ACCESSORY DWELLING UNIT PROTOTYPE

# THUJA

**Category 1:** Carriage House

Submitted to the District of Squamish for consideration in the Accessory Design Unit Design Competition on

**May 23, 2024**

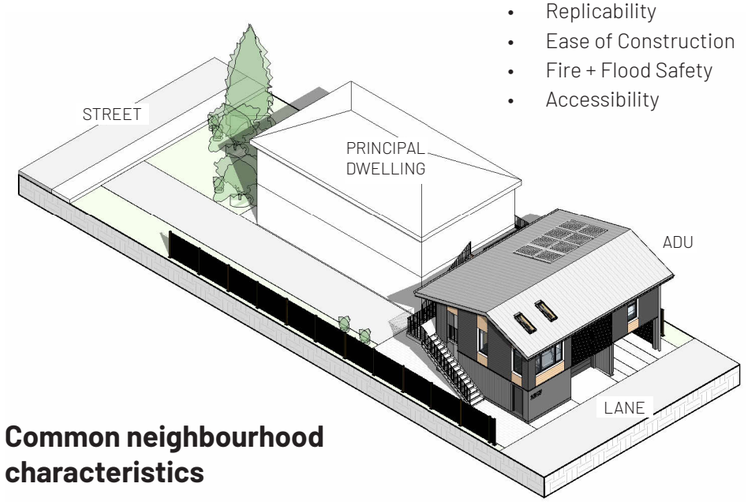
Revision 1 - July 25, 2024

# Prototype Thuja

Prototype Thuja offers an affordable and attractive option for Accessory Dwelling Units (ADUs) in the Carriage House category. The design prioritizes resilience and durability with simple, standardized building materials and components, avoiding complex assemblies that require specialized trades. This approach aims to ensure replicability, control costs, and provide flexibility for individual needs. As a Carriage House, this proposal seeks to preserve valuable greenspace in the rear of the lot while also providing functional and flexible spaces for residents of both dwellings to work, play, and live. While the overall orientation of the building will be different for each lot, the relative orientation of the living room towards the lane provides the greatest access to natural light and addresses privacy, overlook, and CPTED issues within the neighbourhood context. This proposal shows space for a future porch lift, which should be considered optional on a per application basis.

The primary objective of designing the assemblies for this project was to ensure resilience, particularly against severe flooding. Emphasis was placed on ensuring that assemblies at or below the Flood Construction Level (FCL) would endure flooding events without necessitating extensive remediation. These assemblies consist entirely of non-organic materials, and all critical building equipment has been strategically located above the FCL. This approach aims to minimize damage and maintain operational continuity, aligning with best practices for resilient infrastructure in flood-prone areas.

## Isometric Massing Diagram



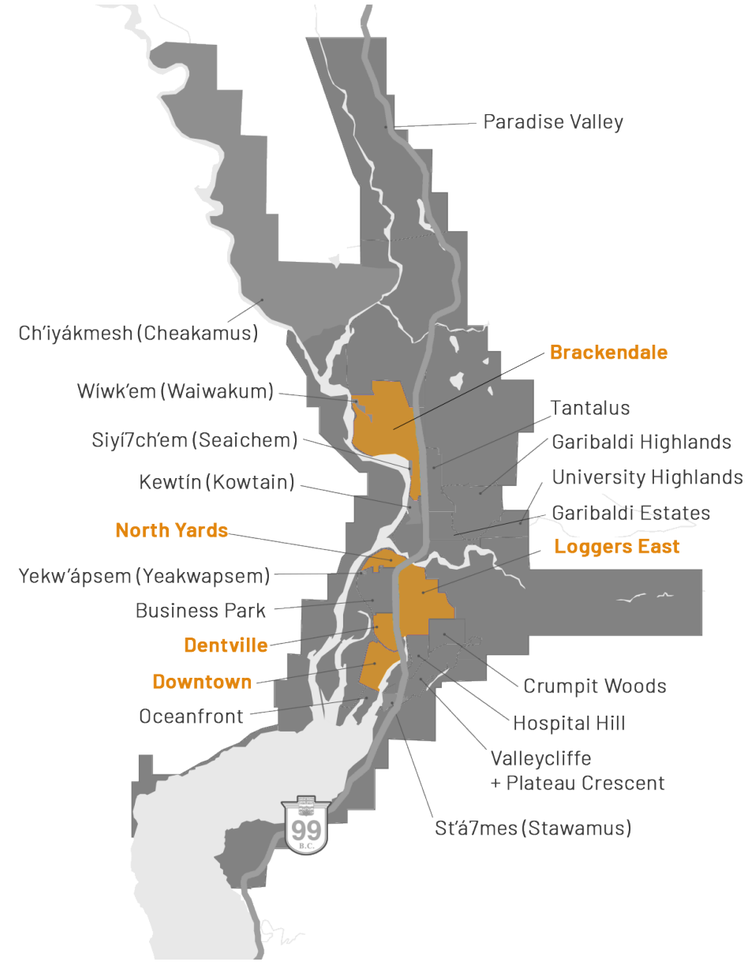

## Design Objectives

- Resiliance
- Replicability
- Ease of Construction
- Fire + Flood Safety
- Accessibility

## Common neighbourhood characteristics

- Small lots
- Laneway access
- Relatively higher density

## Applicable Neighbourhoods




Source: District of Squamish[1]

## Typical Existing Conditions

Downtown Laneway Streetscape

# Project Information

**Authority having jurisdiction:**
District of Squamish

**Proposed use(s):**
Residential - Accessory Dwelling Unit

**Site area:** 556 m² (5,988 sf )

**Easements / ROWs:** None

**Lot coverage:**
Original: 20.1%
Proposed: 41.5%

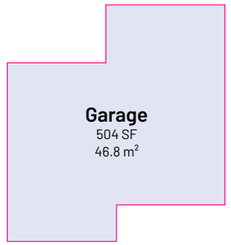
**Proposed height:** 6.6m

**Setbacks:**

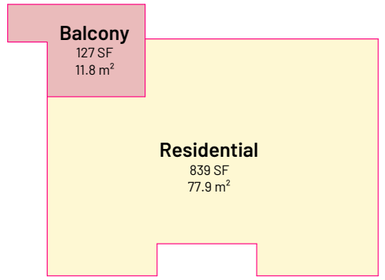
| | Required | Proposed |
|---|---|---|
| Front | 2.0m | 4.4m (to principal dwelling) |
| Side | 1.2m | 2.9m, 1.2m |
| Rear | 0.6m | 0.76m |

# Area Summary

**LEVEL 1**




**LEVEL 2**




## FAR by Level

| Level | Use | Area (SF) | Area (SM) |
|---|---|---|---|
| L2 | Residential | 839 | 78 |

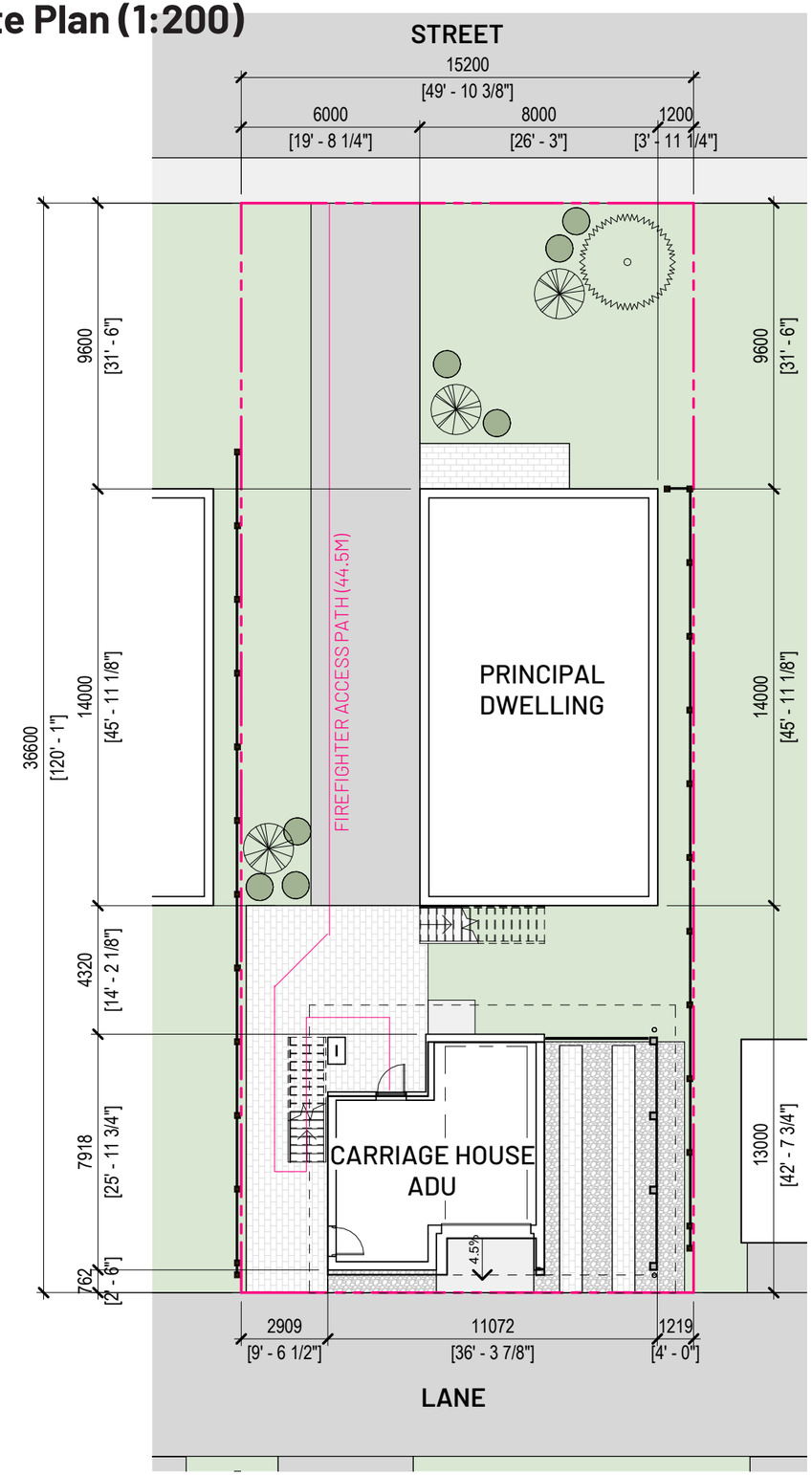
## FAR Exclusions

| Level | Use | Area (SF) | Area (SM) |
|---|---|---|---|
| L1 | Exclusion | 504 | 47 |
| Total Exclusions | | 504 | 47 |

## Balcony Area

| Level | Use | Area (SF) | Area (SM) |
|---|---|---|---|
| L2 | Balcony | 127 | 12 |

# Site Plan (1:200)




# Building Code Summary

**Applicable Building Code:** BCBC 2024

**Energy Efficiency Compliance Pathway:**
Part 9.36 Prescriptive Path

**Construction Type:** Combustible

**3.2.4.19 - Visible Signal Devices and Visible Warning Systems:** Visible signals proposed in addition to alarm signals

**3.2.5.12 - Automatic Sprinkler System:**
Sprinklers proposed (NFPA 13R)

**9.10.15.5 - Construction of Exposing Building Faces of Houses:**

- Combustible cladding and soffits permitted

**TABLE 9.10.15.4:**

| Exposing Building Face | Area of EBF | Limiting Distance (m) | % Glazing Allowed | % Glazing Proposed |
|---|---|---|---|---|
| North | 40.0m² | 4.3m | 32% | 8.2% |
| East | 28.6m² | 1.2m | 100% | 23.3% |
| South | 36.2m² | 6.3m | 69% | 35% |
| West | 44.36m²* | 2.9m | 10% | 7.5% |

**Notes:**

1. Design development drawings as provided are for general illustration of form, character, and constructability only. Detailed Building Code analysis will be required for individual applications at the Building Permit application phase.
2. * = 1 hr fire rated door required at garage door on West elevation.

# Construction Cost

## Hard costs

| Type | Description | Unit Cost | Cost ($) |
|---|---|---|---|
| Building[2] | 823 sf | $255 / sf | $209,865.00 |
| Garage | 835 sf | $80 / sf | $66,800.00 |
| Site improvement | | 5% | $13,833.25 |
| **SUBTOTAL** | | | **$290,498.25** |

## Soft costs

| Type | Unit Cost | Cost ($) |
|---|---|---|
| Permits, fees, etc. | 30% | $87,149.48 |
| Consultants | 10% | $29,049.83 |
| Loan Interest | 5% | $14,524.91 |
| Contingency | 5% | $14,524.91 |
| **SUBTOTAL** | | **$145,249.13** |

**Estimated Total** **$435,747.38**

**Notes:**

1. GST / PST not included.
2. The estimated total cost of construction is forecast using available data from reliable sources and generalized market assumptions and should not be relied upon for construction purposes. Applicants should undertake individual cost survey analysis based on specific applications as they pertain to individual lots.

## Business Case

20 year repayment period x $1,815.61 / month = $435,747.38

# Affordability

Access to affordable and secure housing in the Lower Mainland and Squamish is a crisis being faced by current and future generations, impacting their ability to work, live, play, and thrive in their local community. Innovative responses to the housing crisis, such as standardized housing designs, are anticipated to contribute to security of affordable housing by reducing up-front housing costs through delivery of a streamlined permitting process and efficient construction practices.

## Local materials and trades

The materials and assemblies chosen for this project are readily available from local suppliers and do not necessitate highly-specialized trades for installation or maintenance. This ensures that a larger pool of experienced trades and material suppliers are available to support construction activity, which generally has a positive impact on construction costs.

## Standard “kit of parts”

This project prioritizes inclusivity and replicability. It uses locally available materials and standardized building components to enhance constructability and control costs effectively. For example, the project was designed using conventional sizes of roof trusses and floor joists, deliberately steering clear of intricate assemblies, large spans, cantilevers, or complicated geometry requiring advanced techniques or additional structural elements.

## Durability

The exceptional durability of the proposed assemblies at or below the FCL are intended to withstand the worst-case flooding scenarios within the District of Squamish. Resilience, crucial for enduring disasters and heavy wear, is integral to both affordability and sustainability. One of the design goals of this project is to facilitate a return to normal operation as quickly and cheaply as possible following a flood or fire event by designing for material and structural resiliancy.

# Sustainability and Resiliance

This ADU prototype has been designed with sustainability and resiliancy as core principles driving the design. In this project, we adopted the stance that the most sustainable path for a building subject to a potential future flooding event would be for as much of the original structure elements to be undamaged and reused as much as possible. Any walls or floors which may have contact with flood water exclude utilize non-organic and non-porous materials which are designed to dry passively.

In addition, this design prioritizes low embodied carbon materials and integrates products with minimal global warming potential into the proposed assemblies. Despite concrete's high embodied carbon footprint, the design rationale argues that its durability and resilience make it less impactful than materials requiring a complete rebuild after a flooding event.

## FireSmart Design

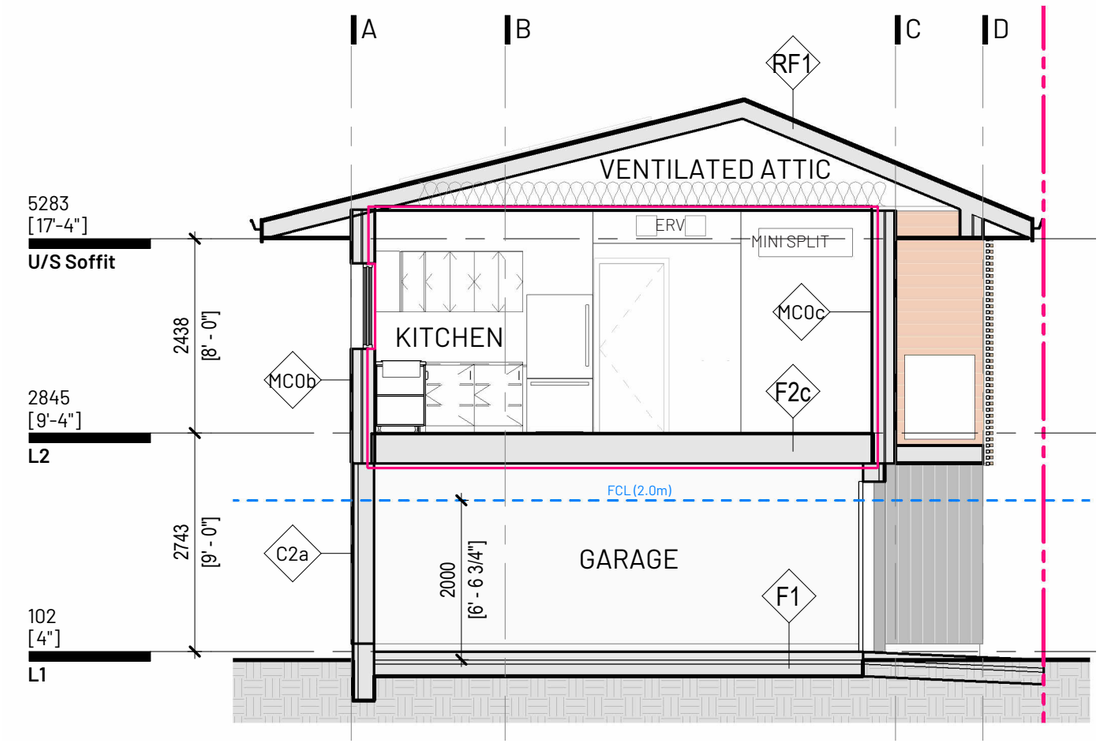
This proposal embraces principles from both FireSmart design and flood resiliency best practices. The proposed design incorporates standing metal seam roofing—a Class A fire retardant material with low flame spread—as well as Class A steel siding. Metal vents and flashing, recommended by FireSmart Canada, complement these choices. Decks, ramps, stairs, and overhangs are intentionally left open for simplified maintenance and combustible material removal. Furthermore, the site layout ensures combustible planting and tree canopies are kept at a safe distance from the building.

## Heating and Ventilation

The project plans to use electric baseboards for heating, with additional support from a ductless mini-split heat pump for winter heating and summer cooling. An Energy Recovery Ventilator (ERV) in the hallway bulkhead manages air changes per hour and humidity, without directly consuming carbon-intensive fuels during building operation.

## Solar Energy

The standing seam metal roof, with its slightly reflective and high albedo surface, mitigates heat island impacts and reduces solar heat gain into the building. This type of roof is well-suited for installing photovoltaic cell arrays, as the raceway channels can be directly fastened to the standing seams above the roof deck surface. A vertical chase from the electrical panel to the roof will be accommodated in the design development phase.




## Thermal Performance

The project is designed to meet or even surpass the prescriptive requirements of the BC Building Code 2024 Part 9, as outlined in Section 9.36. Adopting a strategy of continuous exterior insulation enables future modifications to the insulation value of the walls by adjusting the amount and type of insulation within the wall cavity. This design flexibility empowers homeowners to enhance performance by adding to or replacing cavity insulation in the future, if desired.

## Airtightness

The continuous exterior insulation strategy complements the attainment of a high-performance air tightness rating. Foil-faced polyisocyanurate insulation is particularly suited to this objective. In subsequent design phases, we will pursue an external air barrier strategy consistent with the BC Housing Illustrated Guide to Achieving Airtight Buildings and compliant with BCBC 2024 9.36.2.9.

## FCL Level

In a flood event, the walls and floors at or below the Flood Control Level (FCL) are designed to withstand sustained exposure to water and facilitate passive drying following the flood event.

## Stormwater Management

Permeable surfaces are proposed for all on-site walk and driveways where permitted.

## Sprinklers & Domestic Water

Domestic hot water is provided by a tankless water heater, located in the dining room millwork, and distributed through the half-height wall to the rest of the dwelling. All critical equipment servicing the operation of the dwelling is located above the FCL.

While sprinklers are generally not required for this type of building (depending upon local site conditions, according to BCBC 2024), the project includes provision for sprinklers and required mechanical equipment. Sprinklers are an important component to FireSmart buildings and provide substantial fire protection to inhabitants and adjacent structures at minimal initial cost.

Table 9.36.2.6-B:

| | Required (Effective) | | Proposed (Effective) | | |
|---|---|---|---|---|---|
| **Assembly** | **RSI** | **R** | **RSI** | **R** | **Reference (BCBC 2024)** |
| Ceiling below attic | 6.91 | 39.23 | 7.79 | 44.23 | 9.36.2.6-B |
| Cathedral ceiling | 4.67 | 28.50 | 5.02 | 28.50 | 9.36.2.6-B |
| Walls | 2.78 | 15.78 | 4.11 | 25.42 | 9.36.2.6-B |
| Foundation walls | 1.99 | 11.30 | 3.27 | 18.57 | 9.36.2.8-B |
| Floors over unheated space | 4.67 | 26.52 | 5.88 | 33.43 | 9.36.2.8-B |
| Unheated floors | 1.96 | 11.13 | 3.27 | 18.57 | 9.36.2.8-B |

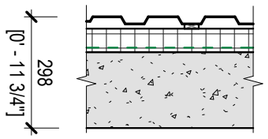
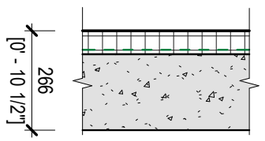
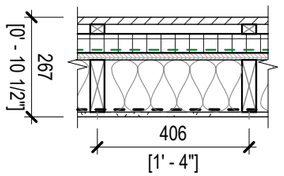
## Embodied Carbon

The BC Energy Step Code presents designers the opportunity to address the operational carbon emissions over the lifetime of the building. This proposed design seeks to also minimize the embodied carbon of the project by ensuring that building elements are resilient and do not need to be rebuilt after a flood event. Assemblies have been designed to not only meet the current and future thermal requirements, but which utilize low embodied carbon materials wherever possible. For example, polyisocyanurate insulation was proposed over XPS due to the embodied carbon, however assemblies can easily be modified for individual applications as required.

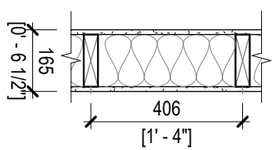
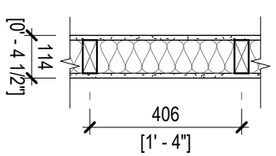
| **Product** | **kg of C02e/m2** |
|---|---|
| XPS (Legacy) | 4937 |
| Brick | 4725 |
| Fibre cement boards | 1703 |
| Steel siding | 1422 |
| XPS (New) | 715 |
| Mineral fibre (Rigid) | 473 |
| EPS | 288 |
| Polyisocyanurate | 252 |
| Fibreglass batt | 154 |

Source: City of Nelson[3]

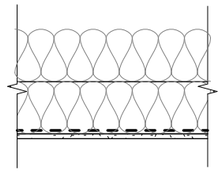
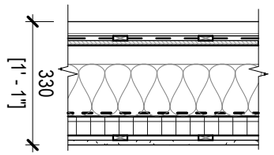
# EXTERIOR WALLS

| PLAN DETAIL | TYPE | CONSTRUCTION | RSI |
|---|---|---|---|
|  | C2a | REINFORCED CAST-IN-PLACE CONCRETE WALL ABOVE GRADE + EXTERIOR INSULATION<br>• Vertical corrugated metal siding 25.4mm (1")<br>• Horizontal strapping 12.7mm (1/2")<br>• 50.8mm (2") polyisocyanurate insulation<br>• Vapour permeable self-adhered membrane<br>• 203mm (8") concrete wall | 3.27 |
|  | C2f | REINFORCED CAST-IN-PLACE CONCRETE WALL BELOW GRADE + EXTERIOR INSULATION<br>• Drainage board 12.7mm (1/2")<br>• 50.8mm (2") polyisocyanurate insulation<br>• Vapour permeable self-adhered membrane<br>• 203mm (8") concrete wall | 3.26 |
|  | MS0a<br>MS0b<br>MS0c | METAL SIDING ON 2X6 STUD WALL<br>• Metal lap siding 12.7mm (1/2")<br>• Vertical strapping 25.4mm (1")<br>• 50.8mm (2") polyisocyanurate insulation<br>• Vapour permeable self-adhered membrane<br>• Plywood sheathing 12.7mm (1/2")<br>• 2x6 wood framing filled with R19 batt @16" OC (optional for higher thermal performance)<br>• Smart vapour retarder membrane<br>• Gypsum wall board 12.7mm (1/2") | 4.11 |

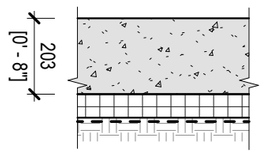
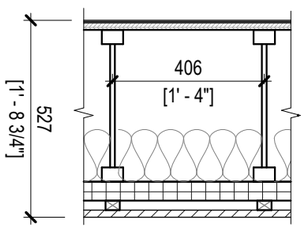
# INTERIOR WALLS

| PLAN DETAIL | TYPE | CONSTRUCTION | RSI |
|---|---|---|---|
|  | S0a<br>S0b | INTERIOR 6" WOOD STUD WALL<br>• 1/2" gypsum wall board<br>• 2x6 wood studs @ 16" oc<br>• Fibreglass batt insulation 139.7mm (5.5") [S0a only]<br>• 1/2" gypsum wall board | N/A |
|  | S0c<br>S0d | INTERIOR 4" WOOD STUD WALL<br>• 1/2" gypsum wall board<br>• 2x4 wood studs @ 16" oc<br>• Fibreglass batt insulation 88.9mm (3.5") [S0c only]<br>• 1/2" gypsum wall board | N/A |

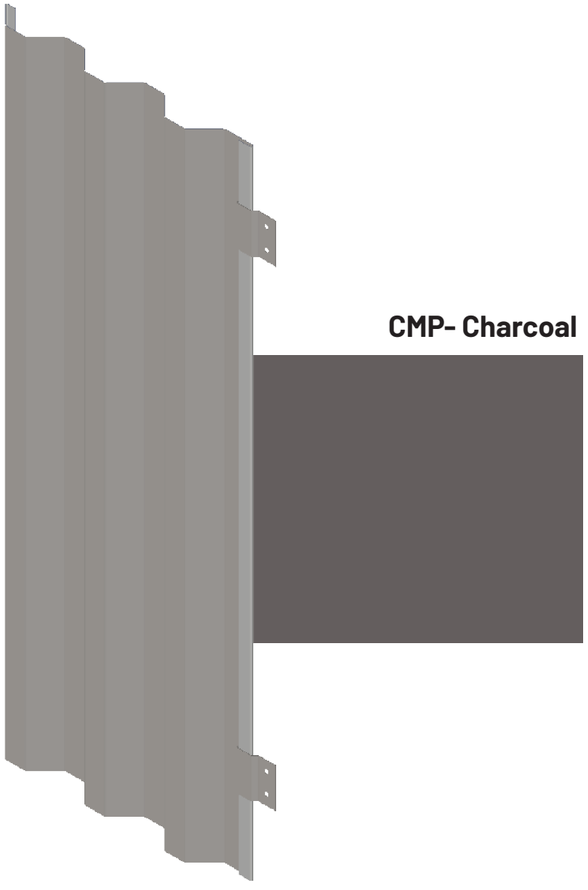
# ROOF / CEILINGS

| PLAN DETAIL | TYPE | CONSTRUCTION | RSI |
|---|---|---|---|
|  | RF1 | VENTILATED ATTIC ROOF<br>• Standing seam metal roof 38.1mm (1.5")<br>• Horizontal strapping 12.7mm (1/2")<br>• Vapour permeable self adhered membrane<br>• Plywood sheathing 12.7mm (1/2")<br>• Unconditioned space (varies)<br>• Wood roof truss (size TBD)<br>• Fibreglass batt insulation 279.4mm (11")<br>• Smart vapour retarder membrane<br>• Gypsum wall board 12.7mm (1/2") | 7.79 |
|  | RF2 | CATHEDRAL CEILING ROOF<br>• Standing seam metal roof 38.1mm (1.5")<br>• Horizontal strapping 12.7mm (1/2")<br>• Vapour permeable self adhered membrane<br>• Plywood sheathing 12.7mm (1/2")<br>• 2x8 wood rafter<br>• 50.8mm (2") polyisocyanurate insulation<br>• Smart vapour retarder membrane<br>• 50.8mm (2") polyisocyanurate insulation<br>• Gypsum wall board 12.7mm (1/2") | 5.02 |

# FLOORS

| PLAN DETAIL | TYPE | CONSTRUCTION | RSI |
|---|---|---|---|
|  | F1 | UNHEATED SLAB ON GRADE<br>• 6 mil polyethylene vapour barrier<br>• 50.8mm (2") polyisocyanurate insulation<br>• 152.4mm (6") concrete slab | 3.27 |
|  | F2a<br>F2b<br>F2c | TJI TRUSS WITH EXTERIOR INSULATION<br>• Linoleum tiles with cork underlay 6mm (1/4")<br>• OSB sheathing 19.05mm (3/4")<br>• 16" TJI joist @ 16" OC<br>• Fibreglass batt insulation 139.7mm (5.5")<br>• Polyisocyanurate insulation 50.8mm (2") fastened directly to joists with seams taped<br>• Horizontal strapping 12.7mm (1/2")<br>• Metal soffit 12.7mm (1/2") (F2b)<br>• Type X GWB 15.88mm (5/8") (F2c) | 5.02 |

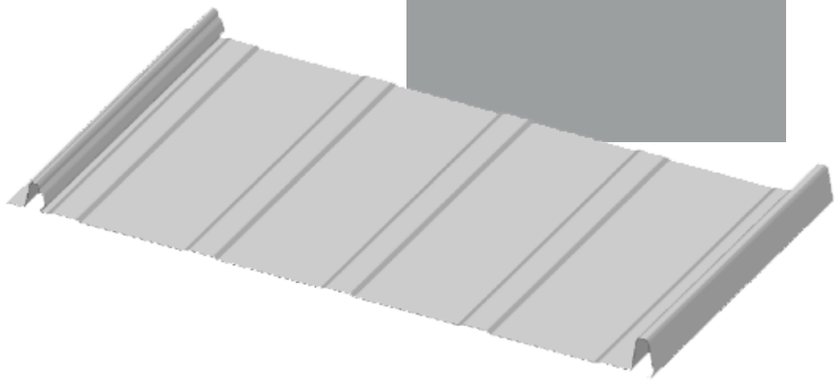
**Corrugated Metal Panel**
[C2a]



**CMP- Charcoal**

**Standing Seam Metal Roofing**
[RF1]

**SSMR - Regent Grey**



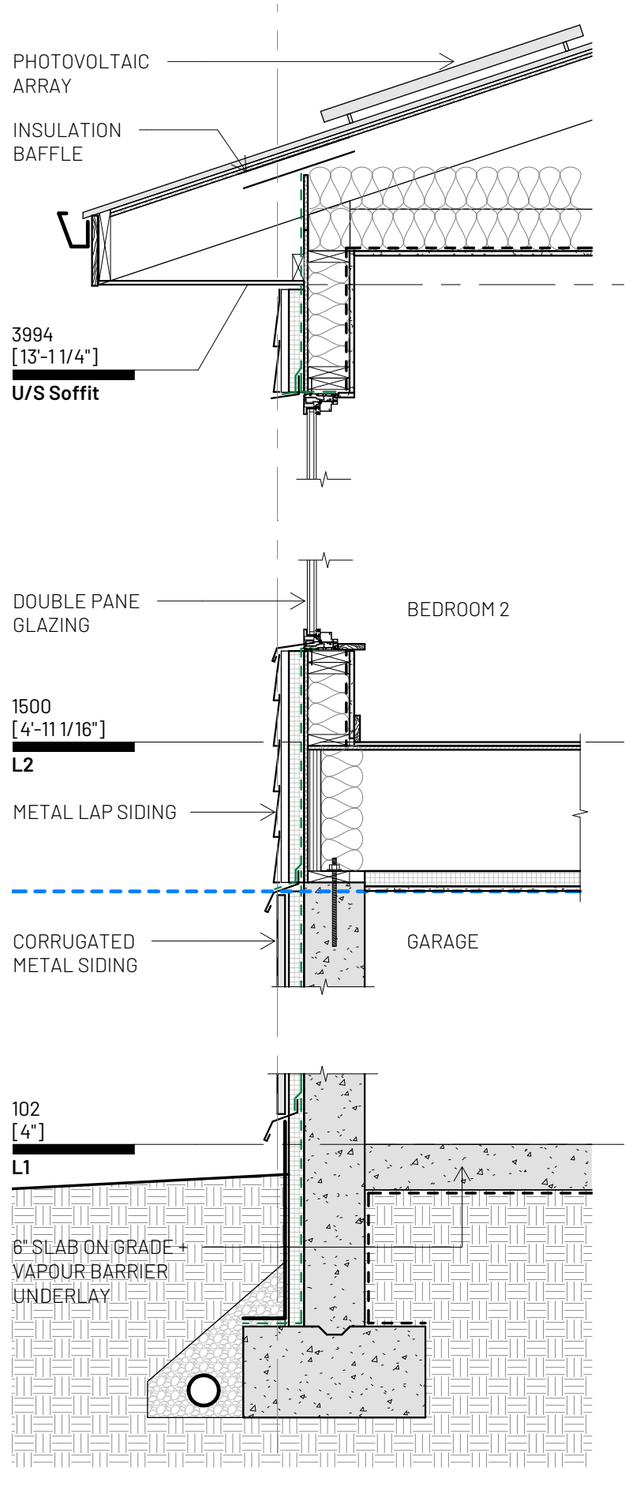
**Metal Lap Siding**
[MS0a, MS0b, MS0c]

**MS-1 - Black**

**MS-2 - Western redcedar**

**MS-3 - Copper Penny**

## Wall Section



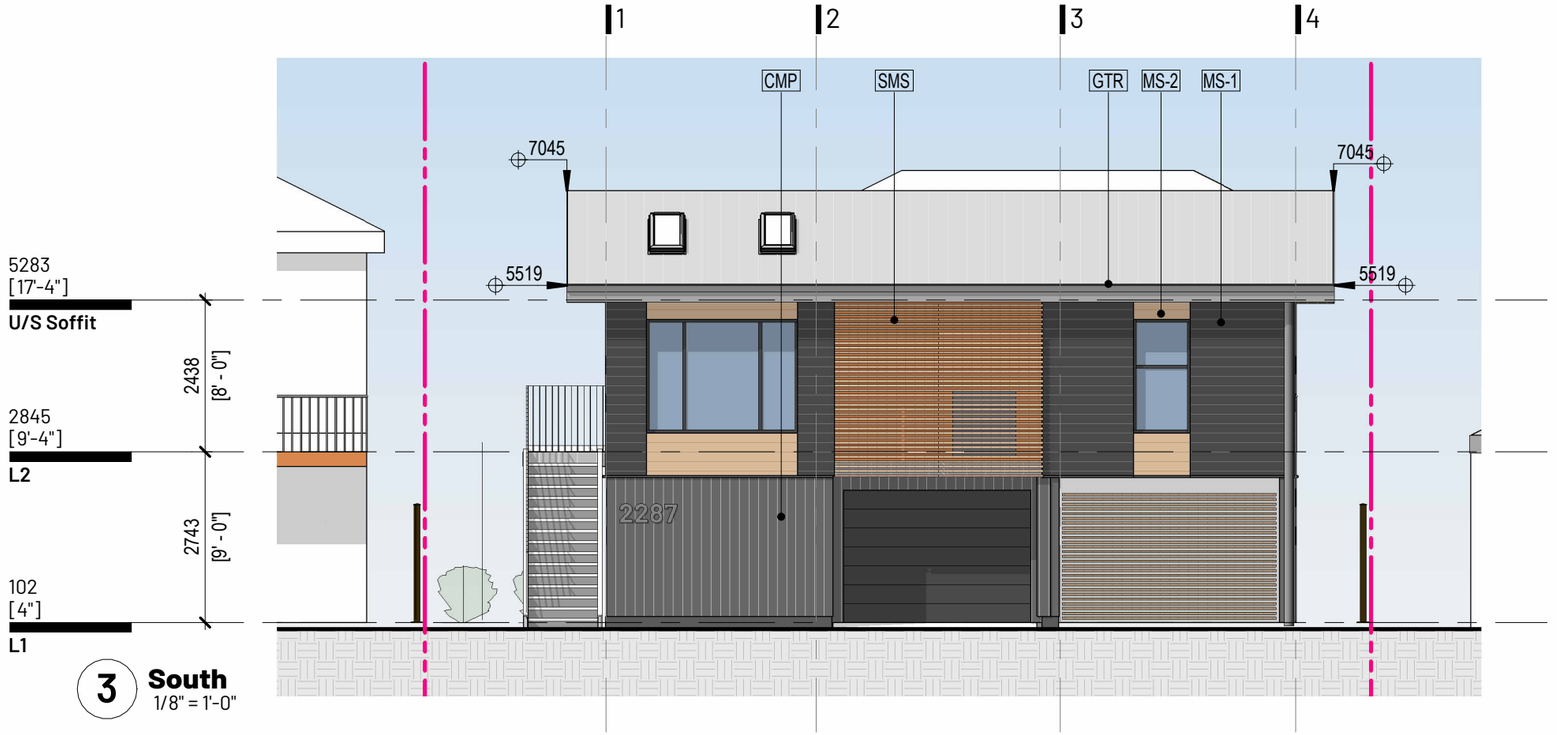
# Innovative Design

The design concept for this Accessory Dwelling Unit emphasizes the integration of cutting-edge building science principles in a manner that is both simple to construct and easily replicable. The architectural advancements primarily prioritize resilience and sustainability, while also placing significant emphasis on aesthetics and functionality to cater to a wide range of household compositions and requirements, thereby promoting inclusivity.

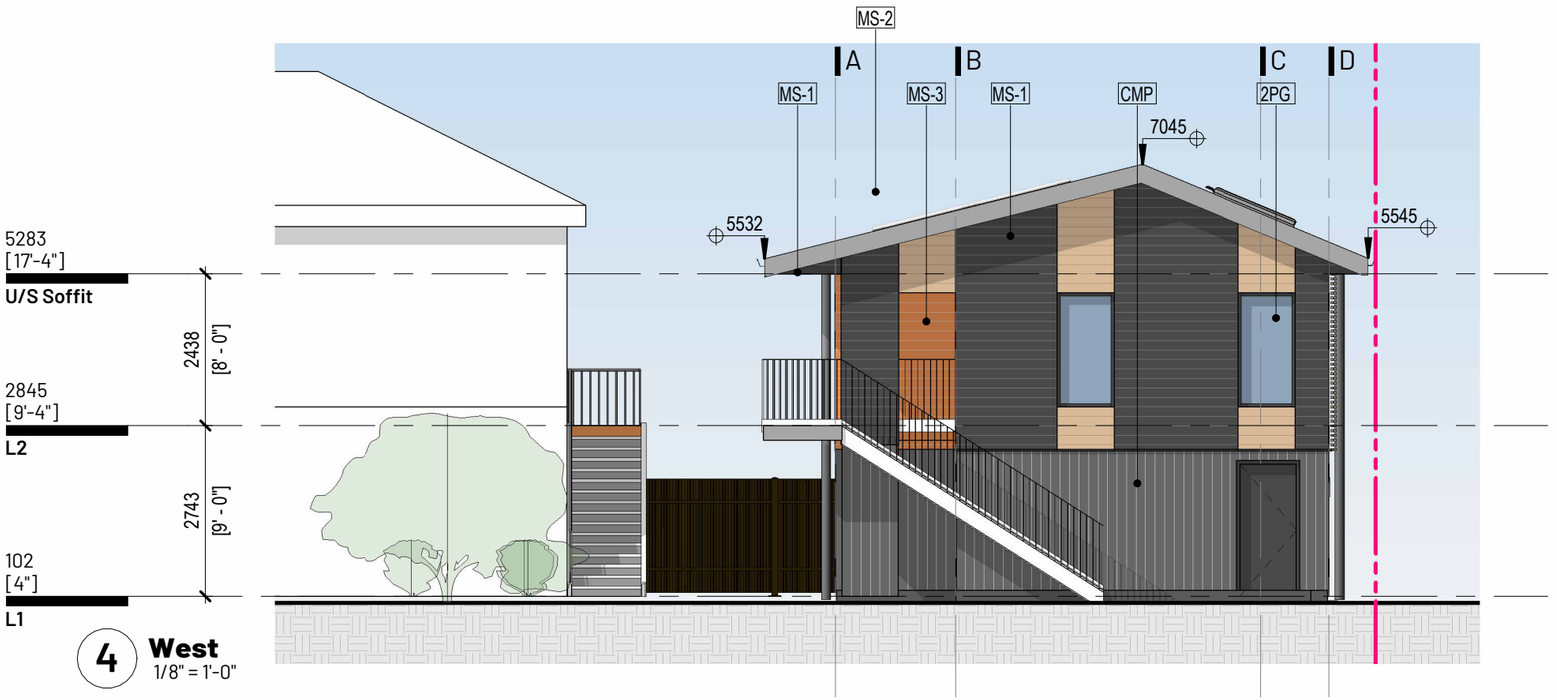
- Outdoor stairs, preferrably metal framed, are easily replaced following a flood event (if required). Enclosed stairs in wood stud enclosures are not resilient to flood events and would require significant remediation for re-occupancy.
- All critical equipment required for occupancy is located above FCL.
- All circuits and junction boxes are located at or above FCL.
- Metal siding and roof are flood and fire resistant, while also representing a low carbon option for high durability materials. Many of these metal components can also be comprised of recycled materials, further reducing embodied carbon.
- Standing seam roof is inherently solar photovoltaic ready.
- Metal roof has high albedo, reducing heat island effect.
- External insulation strategy allows for flexibility in individual design applications. The proposed wall assemblies could accomodate higher levels of thermal performance with minimal impact to setbacks or layout.
- Sliding metal screens provide screening for the heat pump compressor. The void in this area also provides storage space for bicycles or gardening equipment, and will facilitate maintenance access to the ventilated attic, ensuring that attic access is not required from within the air barrier perimeter.

## KEYNOTE LEGEND

| TAG | DESCRIPTION |
|---|---|
| 2PG | DOUBLE PANED GLAZING |
| CMP | CORRUGATED METAL PANEL |
| GTR | GUTTER |
| MS-1 | METAL SIDING - TYPE 1 |
| MS-2 | METAL SIDING - TYPE 2 |
| MS-3 | METAL SIDING - TYPE 3 |
| SMS | SLIDING METAL SCREEN |

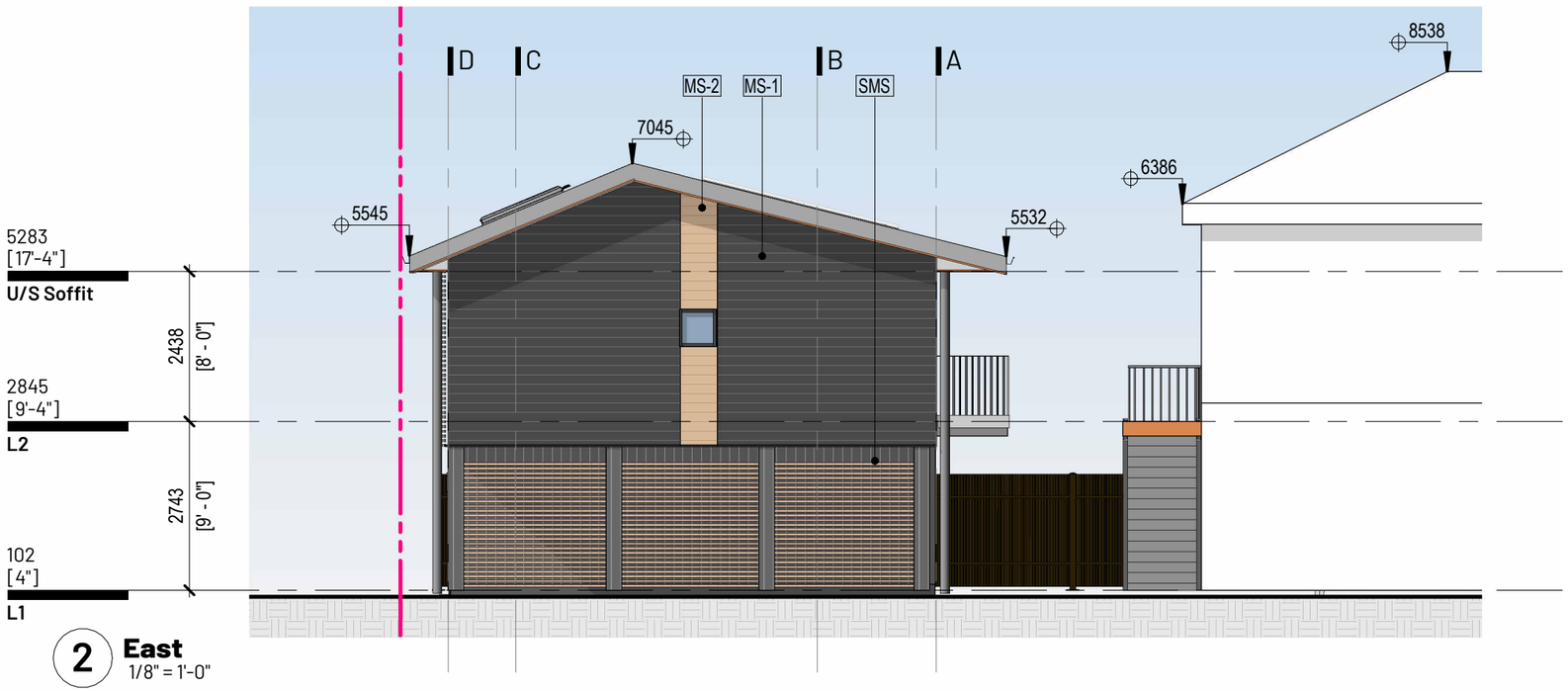



3 **South**
1/8" = 1'-0"




4 **West**
1/8" = 1'-0"


1 **North**
1/8" = 1'-0"




2 **East**
1/8" = 1'-0"

# Accessibility

The design of this Accessory Dwelling Unit goes above and beyond the BCBC 2024 Part 9 Accessibility Requirements, providing accomodation for future modifications to the building to allow access to living spaces above grade. Adequate space and structure has been provided in the Site Plan to allow for a patio lift to be constructed to provide access to L1 in the future. Additionally, the living spaces at L1 are designed to accommodate and compliment future accessibility needs. This future-oriented site layout promotes flexibility in individual applications as they pertain to individual circumstances and lot configurations, and does not compromise the ability of applicants to reconfigure the design as needs change over time.

## KEYNOTE LEGEND

| TAG | DESCRIPTION |
|---|---|
| 2PG | DOUBLE PANED GLAZING |
| CMP | CORRUGATED METAL PANEL |
| GTR | GUTTER |
| MS-1 | METAL SIDING - TYPE 1 |
| MS-2 | METAL SIDING - TYPE 2 |
| MS-3 | METAL SIDING - TYPE 3 |
| SMS | SLIDING METAL SCREEN |

## Bibliography


1 District of Squamish. (2017). Squamish 2040 Official Community Plan Bylaw 2500.2017.

2 BC Housing. (September 2017). Illustrated Guide to Achieving Airtight Buildings.

3 BC Housing. (2015). Illustrated Guide to Energy Efficiency Requirements for Houses in British Columbia.

4 BC Ministry of Housing. (2024). Provincial Policy Manual & Site Standards for Small-Scale, Multi Unit Housing

5 District of Squamish. (2011). District of Squamish Zoning Bylaw, No.2200, 2011.


## Works Cited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2 Altus Group. (2024). Canadian Cost Guide 2024.BC Housing. (2015). Illustrated Guide to Energy Efficiency Requirements for Houses in British Columbia.

3 City of Nelson. (2022). Material Carbon Emissions Guide.District of Squamish. (2011). District of Squamish Zoning Bylaw, No.2200, 2011.


# APPENDIX A
## PROJECT DRAWINGS

1 2899 [9' - 6 1/8"]
2 3377 [11' - 1"]
3 3921 [12' - 10 3/8"]
4 3783 [12' - 5"]
1219 [4' - 0"]
11081 [36' - 4 1/4"]

1 A400

CONCRETE PAD FOR FUTURE LIFT

C2a

PERMEABLE GROUND COVER

PAVING STONES

OPTIONAL FENCING

1573 [5' - 2"]
1326 [4' - 4 1/4"]
1932 [6' - 4"]
376 [1' - 2 3/4"]
2750 [9' - 0 1/4"]
300 [0' - 11 7/8"]
3542 [11' - 7 1/2"]
1219 [4' - 0"]

002 D1 36 84

REGULAR STALL (2.75m x 5.8m)

6136 [20' - 1 5/8"]

2 A400

UP

GARAGE

COVERED OUTDOOR AREA

4901 [16' - 1"]
7930 [26' - 0 1/8"]
5420 [17' - 9 3/8"]
3088 [10' - 1 1/2"]
453 [1' - 5 7/8"]
3000 [9' - 10 1/8"]
176 [0' - 7"]

102

001 D1 36 84

003 OH1 118 84

88

4.5%

1859 [6' - 1 1/8"]

1097 [3' - 7 1/4"]
762 [2' - 6"]

0

1 A400

PAVING STONES

PERMEABLE GROUND COVER

11081 [36' - 4 1/4"]

2899 [9' - 6 1/8"]
3377 [11' - 1"]
3921 [12' - 10 3/8"]
3783 [12' - 5"]
1219 [4' - 0"]

A
B
C
D

**Squamish ADU Design Competition**

SCALE: 1 : 50

**L1 Enlarged**

# A100

1 2 3 4

2899 [9' - 6 1/8"] | 3377 [11' - 1"] | 3921 [12' - 10 3/8"] | 3783 [12' - 5"] | 1219 [4' - 0"]

11081 [36' - 4 1/4"]

1 A400

FUTURE PATIO LIFT

KNOCKOUT RAILING PANEL FOR FUTURE LIFT

MC0a

1151 [3' - 9 3/8"]

BALCONY

1932 [6' - 4"]

MC0c

1194 [3' - 11"]

1573 [5' - 2"]

2768 [9' - 1"]

827 [2' - 8 5/8"]

FOYER

KITCHEN

3112 [10' - 2 1/2"]

BEDROOM 1

3555 [11' - 8"]

2554 [8' - 4 5/8"]

3216 [10' - 6 5/8"]

1869 [6' - 1 5/8"]

ON DEMAND HOT WATER HEATER IN MILLWORK

2 A400

UP

LIVING

3802 [12' - 5 5/8"]

3120 [10' - 2 7/8"]

TUB WITH ABILITY TO BE RETROFITTED TO SHOWER

3075 [10' - 1 1/8"]

2999 [9' - 10 1/8"]

1408 [4' - 7 3/8"]

2872 [9' - 5 1/8"]

BEDROOM 2

2562 [8' - 4 7/8"]

795 [2' - 7 3/8"]

MC0c

1090 [3' - 6 7/8"]

COMPRESSOR

A

B

C

D

4901 [16' - 1"]

7930 [26' - 0 1/8"]

1097 [3' - 7 1/4"]

762 [2' - 6"]

1932 [6' - 4"]

11081 [36' - 4 1/4"]

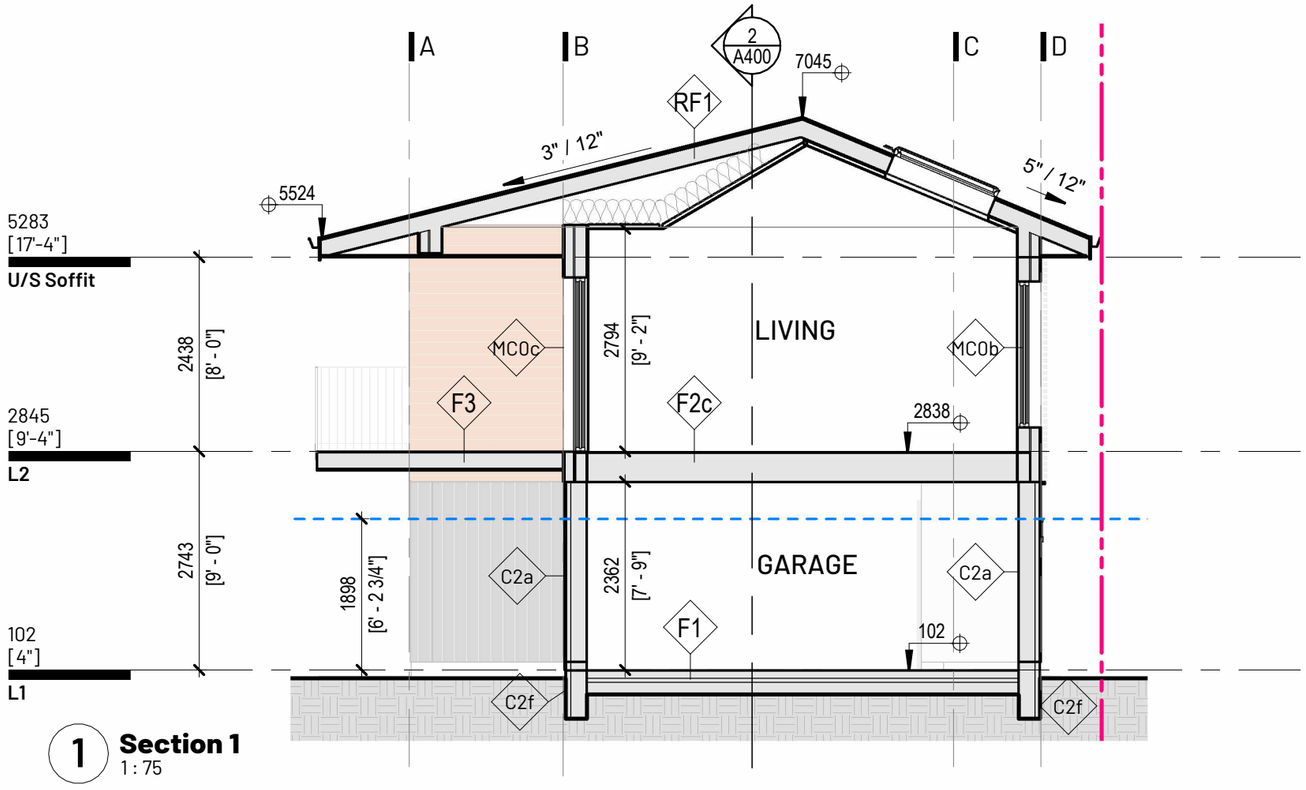
2899 [9' - 6 1/8"] | 3377 [11' - 1"] | 3921 [12' - 10 3/8"] | 3783 [12' - 5"] | 1219 [4' - 0"]

**Squamish ADU Design Competition**

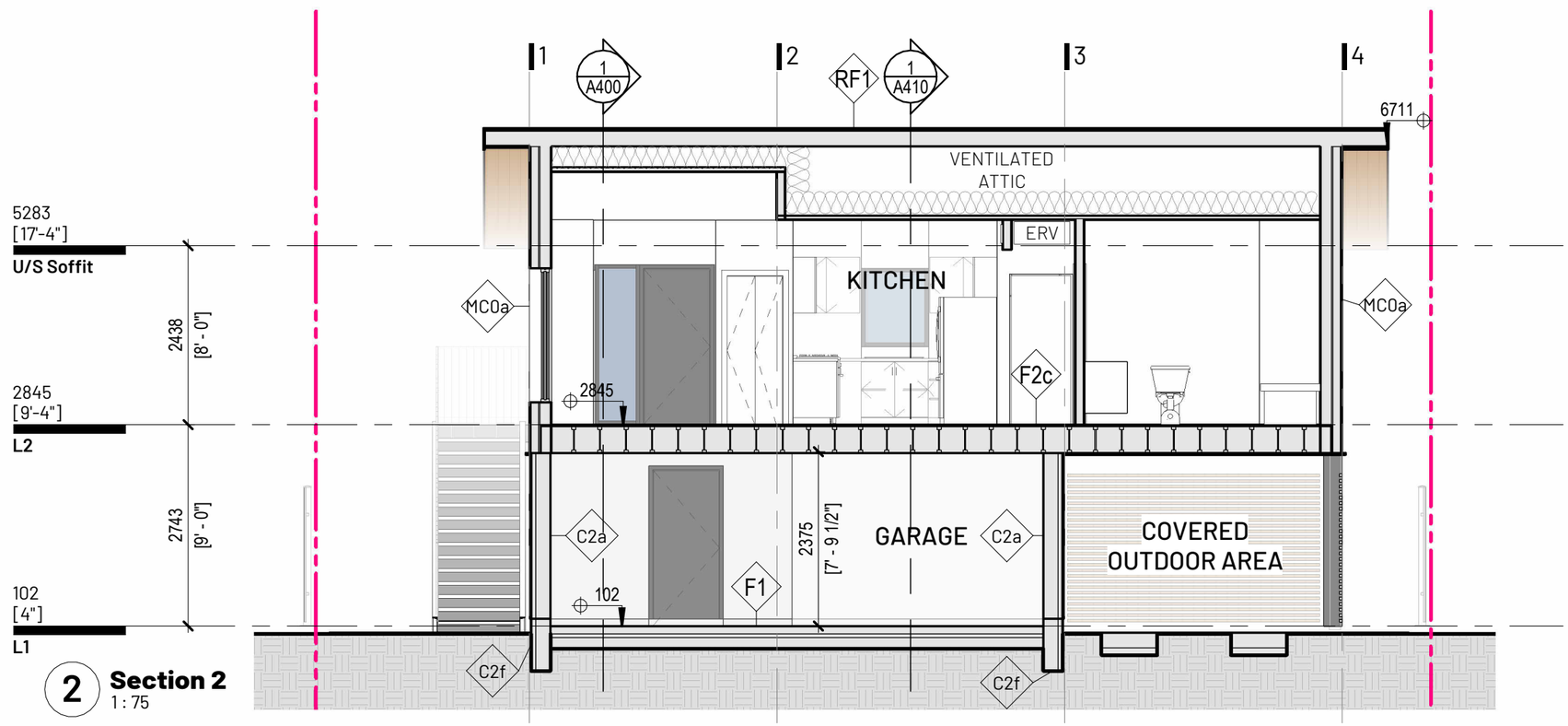
SCALE: 1 : 50

**L2 Enlarged**

# A101




1 **Section 1**
1 : 75




2 **Section 2**
1 : 75

**Squamish ADU Design Competition**

SCALE: 1 : 75

**Sections**

# A400