Pacific Northwest Forest

MASS TIMBER PILOT STUDY

Key Findings and Next Steps

CreateTO Board: March 27, 2023

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Agenda

1. PURPOSE
2. MASS TIMBER PILOT PROGRAM
3. BUILDING TYPOLOGIES
4. ENERGY AND COSTING METRICS
5. KEY CONCLUSIONS
6. NEXT STEPS

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PURPOSE

On June 20, 2022, CreateTO Board received Item 2022.RA32.5 "Integrating a Climate Action Approach to City Real Estate Decisions - Mass Timber Pilot Program" and directed staff to report back to the CreateTO Board on the progress of the Mass Timber Affordable Housing Pilot Program.

The purpose of this presentation is to report the conclusions of the pilot program and receive:

- ❑ CTO Board's endorsement of the report recommendations
- ❑ CTO Board's direction to work with City Planning, to advance the rezoning for a 10-storey mass timber building on the City lands at 1113-1117 Dundas Street West

Ex: BROCK COMMONS (18-storey student residence - UBC, Vancouver)

WHAT IS A MASS TIMBER BUILDING

A building is considered a mass timber building when the primary load-bearing structure is made of mass timber (including engineered wood) rather than steel or concrete. Mass timber, contrary to production of other structural materials such as steel and concrete, stores rather than emits carbon which results in a lower carbon development.

As of July 2022, the Ontario Building Code (OBC) allows encapsulated mass timber buildings up to 12-storeys and with 25% of ceilings to be exposed, consistent with the National Building Code.

THE PILOT PROGRAM

CreateTO, in collaboration with the City's Environment and Climate Division, the Housing Secretariat, and City Planning, have advanced the Pilot Program to assess the feasibility of developing new housing with mass timber.

Objectives

To assess and identify future development opportunities on City-owned real estate assets that can deliver on the following pillars:

- ✓ New housing, both affordable and market;
- ✓ Development that is grounded in sustainability and climate action; and
- ✓ Development that is cost-effective and efficient to construct in the City.

The pilot study evaluated two building typologies:

- Typology 1: Midrise (modelled on 1113-1117 Dundas Street West & 1675 Danforth Garage)
- Typology 2: Tall Building (modelled on 150 Queens Wharf)

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TWO BUILDING TYPOLOGIES

TYPOLOGY 1: MIDRISE

Mid Rise residential mixed-use building with Encapsulated Mass Timber Construction (EMTC)

10-storey building with laneway housing

modelled on 1113-1117 Dundas Street

12-storey hybrid building

modelled on 1627 Danforth Ave

TYPOLOGY 2: TALL BUILDING

Tall Building, EMTC/Concrete (Hybrid) construction

18-storey hybrid tall building

modelled on 150 Queens Wharf Rd

Please see APPENDIX A for demonstration plan details and construction sequencing

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ENERGY AND COSTING METRICS: EVALUATION FRAMEWORK

The Pilot Program examined each of the typologies using the following metrics:

1) ENERGY PERFORMANCE

- Are energy standards met for the building typologies targeting TGS Version 4, Tier 1 and TGS Version 4, Tier 3?

2) LIFE CYCLE CARBON ASSESSMENT

- Life cycle carbon assessment (LCA) provides a preliminary estimate of the embodied carbon footprint for each of the mass timber typologies. Is each typology on track to achieve low-embodied carbon values?

3) TIER 1 VS TIER 3 COST PREMIUM

- What is the cost premium to go from TGS Tier 1 to Tier 3 for each typology?

4) MASS TIMBER VS CONCRETE CONSTRUCTION COSTS

- What is the cost premium to construct concrete versus mass timber for 10-storey and 12 storey buildings?

5) MASS TIMBER VS CONCRETE CONSTRUCTION SCHEDULES

- What is the impact to construction schedules when using concrete versus mass timber?

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ENERGY AND COSTING METRICS: EVALUATION SUMMARY

The following is a high level summary of the results for each building typology:

#	METRIC		10-STOREY *modelled on 1113-1117 Dundas Street*	12-STOREY *modelled on 1627 Danforth Ave*	18-STOREY *modelled on 150 Queens Wharf Rd*
1	**ENERGY PERFORMANCE**	Energy Use Intensity Standard	Achieved	Achieved	Not Achieved
		Thermal Energy Demand Intensity Standards	Not Achieved	Not Achieved	Not Achieved
		Greenhouse Gas Intensity Standards	Achieved	Achieved	Achieved
2	**LIFE CYCLE CARBON ASSESSMENT**	Life Cycle Assessment ("LCA") Of Embodied Carbon	On track	On track	On track
3	**TIER 1 VS TIER 3 COST PREMIUM**	Percentage Premium	2.8%	3.2%	3.0%
4	**MASS TIMBER VS CONCRETE CONSTRUCTION COSTS**	Percentage Difference (premium of using concrete)	9.75%	.67%	N/A*
5	**MASS TIMBER VS CONCRETE CONSTRUCTION SCHEDULES**	Impact to construction schedules	*Discussions with industry leaders and suppliers indicate that mass timber allows for a significantly reduced construction timing*		

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*was not undertaken given the hybrid nature of the 18- storey typology

ENERGY AND COSTING METRICS: KEY CONCLUSIONS

The Mass Timber Housing Pilot Program demonstrates mass timber construction provides a sustainable and cost effective opportunity to impact housing stock in the City.

Key Conclusions:

1) ENERGY PERFORMANCE

- TGS Tier 3 energy use is achieved with the **10-Storey and 12-Storey Typologies meeting the Energy Use Intensity and Green House Gas Intensity performance standards and operating as efficient low-carbon buildings.**
- Capital investments in geothermal, air source heat pumps, photovoltaics and enhanced building envelopes are key drivers contributing to successfully achieving the energy performance standards.
- **Geothermal should be pursued wherever possible** as it:
  - Improves energy performance;
  - Generates greater utility savings and a shorter payback time; and
  - Enables potential partnership with energy providers.

2) LIFE CYCLE CARBON ASSESSMENT

- Each of the Typologies are **on track to achieve low-embodied carbon values** with a mass timber structure.
- The findings for all three typologies are below the TGS Tier 3 requirement and would **meet the most aggressive Toronto Green Building Council's Zero Carbon Building Design Standard Version 3, June 2022 with a greater than 40% reduction in Embodied Carbon Intensity**.

ENERGY AND COSTING METRICS: KEY CONCLUSIONS

3) TIER 1 VS TIER 3 COST PREMIUM

- On average, the analysis found **a 3% premium to deliver a mass timber building that targets TGS Tier 3** as compared to Tier 1.
- The key capital cost drivers for the Tier 3 premium are:
  - A high-performance enclosure (e.g. triple glazed windows instead of double);
  - Mechanical systems that use electrically-driven heat pumps instead of conventional chillers and gas boilers; and
  - Rooftop PV panels installed as opposed to being PV-ready only.
- Upfront investment to achieve Tier 3 performance standards will minimize the risk associated with future required retrofit and bring on stream energy efficient buildings to support climate action initiatives.

4) MASS TIMBER VS CONCRETE CONSTRUCTION

- Given the current state of the market with inflated costs particularly in form work, rebar and concrete, mass timber construction costs are shown to be less than conventional concrete construction.
- As there is a stabilization of materials (concrete) and form work, it is **anticipated that mass timber construction will be price competitively with conventional construction in concrete and steel.**

5) CONSTRUCTION SCHEDULES

- Discussions with industry leaders and suppliers indicate that **mass timber allows for a significantly reduced construction timing which, can result in financing and capital cost savings** that could add to the cost effectiveness of mass timber construction and become a material of choice for mid-rise developments.
- Mass timber construction requires **an upfront integrated approach to design** - architects, engineers, contractors and manufactures will need to work closely together starting on day one.

NEXT STEPS

Advance the opportunity for a mass timber building at 1113-1114 Dundas Street West by:

- ❑ Advancing the rezoning for a 10-storey mass timber building on the City lands at 1113-1117 Dundas Street West
- ❑ Report on the business case in Q1, 2024 with an opportunity to advance a market offering for a 10-storey storey mass timber residential building at 1113-1114 Dundas Street West
- ❑ Examine opportunities to scale up the mass timber construction on City lands that provides a more sustainable building construction approach.
- ❑ Report back to the Board of Directors in Q1, 2024 with opportunities to deliver mass timber buildings on other City sites.

Thank you

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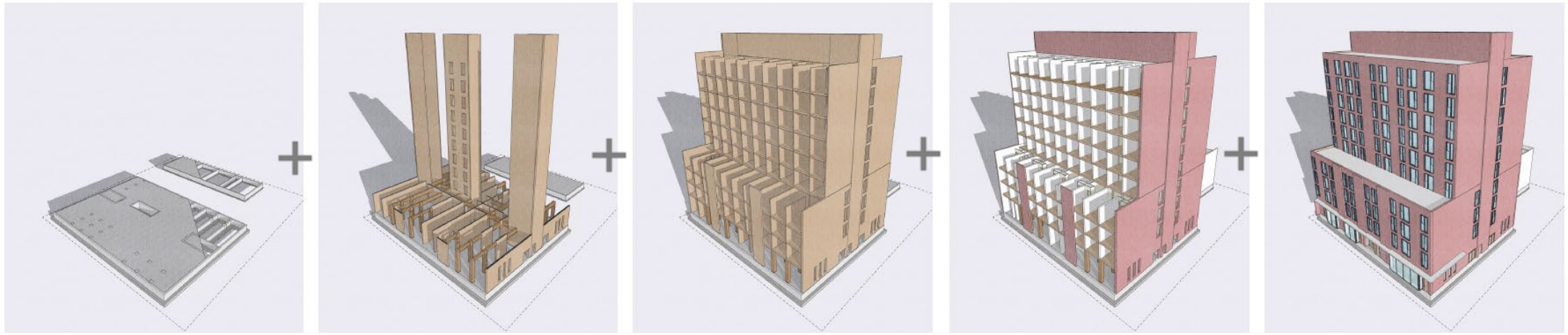
APPENDIX A: DEMONSTRATION PLANS: 10-STOREY TYPOLOGY

10-STOREY
modelled on 1113-1117 Dundas Street

Development Statistics	Structure	Mechanical Systems	Renewable Energy
· A 7,330 m2 residential building · A 10-storey building with non-residential space at grade fronting Dundas Street and a stand-alone row of 2-storey laneway suites · 100 residential units · No below grade parking	CLT walls and floors and glulam beams; concrete will be used for the slab-on-grade foundation; · A compact built form and high-performance envelope; · Minimal façade articulation (i.e. no balconies; minimal step back only at fourth floor); · A low ~35% window-to-wall ratio and triple glazed windows with fiberglass frames and 100 mm of insulation; and · Use of a fibre cement rainscreen cladding, which is durable and non-combustible, but lower in embodied carbon compared to other options.	· Heating and cooling provided by ground source heat pumps (i.e. geo-exchange field); · Heating and cooling will be delivered to the suites via four-pipe fan coil units with integrated high efficiency ERV; · Hot water provided by a separate air source heat pump with some geo-exchange preheat; · Supplemental heating and hot water provided by an electric boiler; and · The only natural gas use proposed is for the emergency generator, which will ensure resilience in the event of an area-wide power outage.	· Renewable energy on the site is proposed using Photovoltaic ("PV") panels on the roof; · Note PV renewable energy is not sufficient to achieve net zero emissions, however it will help to ensure that the proposed building complies with the Greenhouse Gas Intensity requirements of TGS Version 4, Tier 3 and reduce the burden of the building on the grid during peak summer conditions.

3D Massing – Construction Sequence | Building



Concrete foundation walls and slab-on-grade

Ground floor structure of CLT walls and glulam post +beam

CLT stair and elevator shafts

CLT floor and wall structure

Light wood or metal framing for interior partitions and laneway building

Mass timber encapsulation

Enclose building with remaining exterior walls and roofs

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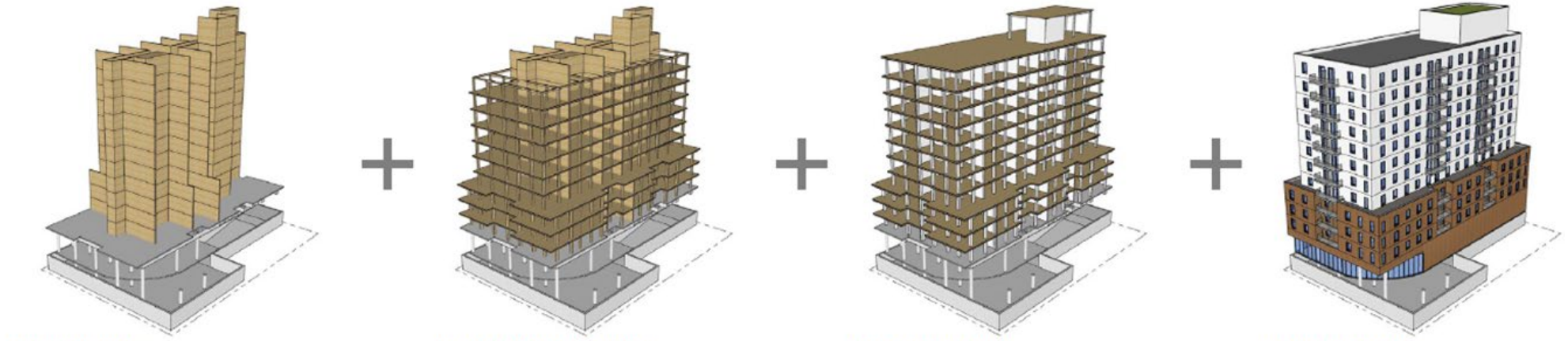
APPENDIX A: DEMONSTRATION PLAN: 12-Storey Typology

12-STOREY *modelled on 1627 Danforth Ave*			
Development Statistics	**Structure**	**Mechanical Systems**	**Renewable Energy**
· A 10,652 m2 residential building · 12-storeys with at grade non-residential space along Danforth Avenue · 121 residential units · One level of underground parkin	Danforth Building A is a hybrid mass timber building consisting of: · Concrete structure underground level up to the second floor; · Concrete structural core - Level P1- 1; · Mass Timber structural core Levels 2 and above; · Above-grade, the podium step back wraps around the entire building, and there are balconies on each façade; and · The enclosure includes more carbon intensive materials, including masonry veneer and aluminium composite cladding, as well as load-bearing steel studs	. The mechanical system uses a central air source heat pump plant to provide heating and cooling water to fan coils throughout the building; and · Backup electric boilers are required to supplement the heating when temperatures drop below -5C.	Renewable energy on the site is proposed using Photovoltaic ("PV") panels on the roof: · A sizable portion of the roof top is utilized for indoor and outdoor amenity and a large area for outdoor mechanical space required for the air source heat pump equipment and potentially a generator for life safety and resilience; and · Amenity and mechanical requirements therefore reduce the roof top area available for PV panels.

3D Massing – Construction Sequence | Building



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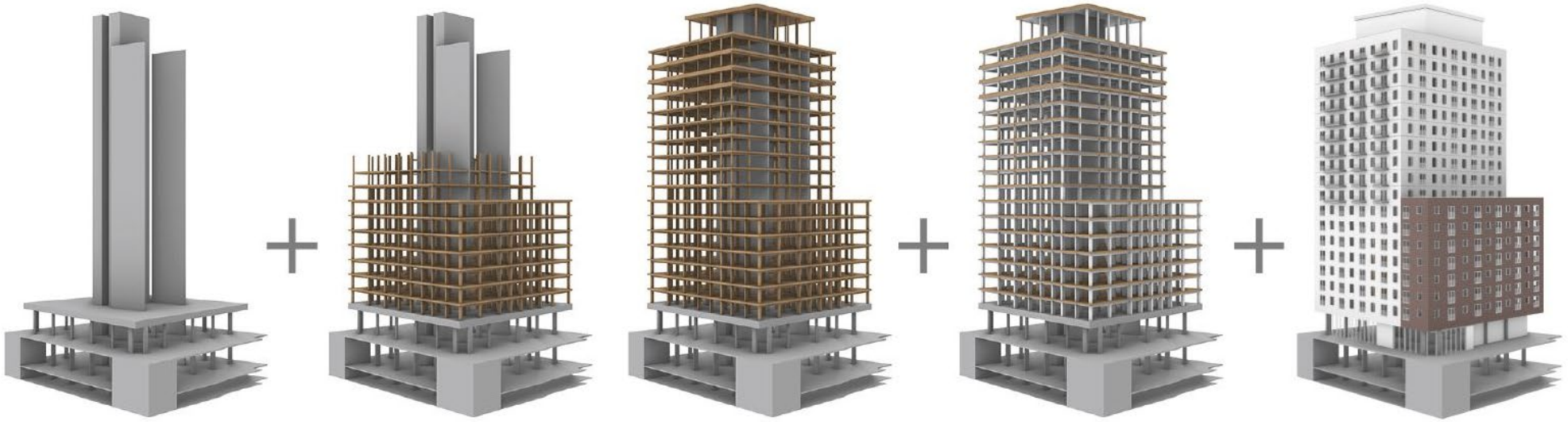
APPENDIX A: DEMONSTRATION PLANS: 18-Storey Typology

18-STOREY *modelled on 150 Queens Wharf Road*			
Development Statistics	**Structure**	**Mechanical Systems**	**Renewable Energy**
· A 15,463 m2 residential building · 18-storey with non-residential space at grade · 177 residential units above grade · Two levels of underground parking	· Hybrid mass timber building with concrete underground parking and building cores to the full height of the building; · Encapsulated mass timber structure to the remaining areas above the second floor; and · 25% window to wall ratio	· Mechanical system uses a central air source heat pump plant to provide heating and cooling water to fan coils throughout the building; · Back up electric boilers are required to supplement the heating output when temperatures drop below -5C; and · The only natural gas use proposed is for the emergency generator, which will ensure resilience in the event of an area-wide power outage.	· Renewable energy on the site is proposed using Photovoltaic ("PV") panels on the roof

3D Massing – Construction Sequence | Building



CONCRETE ELEVATOR & EXIT STAIR CORE
2ND FLOOR TRANSFER SLAB
CONCRETE COLUMNS & FOUNDATION

+ GLU-LAM COLUMNS AND BEAMS
+ CLT FLOOR SLABS

+ GWB ENCAPSULATION

+ GLAZING & CLADDING

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