# M+G Consulting

**New Highschool in Jerrabomberra**
**Environa Road, Jerrabomberra, NSW 2619**

**NSW Department of Education**

# Structural Schematic Design Report

**Issued for: SSD**
**Revision: G**

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# Report Amendment Register

| REV. | DATE | ISSUE/ AMENDMENT | | INITIALS/ REVIEWED BY | |
|---|---|---|---|---|---|
| 1 | 22 March 2021 | | Schematic (Meinhardt Bonacci) | DR/AB | |
| A | 08 April 2021 | | Schematic (Meinhardt Bonacci) | DR/AB | |
| B | 09 April 2021 | | Schematic (Meinhardt Bonacci) | DR/AB | |
| C | 23 April 2021 | | Schematic (Meinhardt Bonacci) | DR/AB | |
| D | 07 May 2021 | | Schematic (Meinhardt Bonacci) | DR/AB | |
| E | 13 May 2021 | | Schematic (Meinhardt Bonacci) | DR/AB | |
| F | 20 September 2021 | | Schematic (M+G) | NN/SM | |
| G | 21 September 2021 | | Schematic (M+G) | NN/SM | |

Prepared by: M+G Consulting

Date: 21 Sept 2021

Project No 5555

Issued for Review

Discipline: Structural

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# 1. Introduction

This structural engineering schematic design report accompanies an Environmental Impact Statement (EIS) pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act) in support of an application for a State Significant Development (SSD No 24461956). The SSDA is for a new high school located at Jerrabomberra.
This report addresses the Secretary's Environmental Assessment Requirements (SEARs), notably:

| SEARs Requirement | Response |
|---|---|
| **(INSERT RELEVANT SEAR)** | |
| **NIL** | **NIL** |

# 2. Proposal

The proposed development is for the construction of a new high school in Jerrabomberra. The proposal will meet community demand and to ensure new learning facilities are co-located near existing open space infrastructure. The proposal generally includes the following works:

- Site preparation;
- Construction of a series of buildings up to three storeys including administration/staff areas, library, hall and general learning spaces;
- Construction of new walkways, central plaza and outdoor games courts;
- Construction of a new at-grade car park;
- Associated site landscaping and open space.

The proposal has been designed to accommodate approximately 500 students with Stream 3 teaching spaces, however the core facilities will be future proofed to a Stream 5 to enable possible future expansion to meet projected demand.

The proposal will include site preparation works, such as clearing and levelling to accommodate the proposed buildings and play areas. The proposal will involve the construction of a series of buildings housing general learning spaces, administration and staff wings, outdoor learning areas, a library and assembly hall.

The proposal will include construction of a new driveway and hardstand with access proposed off the northern stub road east of Environa Drive. Pedestrian access is proposed off Environa Drive and the northern stub road.

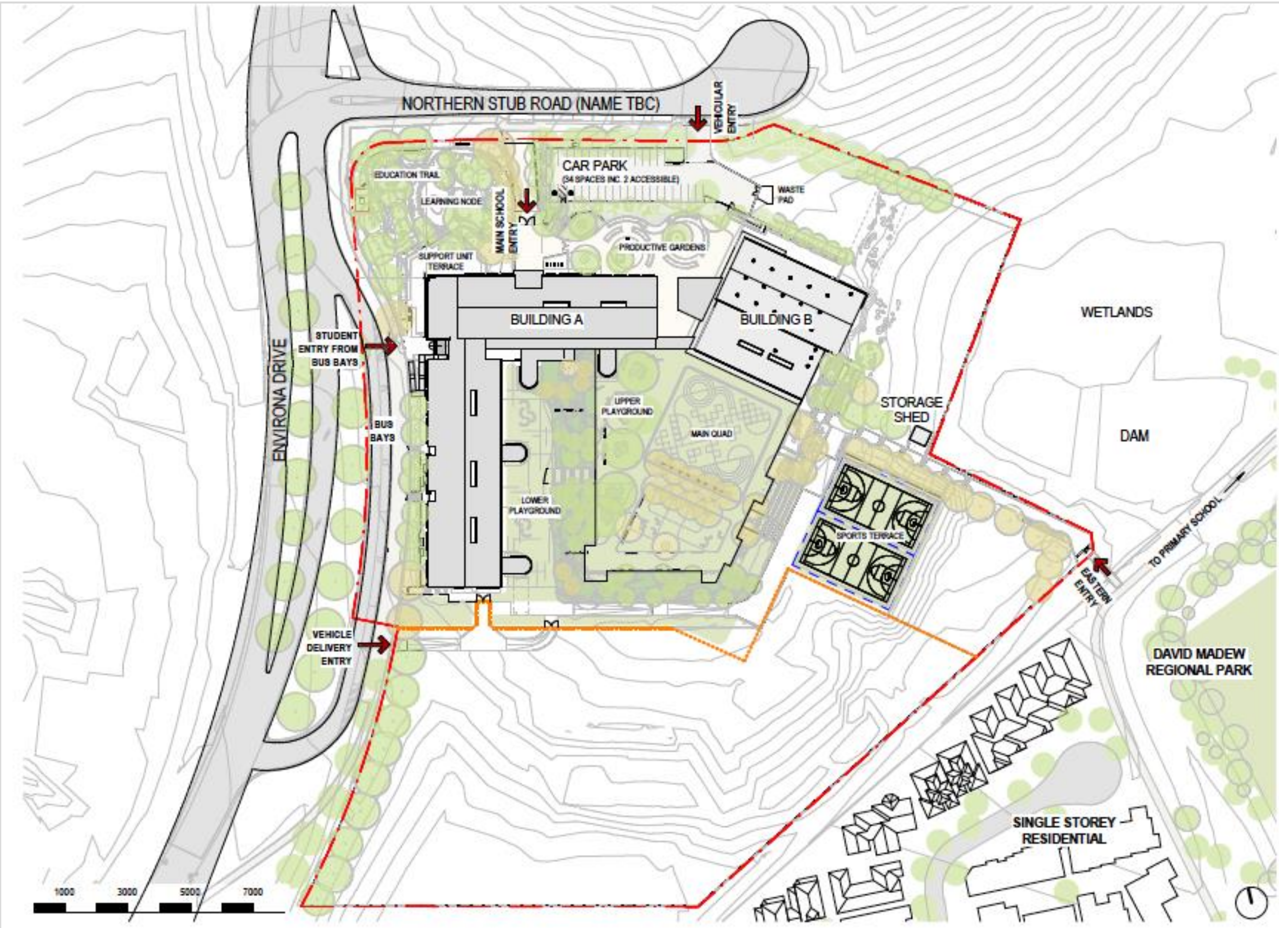


*Figure 1 – Proposed landscape site plan, Source: CONTEXT Landscape Architecture*

## 2.1. Site Description

The proposed development is located within the South Jerrabomberra Innovation Precinct, also referred as the Poplars Innovation Hub, in the local government area of Queanbeyan-Palerang Regional Council.

The school site- is part of an existing lot (Lot 1 in DP 1263364), which is approximately 65.49ha in area and will be characterised by a mix of business park and open space uses and a new north-south connector road named Environa Drive.

Delivery of the Precinct is underway with Environa Drive currently under construction. Most of the-lot, however, remains undeveloped.

The school site is subject to a proposed lot (Lot 2 in DP 1263364), which was approved by Council under DA332-2015 on 10 March 2021 but is not yet registered. The approved lot is irregular in shape, is largely cleared and is approximately 4.5ha in area. A small dam is located adjacent to the south eastern boundary of the site, which forms part of a broader wetland.

The site is located in excellent proximity to existing open space facilities. It adjoins David Madew Regional Park to the south east and is located 100m east of an existing recreational field associated with Jerrabomberra Public School.

A description of the site is provided in the table below.

| Table 1 – New High School in Jerrabomberra Site Description | |
|---|---|
| Item | Description |
| Site address | School address yet to be determined however, it is located within the Jerrabomberra Innovation Precinct at 300 Lanyon Drive, Jerrabomberra. |
| Legal description | Lot 1 in DP 1263364 (existing)<br>Lot 2 in DP 1263364 (proposed, but not registered) |
| Total area | Lot 1 – 65.49ha<br>Lot 2 – 4.5ha |
| Frontages | The site provides frontage to Environa Drive and the northern stub road, both currently under construction. |
| Existing use | The site is undeveloped and contains a series of small vegetation clusters scattered across the site. |
| Existing access | Existing access is via an informal unsealed driveway off Tompsitt Drive along the northern boundary of the existing lot.<br>The site will be accessed via Environa Drive and a secondary access road (North Road), which is currently under construction. |
| Context | Land to the south is primarily residential in nature.<br>Jerrabomberra Public School and David Madew Regional Park are located to the east/south-east, while land to the west is undeveloped and features Jerrabomberra Creek.<br>The site is located within the South Jerrabomberra Innovation Precinct, which is currently under construction.<br>The areas north and west of the site are currently undeveloped but the site is currently undergoing a transition from rural to business park uses.<br>Development further north on the opposite side of Tompsitt Drive and along Edwin Land Parkway includes retail and commercial uses.<br>Development immediately to the south includes existing low density residential development. Land in the south west has been identified for future low density residential, light industrial and business park uses. |


*Figure 2 – Site aerial depicting the land subject to the proposed High School. Source: TKD Architects*

## 2.2. Existing Conditions

### 2.2.1. Topography and Geotechnical Investigation

Initially, the proposed site was decided on in April 2019 as a section of the South Poplar Estate measuring roughly 3.0 ha. In September 2020 this was revised, and an additional area of 1.5 ha was added to the original development site.

According to the Geotechnical Report provided by Douglas Partners in 12th of May 2021, the proposed building envelope is located on top of a small hill/ridgeline and generally slopes in all directions with an overall regional slope from the north-east to the south-west with surface levels ranging from approximately 605 m to 592 m Australian Height Datum (AHD).

The soil found on this site was generally classified as consisting of topsoil atop of silt/sand or clay. Bedrock was encountered at the depth of 0.3m-5.65m & 6.0m & 7.0M in various boreholes. The succession of strata is broadly summarised below:

- TOPSOIL: generally low plasticity clay with a various mixture of sand and silt in all boreholes to depths of 0.1 m – 0.35 m; overlying

- COLLUVIUM / RESIDUAL: generally low to medium plasticity clayey soils and medium dense to very dense sandy soils in Bores 1 – 6 and 8, from 0.1 m – 0.2 m depths to 0.3 m – 3.2 m depths

- EXTREMELY WEATHERED ROCK: generally medium dense to very dense sandy soils with a various mixture of clay, silt and gravel in all the boreholes except Bores 4 and 14 from 0.15 m – 3.2 m depths to 0.3 m – 5.65 m depths;

- BEDROCK: variably extremely low to extremely high strength, extremely/highly weathered to fresh rhyodacitic ignimbrite in all boreholes from 0.3 m – 5.65 m depths to the limit of investigation depths of 6.0 m – 7.0 m.

Refer to – Douglas Partners Geotechnical Report, Project # 94188.02 dated May 2021.

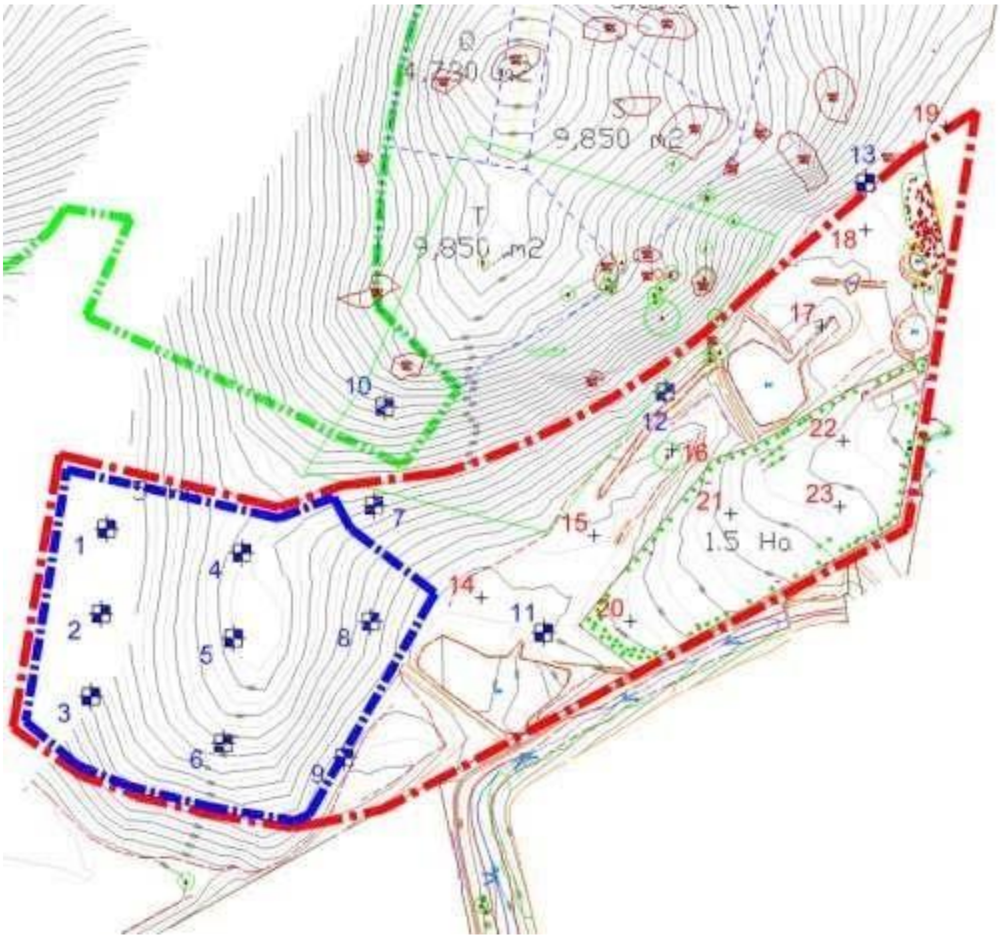


*Figure 3 - Borehole locations based on Douglas Partners geotechnical report*

The study report has been prepared with project No. 94188.02 & document No. R.001.Rev1, dated 12th of May 2021. Figure 4 indicates the geological units extracted from geology map.

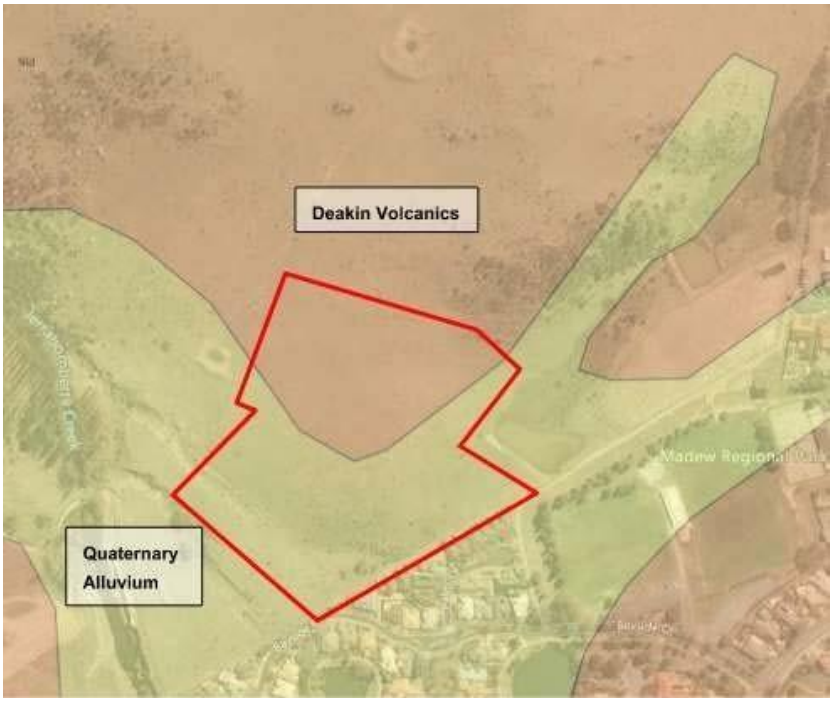


*Figure 4 - Extract from Geology Map*

The findings of the 94188.02 geotechnical report are consistent with what has been described in 2019 report. Figure 5 highlights the borehole locations based on Douglas Partners geotechnical investigations. Refer to "Appendix A – Douglas Partners Geotechnical Report" for a copy of Douglas Partners most recent geotechnical study.


*Figure 5 – Layout of Geotechnical Boreholes based on Douglas Partners Report*

Schematic footing design has been developed based on the geotechnical engineering findings as per above-mentioned reports.

All footings must find within a uniform bearing stratum of suitable strength/material, below the zone of influence of any uncontrolled fill (if left in place), service trenches, backfill zones, retaining walls or underground structures. Masonry walls should be articulated in accordance with current best practice.

It is recommended that either bored piers or pad footings founding on rock would provide the most robust footing system to support columns, especially for two to three storey structures. Footings to rock would minimise total and differential settlements as it allows a strong uniform bearing stratum to be utilised. Bulk earthworks in areas of structures could then be treated as form fill as the structural loading would be transferred to the rock stratum. It should be noted that suitable compaction of the form fill still needs to be applied as the fill would be required to support services (i.e., piling rig, plant etc.). This should be to a Level 2 standard as defined in AS3798:2007.

### 2.2.2. Structural Condition

The site has previously been used as land for sheep grazing, horse and cattle agistment, pig husbandry and wheat farming as part of a much larger grazing property since the mid to late 1800s.

Construction of the new Environa Drive along with an additional new road (yet to be named) is currently underway.

### 2.2.3. Existing Live Services

A survey has been undertaken for the site which shows there are currently no existing live services running through the proposed developmental area. Therefore, no special footing requirements need to be considered at this stage. This has to be confirmed once a detailed investigation conducted on site in due course.

# 3. Structural System

This report illustrates the current proposed structural system for the school. Structural system for Monaro schools comprises of DFMA superstructure fabricated off-site & conventional reinforced concrete footing system completed as part of early construction works.
SFMA guideline prepared by SINSW is the benchmark document for design and detailing of the DFMA modules. Where there is any deviation from the guideline, relevant consultants are to liaise with appointed project manager/contractor and seek approval from SINSW.
The final structural systems not only should be cost effective and complying with the NCC- National Construction Code- performance requirements- i.e. fire rating and acoustic- but also consider the site- specific constraints.

As per SINSW instructions the project would be delivered as a DfMA- designed for manufacturing and assembly off site- meaning that the superstructure would be manufactured off site in a factory and then delivered to site and craned into the final location. The proposed system for this project is volumetric modular construction.

## 3.1. Footing Options

Douglas Partners geotechnical engineering report has been utilized for design of footing system. Depending on the depth of bulk excavation required, pad or strip footings or bored piers may be found on future controlled fill, suitable natural soils or in situ rock.

Considering that shallow layers of soil do not accommodate the required bearing capacity, pile footing is the ideal option to achieve the nominated allowable bearing capacity. Proposed school structures are low rise buildings (1-3 storeys). Therefore, to accommodate the volumetric modular construction pile footing has been nominated as the ideal option all across the site. Where it is necessary to avoid overloading the in-ground services, pile footing to be installed. Also, at the location of lateral bracing bays, piles would be recommended to resist the additional upwards and downward loading due to lateral loading.

## 3.2. Superstructure

Volumetric modular construction is proposed for this project. This includes floor cassettes out of steel joists supported by steel ring floor beams as floor and ceiling joists supported by module ceiling ring beam. The ring beams will be supported by a combination of temporary and permanent steel posts.

The modules will be connected to each other on site using fasteners in corners. Detail varies between manufacturers and will be confirmed at design development stages.
The modules will be cross braced down to the footing level to provide lateral stability. If needed proper connections would be provided to the stair and lift cores to provide additional lateral stability.

The NSW Schools DfMA System comprises various parts that work in synergy with each other and allow each project to use the system to meet varying spatial and programmatic needs. The system aims to standardise certain aspects of spatial planning and componentry but allows each project to be creative to assemble an architecture of its place and to meet its needs.

The system comprises:

- Framework
  - The framework to enable a standardised layout that is future flexible to easily convert spaces to different uses
- Structural System
  - The beams, columns, floor system i.e., Timber frame, concrete, steel, volumetric or hybrid
- Space types
  - The classrooms, support spaces, practical activities areas, specialist spaces etc
- Components
  - Façade, walkway, roof, stairs, joinery, finishes, furniture

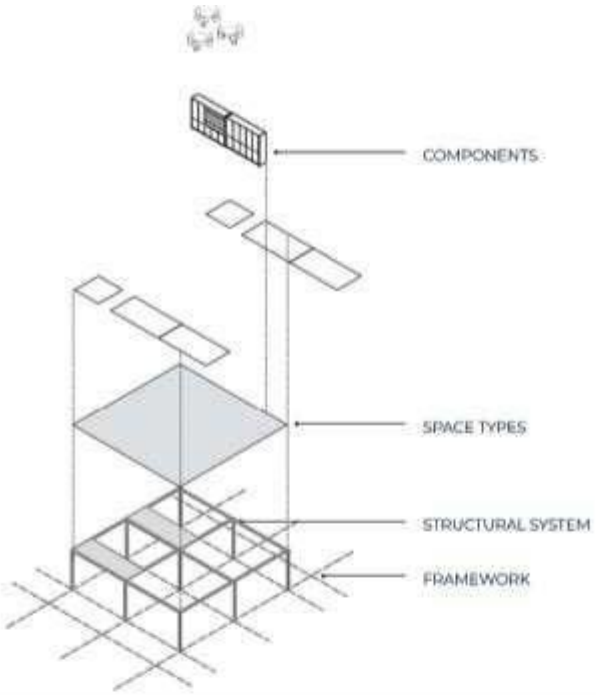


*Figure 6 - Components of DFMA system (Extracted from SINSW DFMA Guideline)*

## 3.3. Steel Superstructure

The steel system is composed of the following, refer to Figure 6:

- Steel Columns spaced at 9m x 7.5m on the 9m framework set up by the planning system.
- Primary steel beams spaced 9m apart on the 9m framework
- Secondary steel beams spaced 7.5m apart
- Steel bracing system on the facade
- Steel cassette floor sitting within the framing system
- All steel structure and floor members require fire protection according to BCA subject to fire engineer's advice.

Fire resistant treatment or enclosure is required for the steel structural system. The following fire- resistant systems are available with Pros/Cons for each one:

Intumescent Paint

- Difficult at junction
- Regular maintenance is required
- Easy to be damaged
- Wet Trade

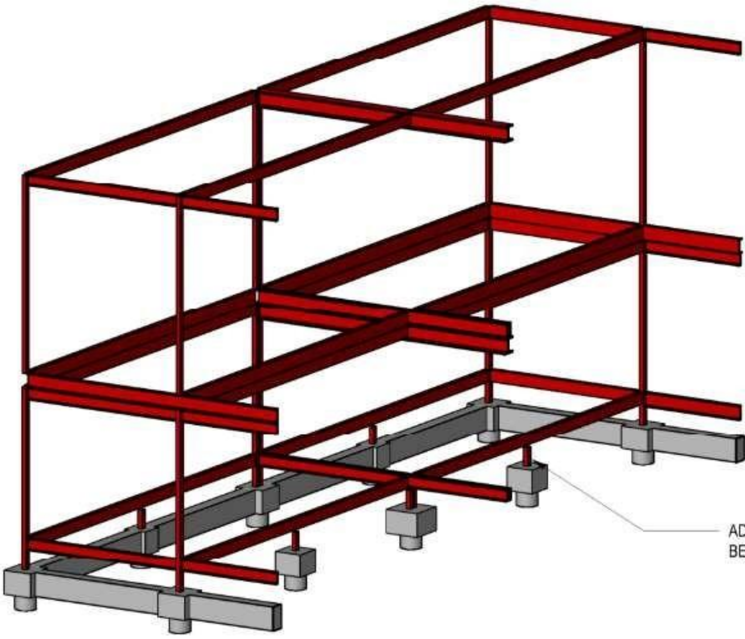


*Figure 7 – Steel framing system – Two storey*

Prefabricated, Pre-finished component including junction

- Connection between panels needs to be detailed
- Maintenance – visual access behind panels Boxed
- System needs to be assembled and finished on site, not DfMA

The RCP in Figure 8 details the structural component sizes for the steel structure system.
Disclaimer:

- All structural element sizes are indicative only; they are high level figures for the purpose of this report.
- The column size is designed for a 3-storey building

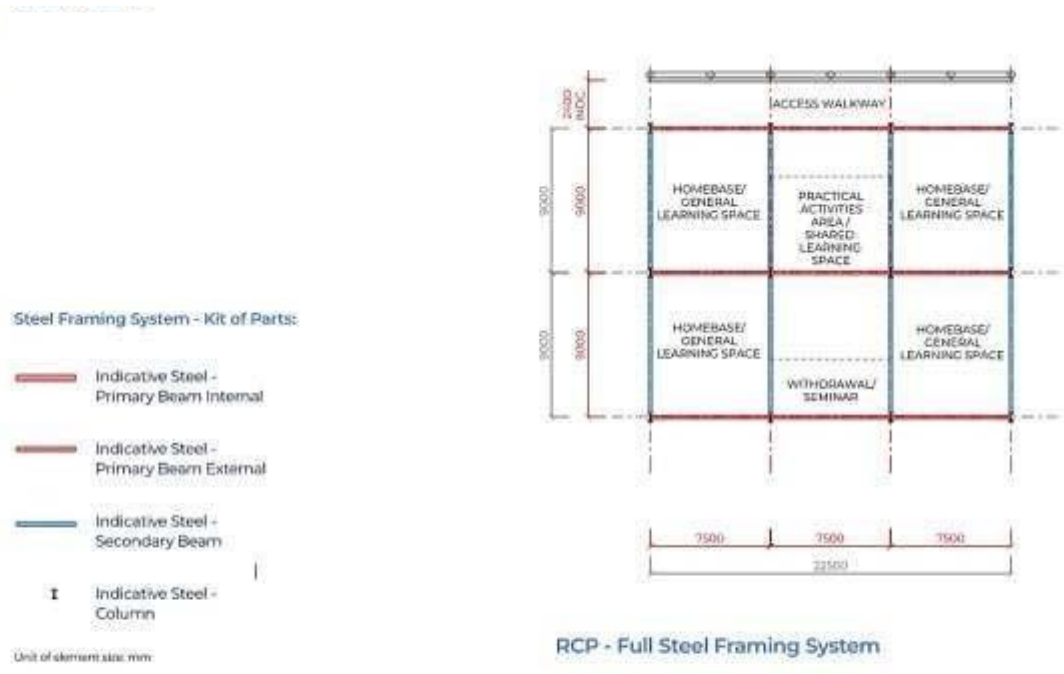


*Figure 8 – Reflected ceiling plan (Extracted from SINSW DFMA Guideline)*

The diagrams in Figure 9 indicate the specific zones allocated to services. The steel structure has been designed to allow easy maintenance and access to all services.

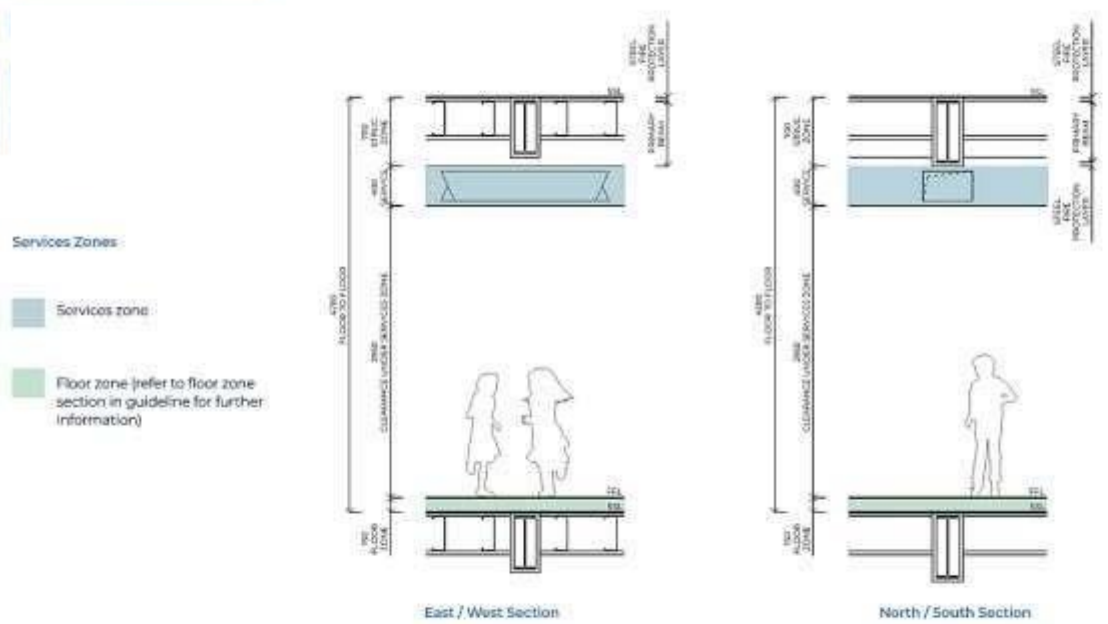


*Figure 9 – Services zone in ceiling (Extracted from SINSW DFMA Guideline)*

## 3.4. Roof

The roof either will be a separate roof module or will form part of the top floor modules. Following loads and environmental impacts are to be considered in design of roof system, refer to Figure 10.

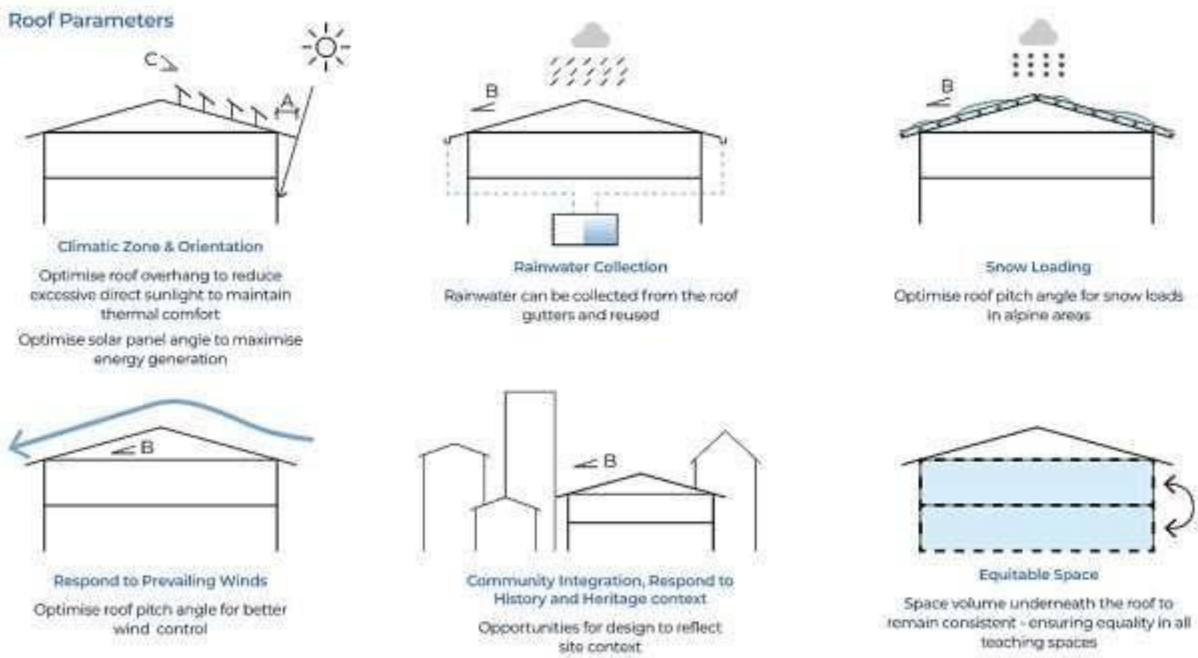


*Figure 10 – Roof design considerations (Extracted from SINSW DFMA Guideline)*

### 3.4.1. Roof Form Matrix

The design of the roof provides an opportunity to customise the design system (). The approach should take into account and be tailored to respond to:

- Community Integration
- Climate Zone and Orientation
- History and Heritage
- Opportunities for Water Collection
- Energy Generation
- Thermal Performance
- Visual Identity

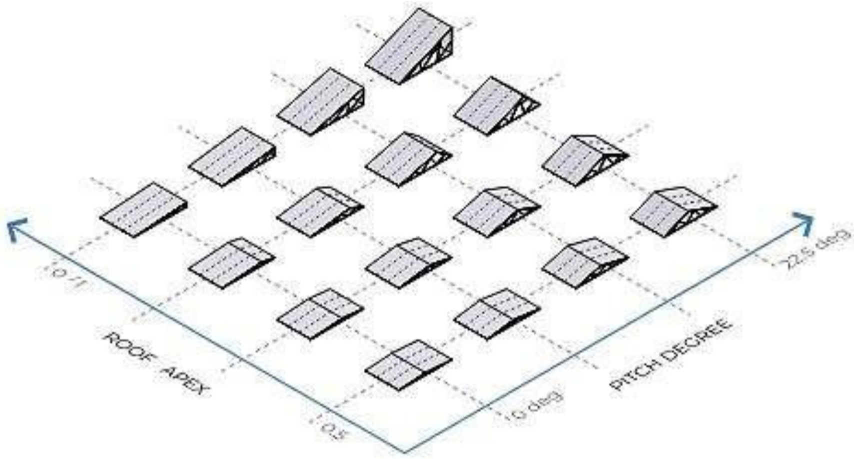


*Figure 11 - Roof pitch outline (Extracted from SINSW DFMA Guideline)*

### 3.4.2. Roof - Base Option

The base option of the roof comprises of three main components - Structure, Sheeting and PV Panels. The roof pitch angle is set at 4 degrees to comply with the current EFSG requirements, refer to Figure 12.

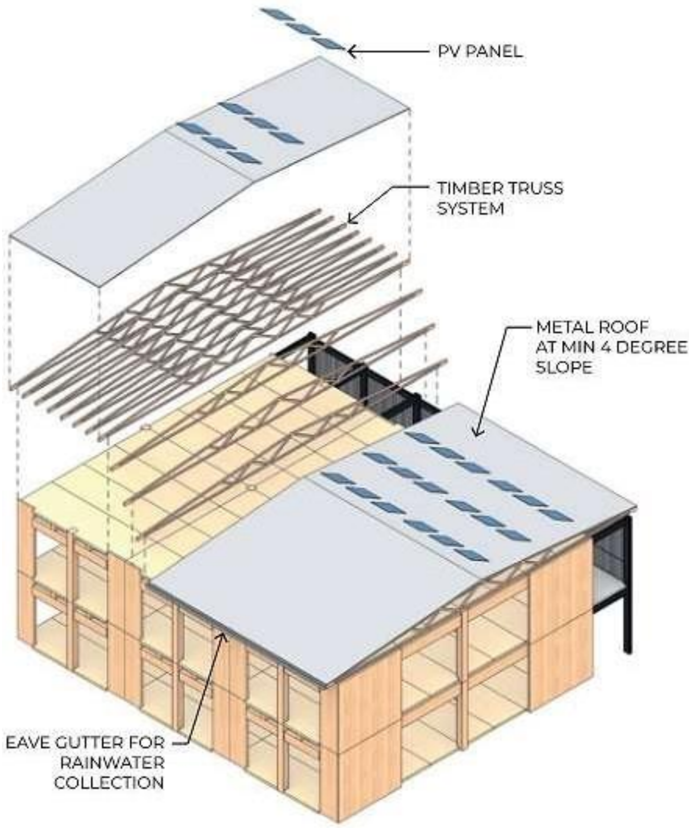


*Figure 12 - Roof main components (Extracted from SINSW DFMA Guideline)*

### 3.2.3. Lateral Bracing System

To provide lateral stability of DFMA units, lateral load bearing system similar to what is lateral bracing System shown in Figure 13 to be utilized. Bracing frame to extend from base to roof.

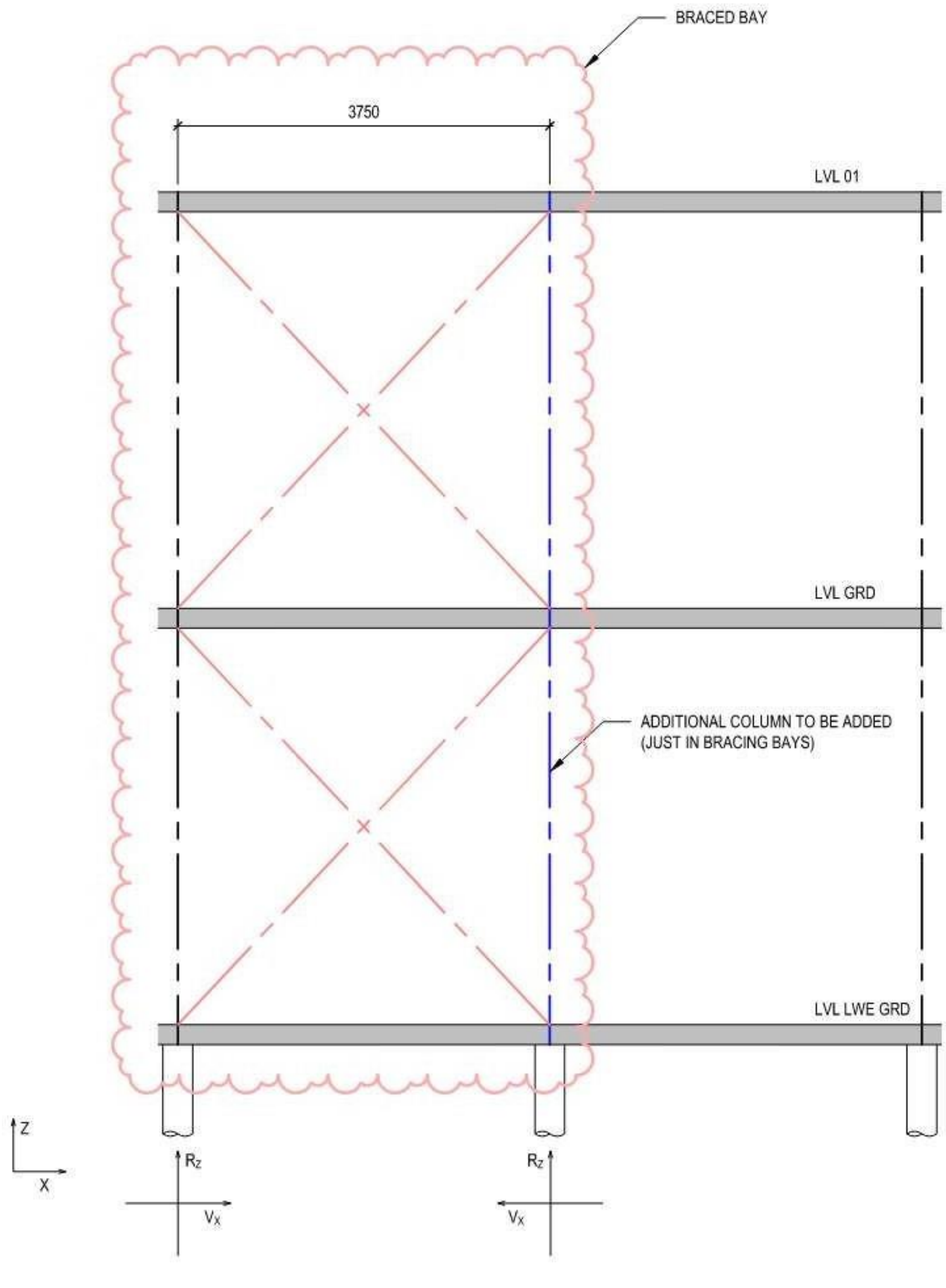


*Figure 13 – Lateral Bracing System*

# 4. Structural Design

## 4.1. Australian Standards and NCC

The following Australian Standards in combination with NCC 2019 are used in the structural design of this project.

AS/NZS 1170.0/2002 – Part 0: Structural design actions
AS/NZS 1170.1/2002 – Part 1: Permanent, imposed and other actions
AS/NZS 1170.2/2011 – Part 2: Wind actions
ASNZS 1170.3-2003 – Part 3: Structural design actions - Snow and ice actions
AS/NZS 1170.4/2007– Part 4: Earthquake loads
AS3600 – 2018: Concrete structures
AS4100 – 1998: Steel structures
AS1720- 2010: Timber Structures
AS3700 – 2018: Masonry Structures
AS2159 – 1995: Piling
AS/NZS4600 – 2001: Cold-formed steel structures
AS/NZS3828 – Guidelines for the erection of building steelwork

## 4.2. Site specific information and ground conditions

M+G Consulting assumes that external reports are professionally prepared by appropriately qualified sub- consultants and reviewed by the SINSW. M+G Consulting rely on the information provided in these external reports and will not be held responsible for any of the recommendations or advice contained within these reports.

*Geotechnical Report*

Geotechnical investigations are to be undertaken. No geotechnical report available to date – Outlined in previous section.

*Foundation Design and Concepts*

All the footings are to be founded on natural ground: the underlying sandstone laminate or hard clays.

*Site Retention/ Retaining Walls Including Temporary and Permanent Batters*

Minor retaining walls will be required for sub floor areas under modules.

*Groundwater Table*

No ground water has been identified during the investigation.

*Earthquake*

The earthquake design will be carried out in accordance with the Earthquake Design Code AS1170.4- 2007

*Wind Tunnel Testing*

None carried out by M+G Consulting. None will be required for this project as per wind code requirements.

*Snow Loadings*

Design for Snow loadings will be carried out in accordance with ASNZS 1170.3-2003 – Part 3: Structural design actions - Snow and ice actions

*Dilapidation Reports*

None carried out by M+G Consulting.

## 4.3. Design Loading Information

Loads and their appropriate load combinations will be in accordance with AS1170.0, AS1170.1, AS1170.2, AS1170.3 and AS1170.4. The applied loading is summarised in this section of this design brief.

This section is to be read in conjunction with the structural drawings, which will indicate the design loads of each floor on the concrete outline drawing. Note, masonry walls loads are excluded from these loading drawings and should be taken from the relevant architectural drawings.

*Self-Weight Loads (SW)*

Self-Weight loads shall be calculated as provided for in the current version of AS1170. Part 1: Permanent, imposed and other actions.
Material densities are taken from AS1170.1.

*Super Imposed Live and Dead Loads*

Live loads are taken from AS1170. Part 1: Permanent, imposed and other actions. The following table describes the more significant loading on the project, and further clarification of floor loads can be obtained by referring to the loading diagrams in the structural set of drawings.

Pattern Live loads shall be considered if applicable in accordance with Clause 2.4.4 of AS3600.
Live load reduction shall be applied to AS1170.1 if appropriate for vertical elements.

### 4.3.1. Facade Loading

Assumed to be lightweight fibre cement cladding and in some small areas of the roof are lightweight metal.

### 4.3.2. Building Wind Loads

To AS1170.2 for a Region A2 wind and a Terrain Category 3.

### 4.3.3. Construction Live Loads

5KPa allowance should be made for construction loading on concrete floors/pavements.

### 4.3.4. Snow Loads

In accordance with AS1170.3 considering that proposed sites are in sub-alpine regions.

### 4.3.5. Earthquake Loads

Importance Level 3

### 4.3.6. Robustness Loads

In accordance with the requirements of AS1170.0/2002 Amendment 3 the robustness load is taken as 1.5% of the gravity load ($G + \psi cQ$).

### 4.3.7. Blast and Impact Loading

It is noted that the design of the building and structure and boundary walls if any has not been designed for any vehicle impact loads (other than car-park barriers loads taken from AS1170.1), nor has the building or its structure been designed for any blast/explosion loadings or terrorist induced loading events.

## 4.4. Limit State Design Criteria for Structural Elements

### 4.4.1. General Design Approach

The limit state design for strength, serviceability and stability of the relevant structural elements within the building will generally follow the established criteria in the relevant material design codes AS4100 and AS3600 unless noted otherwise below.

### 4.4.2. Structural Movements

Building Sways (Deflection) subject to service wind loads shall satisfy; Total lateral deflection to not exceed height/500.

Inter-storey deflection to not exceed inter-storey/500 or 12mm, whichever is lesser.

Floor Deflections to AS3600 and AS4100, limited to span/250 total and span/500 incremental for flexible partitions, and span/500 total and span/1000 incremental for (non-flexible) rigid partition walls without regularly spaced movement joints. Deflections for transfer elements shall be limited to the lesser of Span/360 or 10mm max total deflection.

### 4.4.3. Fire Resistance

Fire rating to AS3600/AS3700/AS4100. Generally, the elements are to be designed for a FRL of; 120/120/120 by BCA Consultant.

### 4.4.4. Crack Control

Generally, all internal suspended slabs will be designed for a moderate degree of crack control, except for external roof slabs over living areas where a strong degree of crack control will be adopted. For Post tension slabs, this will result in a minimum post tension stress of 1.4MPa and 2.0MPa for moderate and strong degree of crack control, respectively. Refer to Section 4.8 for further minimum requirement to external slabs over living areas.

Pour strips or Temporary Movement Joints (TMJs) will be introduced where appropriate to minimise the long-term creep and shrinkage effect of the concrete and these will be co-ordinated with the builder construction programme.

### 4.4.5. Minimum Connection Requirements and Ties

All connections, including but not limited to beam/slabs to columns/wall, precast, etc, shall be designed to clause 6.2.3 AS1170.1 for the transfer of the lateral loads and robustness.

### 4.4.6. Durability

All connections, including but not limited to beam/slabs to columns/wall, precast, etc, shall be designed to clause 6.2.3 AS1170.1 for the transfer of the lateral loads and robustness.

### 4.4.7. Floor Vibrations

Floors shall be designed to ensure that there are only slight perceptible vibrations under footfall effects, or from other internal or external sources.
Floors shall be designed to ensure they comply with the recommended acceleration and velocity limits in the relevant standards. The R value method outlined in Annex A of AS2670.2 and Appendix A of BS6472 will be used. A dynamic assessment shall be undertaken in accordance with SCI p354 Design Guidelines or approved equivalent. The floor structures shall be designed to achieve a maximum "Multiplying Factor" R value as appropriate.

The following parameters shall be used for the analysis:

- Weight of 1 person 746N (76kg x 9.81)
- Dynamic Concrete Modulus – of 1.2 x Ec as provided in AS3600 is to be used

Floors are not designed for vibration emanating from plant equipment, ducting, fans etc. All vibrations from plant are to be isolated at the source with dampers and vibration isolation devices.

## 4.5. Structural Steel Design Criteria

Vertical Deflection Criteria
The design criteria for vertical deflections of structural steel rafters and beams are as follows;
Total Deflection (after pre-cambers)

| | |
|---|---|
| Self-Weight and Dead Load: | Span/300 or 20mm |
| Self-Weight, Dead Load and short-term Live Load: | Span/250 Incremental Deflection Short |
| Term Live Load or Wind Load: | Span/200 or 30mm |
| Ceiling Dead Load only: | Span/500 |

Incremental and Total Deflection criteria are based on AS1170.0:2002 Table C1 for Rippling, sagging and cracking limit requirements for hung ceilings

Incremental deflections to rafters and primary beams can be additional and consideration of suitable deflection heads to walls is required.

It is assumed that appropriate movement and expansion joints are installed into brittle ceiling finishes and fixtures to assist in controlling cracking from the roof deflections described above.

For Cantilever beams and rafters, the deflection limit at the ends of the cantilevers is based on the above limits but with the span being equivalent to twice the distance from the support to the end of the cantilever.

## 4.6. Construction Materials: Codes, Properties and Construction Practices

Concrete
The design, material properties and construction of all reinforced concrete elements shall comply with the provisions of AS3600 and any other relevant reference noted in this brief
For detailed information on the specification of concrete elements refer to the Concrete Specification.
In particular take note of the curing requirements within the specification to prevent shrinkage and drying shrinkage cracking.

Structural Steel
The design, material properties and construction of all structural steel elements shall comply with the provisions of AS4100 and any other relevant reference noted in this brief
For detailed information on the specification of concrete elements refer to the Structural Steel Specification.

## 4.7. Design Certification by Others

All the structural items are to be certified by relevant qualified designer.

### 4.7.1. Design and Certification of Waterproofing

All roofs, retaining walls, hydrostatic basement slabs, and balconies that require waterproofing will not be structurally designed to be watertight. It is not intended to rely on the inherent crack resistance of the reinforce/post-tensioned slabs and walls to resist water ingress. The crack control measures adopted for these concrete elements cannot be solely relied upon for water tightness. As such, the water tightness of the slab shall be achieved through the application of appropriate waterproofing membranes that are applied, designed, specified, and certified by another consultant.