1.1 BUILDING DESCRIPTION:

Location: 2958 Princess Ave, North Vancouver, BC
Building Type: Single Family Residential - Retrofit
Certification Type: EnerPHit
Year of Construction: 2017
Gross Floor Area: 326 m2

1.2 Brief Description of Construction Task

The original building design was complicated with three different roof lines, a turret sticking out from the centre of the main living area, two slopes (butterfly wings) on either side and a flat (skirt) roof around the perimeter and over the garage. These features required some back and forth with the Designer to address thermal bridges and envelope between the many junctions.

Princess Avenue EnerPHit house is a two storey single family house with a secondary unit and an attached garage outside the principal envelope. This home is the first Passive House EnerPHit in Canada and has been certified by the German Passive House Institute. The living and dining area faces east with mountain view. Existing trees near the south facing wall pose a problem with maximizing solar heat gain along with the large windows facing east. HRV exhaust ducts had been placed along these windows to help mitigate the comfort criterion. With the window install having psi value of 0.013 W/(mK), it has helped mitigate thermal bridging. There are no electric baseboard heaters. Owner had no issue with comfort so there was no need for dehumidification and portable heaters. The character of the building strikes a touch of modern style architecture. The use of natural stone and horizontal sidings fits well with the neighboring houses. The building is situated on a sloping site. Although this is two storey house, the front of the building presents a bungalow look while the double storey rear competes well with the tall surrounding trees towards the rear of the property. There are two flat roofs. Smaller flat roof over the main roof was provided to break a long straight roof long while contributing to over height interior ceiling.

1.3 Responsible project participants Designer Consultant: Czar Villanueva Certifying Body: Peel Passive house	Passive House Database ID: 5158

2.0 PROJECT DESCRIPTION:

KEY FEATURES:

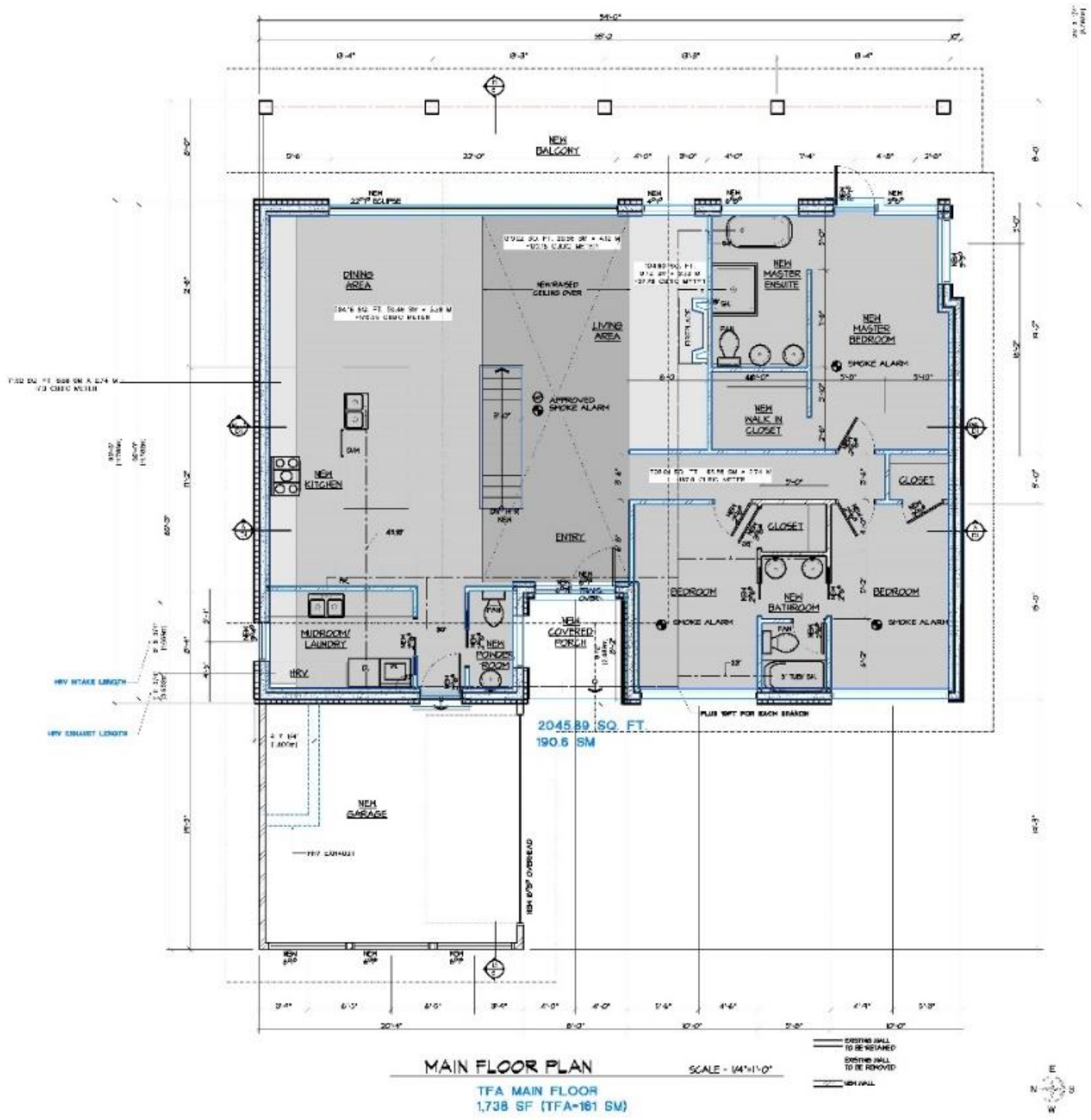
- PHPP annual heating demand: 18[Kwh/(m2a)]
- PHPP Heating Load: 9 W/(m2)
- PHPP primary energy demand: 55 [Kwh/(m2a)]
- Floor Slab 0.137 W/(m2 K)
- Walls Above Grade 0.122 W/(m2 K)
- Walls Below Grade 0.107 W/(m2 K)
- Basement Ceiling 0.114 W/(m2 K)
- Roof 0.127 W/(m2 K)
- Windows/Doors 0.85 W/(m2 K)
- Heat Recovery Ventilator Effective heat recovery: 83.4%
- Pressure test n50 0.51h-1

Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	322.0				
Space heating	Heating demand	kWh/(m²a)	18	≤	25	-	yes
	Heating load	W/m²	9	≤	-	-	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	-	≤	-	-	-
	Cooling load	W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C)	%	0	≤	10		yes
	Frequency excessively high humidity (> 12 g/kg)	%	0	≤	20		yes
Airtightness	Pressurization test result n_{50}	1/h	0.5	≤	1.0		yes
Minimum thermal protection	fulfilled?	yes/no			yes		yes
	Smallest temperature factor $f_{Rsi=0.25\ m²K/W}$	-	-	≥	0.70		-
	highest U-value	W/(m²K)	0.82	≤	0.85		yes
	highest U-value	W/(m²K)	-	≤	1.00		-
	highest U-value	W/(m²K)	0.11	≤	1.10		yes
	highest U-value	W/(m²K)	0.14	≤	0.65		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	124	≤	-		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	55	≤	64	64	yes
	Generation of renewable energy	kWh/(m²a)	0	≥	-	-	

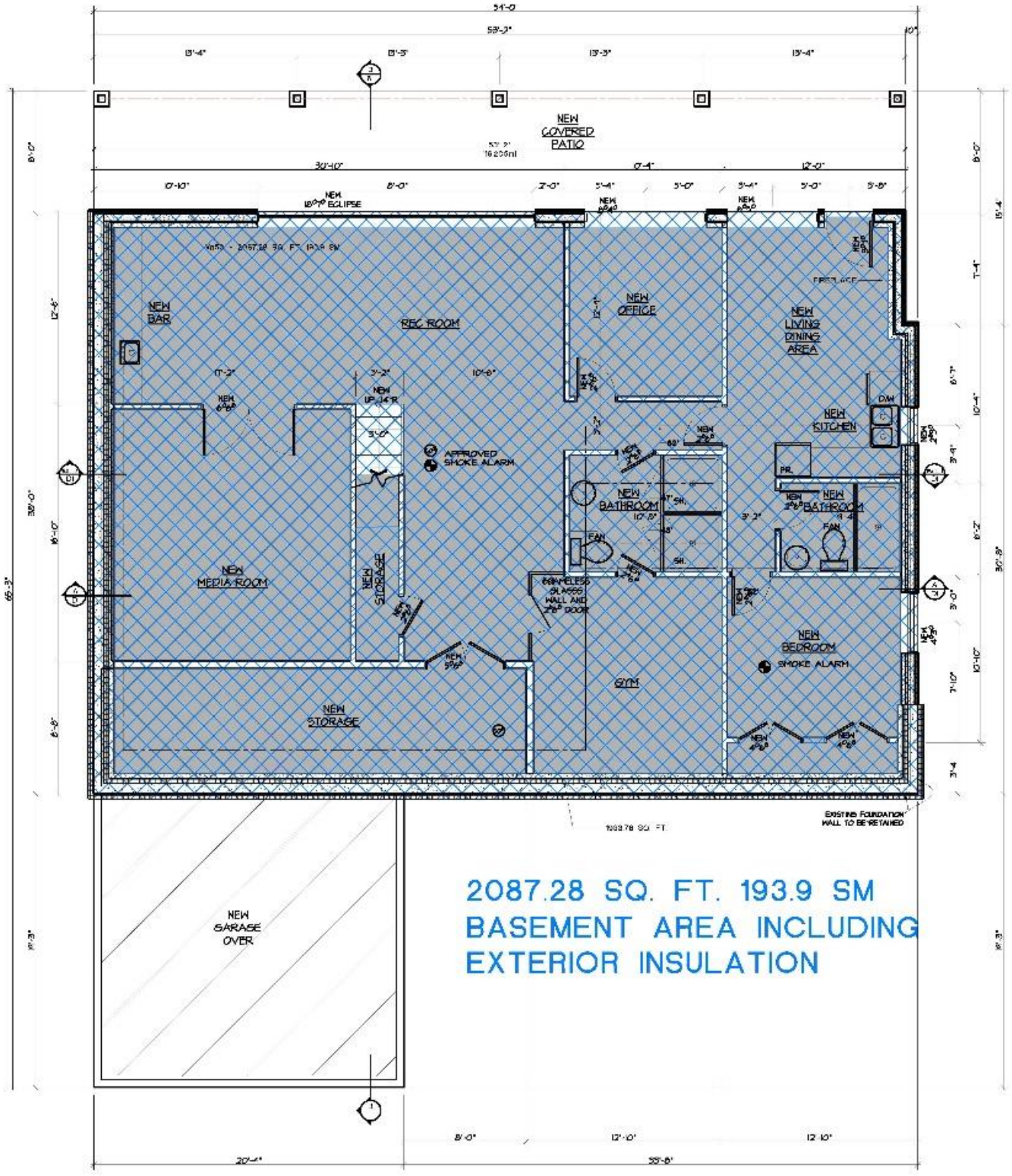
[2] Empty field: Data missing; '-': No requirement

3.0 Drawings



MAIN FLOOR PLAN SCALE - 1/4"=1'-0"

TFA MAIN FLOOR
1,738 SF (TFA=161 SM)

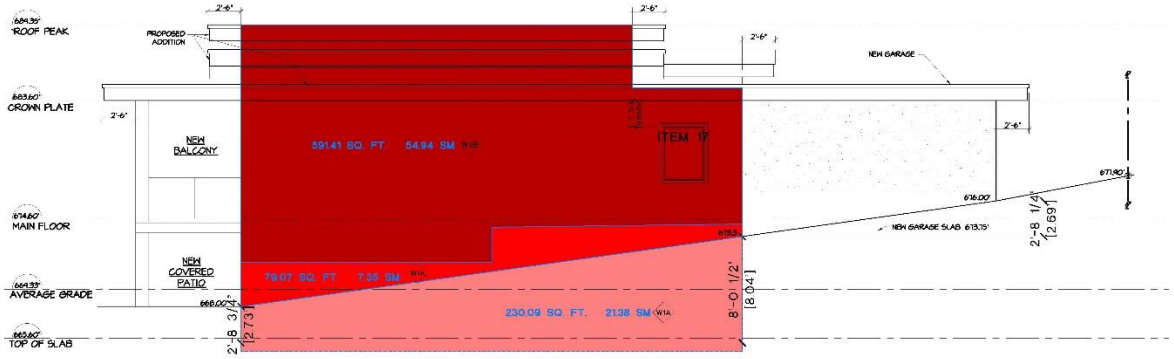


BASEMENT FLOOR PLAN

SCALE - 1/4"=1'-0"

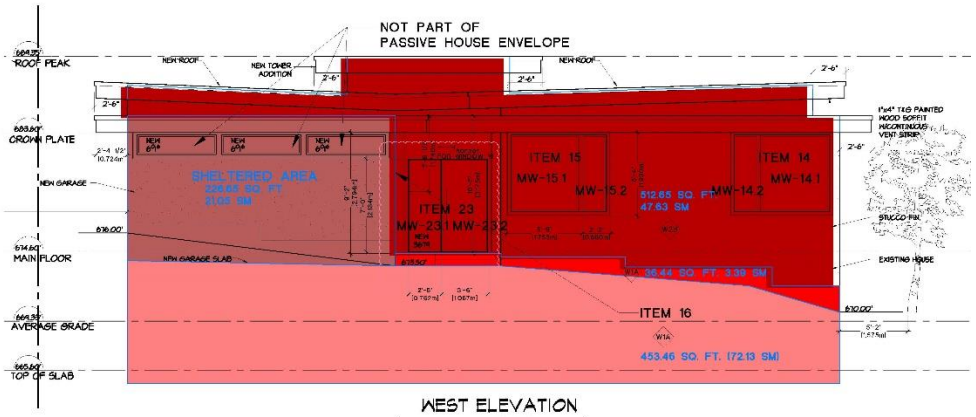
TFA BASEMENT
1757.39 SQ. FT. (163.27 SM)

EXISTING WALL TO BE RETAINED
EXISTING WALL TO BE REMOVED
NEW WALL



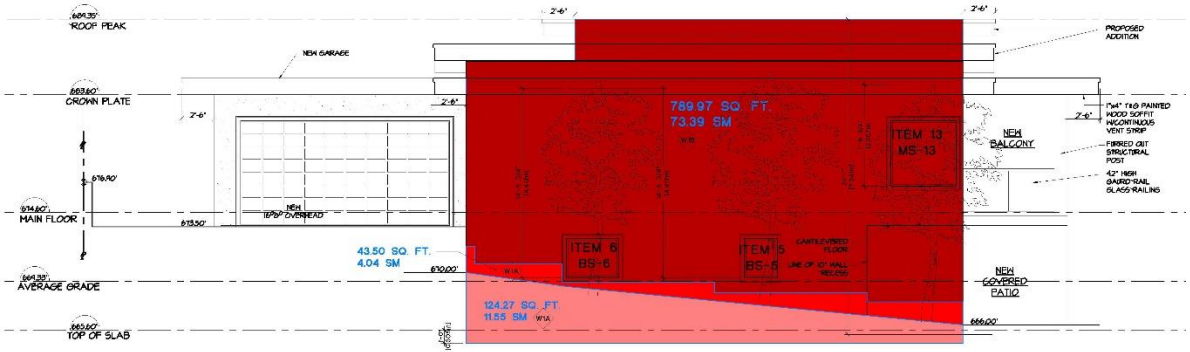
NORTH ELEVATION

SCALE - 1/4"=1'-0"



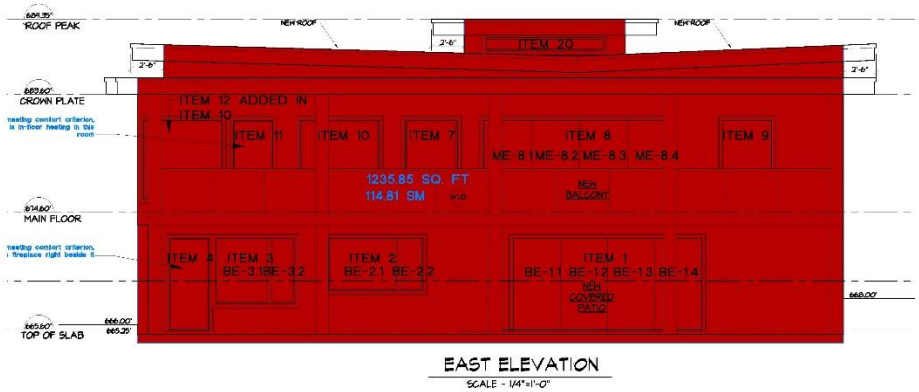
WEST ELEVATION

SCALE - 1/4"=1'-0"



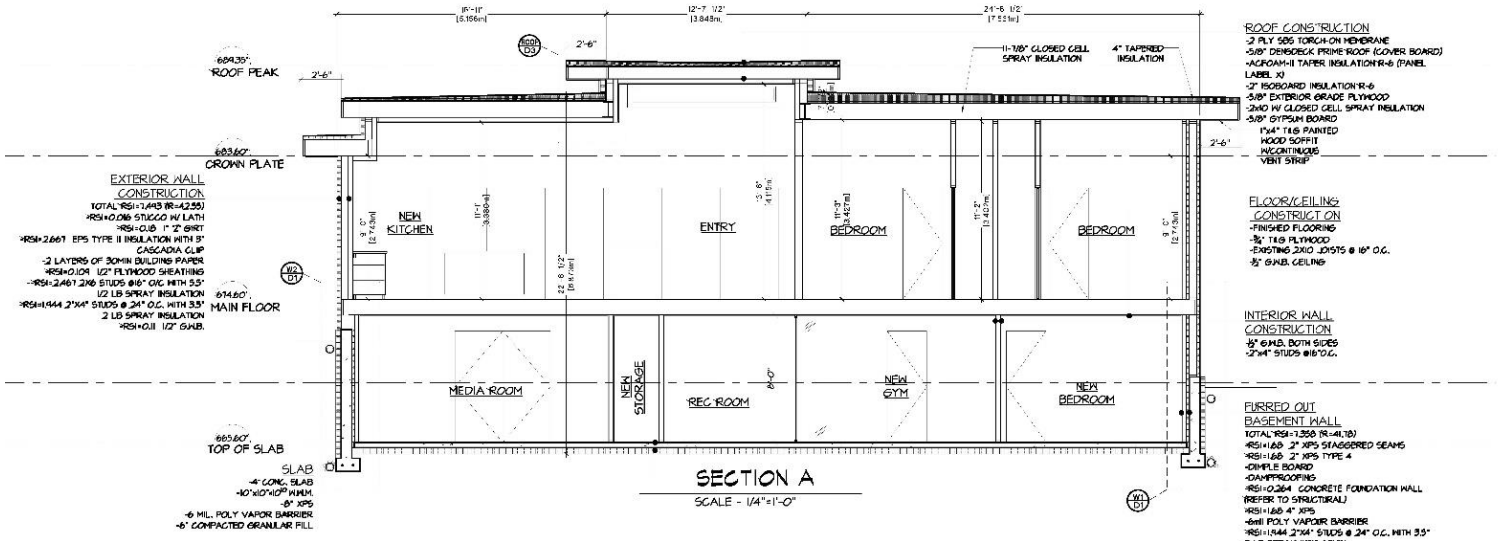
SOUTH ELEVATION

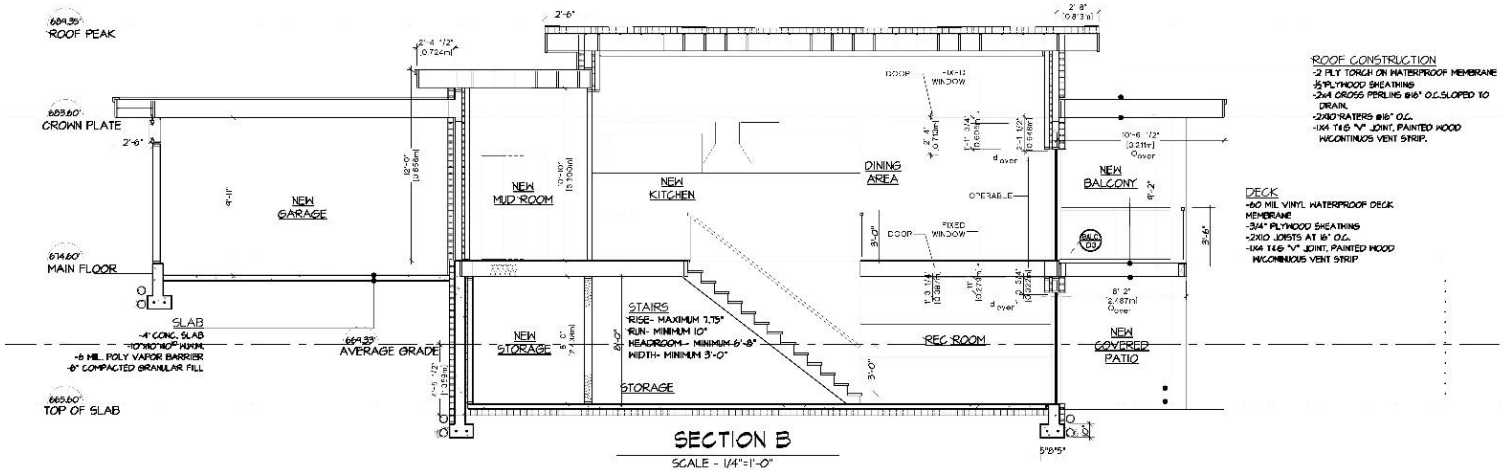
SCALE - 1/4"=1'-0"

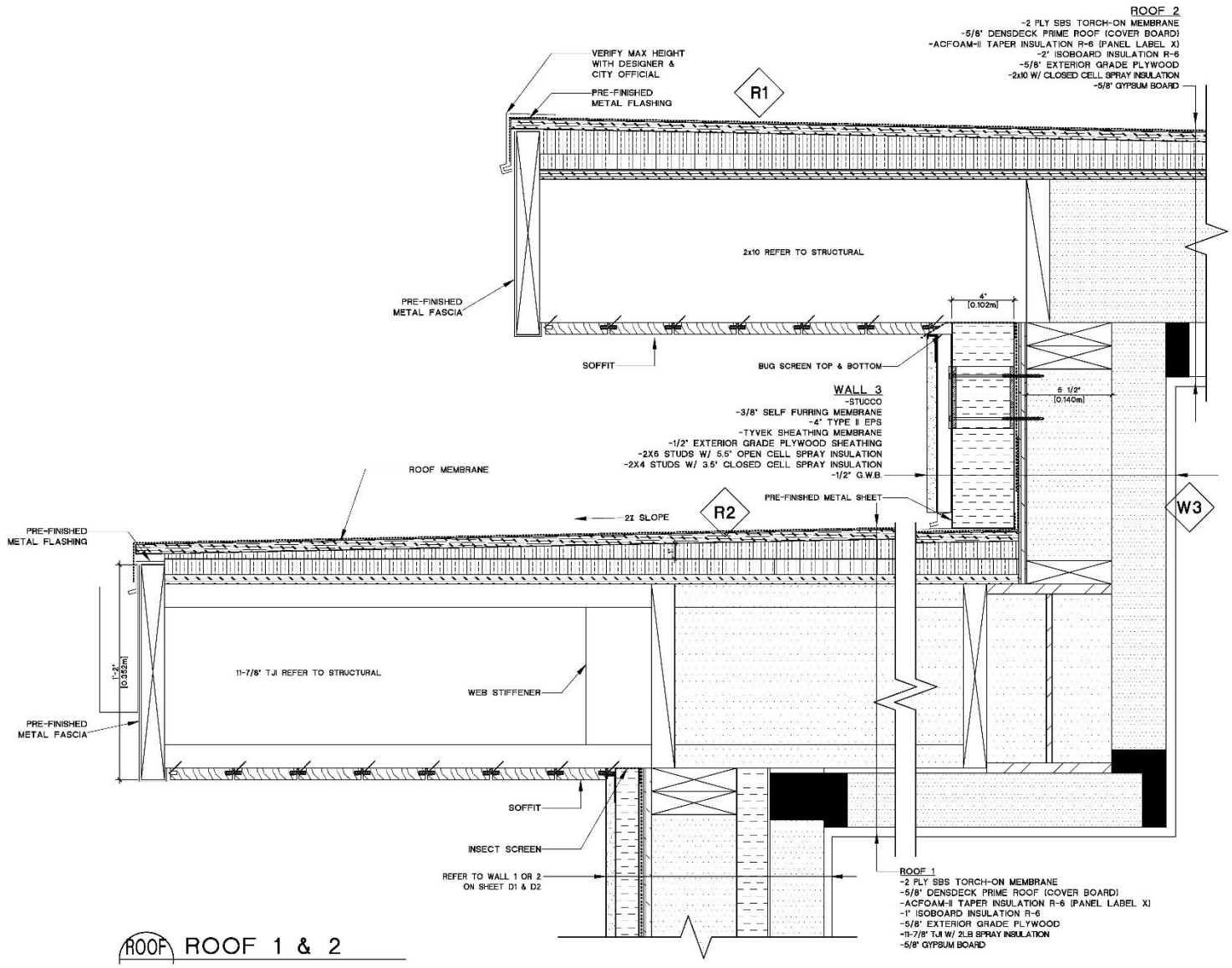


EAST ELEVATION

SCALE - 1/4"=1'-0"


684.35'
ROOF PEAK
683.60'
CROWN PLATE
674.60'
MAIN FLOOR
665.60'
TOP OF SLAB
NEW KITCHEN
ENTRY
BEDROOM
BEDROOM
MEDIA ROOM
NEW STORAGE
REC ROOM
NEW GYM
NEW BEDROOM
ROOF CONSTRUCTION
-2 PLY SBS TORCH-ON MEMBRANE
-5/8" DENSDECK PRIME ROOF (COVER BOARD)
-ACFOAM-II TAPER INSULATION R-6 (PANEL LABEL X)
-2" ISOBOARD INSULATION R-6
-5/8" EXTERIOR GRADE PLYWOOD
-2X10 W/ CLOSED CELL SPRAY INSULATION
-5/8" GYPSUM BOARD
1"x4" T&G PAINTED WOOD SOFFIT W/CONTINUOUS VENT STRIP
11-7/8" CLOSED CELL SPRAY INSULATION
4" TAPERED INSULATION
EXTERIOR WALL CONSTRUCTION
TOTAL: RSI=7.493 (R=42.55)
-RSI=0.016 STUCCO W/ LATH
-RSI=0.18 1" 2" GIRT
-RSI=2.667 EPS TYPE II INSULATION WITH 3" CASCADIA CLIP
-2 LAYERS OF 30MIN BUILDING PAPER
-RSI=0.109 1/2" PLYWOOD SHEATHING
-RSI=2.467 2X6 STUDS @16" O/C WITH 5.5" 1/2 LB SPRAY INSULATION
-RSI=1.944 2"X4" STUDS @ 24" O.C. WITH 3.5" 2 LB SPRAY INSULATION
-RSI=0.11 1/2" G.W.B.
FLOOR/CEILING CONSTRUCTION
-FINISHED FLOORING
-3/4" T&G PLYWOOD
-EXISTING 2X10 JOISTS @ 16" O.C.
-1/2" G.W.B. CEILING
INTERIOR WALL CONSTRUCTION
1/2" G.W.B. BOTH SIDES
-2"x4" STUDS @16" O.C.
FURRED OUT BASEMENT WALL
TOTAL: RSI=3.358 (R=41.18)
-RSI=1.68 2" XPS STAGGERED SEAMS
-RSI=1.68 2" XPS TYPE 4
-DIMPLE BOARD
-DAMPPROOFING
-RSI=0.264 CONCRETE FOUNDATION WALL (REFER TO STRUCTURAL)
-RSI=1.68 4" XPS
-6mil POLY VAPOUR BARRIER
-RSI=1.944 2"X4" STUDS @ 24" O.C. WITH 3.5" 2 LB SPRAY INSULATION
-RSI=0.11 1/2" G.W.B.
SLAB
-4" CONC. SLAB
-10"x10"x10" MIN.
-6" XPS
-6 MIL. POLY VAPOR BARRIER
-6" COMPACTED GRANULAR FILL
SECTION A
SCALE - 1/4"=1'-0"


684.35'
ROOF PEAK
683.60'
CROWN PLATE
674.60'
MAIN FLOOR
665.60'
TOP OF SLAB
654.33'
AVERAGE GRADE
NEW GARAGE
NEW MUD ROOM
NEW KITCHEN
DINING AREA
NEW BALCONY
NEW STORAGE
REC ROOM
NEW COVERED PATIO
STORAGE
STAIRS
RISE- MAXIMUM 7.75"
RUN- MINIMUM 10"
HEADROOM- MINIMUM 6'-8"
WIDTH- MINIMUM 3'-0"
ROOF CONSTRUCTION
-2 PLY TORCH ON WATERPROOF MEMBRANE
-1/2" PLYWOOD SHEATHING
-2x4 CROSS PERLINS @16" O.C. SLOPED TO DRAIN
-2X10 RAFTERS @16" O.C.
-1X4 T&G "V" JOINT, PAINTED WOOD W/CONTINUOUS VENT STRIP.
DECK
-60 MIL VINYL WATERPROOF DECK MEMBRANE
-3/4" PLYWOOD SHEATHING
-2X10 JOISTS AT 16" O.C.
-1X4 T&G "V" JOINT, PAINTED WOOD W/CONTINUOUS VENT STRIP
SLAB
-4" CONC. SLAB
-10"x10"x10" MIN.
-6" XPS
-6 MIL. POLY VAPOR BARRIER
-6" COMPACTED GRANULAR FILL
SECTION B
SCALE - 1/4"=1'-0"



Steel I-beam was specified by Structural Engineer to support the upper roof. This detail show 2x4 furring below the I-beam as well as inside face with closed cell insulation. Type 2 EPS provided over the roof. Closed cell insulation sprayed within roof joist. This was analysed in THERM and was thermal bridge free.

Building assembly description	
02kf	R2 LOWER ROOF

Heat transmission resistance [m²K/W]

Orientation of building element	1-Roof	interior R_{si}	0.10
Adjacent to	1-Outdoor	exterior R_{se}	0.04

A parallel building assembly layers

Area section 1	λ [W/(mK)]	Area section 2 (option	λ [W/(mK)]	Area section 3 (option	λ [W/(mK)]	Total width Thickness t_s [mm]
1/2" PLYWOOD	0.130					13
1/2" PLYWOOD	0.130					13
1.25" CLOSED CELL	0.038	TJI 1.25" FLANGE	0.130	TJI 1.25" FLANGE	0.130	32
9.375" CLOSED CELL	0.038			9.375" TJI 3/8"	0.130	238
1.25" CLOSED CELL	0.038	TJI 1.25" FLANGE	0.130	TJI 1.25" FLANGE	0.130	32
3.5" AIR IN 2X4	0.210	2X4 FURRING	0.130			16
5/8" DRYWALL	0.250					16

Percentage of sec. 1	Percentage of sec. 2	Percentage of sec. 3	Total
89%	8.6%	2.3%	35.9 cm

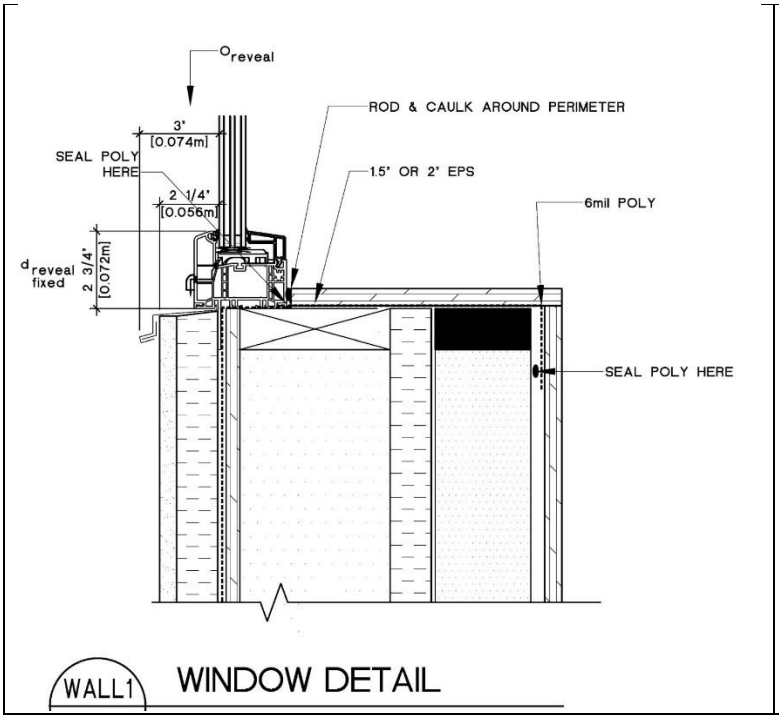
U_0:	0.128	W/(m²K)
R_0:	7.833	(m²K)/W

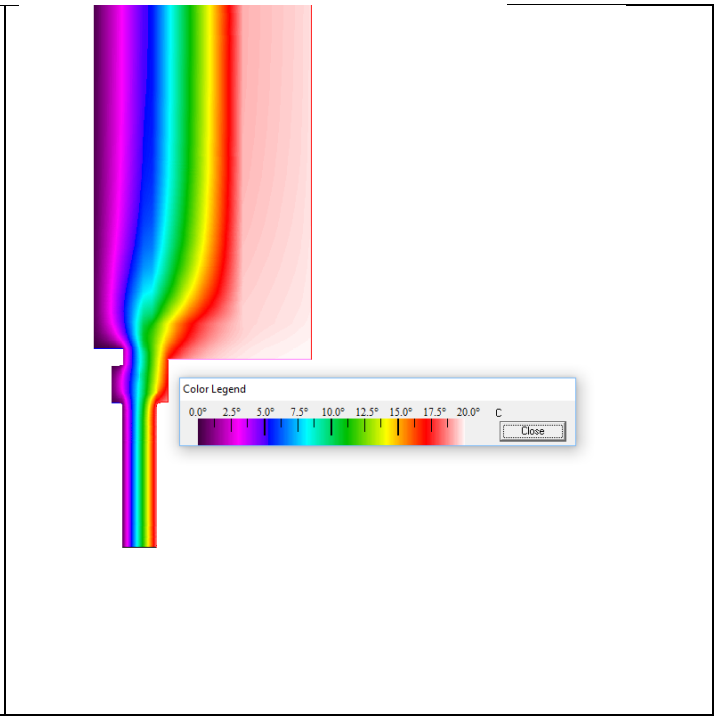
B wedge-shaped building assembly

	λ [W/(mK)]	Area section 2 (option	λ [W/(mK)]	Area section 3 (option	λ [W/(mK)]	Thickness t_1 [mm]
2" EPS	0.029					191

Percentage of sec. 1	Percentage of sec. 2	Percentage of sec. 3	Thickness t_1 [cm]
100%			19.1 cm

U_1:	0.151	W/(m²K)
R_1:	6.615	(m²K)/W
U-value rectangular area:	0.093	W/(m²K)
U-value of triangular area with the thickest point at the apex:	0.102	W/(m²K)
U-value of triangular area with the thickest point at the apex:	0.083	W/(m²K)





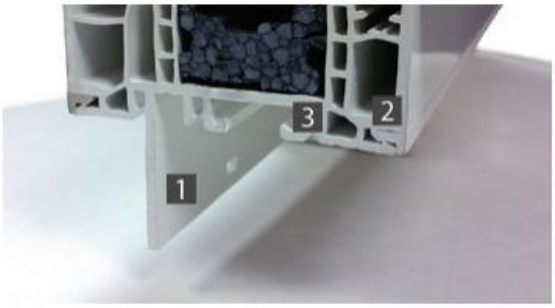
EuroLine 4700 Series, ThermoPlus PHC triple pane windows were used with PVC frame with insulation fillings of expanded polystyrene (0.031 W/(mK)).

U-value frame 0.78 W/(m2 K)
Solar factor (g) 0.55
Pane thickness: 44 mm (4/16/4/16/4), spacer: Super Spacer TriSeal / T-Spacer Premium
The window U-values were calculated for the test window size of 1.23m _ 1.48m with U_g = 0.70 W/(m2 K).
If a higher quality glazing is used, the window U-values will improve as follows:

Glazing	U_g =	0.70	0.64	0.58	0.53	W/(m² K)
		↓	↓	↓	↓	
Window	U_W =	0.79	0.75	0.71	0.68	W/(m² K)

Frame values		Frame width b_f mm	U-value frame U_f W/(m² K)	Ψ-glass edge Ψ_g W/(m K)	Temp. Factor $f_{Rsi-0.25}$ [-]
Top	(b_t)	115	0.78	0.027	0.74
Side	(b_s)	115	0.78	0.027	0.74
Bottom	(b_{bt})	115	0.78	0.027	0.74
Spacer: Super Spacer TriSeal / T-Spacer Premium				Secondary seal: Polysulfide	

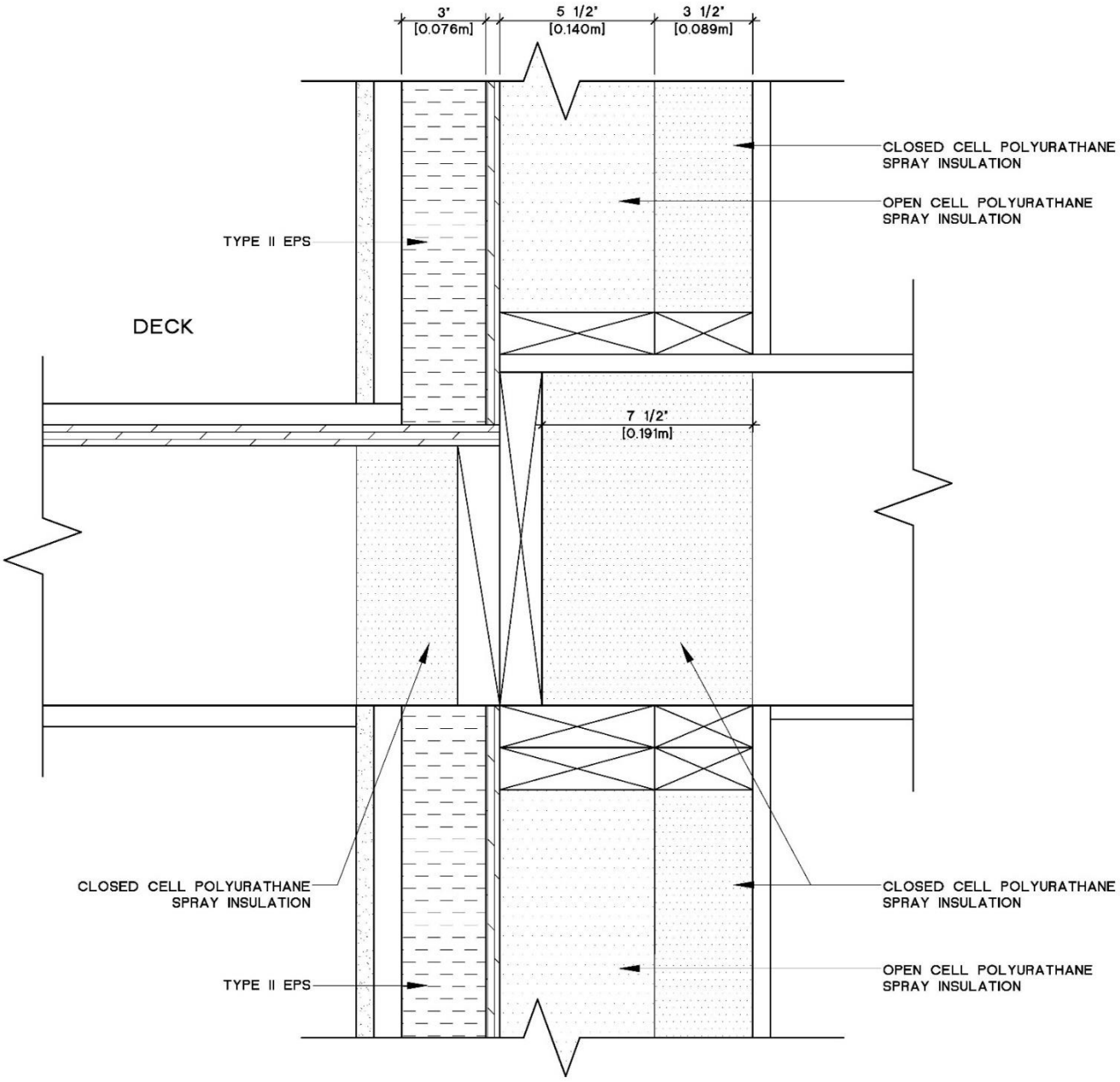
EuroLine's exclusive GENEO frame features:
1. Integral nailing fin
2. Accessory grooves
3. Support legs



The integral nailing fin is welded together with the rest of the frame, making it air and water tight, and much stronger than a snapped-in or glued-on fin could be.

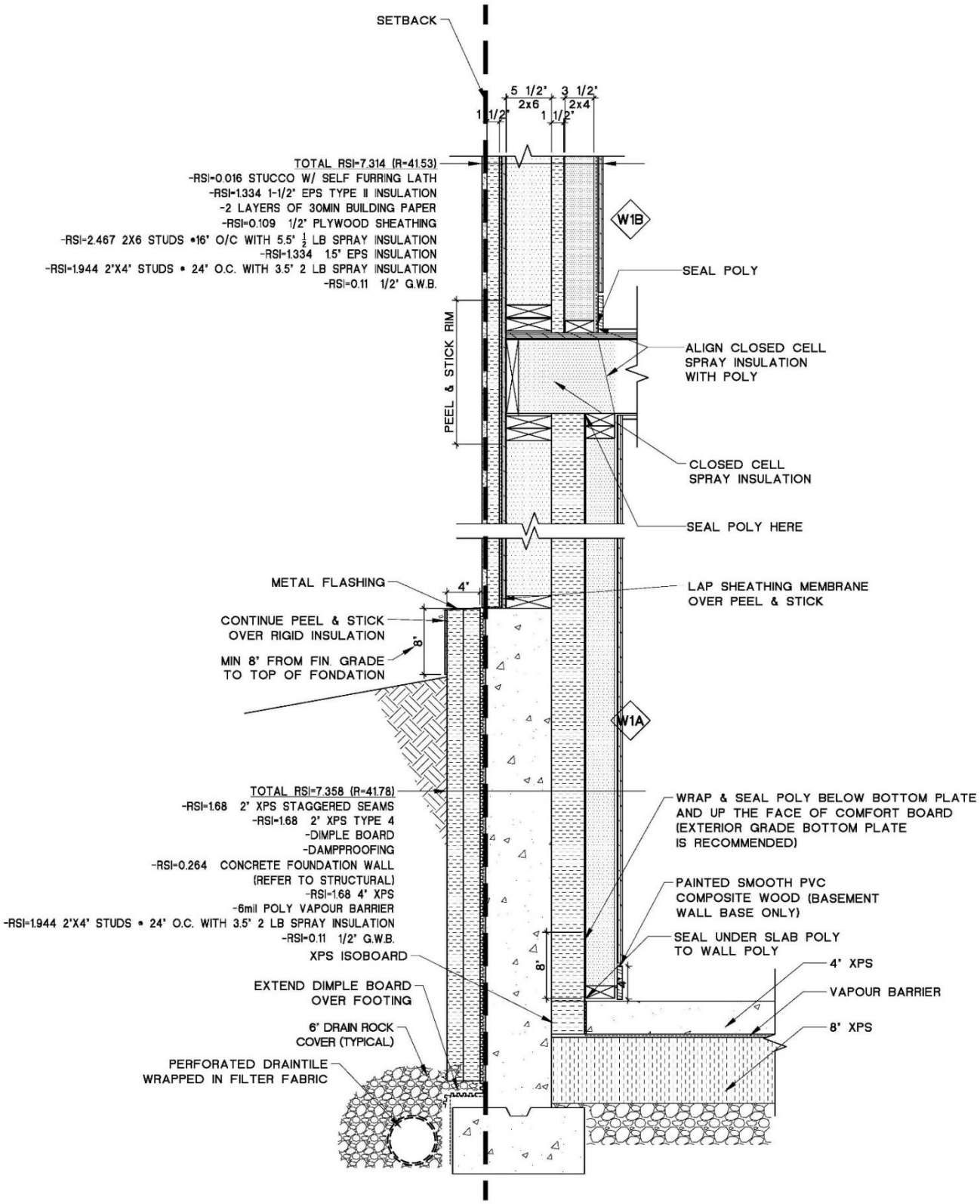
Grooves on the exterior and interior of the frame allow for easy snap-in installation of brickmoulds, drywall returns and other accessory profiles − they also aid in the connection of mulled units, as cover caps can be snapped into the grooves, further strengthening the connection.

Support legs transfer the load of the unit onto the sill of the window opening through shimming and are designed in such a way that strap anchors can be fastened without having to screw them into the frame. The flat surface facilitates proper application of rod and caulk.



BALC. DETAIL @ BALCONY

Spray foam insulation had been specified to avoid condensation on the rim joist. This also helped mitigate thermal bridging. The 2x6 exterior wall framing and the 2x10 floor joist are existing. Type 2 EPS has been provided on the exterior plywood and 2x4 with open cell insulation provided on the interior side.



WALL1 EXTERIOR WALL AT SETBACK

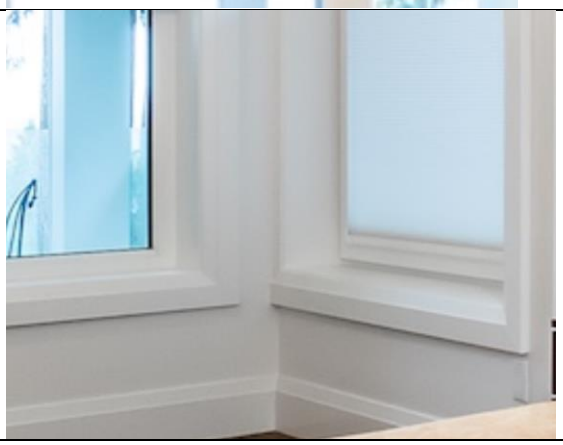
U-Value 0.122 W/(m²K) This is the south side wall detail which was almost against the required setback, 1.5" EPS was the thickest insulation the city allowed to avoid setback encroachment. However, 4" Type 2 EPS were provided on the remaining exterior walls. The City did allow 4" XPS along the foundation and 8" above grade. The U-Value of slab on grade is 0.122 W/(m²K) and the foundation wall is 0.107 W/(m²K).

4.0 Airtightness & Ventillation

It is tricky to achieve the required airtightness in Passive House Enerphit certification since framing are already existing. Areas such as rim joist and roof soffit are our main concern during design and consrtuction. We were reluctant to use spray foam insulation, however since this project was the first retrofit Passive House in Canada, we did not have very many references to follow. The Owner Builder has decided that spray foam insulation was the preferred choice to solve this issue and to ensure we meet the airtightness standard of 1.0 h-1. The final blower test result is 0.51 h-1 at 50 Pa. Passive House standards was fairly new in our region when we started. City of Vancouver current requirement for airtighness is 3.5 ACH @50 Pa. For the past four years, British Columbia Canada has been devasted with forest fire due to record amount of heat waves. Every summer it is almost expected there will be a forest fire. The photo below on this PH project indicates how much dust theHRV filter has collected during the forest fire for the perior of one month only in July 2017.

5.0 Descrition of air tight cover: 6mil poly vapour barrier provided on warm side. Tyvek commercial wrap applied on exterior plywood sheathing, seams are taped with SIG-Wigluv and Hanno-Duo Easy.

Floors: 100mm concrete slab on poly vapour barrier on 200mm Extruded Polystyrene. There are no floor overhangs. Vapour barrier was sealed and taped to wall poly between 2x4 service wall and 100mm extruded polystyrene.	
Exterior Wall: Exterior plywood sheathing were taped. The main concern was the rimjoist, which was sealed wit polyurethane spray insulation. 6mil Poly vapour barrier used on the warm side of walls. Drywalls applied on all interior wall surface from top of concrete slab or subfloor to underside of ceiling and floor joist. Drywalls were also taped and sealed.	

Ceiling/Roof: 6mil UV poly vapour barrier used on warm side of ceiling. Poly was was taped and seaeld to wall poly. Drywall were taped and sealed. Basement ceiling was covered with similar manner.	
Windows: The window frame are sealed with polyurethane spray, rod and silicone caulk to the perimeter framing. 6mil poly vapour barrier sealed to sheathing air barrier. Window opening were covered with 12.7mm drywall.	

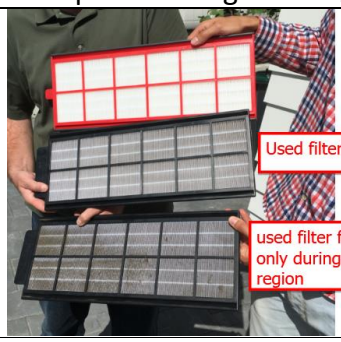
Test results:

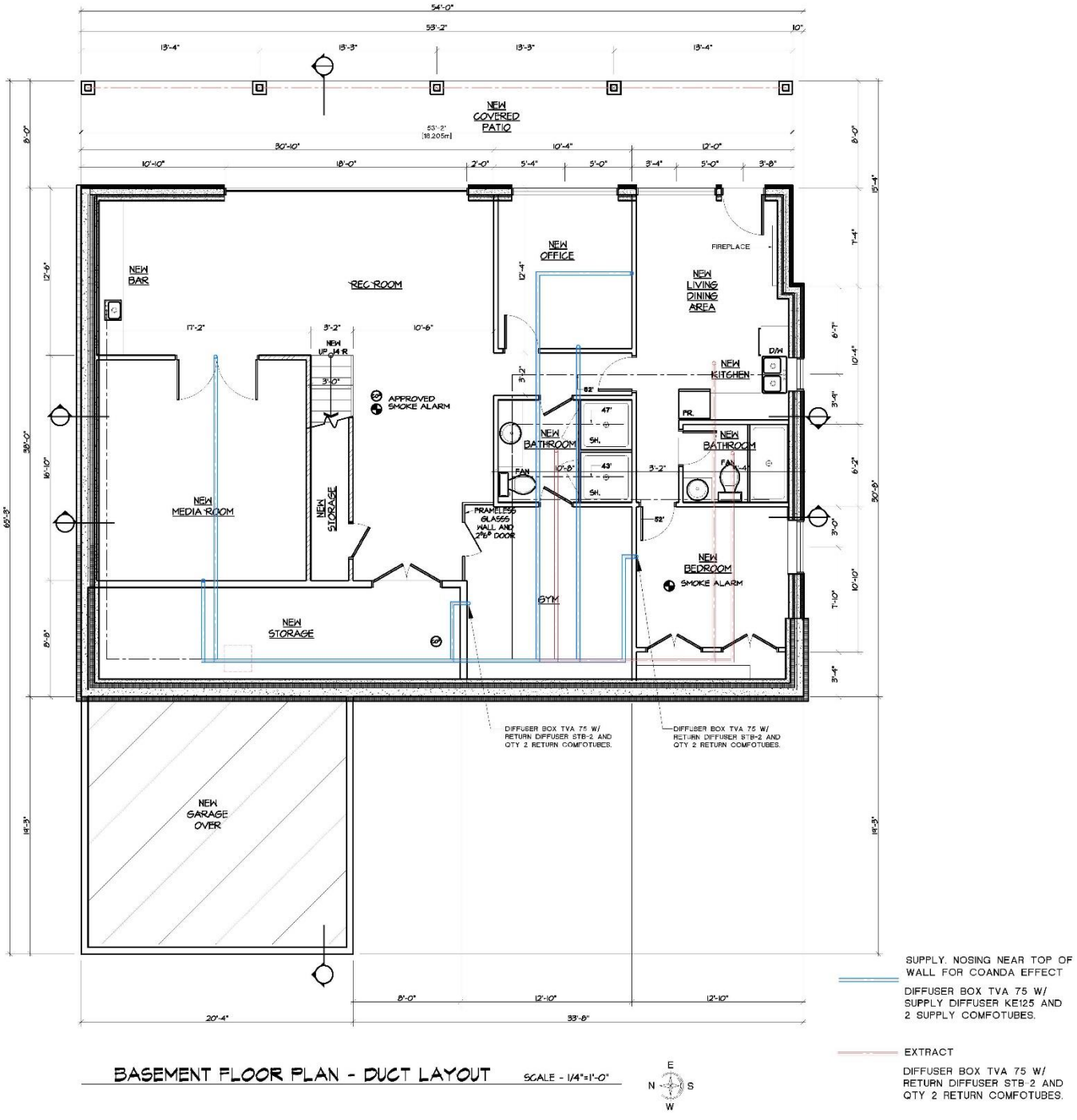
Building and Test Information	
Test file name:	**EN13829-EU 2017-04-22 1153**
Building volume [m^3]:	**908.7**
Envelope Area [{m^2]:	
Floor Area [{m^2]:	**321.5**
Building Height (from ground to top) [m]:	**6.9**
Building Exposure to wind:	**Partially protected building**
Accuracy of measurements:	**1%**

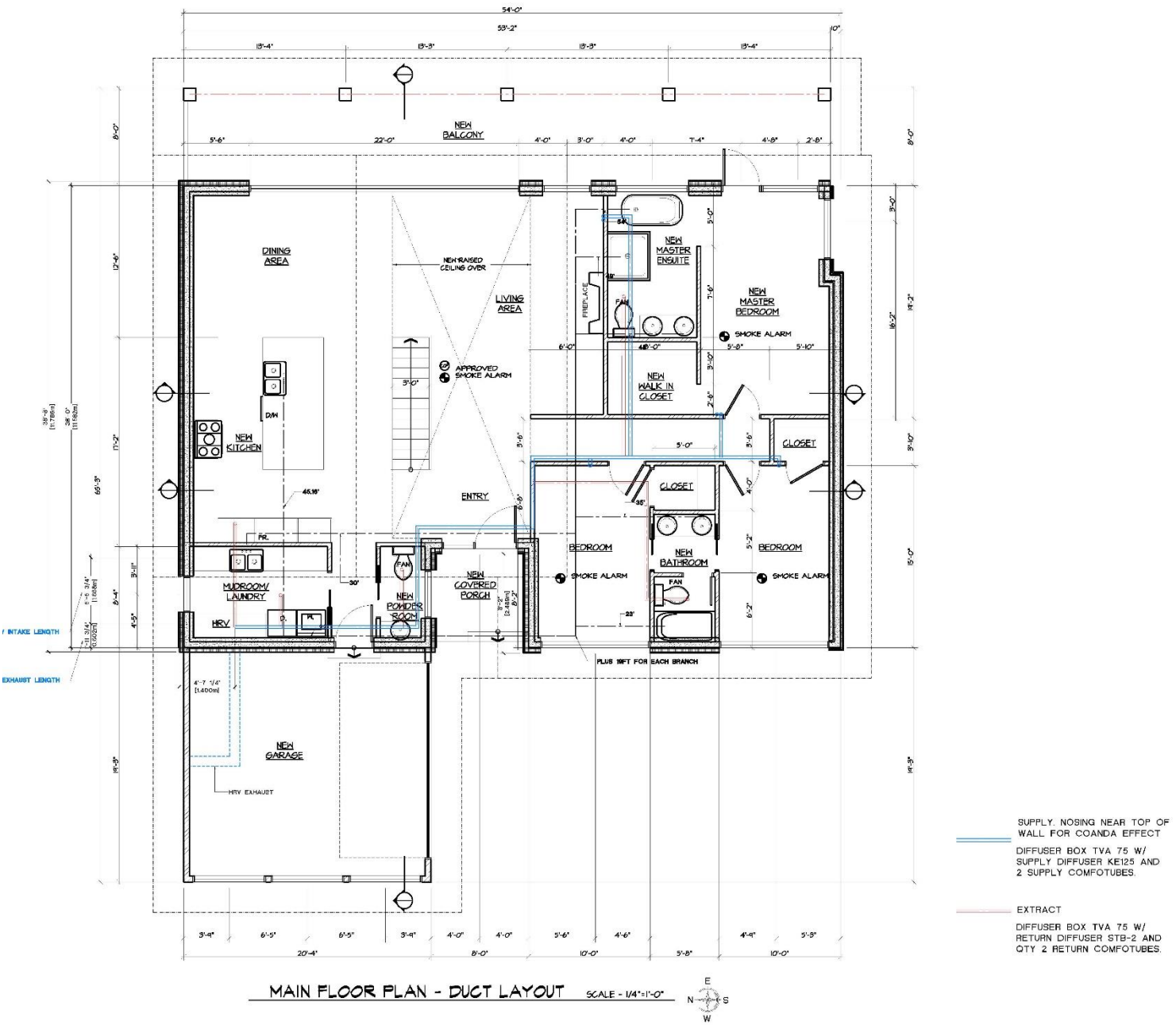
Results	
Air flow at 50 Pa, [m^3/h]	**466.5**
Air changes at 50 Pa, n_{50} [/h]	**0.51**
Flow per Envelope Area at 50 Pa, [$m^3/h/m^2$]	
Flow per Floor Area at 50 Pa, [$m^3/h/m^2$]	**1.451**
Effective leakage area at 50 Pa, [cm^2]	**142.0**
Equivalent leakage area at 50 Pa, [cm^2]	**233.1**
Leakage per Envelope Area at 50 Pa, [cm^2/m^2]:	
Leakage per Floor Area at 50 Pa, [cm^2/m^2]:	

7.1 Ventillation & Ductwork:

Heat recovery ventillator (Comfoair 550) was use of up to 324 cfm with 83.4% efficiency with an electric power consumption of 0.31 Wh/m^3. 75mm insulation used to wrap both exhaust and intake duct. To reduce thermal bridging, exhaust duct was placed through interior wall between PH envelope and semi heated garage. Air transfer takes place through 1” air gap between floor and bottom of doors.







Recirculating hood vent used for kitchen and ductless condensing dryer used to lower thermal bridging.

5.0 Heating

The south wall faces an adjacent building and trees with large amount of shading intrusion during winter season. Solar heat gain activty happens more on the west side that faces street with no shading disturbance. Two electric fireplaces used near east facing windows and doors one on each floor.

Fireplace on main floor near east door/windows	Fireplace on basement floor near east doors/windows
	

6.0 PHPP Calculations
EnerPHit Verification

Building:	Single Family Home		
Street:	2958 Princess Ave		
Postcode/City:	V7N 2C8	North Vancouver	
Province/Country:	BC	CA-Canada	
Building type:	Single Famile Home		
Climate data set:	CA0003b-Vancouver		
Climate zone:	3: Cool-temperate	Altitude of location:	205.6 m
Home owner / Client:	Nino Giangrande		
Street:	2958 Princess Ave		
Postcode/City:	V7N 2C8	North Vancouver	
Province/Country:	BC	CA-Canada	

Architecture:	Aform Development Inc - Czar Villanueva		
Street:	1103-1139 West Broadway		
Postcode/City:	V6H 1G1	Vancouver	
Province/Country:	BC	CA-Canada	
Mechanical system:			
Street:			
Postcode/City:			
Province/Country:			
Energy consultancy:	Aform Development Inc - Czar Villanueva		
Street:	1103-1139 West Broadway		
Postcode/City:	V6H 1G1	Vancouver	
Province/Country:	BC	CA-Canada	
Certification:	Peel Passive House Consulting		
Street:	118 Craigleith Road		
Postcode/City:	L9Y 0S3	Blue Mountains	
Province/Country:	Ontairo	Canada	

Year of construction:	2016	Interior temperature winter [°C]:	20.0	Interior temp. summer [°C]:	25.0
No. of dwelling units:	2	Internal heat gains (IHG) heating case [W/m²]:	2.4	IHG cooling case [W/m²]:	2.4
No. of occupants:	5.9	Specific capacity [Wh/K per m² TFA]:	60	Mechanical cooling:	

Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	322.0				
Space heating	Heating demand	kWh/(m²a)	18	≤	25	-	yes
	Heating load	W/m²	9	≤	-	-	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	-	≤	-	-	-
	Cooling load	W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C)	%	0	≤	10		yes
	Frequency excessively high humidity (> 12 g/kg)	%	0	≤	20		yes
Airtightness	Pressurization test result n_{50}	1/h	0.5	≤	1.0		yes
Minimum thermal protection	fulfilled?	yes/no			yes		yes
	Smallest temperature factor $f_{Rsi=0.25\ m^2K/W}$	-	-	≥	0.70		-
	highest U-value	W/(m²K)	0.82	≤	0.85		yes
	highest U-value	W/(m²K)	-	≤	1.00		-
	highest U-value	W/(m²K)	0.11	≤	1.10		yes
	highest U-value	W/(m²K)	0.14	≤	0.65		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	124	≤	-		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	55	≤	64	64	yes
	Generation of renewable energy	kWh/(m²a)	0	≥	-	-	

[2] Empty field: Data missing; '-': No requirement

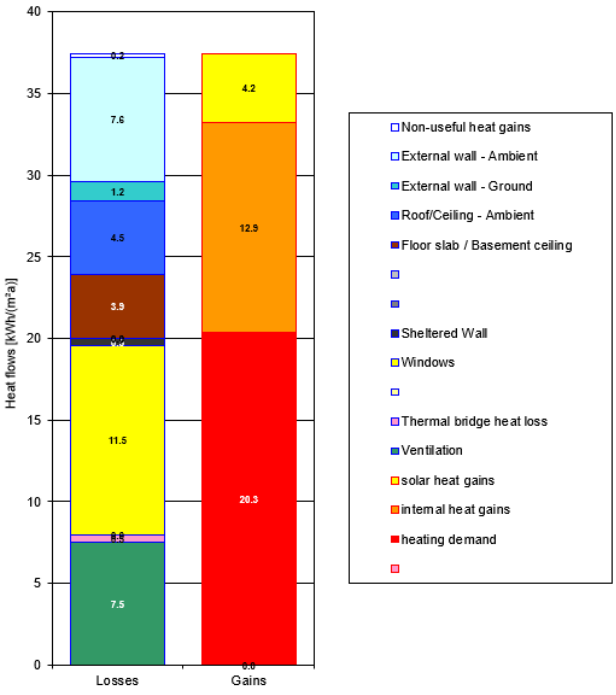
I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

EnerPHit Classic? yes

Task:	First name:	Surname:	Signature:
1-Designer	Czar	Villanueva	

Issued on:	City:
28-10-16	Vancouver

Energy balance heating (annual method)



7.0 Construction Cost:

The cost for the standard building was $2,960/SM. The cost for energy efficiency was an additional 16%. The high extra cost was mainly due to additional insulation provided for an outdoor swimming pool, an envelope Consultant had to be involved to oversee any potential condensation issue and dealing with multi level roof and thermal bridging as well as installation of large amount of east facing windows.

User satisfaction and comments:

Existing House 	Front entry 
South side showing plywood seams taped 	HRV Duct 

North Side

Rear (East side)

Rear (East side) Complete. This side has a great view.

West complete

South Complete

North Complete