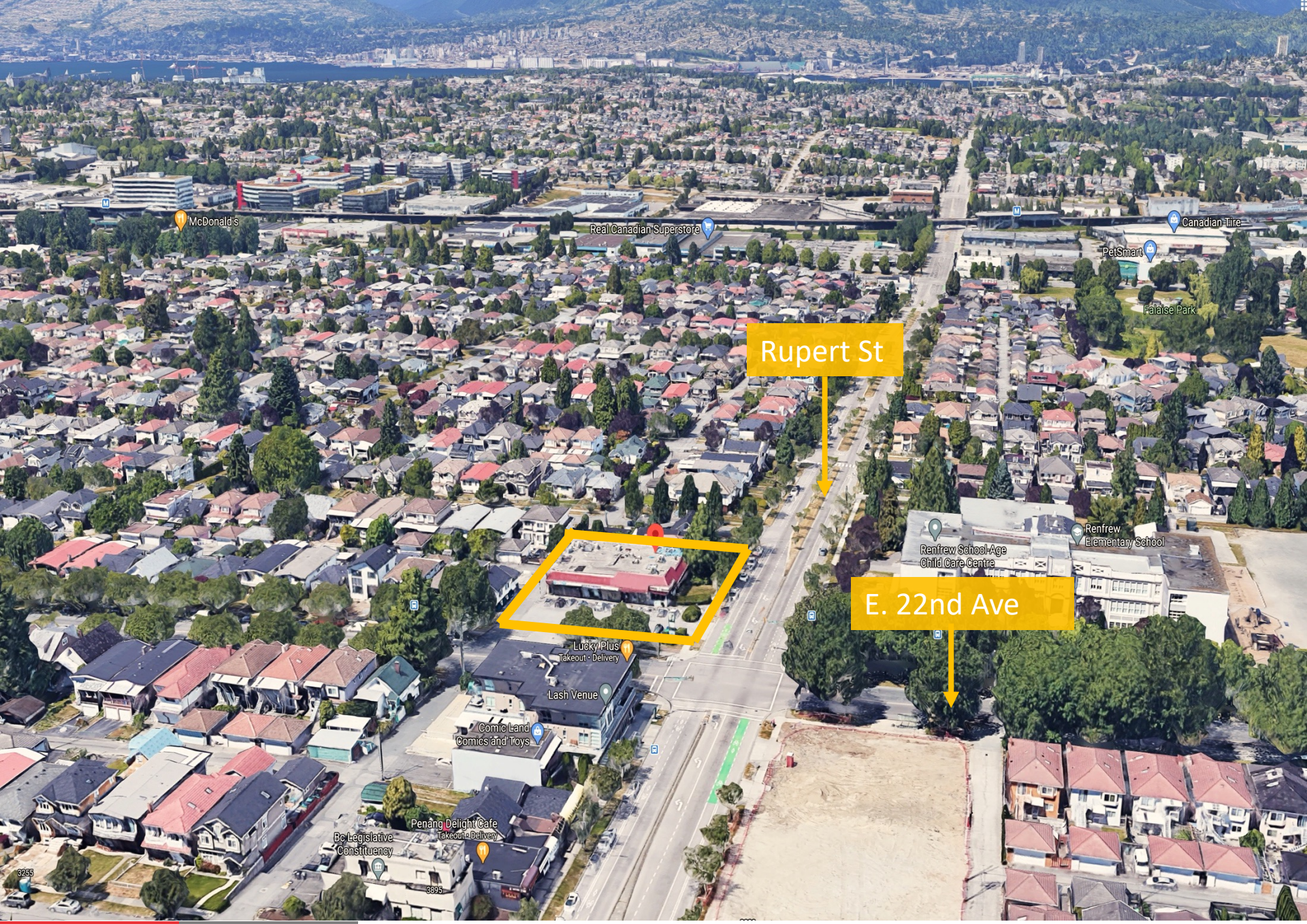
ZEBX DECARB LUNCH SERIES - March 2021

THE PEAK - 3737 Rupert St. Vancouver BC

52 Suite Market Rental Housing + 2 commercial units

CANADA ZEBx CORNERSTONE architecture CONSTRUCTION



PASSIVEHOUSE CANADA

zebx

CORNERSTONE architecture

BOLD CONSTRUCTION

PASSIVEHOUSE CANADA zebx CORNERSTONE architecture BOLD CONSTRUCTION

PASSIVEHOUSE CANADA zebx CORNERSTONE architecture BOLD CONSTRUCTION

THEMES

compactness

window / shading

materials / building science

details / mock-up

commissioning

DESIGN TEAM

design challenges

design decisions

energy model

verification

CONSTRUCTION TEAM

constructability

cost

schedule

trades education

zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

compactness

window / shading

materials / building science

details / mock-up

commissioning

DESIGN TEAM | CONSTRUCTION TEAM

Form driven by planning department's urban design agenda, and the client's desire to maximize unit count and FSR

Corners and steps are expensive

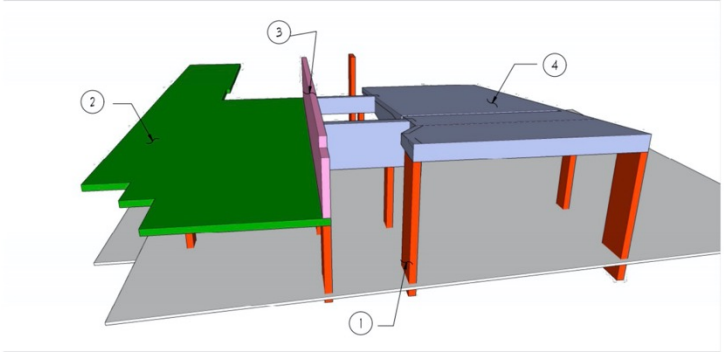
zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

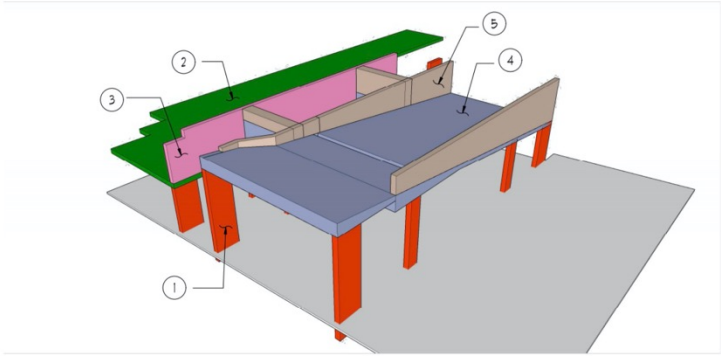
BOLD CONSTRUCTION

Complex ground floor geometry isn't influenced by passive house metrics

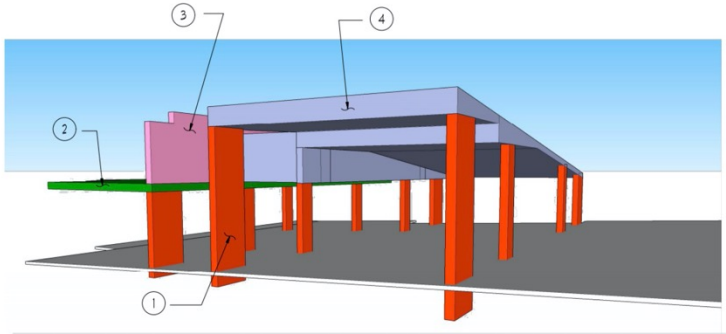


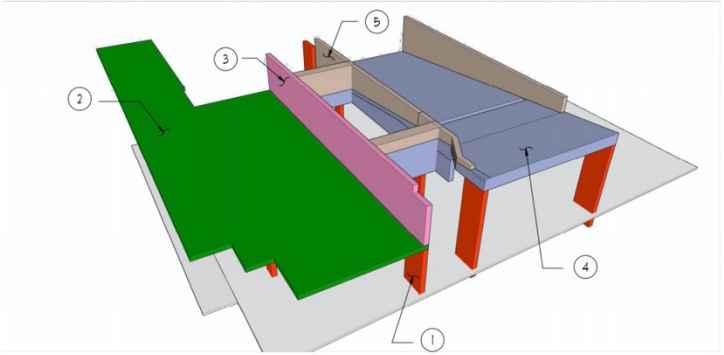
POUR SEQUENCE

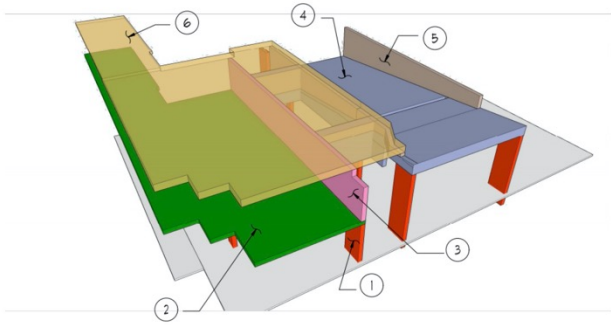
1.	RED	COLULM
2.	GREEN	SLAB (STORAGE MEZZ.)
3.	PINK	WALL BEAM (STORAGE MEZZ.)
4.	LIGHT BLUE	BEAM & WALL BEAM (LOWER PART) + RAMP SLAB
5.	LIGHT BROWN	BEAM & WALL BEAM (UPPER PART)
6.	YELLOW	L1 SLAB



Concrete pour sequence diagram







THEMES

compactness

window / shading

materials / building science

details / mock-up

commissioning

DESIGN TEAM

CONSTRUCTION TEAM

zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

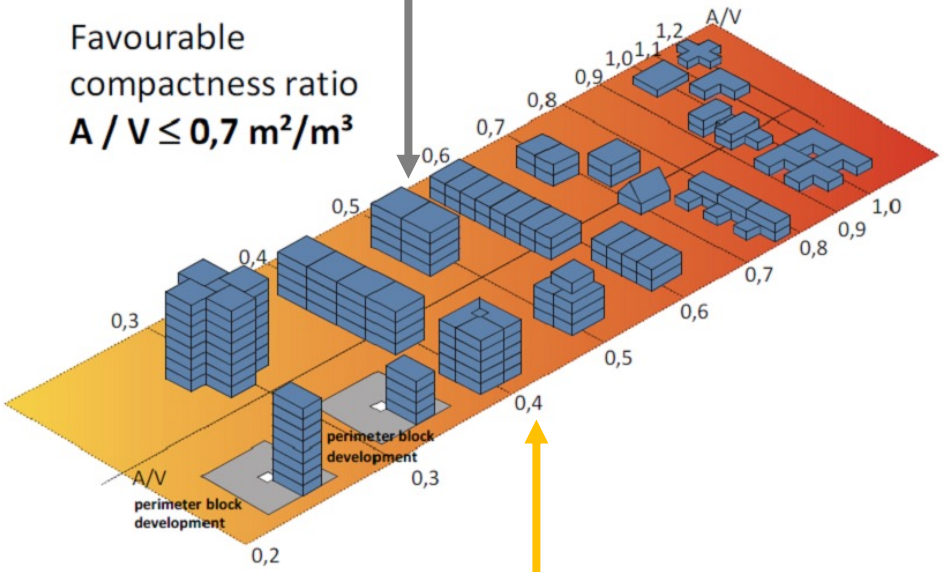
BOLD CONSTRUCTION

Surface area to Volume Ratio

LMC: 0.57

Favourable compactness ratio

A / V ≤ 0,7 m²/m³



The Peak: 0.42

The Heights: 0.42

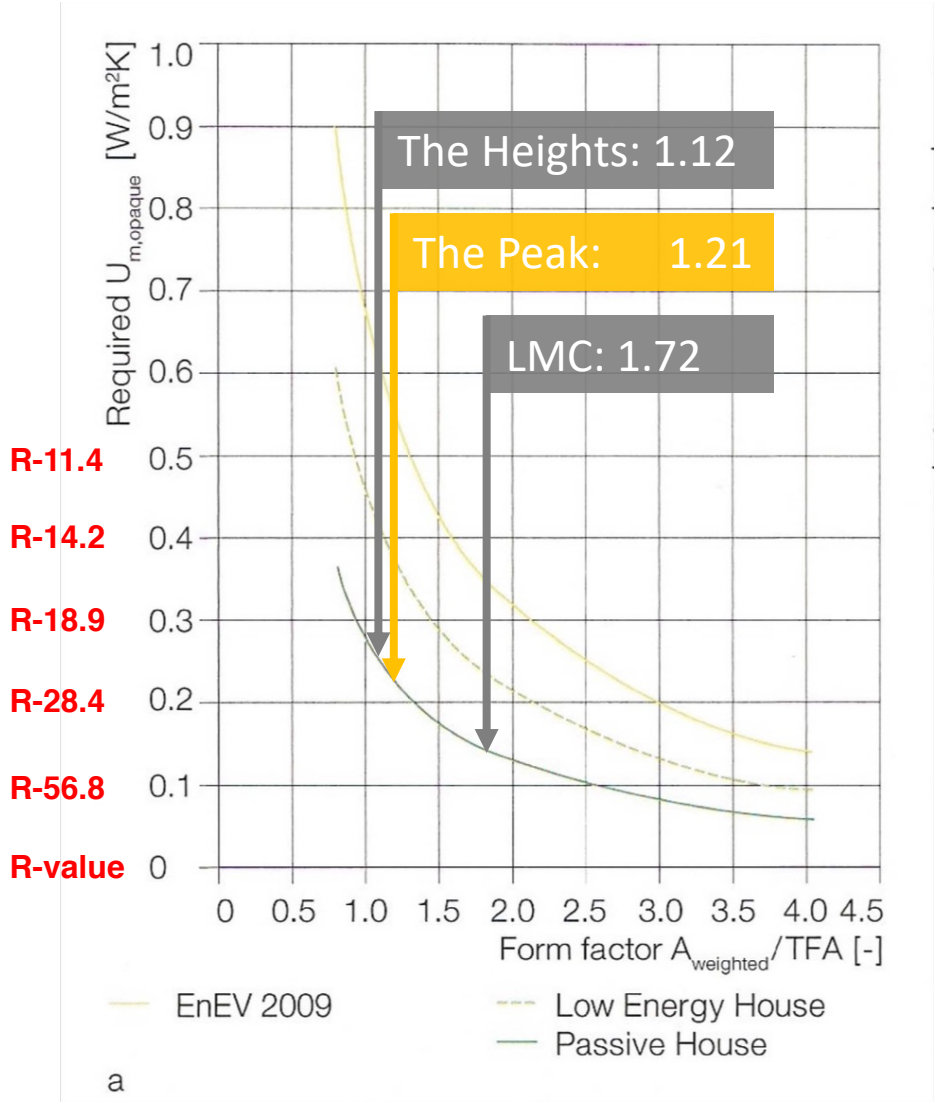
Heat Loss Form Factor

The Peak
Average weighted U-value:
0.266 W/m²K
R-21.3

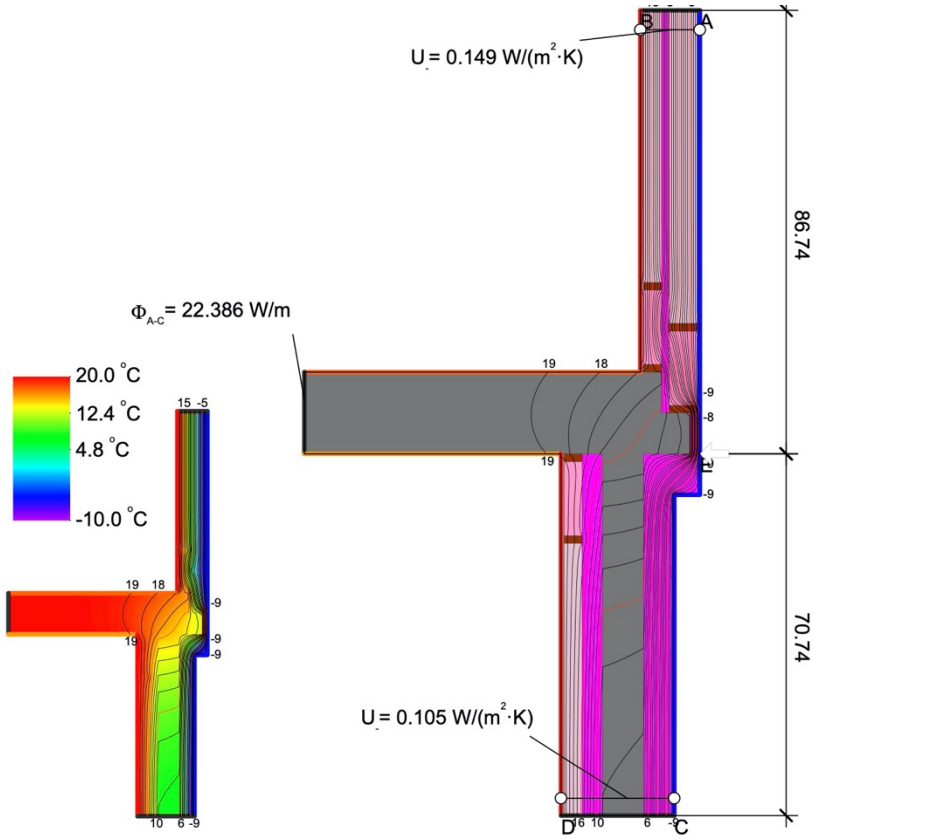
Average U-value windows:
0.84 W/m²K

Heating Demand:
13.1 kWh(m²a)

PER:
56.6 kWh(m²a)



Fewer corners, fewer thermal bridges to model



$$\psi_{A\text{-}E\text{-}C} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - U_2 \cdot b_2 = \frac{22.386}{30.000} - 0.149 \cdot 2.203 - 0.105 \cdot 1.797 = 0.229 \text{ W/(m·K)}$$

Material	λ[W/(m·K)]
Blown fiberglass R4.0/inch	0.036
Concrete, reinforced (with 1% of steel)	2.300
EPS R4.0/inch	0.036
EQ 2x4 16in oc w Blown fiberglass	0.044
EQ 2x6 16in oc w Blown fiberglass	0.044
Gypsum board R0.9/inch	0.160
Plywood 500 kg/m3	0.130
Timber 450 kg/m3 (softwoods)	0.120

Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]
Exterior, ventilated		-10.000	0.130
Interior, heat flux, downwards		20.000	0.170
Interior, heat flux, upwards		20.000	0.100
Interior, normal, horizontal		20.000	0.130
Symmetry/Model section	0.000		

Thermal bridge inputs

No.	Thermal bridge - denomination	Group No.	Assigned to group	Quantity	x (	Length [m]	-	Subtraction length [m]	)=	Length ℓ [m]	User determined psi value [W/(mK)]
1	1.] Slabs/Ground				x (		-		) =		
2					x (		-		) =		
3	Elev.Lobby Int.Corners C1C/C1J	16	Perimeter thermal bridges	1	x (	10.21	-		) =	10.21	0.025
4	Elev.Lobby Slab on Grade:7/A-D.2	16	Perimeter thermal bridges	1	x (	21.53	-		) =	21.53	0.008
5	Elev.Lobby Slab to Pit wall (Ext.perim.) 4/A-D.1	16	Perimeter thermal bridges	1	x (	5.62	-		) =	5.62	0.008
6	Elev.Lobby Slab to Pit wall (Int.perim.) 4 SIM/A-D.1	17	Thermal bridges FS/BC	1	x (	5.62	-		) =	5.62	0.018
7					x (		-		) =		
8	Elev.Pit Slab on Grade: F1D/C1E	17	Thermal bridges FS/BC	1	x (	11.23	-		) =	11.23	0.596
9					x (		-		) =		
10	Ext.Wall/GF				x (		-		) =		
11	Ext.Wall at GF: Parkade Entry Ramp C1C/F1B (perimeter)	16	Perimeter thermal bridges	1	x (	10.20	-		) =	10.20	0.224
12	Ext.Wall at GF: Parkade Entry Ramp C1C-SIM/F1B (perimeter)	16	Perimeter thermal bridges	1	x (	4.00	-		) =	4.00	0.088
13	Ext.Wall at Ground Floor: 1A at Step Slab (perimeter)	16	Perimeter thermal bridges	1	x (	76.50	-		) =	76.50	0.030
14					x (		-		) =		
15					x (		-		) =		
16	Ext.Wall at Ground Floor: S.Wall at Step Slab (perimeter)	16	Perimeter thermal bridges	1	x (	16.81	-		) =	16.81	0.006
17	Ext.Wall over Parking Inverse (Int.perim.) at Elev.Lobby: C1C/F1B	16	Perimeter thermal bridges	1	x (	27.13	-		) =	27.13	0.033
18	Total Perimeter: Ext.Wall at Ground Floor over Parking				x (		-		) =		0.055
19					x (		-		) =		
20	Ext.Wall/L2				x (		-		) =		
21					x (	5.39	-		) =		
22	Ext.Walkway over Amenity: Int.Edge 7/A-D.11	15	Thermal bridges Ambient	1	x (	5.55	-		) =	5.55	0.055
23	Ext.Wall at L2 Deck Slab Edge 7/A-D.3	15	Thermal bridges Ambient	1	x (	13.21	-		) =	13.21	0.341
24	Ext.Wall at L2 Slab Edge 5/A-D.3	15	Thermal bridges Ambient	1	x (	13.25	-		) =	13.25	0.217
25	Ext.Wall at L2 Slab Edge over Parkade Ramp 3/A-D.3	15	Thermal bridges Ambient	1	x (	9.35	-		) =	9.35	0.288
26	Ext.Wall at L2 Slab Edge over Parkade Ramp Inverse 3 SIM/A-D.3	15	Thermal bridges Ambient	1	x (	20.33	-		) =	20.33	0.091
27	Ext.Wall at L2 Slab: Ext.Edge over Ext. Space 7 SIM/A-D.3	15	Thermal bridges Ambient	1	x (	7.67	-		) =	7.67	0.125
28	Ext.Wall at L2 Slab: Int.Edge over Ext. Space 7 SIM/A-D.3	15	Thermal bridges Ambient	1	x (	7.95	-		) =	7.95	0.158
29					x (		-		) =		
30	Floor over L2 Ext.Space: Int.Edge 8 SIM/A-D.5	15	Thermal bridges Ambient	1	x (	22.49	-		) =	22.49	0.041
31					x (		-		) =		
32	Typical				x (		-		) =		
33	Ext.Wall at Typical Floor line 1/A-D.5	15	Thermal bridges Ambient	1	x (	410.17	-		) =	410.17	0.011
34					x (		-		) =		
35	Ext.Wall: Typical Int.Corners 9/A-D.5	15	Thermal bridges Ambient	1	x (	238.20	-		) =	238.20	0.029
36					x (		-		) =		
37	Roof/Decks/Elev.Overrun				x (		-		) =		
38					x (		-		) =		
39					x (		-		) =		
40	Ext.Wall at Vinyl Decks 3/A-D.13	15	Thermal bridges Ambient	1	x (	91.85	-		) =	91.85	0.005
41					x (		-		) =		
42					x (		-		) =		
43	Main Roof Inverse: At Elevator shaft 2/A-D.13	15	Thermal bridges Ambient	1	x (	34.41	-		) =	34.41	0.031
44					x (		-		) =		
45	Roof Deck over Interior Space: Int.Edge 1/A-D.11	15	Thermal bridges Ambient	1	x (	69.93	-		) =	69.93	0.041
46	-				x (		-		) =		
47					x (		-		) =		
48					x (		-		) =		
49					x (		-		) =		
50					x (		-		) =		
51	Plumbing Vent stack's: No AAV's	15	Thermal bridges Ambient	1	x (	1840.45	-		) =	1840.45	0.013
52	Rainwater Pipes Through Bldg	15	Thermal bridges Ambient	1	x (	137.670	-		) =	137.67	0.041
53	HRV- vent side exhaust/intake	15	Thermal bridges Ambient	6	x (	1.00	-		) =	6.00	0.031
54	Parkade Column	15	Thermal bridges Ambient	3	x (	1.00	-		) =	3.00	0.677
55	Possible RW Penetrations & Verticle Lengths	15	Thermal bridges Ambient	9	x (	1.00	-		) =	9.00	0.062
100					x (		-		) =		

THEMES

compactness

window / shading

materials / building science

details / mock-up

commissioning

DESIGN TEAM

design challenges

design decisions

energy model

verification

CONSTRUCTION TEAM

constructability

cost

schedule

trades education

zebx

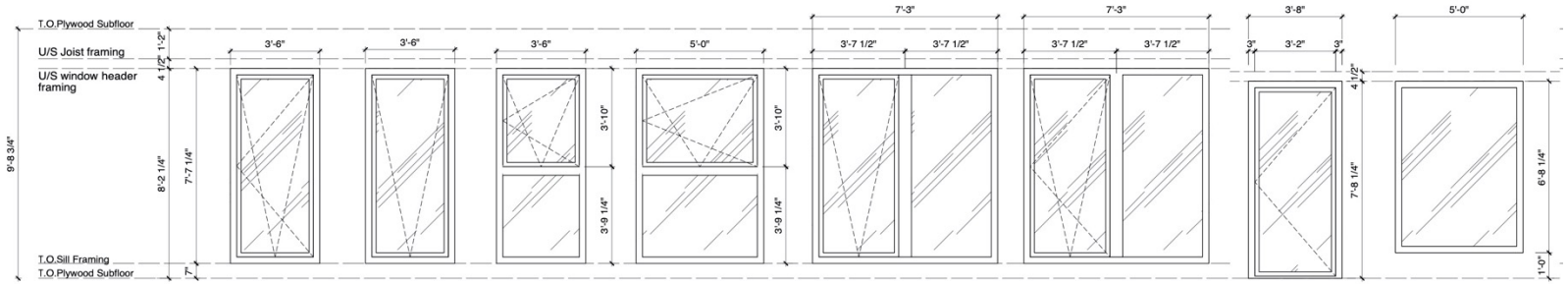
PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

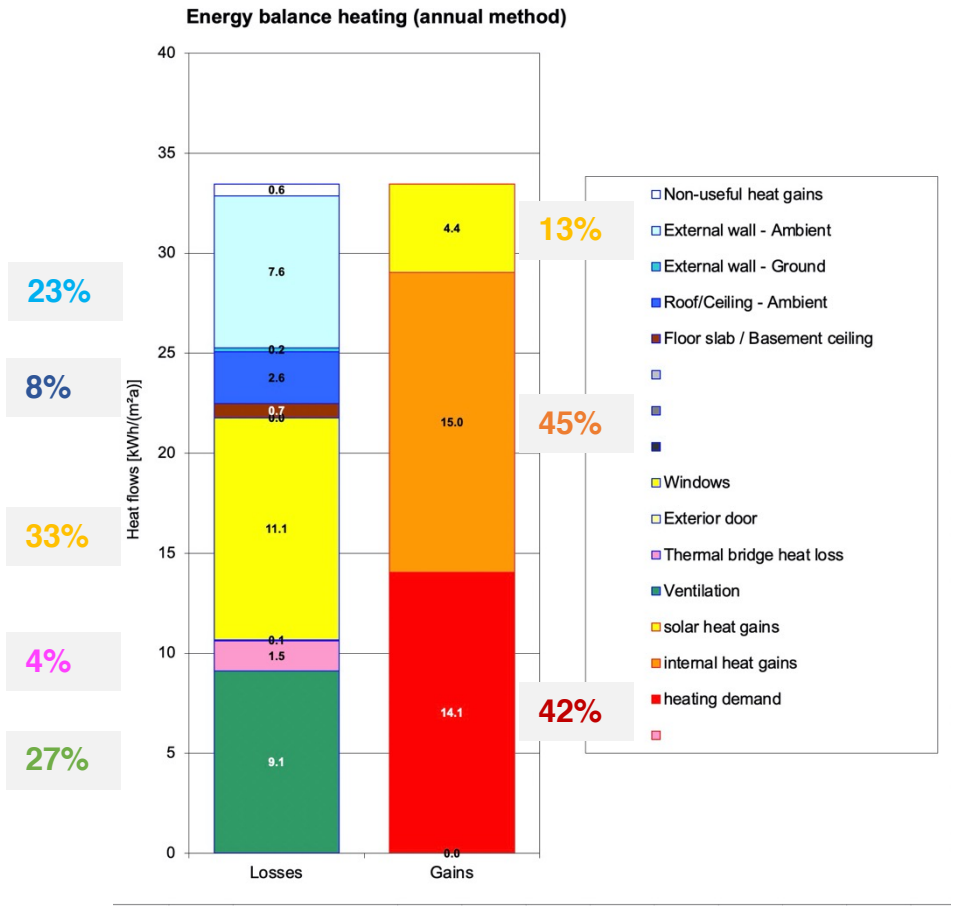
Simplify window types

Reduce number of mullions

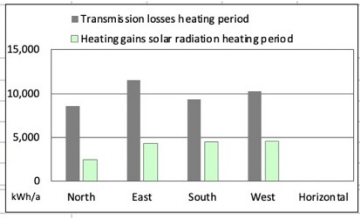


Solar gain should not be relied on as major contributor to heat gain

Shading and low heat gain glazing affects the total heating gains, but it is required to limit overheating



g-Value	Solar irradiation reduction factor	Window area m²	Window U-Value W/(m²K)	Glazing area m²	Average global radiation kWh/(m²a)		Transmission losses heating period kWh/a	Heating gains solar radiation heating period kWh/a
0.34	0.45	134.68	0.86	97.12	118	North	8557	2442
0.35	0.25	186.88	0.84	130.15	261	East	11515	4274
0.34	0.19	150.30	0.84	103.98	476	South	9292	4495
0.34	0.27	171.02	0.82	116.84	283	West	10283	4552
0.00	0.00	0.00	0.00	0.00	412	Horizontal	0	0
0.34	0.28	642.88	0.84	448.09			39647	15763



THEMES

compactness

window / shading

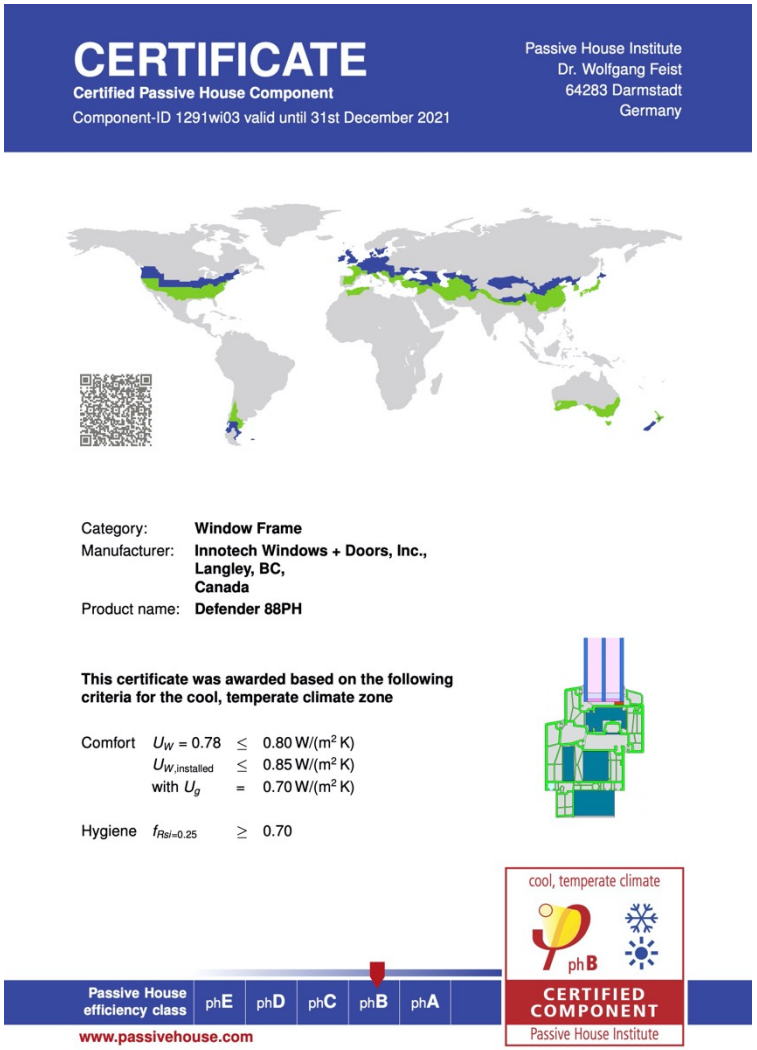
materials / building science

details / mock-up

commissioning

DESIGN TEAM

CONSTRUCTION TEAM



CERTIFICATE

Certified Passive House Component

Component-ID 1291wi03 valid until 31st December 2021

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany

Category: **Window Frame**
Manufacturer: **Innotech Windows + Doors, Inc., Langley, BC, Canada**
Product name: **Defender 88PH**

This certificate was awarded based on the following criteria for the cool, temperate climate zone

Comfort $U_W = 0.78 \leq 0.80\ W/(m^2 K)$
$U_{W,installed} \leq 0.85\ W/(m^2 K)$
with $U_g = 0.70\ W/(m^2 K)$

Hygiene $f_{Rsi=0.25} \geq 0.70$

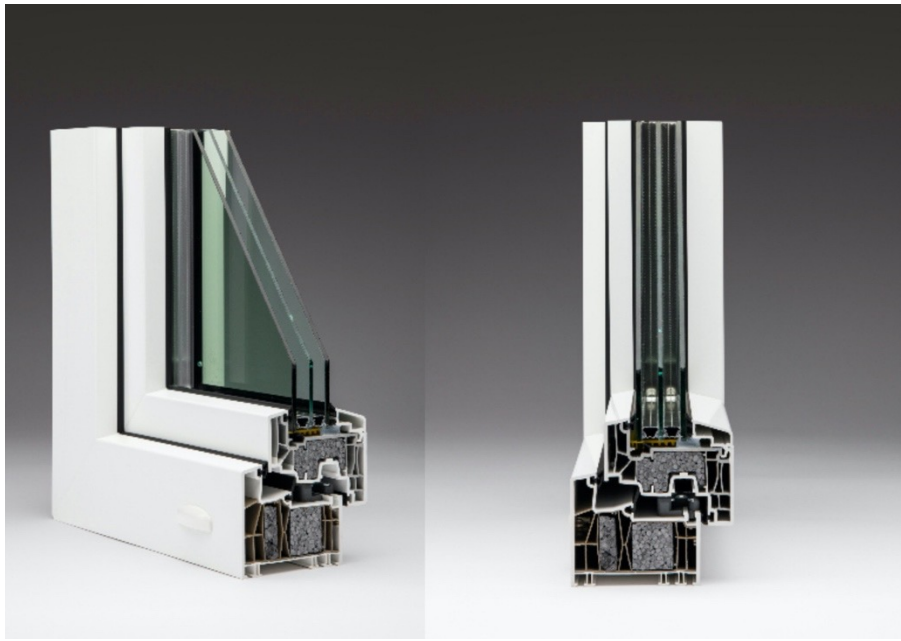
cool, temperate climate

phB

Passive House efficiency class: phE | phD | phC | phB | phA

CERTIFIED COMPONENT
Passive House Institute

www.passivehouse.com



Heavy

Require installation by professionals,

Not installed by framers

Cost

Shop drawing more demanding

zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

Methods for dealing with overheating:

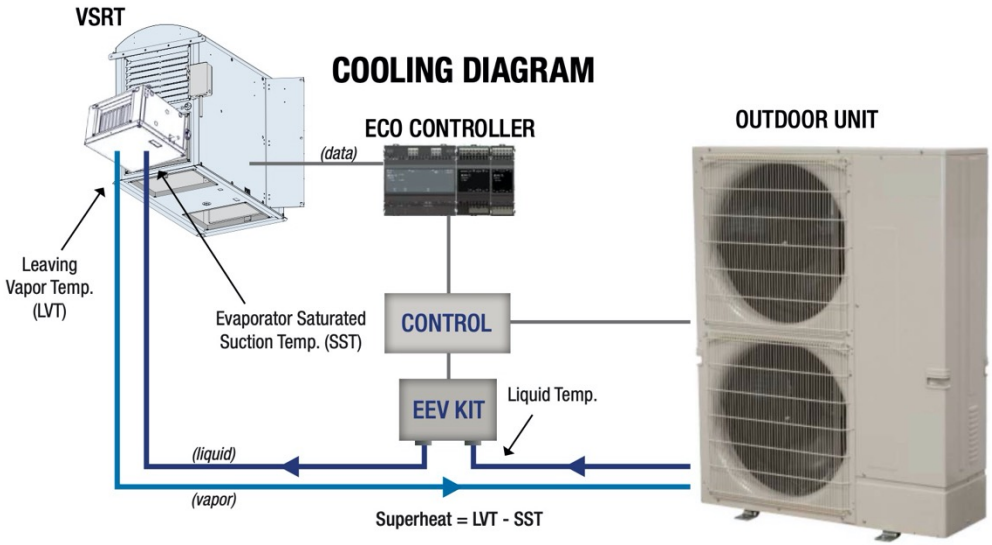
Opening windows

Supply air cooling specified

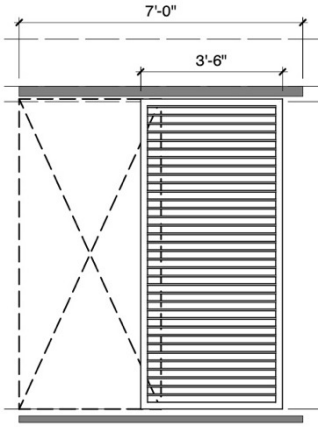
Fixed or Operable shading

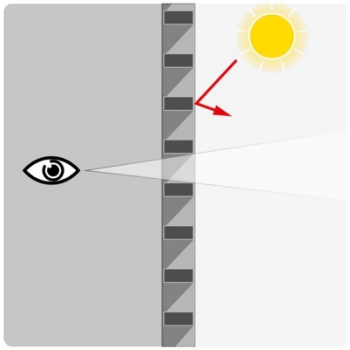
Ceiling fans (rough-in)

Smart glass (could be considered)



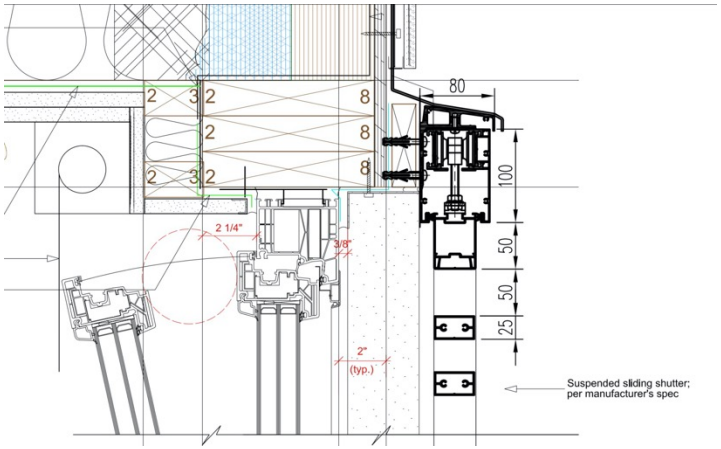
Manual Sliding Screens





Shading percentage depends on the angle of the sun - from 100% to 0%

Rely on occupant behavior



Difficult mounting detail

Not much local supply

High cost per window

THEMES

compactness

window / shading

materials / building science

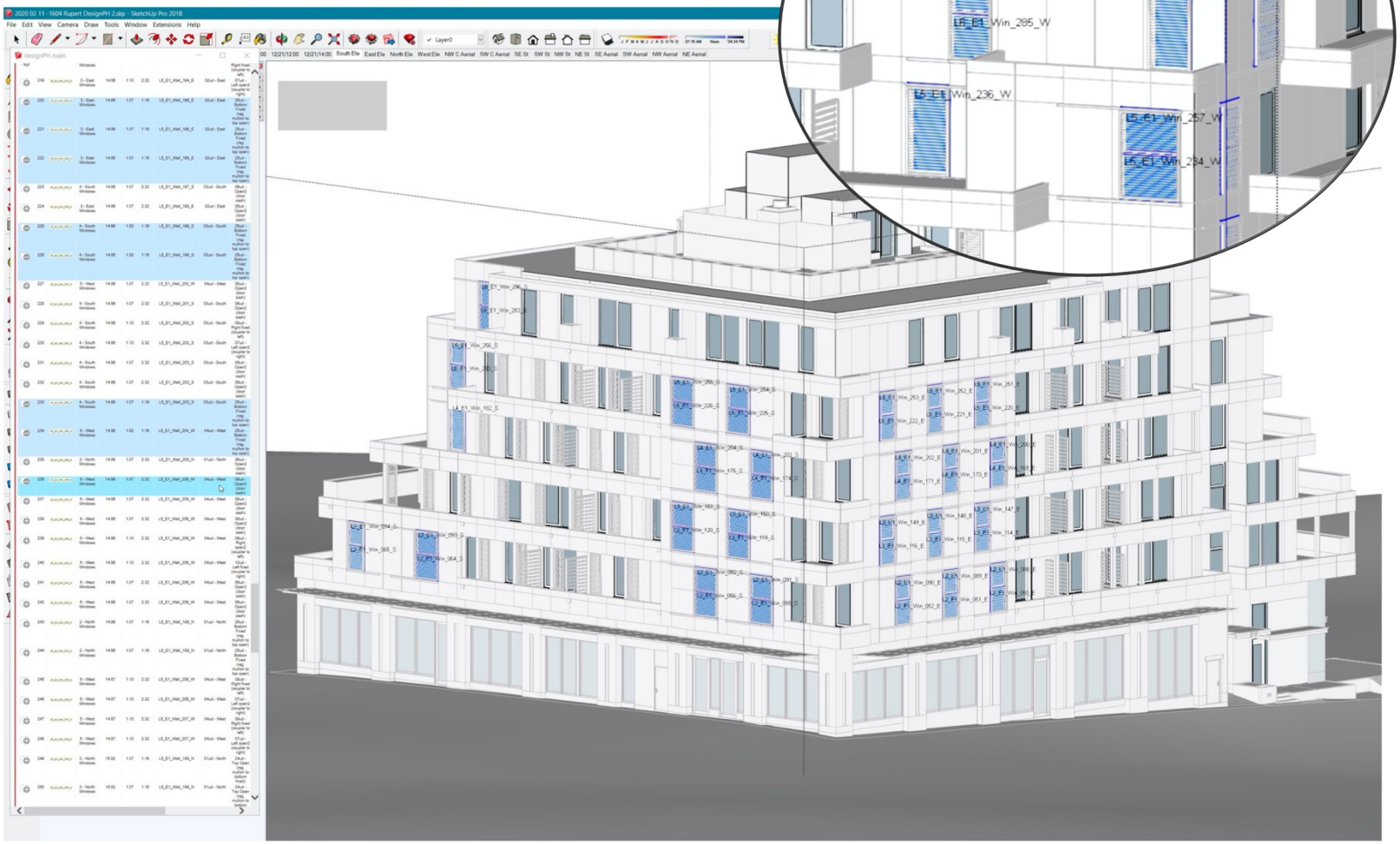
details / mock-up

commissioning

DESIGN TEAM

CONSTRUCTION TEAM

Manual sliding screens are modeled twice, once in open position and once in closed, and use a weighted average

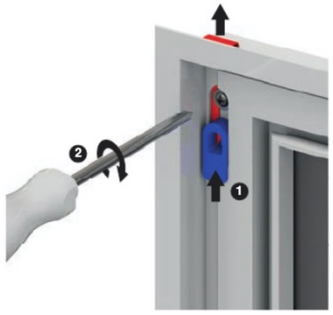


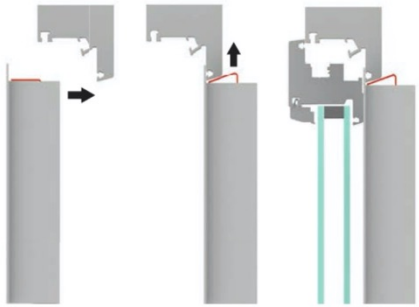
zebx

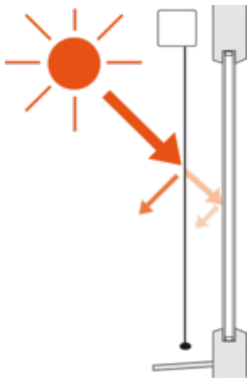
PASSIVEHOUSE CANADA

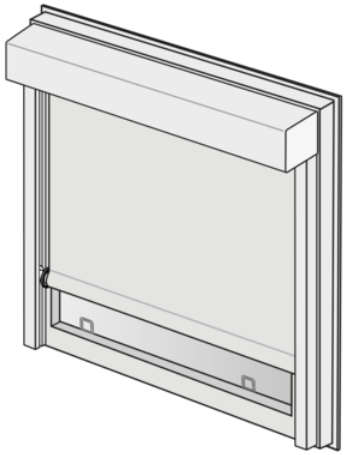
CORNERSTONE architecture

BOLD CONSTRUCTION









Automated Exterior Blinds

Window frame mounted version that can be installed from the inside

Good long-term access for maintenance

Provides 86% shading throughout

Allow for higher solar heat gain glass

Automated for better control

THEMES

compactness

window / shading

materials / building science

details / mock-up

commissioning

zebx

PASSIVEHOUSE CANADA

DESIGN TEAM

design challenges

design decisions

energy model

verification

CORNERSTONE architecture

CONSTRUCTION TEAM

constructability

cost

schedule

trades education

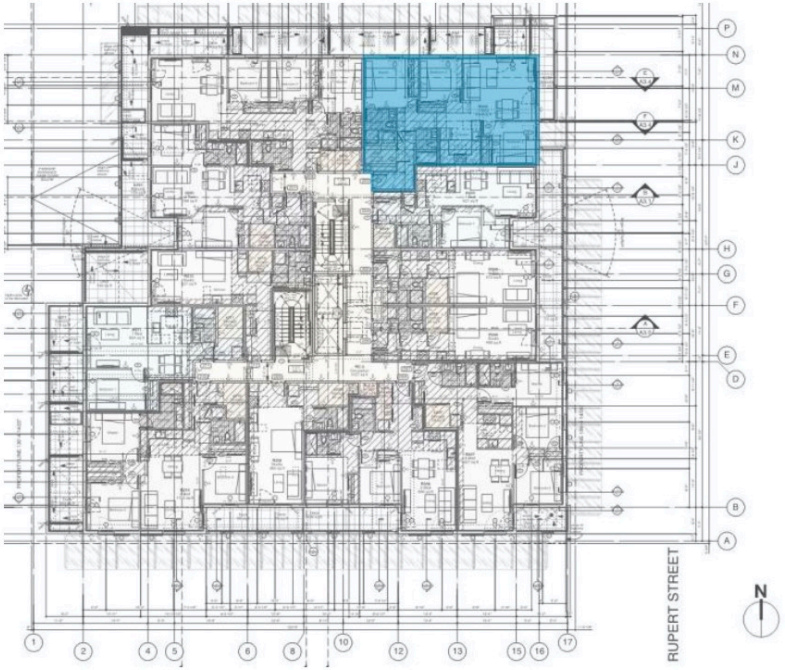
BOLD CONSTRUCTION

RDH selected 3 units for critical suite overheating analysis

6th floor south facing 1-bedroom suite

6th floor south-west facing 2-bedroom corner suite

2nd floor north-east facing 3-bedroom corner suite



THEMES

compactness

window / shading

materials / building science

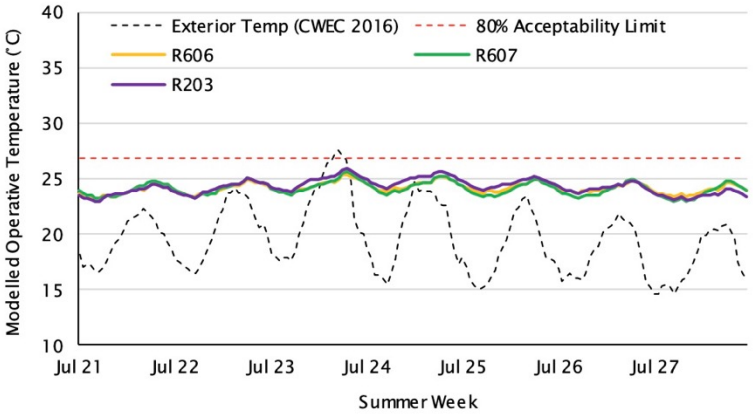
details / mock-up

commissioning

zebx PASSIVEHOUSE CANADA

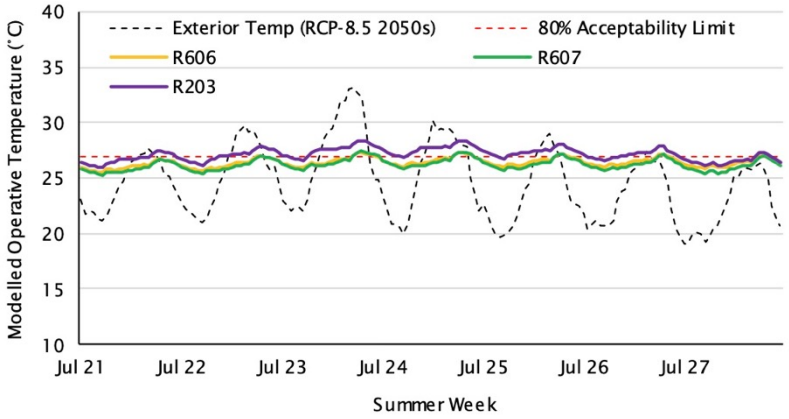
DESIGN TEAM	CONSTRUCTION TEAM

RDH



CWEC 2016

~ 5 hours above 80% acceptability limit



RCP-8.5 2050s

~ 602 hours above 80% acceptability limit

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

compactness

window / shading

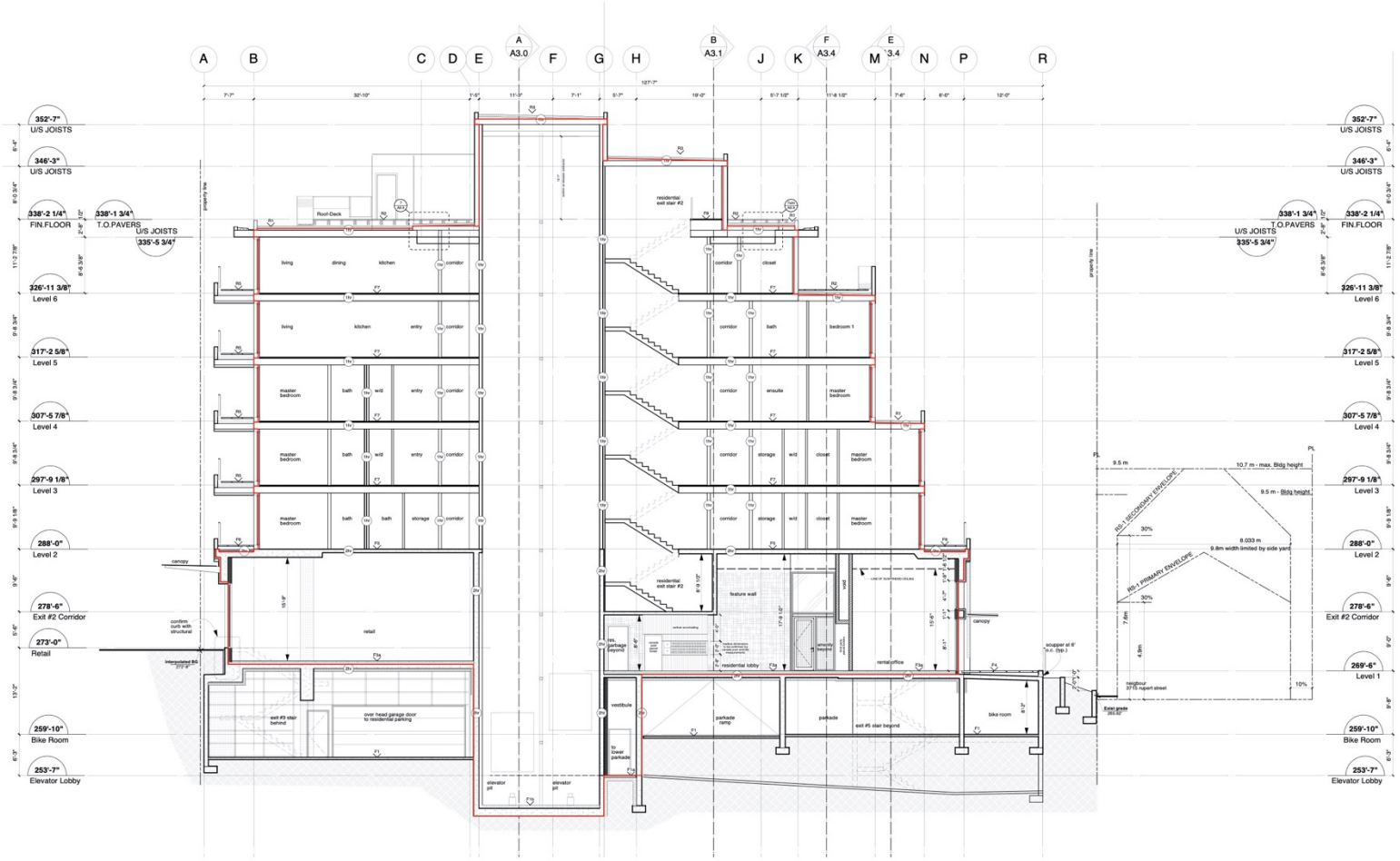
materials / building science

details / mock-up

commissioning

DESIGN TEAM

CONSTRUCTION TEAM



Detailing continuity of air barrier in section and in plan

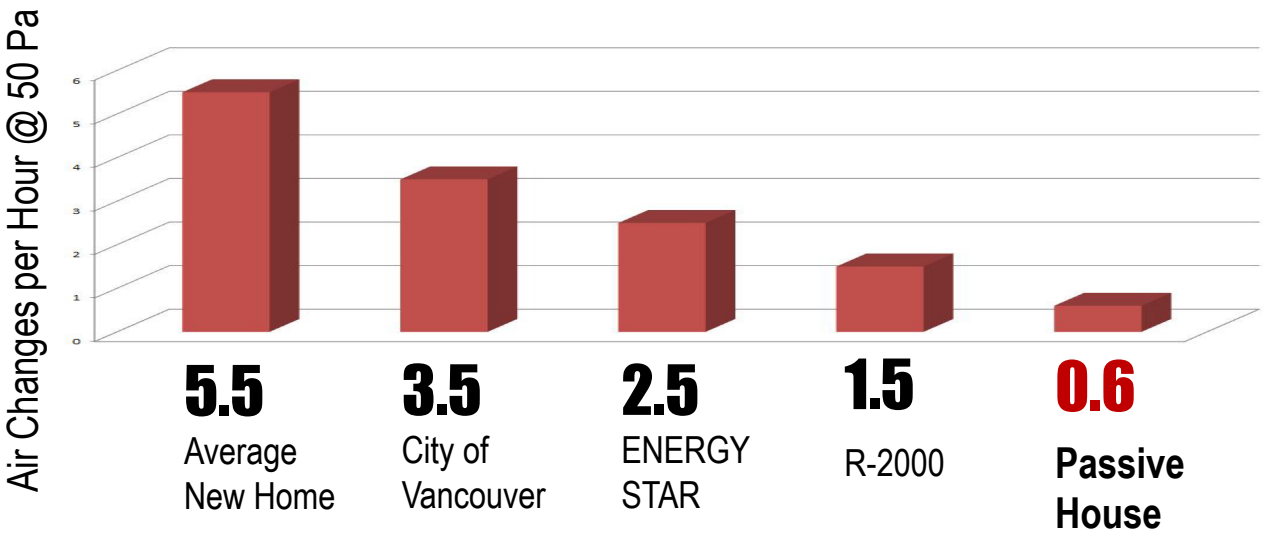
Educating the trade regarding the required details

zebx

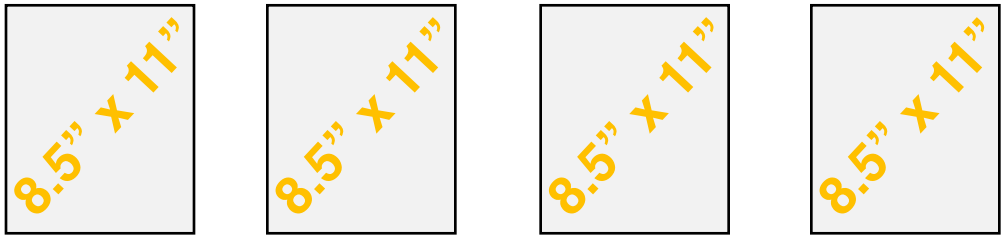
PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

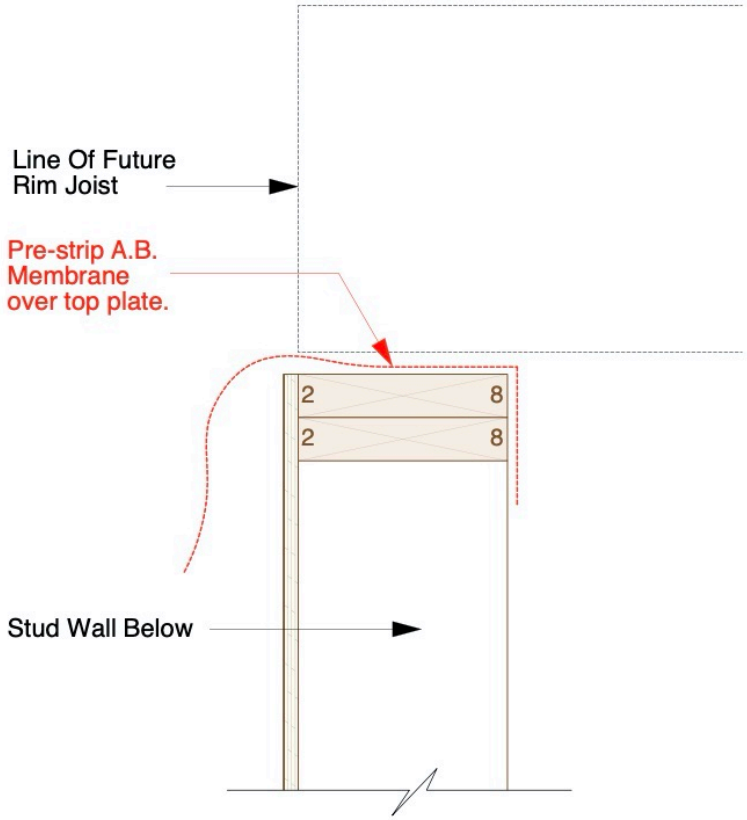


400 inch² of hole @ 10Pa for the entire building envelope



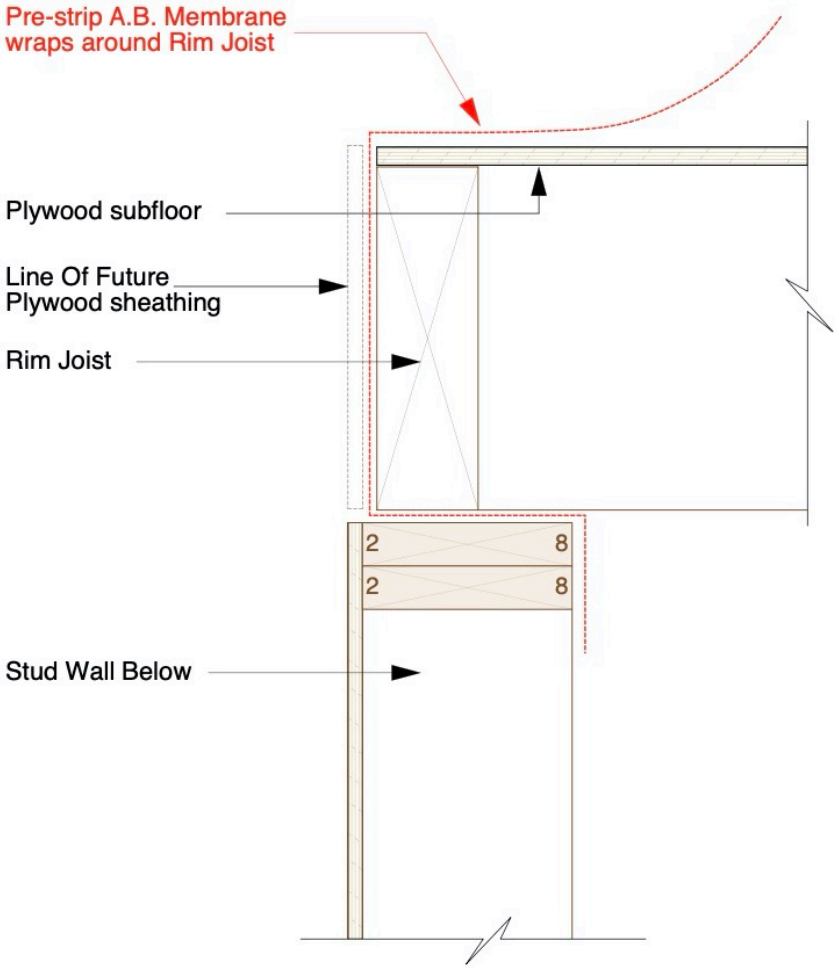
DESIGN TEAM

CONSTRUCTION TEAM



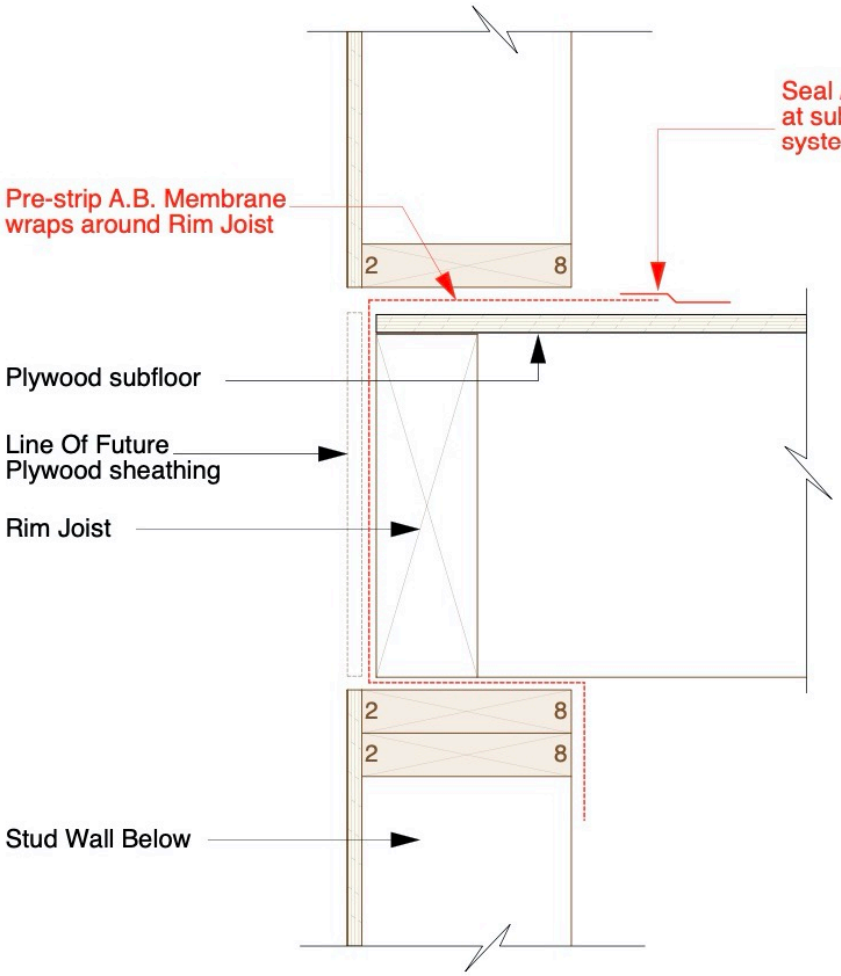
STEP 1

coordination with the trades to provide the “floppy bits”



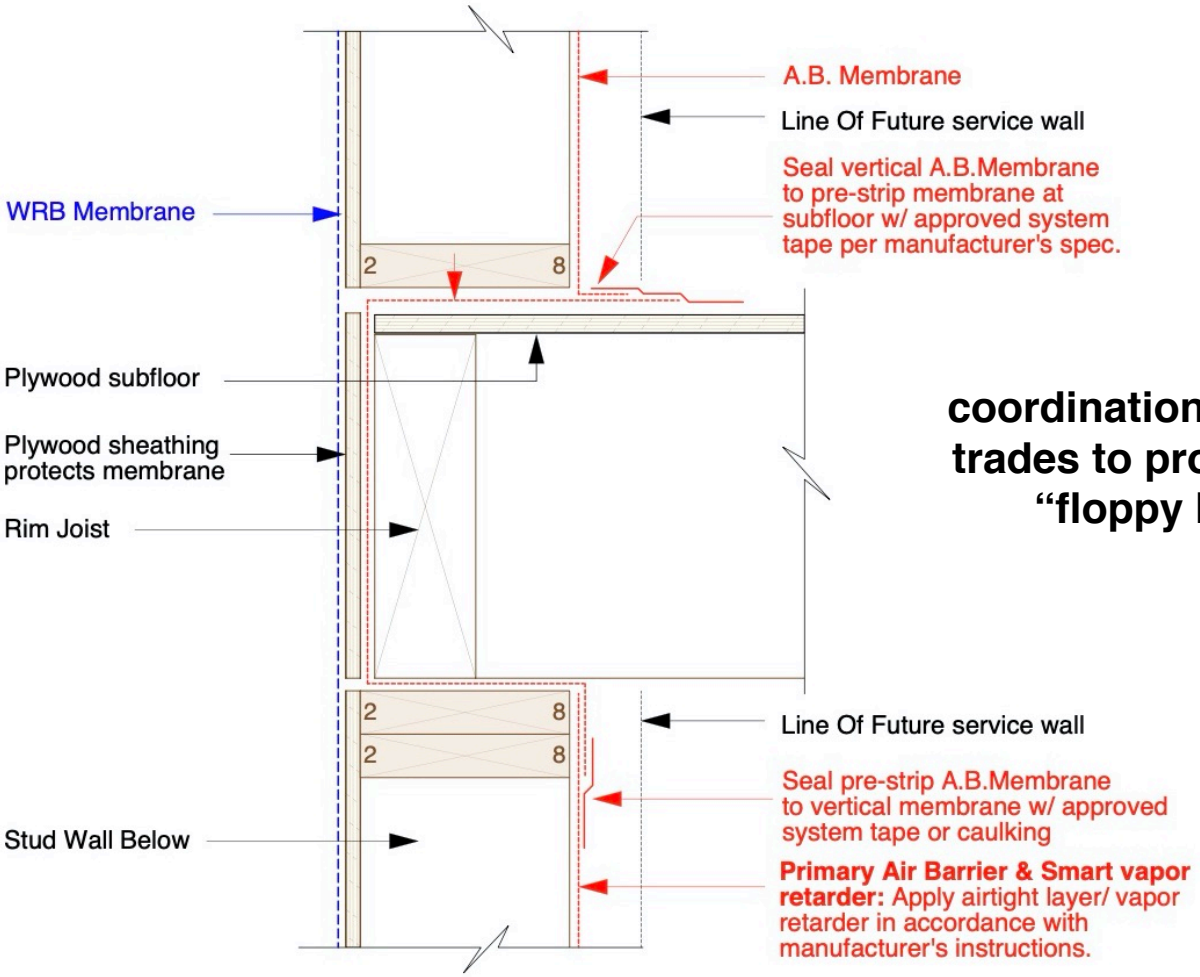
STEP 2

coordination with the trades to provide the "floppy bits"



STEP 3

coordination with the trades to provide the "floppy bits"



coordination with the trades to provide the "floppy bits"

STEP 4

DESIGN TEAM

CONSTRUCTION TEAM

Smart vapour control layer allowed more insulation in the roof cavity

Educate the trade to protect vulnerable air barrier components

DESIGN TEAM

CONSTRUCTION TEAM

EPDM Gasket Template

Provide penetration schedule

Verify 1 wire per hole, ensure floppy bits are installed by the trades while wires and pipes are being installed

THEMES

compactness

window / shading

materials / building science

details / mock-up

commissioning

DESIGN TEAM

design challenges

design decisions

energy model

verification

BREAK

CONSTRUCTION TEAM

constructability

cost

schedule

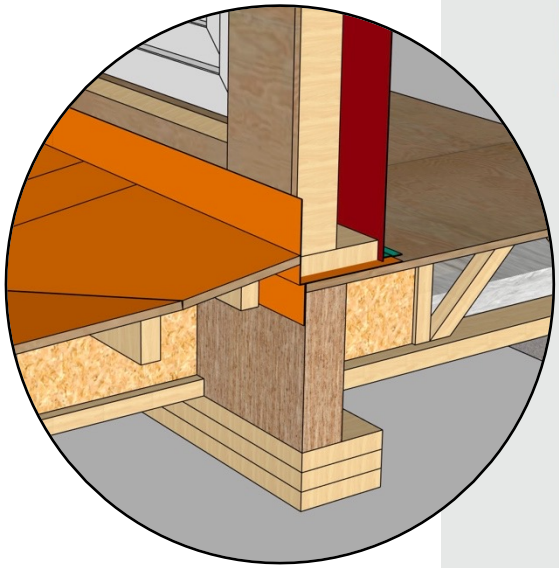
trades education

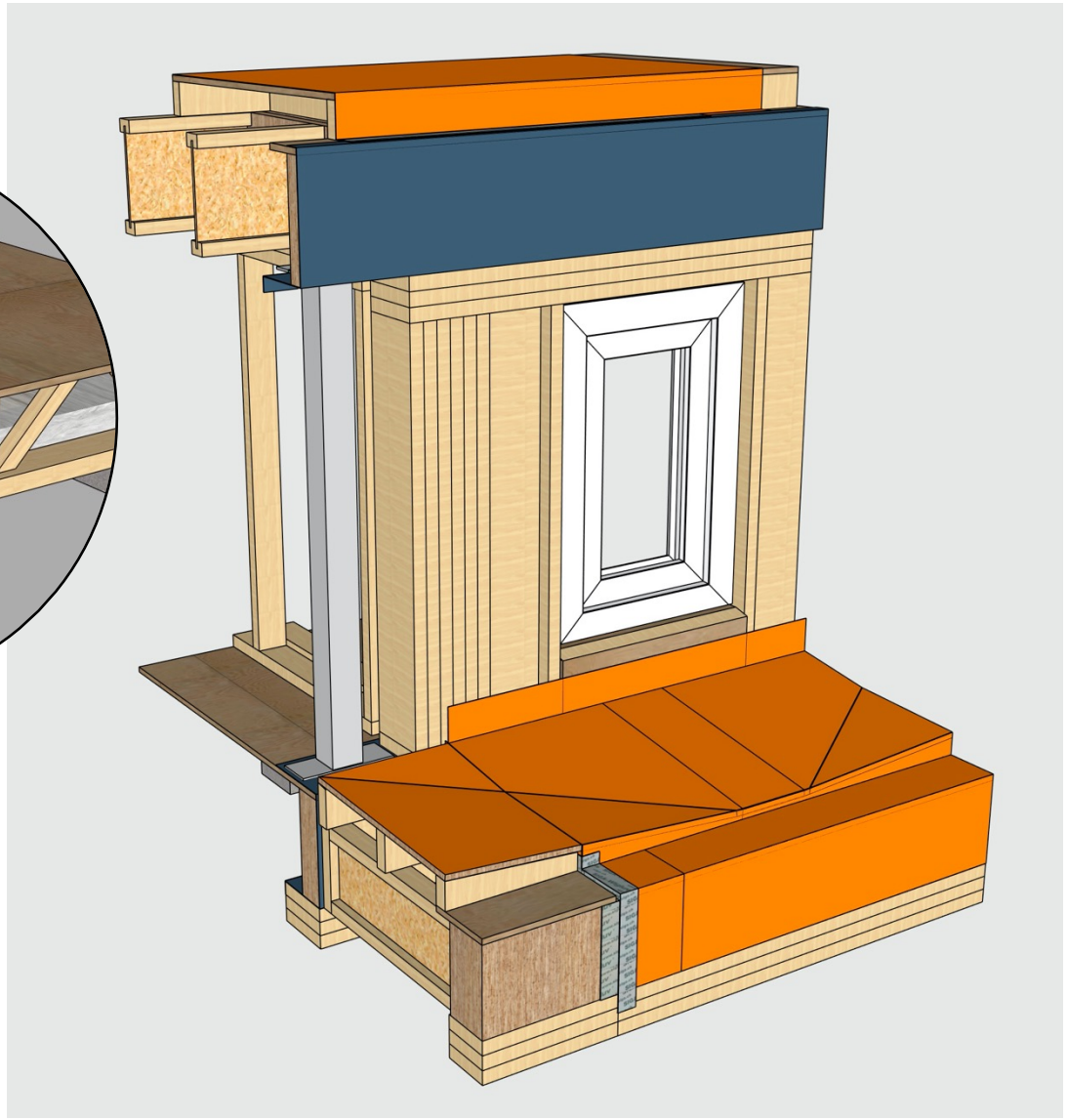
zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION





Sequencing of framing and membranes

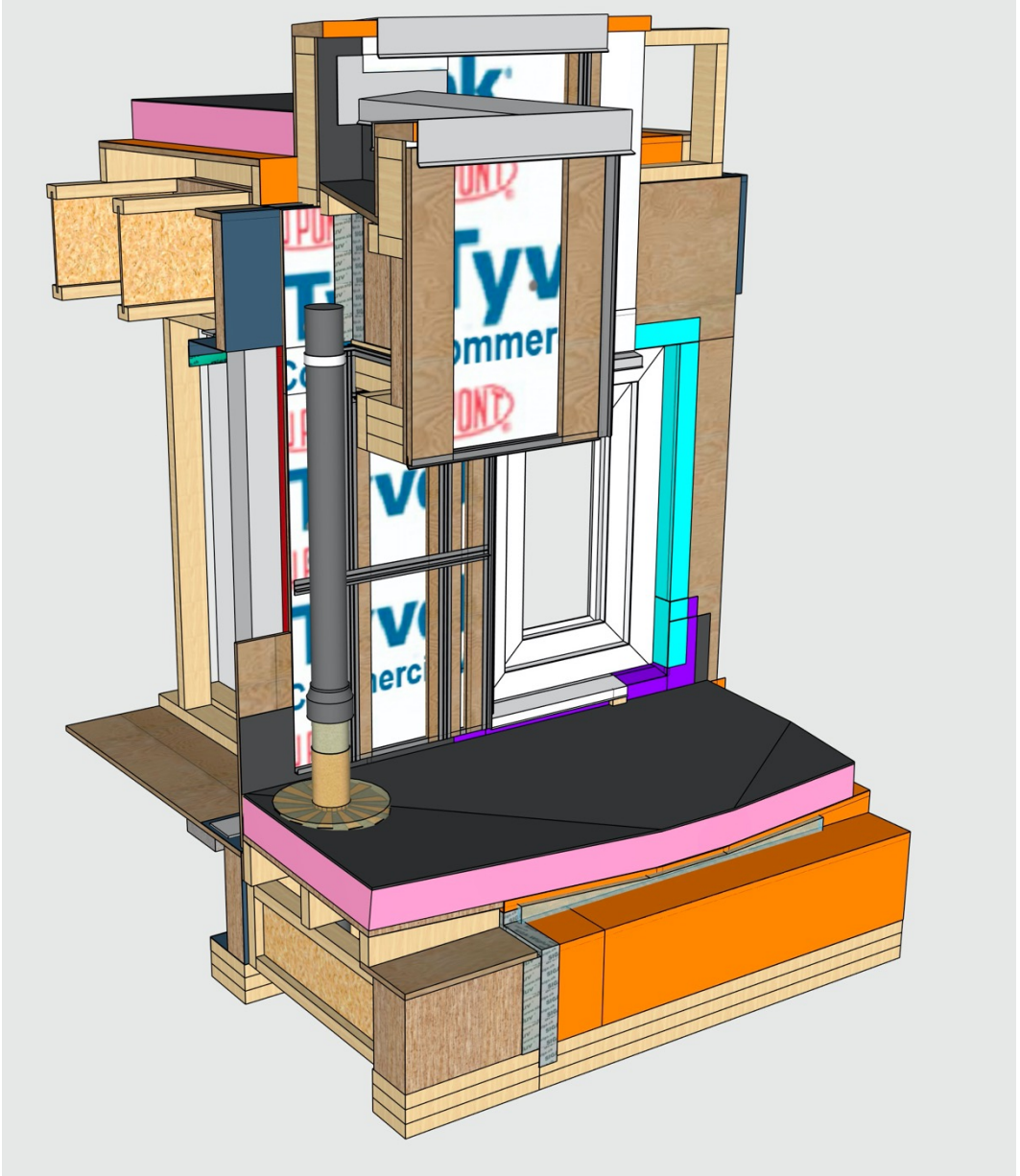
compactness

window / shading

materials / building science

details / mock-up

commissioning



THEMES

DESIGN TEAM

CONSTRUCTION TEAM

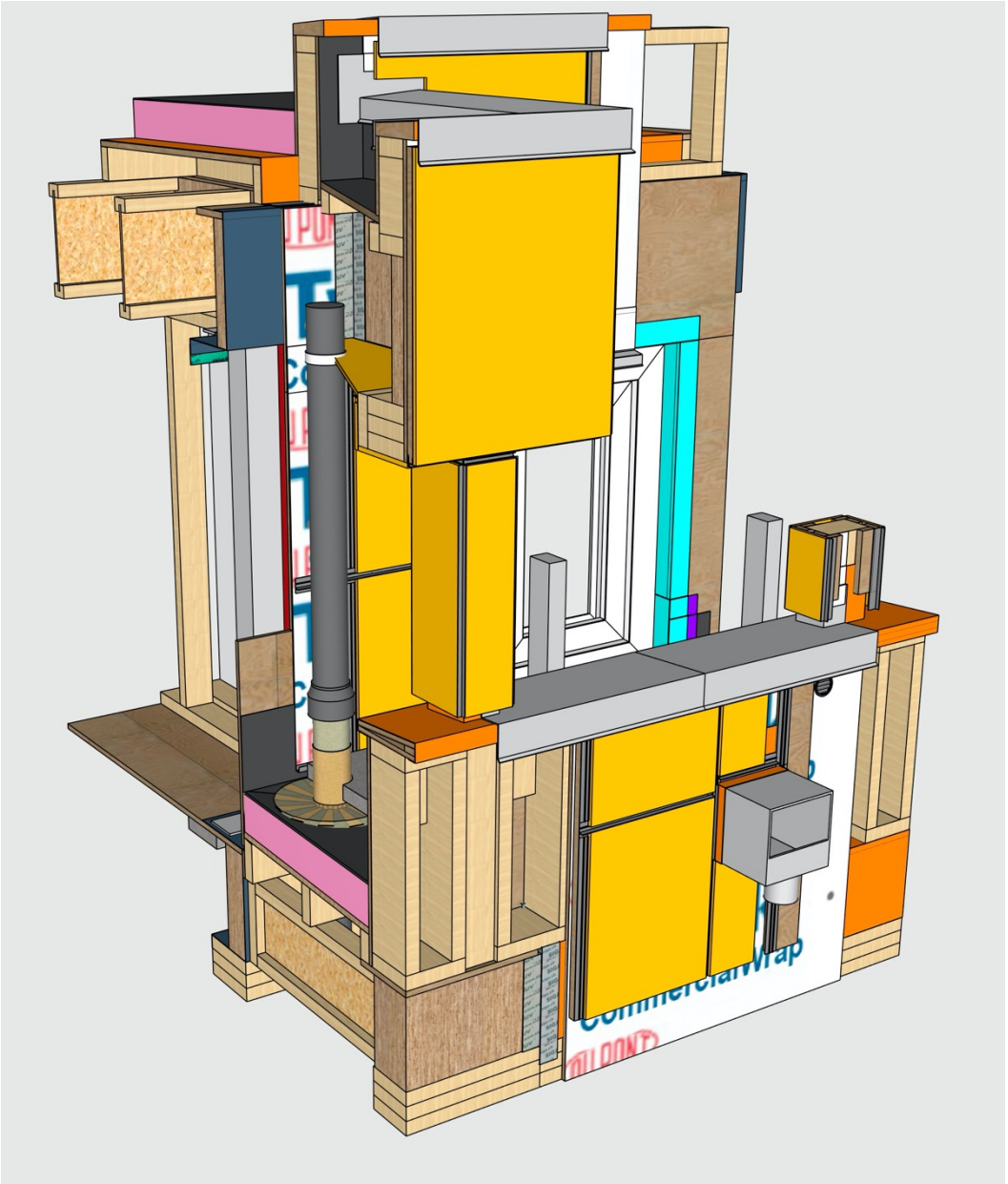
compactness

window / shading

materials / building science

details / mock-up

commissioning



zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

DESIGN TEAM | CONSTRUCTION TEAM

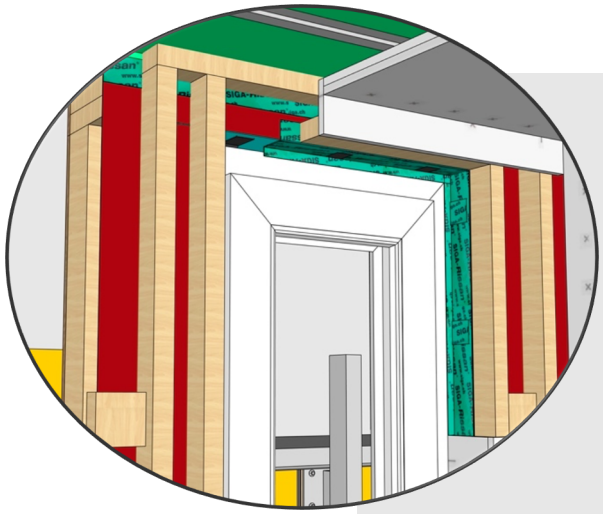
compactness

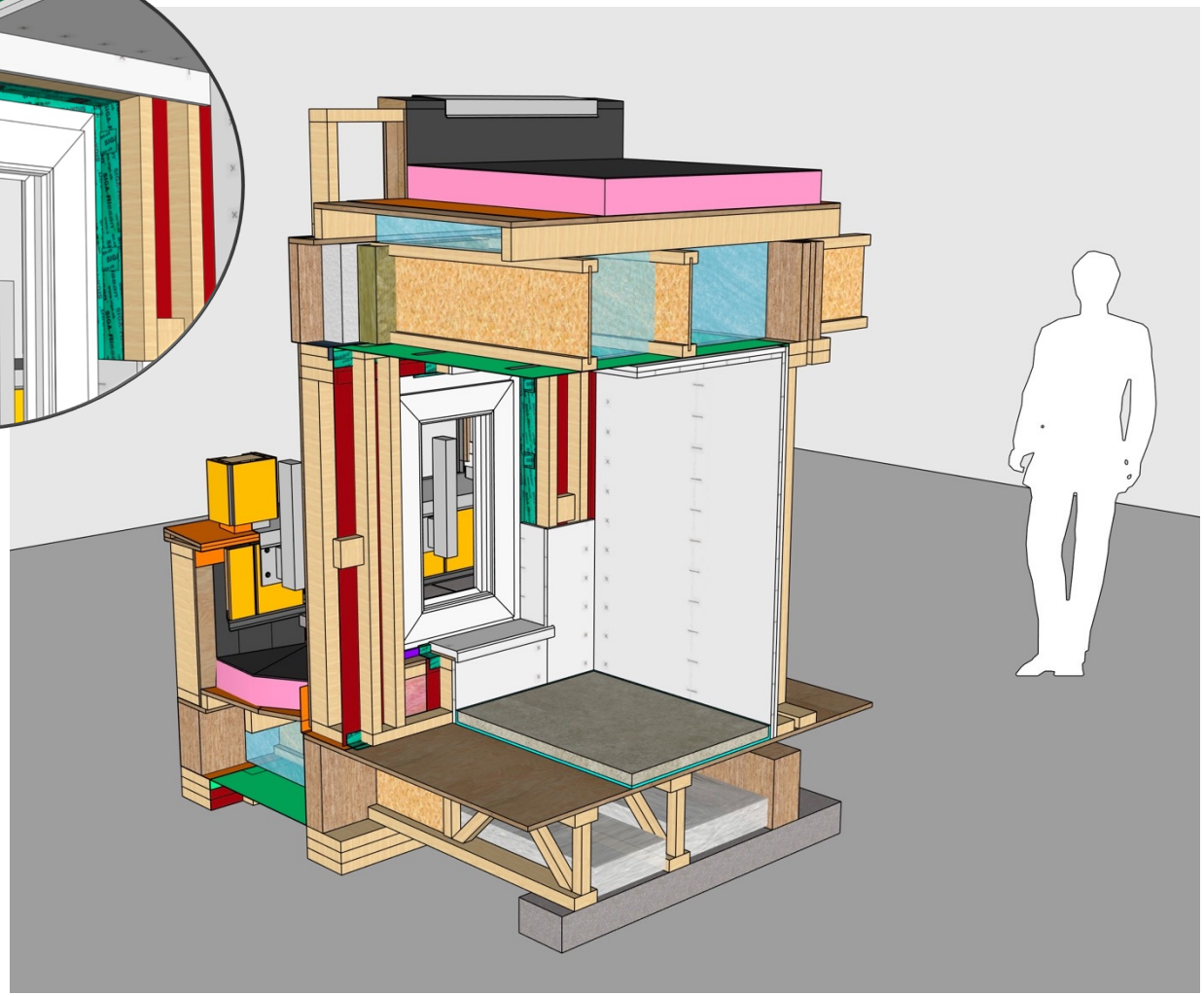
window / shading

materials / building science

details / mock-up

commissioning





zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

DESIGN TEAM

CONSTRUCTION TEAM

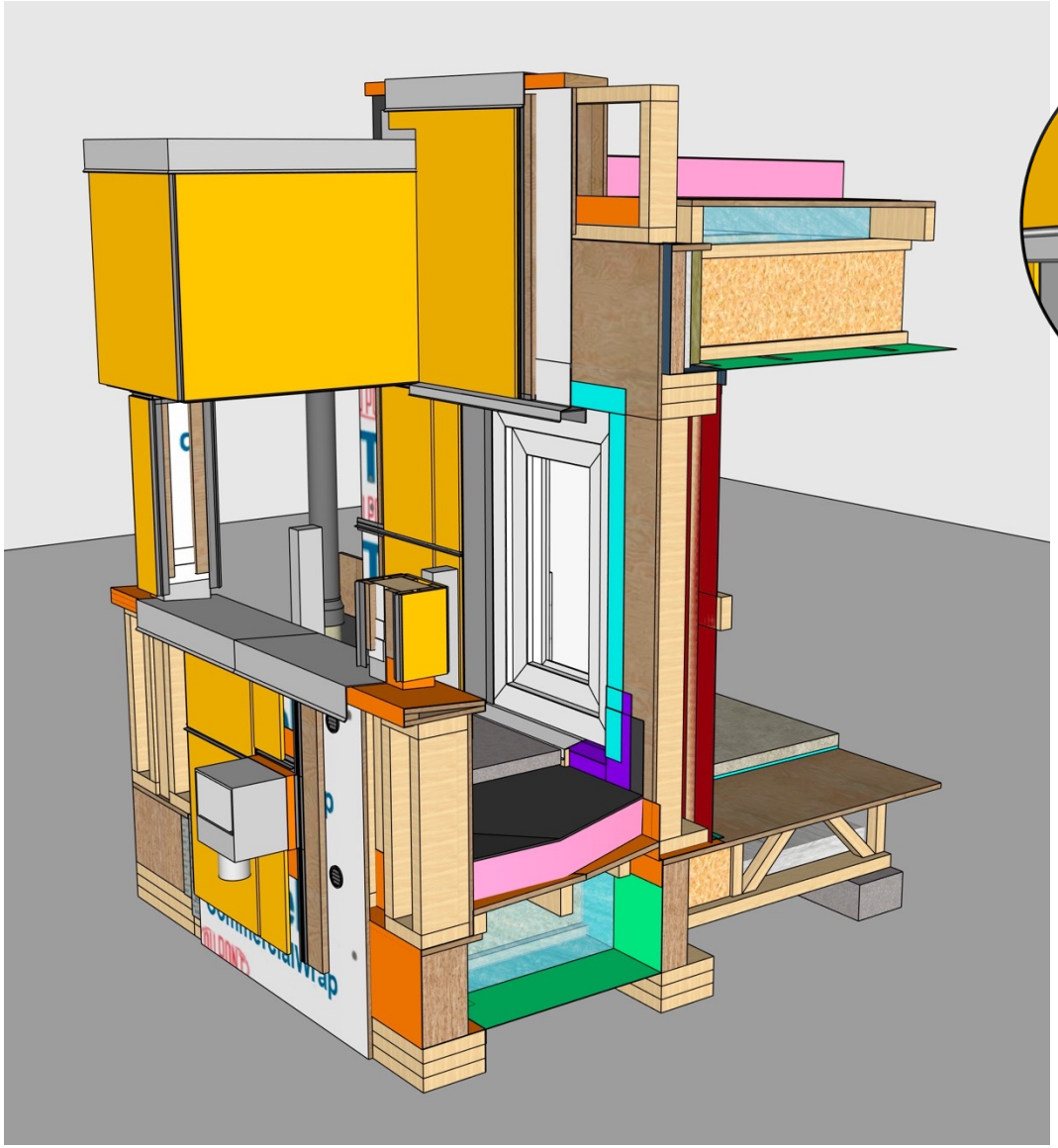
compactness

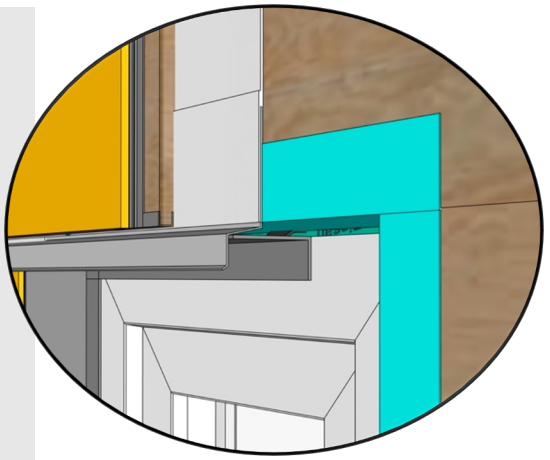
window / shading

materials / building science

details / mock-up

commissioning





Mock-up is key to working out the constructability of the details, educating the trades, and having a reference for when new trades and employees join the team

zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

DESIGN TEAM | CONSTRUCTION TEAM

compactness

window / shading

materials / building science

details / mock-up

commissioning

zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

compactness

window / shading

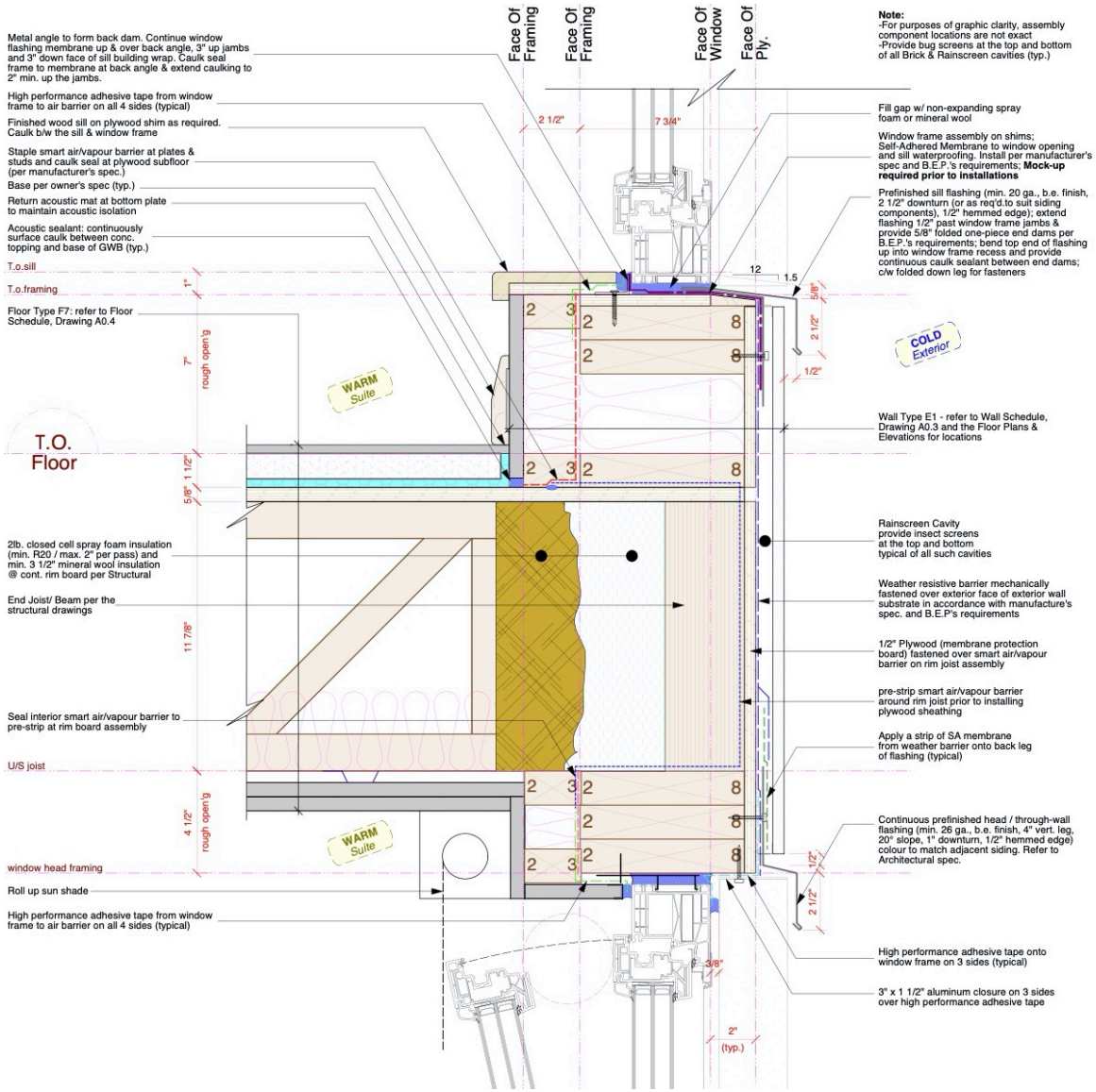
materials / building science

details / mock-up

commissioning

DESIGN TEAM

CONSTRUCTION TEAM



zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

compactness

window / shading

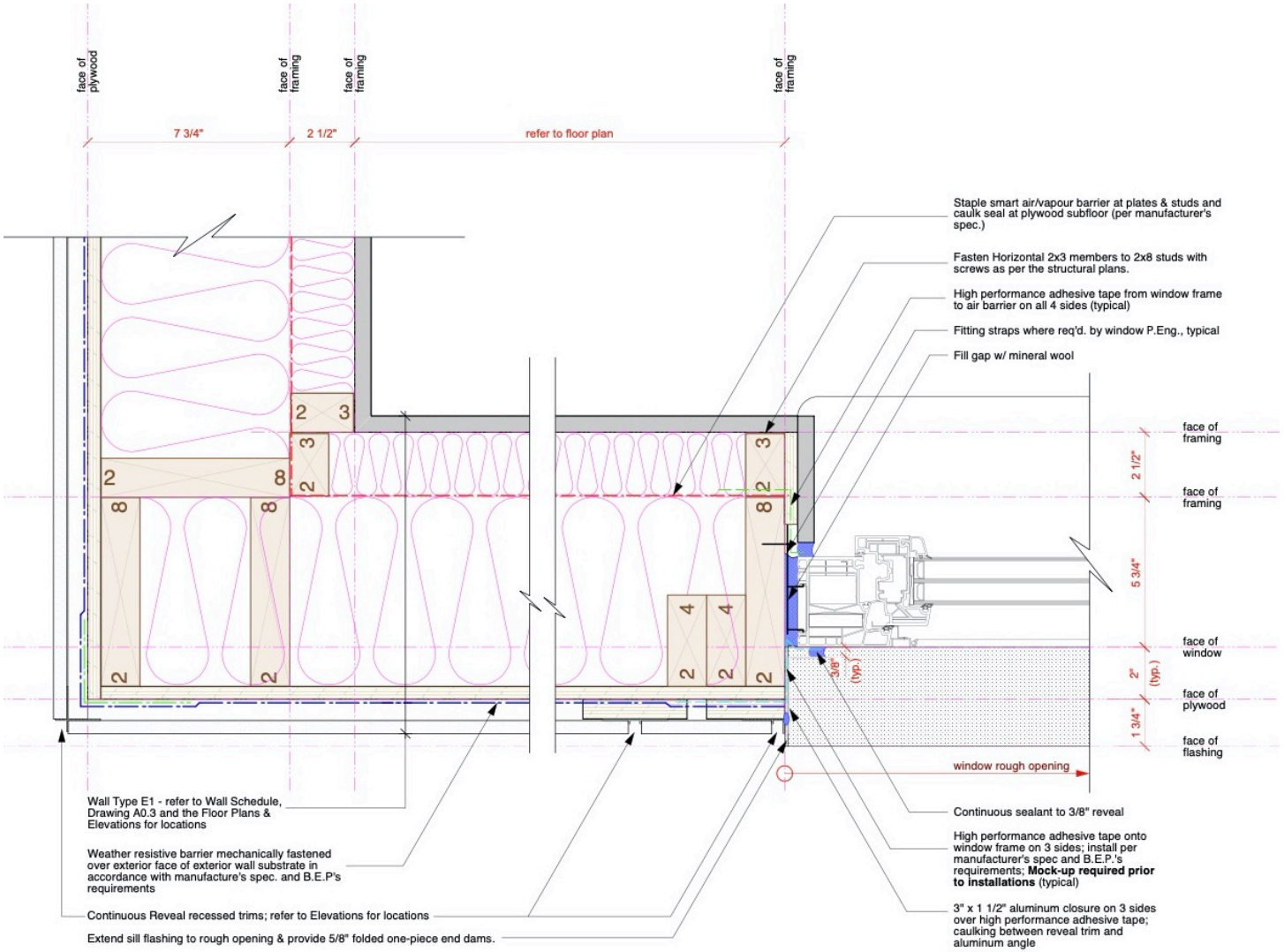
materials / building science

details / mock-up

commissioning

DESIGN TEAM

CONSTRUCTION TEAM



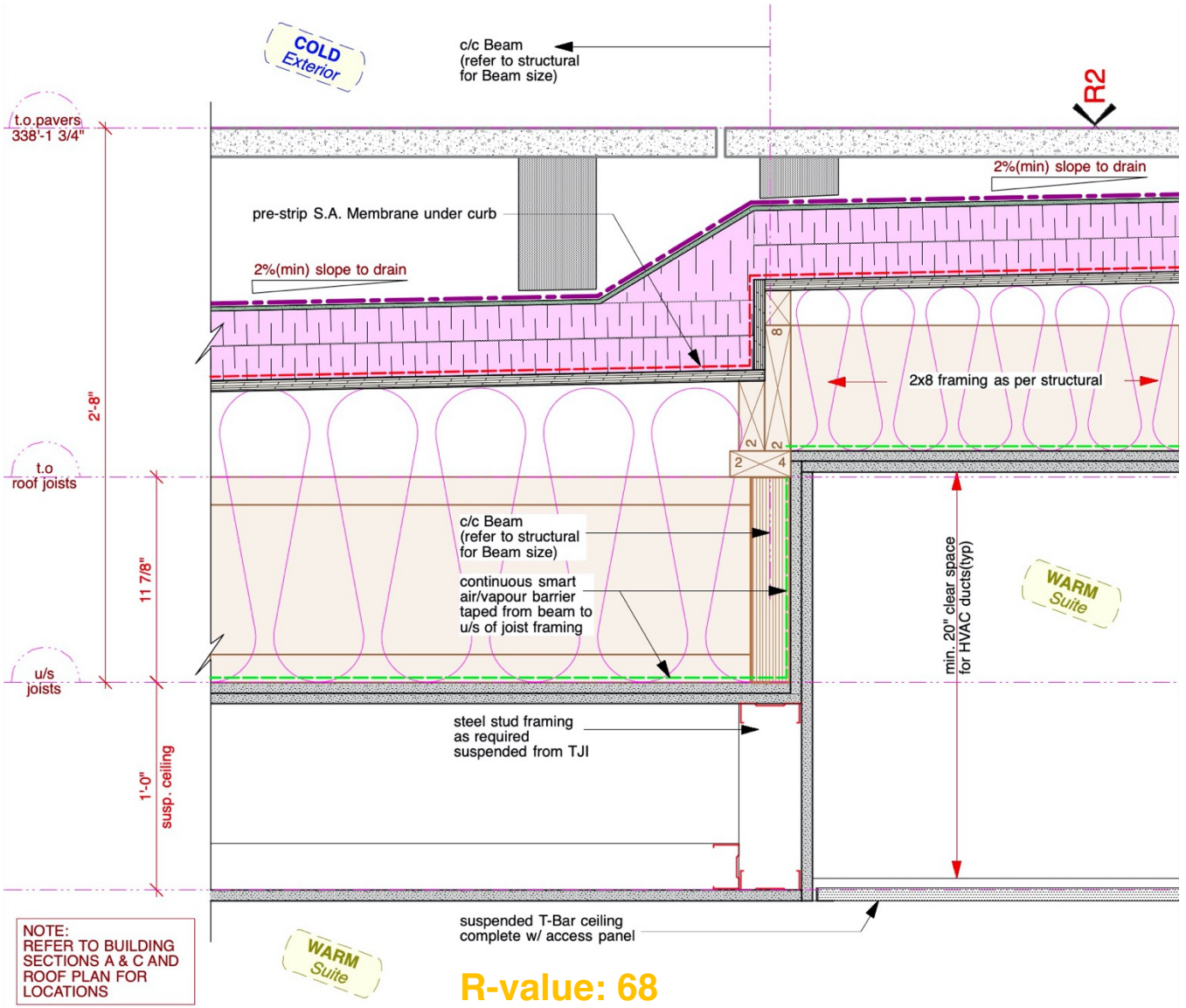
zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

Assembly no.	Building assembly description						Interior insulation?	
01ud	[E1] Exterior Wood Frame PH Wall							
		Heat transmission resistance [m²K/W]						
Orientation of building element	2-Wall	interior R_{si}	0.13					
Adjacent to	3-Ventilated	exterior R_{se}:	0.13					
Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]		Thickness [mm]	~ [in]
5/8" Gypsum wallboard	0.250						16	5/8
2 1/2 ComfortBatt	0.037	2x3 @24" OC	0.130				64	2 1/2
								0
7.25" ComfortBatt	0.037			2x8 @16" OC	0.130		184	7 1/4
1/2" Plywood	0.130						13	1/2
rainscreen								0
								0
								0
	Percentage of sec. 1		Percentage of sec. 2		Percentage of sec. 3		Total	
	72%		9.4%		18.8%		27.6	cm
			R (hr ft2.F/Btu)				RSI	R.eff
U-value supplement		W/(m²K)	31	U-value:	0.181	W/(m²K)	5.54	31.45



R-value: 68

U-value: 0.084

compactness

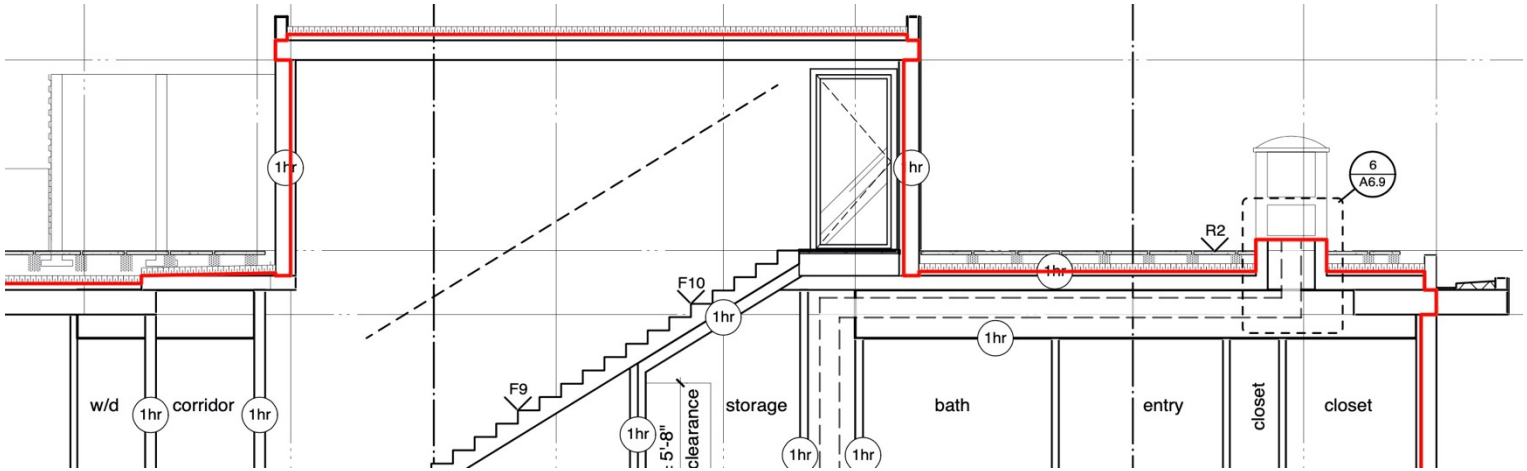
window / shading

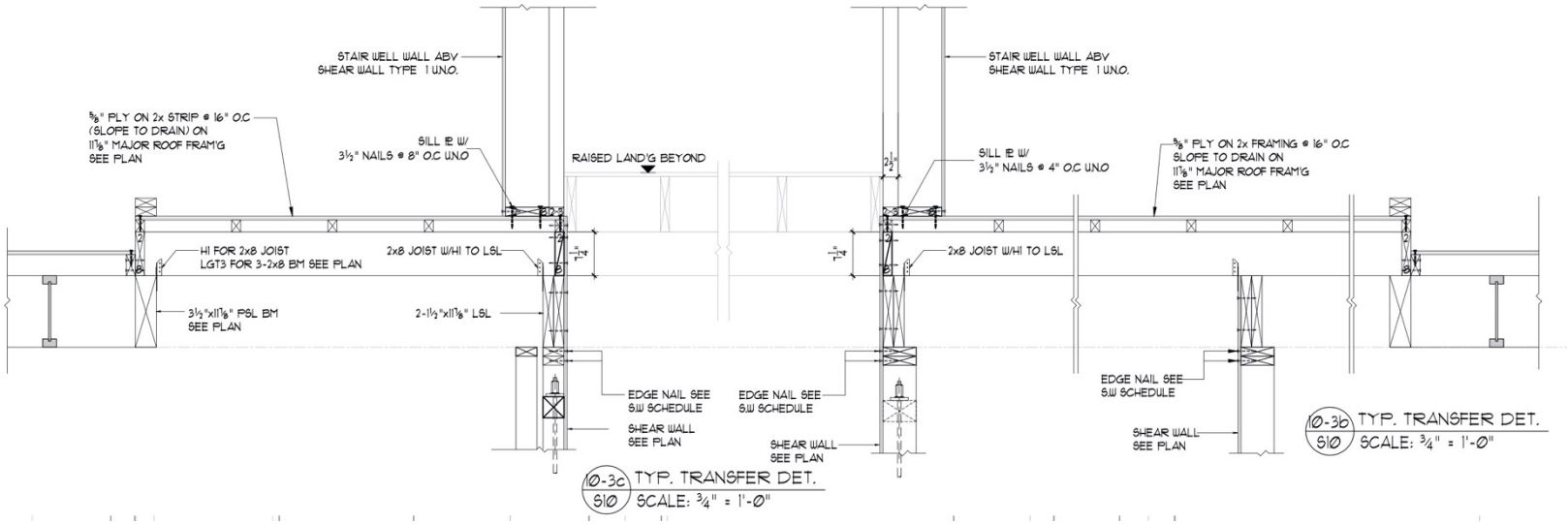
materials / building science

details / mock-up

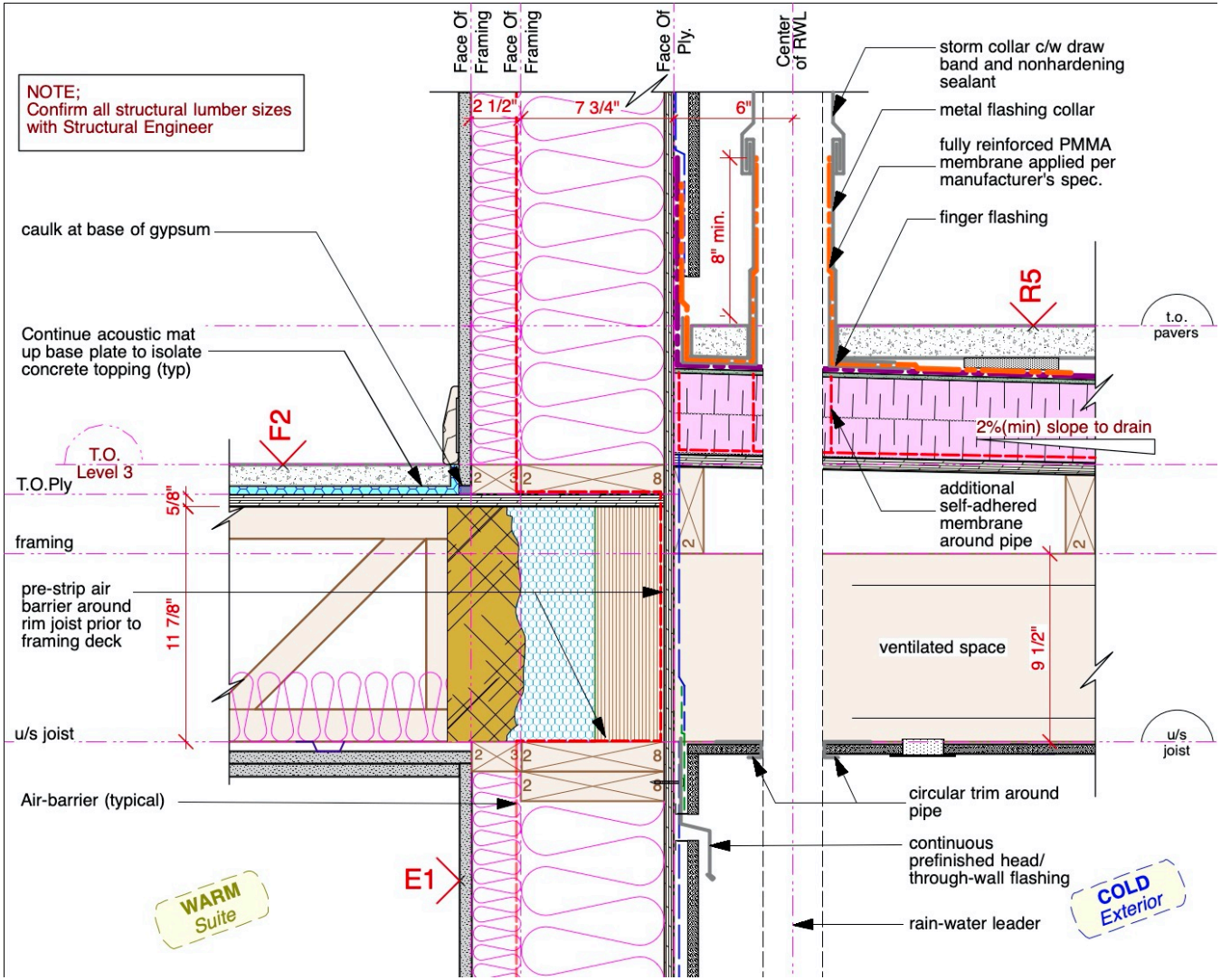
commissioning

Stepped roof structure to account for ventilation ducts and cooling coils





Exterior rainwater leader to reduce heat loss and thermal bridging



THEMES

compactness

window / shading

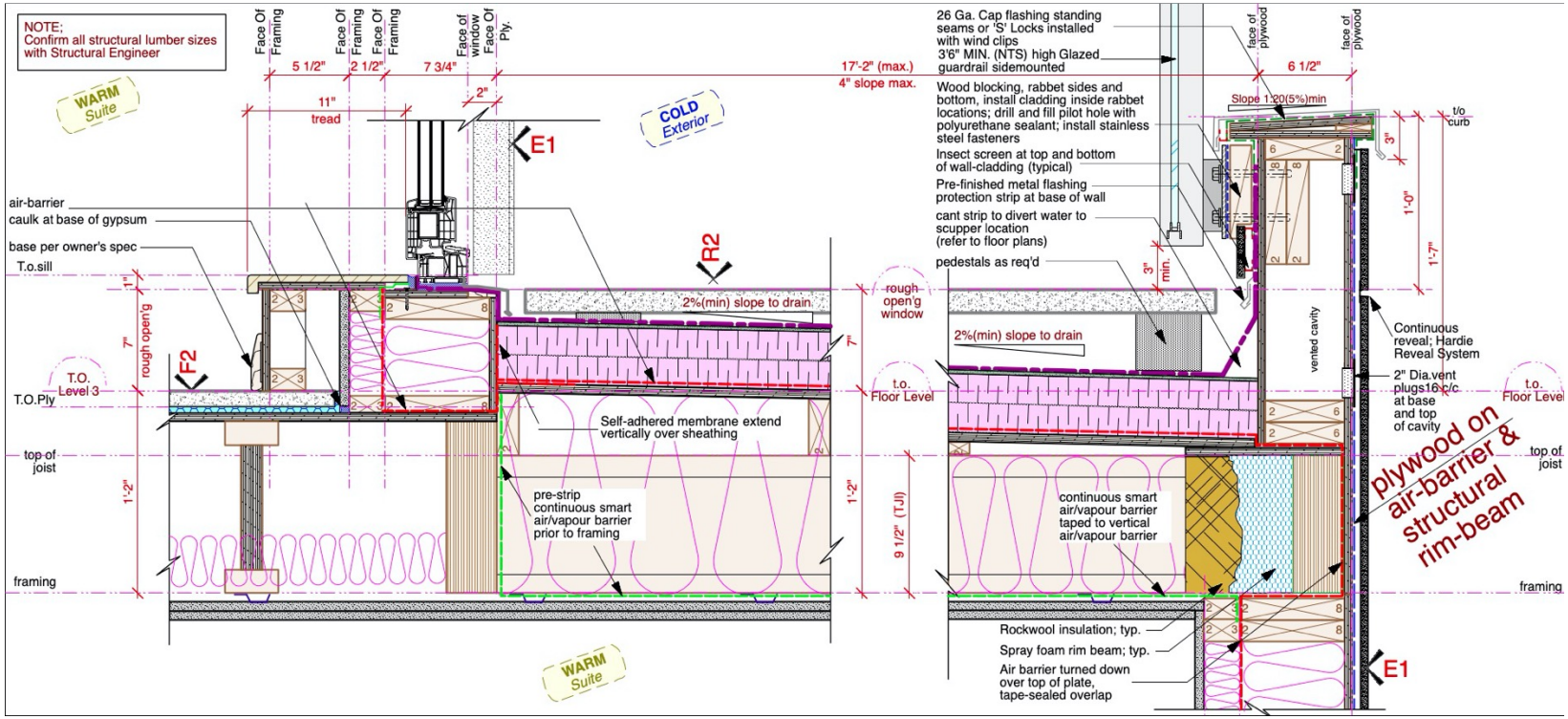
materials / building science

details / mock-up

commissioning

DESIGN TEAM

CONSTRUCTION TEAM



zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

compactness

window / shading

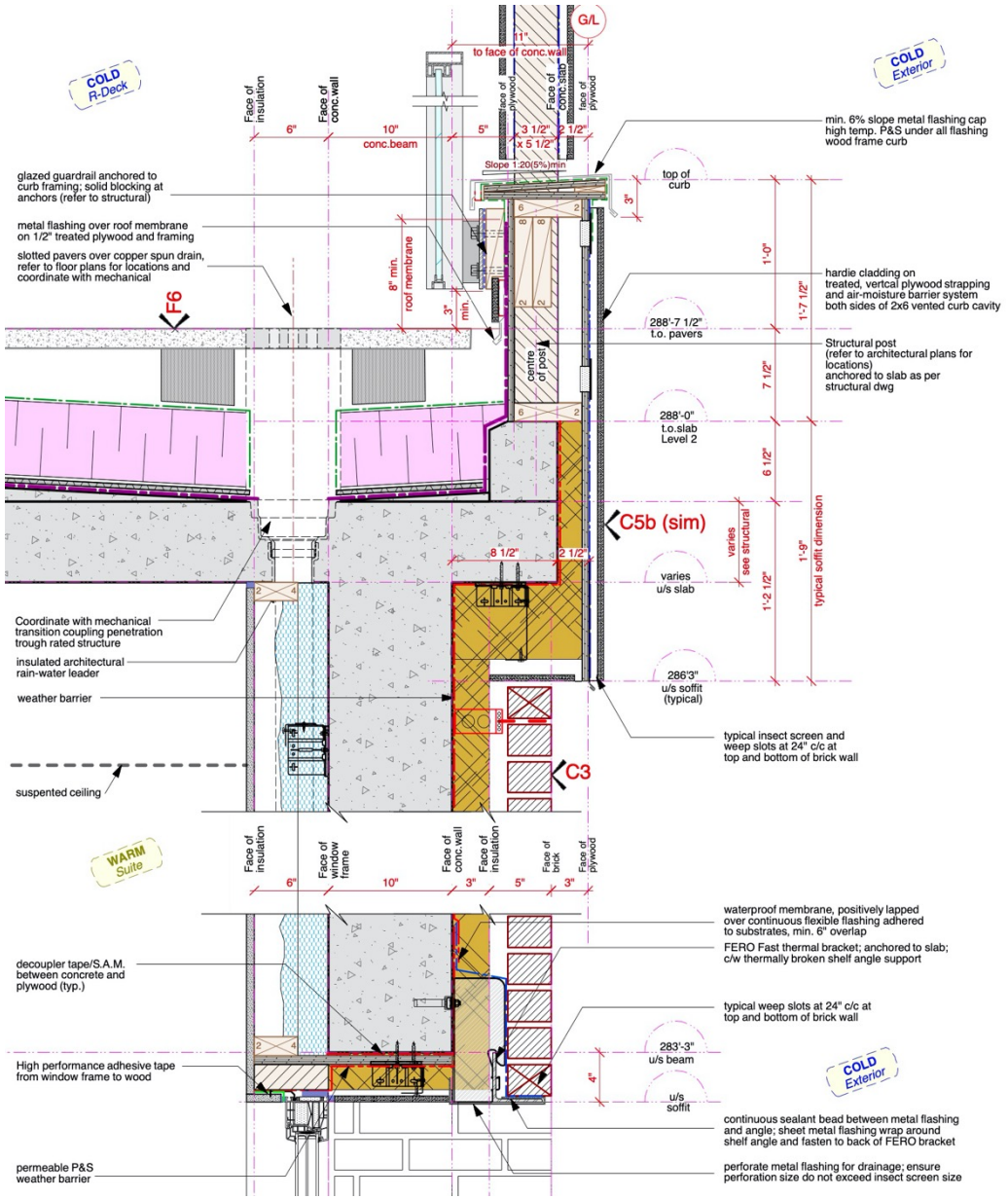
materials / building science

details / mock-up

commissioning

DESIGN TEAM

CONSTRUCTION TEAM



zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

compactness

window / shading

materials / building science

details / mock-up

commissioning

DESIGN TEAM

CONSTRUCTION TEAM

zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

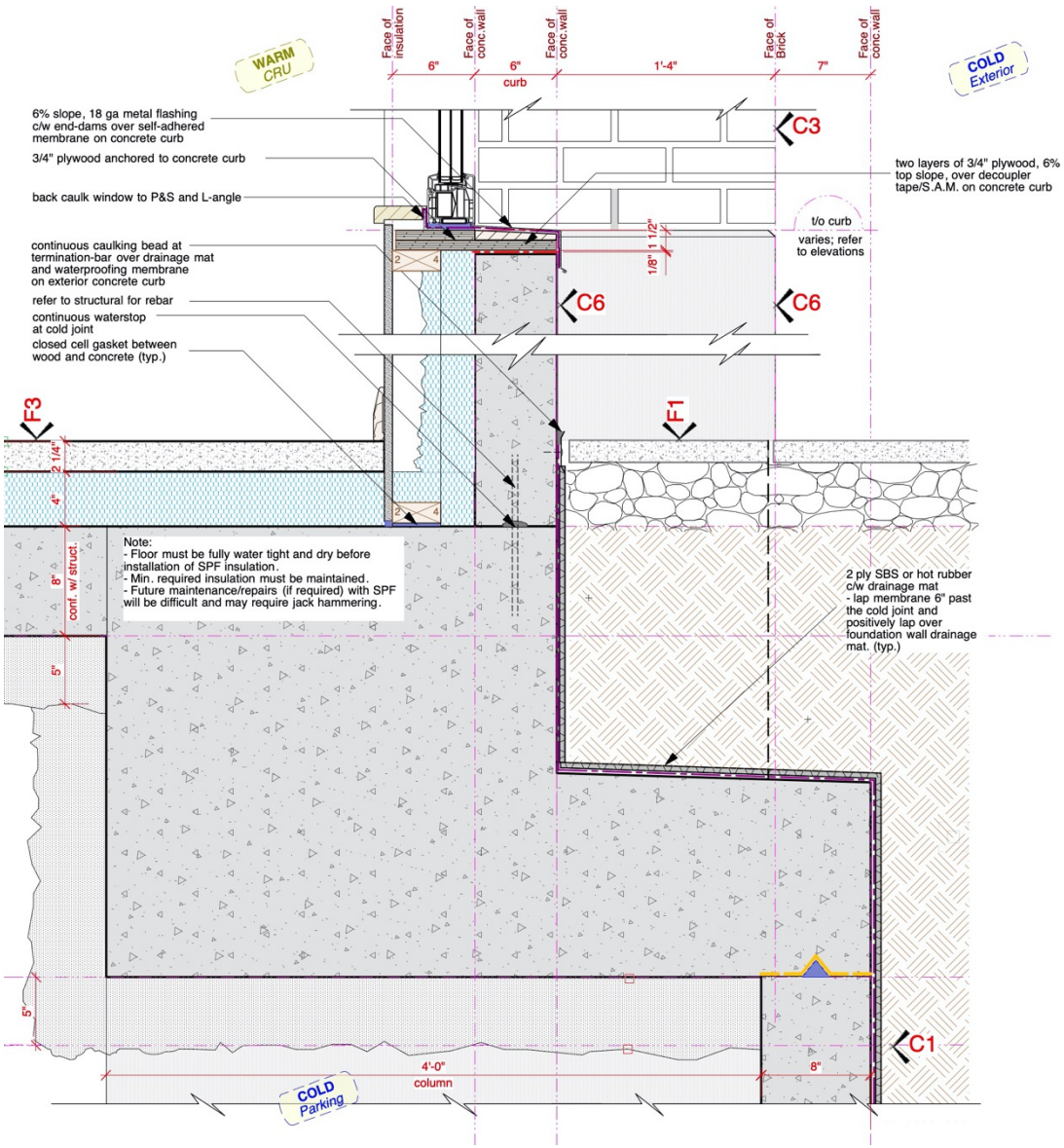
compactness

window / shading

materials / building science

details / mock-up

commissioning



THEMES

compactness

window / shading

materials / building science

details / mock-up

commissioning

DESIGN TEAM

CONSTRUCTION TEAM

zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

compactness

window / shading

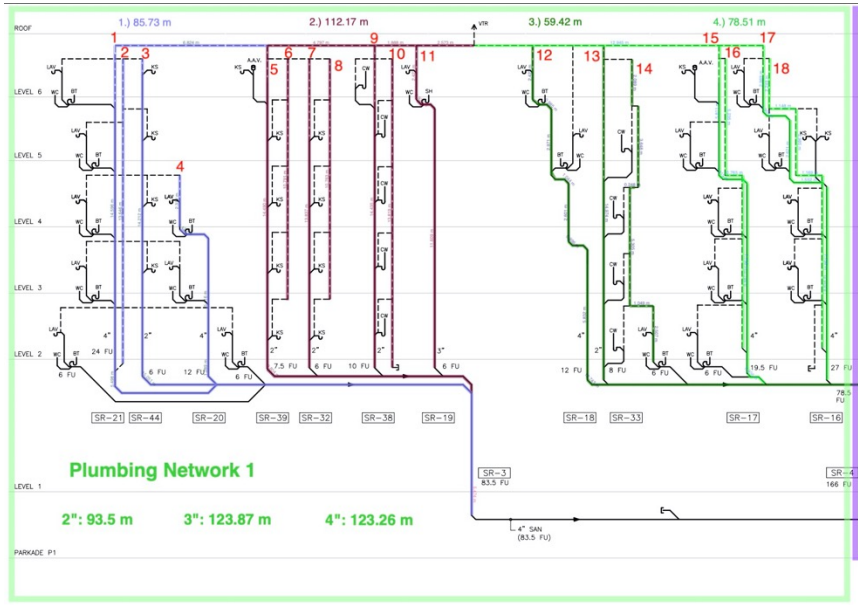
materials / building science

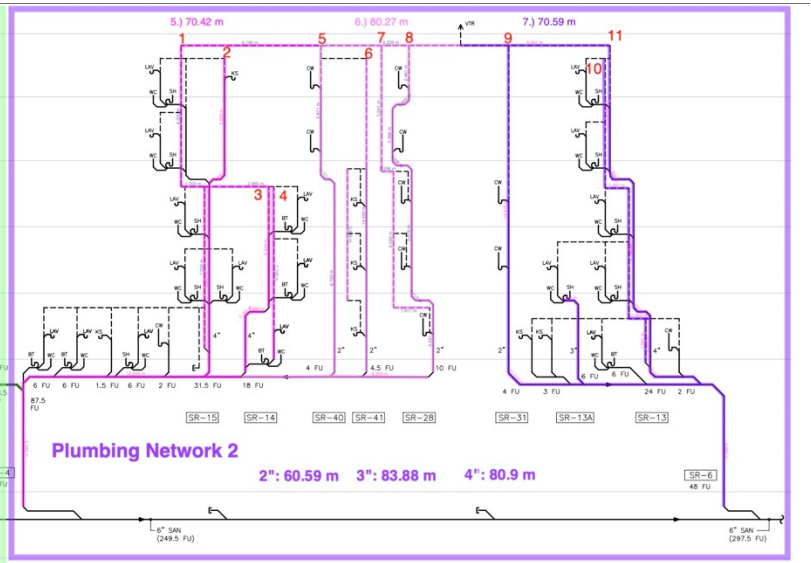
details / mock-up

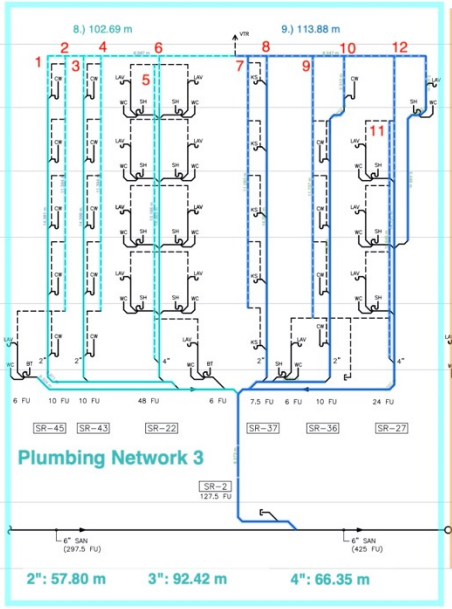
commissioning

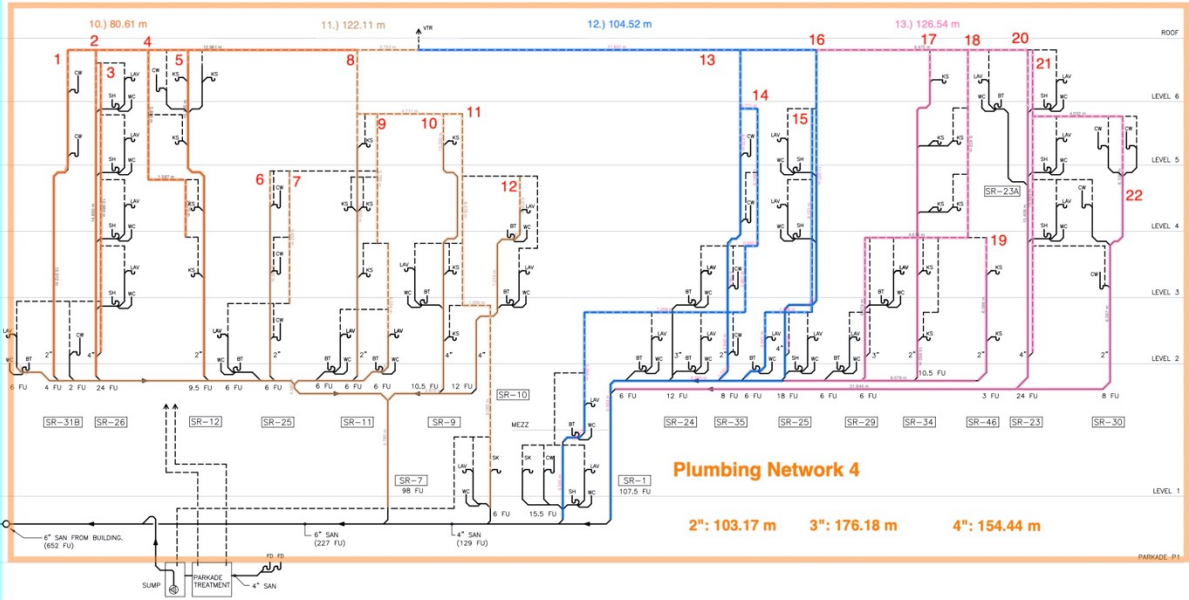
DESIGN TEAM

CONSTRUCTION TEAM









zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

DESIGN TEAM

CONSTRUCTION TEAM

Air Admittance Valves

Limit the pressure fluctuations within the drainage system, and to protect water trap seals

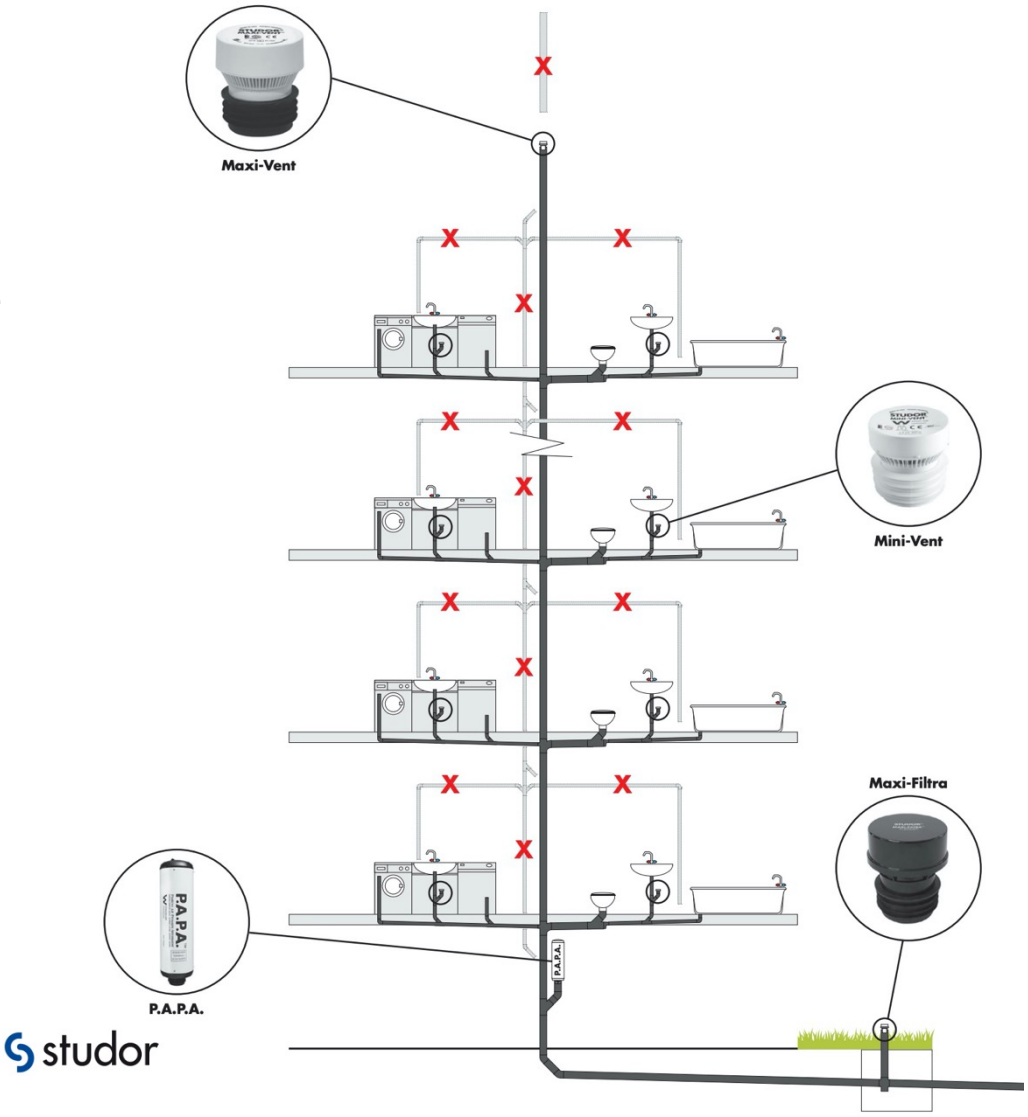
Positive Air Pressure Attenuator

Provides complete protection against positive and negative pressures in the system

Ideal AAV solution as recommended by the manufacturer, because it saves venting pipes

So far, it hasn't been accepted in the City of Vancouver

Losses through venting pipe can add up to 1 kWh/m²a



THEMES

compactness

window / shading

materials / building science

details / mock-up

commissioning

DESIGN TEAM

design challenges

design decisions

energy model

verification

CONSTRUCTION TEAM

constructability

cost

schedule

trades education

zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

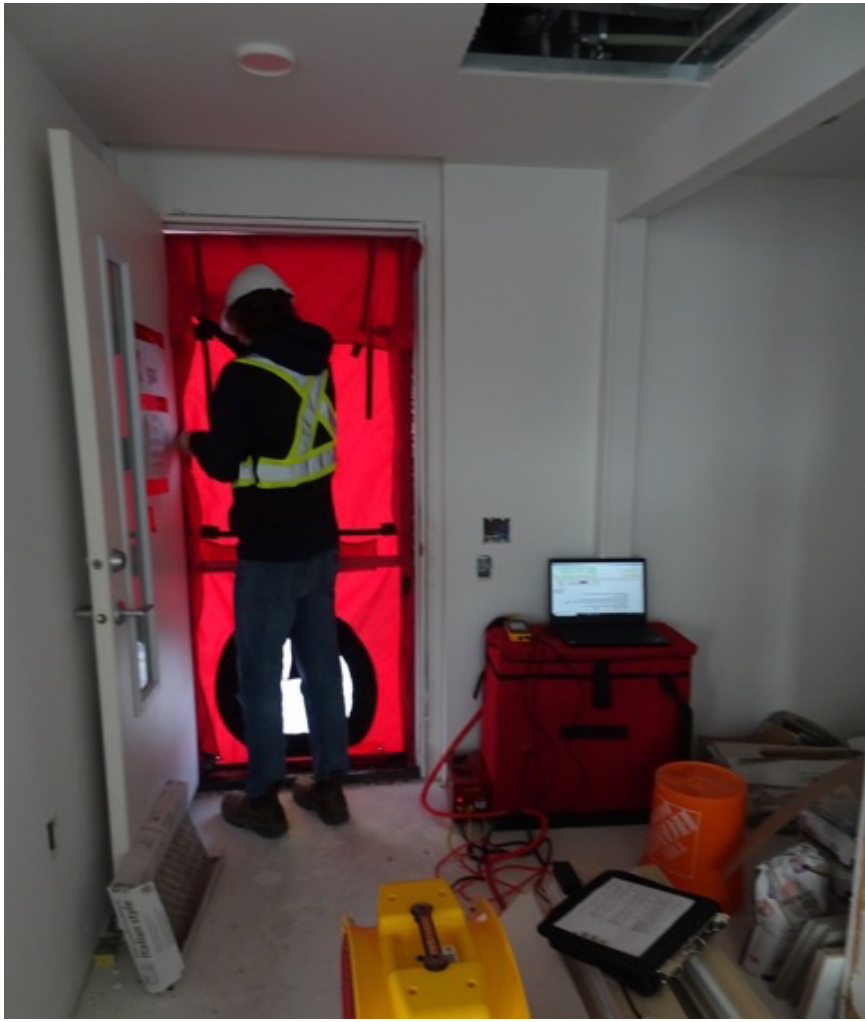
compactness

window / shading

materials / building science

details / mock-up

commissioning

DESIGN TEAM	CONSTRUCTION TEAM
	
Typical blower door set-up	
For passive house, a single blower should be adequate	**Building needs to be empty Typically done on weekend**

zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

Preparing the building for air tightness test takes resources and time

Create access for items that needs to be sealed

We recommend contractor have their own blower to pretest for air leakage

THEMES

compactness

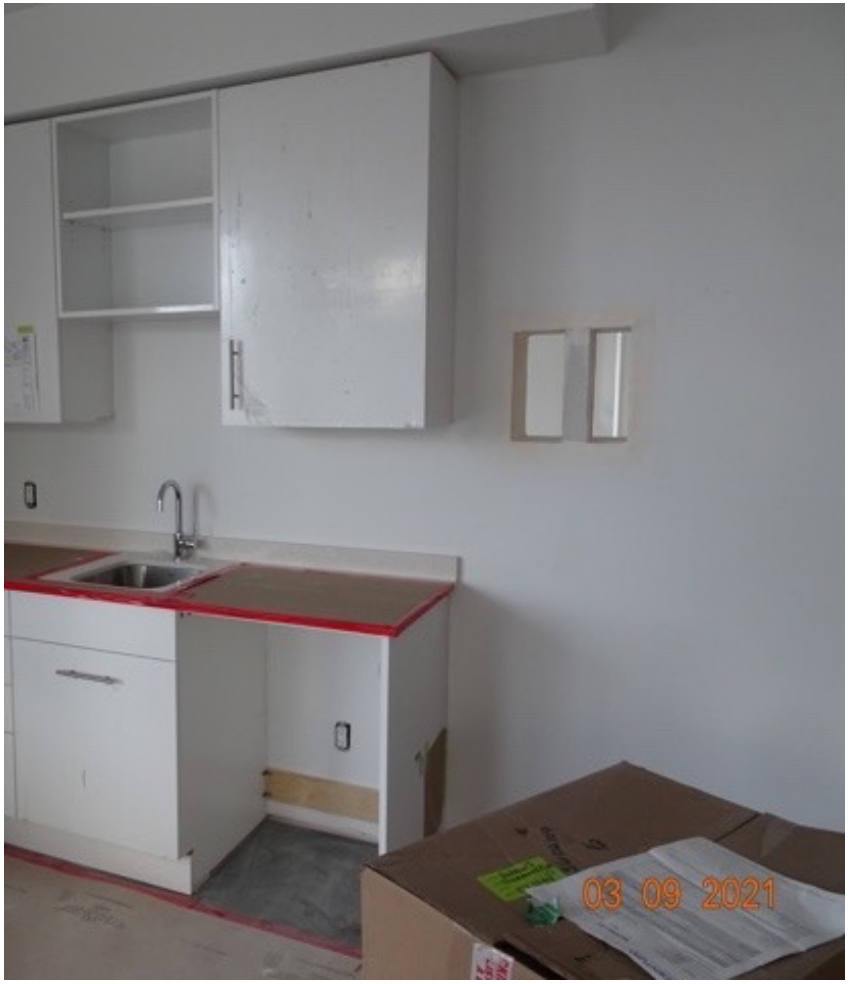
window / shading

materials / building science

details / mock-up

commissioning

DESIGN TEAM	CONSTRUCTION TEAM



When there is no interior corridor, we need air connections between suites

Walls must be repaired after air test

zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

compactness

window / shading

materials / building science

details / mock-up

commissioning

DESIGN TEAM

CONSTRUCTION TEAM

Certificate

Certified Passive House Component
For cool, temperate climates, valid until 31 December 2018

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
GERMANY

Category: **Heat recovery unit**
Manufacturer: **Ventacity Systems, Inc.**
97201 Portland, UNITED STATES
Product name: **VS1000 RT**

This certificate was awarded based on the following criteria:

Thermal comfort	$\Theta_{supply\ air} \geq 16.5$ °C at $\theta_{outdoor\ air} = -10$ °C
Effective heat recovery rate	$\eta_{HR,eff} \geq 75\%$
Electric power consumption	$P_{el} \leq 0.45$ Wh/m³
Performance number	≥ 10
Airtightness	Interior and exterior air leakage rates less than 3% of nominal air flow rate
Balancing and adjustability	Air flow balancing possible: yes Automated air flow balancing: yes 2)
Sound insulation	It is assumed that large ventilation units are installed in a separate building services room. Sound levels documented in the appendix of this certificate
Indoor air quality	Outdoor air filter F7 Extract air filter G4
Frostprotection	Frost protection required Different strategies mentioned in the appendix of this certificate

Certified for air flow rates of 500 - 1100 m³/h
At an external pressure of **228 Pa** 1)
Requirements non residential buildings (Therewith device also applicable for residential building)

$\eta_{HR,eff}$ **82%**

Electric power consumption 0.45 Wh/m³

Performance number 9.4 3)

1) Available pressure difference with installed filter: **180 Pa**. Additional components (e.g. heater coil) decrease the available pressure difference accordingly.
2) Air flow balance to be set within the framework of adjustment
3) Recommended performance number is deceeded.

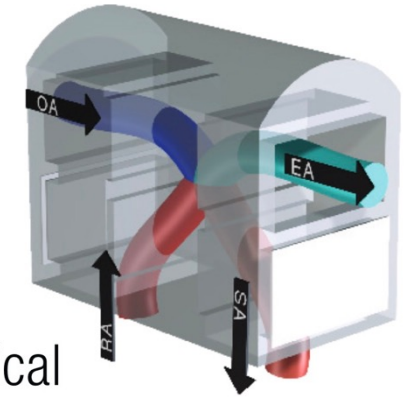
Further information can be found in the appendix of this certificate.

CERTIFIED COMPONENT
Passive House Institute

www.passivehouse.com 0931vl03

Certified units are easier for modeling and certifying

VENTACITYSYSTEMS
Making Buildings Healthy – Efficient – Smarter



Vertical

zebx
PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

compactness

window / shading

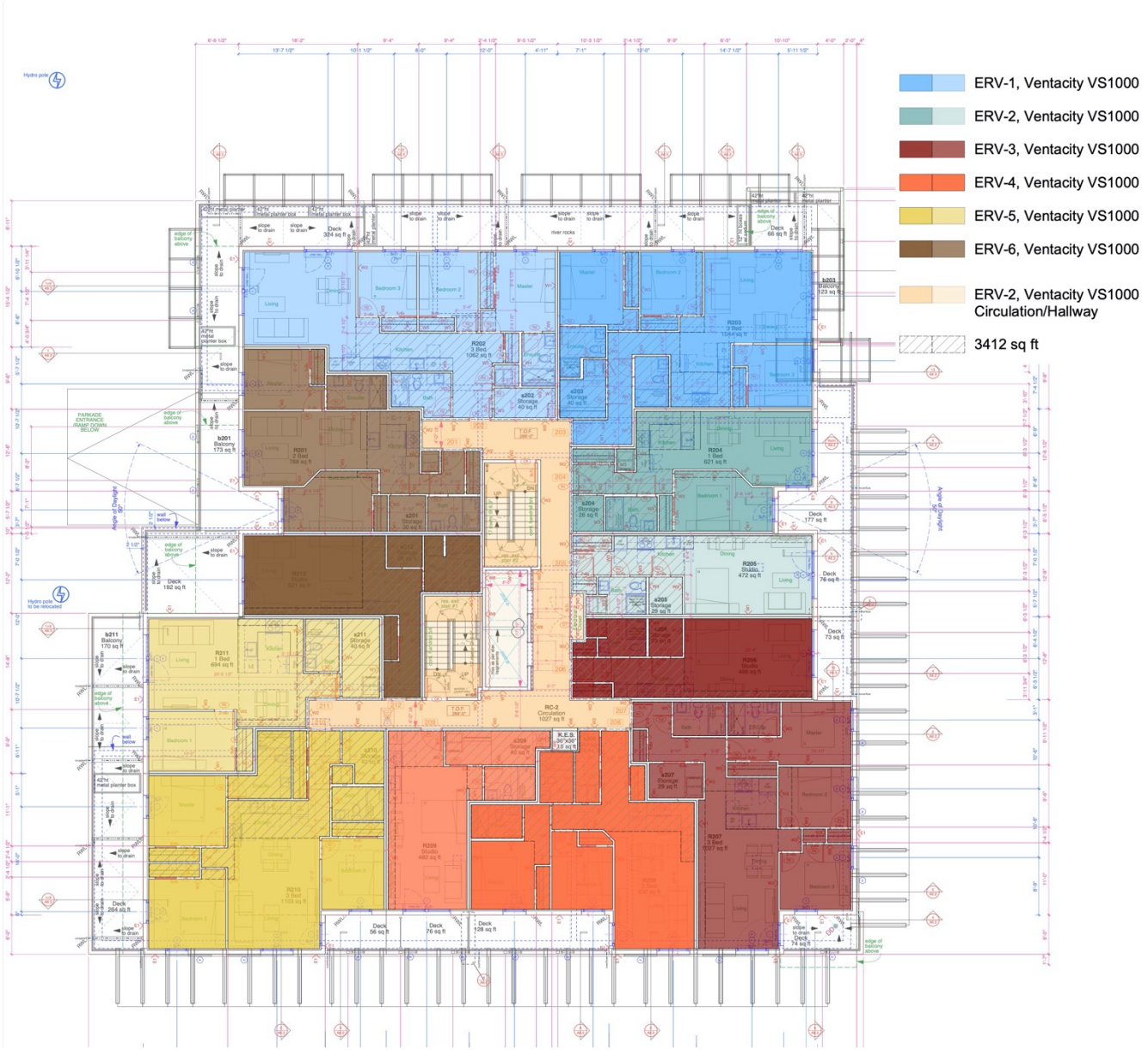
materials / building science

details / mock-up

commissioning

DESIGN TEAM

CONSTRUCTION TEAM



zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

THEMES

compactness

window / shading

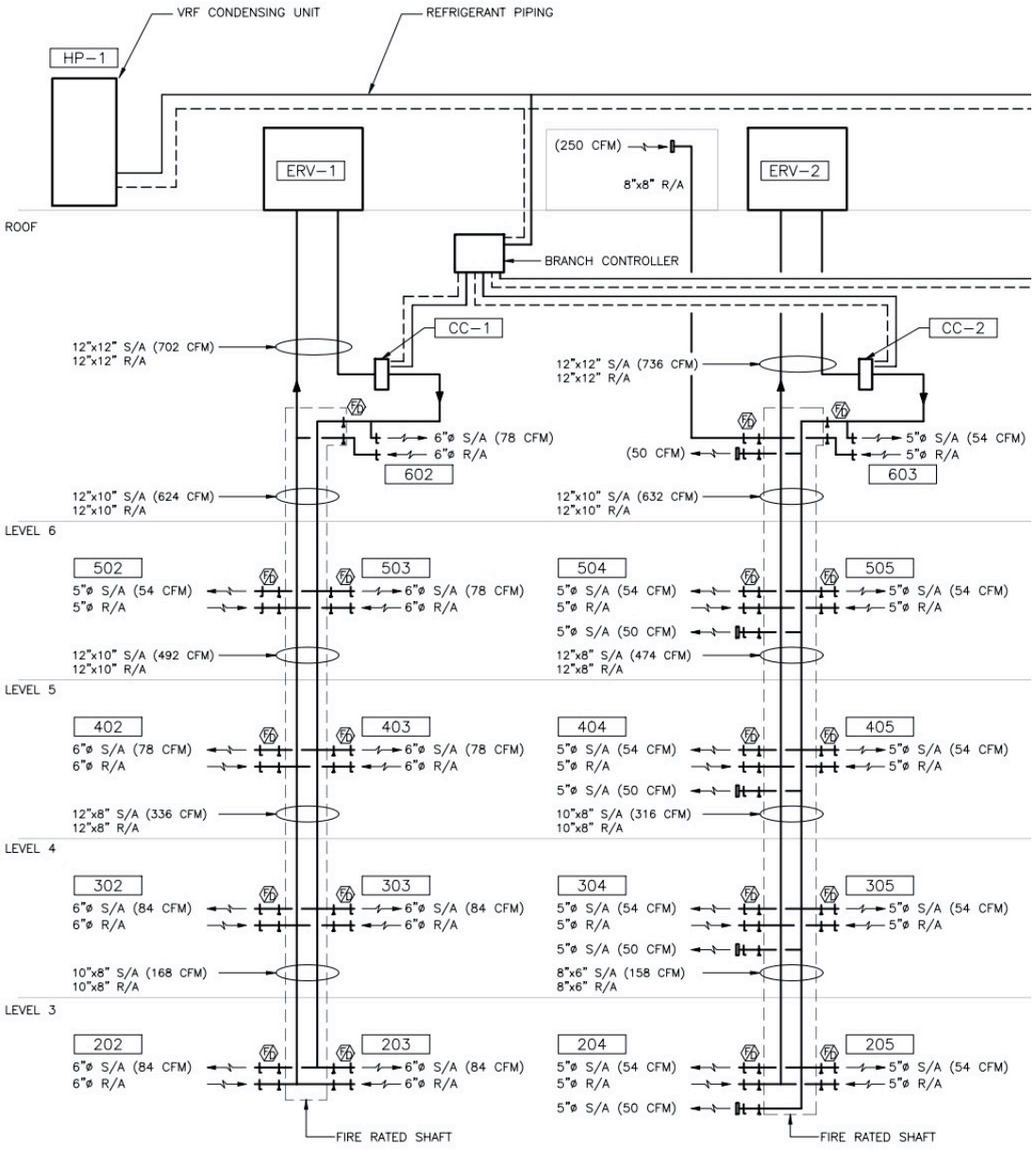
materials / building science

details / mock-up

commissioning

DESIGN TEAM

CONSTRUCTION TEAM



zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION

compactness

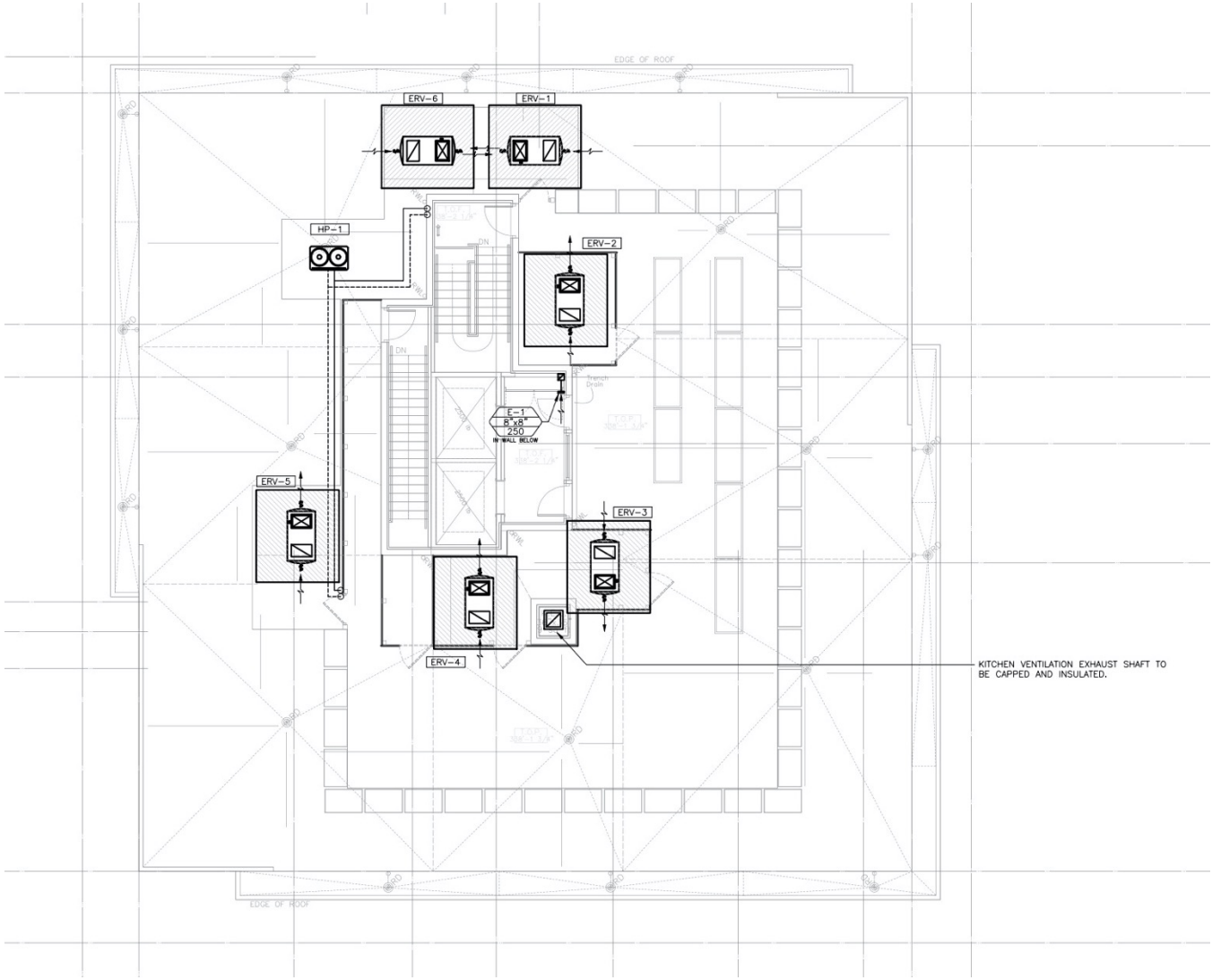
window / shading

materials / building science

details / mock-up

commissioning

ERV on roof with dx coil in the ceiling below



compactness

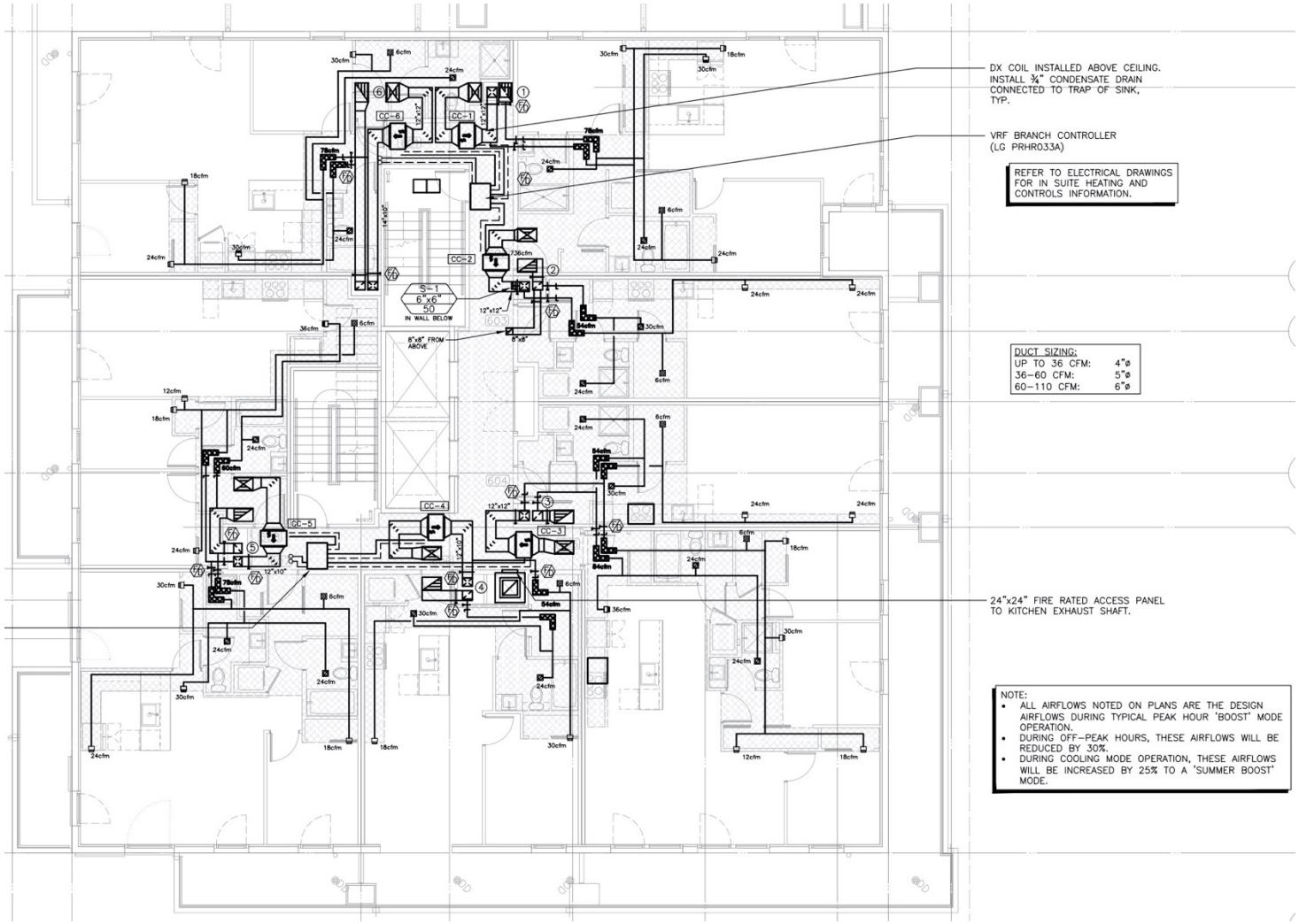
window / shading

materials / building science

details / mock-up

commissioning

ERV on roof with dx coil in the ceiling below



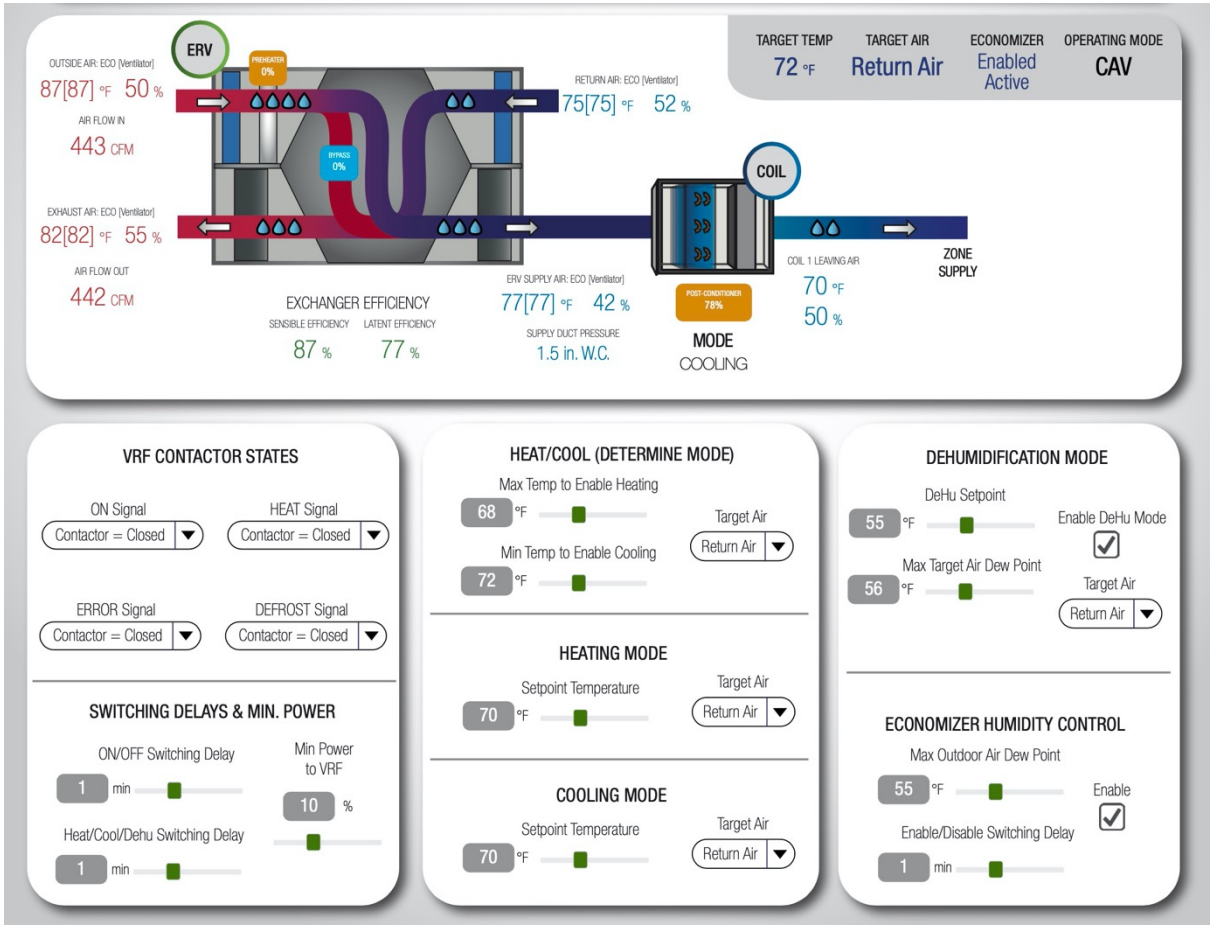
compactness

window / shading

materials / building science

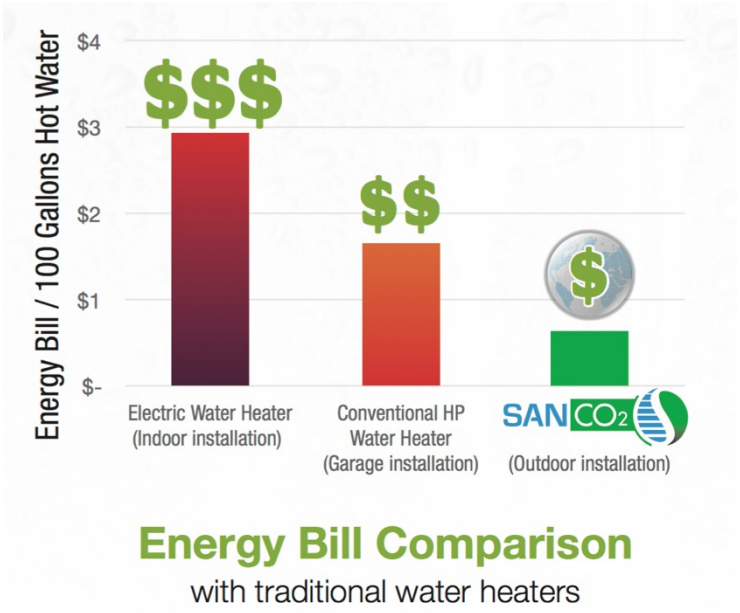
details / mock-up

commissioning



Units need to be commissioned and monitored for performance and maintenance

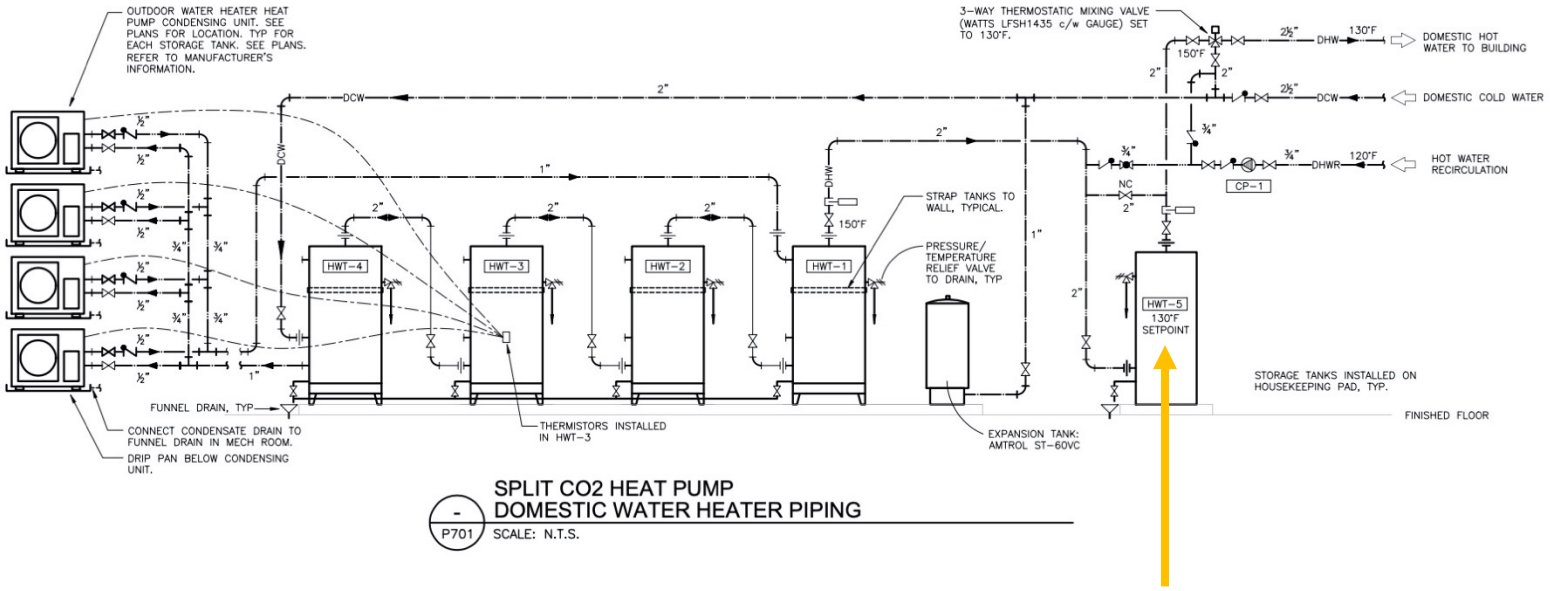
The Ventacity ERV controls the cooling based on the return temperature



Energy Bill Comparison
with traditional water heaters

Cost effective solution with a COP of 3.5—4

CO2 is the refrigerant which is a low impact greenhouse gas



Heat pumps needs large storage tanks and generate hot water over about 14 hours a day

Most efficient when they lift water temperature from incoming city supply to 150°F

Electric resistance tank to make up recirculation losses

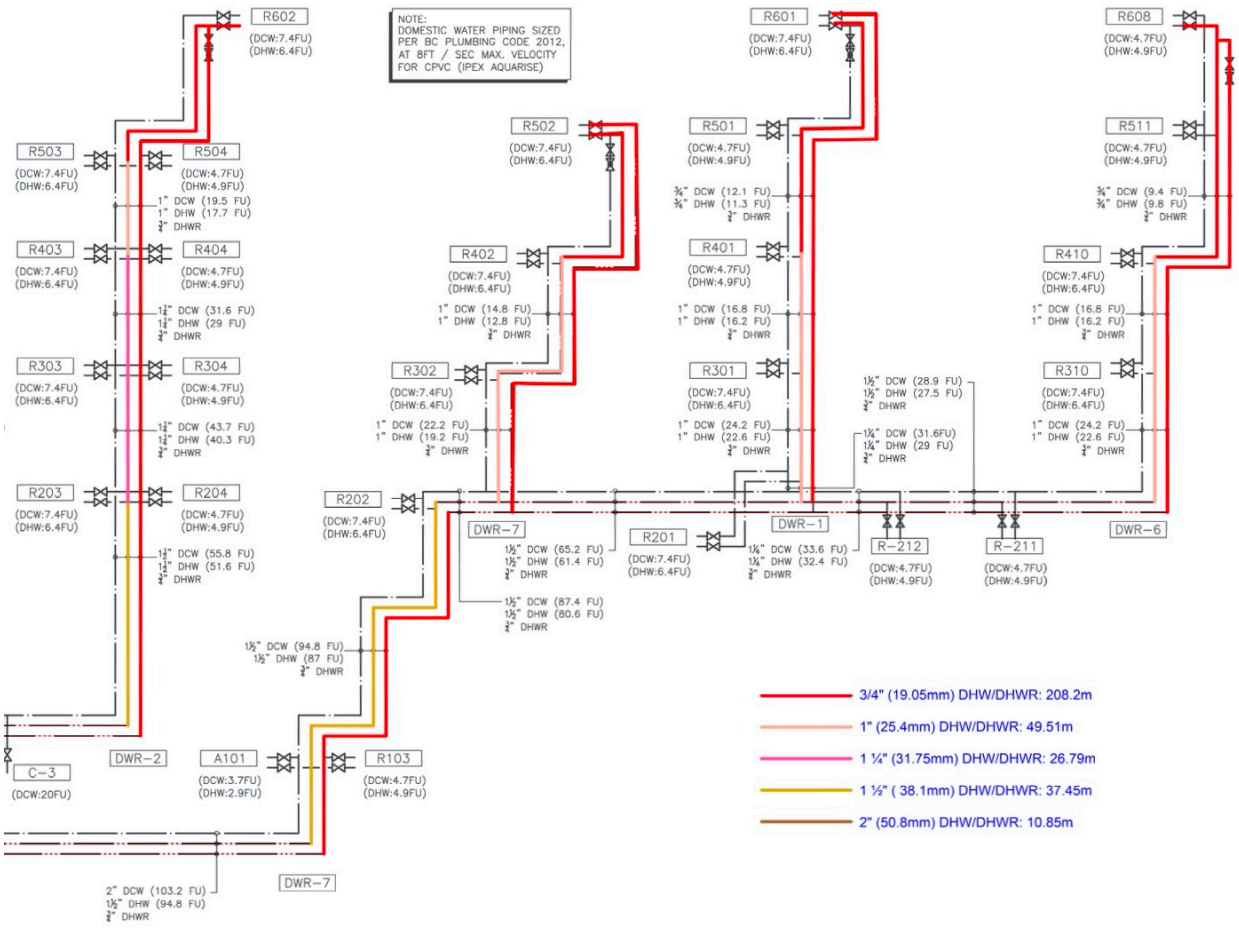
compactness

window / shading

materials / building science

details / mock-up

commissioning



Length of all hot water recirculation pipes are measured for internal heat gain

Hot water pipes need high level of insulation

THEMES

compactness

window / shading

materials / building science

details / mock-up

commissioning

DESIGN TEAM

design challenges

design decisions

energy model

verification

CONSTRUCTION TEAM

constructability

cost

schedule

trades education

zebx

PASSIVEHOUSE CANADA

CORNERSTONE architecture

BOLD CONSTRUCTION