Environmental Considerations Overview

This high-school was designed with a holistic biophilic approach, utilizing core principles of biophilic theory, with an integration of environmental and salutogenic design. From the outset the entire project attempted to explore a holistic approach to site, with structural, mechanical, programming, and aesthetic all integrally tied to the site and environment the project is based in.

This project predicates views to and of nature, utilizing common spaces and hallways to provide study spaces and opportunities for students to immerse themselves in natural elements. By predicating the form around an internal courtyard I was able to maximize access to natural views, program exterior spaces, and provide varied and optimal learning opportunities. This programming also allowed a provision for multi-use accessibility, by allowing the front building to double as a community centre, with gym, workshop, community kitchen, and banquet space accessible to the community. Further back in the site, the classrooms and library are preserved for student use.

The location was situated within an existing clearing, with minimal disruption to surrounding context. Trees that would have to be removed could be utilized to generate a living shoreline, creating flood protection. The surrounding trees in unison with planting strategies, could be employed to provide evapotranspiration in the summer, and act as a wind barrier in the Winter. Massing choices predicate maximum south roof exposure for ample solar generation, and provide ideal cross ventilation for the primary Summer wind direction, while sheltering the building in the Winter as the primary winds come against its narrow elevations. In addition to evapotranspiration, the planting strategies allow for the foliage to provide seasonal shading devices, with the leaves either blocking light in the Summer, or falling and allowing maximum light penetration in the winter. Through this and active systems elaborated on in the next spread, this project works symbiotically with the site, providing passive and active strategies to heating and cooling, maximizing the sites biophilic qualities, and utilizing design to benefit the users and site, allowing both a maximal benefit for both user cognitive and physical benefits, while maintaining site health.

I firmly believe that every element of design plays a profound role in the success or failure of a project, with detail an integral part to the realization of ambitions. In order to realize the environmental ambitions of this project, it required a careful consideration of materials, structure, and finishes, from both a psychological, environmental, and aesthetic perspective. To achieve this, I have utilized visualizations to illustrate the importance of natural light, natural materials such as wood, and natural colours such as greens, yellows, browns, and blues, to align with the ambitions of the project. Material choices extend beyond the aesthetic ambitions, but underly the design ambitions for circular design, through utilizing materials with substantial opportunity for re-use, as is the case with DLT, CLT, and hardwood, as well as benefiting from the psychological benefits found through cognitive restoration, anxiety reduction, and reduced stain. All of these elements, in addition to active and passive environmental heating and cooling symbiosis, and salutogenic circulation, work collaboratively to generate a project that simultaneously looks after the health of the community, the site, the end users, and ultimately the planet for generations to come. It is this holistic approach to design, utilizing the latest cognitive research, most current thoughts on sustainability, and accessible technology that I believe architecture can adapt to the challenges of this century, and transcend above our ambitions.

Through utilizing existing technologies we can approach the site and building as two objects working toward symbiosis, with the building utilizing the earths resources to generate energy, heat and cool space, clean air, and utilize rain water. Through both solar and thermal PV we can generate energy and maintain the sites ground source temperatures to create a balanced system. In addition, systems like heat pumps, earth tubes, and water collection can all provide resources to manage the needs of the building. Natural systems, like evapotranspiration, seasonal leaf loss, and ocean current characteristics can all be utilized to work in relationship to the site.

This holistic relationships spreads to material choice, with material decisions largely made in context to its ability to participate in a circular system, proximity, and sustainable potential. Exterior finishes, in this case cedar shake and shou sugi ban siding, are chosen for durability and circular system potential. Insulation is sourced from an entirely carbon neutral process, utilizing natural cork. This process all integrates not only to meet the sustainable goals of the project, but work holistically toward the biophilic and environmental design goals. The presence of natural material choices and reliance on organic material, both on and off site, contribute to proven cognitive benefits to reduce stress and cognitive strain, as well as increasing air quality and proven to benefit to student performance. Ultimately this project exemplifies the design ambitions of an environmental design based approach, where through a rigorous attention to all aspects of the architectural project we can create spaces that achieve better environmental relationships, produce better learning environments, and can both physically and psychologically benefit its users. This project exemplifies my approach to design and belief in the integration of architecture and environmental design as the driving force to furthering architectures ability to provide for the needs of its occupants and improve our lives.

Ultimately, this project explores innovation in sustainable design through a rigorous process of integrating both sustainable building principles and environmental design research in how to promote sustainable action in occupants, and how to immerse occupants in environmental interactions both random and programmed. Through approaching the building and site as integrally tied we can expand passive practices in orientation, fenestration & massing, with added approaches of consideration biological processes such as evapotranspiration, ocean currents, seasonal leaf changes, and living shorelines, to strengthen our site. In addition, active strategies such as balancing the sites ground temperatures through solar thermal, when combined with earth tubes and heat pumps, allow us to work with the site to maintain a ground temperature year long and benefit from the Earths natural resources. This allows the building to have a minimal impact on the site itself but benefit from its numerous natural processes. Finally, though sourcing local, sustainable materials with maximal circular potential, we can utilize our resources to have both a minimal impact on initial generation, but also allow for a maximum lifespan, with the greatest potential for re-use and to participate in a circular economy. These combined approaches all ultimately contribute a holistic mindset which allow the building to extent beyond the needs of its physical characteristics but to the site, and health of its occupants in promoting cognitive benefit and encouraging interactions with natural elements which have shown to contribute to increased alignment with sustainable views and actions in its users. Thank you for taking the time to consider me for this award.

Red Oak School

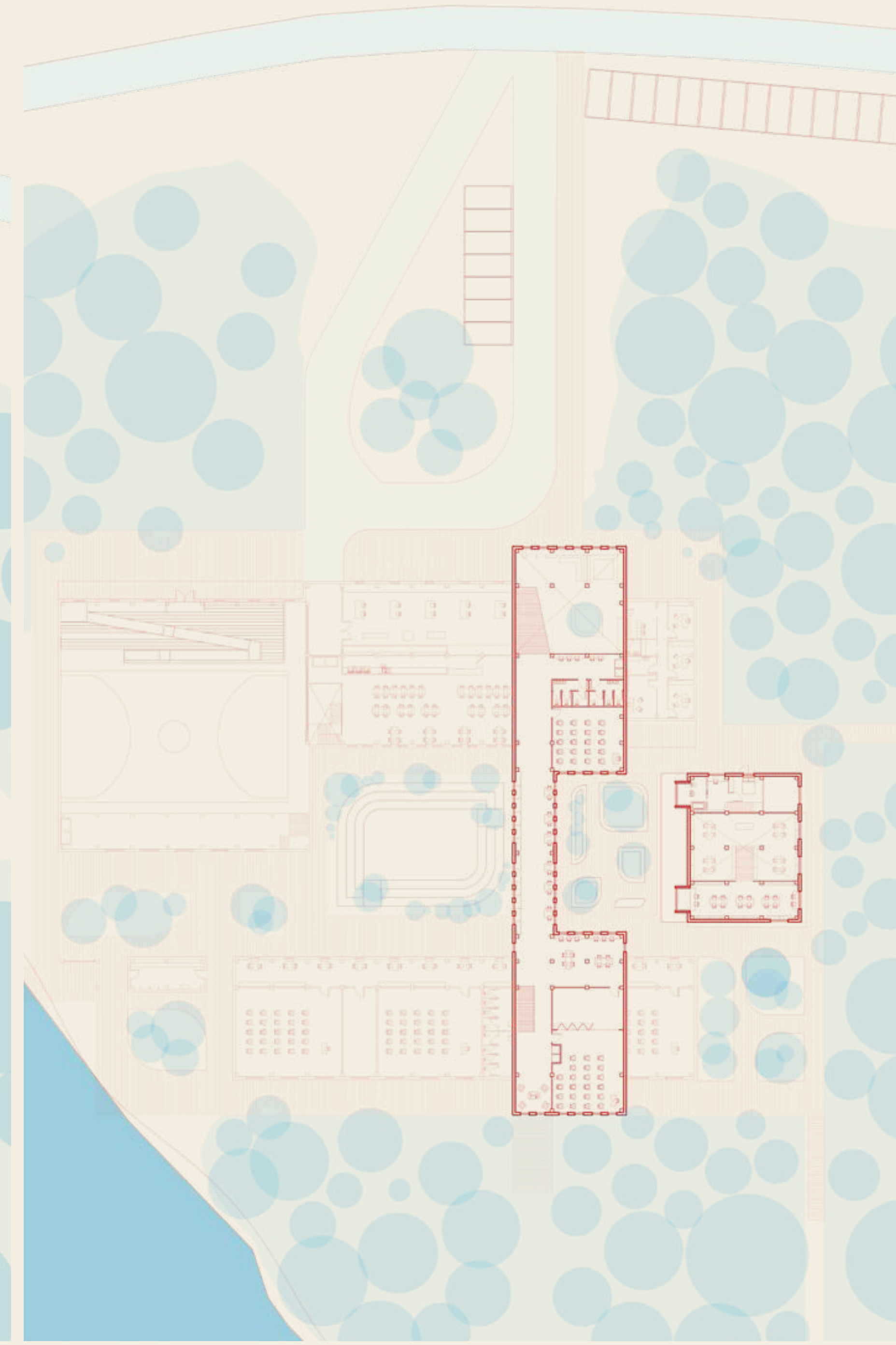
4B STUDIO P1
SEPT 2021

A schematic design project predicated around the design of a rural high school on Prince Edward Island. This project combined elements of biophilic design, salutogentic design, and passive design strategies to explore a holistic design process.

Floor Plans

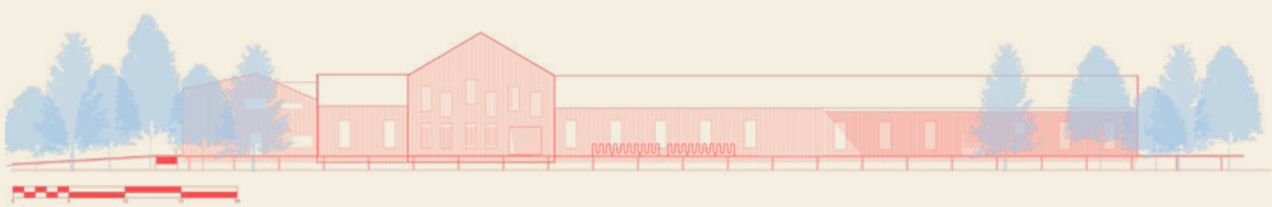
Concentrated around a central courtyard the plans predicate a mixed use community centre, located at the front of the site, with the classrooms and library setback, connected through a second floor bridge. This massing also allowed for maximal biophilic engagement with views to nature visible from most places. The courtyard and walkways provide ample connection to outdoor programming and promote engagement. The placement of buildings and feature stairs also provide a salutogenic approach, promoting movement and activity.

GF PLAN



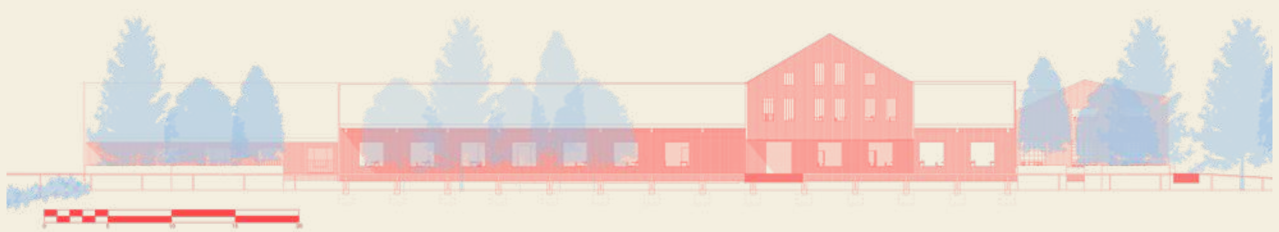
F2 PLAN

Elevations



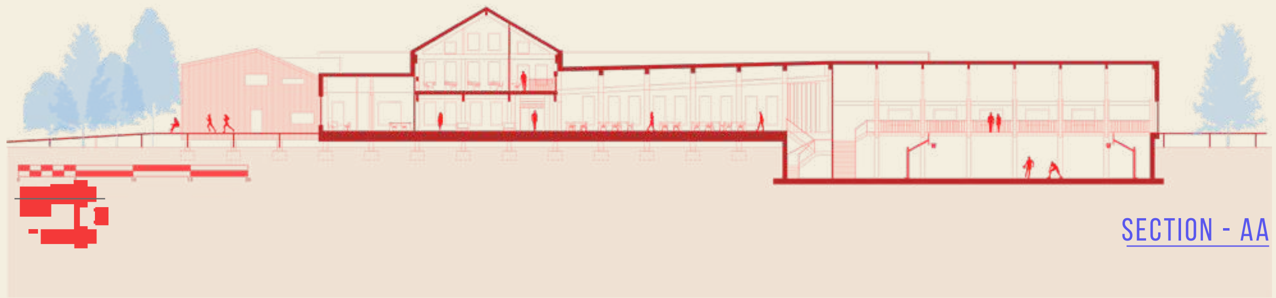
NORTH ELEVATION

COURTYARD SOUTH ELEVATION/SECTION



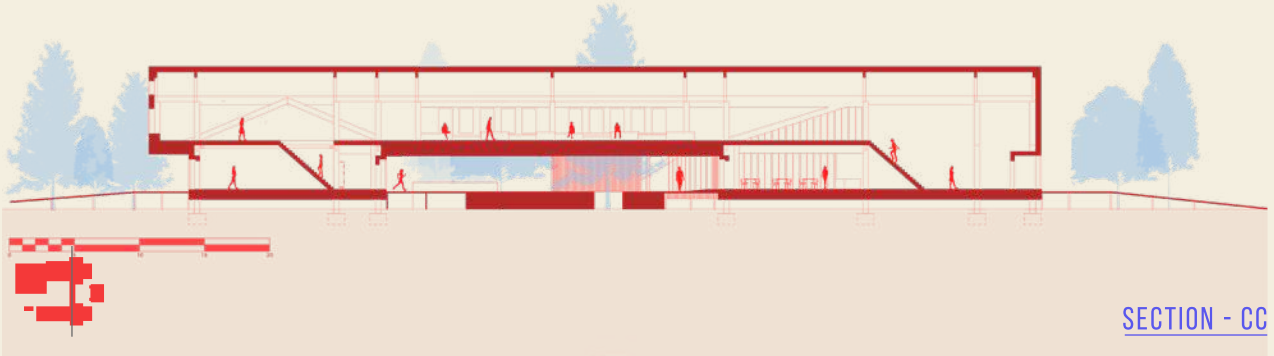
SOUTH ELEVATION

Sections



SECTION - AA

SECTION - BB



SECTION - CC

Use Axonometric

LIBRARY CLOSE UP

ENTRY CLOSE UP

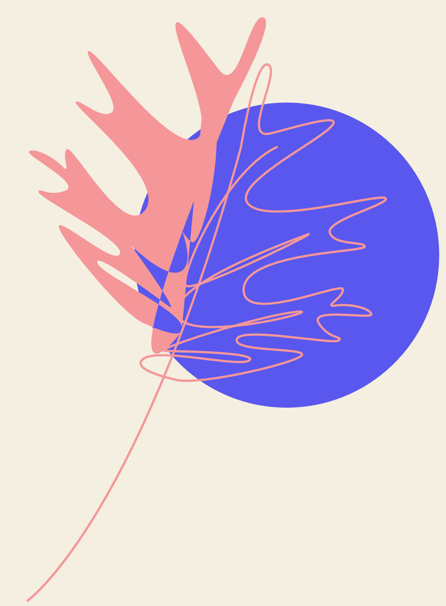
SITE AXONOMETRIC

Site Design

Extending beyond a simple consideration of site and built form, my approach attempts to utilize the site as part and parcel of the overall project. Resources such as water, wind through the site, solar potential of the site, and most importantly seasonal changes in foliage and plant life, contribute essential responses for the buildings seasonal operation and comfort.

Explicit attempts are made to balance the natural resources of the site; shelter, foliage, natural ventilation, solar potential, with systems which ensure its continued success, rain water irrigation, solar thermal etc.

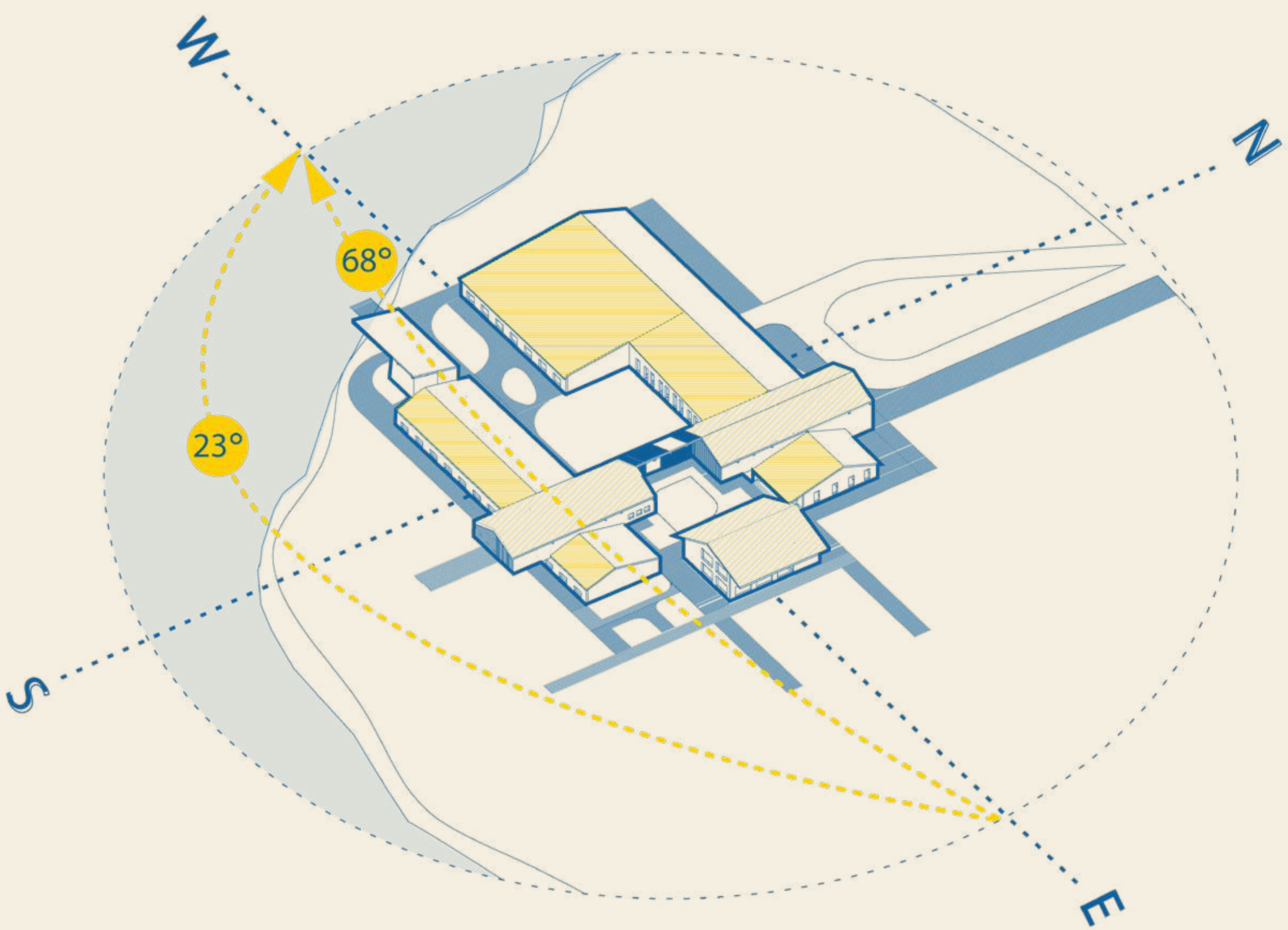
Massing plays an important role from the outset, with key decisions sheltering the building through the winter and maximizing ventilation in the summer, with a constant maximization of PV potential.

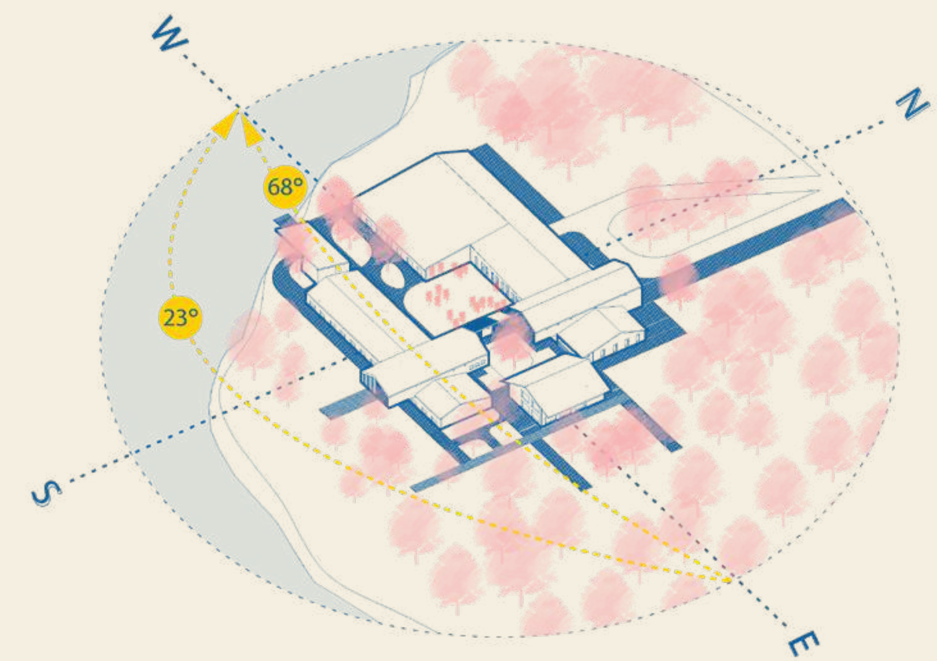


Solar Orientation

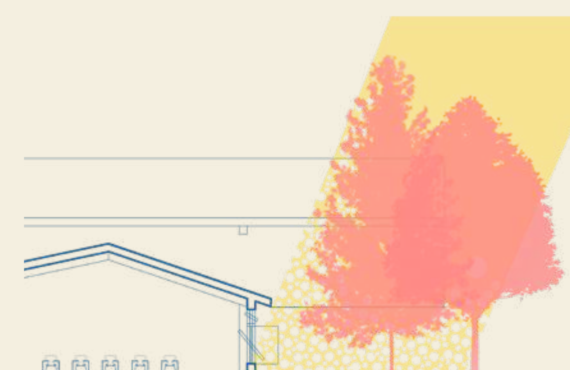
Massing has been optimized to provide a wealth of south glazing to optimize passive solar gain, with a maximum provision of south oriented slanted roofing for optimal solar panel placement. Additional East and West oriented roofing provides secondary mounting options for solar.

In addition to overhangs, existing and planned plantings are used to reject high summer sun, with the loss of foliage in the fall allowing a natural reduction of shading to allow more light to penetrate in colder months, allowing the building and site to act in symbiosis.

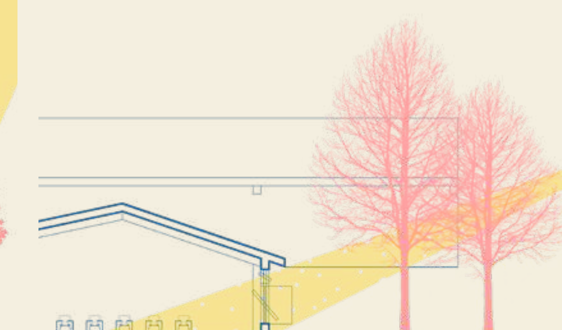




In working with the core tenants of biophilia, our site embraces the existing and planted surroundings to generate passive strategies which provide high summer shading, mixed shading in spring and fall, and allow maximal light penetration in the winter. This allows the building to work in symbiosis with the site and connect the building to its surroundings.



SUMMER SHADING STRATEGY

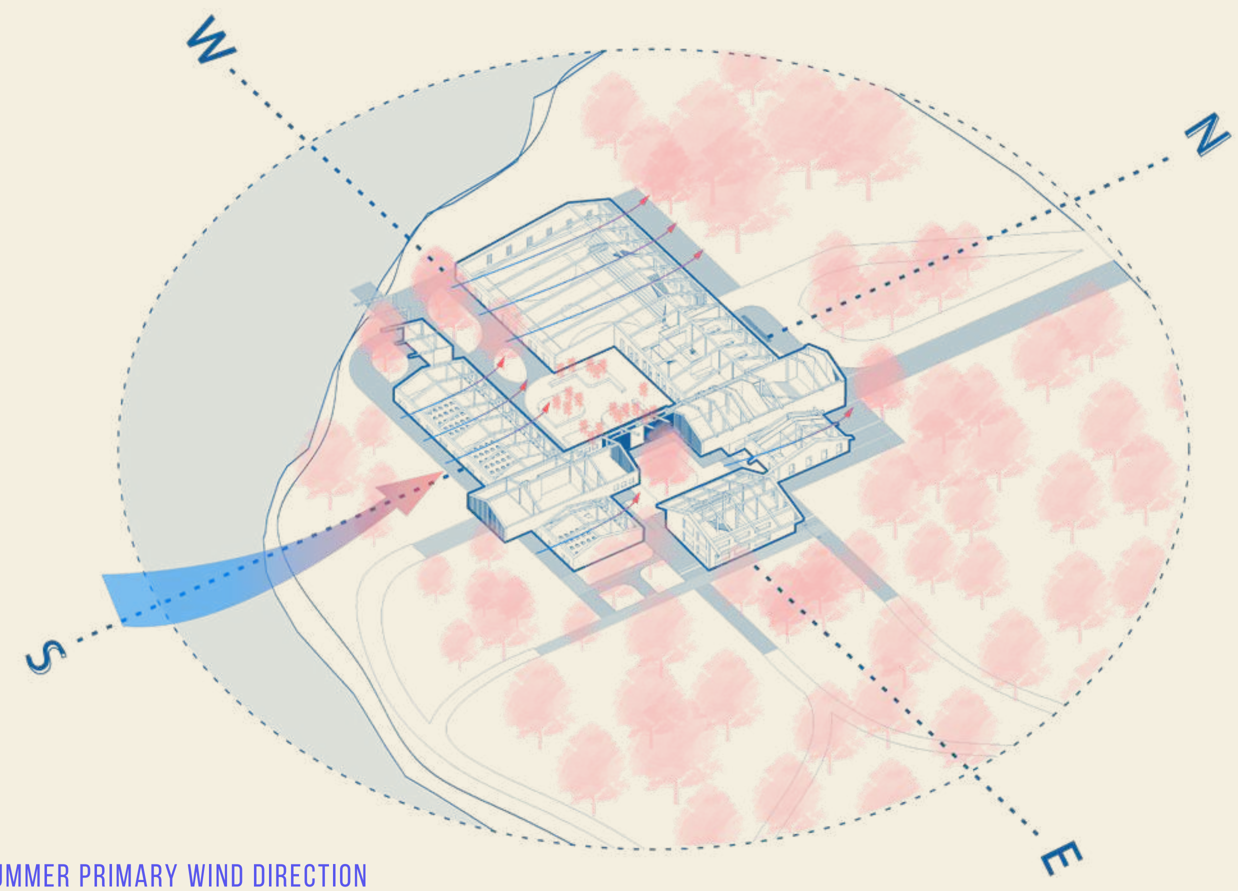


WINTER LIGHT OPTIMIZATION

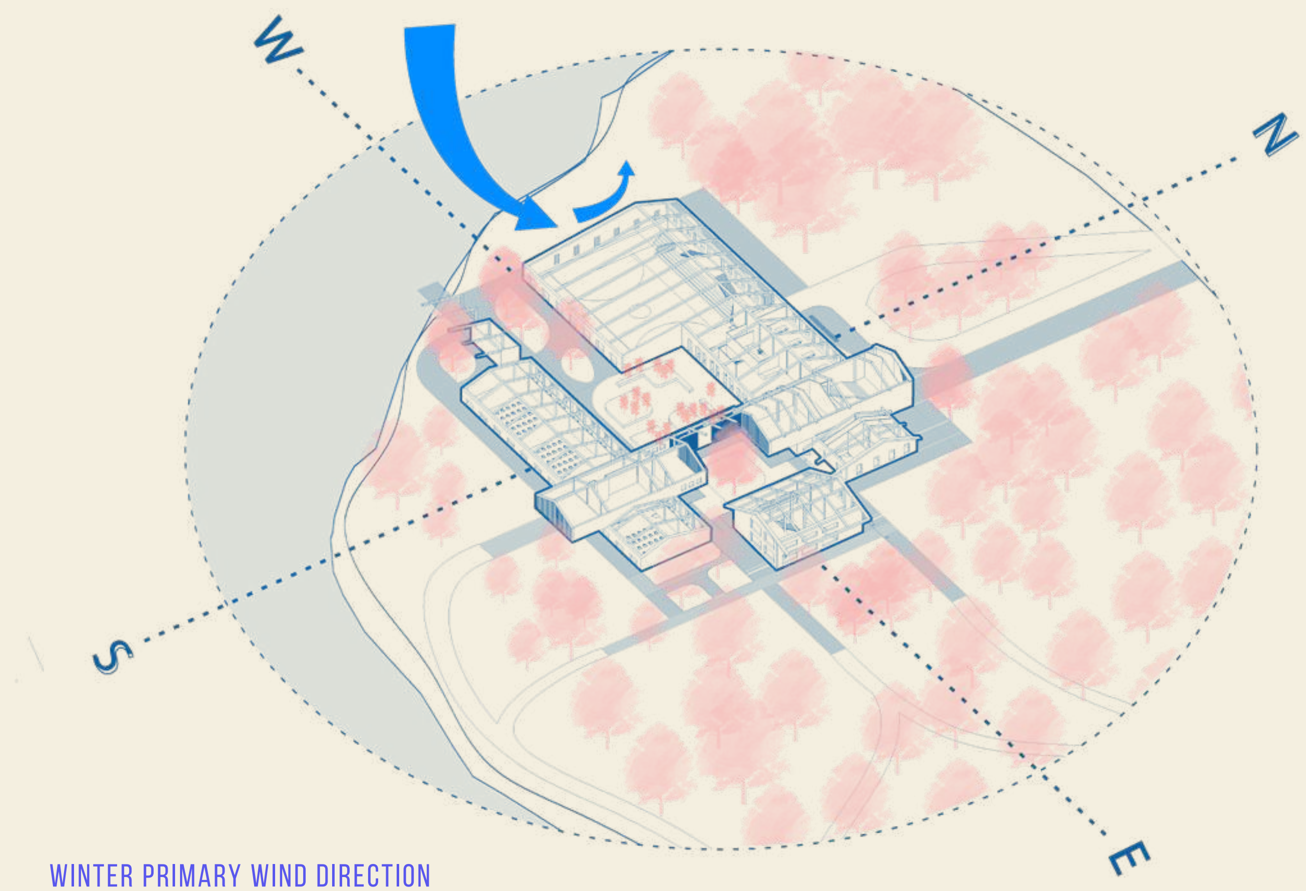
Paired with evapotranspiration, the existing and introduced plantings provide seasonal shading, reducing the need for mechanical systems and optimizing connection with the site.

Wind Orientation

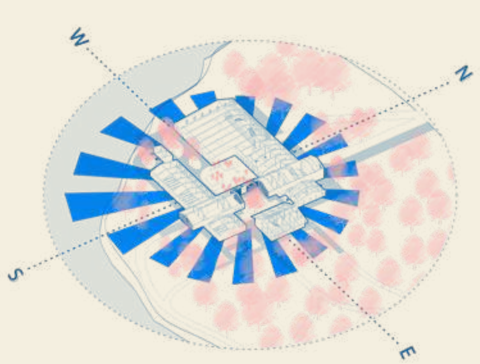
Sheltered on all sides by existing foliage, the building form uses the site to naturally protect itself from intense winds and utilizes evapotranspiration to passively cool the air temperature. In the Summer, winds primarily from the south-west travel over the water and through the existing foliage where it can transfer through much of the built form through natural cross ventilation created by strategic openings in the building and floor plates. Tilt and turn windows were specified to optimize maximum control. In the Winter primarily west and north-western winds come against the narrow facades enabling wind chill to be mitigated, with more northern winds traveling first through the dense northern part of the site.



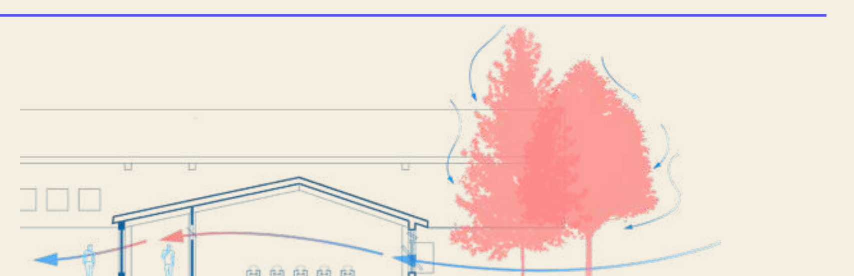
SUMMER PRIMARY WIND DIRECTION



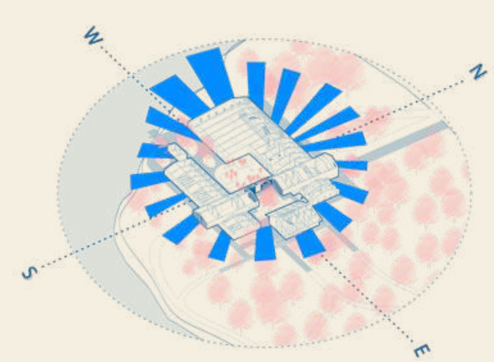
WINTER PRIMARY WIND DIRECTION



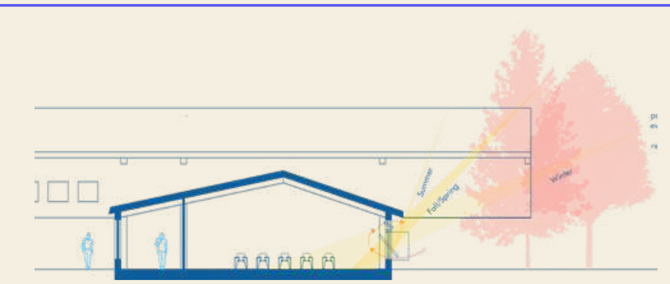
SUMMER WINDS DIRECTION %



Evapotranspiration, the process of water transferring from land to the atmosphere by soil and through transpiration in plants, actively lowers air temperature and provides passive cooling opportunities in the summer months. By retaining existing foliage and through new planting we can optimize this effect to passively cool the building, working in symbiosis.

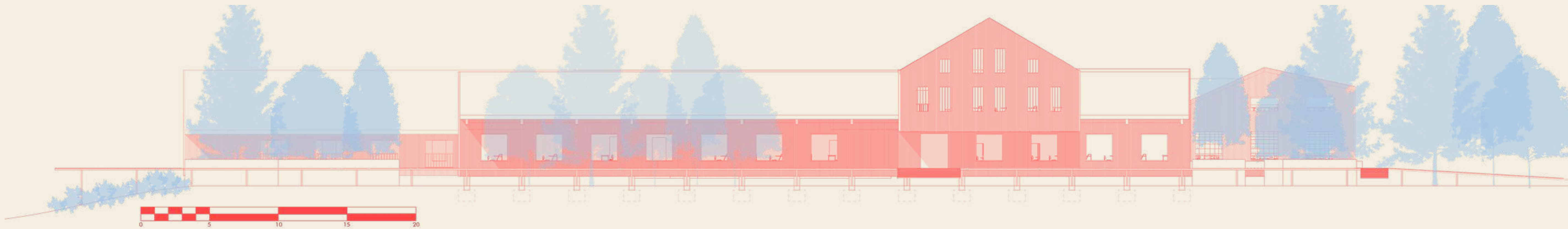


WINTER WINDS DIRECTION %



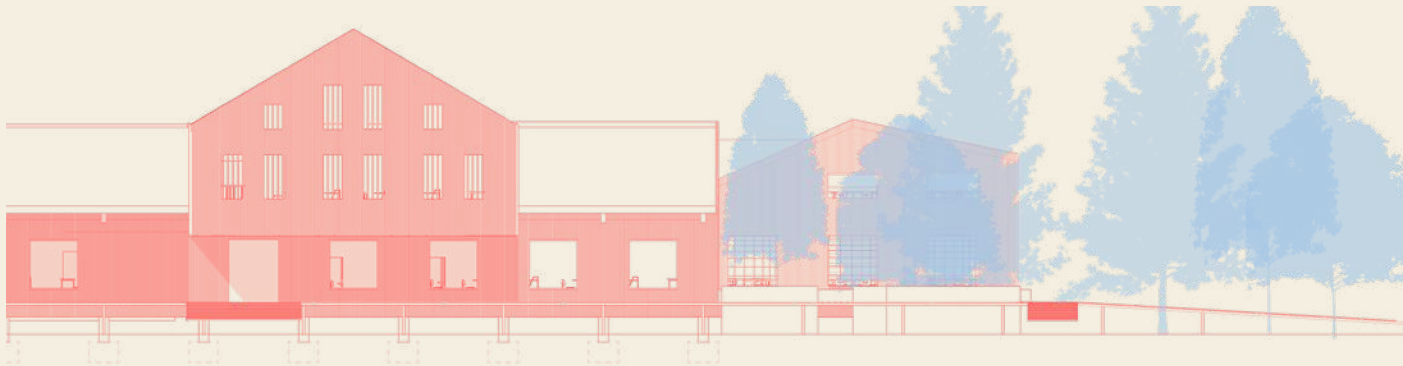
By orienting the building to reduce western exposure we can reduce the buildings vulnerability to cold winds in the winter. Equally by utilizing the existing forest we can slow and disrupt winds traveling through the canopy, reducing its effect in the winter months. While the canopy also disrupts winds during the summer months it is offset by the benefits of evapotranspiration

Climate Change



To protect against flooding and potential extreme weather events, the shoreline is re-enforced with the trees felled for construction. This process allows for the creation of a living shoreline, by creating a tightly packed protective barrier, with deeply enriched soils which will accelerate new growth and establish a tightly wound network of roots. This is a much more effective strategy to the placement of rocks or concrete, as it creates a resilient shoreline that strengthens the remaining soil, and instead of breaking down overtime, will continue to strengthen.

In addition to the shoreline strategy, the building is raised 700mm off of the ground, with elevated walkways matching this decision. This allows the building to remain protected if seasonal flooding worsens, or if extreme events significantly threaten the site.



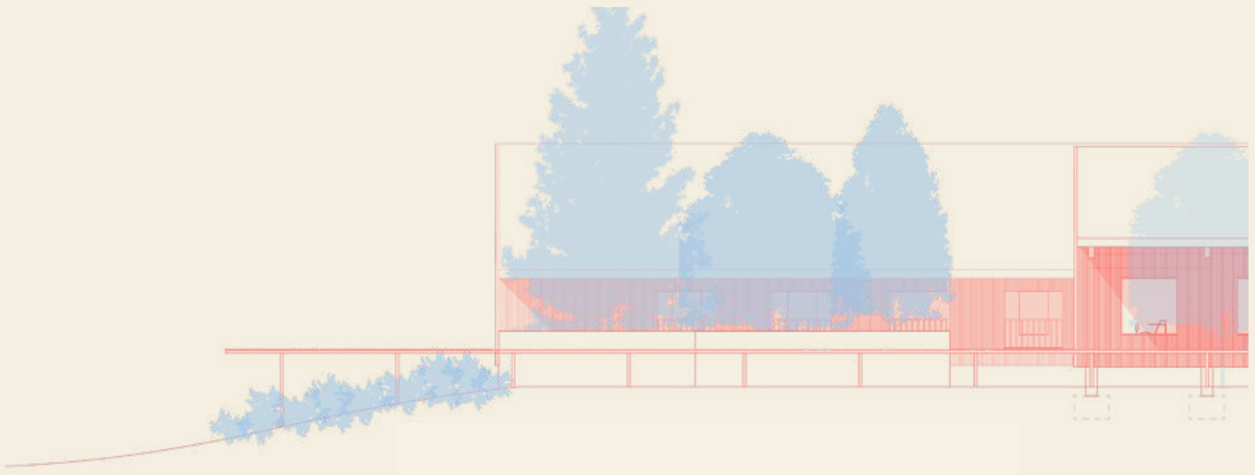
RAISED WALKWAY ILLUSTRATION

As many trees as possible are retained.

Trees that require removal are left on site.

These trees are broken down and transported to the shoreline.

Here they are packed tightly, enriching the soil and accelerating new growth, allowing strong roots to form, protecting the shoreline.

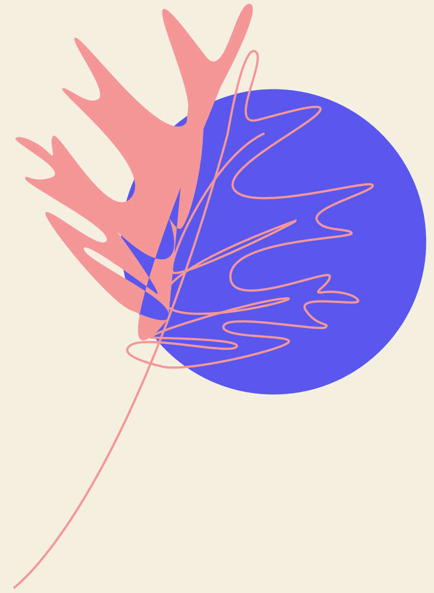


LIVING SHORELINE SYSTEMS DIAGRAM

Enclosure

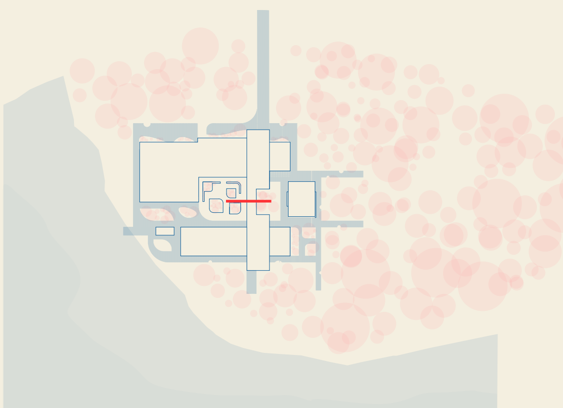
The envelope is designed around embracing key biophilic notions. By introducing as many natural elements as possible, most notably wood products on the interior and exterior, we can draw upon decades of research which support a link between the presence and visual stimuli of natural materials as links to reducing stress levels, optimizing brain function, and improving learning and well being.

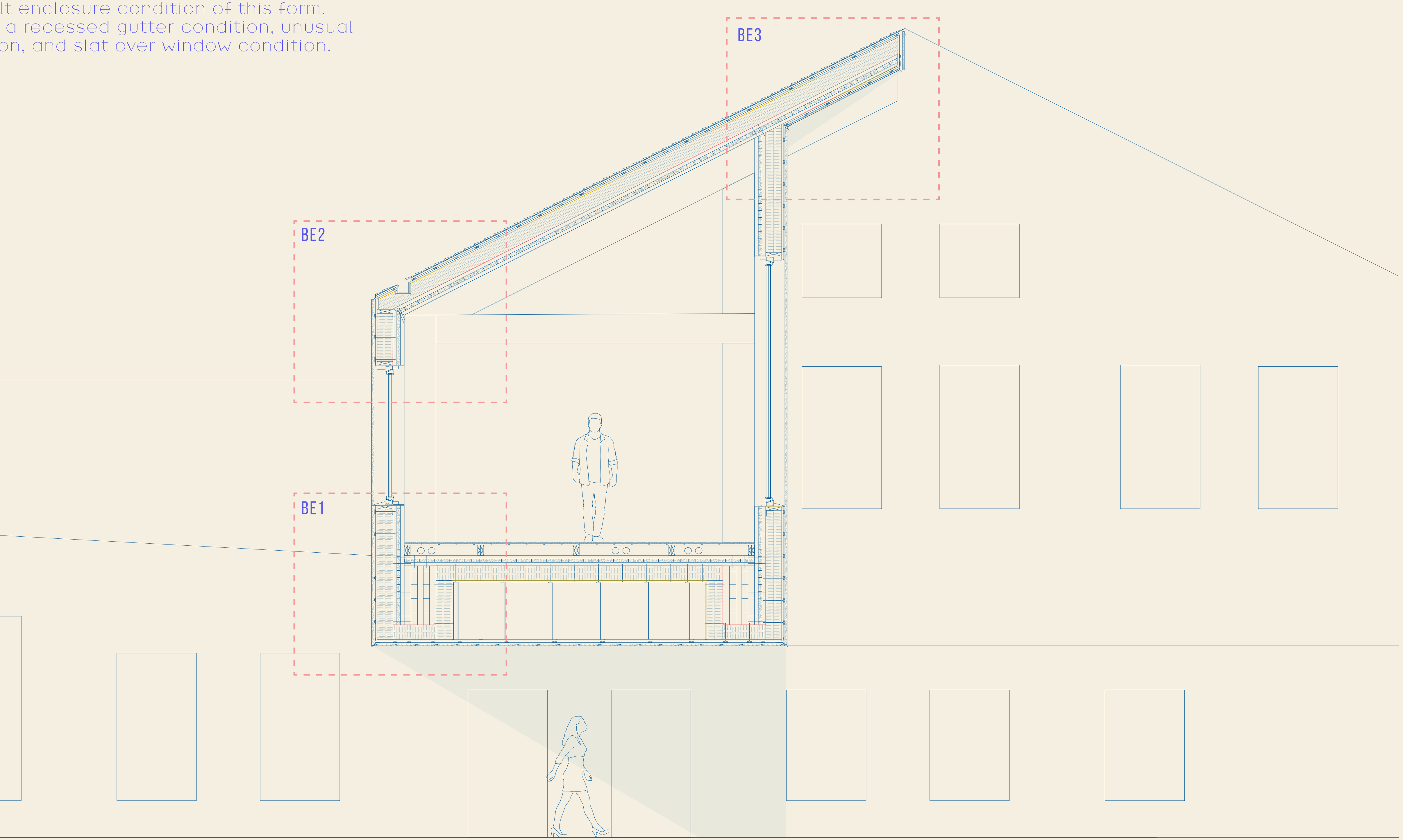
Wherever possible, wood is used as an alternative to metal fixtures for its lower carbon impact, and a carbon negative insulation was sourced for its biodegradable and environmental properties, as it makes up a significant portion of total material properties due to adherence to Passive House Standards of an r-60 enclosure.



Bridge Enclosure

A section is cut through the bridge connecting the "community center" building and "classroom" building. This section was chosen as it represents a number of difficult connections and issues, presenting what is most likely the most difficult enclosure condition of this form. This section illustrates detailing of a recessed gutter condition, unusual corner condition, overhang condition, and slat over window condition.





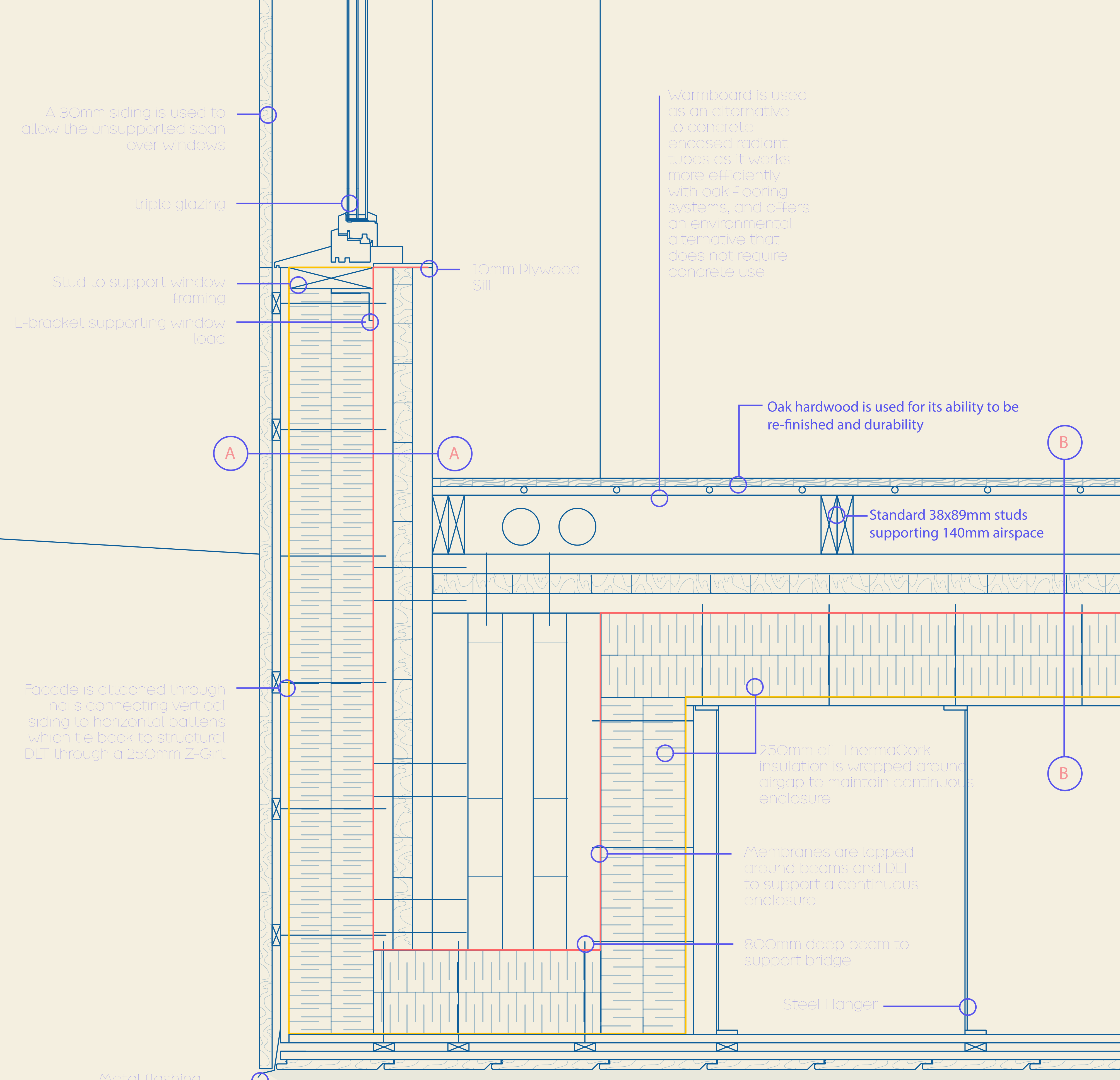
BE1 Detail

AA

Wall Assembly: Interior - Exterior
- 140mm DLT Panel
- Water Membrane
- 250mm of Thermacork carbon negative insulation (Fixed Via tiebacks)
- Z Girt (250mm, placed 400mm o.c)
- Blueskin
- Vertical timber batten (21x51mm) spaced 400mm o.c
- Horizontal timber batten (21x51mm) spaced 400mm o.c with 25mm airspace
- Shou Sugi Ban Timber Siding (Pine) 30mm Sourced from re-used Canadian pine.

BB

Floor Assembly: Interior - Exterior
- 5/8th Inch solid oak hardwood flooring (chosen for durability and natural character)
- S Warmboard with radiant in floor heating tubes fitted. (Warmboard consists of 13/16 inch plywood with radiant in floor heating tubes)
- 140mm service space framed by standard 2x4 studs
- 140mm DLT Panel
- Water Membrane
- 250mm of Thermacork carbon negative insulation (Fixed Via tiebacks)
- Z Girt (250mm, placed 400mm o.c)
- Blueskin
- Timber battens (21mm x 51mm) securing insulation
- Zinc Fasteners through 280mm airspace to allow beam clearance
- 30mm timber battens carrying facade load back through connections to DLT
- Horizontal timber batten (21x51mm) spaced 400mm o.c
- Vertical timber batten (21x51mm) spaced 400mm o.c
- Ship lapped shou sugi ban timber siding (Pine) 19mm

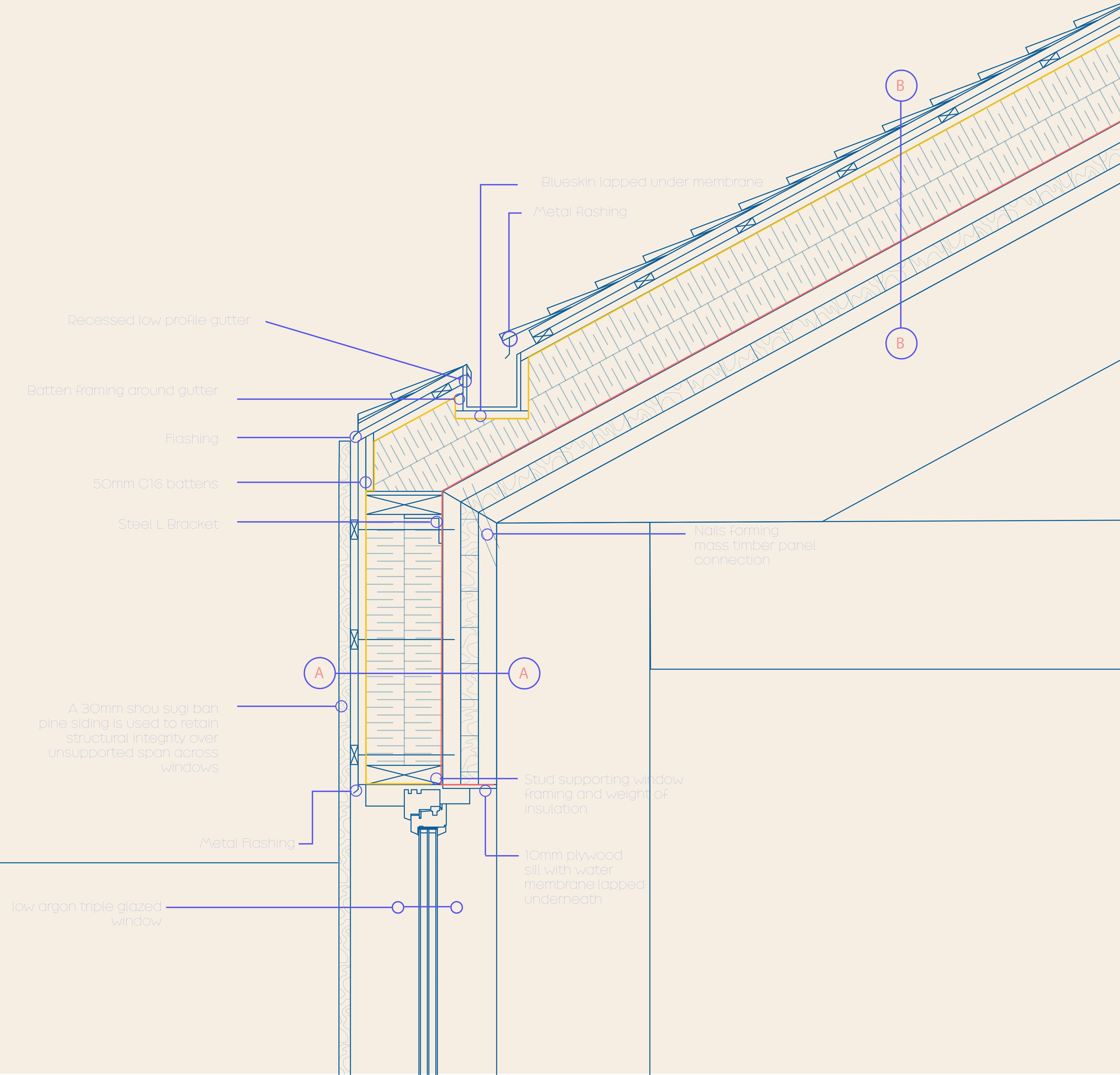


Hanging siding it carried back to structural DLT through a continuous line of nails connecting pine siding to horizontal battens which connect into vertical battens tied back to additional battens, connecting via Z-Girt to the DLT structure

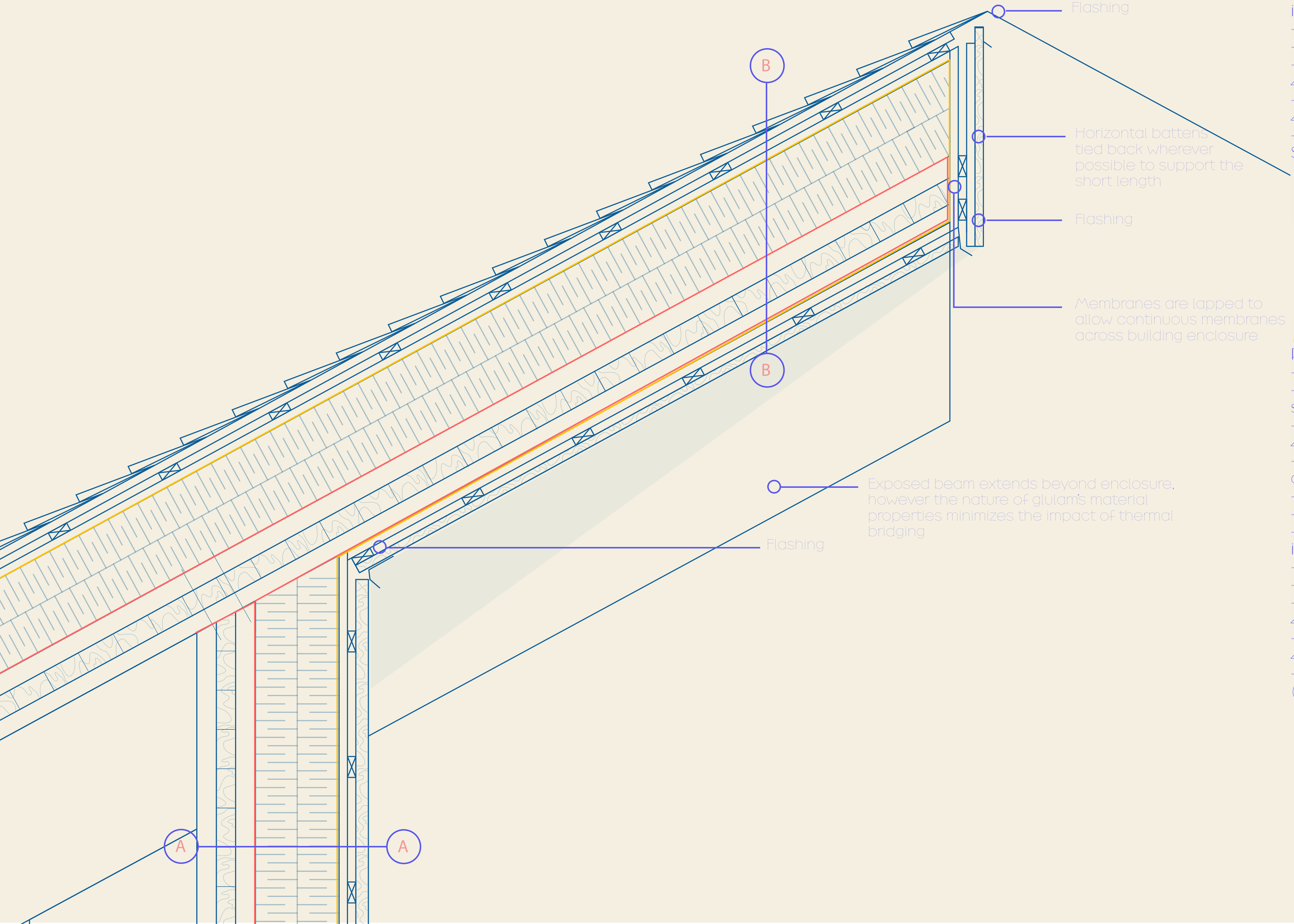
BE2 Detail

AA
Wall Assembly: Interior - Exterior
- 140mm DLT Panel
- Water Membrane
- 250mm of Thermacork carbon negative insulation (Fixed Via tiebacks)
- Z Girt (250mm, placed 400mm o.c)
- Blueskin
- Vertical timber batten (21x51mm) spaced 400mm o.c
- Horizontal timber batten (21x51mm) spaced 400mm o.c
- Shou Sugi Ban Timber Siding (Pine) 19mm Sourced from re-used Canadian pine.

BB
Roof Assembly: Interior - Exterior
- 140mm DLT Panel
- Water Membrane
- 250mm of Thermacork carbon negative insulation (Fixed Via tiebacks)
- Z Girt (250mm, placed 400mm o.c)
- Blueskin
- Vertical timber batten (21x51mm) spaced 400mm o.c
- Horizontal timber batten (21x51mm) spaced 400mm o.c
- 18mm Shou Sugi Ban Timber Shingles (200mm x 2400mm panels)



BE3 Detail



AA

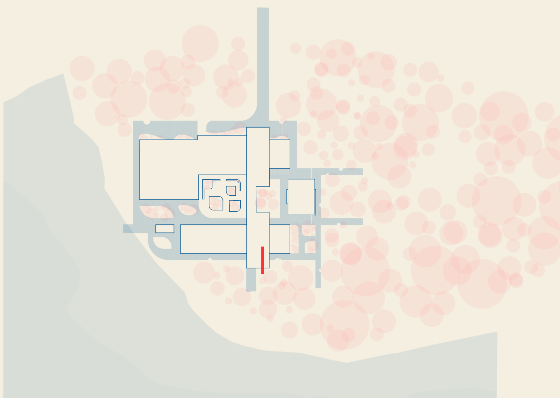
Wall Assembly: Interior - Exterior
- 140mm DLT Panel
- Water Membrane
- 250mm of Thermacork carbon negative insulation (Fixed Via tiebacks)
- Z Girt (250mm, placed 400mm o.c)
- Blueskin
- Vertical timber batten (21x51mm) spaced 400mm o.c
- Horizontal timber batten (21x51mm) spaced 400mm o.c
- Shou Sugi Ban Timber Siding (Pine) 30mm Sourced from re-used Canadian pine.

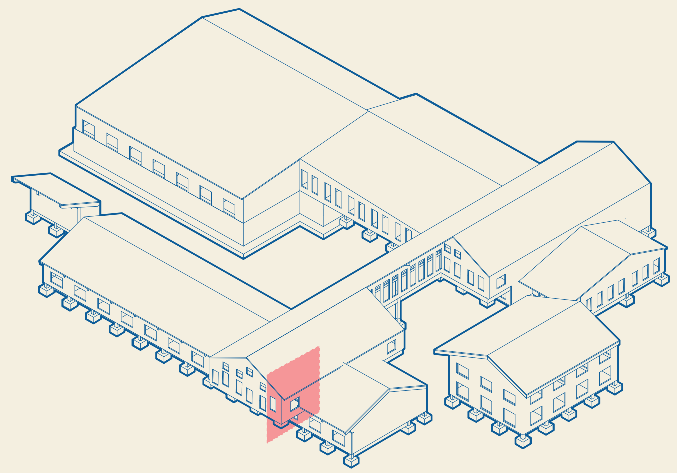
BB

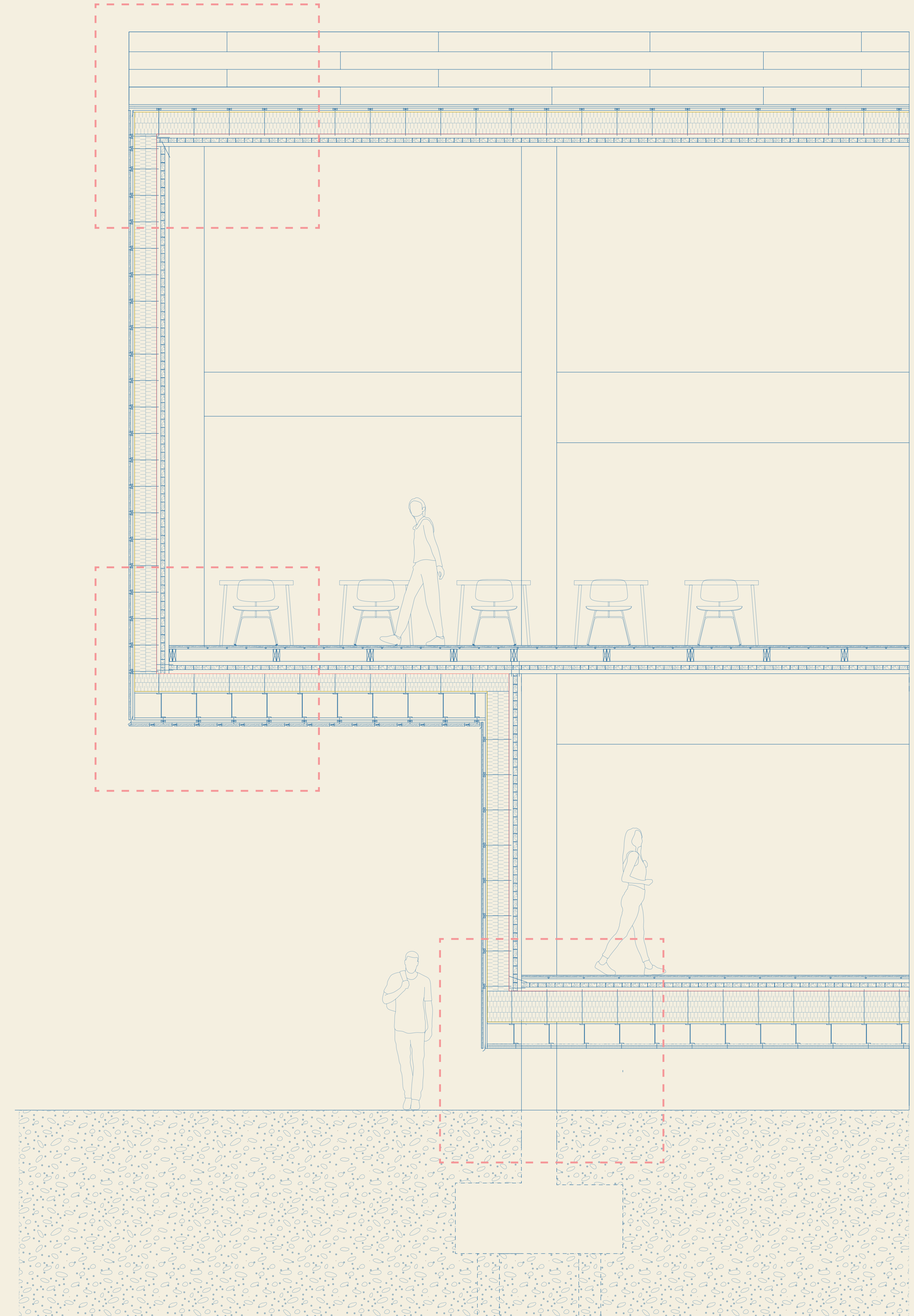
Roof Assembly: Bottom to Top
- Shou Sugi Ban Timber Siding (Pine) 19mm
- Horizontal timber batten (21mmx51mm) spaced 400mm o.c
- Vertical Timber Batten (21mmx51mm) spaced 400mm o.c
- Lapped Water and Blueskin membranes to allow continuity
- 140mm DLT Panel
- Water Membrane
- 250mm of Thermacork carbon negative insulation (Fixed Via tiebacks)
- Z Girt (250mm, placed 400mm o.c)
- Blueskin
- Vertical timber batten (21x51mm) spaced 400mm o.c
- Horizontal timber batten (21x51mm) spaced 400mm o.c
- 18mm Shou Sugi Ban Timber Shingles (200mm x 2400mm panels)

Cantilever Condition

This condition illustrates a cantilevered position present in several locations throughout the building form. Representing a significant moment, it outlines the buildings approach to enclosure design, which uses Passive House standards to produce an R60 enclosure with continuous wrapping insulation of the ground, walls, and roof. The building itself is placed 700mm above grade, offering flood protection, and allowing the underside to be cleaned and maintained, as well as simplifying installation.







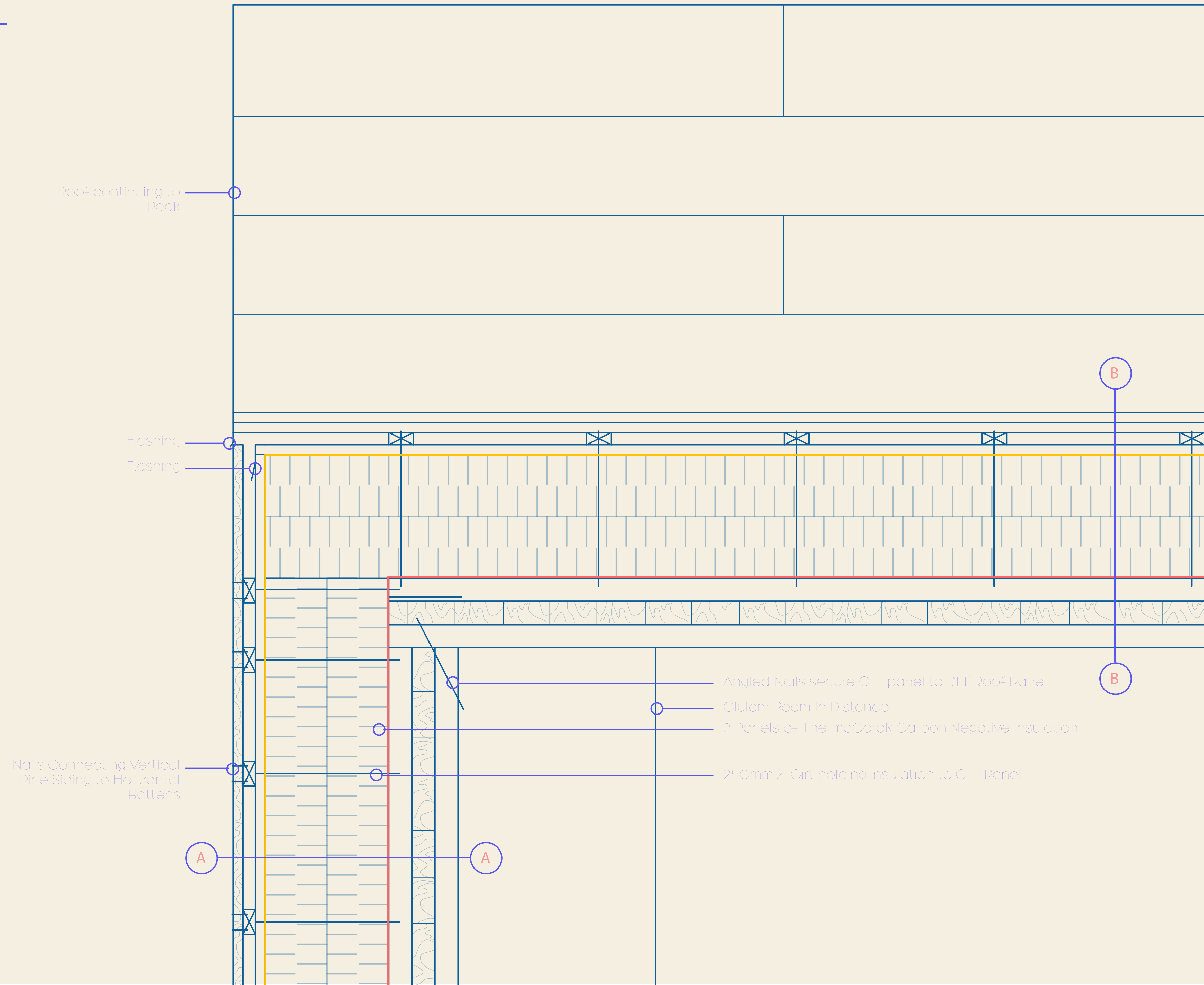
CC1

AA

Wall Assembly: Interior - Exterior
- 140mm CLT Panel
- Water Membrane
- 250mm of Thermacork carbon negative insulation (Fixed Via tiebacks)
- Z Girt (250mm, placed 400mm o.c)
- Blueskin
- Vertical timber batten (21x51mm) spaced 400mm o.c
- Horizontal timber batten (21x51mm) spaced 400mm o.c
- Shou Sugi Ban Timber Siding (Pine) 19mm Sourced from re-used Canadian pine.

BB

Roof Assembly: Interior - Exterior
- 140mm DLT Panel
- Water Membrane
- 250mm of Thermacork carbon negative insulation (Fixed Via tiebacks)
- Z Girt (250mm, placed 400mm o.c)
- Blueskin
- Vertical timber batten (21x51mm) spaced 400mm o.c
- Horizontal timber batten (21x51mm) spaced 400mm o.c
- 18mm Shou Sugi Ban Timber Shingles (200mm x 2400mm panels)



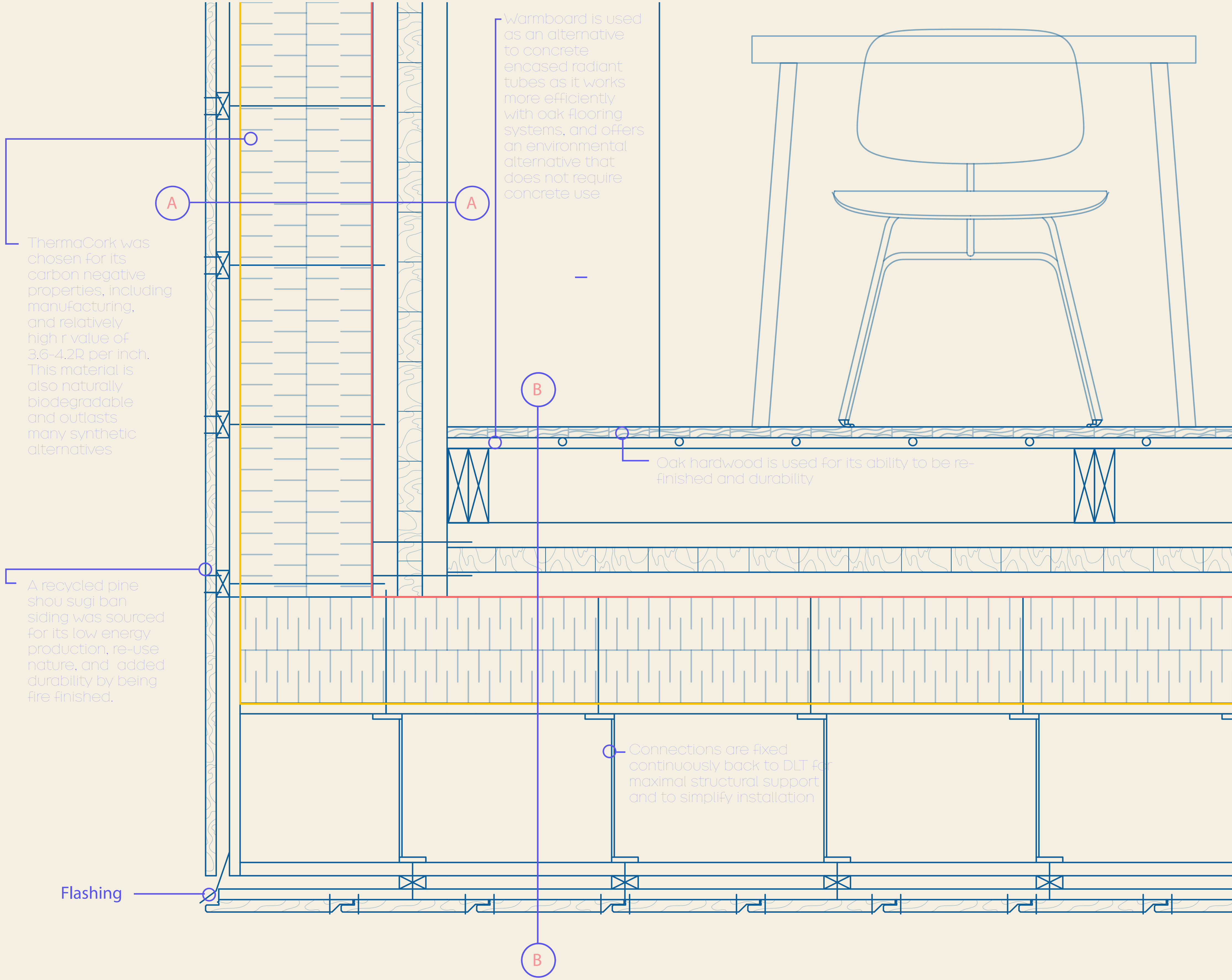
CC2

AA

Wall Assembly: Interior - Exterior
- 140mm CLT Panel
- Water Membrane
- 250mm of Thermacork carbon negative insulation (Fixed Via tiebacks)
- Z Girt (250mm, placed 400mm o.c)
- Blueskin
- Vertical timber batten (21x51mm) spaced 400mm o.c
- Horizontal timber batten (21x51mm) spaced 400mm o.c
- 25mm Airspace
- Shou Sugi Ban Timber Siding (Pine) 19mm Sourced from re-used Canadian pine.

BB

Floor Assembly: Interior - Exterior
- 5/8th Inch solid oak hardwood flooring (chosen for durability and natural character)
- S Warmboard with radiant in floor heating tubes fitted. (Warmboard consists of 13/16 inch plywood with radiant in floor heating tubes)
- 140mm service space framed by standard studs
- 140mm DLT Panel
- Water Membrane
- 250mm of Thermacork carbon negative insulation (Fixed Via tiebacks)
- Z Girt (250mm, placed 400mm o.c)
- Blueskin
- Timber battens (21mm x 51mm) securing insulation
- Zinc Fasteners through 280mm airspace to allow beam clearance
- 30mm timber battens carrying facade load back through connections to DLT
- Horizontal timber batten (21x51mm) spaced 400mm o.c
- Vertical timber batten (21x51mm) spaced 400mm o.c
- Ship lapped shou sugi ban timber siding (Pine) 19mm



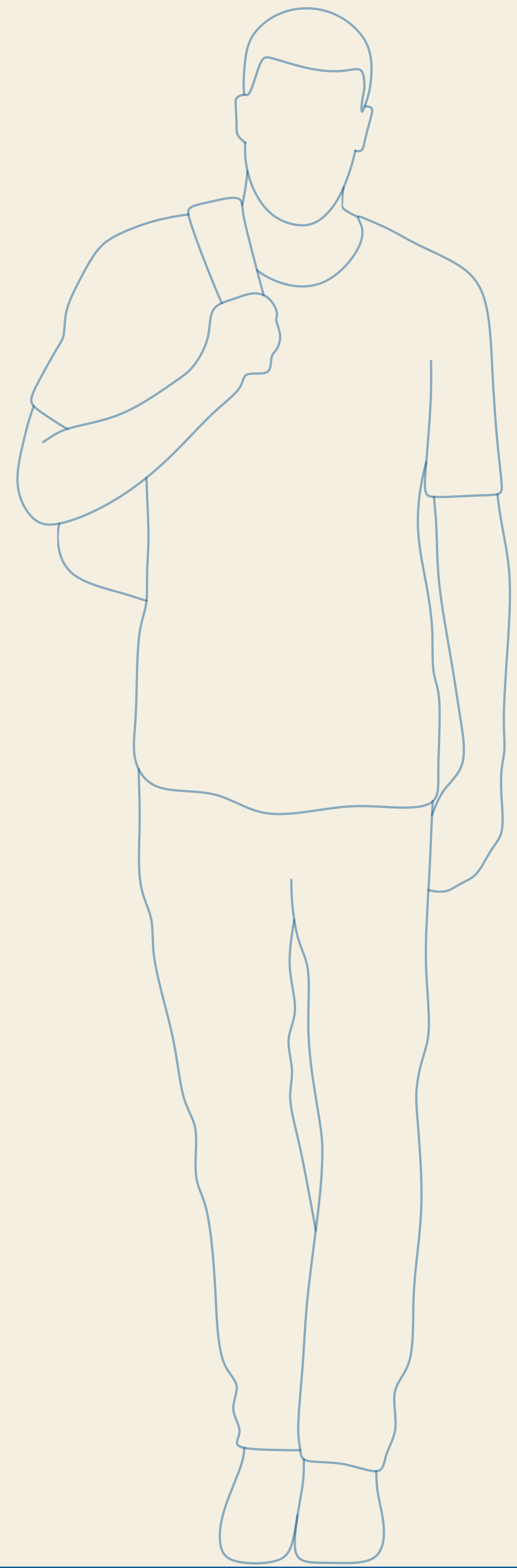
CC3

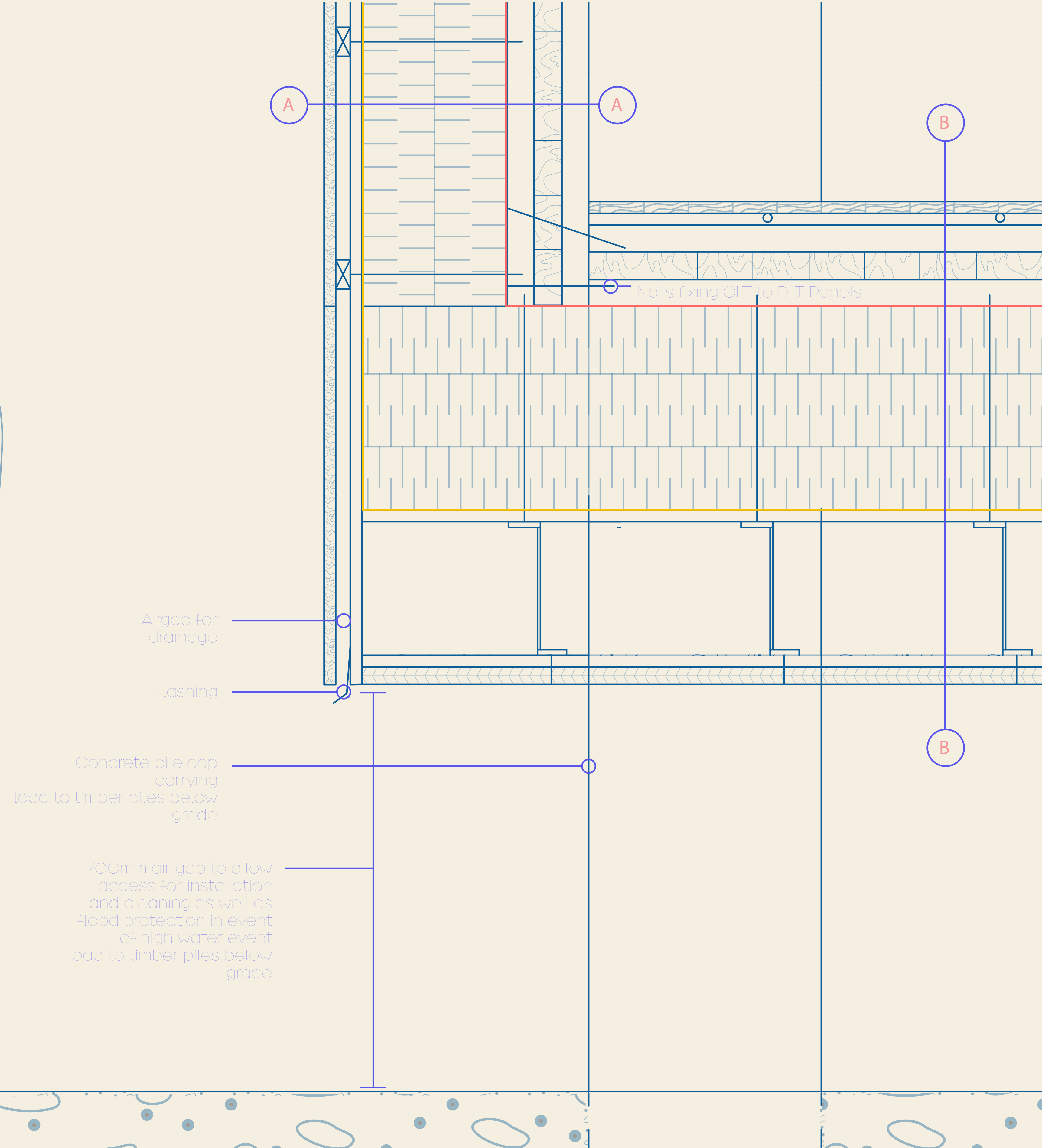
AA

Wall Assembly: Interior - Exterior
- 140mm CLT Panel
- Water Membrane
- 250mm of Thermacork carbon negative insulation (Fixed Via tiebacks)
- Z Girt (250mm, placed 400mm o.c)
- Blueskin
- Vertical timber batten (21x51mm) spaced 400mm o.c
- Horizontal timber batten (21x51mm) spaced 400mm o.c
- 25mm Airspace
- Shou Sugi Ban Timber Siding (Pine) 19mm Sourced from re-used Canadian pine.

BB

Floor Assembly: Interior - Exterior
- 5/8th Inch solid oak hardwood flooring (chosen for durability and natural character)
- S Warmboard with radiant in floor heating tubes fitted. (Warmboard consists of 13/16 inch plywood with radiant in floor heating tubes)
- 140mm service space framed by standard studs
- 140mm DLT Panel
- Water Membrane
- 350mm of Thermacork carbon negative insulation (Fixed Via tiebacks)
- Z Girt (250mm, placed 400mm o.c)
- Blueskin
- Timber battens (21mm x 51mm) securing insulation
- Zinc Fasteners through 280mm airspace to allow beam clearance
- 30mm timber battens carrying facade load back through connections to DLT
- 30mm of marine grade plywood for durability.
- 700mm Airgap for cleaning and access as well as flood protection





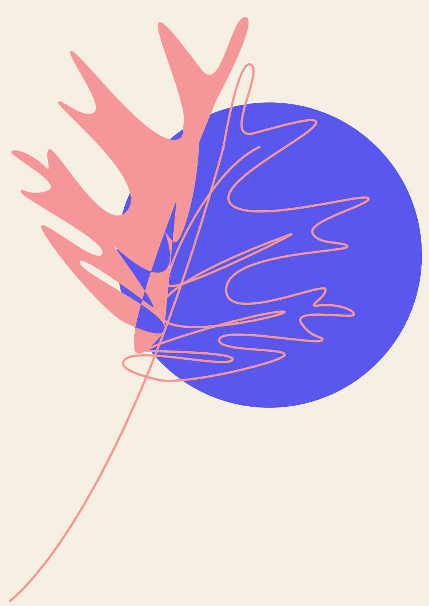
Systems

Systems approaches contribute strongly to the ethos of working symbiotic-ally with the site, with systems chosen to support the sites continued health, while utilizing its resources to reduce energy needs.

As elaborated in the systems overview, each system relates to one, or multiple natural elements present on the site, and uses it to both efficiently maintain the building, but also to contribute to the sites future health.

From a biophilic perspective, this systems approach represents a commitment to the continued health of the site; recognizing that the presence of natural stimuli provides health benefits in air purification and researched cognitive benefits (reduced stress, increased cognitive resources, and improved test scores), as essential components to the success or failure of the school.

In addition to the health benefits, a lowering of energy and carbon demand can be achieved by working closely with the site, contributing to a long term perspective of slowing climate change, and ensuring the site, and planets future.



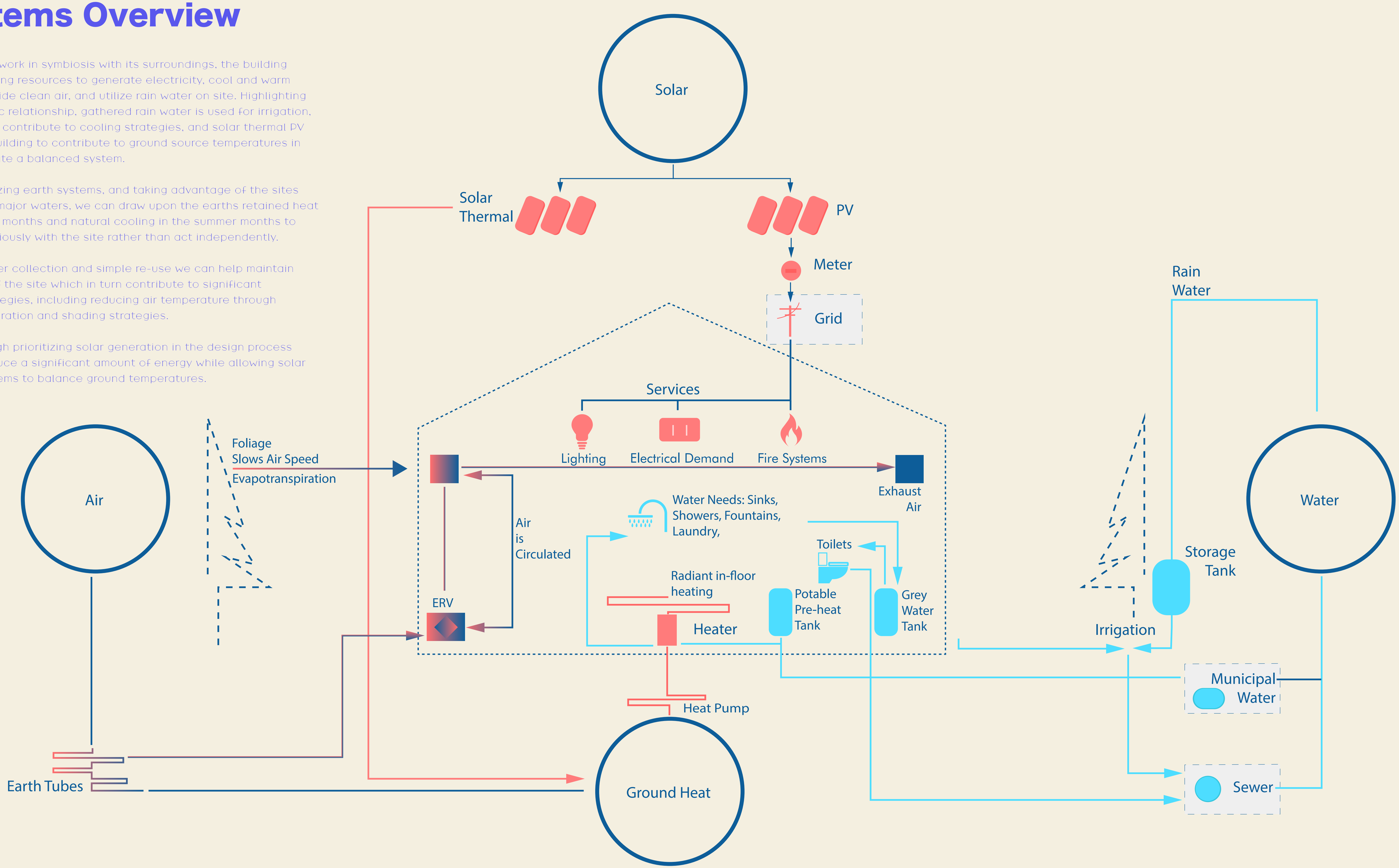
Systems Overview

Designed to work in symbiosis with its surroundings, the building utilizes existing resources to generate electricity, cool and warm spaces, provide clean air, and utilize rain water on site. Highlighting this symbiotic relationship, gathered rain water is used for irrigation, which in turn contribute to cooling strategies, and solar thermal PV allows the building to contribute to ground source temperatures in order to create a balanced system.

Through utilizing earth systems, and taking advantage of the sites proximity to major waters, we can draw upon the earths retained heat in the Winter months and natural cooling in the summer months to work harmoniously with the site rather than act independently.

Through water collection and simple re-use we can help maintain the health of the site which in turn contribute to significant passive strategies, including reducing air temperature through evapotranspiration and shading strategies.

Finally through prioritizing solar generation in the design process we can produce a significant amount of energy while allowing solar thermal systems to balance ground temperatures.

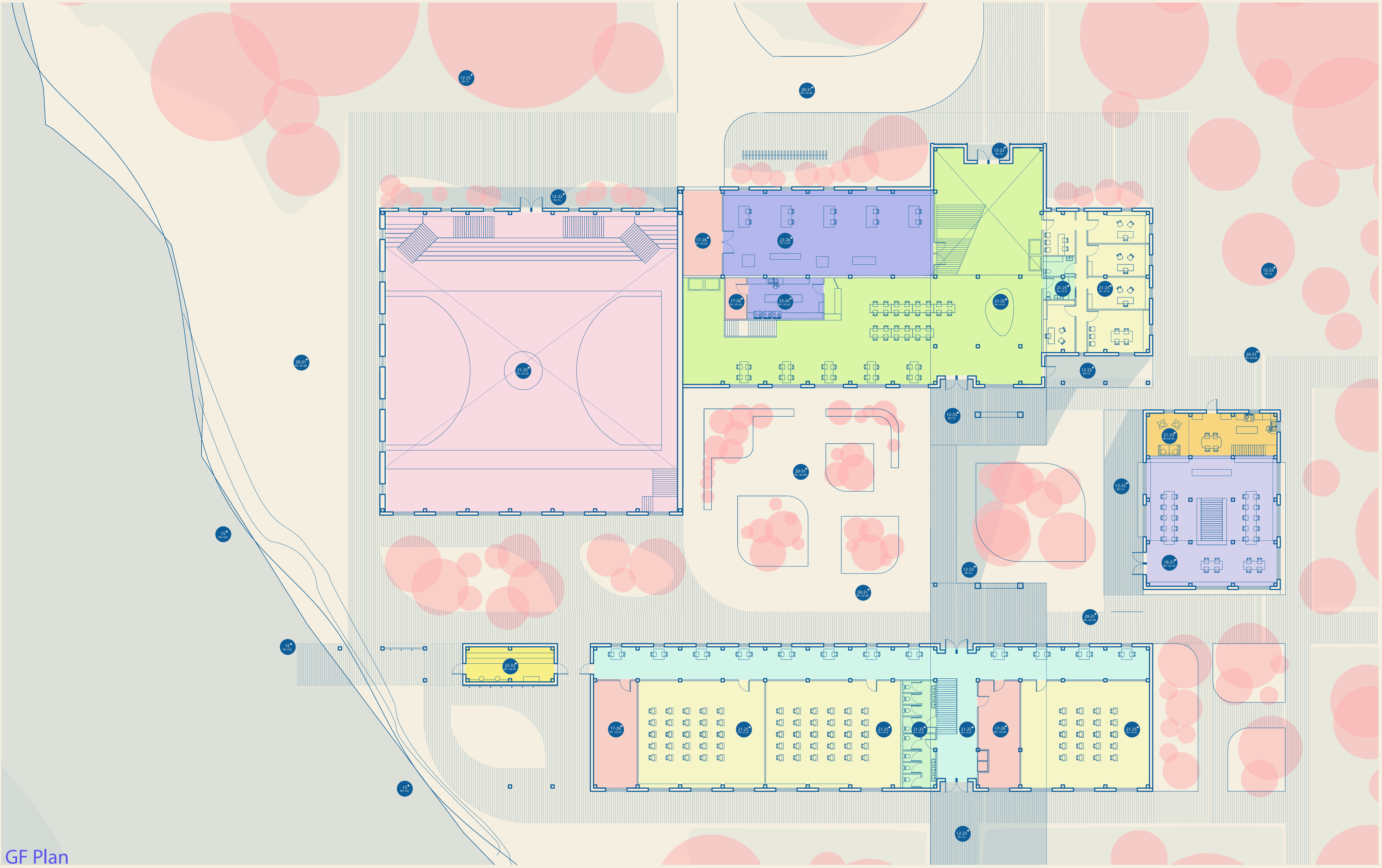


Comfort Zones: Winter

In retaining the ethos of working directly with the site, comfort considerations look at seasonal needs and expectations to determine heating and cooling demands during various seasons. Winter demands indicate a lower temperature requirement and consider average temperatures through the winter months in both shaded and direct conditions.

Comfort Zones: Summer

Summer conditions indicate a higher tolerance of warmer temperatures, with plantings throughout the site offering shading and protection from direct sun both in interior spaces and when utilizing exterior spaces.



Classrooms and Administration
Temp Target: 21-25
Target RH: 35-60%
standard ventilation

Storage & Recieving
Temp Target: 17-26
Target RH:50-60%
low ventilation

Bathrooms
Temp Target: 21-25
Target RH:35-60%
heavily ventilated

Entry/Dining
Temp Target: 21-25
Target RH:35-60%
standard ventilation

Circulation
Temp Target: 21-25
Target RH:35-60%
well ventilated

Library
Temp Target: 18-21
Target RH:30-50%
well ventilated

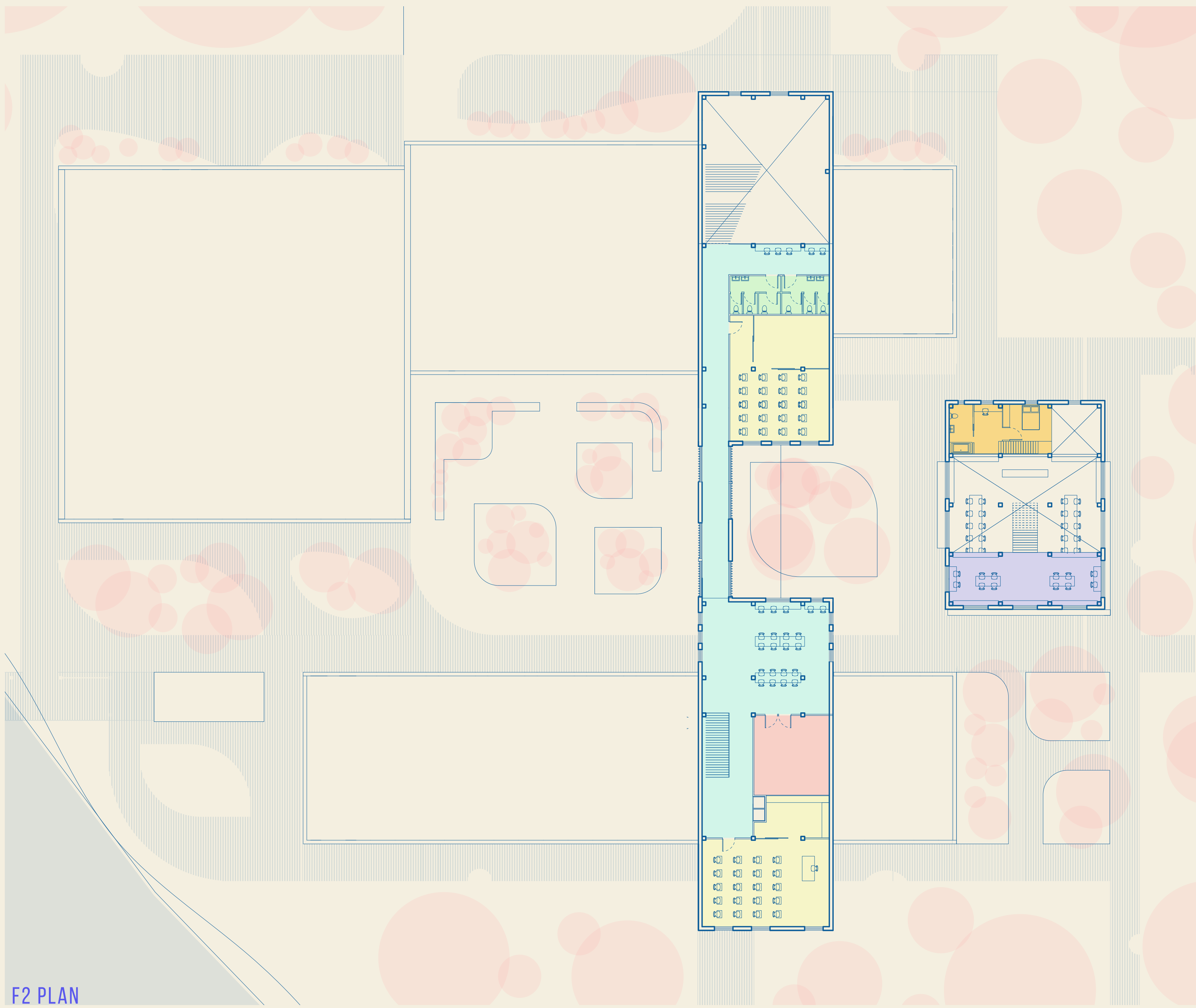
Workshop & Kitchen
Temp Target: 22-26
Target RH:35-60%
well ventilated

Artist Residence
Temp Target: 21-25
Target RH:35-60%
Standard Ventilation

Gym
Temp Target: 21-25
Target RH:35-60%
well ventilated

Sauna
Temp Target: 22-32
Target RH:40-90%
well ventilated

Comfort Zones: Second Floor



Classrooms and Administration
Temp Target: Winter:18-21, Summer:21-25
Target RH: 35-60%
standard ventilation

Storage & Recieving
Temp Target: Winter: 5-16, Summer:17-26
Target RH:50-60%
low ventilation

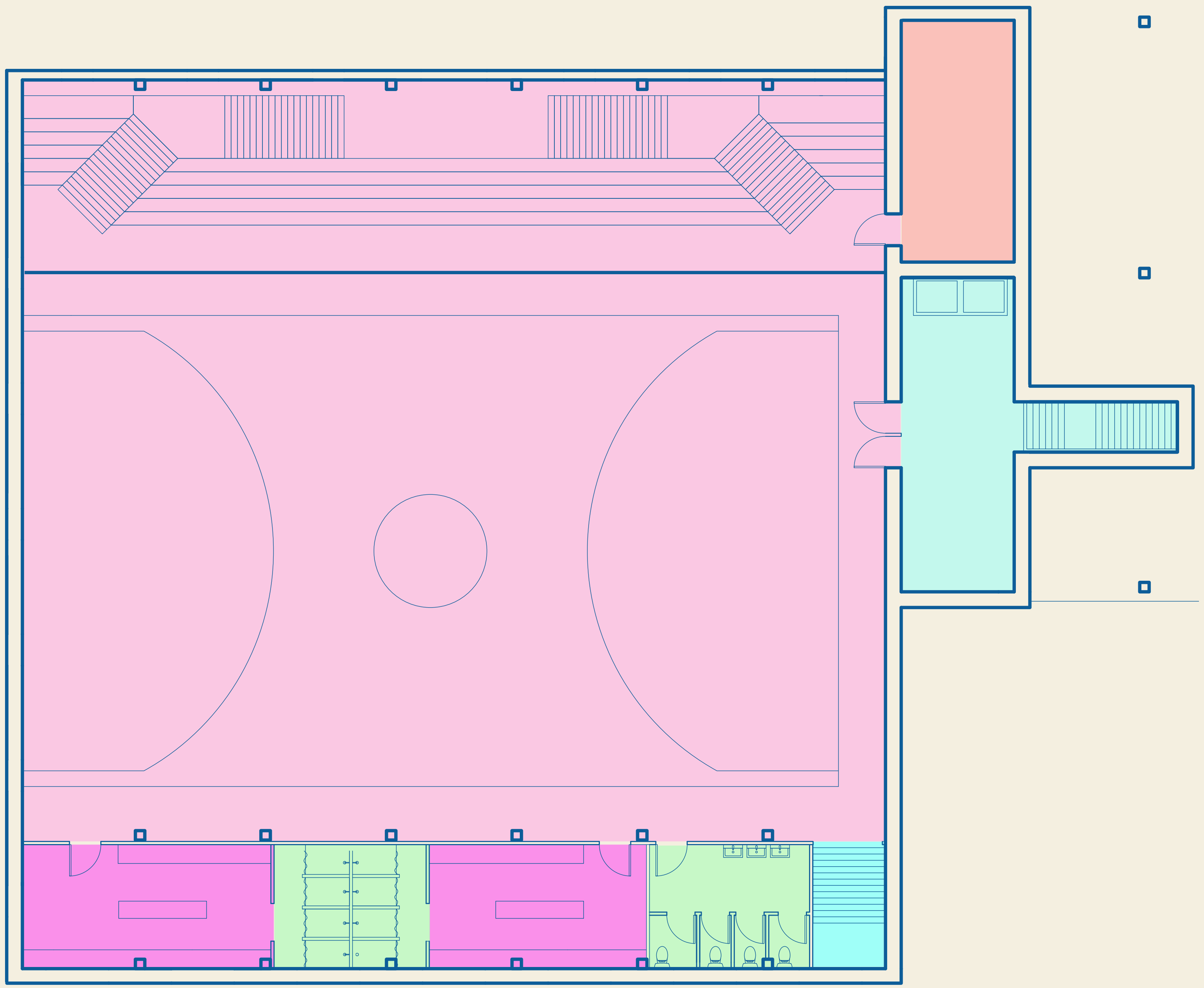
Bathrooms
Temp Target: Winter:18-21, Summer:21-25
Target RH:35-60%
heavily ventilated

Circulation
Temp Target: Winter:18-21,Summer:21-25
Target RH:35-60%
well ventilated

Library
Temp Target:18-21
Target RH:30-50%
well ventilated

Artist Residence
Temp Target: Winter:18-21,Summer: 21-25
Target RH:35-60%
Standard Ventilation

Comfort Zones: Gym



-1 FLOOR PLAN: GYM CALLOUT

Storage & Recieving
Temp Target: Winter: 5-16, Summer:17-26
Target RH:50-60%
low ventilation

Bathrooms
Temp Target: Winter:18-21, Summer:21-25
Target RH:35-60%
heavily ventilated

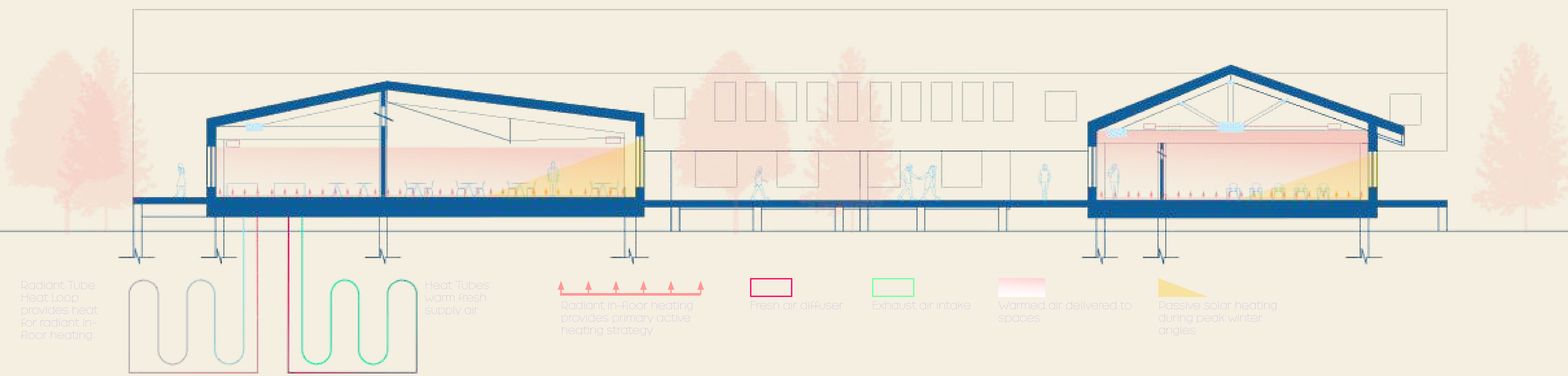
Circulation
Temp Target: Winter:18-21,Summer:21-25
Target RH:35-60%
well ventilated

Gym
Temp Target: Winter 18-22, Summer:21-25
Target RH:35-60%
well ventilated

Changerooms
Temp Target: Winter 18-22, Summer:21-25
Target RH:35-60%
well ventilated

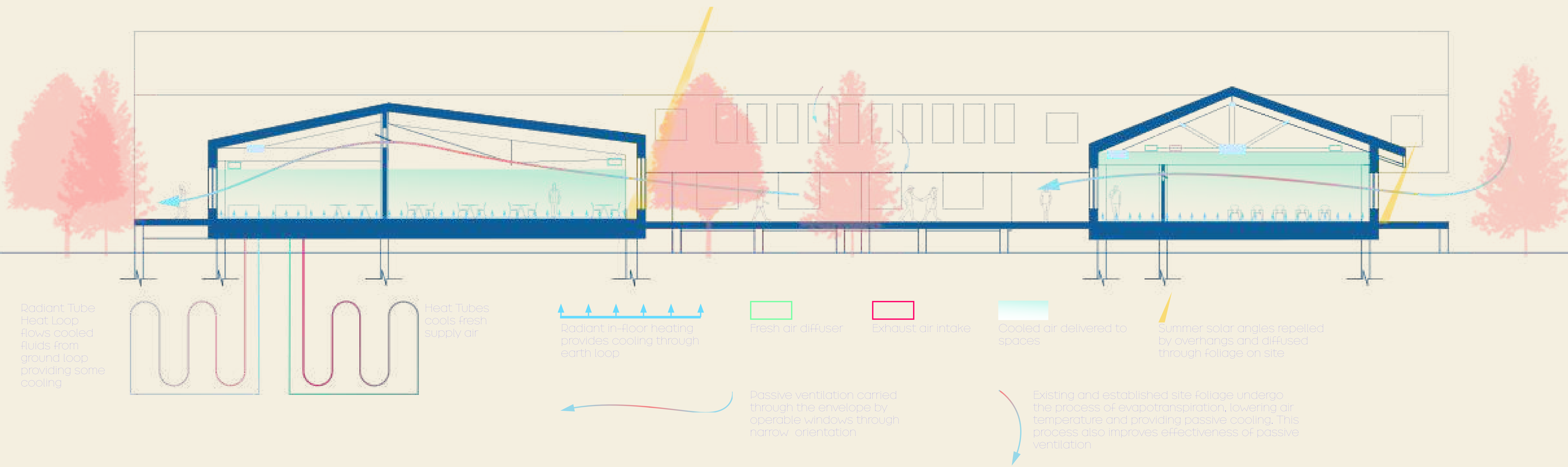
Systems Approach: Winter

During winter or cooling months the building orientation allows it to be largely sheltered from the primarily North-Western winds along its narrow sides. Through a radiant tube heat loop, heat is drawn from the earth and used with an on demand heater to deliver heat to rooms through in-floor radiant heating. This system maintains balance through contribution of solar thermal delivering thermal radiation to the ground. Large windows ensure the low solar angles of winter allow maximum penetration and provide passive heating. Heat tubes buried on site deliver warmed fresh air to the ventilation system which maintains efficiency through an ERV unit. These systems are outlined in greater detail in following pages.



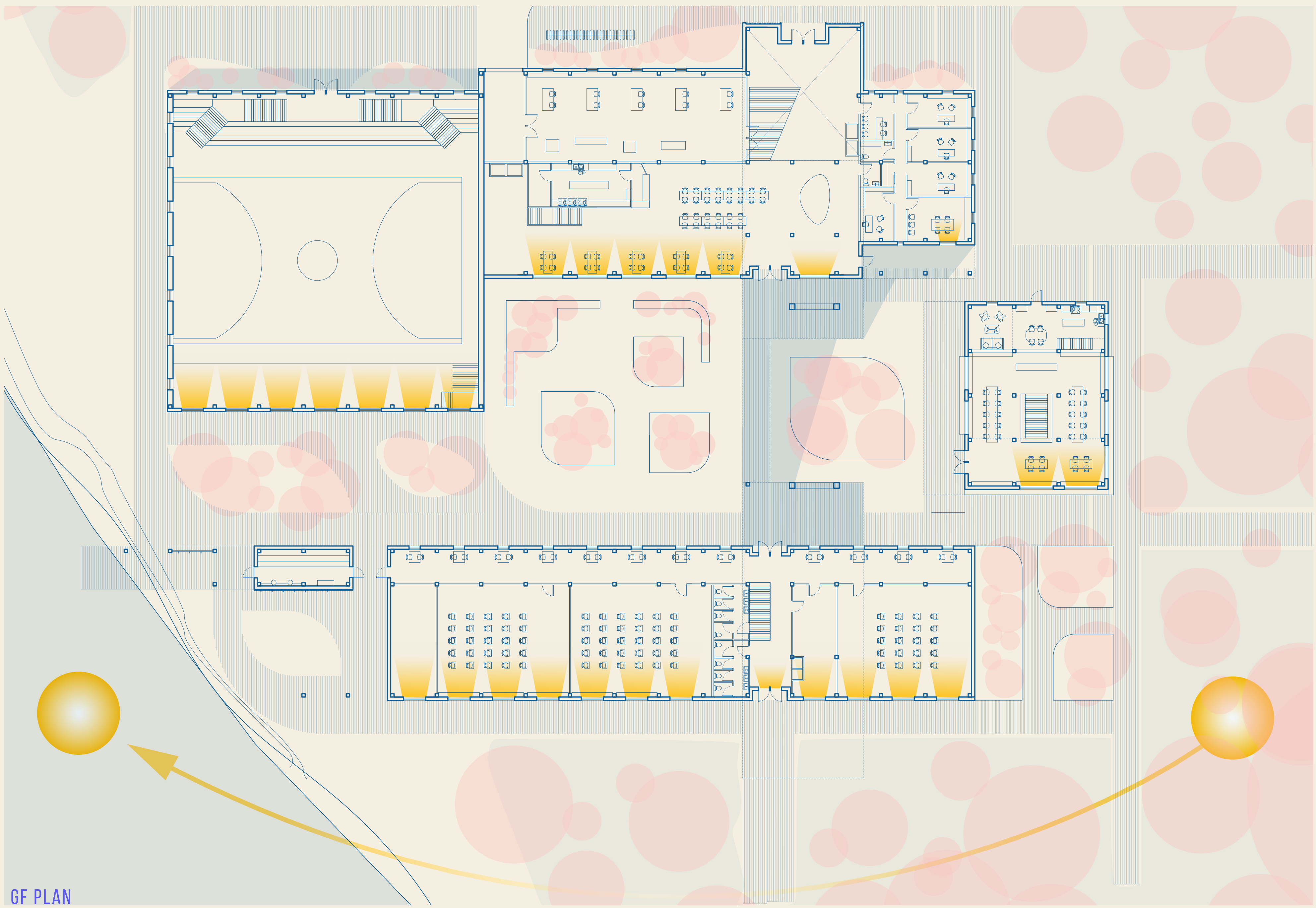
Systems Approach: Summer

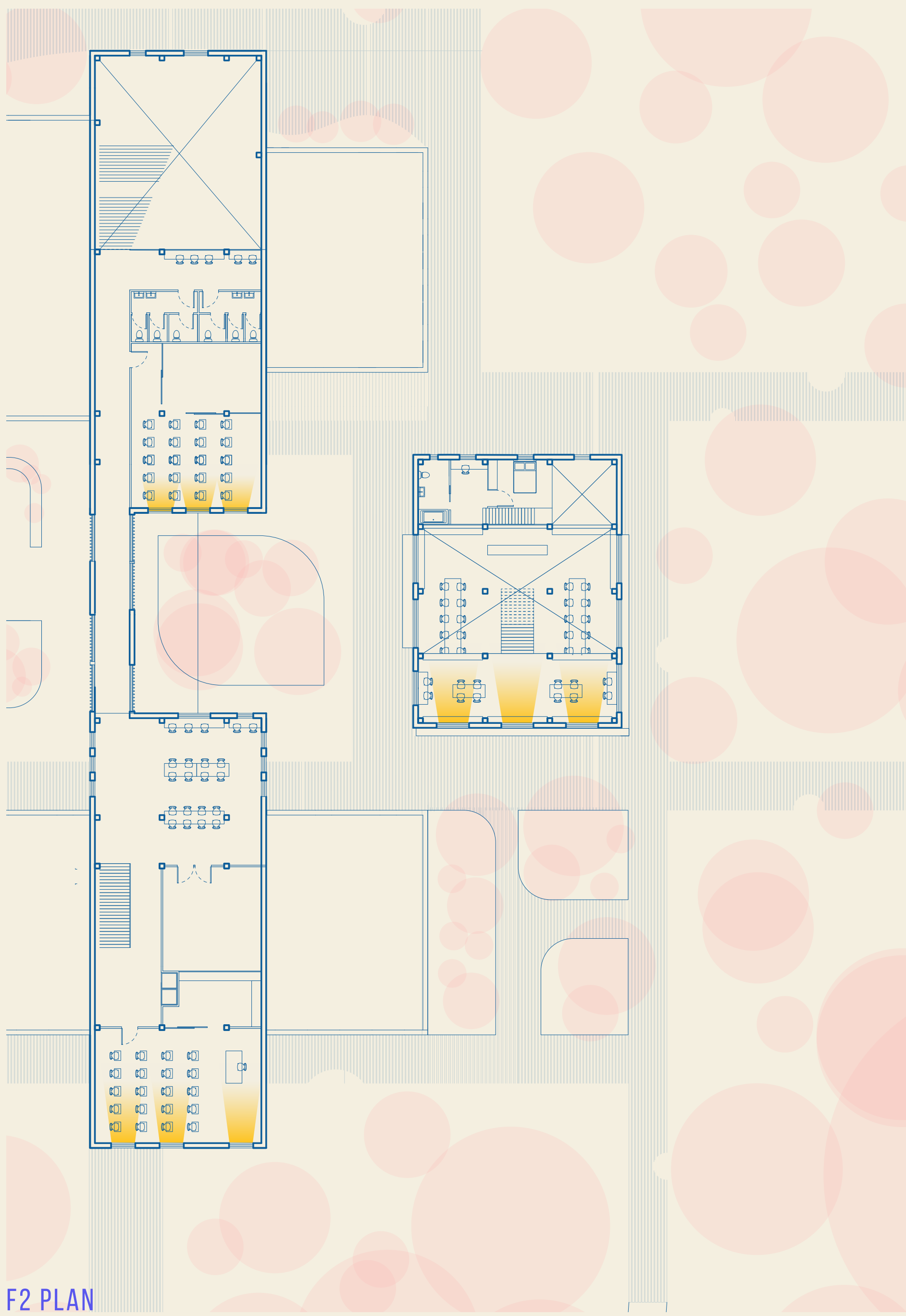
Centered around using as much of the sites natural features as possible, the school takes full advantage of prevailing South-Western winds by orienting the building to allow direct passive ventilation channels throughout the core high occupancy sections of the building. These channels are further bolstered by evapotranspiration, a benefit gained from surrounding much of the built form closely with strong plantings, and using the courtyard to ensure the air is cooled effectively between buildings. Radiant in floor heating tubes also provide some cooling as a bi-product of the geothermal loop which powers the system, and cooler underground temperatures. Heat tubes also ensure the fresh air supply to the HVAC system is cooled before it enters the building, lowering the energy needs to condition the air. Foliage also contributes a significant shading factor, ensuring the windows are shaded during high summer months, with key overhangs providing additional shading.



Passive Heating Strategy

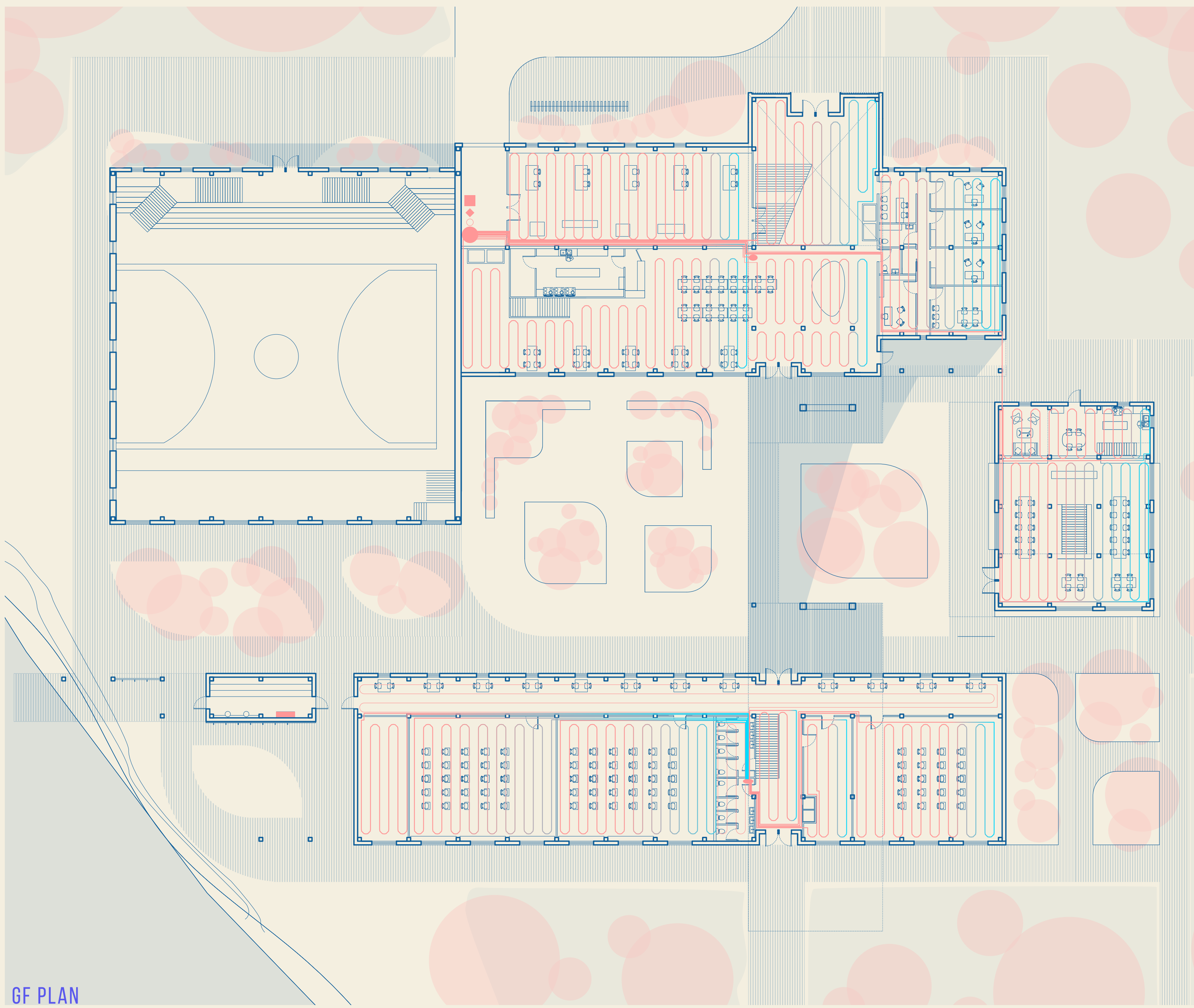
Initial massings were designed to maximize south facing glazing, allowing for ample passive heating through the winter months. In working closely with the site, strategic planting were considered, with deciduous trees being planted or maintained in front of south glazing, allowing for a natural shading device in the Summer, while allowing full exposure in the Winter months. This strategy utilizes the existing island conditions and ecosystems to maximize passive potential.

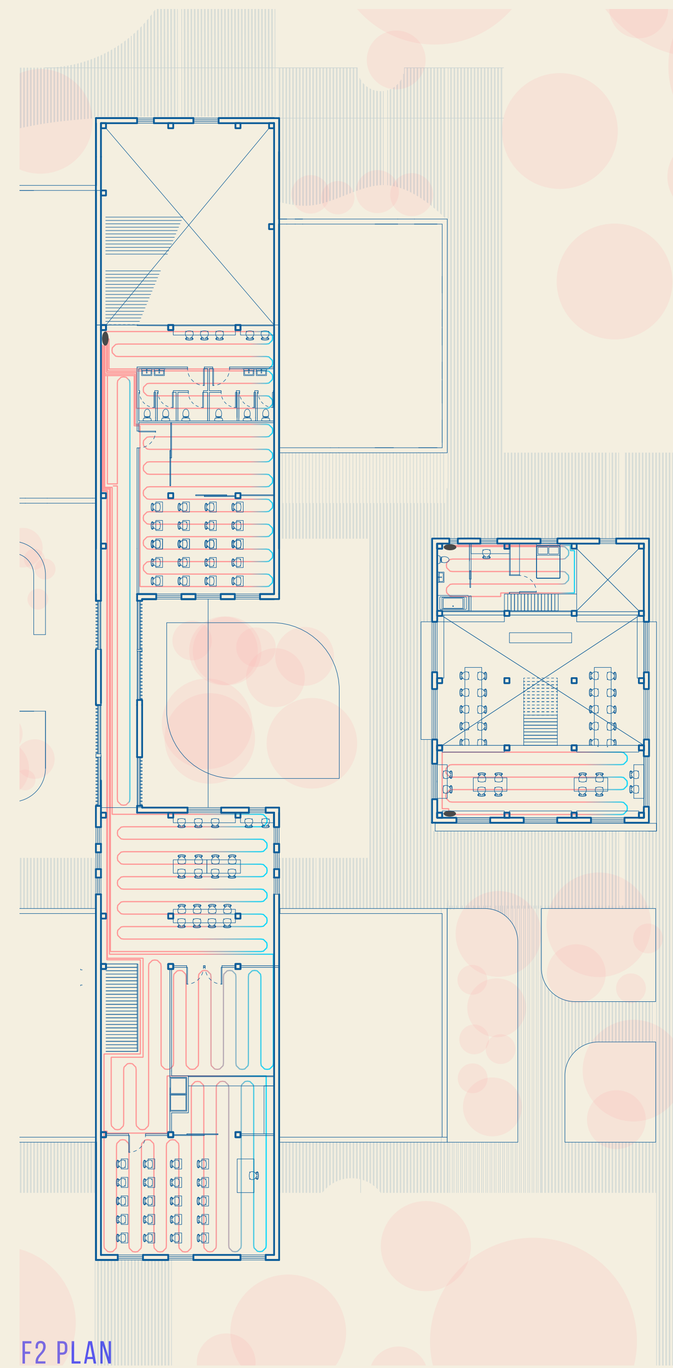


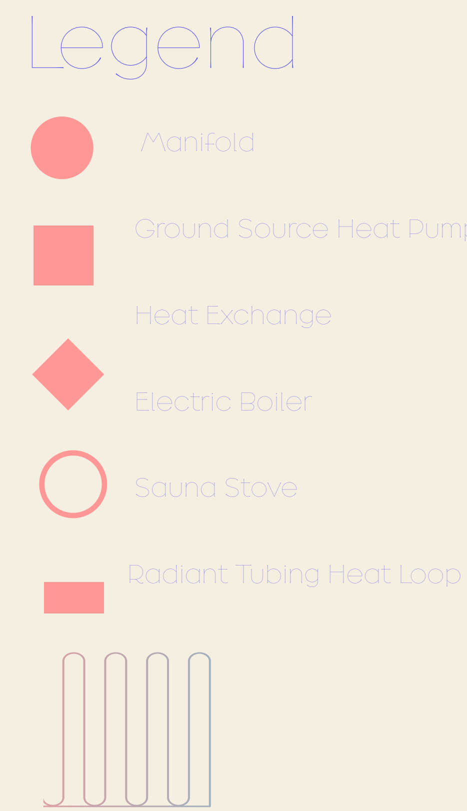


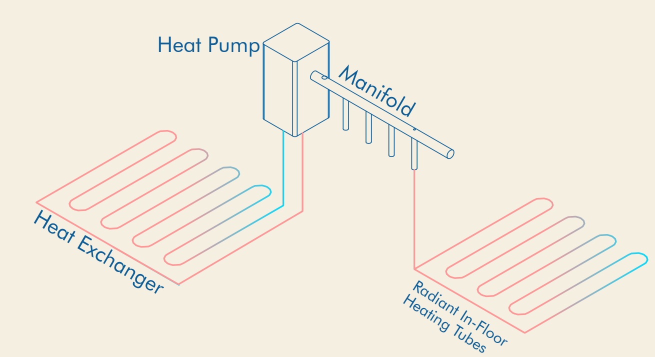
Active Heating Strategy

A geothermal system is paired with radiant in floor heating to provide maximal efficiency in energy use, and in the ethos of utilizing the sites potential. Geothermal PV is paired with traditional PV to contribute clean energy heat back into the earth, allowing the system to remain balanced and provide heating throughout the Winter months. Although a snail pattern would be more efficient, a more traditional system is used due to limitations of Warmboard technology. Warmboard is used as it allows the use of plywood instead of concrete to reduce carbon footprint. Radiant in floor heating tube runs are determined by comfort zones and room divisions. Heat is drawn from the ground via a ground source heat pump, which onces transfered through a heat exchange and manifold is delivered to the building via the radiant in floor heating.



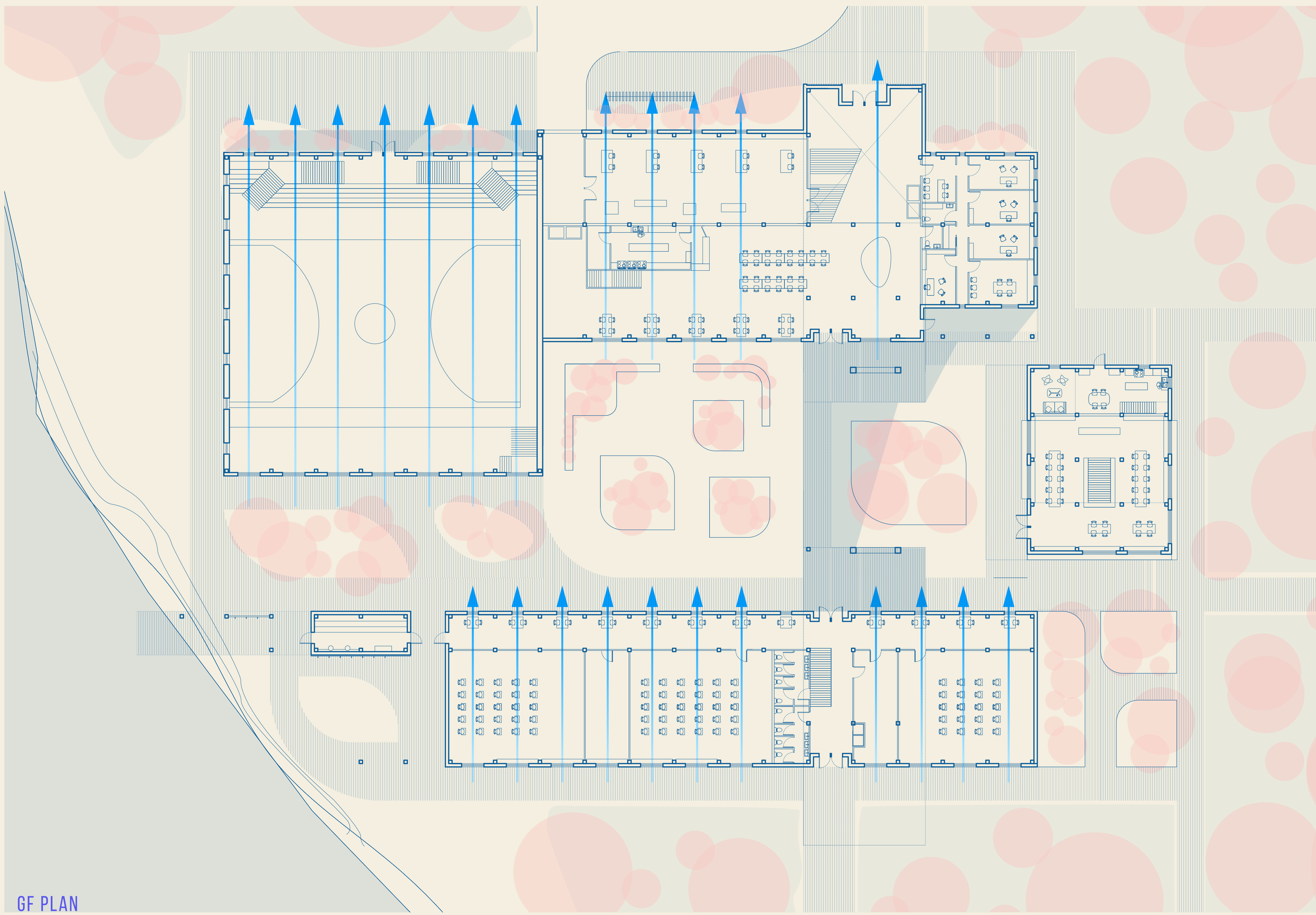






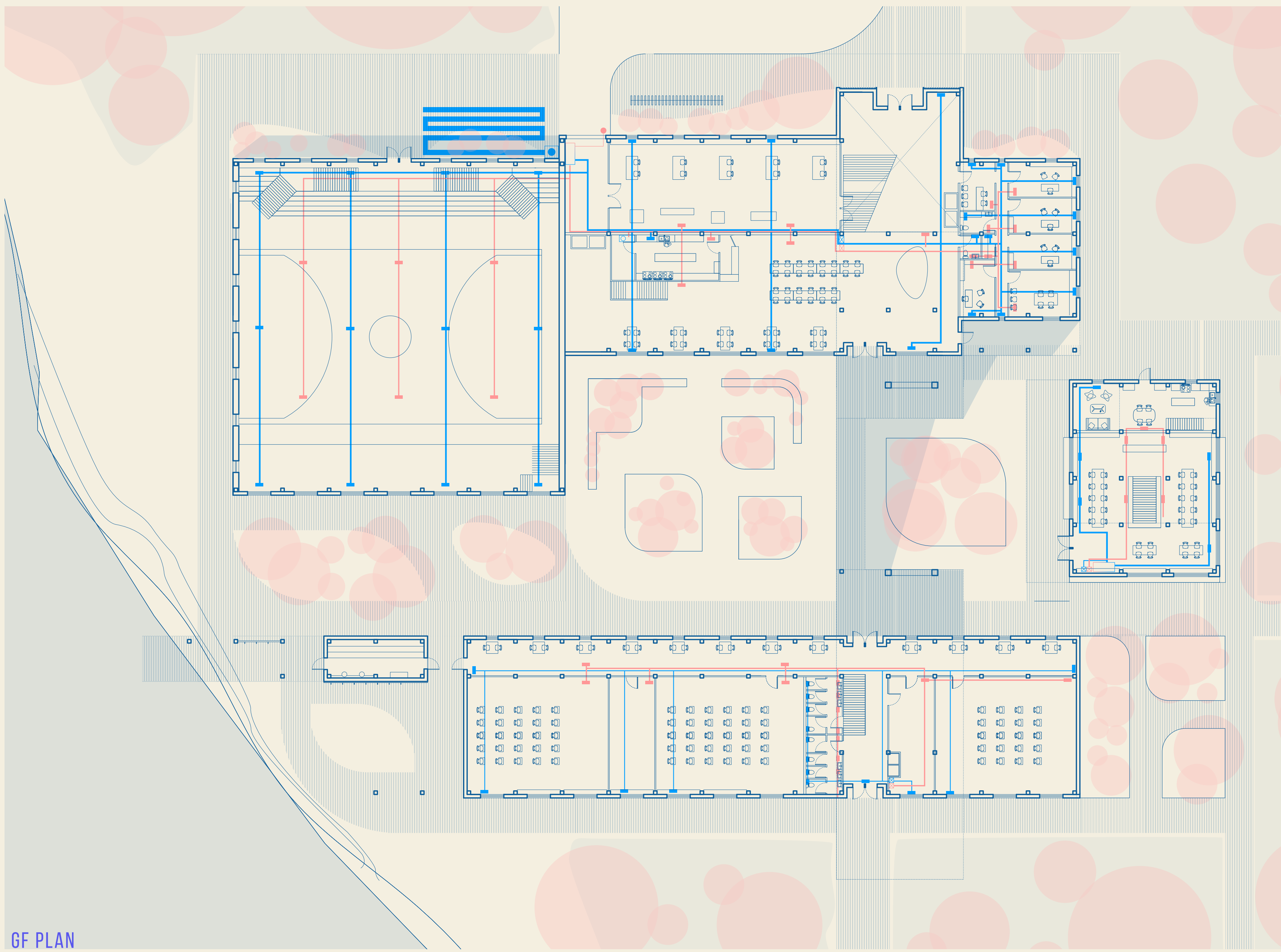
Passive Ventilation Strategy

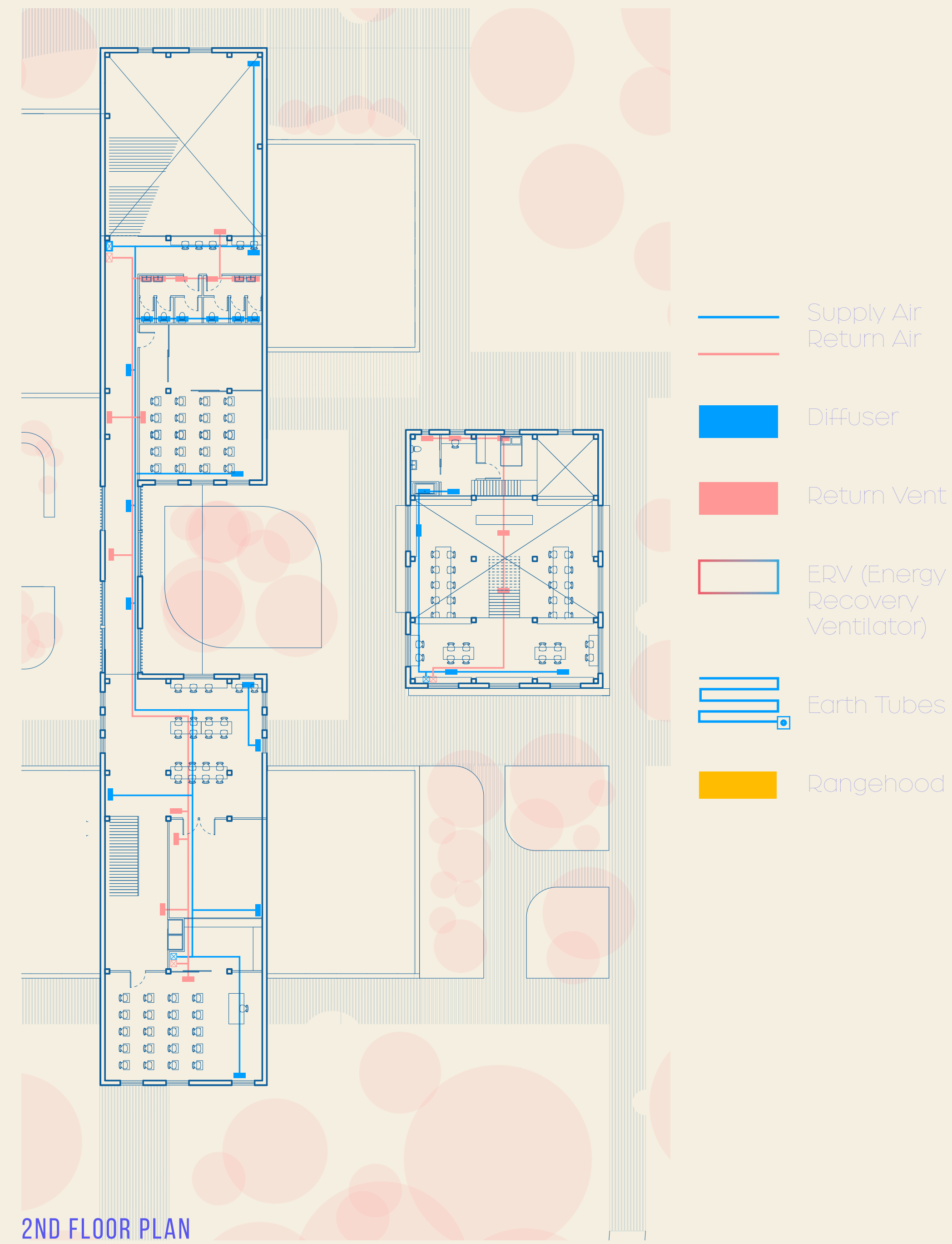
Massing was specifically oriented to take advantage of prevailing SW Summer winds, with narrow sides of buildings oriented South and continuous cross ventilation created through internal and external operable windows. This cross wind, cooled by traveling over the large body of water separating PEI from the mainland, should allow the air to provide substantial cooling and improve the quality of air. The numerous plantings will also contribute to air cooling through evapotranspiration, lowering the air temperature and contributing to a positive environment.



Active Ventilation Strategy

Continuing to work with the natural resources provided by the site, an earth tube system is used to provide cooling during the Summer months, and heating during the Winter. Working with the basic principle that the earths air is warmer underground in the Winter and cooler in the Summer, we use the sites natural conditions to draw air through a purification system, which then distributes that clean, conditioned air, through the rest of the building. An ERV is used to maximize the efficiency of the system and reduce energy demand.



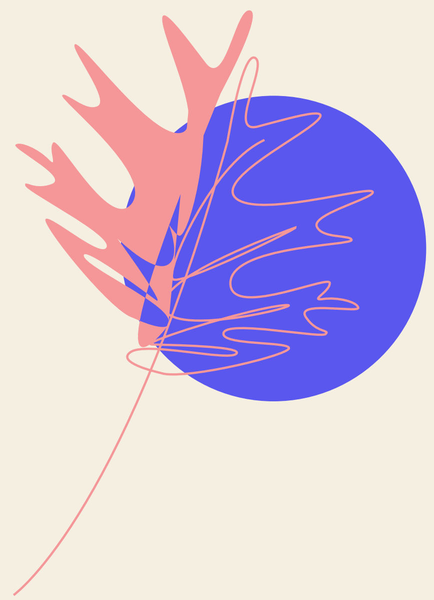


Structure

The choice to used exposed timber is supported by implications of biophilic benefit from the presence of natural materials. Research suggests this material choice could contribute to lowering the number of sick days among students, lowering stress levels among students, and increasing cognitive functions and abilities.

Mass timber was utilized extensively for its carbon sequestering abilities, long life-span, low carbon production demand, ease of ensuring environmental certification, and for its ability to support sustainable forestry and Canadian industry.

Glulam and CLT were sourced from the closest available supplier, StructureCraft, and make up the majority of building materials. This company holds a number of accolades and certifications outlined below. DLT was sourced for floor panels as they offer maximal re-use potential and avoid the use of glue or steel components, further lowering environmental impact. This material was limited however as it could only be sourced from British Columbia and required a high transportation distance.

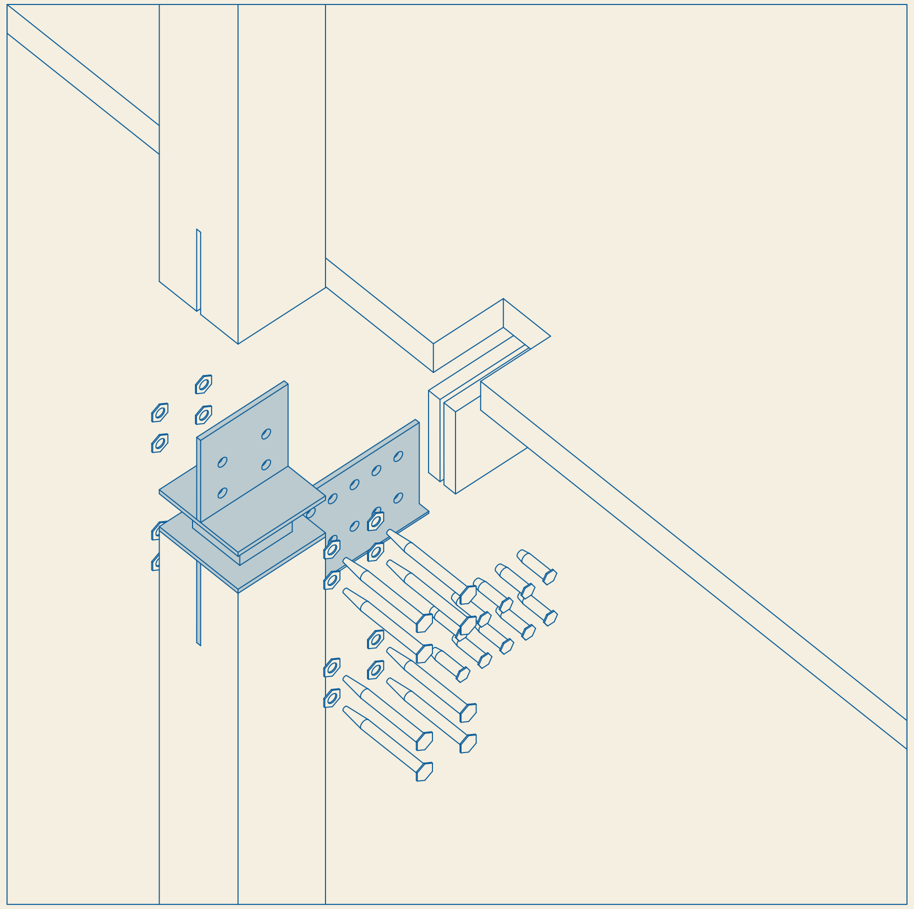


Structure

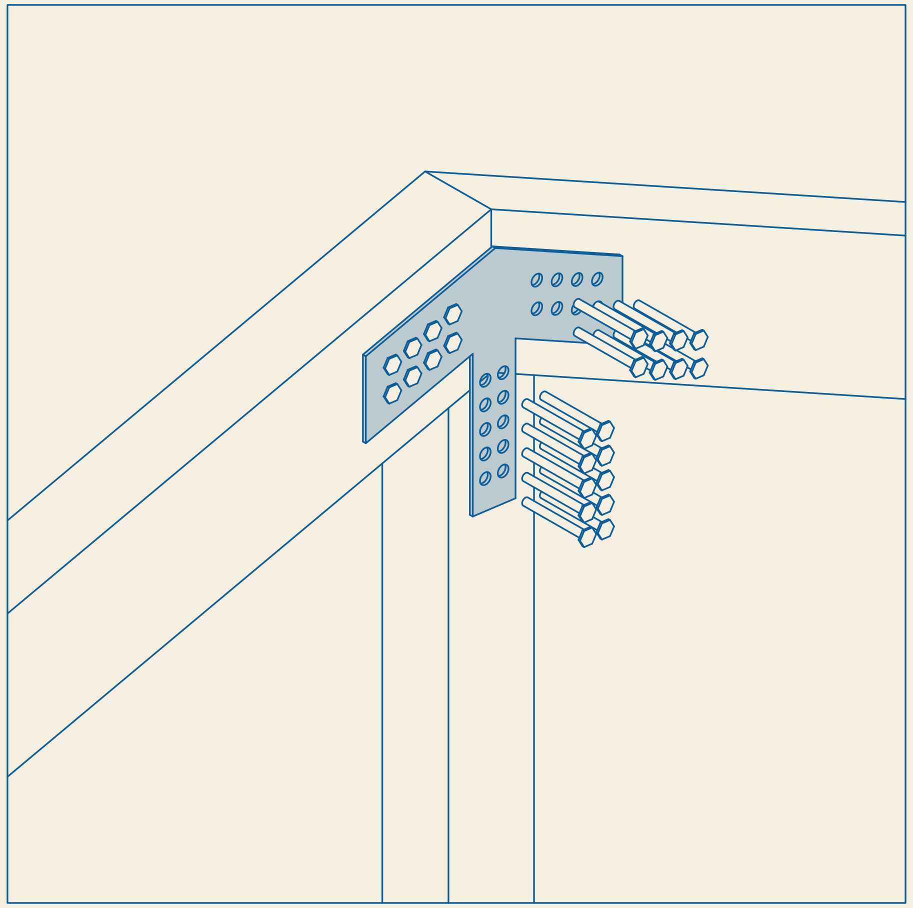
The core structural components are made up of Glulam column and beam assemblies, DLT floor panels, and connected through a series of knife plates and gusset plates. A mass timber approach was chosen as it allowed for a relatively small carbon footprint when compared to similar strategies, a carbon sequestering program, and provided a material that could be easily re-used with limited energy required to fit a new system or structure. DLT was specifically sourced as it does not require glue or steel components, further reducing its carbon footprint and broadening its re-use potential. Steel connections are used for their ease of disassembly and re-use.

Glulam systems are sourced from Nordic Structures in Montreal Quebec, as they are the closest supplier and source from sustainability managed Quebec Forests. Nordic Structures Glulam is also FSC-Certified, Cradle to Cradle certified, C2C Certified Material Health Certificate, offers an EPD report, and NGBS Green certified.

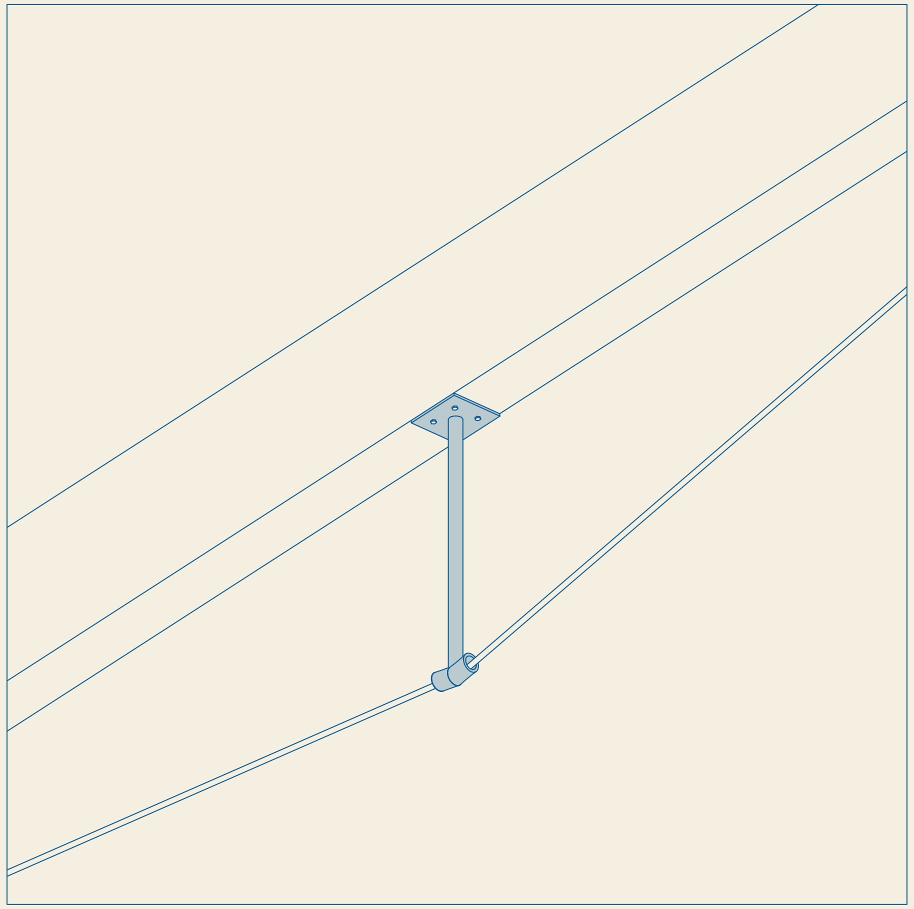
DLT is sourced from Structurecraft in Abbotsford British Columbia, while this requires a significant travel distance it remains the closest supplier and is harvested from sustain-ably managed BC forests.



Primary Structural Detail: Custom knife plates are used which allow for a single connection for column to column, column to beam, and DLT connections. This simplifies the building and dis-assembly process. Self drilling dowels are used to secure the knife plates.

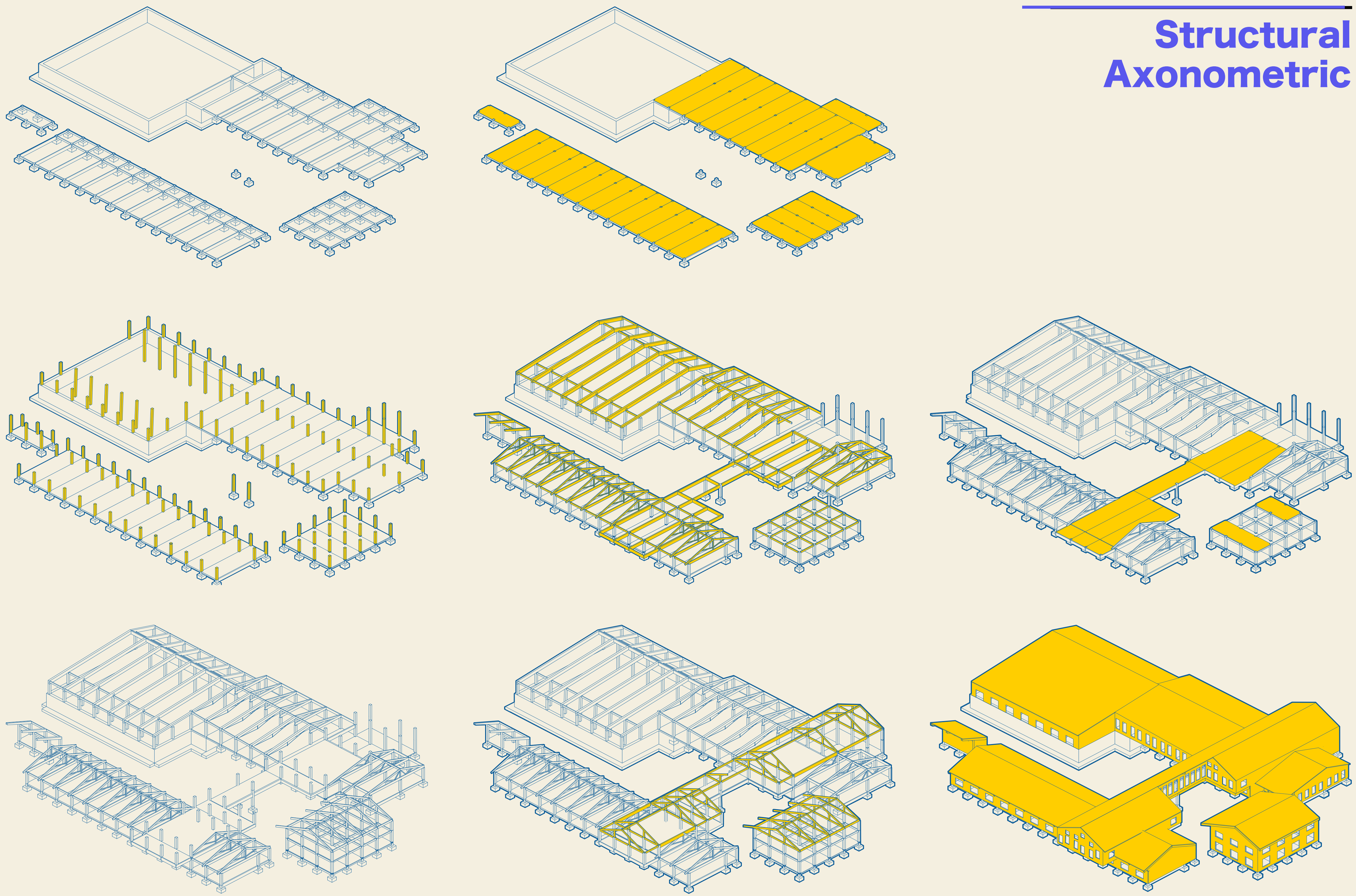


Various truss elements are fixed via gusset plates, allowing for easy disassembly, and pre-manufacturing.



Specifically in the dining area, a reverse king-post tension truss system is used, to eliminate the need of a bottom truss member and maximize floor to ceiling height.

Structural Axonometric



STRUCTURAL ASSEMBLY AXONOMETRIC

Carbon Report

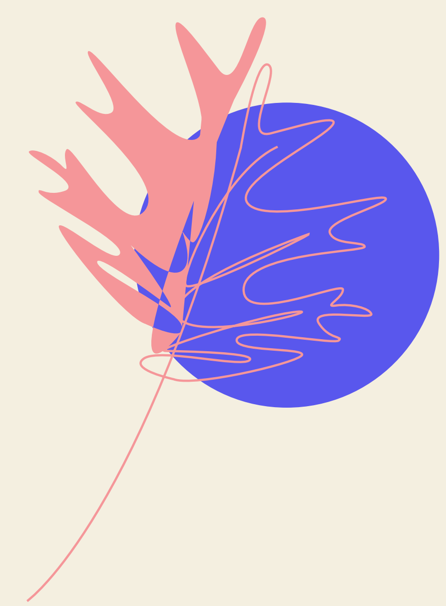
In terms of adherence to biophilic concepts, the reduction of carbon in our building processes necessitate an essential component to the slowing of climate change. For the future of our planet, reduction of loss of life as a result of climate change, and reduction of the severe loss of biodiversity currently occurring on our planet, every attempt needs to be made to significantly reduce the carbon footprint wherever possible.
Wood, a large naturally occurring resource in Canada, when sustainably managed, offers the greatest potential for creating a sustainable building practice in Canada. Through carbon sequestering, and relative low carbon production we can make great strides to reducing our carbon footprint.

A few key choices not reflected in the report is the decision to specifically source a carbon negative insulation, whose waste from production generates 93% of the energy needed to create the product. It is harvested by hand, and the trees used are not damaged, and have a lifespan of up to 150 years. The siding chosen, is made of reclaimed wood, furthering the commitment to sourcing materials from providers that offer sustainable alternatives.

As outlined below, my approach to carbon reduction relied heavily on the establishment of a large PV grid, planned from initial massing decisions.

In addition to PV production, mass timber was largely utilized for carbon sequestering purposes, and wherever possible environmental alternatives to traditional materials were chosen to reduce footprint and utilize Canadian natural resources as much as possible.

My strategies are outlined in much greater detail below.



Carbon Report

To minimize carbon usage in this building I concentrated on specifying low carbon material use whenever possible, and offset my energy needs with mass solar potential from the South, and East and West roof surfaces. This choice was made in the initial massing which allowed me to create the potential for a large array.

Mass timber was used wherever possible, with a post and beam system with DLT panels used to minimize structure as much as possible, and produce a maximally efficient system.

Other key considerations were considered, including the careful sourcing of a fully carbon negative insulation, using timber batten instead of steel connections whenever possible, and integrating wood for both the siding and roof surfaces to avoid steel or concrete wherever possible. Some concrete was integrated, but this was done to allow for smaller timber pile foundations in order to avoid the felling of old growth forests for the building.

Several key massing decisions greatly reduced carbon strain, this included grouping the program into as small a footprint as possible, integrating as much passive strategies as possible, designing from day one with solar generation in mind, and carefully crafting glazing allotment to be of maximal impact, but while retaining an overall low window to wall ratio.

While acknowledging that fasteners and connections made of steel do make a significant impact on carbon over the scale of an entire building, every attempt was made to limit carbon where possible, including notably the large use of DLT which does not require glues or nails, the sourcing of bio-degradable carbon negative insulation, and siding made from re-claimed wood and finished for durability.

Project Designer: Derrick Clouthier
ID Number:20736220

EMBODIED CARBON

Roof Materials
58 m^3 of Timber cladding
19 m^3 of Softwood (battens)
76 m^3 of Air Cavity
1060 m^3 of Wood fibre insulation
424 m^3 of Cross laminated timber (CLT)
3 m^3 of Airtightness membrane
262 m^3 of Softwood (joists/rafters/studs)

External Walls Materials
81 m^3 of Softwood (joists/rafters/studs)
236 m^3 of Cross laminated timber (CLT)
2 m^3 of Airtightness membrane
598 m^3 of Wood fibre insulation
12 m^3 of Softwood (battens)
42 m^3 of Air Cavity
32 m^3 of Timber cladding
296 m^3 of Glazing Triple (Wood and Alu frame)

Internal Walls Materials
60 m^3 of Softwood (joists/rafters/studs)
17 m^3 of Gypsum plasterboard
50 m^3 of Acoustic insulation
10 m^3 of Softwood (joists/rafters/studs)

Floors Materials
42 m^3 of Softwood (joists/rafters/studs)
101 m^3 of Cross laminated timber (CLT)
108 m^3 of Air Cavity
16 m^3 of Softwood plywood
12 m^3 of Hardwood plywood

Ground Materials
38 m^3 of Softwood (joists/rafters/studs)
258 m^3 of Concrete (poured/cast)
34 m^3 of Timber cladding
6 m^3 of Softwood (battens)
45 m^3 of Air Cavity
3 m^3 of Airtightness membrane
32 m^3 of Softwood plywood
905 m^3 of Wood fibre insulation
252 m^3 of Cross laminated timber (CLT)
32 m^3 of Softwood plywood

OPERATIONAL CARBON

Space Function	n	A	H	WWR	N	E	S	W	G	R	WHH	OV	SD	LS	NV
Assembly - Conference/Classroom	5	150	5	0.2	0	0	1	0	1	0	2	1	0	1	1
Circulation - Corridors	1	193	3	0.1	0.8	0.1	0	0.1	1	1	0	0	0	0	1
Circulation - Lobby	1	85	8	0.2	1	0	0	0	1	1	6	0	1	0	1
Food - Cafeteria	1	260	4	0.3	0	0	1	0	1	1	3	1	0	0	1
Food - Kitchen	1	28	3	0	0	0	0	0	1	0	0	0	0	0	0
Library - Stacks	1	140	3	0.3	0	0.3333	0.3333	0.3333	1	1	3	1	0	0	1
Library - Reading	0	55	3	0.3	0	0.375	0.25	0.375	1	1	5	0	0	0	1
Services - Laundry	1	14	3	0	0	0	0	0	0	0	0	0	0	0	0
Offices - Enclosed Layout	3	15	5	0.2	0	1	0	0	1	1	3	0	0	0	1
Offices - Enclosed Layout	1	23	4	0.2	0	0.5	0.5	0	1	1	0	0	0	0	1
Services - Mechanical/Electrical	1	30	4	0	0	0	0	0	0	0	0	0	0	0	0
Services - Washrooms	2	30	3	0	0	0	1	0	0	1	0	0	0	0	0
Storage - Fine	3	40	5	0	0	0	1	0	0	1	0	0	0	0	0
Assembly - Multipurpose	1	154	5	0.1	1	0	0	0	1	1	2	1	0	0	1
Residential - Dwelling	1	82	3	0.1	0.6633	0.1666	0	0.1666	1	1	2	0	0	0	1
Circulation - Corridors	1	167	5	0.2	0.105	0.395	0.105	0.395	0	1	0	0	1	0	1
Services - Washrooms	2	44	4	0	0	0	0	0	1	0	0	0	0	0	0
Assembly - Recreation	1	672	8	0.2	0.2675	0.06	0.2675	0.4005	0	1	3	0	1	0	1

RENEWABLE ENERGY

Solar Energy
2176 m^2 Monocrystalline silicon PVs (Roof)

Wind Energy
0 Turbines
0 m, Blade Length
0 m, Turbine Elevation

Geothermal system type: Closed loop - horizontal pipes
Seasonal activity: Annual
Serviced area percentage: 70%

Project Designer: Derrick Clouthier

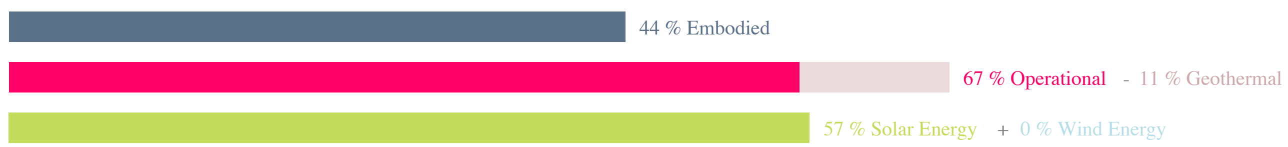
ID Number:20736220

Total Floor Area: 2911 m^2

Lifespan: 100 years

Energy Use Intensity: -3 kWh/m^2

Carbon Footprint: 2450 $kgCO_2e/m^2$



Design Parameters		Orientation		Envelope	
n	Quantity	N	North	G	Ground
A	Space Area (m^2)	E	East	R	Roof
H	Floor Height (m)	S	South		
WWR	Window Wall Ratio	W	West		

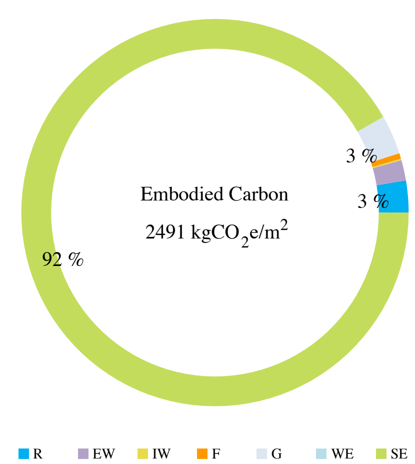
Embodied Carbon Legend		Operational Carbon Legend		Energy Use Intensity Legend	
R	Roof	C	Cooling	PD	Proposed Design
EW	External Walls	H	Heating	AO	Average Ontario
IW	Internal Walls	MV	Mechanical Ventilation	GP	Good Practice
F	Floors	L	Lighting	BP	Best Practice
G	Ground	P	Plug Load	A25	Architecture 2030 - T 2025
SE	Solar Energy	W	Water Heating	A30	Architecture 2030 - T 2030
WE	Wind Energy				

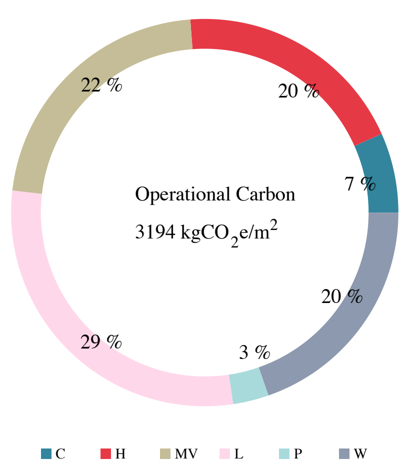
Energy Performance

Cooling	38665 kWh
Heating	113288 kWh
Mechanical Ventilation	127655 kWh
Lighting	169257 kWh
Plug Load	17359 kWh
Water Heating	114057 kWh
Solar	587738 kWh
Wind	0 kWh
Geothermal Reduction	110035 kWh

Global Warming Potential

NO_x	171 kg
SO_2	391 kg
CO_2	7135467 kg





DayLighting		Air Ventilation	
WHH	Window Head Height (m)	NV	Natural Ventilation
OV	Obstructed View		
SD	Shading Device		
LS	LIght Shelf		

Life Cycle

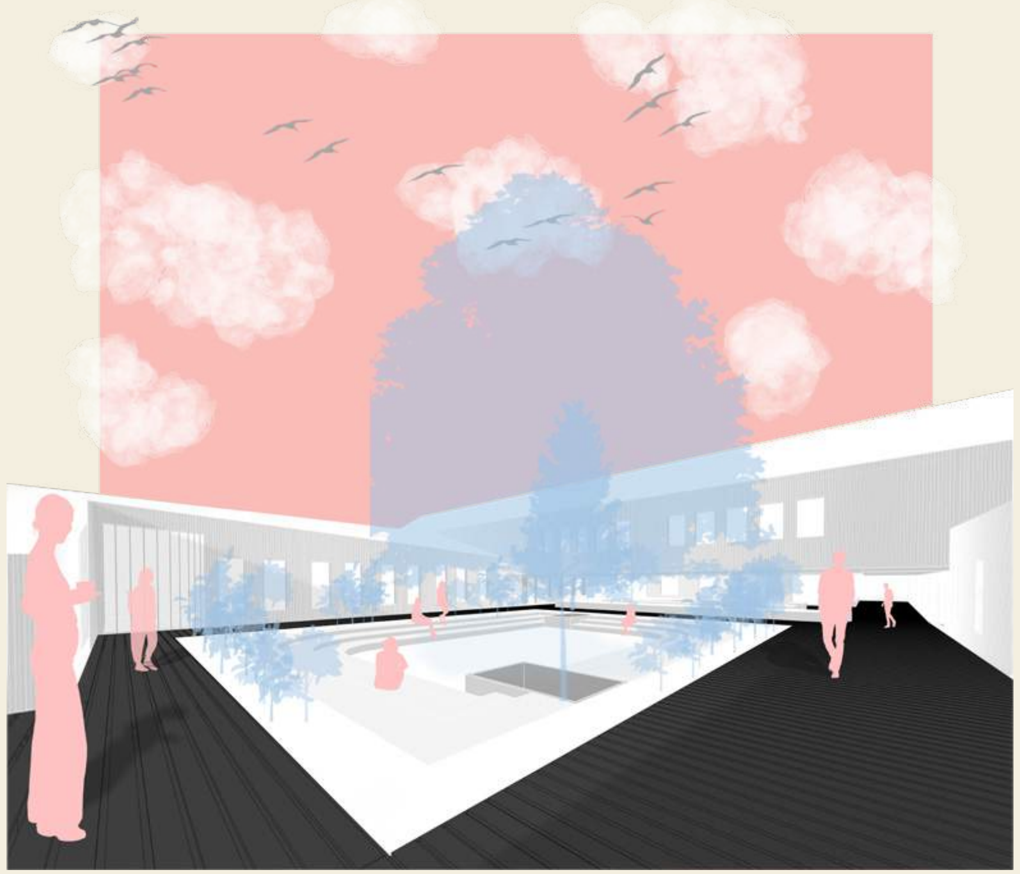
Structure:	Lifespan:	Details:
Glulam:	100+ years	Glulam sourced from Nordic Structures in Montreal, Quebec was chosen for its relative proximity to the site and sustainable sourcing from Quebec forests. Although less easily re-used than DLT, Glulam still allows for members to be cut into smaller members and re-used, with column sizing specifically being considered to maximize re-usability. At the end of this products life cycle it can also be recycled into non-structural products.
Dowel Laminated Timber Panels (DLT)	100+ years	Sourced from StructureCraft in Abbotsford British Columbia, DLT offers a fully cradle to grave product, made entirely of wood sourced from managed British Columbia forests. DLT was chosen as it requires about a third of the energy use to produce comparable engineered wood products, does not require glues or steel components which contribute to a higher carbon use, and enable for a much greater scope of reuse. After completing its service life this product can be fully disassembled and reused for non-structural uses.
Timber Piles	100+ Years	Timber piles were chosen as they can be sourced from renewable and sustainable forests, sequester carbon, and do not require a carbon intensive process to produce. Several smaller piles were sourced as an alternative to having to harvest old growth tree's contributing to sustainable forestry practices. Upon reaching their productive use the wood can be re-used for wood products or converted to biomass for cleaner energy production.
Concrete Pile Caps and limited foundations	100+ Years	Where possible, concrete use was minimized to reduce carbon footprint and environmental impact of the building. Concrete was however used for pile caps, allowing smaller timber piles to be sourced and preventing the harvesting of old growth trees. Additionally, concrete was used to create foundations around the gym in order to retain soil and allow the gym to be partially recessed into the earth. While not useful for effective re-use it can be rendered into aggregate for some use.
Cross Laminated Timber (CLT) Panels	100+ years	CLT is sourced from Nordic Structures in Montreal, Quebec. As mentioned above, proximity, sustainable practice, and accolades informed this structural choice. Nordic Structures Glulam and CLT are FSC-Certified, Cradle to Cradle certified, C2C Certified Material Health Certificate, offers an EPD report, and NGBS Green certified. This choice allows the structure to resist shear forces and create a strong enclosure

Life Cycle

Enclosure:	Lifespan:	Details:
ThermaCork:	50 years	Thermacork was sourced as it is a 100% natural, renewable, recyclable, and biodegradable material made from the outer bark of Oak Trees. The process of thermacork is highly efficient and renewable, with impurities separated during the manufacturing process providing 90-93% of the energy needed to produce the final product. Made essentially of only cork and water the product has a fully carbon negative footprint. With a longevity of 50 years this product provides a long lasting enclosure and naturally biodegrades to provide a full end of life.
Timber Batten	60 years	Made from sustainably sourced timber, this product has a low carbon footprint. After serving its lifespan it can be recycled into biomass or used for small non-structural wood products.
Metal Fasteners	100+ Years	Steel requires a high manufacturing energy to re-use, however it provides a durable and long lasting connection system. Following its usage this product can either be re-used in additional projects if disassembled properly, or if need be, recycled and re-manufactured into a new steel element.
Shou Sugi Ban Cedar Wood Siding	50+ Years	Sourced from Urban Timber Reclaimed Wood Co. in Edmonton Ab, this product utilizes reclaimed wood to manufacture long lasting exterior siding. The burning process of Shou Sugi Ban provides a strengthened and weather resistant exterior which helps prolong the products lifespan. After fulfilling its use, this product can be further re-used in non structural context or used to create biomass.
Triple Paned Window Glazing	10-35 years	While components of window assemblies can be recycled, and effort should be made to do so, including the intact glass, metal, and wood components. It is unlikely these products are often properly recycled. If possible assemblies should be de-constructed and recycled.
Oak Flooring	50-100 year lifespan	At the end of its lifespan, hardwood can be recycled or refinished to be used in other wood products. Most likely flooring would end up in a Re-store or similar architectural re-use facility where it would find second life in other uses.
WarmBoard	30-40 years	Both the tubing and plywood aspects that make up the Warmboard panel have an approximate lifespan of about 30-40 years. The plywood can be either recycled or used in waste to energy markets, allowing the grave condition to find use instead of landfill.

Exterior Visuals

COURTYARD VISUAL

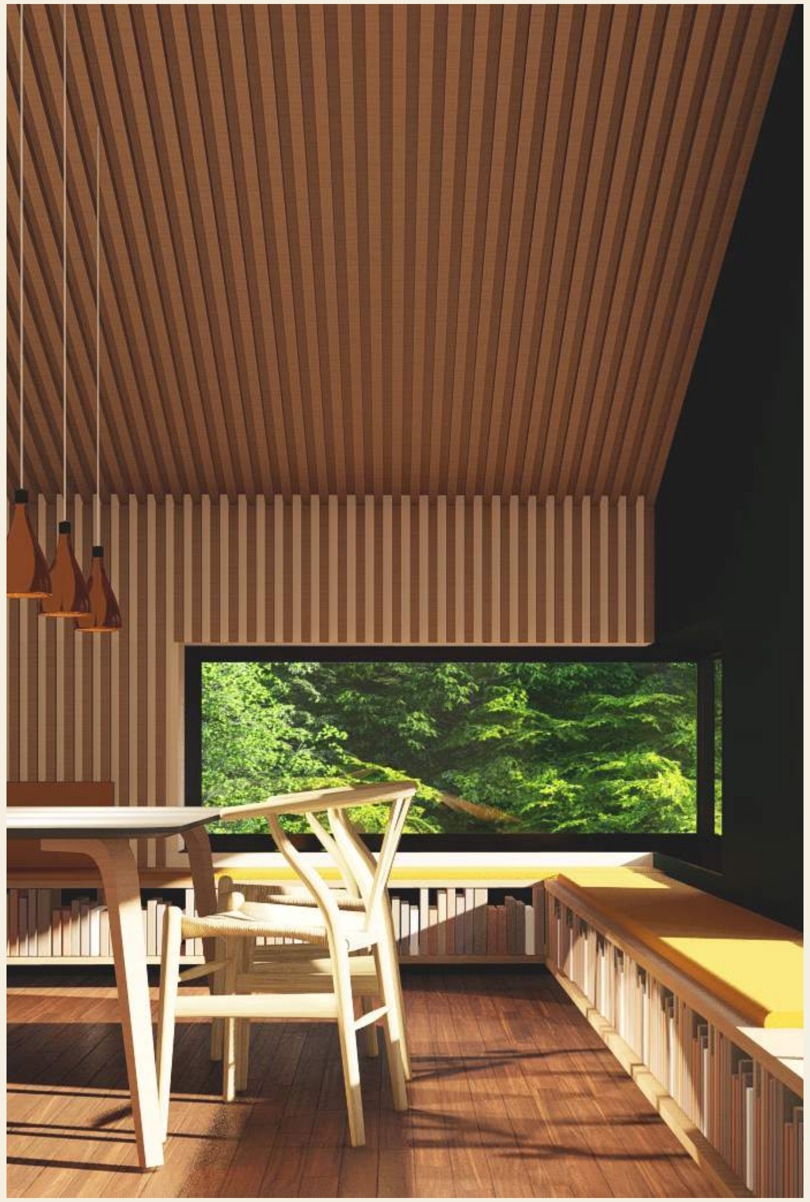


COURTYARD VISUAL

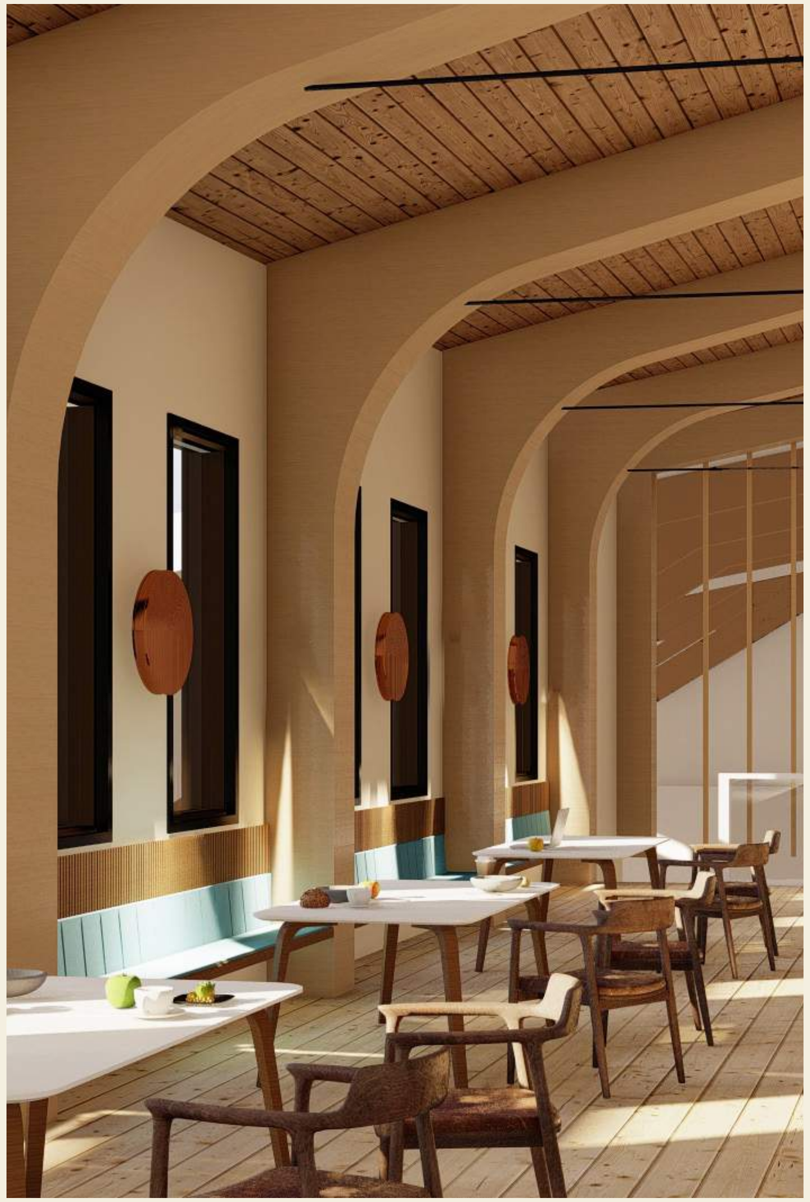
REFLECTIVE COURTYARD

Sustainability extends beyond the physical characteristics of the project, but envelops the ability of space to produce desired behaviour, and to encourage interaction that teaches a connection with our natural environment. When considering the field of environmental design there are lessons that can be applied to the built world. In this project, this takes the form of embracing several core concepts. The first concept surrounds the importance of programming, to provide spaces of engagement, and allow users the opportunity to experience nature in a variety of ways, from outdoor learning spaces, running spaces, gardening, reading, and reflection. The second is the allowance of chance encounters, by providing more lightly programmed spaces, such as seating areas, pathways, etc. we allow for random encounters to occur. Ultimately, research in the field of environmental design has shown psychologically, that engagement with natural elements ultimately promotes and nurtures sustainable beliefs and habits. Recognizing this, it was essential in this project to provide spaces for engagement and promote well-being.

Interior Visualizations



LIBRARY 2ND FLOOR



DINING HALL

BRIDGE STUDY SPACE

To realize the environmental ambitions of this project, it required a careful consideration of materials, structure, and finishes, from both an psychological, environmental, and aesthetic perspective. To achieve this, I have utilized these visualizations to illustrate the importance of natural light, natural materials such as wood, and natural colours such as greens, yellows, browns, and blues, to align with the ambitions of the project. Material choices extend beyond the aesthetic ambitions, but underly the design ambitions for circular design, through utilizing materials with substantial opportunity for re-use, as is the case with DLT, CLT, and hardwood, as well as benefiting from the psychological benefits found in cognitive restoration, anxiety reduction, and reduced stain. All of these elements, in addition to active and passive environmental heating and cooling symbiosis, and salutogenic circulation, work collaboratively to generate a project that simultaneously looks after the health of the community, the site, the end users, and ultimately the planet for generations to come. It is this holistic approach to design, utilizing the latest cognitive research, most current thoughts on sustainability, and accessible technology that I believe architecture can adapt to the challenges of this century, and transcend above our ambitions.