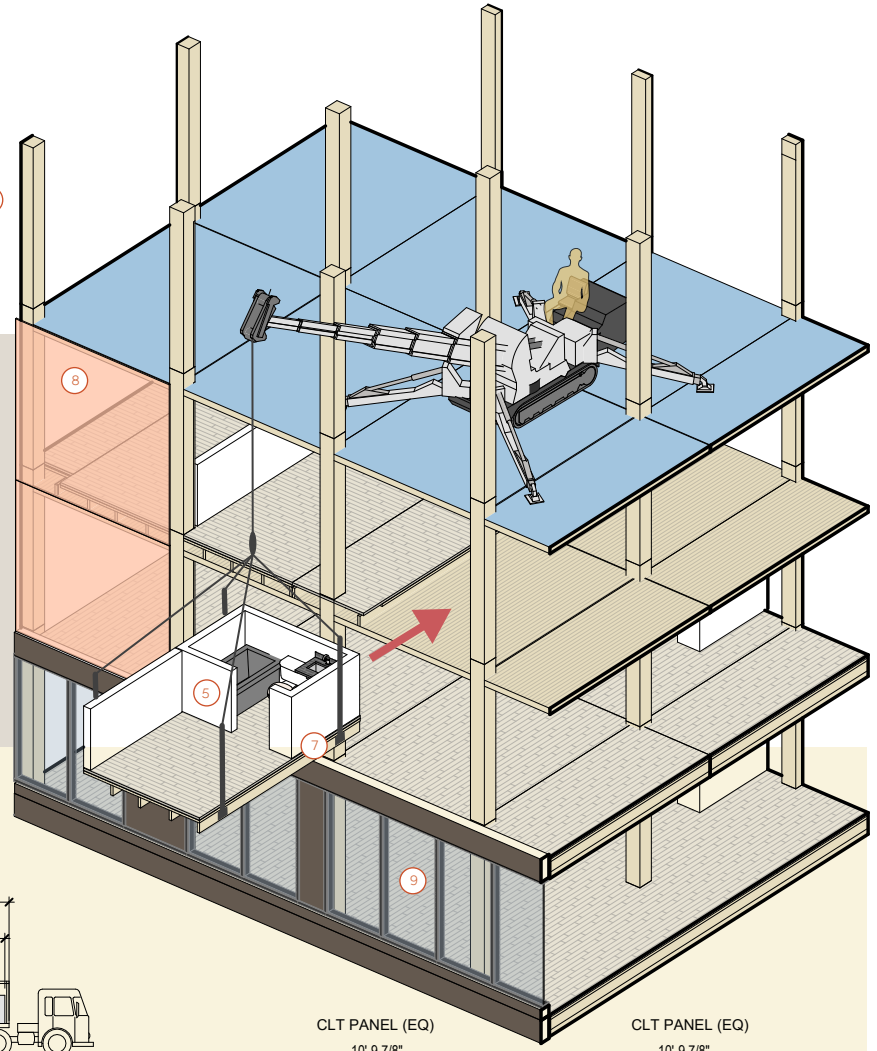
Policy and Collaboration

From assembly line to assembly line

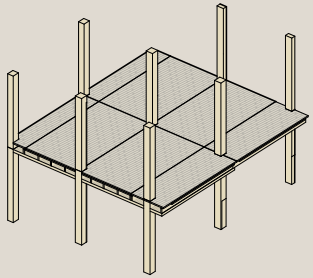
Prefabrication and modularity is an integral component of circularity in the building environment. Mass timber is an inherently prefabricated and modular building system, and yet many projects in the Lower Mainland still resort to traditional methods of connecting the mechanical, electrical, and plumbing services and finishing the interiors once the envelope is delivered and installed. We propose to continue the assembly line from the factory to the building site, and apply the same principles of efficiency to the interiors and building services.

Break the module

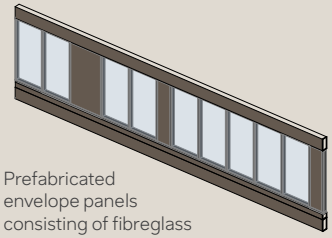
One important consideration we made was to make our interior module smaller than the typical structural grid. With a width small enough to fit inside a cube truck, the smaller modules allow for a greater variety of producers to participate in the production of interior modules. The hybrid volumetric module we designed breaks the rigidity traditionally associated with modular design and allows for flexibility within the floorplans and assemblies.



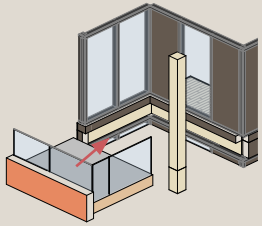
Structure, Envelope, and Balconies



Structure is comprised of GLT columns and CLT slabs which will form a ribbed cassette once the interior module is placed.

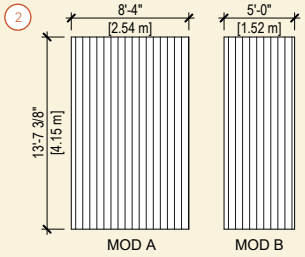


Prefabricated envelope panels consisting of fibreglass window wall and steel stud framing. The steel stud curb ensures that installation does not require custom attachments and is installed like a typical window installation.

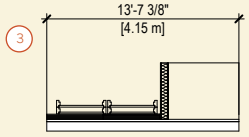


Balconies are LVL slabs interspliced with waterproof membrane layers which prevents water from advancing through multiple veneers.

Interiors + MEP Modules



Maximum dimensions of modules in BC without requiring permit or pilot car for transport are 8'6" x 53'-0".

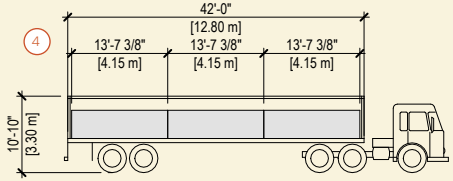


Max lifting weight = 1000 kg

1 sheet 5/8 Type X GWB = 32 kg
2" LVL Panel (4.15m x 2.54m) = 33 kg / m2
8" LVL Beams (4.15m) = 21 kg

10.54m2 LVL Panel = 346 kg
6 LVL Beams = 126 kg
Module base weight = 472 kg + finishes and fixtures

The reduced module size avoids wasteful "shipping of air" and does not require specialized trucks or permits to ship.



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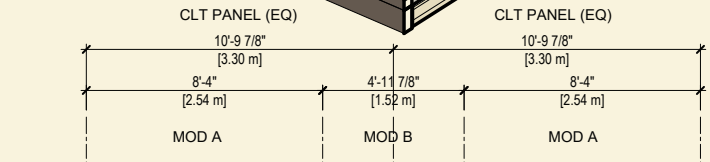
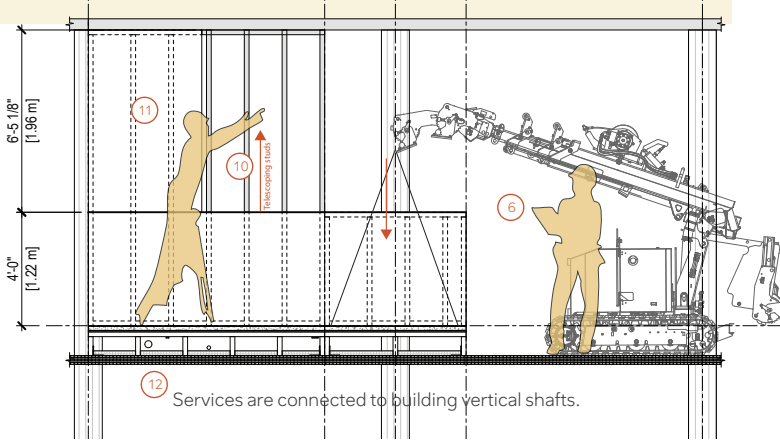


On-Site Assembly Process

Following the successful Deconstruction of existing structures and completion of Site Preparation:

1. Glulam columns and 5-ply CLT slabs installed on site
2. Interior modules are fabricated off-site including all interior finishes, flooring, fixtures, and all mechanical, electrical, plumbing connections, and telescoping stud walls up to 4'-0" in
3. Module packages are packed to include additional components such as doors and drywall sheets, up to a max. weight of 1000kg.
4. Modules are loaded onto a local delivery vehicle. The delivery vehicle is equipped with weather protection on all sides, and ideally is accessible form the top or sides for unloading. Maximum module width of 8'4" ensures simplicity of delivery.
5. Interior modules arrive on site and are immediately craned into place by secondary lifting systems.
6. Rolling mini-picker on floor level manouvers the module into final position.
7. Lifting points on modules double as attachment points to CLT floors below. Modules are fastened to CLT subfloor.
8. Temporary weather protection is preinstalled on floors, and installed on facades where interior units are present
9. Envelope and balcony modules are craned into place by the primary crane.
10. Telescoping steel studs are raised to underside of CLT slab.
11. Interior GWB panels are installed to finish the interior modules.



12 Services are connected to building vertical shafts.

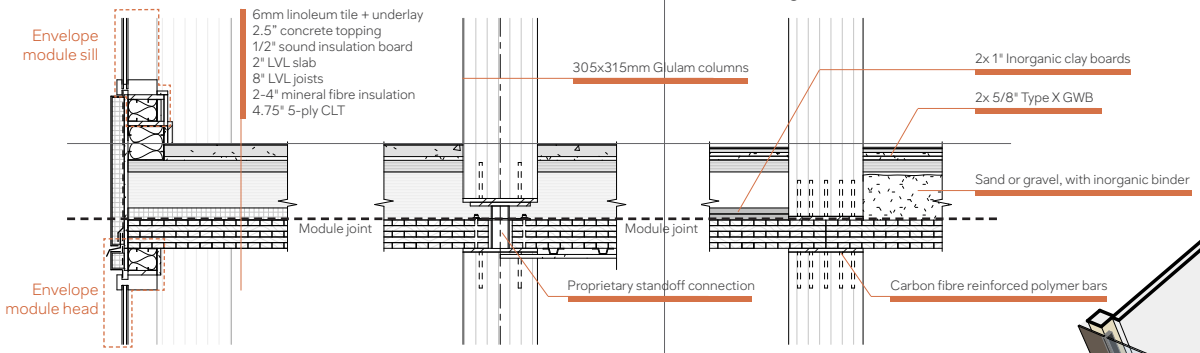
Prefabrication + Modular

Air and Moisture

Envelope modules in this proposal consist of fibreglass window wall embedded within steel stud frames to create modules suitable for prefabrication. Envelope modules were designed to connect to premanufactured curbs and cladding on the interior modules to avoid costly custom attachments.

Fire

Fire and life safety are one the primary concerns when designing any building. This proposal complies with the 35% exposed surface allowance by the building code, and prefabrication allows for encapsulation to be achieved easily in a high quality factory setting.



Acoustics

This proposal suggests a conventional assembly using 2.5" concrete topping to achieve both the encapsulation requirements and the acoustic requirements simultaneously. However, the concrete topping in this floor assembly has by far the highest global warming potential impact of any other assembly component within the project. Replacing the concrete with 2 layers Type X is possible from an encapsulation perspective, but the loss of mass compromises the acoustic performance.

Regenerative Design

What if everything we put into the building was beneficial?

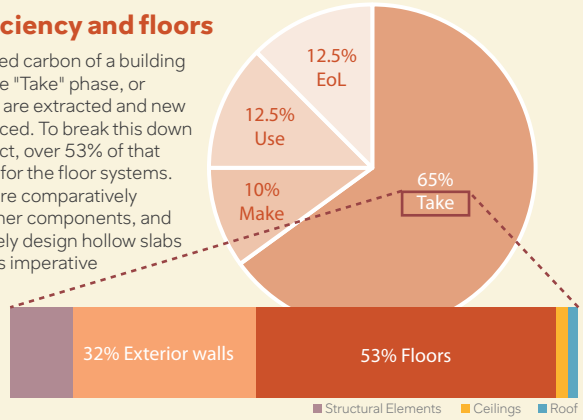
Regenerative materials are substances that, when used and managed responsibly, actively contribute to the restoration and enhancement of natural resources and ecosystems. As William McDonough argues in his book "The Upcycle", consumption of materials is not inherently negative when that consumption has positive externalities.

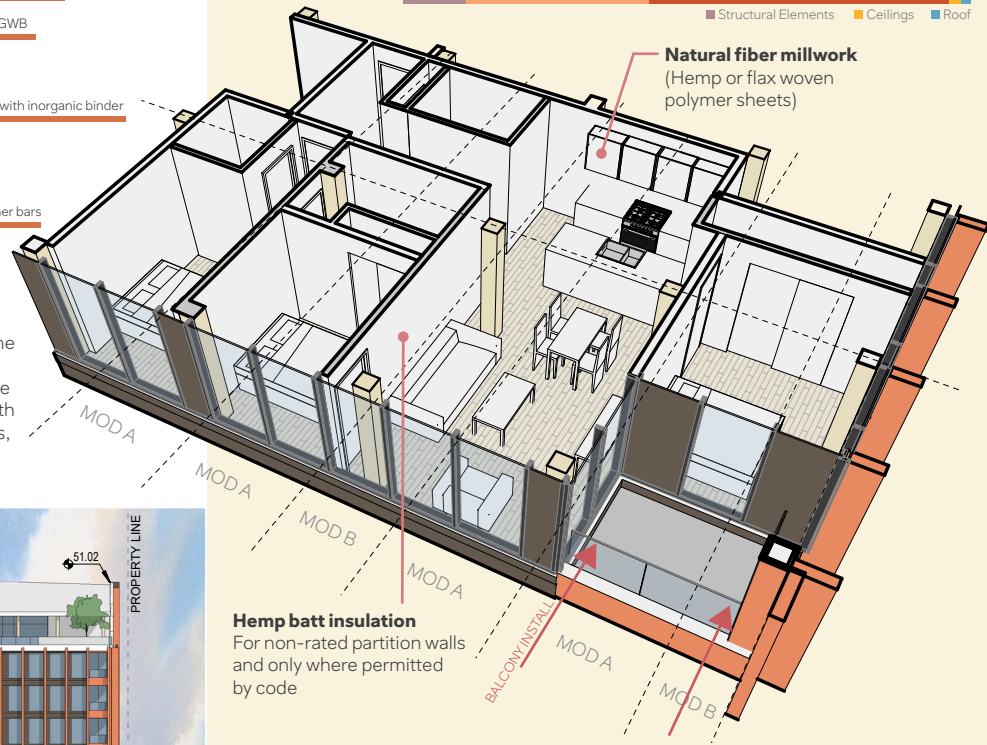
Alternative regenerative section:

There are potential alternatives to fill voids in slabs that can mitigate the issue of achieving the acoustic requirements through mass, such as sand, gravel, or clay. These natural materials are non-combustible and in relative abundance with a low global warming potential. Some materials, like olivine sand from Hope, BC, could even capture atmospheric carbon as it weathers.

Focus on efficiency and floors

65% of the embodied carbon of a building is emitted during the "Take" phase, or when raw materials are extracted and new materials are produced. To break this down further, in this project, over 53% of that energy was utilized for the floor systems. Mass timber slabs are comparatively inefficient to the other components, and finding a way to safely design hollow slabs or slabs with voids is imperative to reducing the carbon footprint associated with creating new mass timber slabs.





Hemp batt insulation
For non-rated partition walls and only where permitted by code

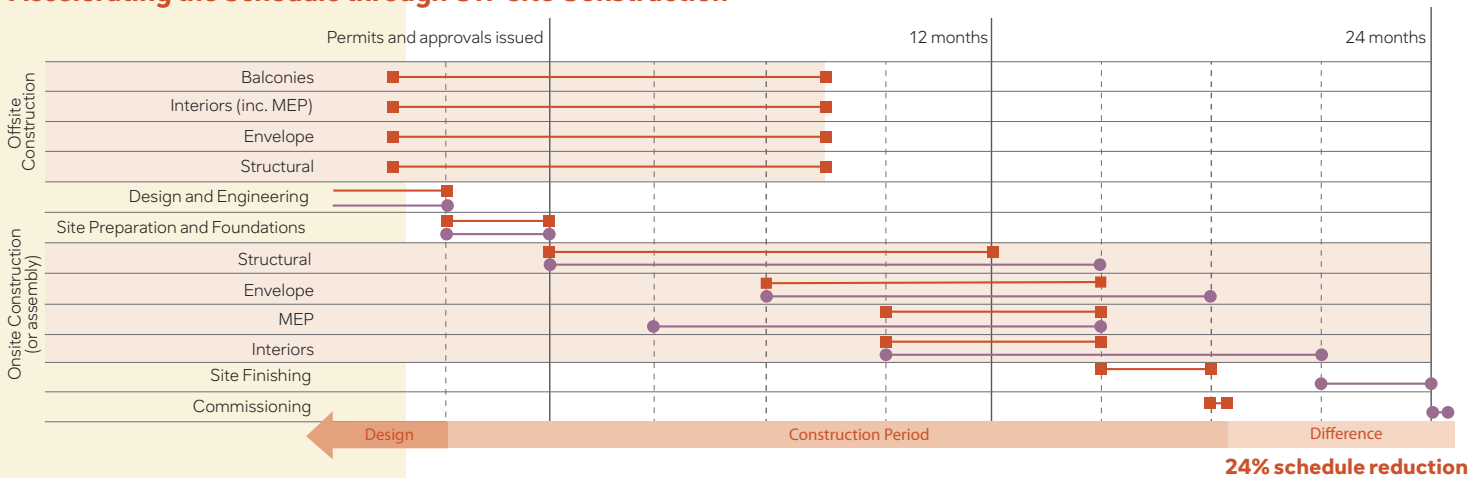
Materials are a reflection of our values

The materials that we choose to surround our daily lives with are a direct reflection of the ideals and concessions we make and value as a society. The majority of embodied carbon emissions are created during the "Take" phase, meaning that the greatest opportunity to address atmospheric carbon lies not in addressing the transportation of goods to site or the operation of the buildings, but by carefully and diligently selecting the materials that we choose to build with.

Design for dissassmbly

Prefabrication enables rapid on-site assembly, but also allows for quick disassembly when components need to be changed or removed. This adaptability is essential to regenerative design, as it meets current needs without always requiring new materials. Disassembled components can often be reused in future projects, lowering both costs and carbon impacts.

Accelerating the Schedule through Off-site Construction



24% schedule reduction

Construction Costs

			Concrete (Base case) ○		Proposal □	
	Area (sf)	Area (m²)	$ / sf	Cost	$ / sf	Cost
Below grade	23,381	2,172	$315	$7,365,015	$315	$7,365,015
Base floor	8,893	826	$420	$3,735,060	$390	$3,557,200
Above 1st storey	86,651	8,050	$400	$34,660,400	$360	$29,894,595
	Quantity		$ / Unit	Cost	$ / Unit	Cost
Balconies			N/A	Included	$20,000	$1,440,000
	Cost / month		# months	Cost	# months	Cost
Monthly overhead	$75,000		25	$1,875,000	19	$1,425,000
TOTAL			401	$47,635,475	367	$43,681,810

8.3% cost reduction

Embodied Carbon

			Concrete (Base case)		Proposal	
	Area (sf)	Area (m²)	Emission intensity (kg $C0_2e$ / m²)	Net emissions (kg $C0_2e$)	Emission intensity (kg $C0_2e$ / m²)	Net emissions (kg $C0_2e$)
Total building (inc. parkade)	118,925	11,048	198	2,187,600	143	1,579,933

28% carbon reduction

Embodied carbon was calculated using the **Building Emissions Accounting for Materials (BEAM) Estimater** produced by Builders for Climate Action. Neither the Construction Cost nor Embodied Carbon included the impact of upcycled or repurposed materials, nor the carbon sink benefit of the ecological stream setback. Future study or proposals would evaluate these considerations to better understand how the embodied carbon of a project or capital costs can be further offset by implementation of circular building strategies.

Works Referenced

1. Undrowned: Black Feminist Lessons from Marine Mammals, Alexis Pauline Gumbs
2. WoodWorks Mass Timber CAD + Revit details
3. RDH Mass Timber Design Guide v2.1 Oct 2022
4. Making Mass Timber Work for High Rise Residential in BC, BTY WSP Axiom + ZGF 2021
5. Technical Guide for the Design and Construction of Tall Wood Buildings in Canada, FP Innovations 2022
6. A Practical Path Forward for Offsite Manufacturing, WoodWorks + Canadian Wood Council

Discussion

We made several adjustments to the schedule, construction cost, and carbon calculators that reflect the advantages put forward by our proposal. Most substantially, we believe that the future cost on carbon will make a concrete base case more expensive above the 1st storey due to increased regulation so we increased the base unit cost to reflect this. We also assumed that timber would still be desireable in a Community Hall design for either scenario, which would be more expensive to implement and mobilize in a full concrete structure. The cost and schedule reductions are largely a result of the efficiencies we anticipate through off-site fabrication. While there is a modest cost reduction, affordability could be greater addressed by utilizing a higher percentage of upcycled or repurposed materials.

Leasehold Business Case

The business case for this project envisions a leasehold project that leases units to potential residents at a price that is below the average market value for freehold properties.

	$ / Unit (Avg.)	Profit at sale	Average Unit Price ($)
Freehold	$455,019	18%	$536,922
Leasehold	$455,019	12.5%	$511,896

$ / Unit: $43,681,810 / 96 Units = $455,019 per unit

The benefits of a leasehold project as opposed to typical freehold are substantial. Since ownership of the land after the lifetime of the building is retained by the developer (Sacred Waters) and the KKS Nations, future generations will have a similar opportunity to develop or redevelop a project that meets their needs in the future. Leasehold also assists in reducing speculation and encourages long-term thinking for the future of the site. Lastly, leasehold arrangements can also provide steady lease income for the ownership group, depending upon the arrangement. Leasehold allows the current generation to develop the site while simultaneously setting up future generations for their own successes.

Assumptions

This project was designed to the specifications outlined in Appendix C of the project brief. As is the nature of competitions, we were unable to consult or work with Sacred Waters Development or the KKS Nations to develop this propopsal, and would welcome the opportunity to revisit the design and proposal as design partners in the future.