1st Passive House PLUS office building in the world

About


Marty Paradine,
PPRE 2008

I have worked in the mining, oil and gas industries as an engineer and operations manager, before moving into my area of passion - sustainability and the built environment. I then acted as an energy consultant and have worked for the past eight years in municipal/local government: Fort St. John, BC as a Sustainability Manager and in Valleyview, Alberta as a Chief Administrative Officer (Town Manager). As Town Manager in Valleyview, I managed 51 full time staff and an annual budget of approximately $13M. In this capacity, I championed the building of our new Municipal Office/Hall to the Passive House Standard. Recently, I have taken on a new role as a College Professor at the Okanagan College in the Sustainable Construction Management Program. I hold an undergraduate degree in Mechanical Engineering, Master of Science in Renewable Energy (PPRE), Master of Science in Business Administration and a Certified Energy Manager accreditation. At the moment, I am working towards finalizing the National Advanced Certificate in Local Authority Administration Level II.

Background

Figure 1 - current Town Hall/Office

The Town of Valleyview has outgrown its current Town Office (above) and we have begun to experience the detrimental aspects of operating out of an aging asset (code compliance, cost to operate increasing, lack of space for new staff, cost of maintenance increasing etc.).

The existing Valleyview Town Hall, located at 4802 - 50th Street, is the primary location of the Town of Valleyview's staff, and is the main location for the Town's management staff and customer service delivery. Originally constructed in 1979, this one-storey 464 m^2 building contains offices, town council chambers, and the original fire apparatus bays, which have since been relocated to a new facility. A 283 m^2 basement is located under the offices and council chambers, and is used for storage and building services. Very little in terms of upgrades have occurred throughout the building's life-span.

In 2015, WSP completed a comprehensive Building Condition Assessment to review the building for compliance with current codes and standards, and to assess the potential for incorporating the two adjacent vehicle bays from the former Fire Hall into a future building expansion. Although the report indicated that the building is in fair condition, and could be upgraded to extend the life expectance for another 25 years, a number of building systems will reach the end of their functional life in the next 5 years, and there are significant architectural, mechanical, and electrical deficiencies, including building code violations that would need to be addressed for the current occupancy. The cost of the deficiencies alone has been estimated at $270,000.

In addition to the range of deficiencies present in the building, the existing functional layout of the facility limits the Town's ability to provide efficient service. Issues identified with the current design include:

• Lack of area for the public in the Council Chambers;
• Insufficient separate meeting rooms from the Council Chambers;
• No separate staff room from the Council Chambers;
• No space for additional staff without a significant renovation; and
• No separation between public and staff washrooms, and there are no barrier free washrooms.

The report also indicated that the cost to fix the deficiencies and to renovate the layout of the building may end up costing more than 75% of the replacement value, and therefore it would be worthwhile to invest in a new building. Since the report, Town administration have determined that the renovation costs would actually be 84% of the replacement value. With this information in hand, Council and administration determined that the best course of action was to build a new building versus renovating the existing property.

This change in direction to build new allowed for further synergies, including:

- Divesting of an aging asset to consolidate operations in new cost efficient asset reduces overall operating costs and selling the current Town Office also generate property tax revenue;
- Through the acquisition of a new site, it was possible to relocate the new office adjacent to downtown thus supporting downtown revitalization efforts; the current office is not in direct proximity of downtown;
- The new site also contains numerous mature trees and a garden which were saved through the land acquisition; these features will provide a public plaza / park as a new amenity for the community; a private developer would have utilized the entire site for building improvements, resulting in the removal of all trees and the garden;
- The current office is surrounded by parking lot and provides no plaza / park for the community which limits programming options for the Town and results in no public use of the site;
- The new site is conducive to high performance building design with excellent southern exposure.

Currently, the Town Office is occupied by 15 staff and elected officials which is the limit determined by available space. The new Town Office will be occupied by 17 (now) -28 (future) staff and is designed with provisions for internal expansion for staff. The building is also designed to accommodate a small external addition (12- 16 additional staff), if need be in the far future. Valleyview should not need to build a new office for at least half a century based on the design provisions and the robustness of the building envelope (and overall design).

Passive House Project

Figure 2 - initial rendering of the new Passive House Town Hall

Figure 3 - updated rendering of the new Passive House Town Hall

The Town of Valleyview is building a new Town Hall (administrative office with council chambers). This project fits in with our overall asset management strategy (understand condition and costs; track and monitor data related to assets; reduce/amalgamate assets where possible; focus on Life Cycle Costs; proactive rather than reactive).

Our objectives related to sustainability are:
1. Minimize life cycle costs;
2. ultra-energy efficient (conservation first approach) with a focus on interior/occupant comfort;

3. simple, low maintenance, durable design with minimalistic systems (mechanical, electrical etc.) for ease of operation / maintenance / replacement; i.e. emphasis on passive features that last the lifetime of the building vs. technologies and systems;
4. adaptable and flexible design to ensure a 75+ year building that we can "grow into";
5. net-zero energy ready building that is able to cost-effectively become net-zero energy at a later date.

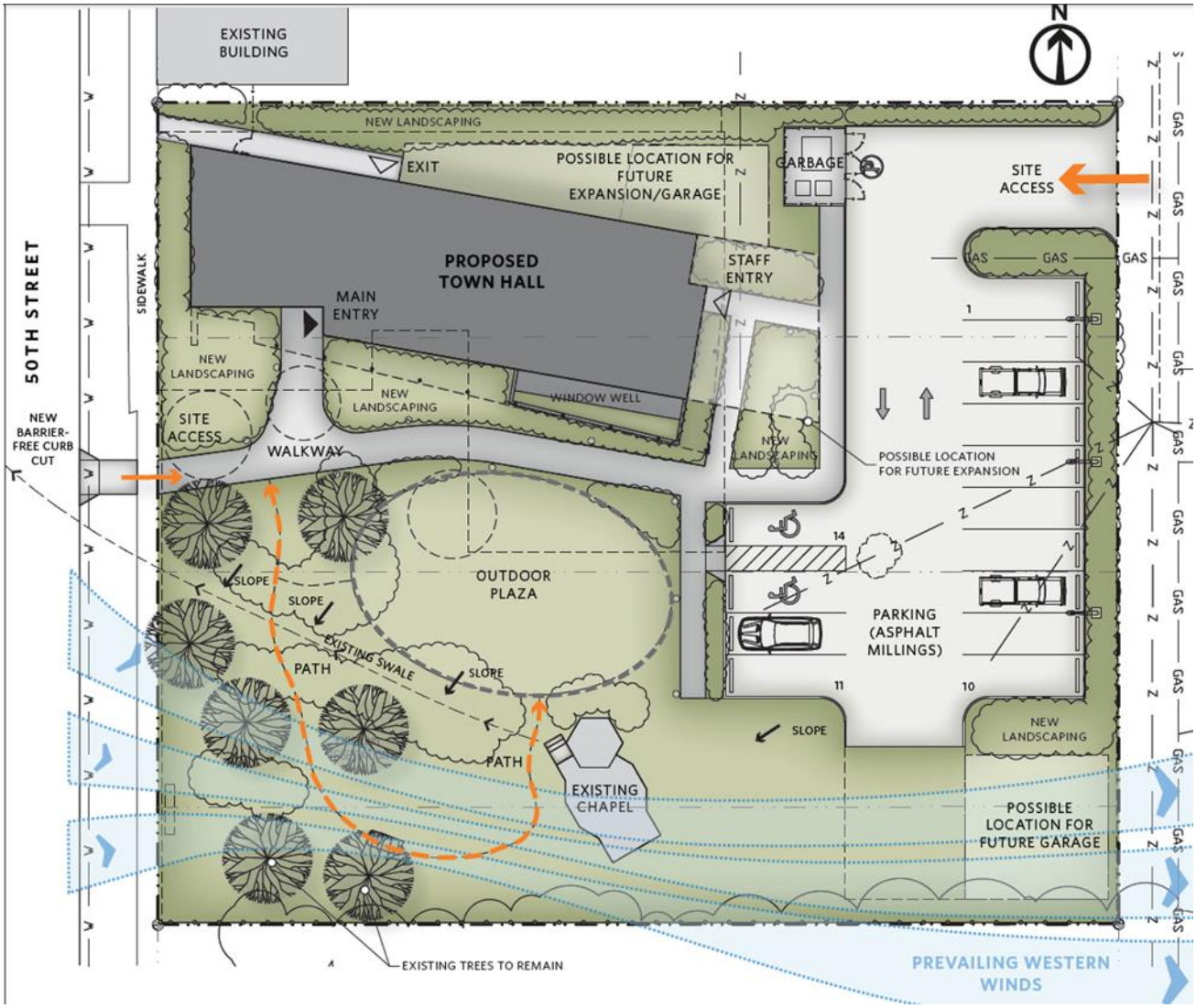


Figure 4 - site plan

Passive House (PH) has been chosen as the energy standard in which to certify the project. Passive House has a proven record of performing in real life as per design and ensures a third party validates the performance of the project. PH is also the most stringent energy conservation standard for buildings in the world. PH is performance based so it gets more difficult to comply with the harsher the climate one is situated in. The airtightness requirement, in particular, is demanding. Here are the performance specs:

Annual Heating Demand	< 15 kWh/m²a
Annual Cooling Demand	< 15 kWh/m²a
Annual primary energy consumption	< 120 kWh/m²a
Constructed airtightness	< 0.6 ACH @ 50 Pa

The above translates into the following design specifications, among others:

- Highly durable and low maintenance materials throughout (interior and exterior)
- Passive House (PH) Certification (i.e. reduce heating cooling demand by 90% annually)
- Simplified mechanical systems based off of air sour heat pumps that are modular based on interior layout; simple to maintain
- Prewiring for photovoltaics (solar electric panels)
- Free spanning roof system so interior spaces can be re-configured in the future
- Wood construction
- LED lighting with natural daylight sensors and controls
- Energy monitoring at the circuit level
- Natural lighting in most spaces
- Passive solar heating
- High performance mechanical ventilation with heat recovery

Below is an indication of how the PH envelope (in our region / project) relates to a code based building as per the energy model. ABC stands for Alberta Building Code (the province in Canada in which the building is situated). NECB stands for the National Energy Code of Canada for Buildings

Assembly/Component	ABC (RSI/R)	NECB (RSI/R)	PH Design (RSI/R)
Above Ground with an HRV (5600 HDD)			
Ceilings below attics	8.67/R50	6.17/R35	17.62/R100
Cathedral ceilings & flat roofs	5.02/R28.5	6.17/R35	17.62/R100
Walls	2.97/R16.9	4.76/R27	12.68/R72
Floors over unheated spaces	5.02/R28.5	6.17/R35	TBD
Below Ground with an HRV (5600 HDD)			
Foundation walls	2.98/R16.9	3.52/R20	12.33/R70
Unheated floors	1.96/R11.1	1.32/R7.5	8.8/R50

Although the original aim was to prewire the building for PV and add them at a later date when prices have further decreased, it was decided to make the project net-zero energy. This means the building will produce as much energy as it consumes over an annual period. Solar electric panels were installed on the roof to generate this electricity. The system capacity is approximately 28 kWp. Including the solar panel installation during the initial construction has many advantages:

- It minimized future penetrations to the building envelope;

- It allows the work to be included in the warranty of the Design-Build Contractor and eliminated the possibility of compromising any building warranty at a later date with a future contractor's installation.

Below is a comparison of the energy performance of our Passive House building relative to a similar code built building:

Estimated Performance Comparision			
Annual Consumption	NECB	Passive House	Reduction
Heating	184,755 kWh	9,353 kWh	95%
Cooling	2,479 kWh	3,163 kWh	-28%
Lighting	39,660 kWh	21,482 kWh	46%
Sum	226,894 kWh	33,997 kWh	85%
Annual GHG Emission	60.2 Tonne	21.8 Tonne	64%

From a cost perspective, below is the anticipated annual savings relative to a code building:

annual	NECB (NG heating)			**PH (all electric)**		PH (NG heating)	
	kWh	GJ conv.	Cost	**kWh**	**Cost**	kWh	Cost
heating	184755	665.118	$ 3,032.94	**9353**	**$ 1,468.42**	9353	$ 153.54
cooling	2497	8.9892	$ 392.03	**3163**	**$ 496.59**	3163	$ 496.59
lighting	39660	142.776	$ 6,226.62	**21482**	**$ 3,372.67**	21482	$ 3,372.67
TOTAL			$ 9,651.59		**$ 5,337.69**		$ 4,022.80
				savings	$ 4,313.90	savings	$ 5,628.78
					45%		58%

The costs are not reduced by the equivalent reduction in energy since the base case (NECB) utilizes natural gas for heating and our project is 100% electric. In Alberta, Canada electricity is 10x more expensive on a kWh basis than natural gas. We have chosen an all-electric based active systems since doing so allows one system to handle both heating and cooling. The system is also easier to maintain and operate, and more flexible for zoning and in achieving preferred occupant comfort. Furthermore, an all-electric system is preferred from a GHG perspective, in the elimination of any point source emissions, and in integrating with PV production on the building.

Figure 5 - completed new Passive House Town Hall (looking Northeast)

Construction was completed in the summer of 2018, the new town hall in Valleyview is slated to become the **1st Passive House PLUS office building in the world**, setting a new standard for energy efficiency. The building will also be the first Passive House certified commercial building in Albert, Canada. Equipped with a 78 panel 28 kW photovoltaic system, this building is aiming to produce as much energy as it uses throughout the year, making it also Net Zero Energy.

This ultra energy efficient ~ 8000 ft^2 and three storey building will be home to Valleyview's municipal staff and council and is also designed to accommodate any future growth of the town with additional room for future workspaces on the lower level, and expansion to the East adjacent to the staircase. It is built using a double stud wall system for the above ground structure and insulated concrete forms for the foundation below ground.

Figure 6 - double stud wall wood framing and taping of joints for air sealing

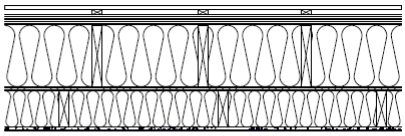
Fresh air is controlled by a Tempeff heat recovery ventilator that utilizes two heat exchanger cores. A damper allows for the rerouting of exhaust and fresh air airflow so as to never freeze up the heat exchanger core. This eliminates the need for auxiliary electricity to defrost the system. Heating and cooling in the building are handled by Mitsubishi split variable refrigerant flow air source hat pump units. The system comprises of two outdoor units and eight indoor units. This allows for a simple electric based system that decouples fresh air delivery from heating and cooling delivery. It also allows for simultaneous heating a cooling in the building. Two Rheem electric heat pump/hybrid hot water tanks are used for domestic hot water in the building.

Actual Performance:

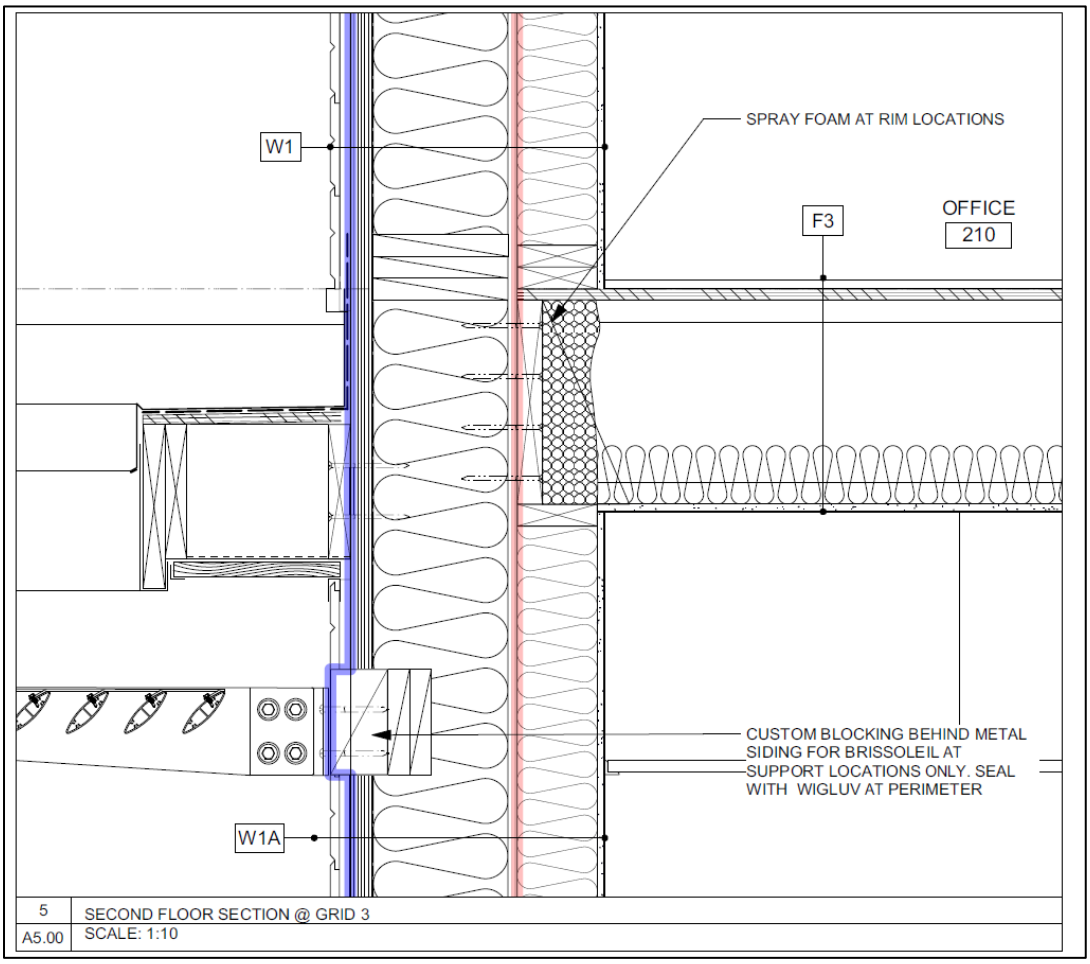
- Airtightness 0.41 ACH @50pa
- Overheating: 0%

- Exterior walls: R 58

W1 - EXTERIOR WALL
REF: -
FRR: -
STC: -



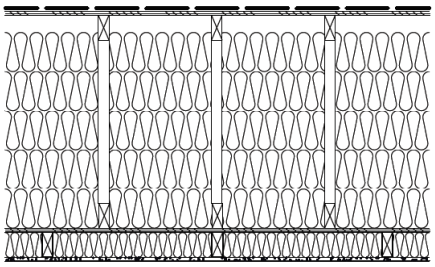
Exterior Finish (As per elevations)
19mm (3/4") air space/ P.T. Wood Strapping
40mm (1.5") Wood Fibreboard (Taped) - GUTEX Multitherm w/ SIGA Wigluv or equiv.
38X235 (2X10") Wood Studs @ 400mm (16") O/C (see structural)
6.34 RSI (R-34) Batt Insulation - 1 layer R-24 ROXUL + 1 layer R-8 Comfortboard
16mm (5/8") OSB Sheathing (Taped) - SIGA Rissan or equiv. (see structural)
38x140 (2X6") Studs @ 600mm (24") O/C (see structural)
4.23 RSI (R-24) Batt Insulation - 1 layer R-24 ROXUL
13mm (1/2") Gypsum Wall Board

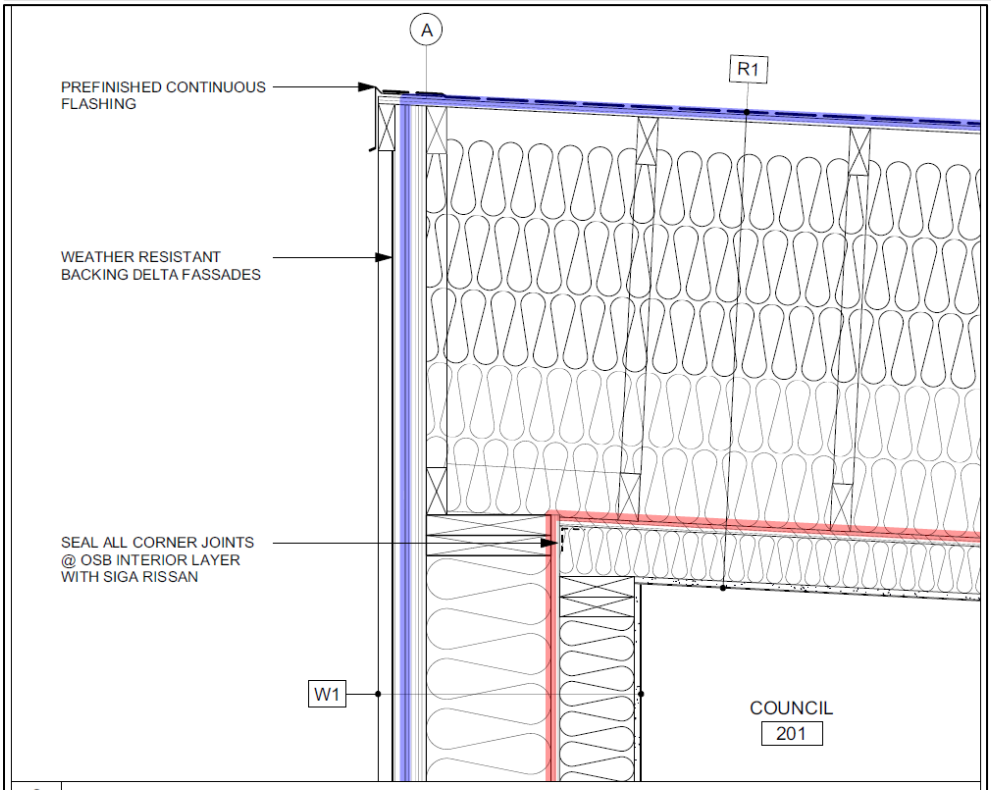


- Truss Roof: R 105

R1 - TYPICAL ROOF
REF: -
FRR: -
STC: -

2 PLY SBS Membrane SOPREMA Soprafix or equiv.
13mm (1/2") Plywood Sheathing
762mm (30") Roof Truss @ 400mm (16") O/C (see structural)
21.15 RSI (R-120) Batt Insulation - 5 layers R-24 ROXUL
16mm (5/8") OSB Sheathing (Taped) - SIGA Rissan or equiv.
38X89 (2X4") Wood Studs @ 610mm (24") O/C
2.47 RSI (R-14) Batt Insulation - 1 Layer R-14 ROXUL
13mm (1/2") Gypsum Wall Board (Type X where required)



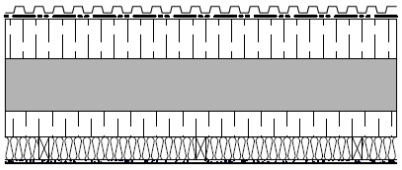


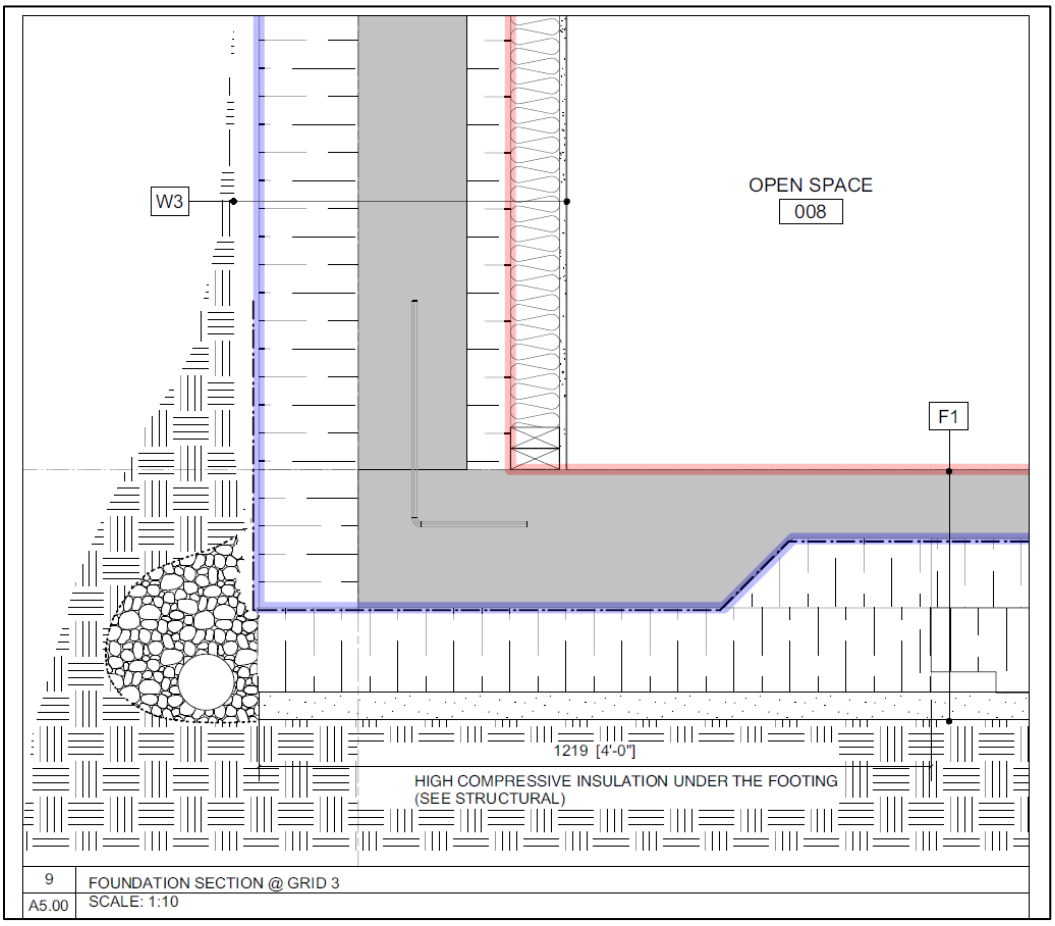
2	ROOF SECTION DETAIL @ GRID A
A5.00	SCALE: 1:10

- Foundation: R 54

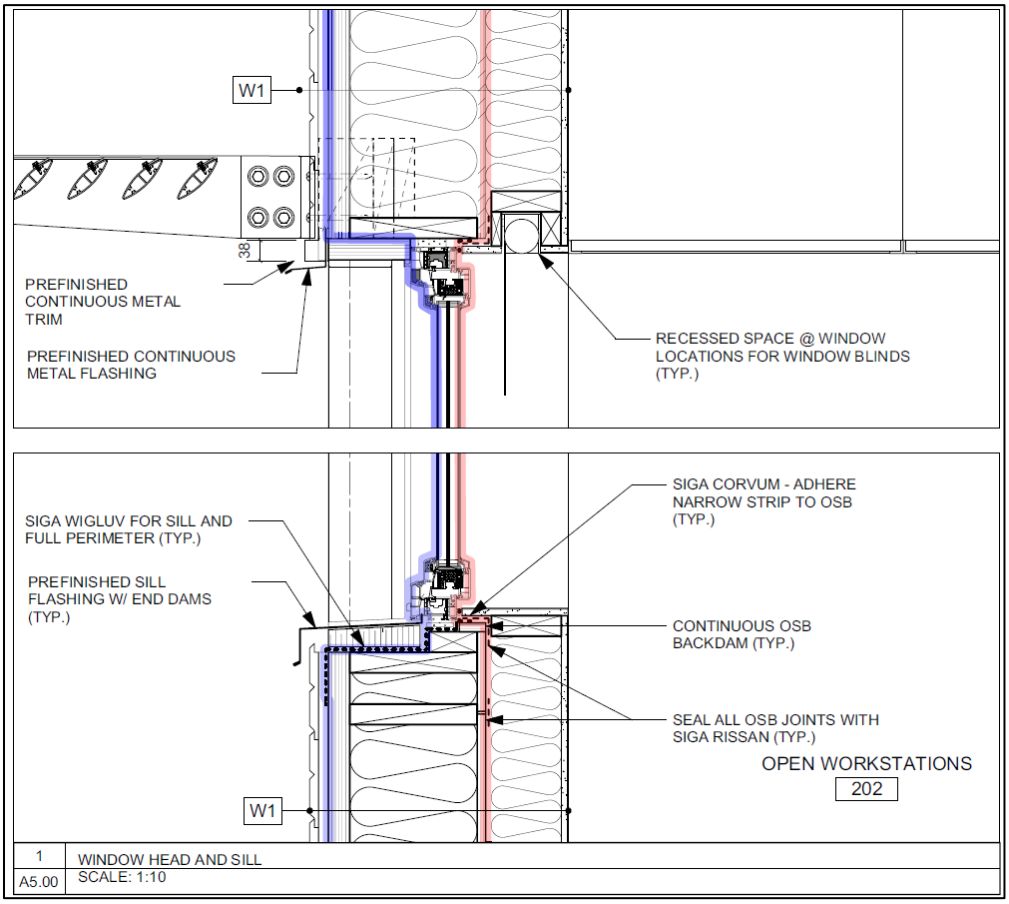
W3 - FOUNDATION WALL
REF: EW1b (ABC/NBC - Table A-9.10.3.1.A)
FRR: 45 min
STC: 0

Dimpled Membrane Tremdrain 1000
Waterproofing COLPHENE ICF or similar.
152mm (6") EPS Insulation
203mm (8") Concrete Wall (see structural)
101mm (4") EPS Insulation
38X89 (2x4") Wood Studs @ 600mm (24") O/C (see structural)
2.47 RSI (R-14) Batt Insulation - 1 layer R-14 ROXUL
13mm (1/2") Type X Gypsum Wall Board





- Windows: R 8 (Euroline)



The design-build contractor (Scott Builders) created some videos on the project:

Project Highlights https://video.scottbuilders.com/en/c/valleyview-highlight

Project Part 1 https://video.scottbuilders.com/en/c/valleyview-part-1

Project Part 2 https://video.scottbuilders.com/en/c/valleyview-part-2

Some construction photos are included below: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