

# Karen's Place formerly Salus Clementine, Ottawa, Ontario Canada – Project ID: 4518



## 1 Abstract



**4 storey multi-family Building with 42 suites, a community office and a range of interior and exterior amenities (Ottawa, Ontario, Canada)**

### 1.1 Data of building

Year of construction/	2015	<b>Space Heating Demand</b>	<b>15</b> kWh/(m <sup>2</sup> a)
U-value Slab on Grade	0.105 W/(m <sup>2</sup> K)		
U-value Foundation Walls	0.122 W/(m <sup>2</sup> K)	<b>Space Heating Load</b>	11 W/m <sup>2</sup>
U-value Exterior Wall	0.106 W/(m <sup>2</sup> K)	<b>Space Cooling Demand</b>	1 kWh/(m <sup>2</sup> a)
U-value Roof	0.077W/(m <sup>2</sup> K)	<b>Space Cooling Load</b>	4 W/m <sup>2</sup>
U-value Window/	0.8 W/(m <sup>2</sup> K)	<b>Primary Energy Demand</b>	113 kWh/(m <sup>2</sup> a)
U-value Door/	1.3 W/(m <sup>2</sup> K)	<b>Airtightness</b>	0.3 ACH

Heat recovery/	75 % Modelled Efficiency		
Special features/	<ul style="list-style-type: none"> <li>• Subsoil glycol loop installed for future free conditioning of outdoor air through heat exchange with the ground.</li> <li>• Renewable energy conduits are installed for future PV panel installation on the roof</li> </ul>		

## 1.2 Brief Description ...

### **Karen's Place, Passive House, Ottawa, Ontario Canada**

Karen's Place project pioneered a revolution in high-quality social housing in North America. It is a 4 storey building, 42-unit housing project for persons living with severe mental illness and other disabilities. The project is considered a beacon project, because it is:

- The first multi-residential social housing project passive house certified in Canada,
- The first light steel Passive House construction in North America
- It is also believed that it is the first passive house certified MURB in a cold climate

It is located on an infill site; east west oriented; in the Heron park area of Ottawa, on Clementine Blvd hence the initial "Salus Clementine" name. The heron park area is a typical residential neighbourhood, well served by public transportation and centrally located with high walking score. It is considered a prominent location in Ottawa. The project is replacing a former dry cleaning facility that was built on the site many years ago. It was no longer there when the client purchased the land but the soil was contaminated with Poly aromatic Hydrocarbons. The project was an opportunity to turn a contaminated brownfield site into an exemplary affordable housing project for the city.

The building includes a heated basement to accommodate building services and storage; a ground floor with various amenity spaces and 6 accessible barrier free units. The remaining 3 upper floors accommodate 12 units each served by a corridor. The layout of a typical apartment of 40m<sup>2</sup> includes an open concept living space with a sleeping alcove, and a versatile living, dining and kitchen space.

The building site is east / west oriented, drastically minimizing the available winter solar gains, whilst increasing the risk of summer overheating on the glazed East and West facades, and driving up the insulation requirements for opaque elements and glazing. Balancing the building's thermal performance with occupant needs for natural light and visual connections to

the exterior was therefore a key design challenge both for winter and summer conditions.

In reaching the Passive House Standard, this building is using less than one seventh of the heating and cooling energy of an identical building constructed to the current Ontario Building Code – this is drastically less than any other such building in Canada's most populous province. Annual heating cost per 40m<sup>2</sup> apartment is at just \$27/year, using a natural gas boiler, with heat circulated via ventilation air.

Karen's Place was delivered through a construction management contract. The General contractor was brought on board early on to provide pre-construction advisory services during Design. He participated in all project meetings with the Client group and Consultants and provided valuable advice with respect to constructability, cost, scheduling and market conditions Construction Contract documentation and Tendering. His assistance in coordinating the government authorities, utility companies and seeking feedback from subcontractor in particular the Heating Ventilation and Air Conditioning was very helpful. His fluency in German came in handy few times along the journey too!

Karen's Place was funded by Ottawa Salus and all 3 levels of government; the City of Ottawa, and the provincial and federal governments through the Investment in Affordable Housing for Ontario (IAH) Program.

The cost for non-profit to be an early adopter of passive house is not small. PH premiums are real and even if the long term business case is there, the cash flow is not always there and that represents a barrier.

For Karen's Place, the PH premiums were covered through fundraising and incentives that they would not normally tap into. For Ottawa Salus; the client; fundraising in the green community was an unforeseen outcome and building the "the greenest, healthiest home for the most vulnerable" also built a very compelling story for donors.

Karen's Family for example financially supported the project because they strongly believed this would be a great way to celebrate Karen's memory who suffered from mental illness and passed away in 2010.

Salus Clementine opened as Karen's place in 2016, in honour of Karen Nesrallah and best of all 42 formerly homeless people are enjoying a higher level of interior comfort and IAQ than residents of even the most expensive apartments in Canada!

In 2012 when the client started looking at passive house, they were the first looking at something at this scale in this climate.

Today, It is good to see that they have inspired major institutions and more org and municipalities are turning to Passive House buildings in Canada and abroad!



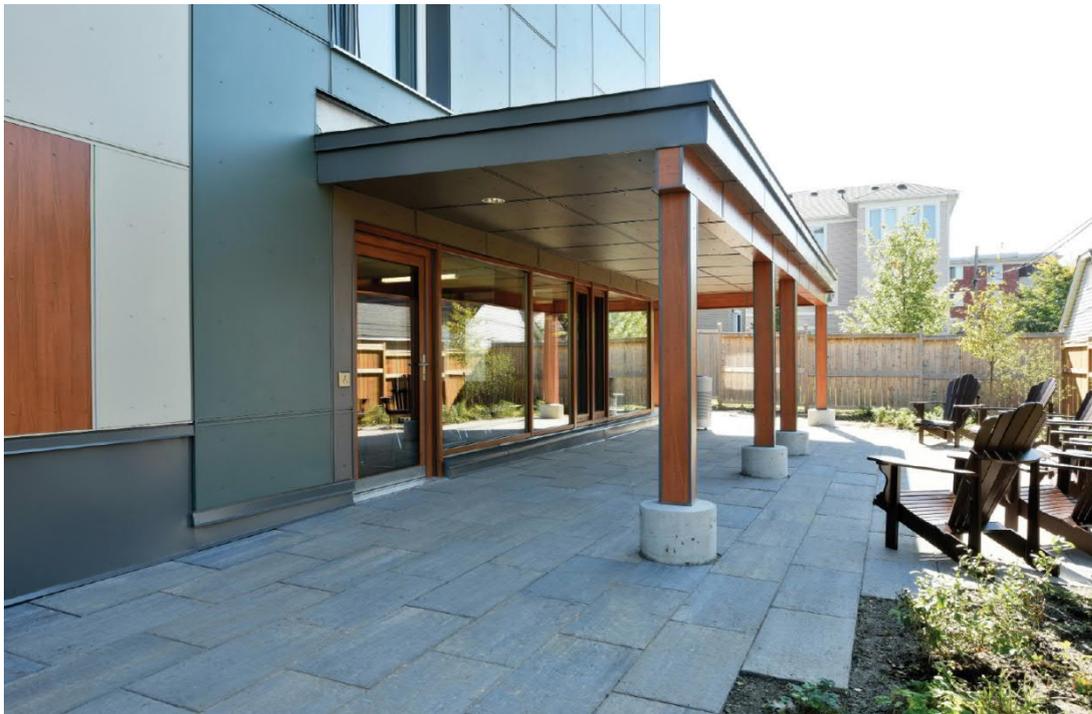
## 2 Views



North / East Perspective



South/ West View



View at backyard west canopy



Common Room arranged with good visual and physical access to the garden on the west and South side of the building



"I feel like a royal king. ... I've been here three weeks and this place has already changed my life."

View at typical barrier free (wheelchair accessible) apartment



View at typical apartment

### 3 Building Section

Since the building is located on a seismic zone with poor soils condition mainly silt and clay and a high water table, only two viable options were considered: light steel construction or wood frame construction.

A light steel structure of light gauge steel studs and joists sitting on the tray slab foundation and foundation concrete walls around the perimeter was selected for the project for easier fire proofing, lower weight on the foundations, stronger seismic resistance, possibility of a panelized system and other economic advantages.



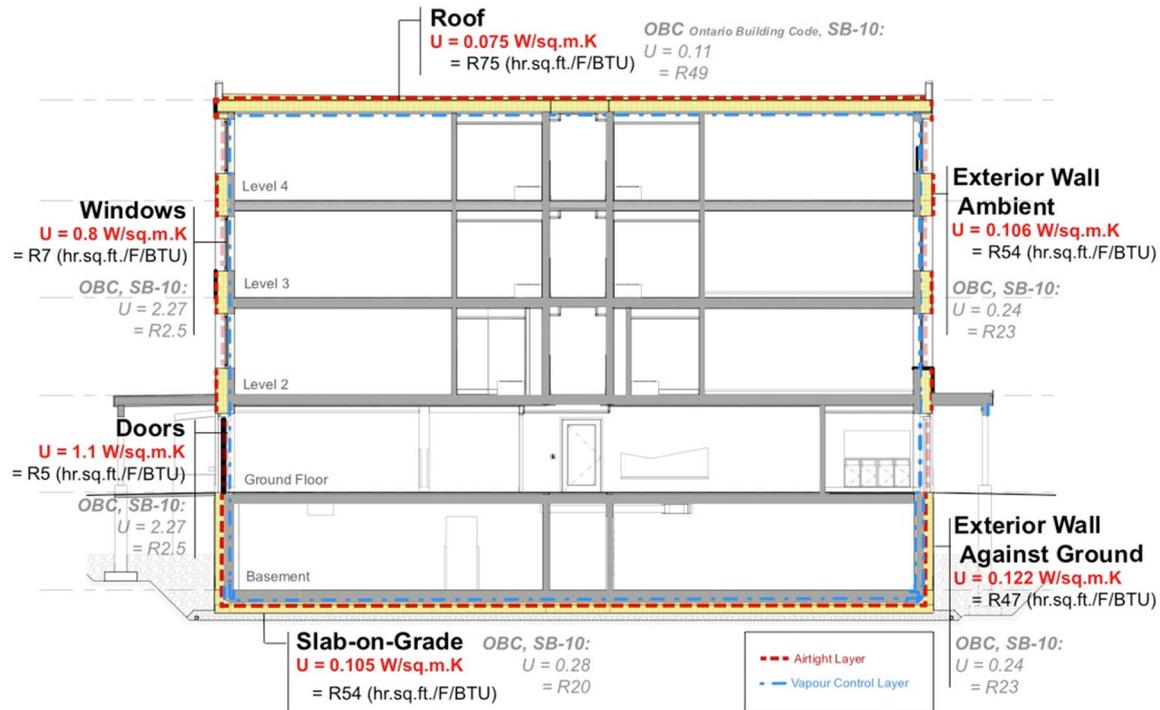
For the thermal envelope, external continuous structural insulated panels (SIPs) were installed outboard of the light steel structure. This decision was made rather quickly as it allowed the use of locally manufactured SIPs for affordability, speed of construction and a panelized system.

SIPs were installed on the below grade foundation walls, the exterior walls and the roof system. In fact the entire building enclosure is made of SIPs with the exception of the slab itself. All the SIPs are made of neopor insulation.



To meet the passivhaus standard, building envelope performance had to be on average doubled compared to the minimum prescriptive requirement of the Ontario building Code.

All control layers thermal, air and vapour are continuous around the thermal envelope.



## 4 Floor Plans

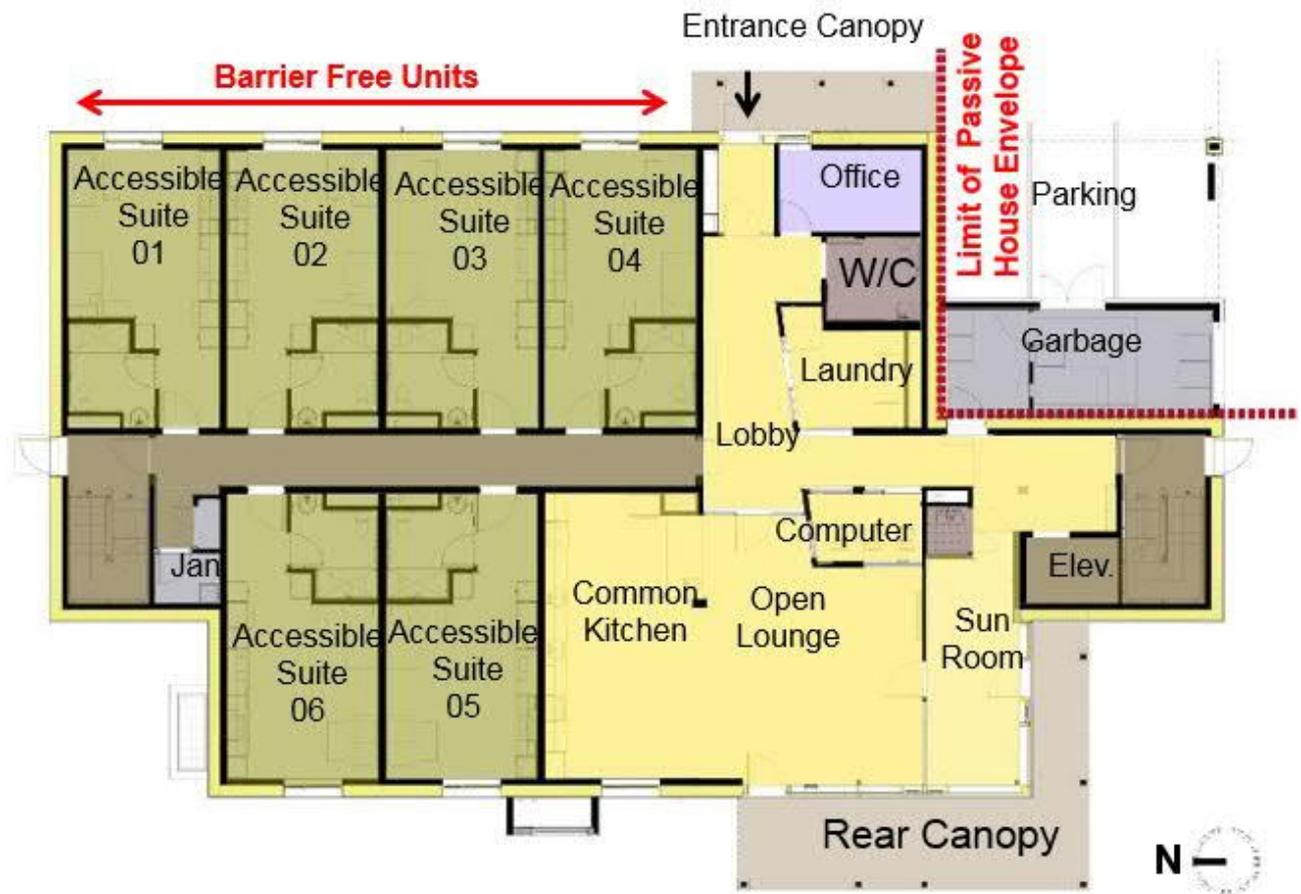
### 4.1 Location On The Site and Ground Floor Plan

The setbacks required by the zoning bylaw dictated the volume of the building. The site is approximately 1,285 m<sup>2</sup> which made it fairly tight for a 42 unit apartment building spread over 4 storeys. “Cosmetic” setbacks were avoided to optimize the area / volume ratio and eliminate shape related thermal bridging. Other architectural strategies were used to fit into the neighbourhood look and feel such as the scale of the exterior siding and pattern of colours...



On the ground floor, the accessible main entrance off Clementine boulevard, leads to the main lobby. One of the main stairs is located next to the Lobby in order to encourage stair use. Resident common spaces include an open concept kitchen, a dining room, an open lounge and a computer room. They are arranged with good visual and physical access to the garden on the west and south side of the building. The recycling and garbage rooms are located for easy pick up from Clementine Boulevard. They are not included in our thermal envelope.

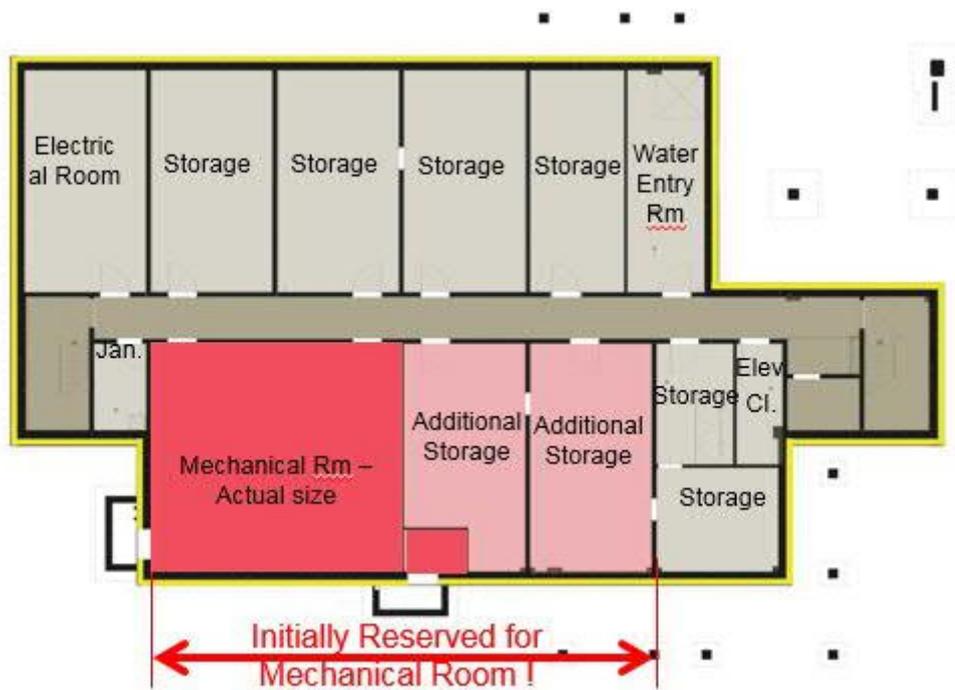
The balance of the ground floor contains six barrier free apartments for people living with physical disabilities.



## 4.2 Basement

The heated basement accommodates the building service spaces and storage rooms. In the early design stages, the mechanical designer requested the full western part of the basement to be reserved for mechanical.

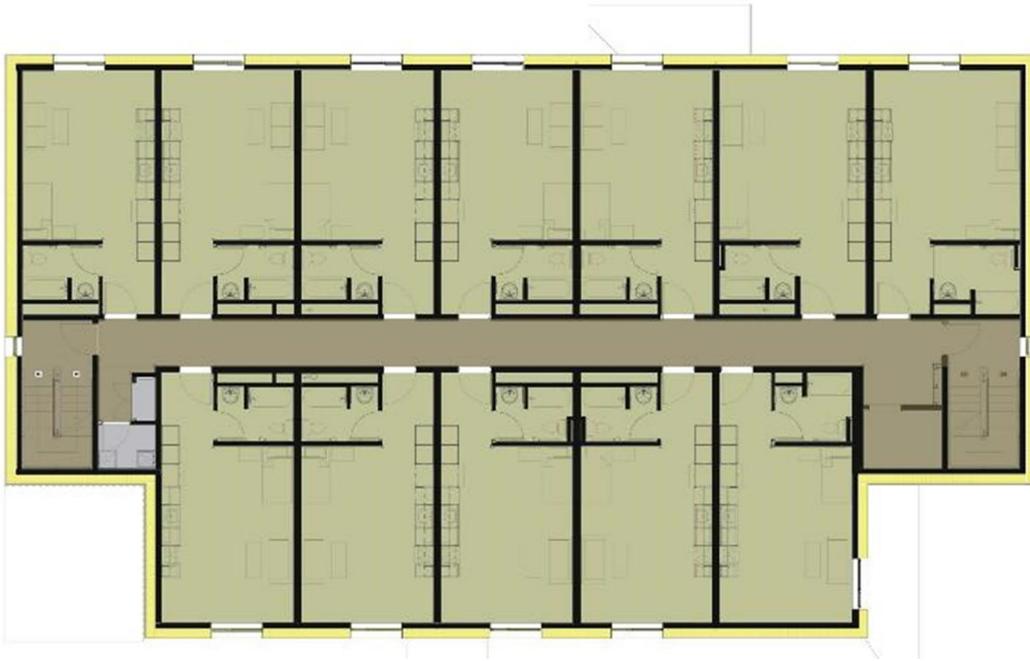
By improving our envelope, cooling and heating loads were reduced drastically and the mechanical room also shrunk its size to less than half.



### 4.3 Typical Upper Floor Plan

Each upper floor accommodates 12 units served by one main corridor. A great effort was made to minimize circulation and service spaces. The layout of each unit provides a single; open concept; living space with a sleeping alcove, and a versatile living, dining and kitchen space.

Meeting the occupant needs for natural light and visual connections to the exterior was of prime importance for this project



Karen's Place, Ground Floor Plan

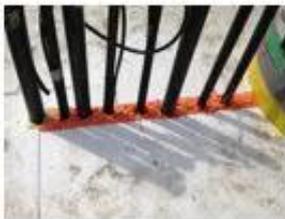
## **5 Construction Details of The Envelope and Passive House Technology**

### **5.1 Construction Including Insulation of The Floor Slab With Connection Points Of Exterior Foundation Walls**

For the basement slab on grade, a tray slab foundation was used to guarantee a thermal bridge free foundation system and optimize the construction scheduling and labour costs. The slab on grade assembly consists of 330mm of concrete on 305mm of insulation expanded polystyrene (EPS) all sitting on granular and creating a superior thermal mass. The insulation is made of 2 sub-layers layers of EPS the first one 230mm thick, the second 75mm thick with a vapour retarder membrane in between. The 75mm sub-layer protects the vapour barrier from the risk of puncture from the concrete reinforcing. The tray slab foundation system eliminates thermal bridging and saves on formwork.



A special care was given at all service penetrations at the basement slab to maintain the continuity of all control layers.



All service penetrations are spray foamed in place



15mil Stego vapor barrier is applied over the entire slab



15mil Stego vapor barrier to extend min 12" beyond the edge elements for a future good lap with the foundation wall airtight layer



All service penetrations are meticulously taped for state of the art airtightness

The concrete slab was poured in one (1) single pour.



Snake chains and reinforcing steel in place, ready for basement slab concrete pour.



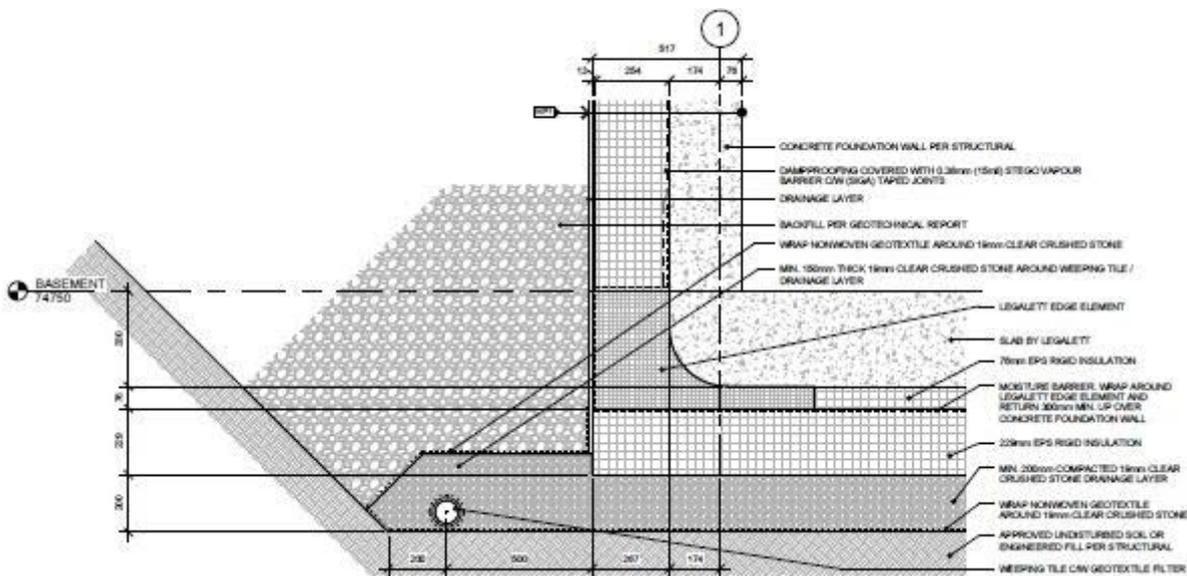
**Cool fact: Number and types of penetrations**

- 1 Elevator shaft size 2660x1931 (8'-9" x 6'-4")
- 2 Cisterns 1,473 mm (4'-10") diameter
- 172 Base plate anchors
- 10 Plumbing stacks
- 14 Drains
- 3 Hydro stacks

180m3 of concrete are poured in 4:30 hours  
Slab was kept wet for 3 days in order to reach design strengths and to prevent cracking. No Saw cutting is allowed



Concrete boom pump in place – concrete pour starts.



**Concrete slab on grade build-up:**

<b>Slab on Grade</b>	330mm Reinforced Concrete 75mm EPS insulation (AMVIC ES-37) 15 mil polyethylene membrane 230 mm EPS insulation (AMVIC ES-37) Granular B	<b>U-value</b> 0.105 W/(m²K)
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The foundation walls are made of poured concrete and below grade SIPs made of monolithic slabs of 250mm neopor with magnesia board on the exterior side to protect the insulation after backfill.

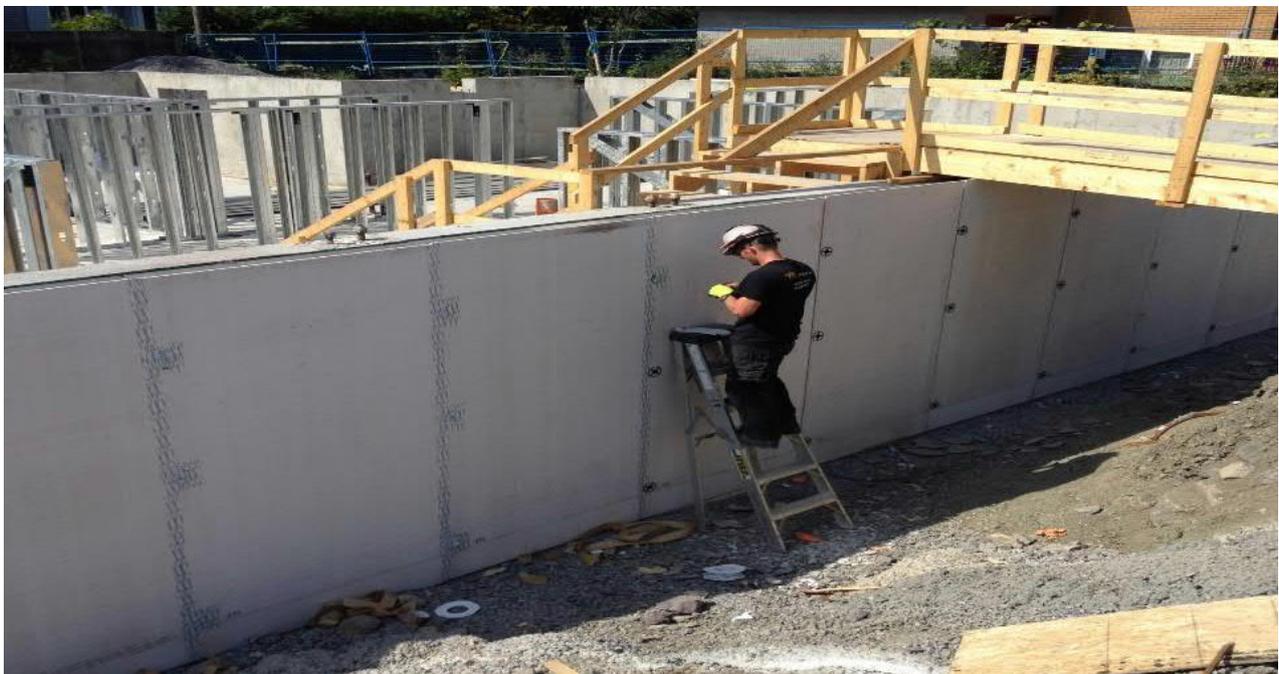
The magnesia board helps resist the soil pressure on the insulation and is protected with a continuous drainage layer.

The magnesia board on the below grade panels is offset by approx. 100mm from the edge of the foam so there is a lap where the panels came together and where the fasteners connect the panel back to the foundations.

By lapping the panelling this way it allows to reduce the number of the thermal bridge free EJOT fasteners used to connect the SIPs to the foundation wall and still get a strong connection of the panels to the building.  
 The below grade SIPs sit on the tray slab edge elements so the thermal layer is continuous underneath the slab.



All below ground SIP joints were taped before the installation of the drainage board.



The SIPs were protected with a continuous drainage board prior to backfill



**Concrete foundation wall build-up:**

<b>Foundation Wall</b>	250mm Reinforced Concrete 15 mil polyethylene membrane Below grade SIP (254mm neopor and 13mm magnesia board) Drainage board	U-value 0.122 W/(m <sup>2</sup> K)
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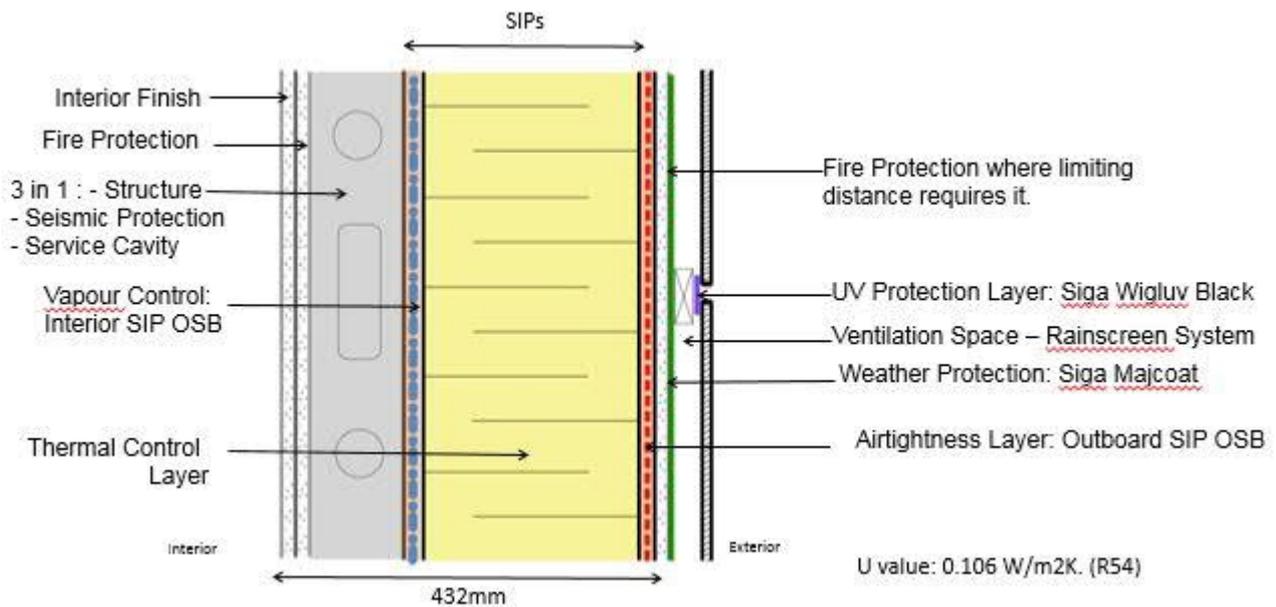
## 5.2 Construction Including Insulation of Exterior Walls And Key Connections

To meet the passive house space heating demand performance target of 15 kWh/ m<sup>2</sup>a, 300mm of continuous insulation were needed around the exterior walls.

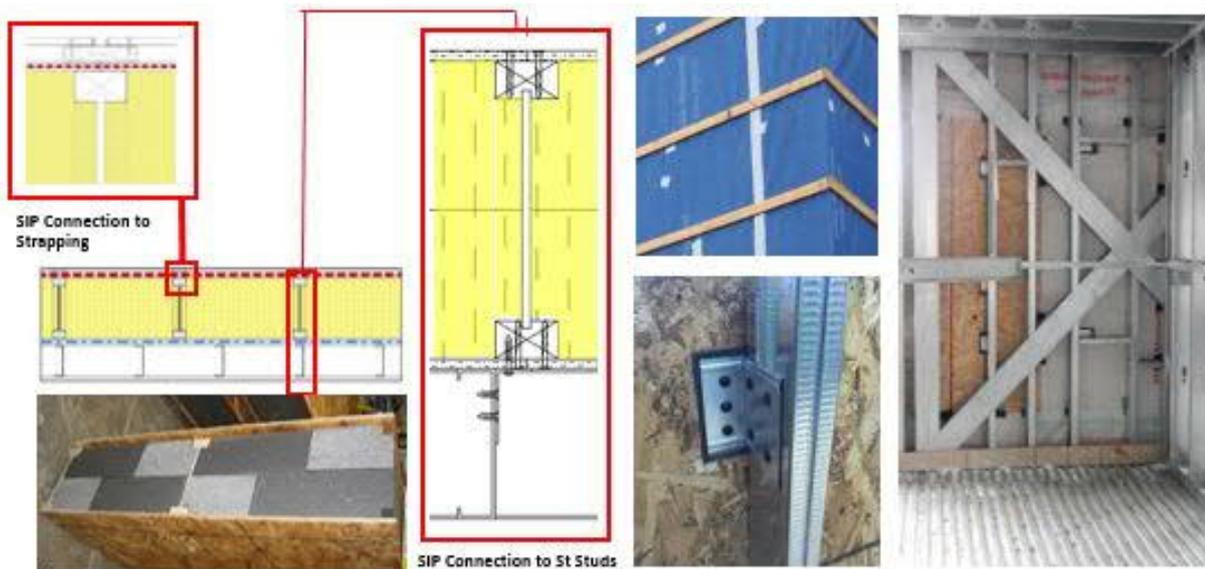
With light steel construction, insulation in the steel cavity was not considered. All the insulation was planned outboard of the light steel structure.

The typical wall assembly was planned as follows from inside to outside: drywall finish, then fire protection layer as required then comes our structure, service cavity and steel bracing all 3 in 1 layer. Then comes the SIPs including the vapour control layer, insulation and the airtight layer. More exterior grade drywall for fire protection is installed as required then the weather barrier, an air gap/ ventilated rain screen and finally, and finally the cladding system.

This exterior wall assembly provides a U value of 0.106 W/m<sup>2</sup>K. and it creates a good service cavity that meets structural requirements, Seismic protection and Fire protection.



The above grade SIPs are not conventional SIPs. They had to accommodate a solid connection to the steel framing on one side and support the cladding on the other side and that's where the I-joists came into play.



The SIP's are sheathed both sides with 11mm thick OSB with I joists every 610mm on centre.

The 300mm neopor core is made of multiple slabs installed with staggered joints to account for risks of shrinkage and avoid large gaps in the insulation if shrinkage should occur due to temperature differential between interior and exterior surface. Multiple small gaps will avoid direct paths between interior and exterior.

The wall panels are pre-manufactured in standard 1220mm x 2440mm elements.

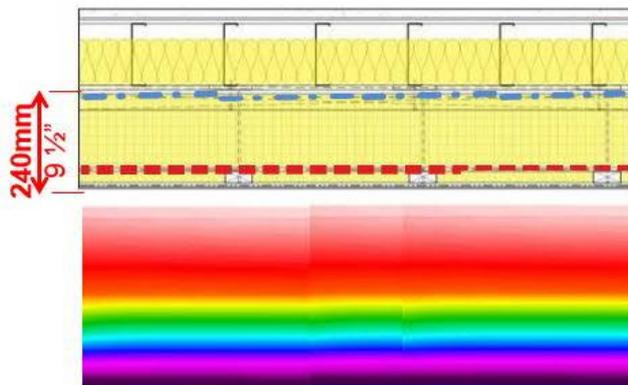
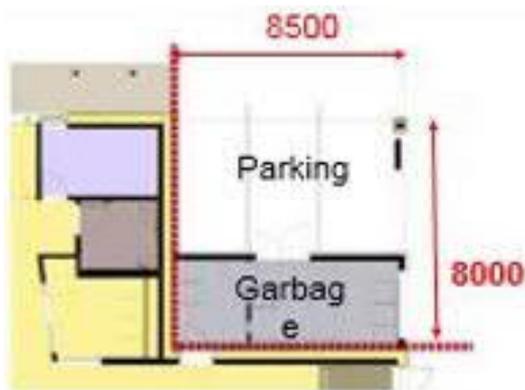
They are non structural. They are just taking the wind load and some seismic loads.

The SIPs are connected to the steel studs with stiffeners and fasteners through the I-joists on one side and the steel stud on the other side.

<b>Exterior Wall</b>	16mm Gypsum Board 152mm light steel studs @ 400 O/C SIP including 11mm OSB, 300mm neopor c/w I Joist @ 610mm O/C, 11mm OSB Ventilated cavity Exterior cladding	U-value 0.106 W/(m <sup>2</sup> K)
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### Construction: Thermal Bridging Reduction Strategies

The garbage room and parking intruding the thermal envelope created some challenges with steel structural elements going through the thermal envelope in addition to the increased transmission heat losses generated by the exposed insulated ceiling above.



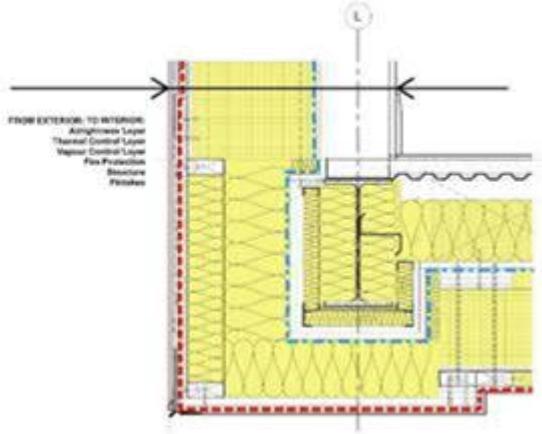
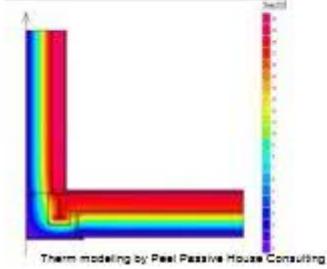
#### Floor Assembly Above Parking and Garbage Room:

- Interior Finish
- Floor Topping and Acoustic Mat
- St Deck
- St Joist with **Mineral Wool Batt Insulation**
- Fire Protection
- Vapour Control Layers
- 240mm **Rigid Insulation**
- Air Control Layers
- Air /Service cavity
- Exterior finish

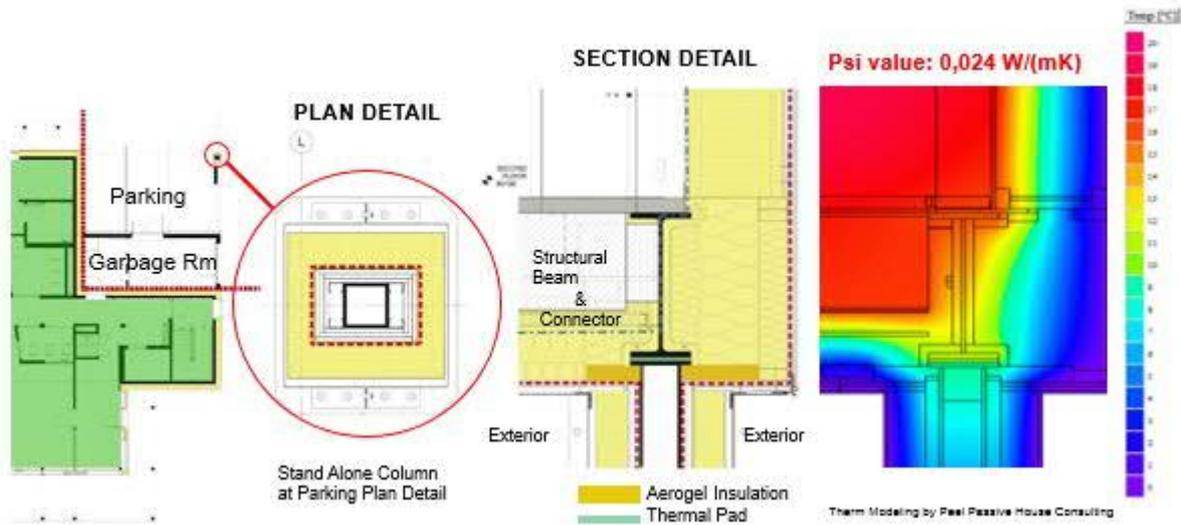
	U-Value
	W/(m <sup>2</sup> K)
FLOOR ASSEMBLY ABOVE PARKING F3	0.107
FLOOR ASSEMBLY ABOVE GARBAGE F4	0.107

The parking and garbage room intrusion also generated few structural thermal bridges, caused by protrusions of highly conductive structural steel through the thermal envelope. Additional insulation at protruding structural elements was installed to minimize heat leaks at columns and beams.

- Section Detail at beam supporting wall above parking **Psi value: -0,020 W/(mK)**  
**Credit to our Energy Budget**
- **Negative thermal bridging** ✓



Aerogel Insulation was strategically used where available thickness for insulation is limited to keep the effects of thermal bridges at a minimum.



Stainless steel fasteners and thermal breaks (Fabreeka thermal pads) were incorporated at critical column/ beam connections to minimize the transmission through the steel elements and keep the dew point outside the structure.



### 5.3 Construction Including Insulation of Roof with Key Connection Points

The roof is made of; interior to exterior; a layer of gypsum board, a 38mm service cavity, Vapour control layer Siga Majvest, the structural insulated panels with 300mm neopor insulation, 28mm air cavity insulated only around the perimeter, 127mm EPS tapered insulation, a recovery board with mod bit roofing

The roof structural insulated panels are pre-manufactured in standard 2440mm x 4880mm elements. They were indeed structural so they weren't just sitting on some other steel structure.

The roof panels are built like a floor system using I-joist and the space between the I-joists is filled with neopor insulation.



<b>Roof</b>	16mm gypsum board 38mm service cavity Vapour control layer Siga Majvest SIP including 11mm OSB, 300mm neopor c/w I Joist @ 610mm O/C, 11mm OSB 28mm air cavity insulated only around the perimeter 127mm EPS tapered insulation 6 mm recovery board & mod bit roofing	0.077 W/(m²K)
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### 5.4 Description of The Window Sections

Windows are sized for 3 purposes: optimizing light, the quality of view and balancing heat losses and heat gains.

In a cold climate like Ottawa, windows are a problem because their U-Value is less than quarter the U Value of the wall and they have to do everything the wall is doing by handling water/ air / vapour and heat.

Selecting passive house appropriate doors, windows, glazing and curtain wall system for this project was critical.

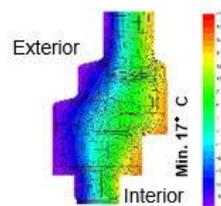
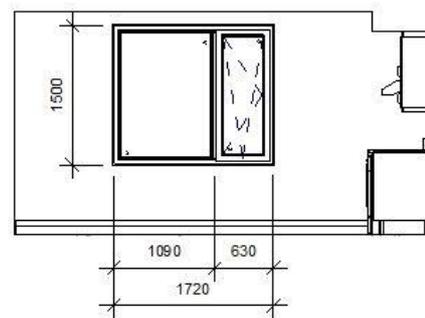
Triple glazed Gaulhofer Passive house certified windows were specified and installed in the suites and window heads are raised close to the ceiling to maximize light penetration.

<b>Window</b>	Passive House Certified Gaulhofer Energato 8000 uPVC window frame with Gaulhofer Arcon triple glazed unit (g value 0.51 and U value 0.53 W/m <sup>2</sup> K)	0.8 W/(m <sup>2</sup> K)
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Each window is comprised of 2 window sashes. The smaller sash is a tilt and turn. The wider sash is fixed on the ground floor and fully operable at the upper floors for cleaning purposes and in an effort to avoid thermal bridges inherent to the installation of roof anchors for window cleaning. Window guards were installed for security reasons. All window operable sashes are equipped with a micro-switch connected to the Building Automation System to shut off the mechanical ventilation, heating/cooling in the room when a window is open.

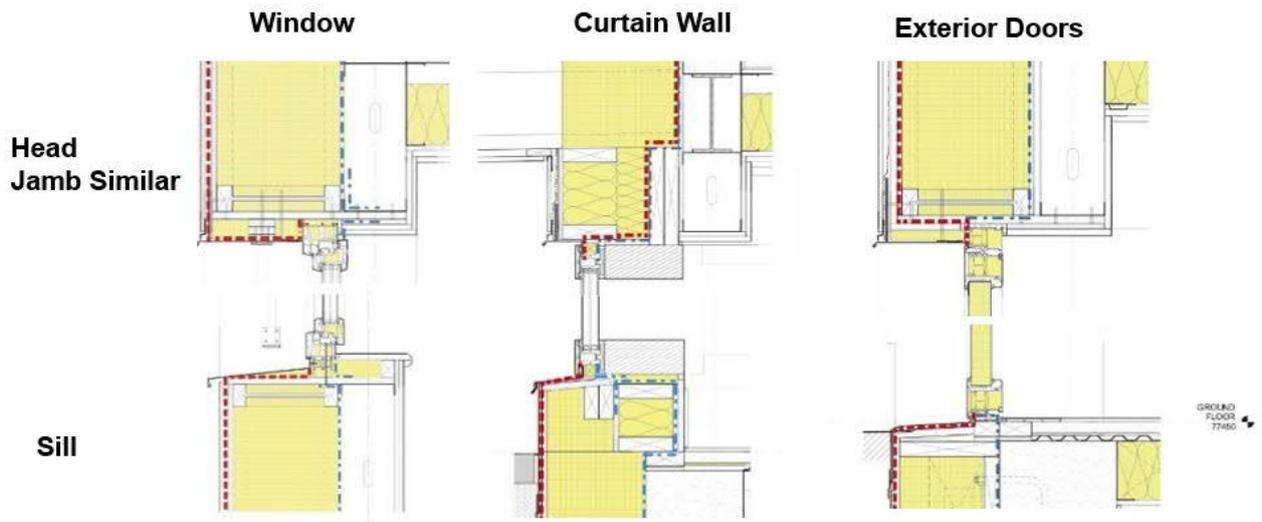


U=0.8W/(m<sup>2</sup>K), R7



(x)3 times more efficient than conventional double glazed windows

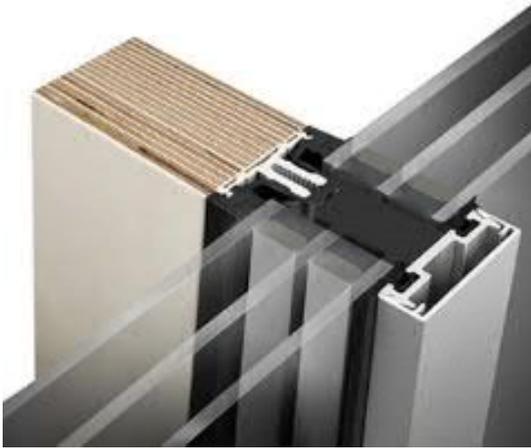
Installation details ensured continuity of the different control layers between window and wall including thermal control, vapour control indicated below with the dashed blue line and airtightness indicated below with the dashed red line.



By following these simple passive House course fundamentals, window, doors and curtain wall Installation details were optimized.



Raico THERM+ 56 H-I, Passive House Certified timber curtain wall with a U- value of 0.8 W/ m<sup>2</sup>K was used around the common rooms with St Gobain triple glazed units (g-value 0.5, Ug= 0.53 W/m<sup>2</sup>K)



Gaulhofer Select Ass 1700/1800 exterior doors with a U value of 1.1W/m<sup>2</sup>K were installed with thermally broken thresholds.



Thermo-profile underneath doors

## 6 Description of The Airtight Envelope

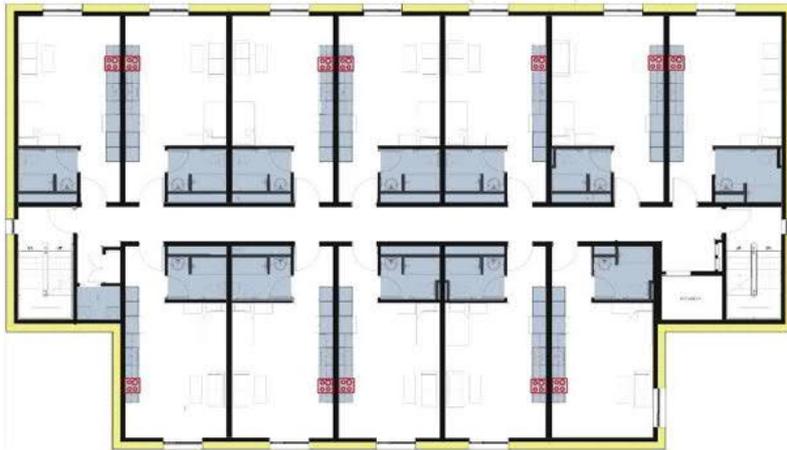
Considering the size of Karen's Place, with an internal volume of 5,770 m<sup>3</sup>, the Passive House Institute recommends meeting the air permeability criterion  $q < 0.6 \text{ m}^3/\text{h}\cdot\text{m}^2$  of external surface area at a differential pressure of 50 Pa and not just the air change rate of 0.6 ACH<sub>50</sub>.

Large buildings typically have a better surface-to-volume ratio than smaller buildings and therefore they meet the air change rate of 0.6 ACH<sub>50</sub> more easily without necessarily being radically airtight. This is why the Passive House Institute introduced the optional criterion of air permeability  $q_{50} < 0.6 \text{ m}^3/\text{h}\cdot\text{m}^2$  for large buildings with a conditioned volume greater than 4000 m<sup>3</sup>.

For Karen's Place the  $q_{50} < 0.6 \text{ m}^3/\text{h}\cdot\text{m}^2$  criteria is equivalent to an air change rate of 0.3 ACH<sub>50</sub>. This was a real challenge that was embraced very early on by the design and construction teams. The airtightness strategy was pretty simple. The primary airtight layer was the outboard OSB of the prefabricated SIPS for above grade walls and roof. All joints are taped.

Below grade, a 15mil high density vapour barrier with taped joints is installed in the tray slab on grade between the 2 layers of insulation and is continuous along the foundation walls and taped to the inboard OSB for vapour control and outboard OSB for airtightness continuity.

Air tightness at Structural penetrations is maintained by taping to the continuous steel structural element. Any fasteners, nail penetration is prepped with nail seal tape to maintain airtightness. The number of plumbing fixtures installed along the exterior walls is minimized. All stoves and cooktops have recirculating vent hoods with a charcoal and an aluminum reusable filter to eliminate additional openings in the passive house envelope and increased risk of air leakage.



Air tightness at service penetrations and electrical conduits is maintained via gaskets and tape.



All service penetrations are meticulously taped for state of the art airtightness



air tight installation at the Steel brackets with Siga Nail Seal Tape



Dryer exhaust damper

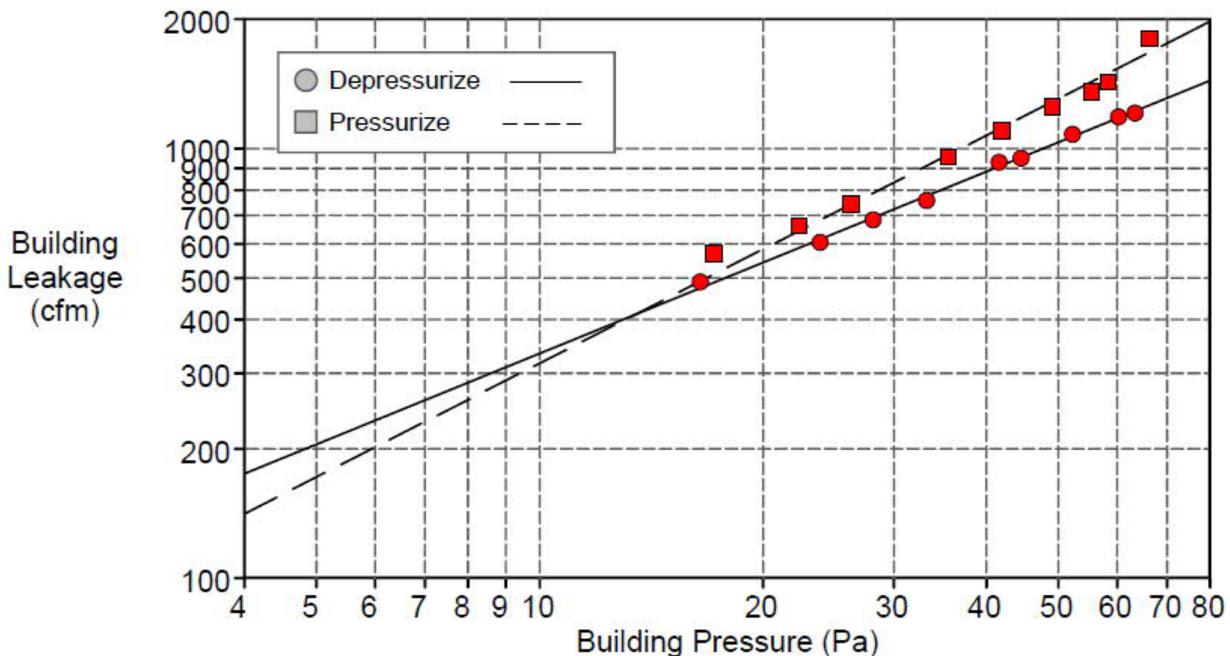


The final blower door test results are as follows:

Depressurization: 0.30 ACH<sub>50</sub> | Pressurization 0.34 ACH<sub>50</sub> | Average: 0.32 ACH<sub>50</sub>

### Test Results at 50 Pascals:

	<u>Depressurization</u>	<u>Pressurization</u>	<u>Average</u>
V50: cfm Airflow	1009 (+/- 1.6 %)	1168 (+/- 3.4 %)	1089
n50: 1/h Air Change Rate	0.30	0.34	0.32
w50: cfm/m <sup>2</sup> Floor Area	0.48	0.56	0.52
q50: cfm/m <sup>2</sup> Envelope Area	0.35	0.41	0.38



The results indicate greater infiltration under pressurization than under depressurization. This is mainly due to infiltrations through the dryer flaps and the quality of the 11mm OSB. Under depressurization, the weather barrier is like vacuumed into the outer OSB of the SIPs, which helps to seal small infiltration points into the OSB. Under pressurization we have the opposite effect.

However with 0.3 ACH<sub>50</sub> the envelope of Karen's Place is certainly super airtight which makes the space super comfortable, draft free and effectively mechanically ventilated for optimum thermal comfort and indoor air quality.

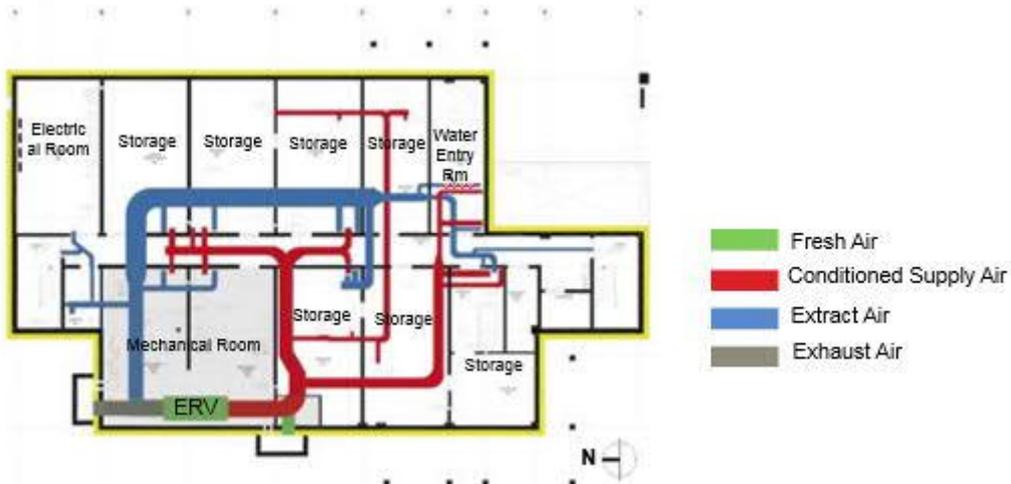
## 7. Description of the Planning of the Ventilation, Heating and Cooling

A centralized ventilation system with delivery of heating and cooling through ventilation air was the selected strategy for Karen's place for several reasons including:

- minimize penetrations in the envelope,
- minimize maintenance cost in the long term,
- simplify the building automation system.

A central dual core ERV (Energy Recovery Ventilator) is placed in the basement mechanical room and air is circulated in the building at a set temperature through the duct

system. The ducts get smaller as we move up through the building. We start with a duct section of 600 x250mm at the basement transition to a 250 x 150mm vertical duct to the various floors and end up with a 150mm diameter supply ducts in the suites.



Basement – ductwork plan



View at completed mechanical room

For the ventilation unit, the mechanical designer specified the Tempeff RG 1200 with a dual core energy recovery and a claimed 90-95% heat recovery efficiency and 70% moisture recovery. The dual core energy recovery features are very attractive because:

- 1- it eliminates the need for pre-heat of outdoor air prior to entering the unit as long as outdoor air temperature does not go below -30degC which is the case for Ottawa. In cold temperatures, frost may form on the exhaust side of the heat exchanger of single core HRV or ERVs. This dramatically reduces the heat recovery

effectiveness and drives up operating costs and risks of failures. With the dual core design and alternating heat exchanges every 60 seconds between the 2 cores, frost doesn't have a chance to form, and one heat exchanger is always delivering conditioned air to the space.

If exhaust air and supply air are above set point, unit will revert to free cooling mode. No energy recovery is taking place.

- 2- high moisture recovery potential that maintains comfortable RH levels indoors throughout the year and saves on humidification/ de-humidification systems. In fact none are provided for this building.

The heat recovery efficiency of the unit was assessed by the Passive House Institute according to their testing protocol and a 20% penalty was applied to the claimed heat recovery efficiency for PHPP modelling.

<b>Energy Recovery Ventilator</b>	Tempeff RGSP 2000 modelled based on a heat recovery efficiency of 75% and electric efficiency of 0.44Wh/m <sup>3</sup>	HXE 75% 0.44Wh/m <sup>3</sup>
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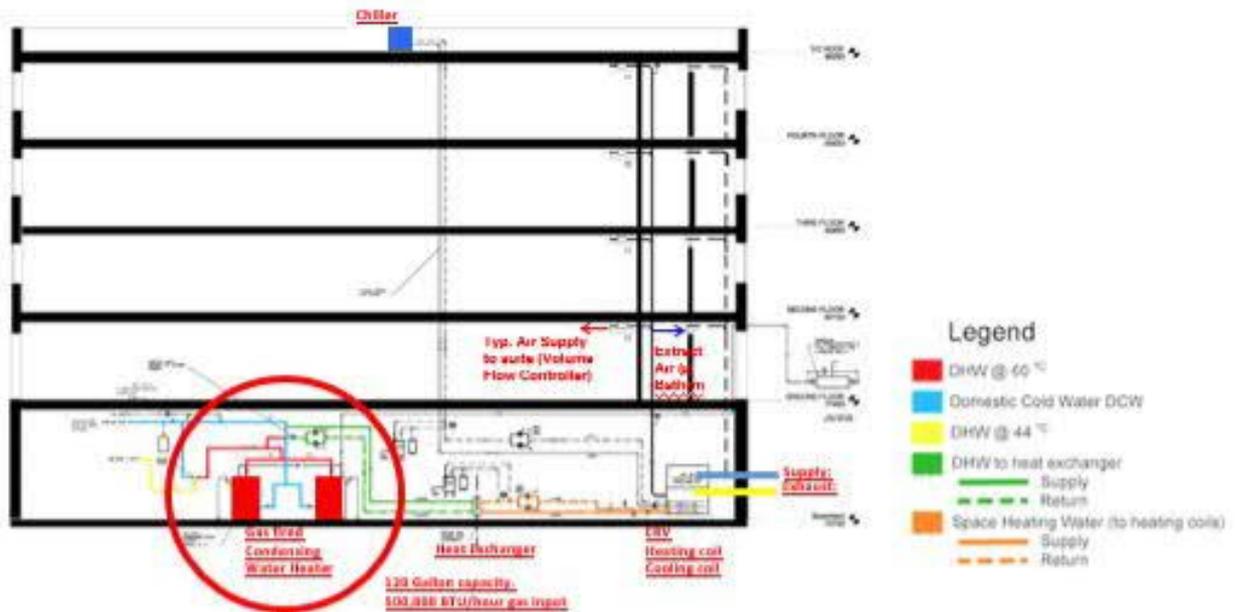
**Heating Strategy:**

Two (2) gas fired 120 gallon condensing water heaters with a 96% efficiency provides the heating needed for the domestic hot water and space heating. Each water heater is sized for meet approx 60% of the total heating water requirement. They work on alternating mode and serve as a back up to each other.

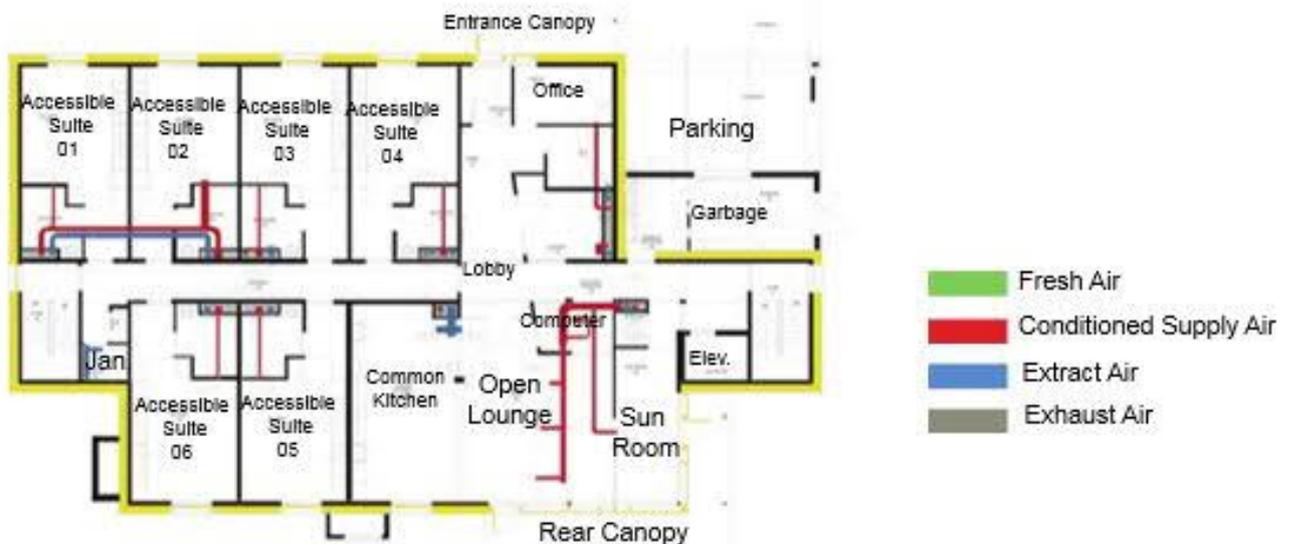
The space heating temperature is pre-set centrally. It can be adjusted between 20°C and 25°C in the winter. The system is sized to provide all of the heating.

**Cooling Strategy:**

An outdoor chiller is located on the roof. It provides cooling again to a pre-set and adjustable point between 20°C and 25°C. The system is also designed to provide all of the cooling.



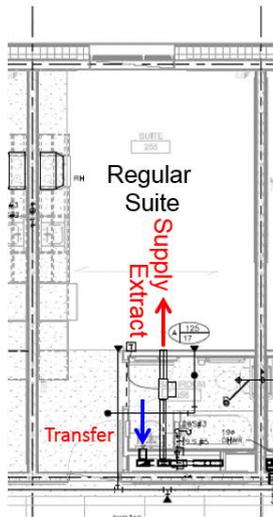
Conditioned ventilation air is supplied to the ground floor and upper floors through vertical shafts (shaded in grey on the floor plan below). A constant pre-set ventilation level is delivered to all suites to ensure the air in the room is renewed with fresh air every 3 hours.



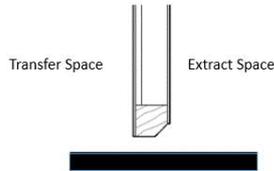
Ground Floor – ductwork plan

Within each suite the ventilation air is supplied to the combined living spaces transferred through the suite entry and the door undercut to the bathroom where it is extracted.

Suite ventilation can be adjusted by 30% by the resident to increase fresh air flow, or the amount of heating or cooling to each apartment. Small silencers are installed at each suite supply & extract to ensure a noise level not greater than 25dB.



**SUITE:**  
 Supply air 52 m<sup>3</sup>/person/hr  
 (17.7 cfm/person)  
 Extract air 52 m<sup>3</sup>/hr @  
 bathroom

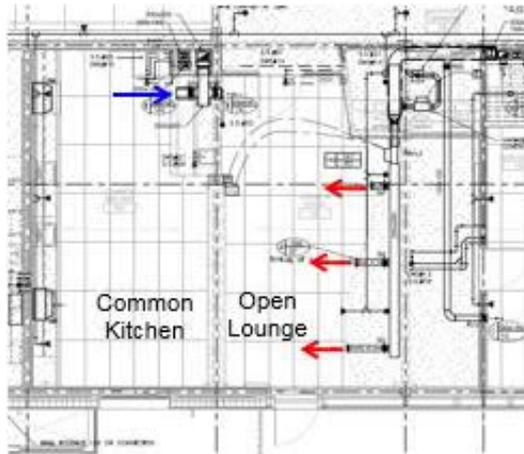


To give more flexibility to the occupants and accommodate thermal comfort differences between tenants, a small 300W electric baseboard heater and a Haiku ceiling fan are installed in the apartments.

Haiku fans are the most efficient in the world. They cost less than a dollar a year to operate, 12 times more efficient than their ENERGY STAR equivalent and they are super quiet.



In the common room, ventilation air is supplied and exhausted within the same room.



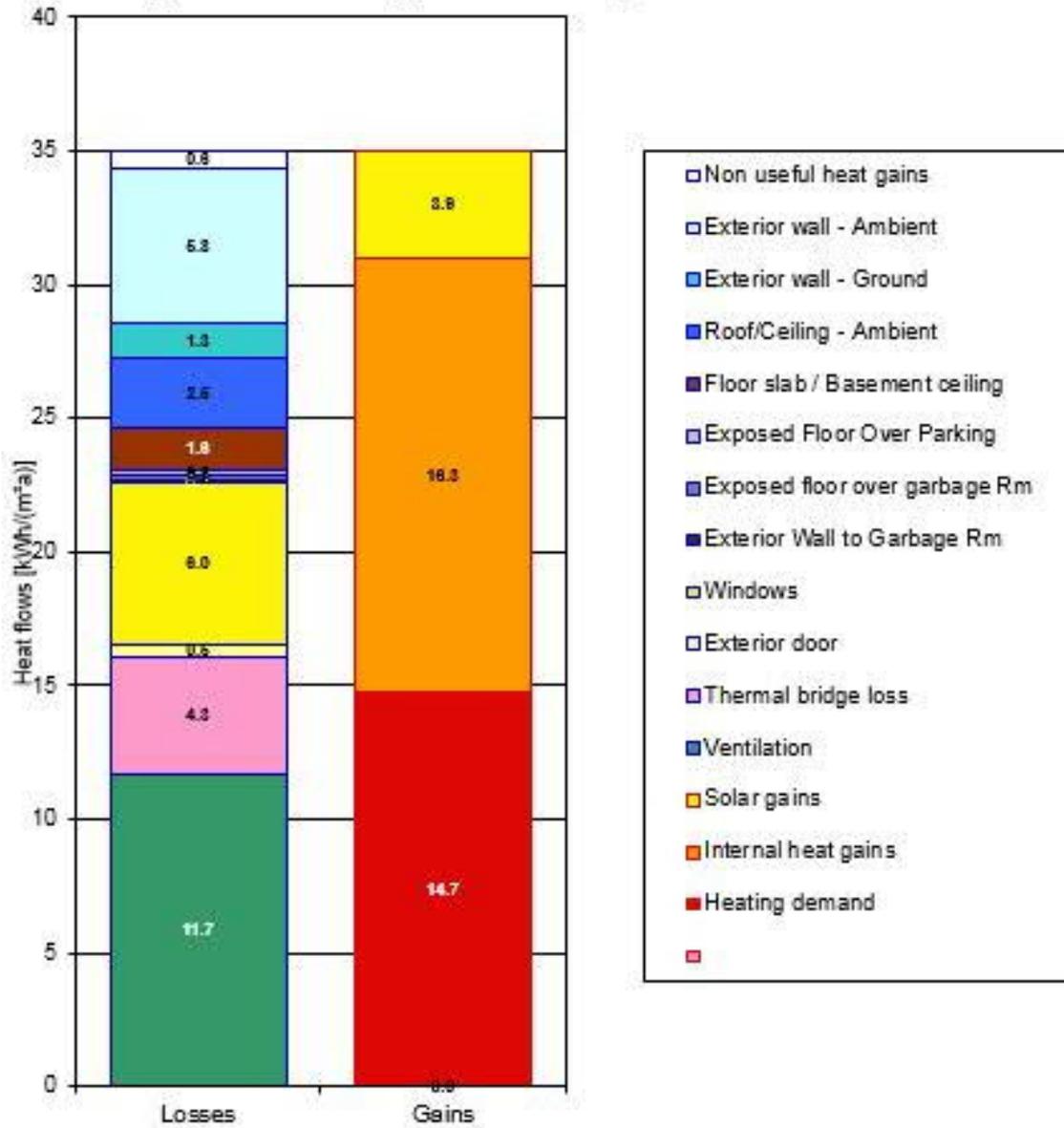
The garbage room located outside the passive house envelope is ventilated directly to the exterior via an exhaust fan running continuously with an odor Control and a programmable spray system. The spray system allow immediate odour neutralization and a biodegradation of the gases. The electrical consumption of the fan and spray system together is minimal and was only included in the PHPP auxiliary electricity calculation.

## 8. Brief Documentation of Important PHPP Results

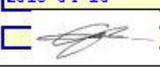
The Energy balance for heating for Karen's Place illustrates how with the density of apartments, number of appliances / m<sup>2</sup> and the additional loads from the elevator, computer room, create high internal heat gains (in orange), much greater than the heating demand and more than 4 times greater than the available solar gains for this project. More than 60% of the heat losses through the windows is compensated for by the solar gains through the windows.

The final space heating demand of 15 kWh/m<sup>2</sup>a accounts for less than 50% of the total transmission and ventilation losses thanks to the internal and solar heat gains.

### Energy balance heating (annual method)



Important PHPP results are summarized below.

<b>Passive House verification</b>						
						
Building:	Salus Clementine Multi- Unit Apartment Building					
Street:	1486 - 1494 Clementine Boulevard					
Postcode / City:	Ottawa					
Country:	Canada					
Building type:	Multiresidential apartment					
Climate:	Ottawa	Altitude of building site (m above sea level):	77			
Home owner / Client:	Ottawa Salus					
Street:	2000 Scott Street					
Postcode/City:	K1Z 6T2, Ottawa, ON					
Architecture:	Sonia Zouari, CSV Architects					
Street:	Suite 402, 1066 Somerset Street West					
Postcode / City:	K1Y 4T3, Ottawa					
Mechanical system:	Smith & Andersen, Michael St Louis, Randa Khartabil					
Street:	Suite 530, 1600 Carling Avenue					
Postcode / City:	K1Z 1B3, Ottawa					
Year of construction:	2015	Interior temperature winter:	20.0	°C	Enclosed volume $V_e$ m <sup>3</sup> :	8643.5
No. of dwelling units:	42	Interior temperature summer:	25.0	°C	Mechanical cooling:	x
No. of occupants:	42.0	Internal heat sources winter:	3.1	W/m <sup>2</sup>		
Spec. capacity:	60	Wh/K per m <sup>2</sup> TFA	Glto summer:	3.6	W/m <sup>2</sup>	
<b>Specific building demands with reference to the treated floor area</b>						
	Treated floor area	2082.2	m <sup>2</sup>		<b>Requirements</b>	<b>Fulfilled?*</b>
Space heating	Heating demand	15	kWh/(m <sup>2</sup> a)		15 kWh/(m <sup>2</sup> a)	yes
	Heating load	11	W/m <sup>2</sup>		10 W/m <sup>2</sup>	-
Space cooling	Overall spec. space cooling demand	1	kWh/(m <sup>2</sup> a)		18 kWh/(m <sup>2</sup> a)	yes
	Cooling load	4	W/m <sup>2</sup>		-	-
	Frequency of overheating (> 25 °C)		%		-	-
Primary energy	Heating, cooling, auxiliary electricity, dehumidification, DHW, lighting, electrical appliances	113	kWh/(m <sup>2</sup> a)		120 kWh/(m <sup>2</sup> a)	yes
	DHW, space heating and auxiliary electricity	59	kWh/(m <sup>2</sup> a)		-	-
	Specific primary energy reduction through solar electricity		kWh/(m <sup>2</sup> a)		-	-
Airtightness	Pressurization test result n <sub>50</sub>	0.3	1/h		0.6 1/h	yes
* empty field: data missing; '-': no requirement						
Passive House?						yes
We confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this application.				Name:	PHPP Version 8.5	
				Surname:	Issued on:	
				Company:	Signature:	
				Peel Passive House Co		

## **9. Construction Costs**

Construction costs are at CAD\$ 203,000 per apartment or CAD\$ 2,731 / m<sup>2</sup> based on a total building area of 3,122 m<sup>2</sup>. This translates into a construction cost premium of 17% based on conventional affordable housing construction costs generally in the range of CAD\$ 2045 / m<sup>2</sup> to CAD\$ 2,637 / m<sup>2</sup> according to the 2018 Canadian Cost Guide developed by Altus Group.

The passive house premium for better building envelope; better windows, more thermal insulation, better airtightness and a ventilation system with heat recovery in addition to all the risks associated with innovation and early adoption of passive house such as the skill shortage and lack of passive house certified components; are real. However the increased useful life of the envelope, the radical reductions in operating and maintenance costs for the service life of the building largely outweigh the cost premium in the initial capital cost and the Client acknowledged that very early on.

## **10. Operational Costs**

The Heating costs Karen's Place are estimated at CAD\$ 27/ apartment / year based on the price of gaz estimated a 5 cents/kWh