ESD REPORT

Parramatta Leagues Club Hotel Development

ESD SERVICES

JHA

CONSULTING ENGINEERS

DOCUMENT CONTROL SHEET

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Executive Summary

The following Ecological Sustainable Design (ESD) report identifies and summarises the key ESD initiatives that will make up the overall approach for the sustainable design of Parramatta Leagues Club Hotel, located to the rear of Parramatta Leagues Club, 1 Eels Place, Parramatta NSW 2150. The development team is committed to maintaining a focus on sustainability throughout the phases of design, construction and operation/occupancy.

The Secretary's Environmental Assessment Requirements (SEARs) principals of ecological sustainable developments has been adopted to ensure the quality of the development and to reduce its overall environmental impact. The proposed development is benchmarking its environmental performance to equivalent to a 4 star Green Star standard.

This report is a holistic and dynamic document which suggests applicable sustainable design strategies to optimise energy efficiency and reduce energy consumption, operational costs and overall environmental impact, while providing a comfortable internal environment and optimising wellbeing, by which all stakeholders can review JHA's considerations and provide feedback for further discussion and review.

Summary of Recommendations

Building Envelope

- Building fabric will comply with the National Construction Code (NCC) 2019 performance requirements
- Glazing will comply with the NCC 2019 performance requirements
- Air infiltration will comply with the NCC 2019 performance requirements
- NCC Section JV3 Modelling should be conducted to optimise maximum walls-glazing requirements

Passive Solar Design

- East, North and West glazing should have acceptable shading to optimise passive solar design
- Passive solar heating and passive cooling should be optimised throughout the development

Natural Ventilation

- Single sided ventilation should be optimised in hotel bedrooms
- Passive Ventilation strategies should be optimised throughout the common areas in the development where possible
- Dynamic simulation should be conducted to determine if natural ventilation will provide adequate thermal comfort for occupants

Indoor Air Quality (IAQ)

- Natural ventilation should be optimised where possible to improve IAQ
- IAQ should be monitored and controlled by CO_2 and/or flow rate controls
- Internal living walls should be considered to optimise IAQ
- Dynamic Modelling should be considered to optimise IAQ

Mechanical

- Wider temperature set points should be considered
- Heat recovery should be optimised throughout HVAC systems
- Intelligent heating, ventilation and air-conditioning (HVAC) controls should be used throughout the HVAC design. Like occupancy, temperature, CO_2 and/or flow rate sensing (except for bedrooms).

Hydraulics

- Rainwater harvesting should be considered for back of house (BOH) services, Common amenities and drip irrigation
- Efficient water fittings should be used throughout the development.
- All pipes and fittings should be insulated to prevent energy loss.
- Water meters should be installed to monitor consumption.

Electrical

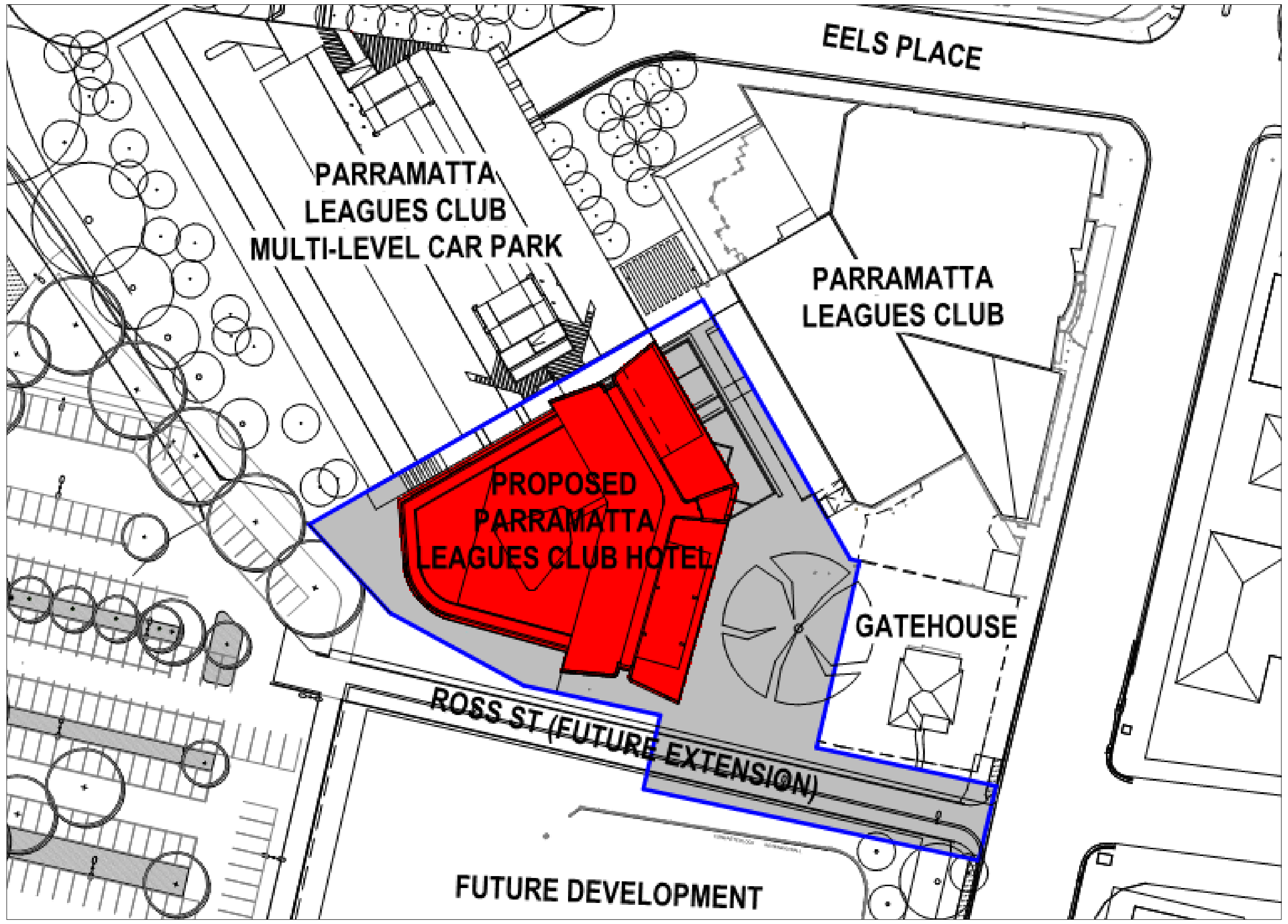
- Photovoltaic panels should be considered for this development.
- Building management system (BMS) and energy monitoring should be considered to improve HVAC, domestic hot water (DHW) and lighting operation, improve efficiency and reduce energy consumption.
- LED lighting should be used throughout, assisted by occupancy, daylight, time and zone controls.

1. Introduction

The proposed hotel development is located in Parramatta, NSW. The local council is City of Parramatta, and the development is within a private recreation development zone. Comprising of 15 levels (including basement) it will contain hotel accommodation, entertainment, dining, and leisure facilities.

Site Location

The site is located directly behind, to the southwest of the existing Parramatta Leagues Club building (1 Eels Pl, Parramatta NSW 2150).



1.1 Principals of Ecologically Sustainable Development

The principles of Ecologically Sustainable Development as defined in clause 7(4) of Schedule 2 of the Environmental Planning and Assessment Regulation 2000 has been incorporated into the design and on-going operation phases of the development as follows:

The Precautionary Principle

Namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:

I. *Careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and;*
II. *An assessment of the risk-weighted consequences of various options.*

☑ This development includes a wide range of ESD strategies that apply to the design, construction and operational stages. The design team will ensure that the building minimises the impact on the environment in the areas of energy, water and materials. A strong focus on passive design, building fabric, Health & Wellbeing, electrical and mechanical systems significantly contributes towards minimising climate change impacts.

Inter-Generational Equity

Namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

☑ This development will not cause any significant impact on the health, diversity and productivity of the environment. The project will contribute to a lively community environment and add architectural interest to the surrounding area.

Conservation of Biological Diversity and Ecological Integrity

Namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration.

☑ This development is proposed on a brown field site (existing car park) adjacent to the Parramatta Leagues Club, Parramatta parkland, a main road, in an urban environment in a western suburb of Sydney. Conservation of the biodiversity and ecological integrity of the surrounding Parramatta parkland where the grey-headed flying fox colony can be found will be a high priority throughout the planning design, construction and operation of the development. Living green walls located on hotel room balconies will help improve the biological and ecological impacts of the development.

Improved Valuation, Pricing and Incentive Mechanisms

Namely, that environmental factor should be included in the valuation of assets and services, such as:

I. *Polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,*
II. *The users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,*
III. *Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.*

☑ The proposed development is benchmarking its environmental performance to equivalent to a 4 star Green Star standard. The development design that will achieve these rating will reduce pollutants and increase sustainability by optimising building fabric, HVAC system and lighting design.

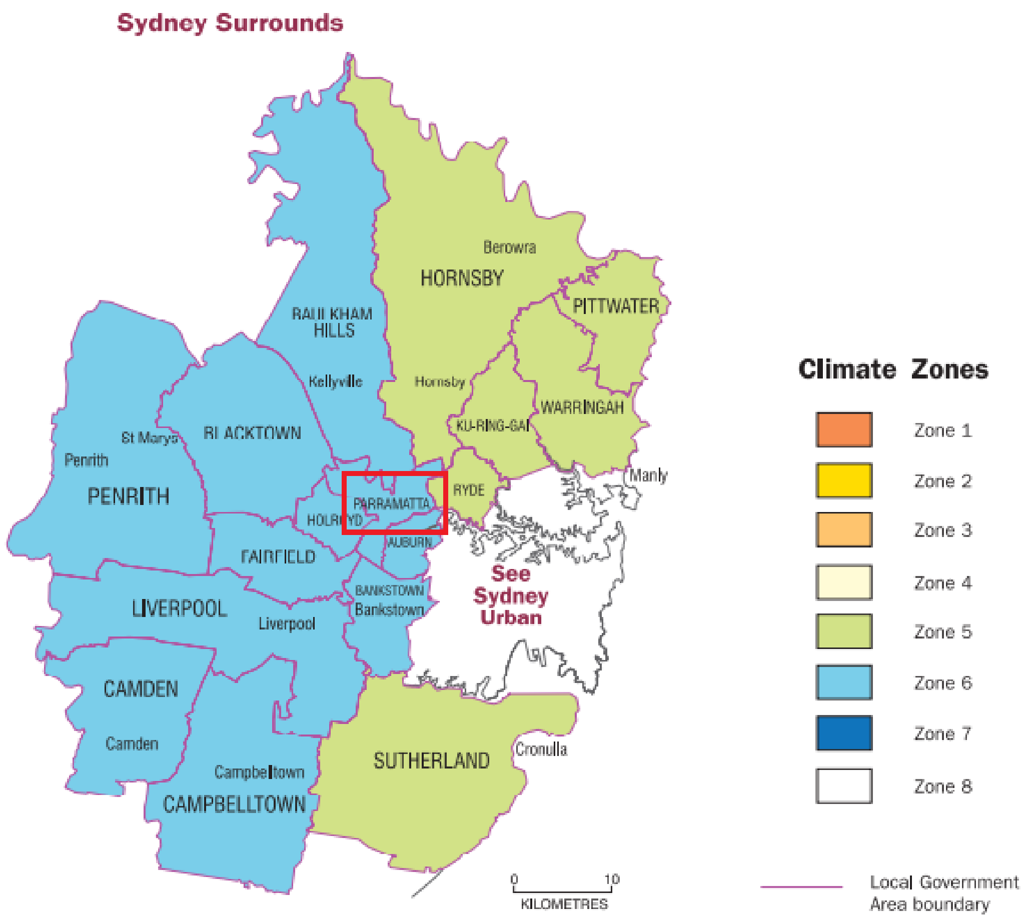
1.2 Site Analysis

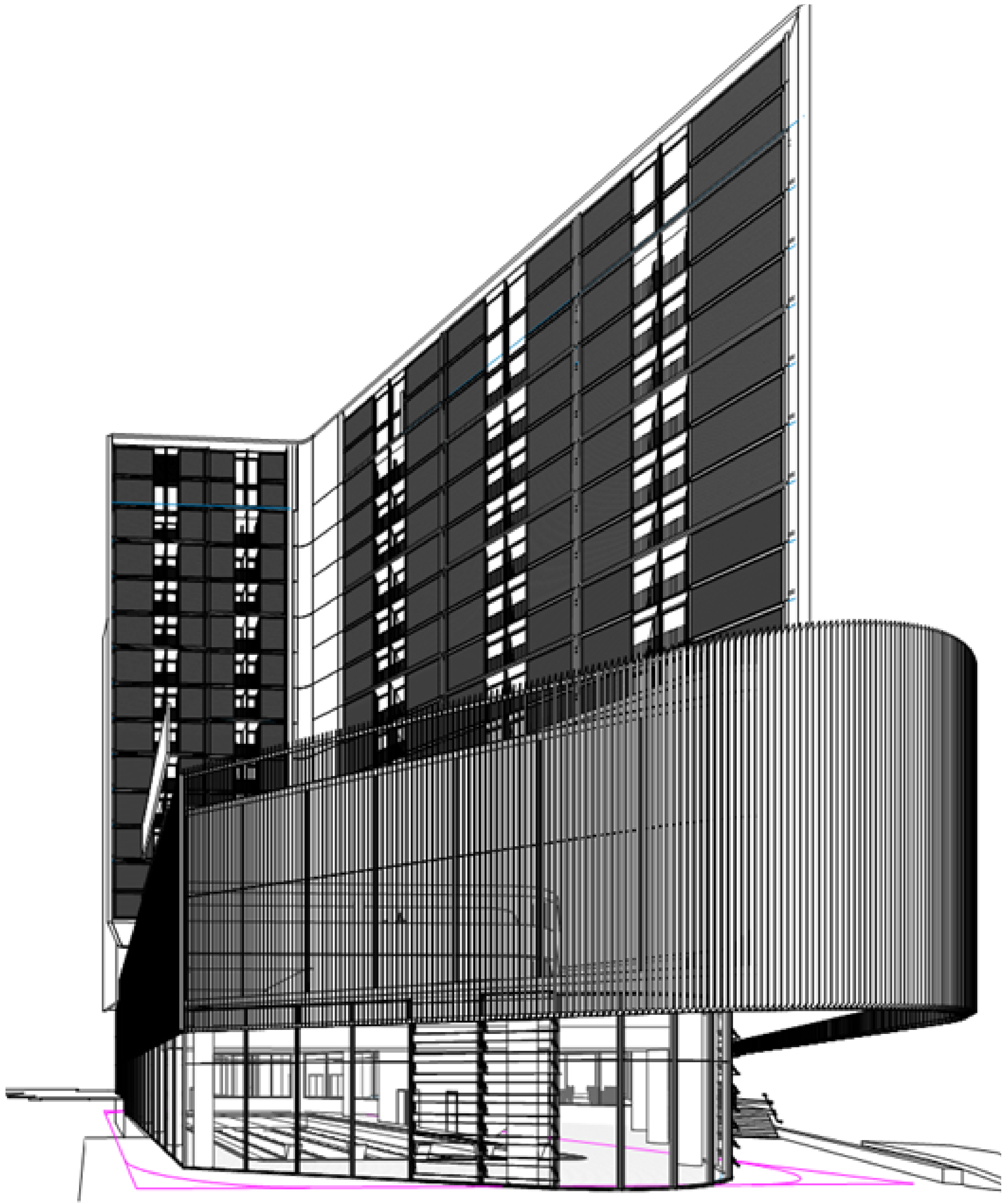
Parramatta is located within BCA Climate Zone 6 (highlighted in red below). Key characteristics include high diurnal (day/night) temperature range, it has four distinct seasons (summer and winter can exceed human comfort range, spring and autumn are ideal for human comfort), mild to cool winters with low humidity, hot to very hot summers, moderate humidity.

Key Design Considerations

Based on the climate of the site, the following techniques should be considered to address thermal comfort:

- Use insulated thermal mass.
- Use high insulation levels.
- Maximise solar access in winter.
- Focus attention on shading performance east and west glazing.
- Consider double glazing in areas with higher heating needs.
- Consider passive solar heating.
- Consider cross ventilation to achieve cooling comfort.
- Use convective ventilation and circulation.
- Use airlock entries to minimise infiltration.





**3D Images of the proposed development, showing openable louvres in swimming pool hall and vertical shading on level 2-3*

2. General ESD Strategies

Ecologically Sustainable Development is a development designed to meet the needs of people today, while conserving the environment for the future benefit of generations to come. This is achieved by developing an energy efficient building that will consume less energy, will have lower running costs and a more healthy / comfortable operating environment than its predecessors.

The main techniques of minimising energy consumption include passive design, appropriate zoning, efficient lighting design and control, efficient mechanical and electrical equipment, energy monitoring and minimising the embodied energy of materials used in constructing the development.

One of the main ways of looking at a buildings impact on the environment is to look at it life cycle including the design, construction, refurbishment and demolition. Life Cycle Assessment is the factual analysis of the buildings whole life impacts in terms of sustainability. LCA uses referenced figures to evaluate the environmental impacts of the building (energy use, emissions, and materials).

2.1 Building Envelope

The building envelope is a fundamental component of the building, protecting its occupants from external conditions and playing a major role in regulating the indoor environment conditions. Optimising the building envelope design can provide a significant reduction in space conditioning loads (heating, cooling and ventilation), consequently reducing energy consumption and operation cost. Thermal modelling should be conducted to determine the optimal building fabric performance.

When the right strategies are integrated through good design, the additional cost for constructing high-performance building fabric can be paid back through savings by installing smaller HVAC equipment and operational cost savings.

2.1.1 Air Infiltration

Minimising air infiltration is a cost effective way of reducing building heating and cooling loads, improve thermal comfort and create a healthier internal environment. An air permeability test can be carried out to determine infiltration rates and help optimise HVAC systems.
NCC 2019 (Draft) has introduced a maximum air-permeability requirement of 5 $m^3/hr.m^2$ at 50 Pa.

2.1.2 Building Fabric

The design team has agreed to meet the performance requirements set in the proposed Draft BCA NCC 2019 Volume One – Section J. It states improved building fabric performance details over the current NCC 2016.

The BCA have specific performance requirements for building fabric based on climate zones, the proposed hotel development is located in climate zone 6.

The current regulatory requirements are set out in BCA NCC 2016 Volume One - Section J. The table below compare NCC 2016 and the draft NCC 2019.

Minimum Building Fabric Performance NCC Volume One (Total R-Value) [1]		
Building Element	NCC 2016 (m^2K/W)	Draft NCC 2019 (m^2K/W)
Roof and Ceilings	R3.2	R3.2
External Envelope Walls	R2.8	R2.8 / R1.4
Internal Walls	R1.8	-
Ground Contact/Exposed Floors	R2.0	R2.0
Glazing	*see Glazing	*see Glazing

[1] Note indicative only as the final version of NCC 2019 has not been released.

2.1.3 Glazing

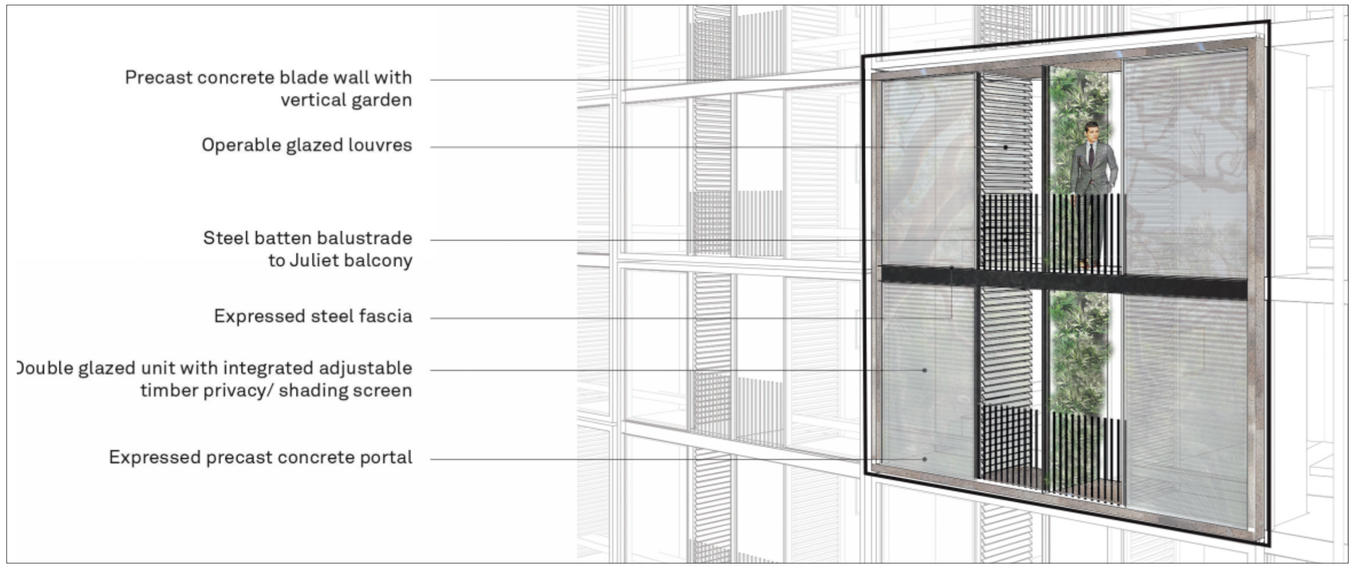
The design team has agreed to satisfy the minimum BCA requirements for glazing set out in the draft NCC 2019. The current BCA requirements are set in NCC 2016 Section J – Part 2 Glazing. The requirements vary according to;

- The location of the development;
- The orientation of glazing;
- The proportion of glazed façade; and
- The amount of shading provided.

Glazing is a major source of unwanted heat gain in the summer and can cause significant heat loss in the winter. High performance glazing can dramatically reduce energy cost and improve thermal comfort.
The BCA requires individual glazing calculations to be conducted on each story, unless two or more stories are identical. The DTS performance requirements produced can be unrealistic and it is advised to perform JV3 energy modelling (NCC 2016, Section J) to determine more realistic window performance details.

The draft NCC 2019 set a higher and more stringent glazing performance. The table below compares the BCA glazing requirements for NCC 2016 and the draft NCC 2019. A typical hotel room on the North, South, Northeast and Southwest façade were calculated. The results are DTS only and are to be optimised with JV3 modelling.
Glazing details and measurements were determined from the following drawings provided by HASSELL Architects.

- SK_180981-01-Façade Materiality (see image below)
- DA_1106 GA Floor Plan – Hotel – Level 4
- DA_3002 GA Section 3 – Podium & Hotel Tower B



Typical Hotel Room						
Façade	Glazing		NCC 2016 (Glazing)		Draft NCC 2019 (Wall-Glazing)	
	Orientation	Area (m^2)	U-Value	SHGC	U-Value	SHGC
North	North	9.18	8.0	0.19	1.48	0.11
	West	2.97	1.0	0.22	1.18	0.07
South	South	9.18	3.4	0.70	1.48	0.11
	West	2.97	1.0	0.22	1.19	0.07
Northeast	Northeast	9.18	8.0	0.20	1.19	0.07
	Northwest	2.97	1.1	0.13	1.48	0.11
Southwest	Southwest	9.18	2.8	0.80	1.48	0.11
	Northwest	2.97	1.1	0.13	1.19	0.07

2.1.4 Green Walls

As urban development strives in cities and green areas are reduced, the urban environment has caused the urban heat island effect. Research has found that metropolitan areas are considerable warmer than that of rural areas. This increase in temperature causes a negative impact on the environment through the increasing energy demands in summer to air pollutants and emissions.

Living green walls reduce this problem by providing shade from the effects of direct sunlight. Also, unlike brick or concrete that store solar energy, plant surfaces reflect it. Exterior walls help to actively cool the air in summer by a process called evapotranspiration, reducing the need to cool the building.
In winter the green areas insulate the building and reduce space heating consumption and operational costs.

Living green walls can turn spaces back into something of natural beauty. They can link indoor spaces to the external landscape and help camouflage buildings for from the external landscape. They can improve the developments value and marketability, especially in urban areas where access to green spaces is not as common.

2.2 Green Roofs

Although installation of a green roof usually involves higher upfront costs than a traditional roof, there are many economic benefits that can make up for this. The increased R-value and the reduced surface temperature of the roof can decrease HVAC loads, in turn reducing energy consumption. A green roof may improve the developments value and marketability, especially in urban areas where little green space is available.

A green roof can help control *storm water runoff and retention*. They can help prevent this by retaining water in the plants and growing medium, thus slowing and reducing the amount of storm water and pollutants entering the ecosystem and, consequently reducing flooding and erosion. Studies have shown that green roofs can capture up to 80% of rainfall during rainstorms, compared to 24% typical for standard roofs.

The temperature in urban areas is often higher than that of rural areas, known as the *urban heat island effect*. Large amounts heavy construction materials (concrete, asphalt etc.) absorb solar radiation and re-radiate it has heat, increasing the local air temperature and in turn surrounding building energy loads. Green roofs help reduce the urban heat island effect by covering these heavy building materials with vegetation that absorbs less heat. They also use solar radiation to evaporate water from the plants which transpire moisture; this process of vaporisation lowers the roof temperature by using heat from the air to evaporate water.

The reduction in cooling loads also helps reduce *greenhouse gas emissions* from fossil fuel combustion associated with the use of HVAC equipment. Adding plants and trees to the urban landscape in turn increases photosynthesis, reducing carbon dioxide levels produced by vehicles, industrial facilities, and mechanical systems. It also increases oxygen production.

Green roof can provide a *habitat* at roof level, especially in urban areas and can have significant benefits for flora, fauna and wildlife, notably invertebrates and birds. Adding nesting boxes and logs to a roof can also increase its *biodiversity*.

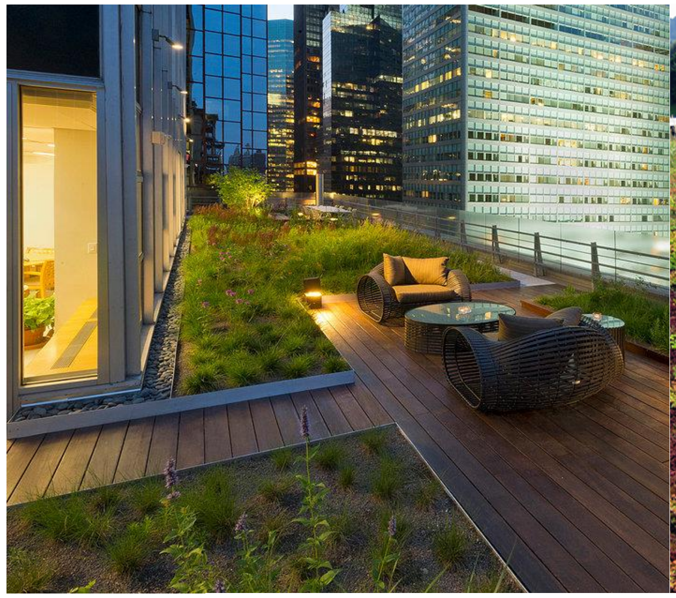
Modern green roofs can be categorized as 'intensive' or 'extensive' systems depending on the plant material and planned usage for the roof area.

Intensive Green Roofs

Intensive green roofs utilize a wide variety of plant species that may include trees and shrubs, require deeper substrate layers (usually >15cm) are generally limited to flat roofs, require 'intense' maintenance, and are often park-like areas accessible to the general public.

Extensive Green Roofs

In contrast, extensive roofs are limited to herbs, grasses, mosses, and drought tolerant succulents such as Sedum, can be sustained in a shallow substrate layer (<10cm), require minimal maintenance, and are generally not accessible to the public. What can be grown depends on such factors as climate, microclimate, substrate depth and composition, and whether supplemental irrigation is available.



Intensive Green Roof

Extensive Green Roof

2.2.1 Recommendations

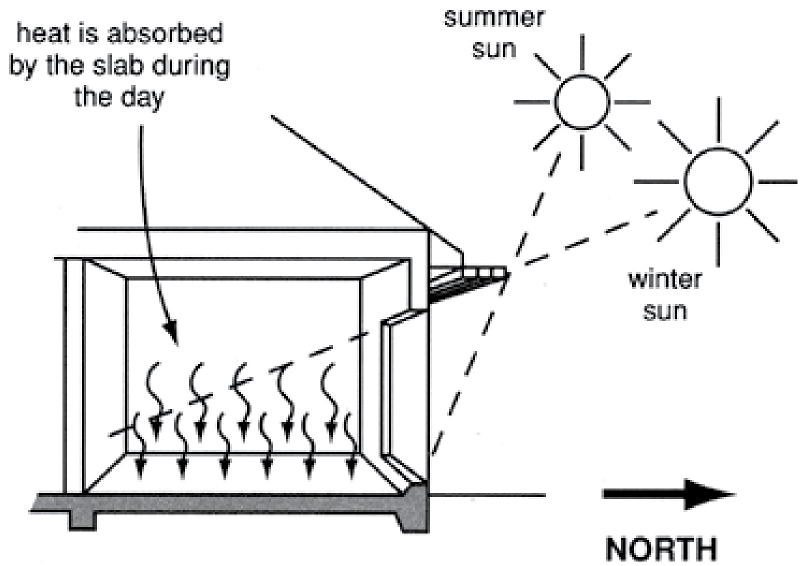
☑ Building fabric will comply with the minimum NCC 2019 performance requirements.
☑ Glazing will comply with the minimum NCC 2019 performance requirements.
☑ Air infiltration will comply with the minimum NCC 2019 performance requirements.
☑ JV3 Modelling should be conducted to optimise maximum walls-glazing requirements.
☑ Green walls should be considered throughout the development.
☑ Green roof should be considered for

2.3 Passive Solar Design

Natural daylight can enhance indoor environmental quality and reduce lighting energy consumption. However, if inappropriately designed, it can increase HVAC energy demand and can even cause thermal discomfort. The following strategies should be used to optimise natural daylight.

2.3.1 Passive Solar Heating

Passive solar heating aims to prevent solar heat gain in the summer and harvest it in the winter, helping spaces retain their heat in the winter and allow it to escape in the summer. To effectively maintain internal comfort conditions, occupants must open/close windows and isolate zones or mechanical controls and set points can be used. Shading devices are used to prevent the higher summer sun from penetrating the building as detailed below in the diagram.



Common areas may have the potential to maintain adequate comfort levels via passive means only. Hotel rooms may use passive methods to assist the mechanical HVAC equipment. Hotel residents cannot be expected to manually maintain comfort conditions in their rooms.

2.3.2 Passive Cooling

Passive cooling is a design approach focused on controlling heat gain and improving heat dissipation, in doing so it improves the indoor thermal comfort and effectively reduces energy consumption and operational costs. It is achieved by either preventing heat from entering the building or removing it. Passive cooling works by optimising shading to block solar heat gain during the summer months, using thermally massive materials like concrete that can absorb heat during the day and release it at night and using air movement inside the building to keep occupants cool.

Shading devices can dramatically reduce the energy required for space heating and cooling. In summer shading devices help prevent excessive solar heat gain that may result in high cooling loads. East, North and West facing windows can positively contribute to passive solar heating in winter, reducing the buildings heating load.

The design of shading devices depends on façade orientation. North facing facades can be effectively shaded with simple overhangs, simply because the sun is at its highest point in the sky. East and West

facades are more difficult to provide shading due to the low azimuth of the sun in the morning and afternoon, vertical shading devices are more effective here.
The following methods can be used to prevent overheating;

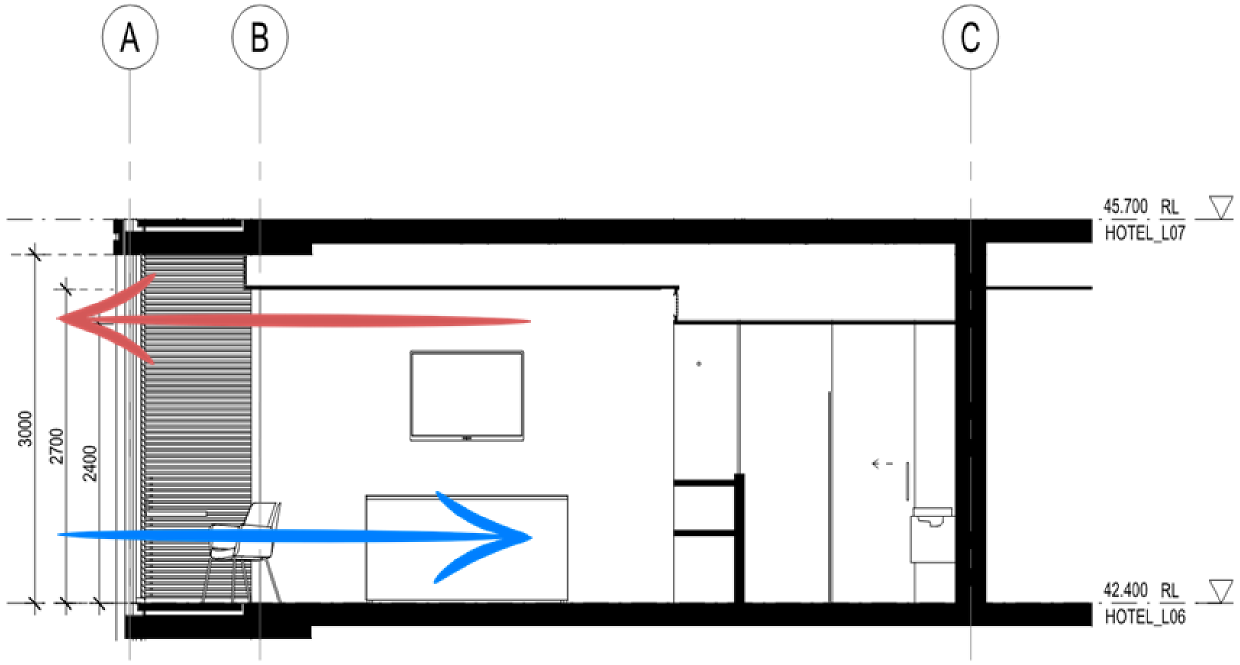
- Shading devices: external shading effectively reduces solar heat gain. Shading devices should be installed on both transparent and opaque surfaces of the building envelope to reduce solar radiation.
- Building fabric: constructing the building envelope with materials containing very good resistance will reduce the amount of heat transferred through the building fabric.
- Internal heat gain: efficient lighting and appliance should be used to minimise internal heat gains.
- Air movement: providing air change to a space is necessary to expel hot humid air out of the building. Air movement increases the evaporation of moisture on peoples skin, improving there comfort conditions.

2.3.3 Recommendations

☑ East, North and West glazing should be shaded acceptable to optimise passive solar design.
☑ Passive solar heating and passive cooling should be optimised throughout the development.

2.4 Natural Ventilation

Natural ventilation is the process of supplying external air to a building or space and removing it without any form on mechanical assistance. Natural ventilation reduces the need or can assist mechanical equipment which can reduce energy consumption and operational cost.
The typical hotel room design will benefit from single sided ventilation. The openable louvered glazing system has an optimal design for single sided ventilation through its high and low level openings, allowing cool fresh air to entre at low level and warm air to escape at high level. The mechanical systems installed should be fitted with optimization controls to allow the system to turn off when the louvers are open. The image below shows a section of a typical hotel room layout.

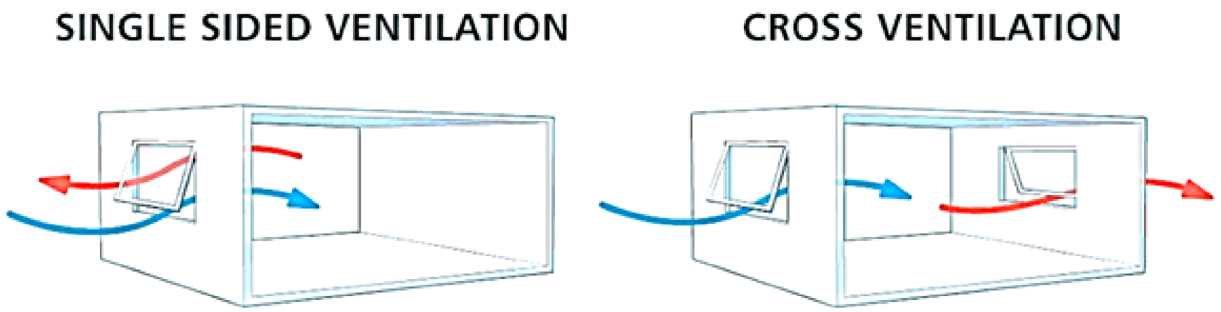


2.4.1 Single Sided Ventilation

Single sided ventilation is only possible when there is an opening on one side of a room. The room will be ventilated as cool air enters the building as the warmer air is exhausted through the same opening. A general rule of thumb for single sided ventilation is that the room depth should not be greater than two times the height of the room.
Single sided ventilation can be improved by adding a double opening (high and low level). This improves air movement and is considerably more efficient.

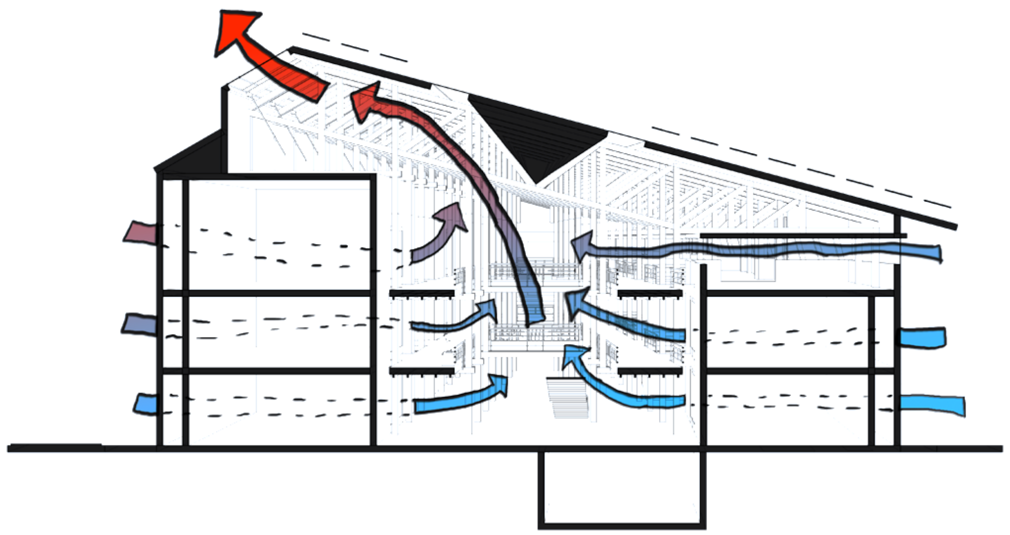
2.4.2 Cross Ventilation

When windows are located on both sides of a room/building cross ventilation is possible. Wind is used as negative pressure on the sheltered side of the building, air will enter the building to equalise the pressure and will be exhausted out the sheltered side.
In the proposed hotel development, cross ventilation could be suitable for common areas, for example circulation/corridor areas, fitness and entertainment areas.



2.4.3 Stack Ventilation

Stack ventilation is the most effective form of natural ventilation. It uses cross ventilation, rising warm air and the difference in air pressure to effectively create a small vacuum, pull eternal air in at low level and exhaust at high level. The diagram below represents air movement through a building using stack ventilation.



2.4.4 Noise Issues

The proposed development is located behind the Parramatta Leagues Club and just off O'Connell St. Noise pollution could potentially be a problem in this area. Acoustic tests should be carried out if natural ventilation is to be the main form of ventilation.

2.4.5 Recommendations

☑ Passive Ventilation strategies should be optimised throughout the common areas in the development.
☑ Single sided ventilation should be optimised in hotel bed rooms.
☑ Dynamic simulation should be conducted to determine if natural ventilation will provide adequate thermal comfort for occupants.

3. Indoor Air Quality

Ventilation and air infiltration are some of the most effective means of achieving good air quality when external air quality is sufficient. If external air quality is poor mechanical ventilation will be required. Pollutants generated indoors such as Volatile Organic Compounds or VOCs, combustion by-products and airborne particles are known to cause nausea, asthma and allergies. Indoor activities like cooking, cleaning and occupant respiration can worsen indoor air quality. Adequate ventilation flow rates should be used to satisfy such areas.

Indoor air quality is often degraded by VOC's emitted from paints, finishes and furniture. Levels of VOC can be five times greater indoors than outdoors. Internal building finishes should be carefully selected to allow spaces to have low or no VOC. The following materials should have low to no VOC.

- Adhesives
- Sealants
- Paints
- Coatings
- Flooring
- Furniture

To assist IAQ air infiltration should be minimised. Excessive infiltration can encourage mould growth and reduce energy efficiency. Ventilation controls like flow rate, CO2 monitor and Humidity control should be installed to provide the optimum IAQ. Dynamic modelling can be conducted to optimise IAQ.

3.1 Internal Green Walls

As well as the visual benefits of living green walls they are natural air-filters, creating a cleaner internal environment and improving the wellbeing of its occupants. As people are exposed to internal toxins in buildings like formaldehyde, carbon monoxide and VOCs Living green walls metabolise these toxins while releasing oxygen into the space.

Like exterior green walls, they actively cool air through the process known as evapotranspiration. Sequentially this will help reduce energy and carbon consumption, overall the environmental impact of building.

Another benefit of internal green walls is the reduction of noise levels. They add and an extra layer of insulation between the plants and wall surface that help reflect, retract and absorb acoustic energy. The reception area may benefit from living green walls as it will have high levels of movement.

3.2 Recommendations

☑ Natural ventilation should be the optimised where possible to improve IAQ.
☑ IAQ should be monitored and controlled by CO2 and/or flow rate controls.
☑ Internal living green walls should be considered to help filter air and reduce energy consumption.
☑ Dynamic modelling should be considered to optimise IAQ.

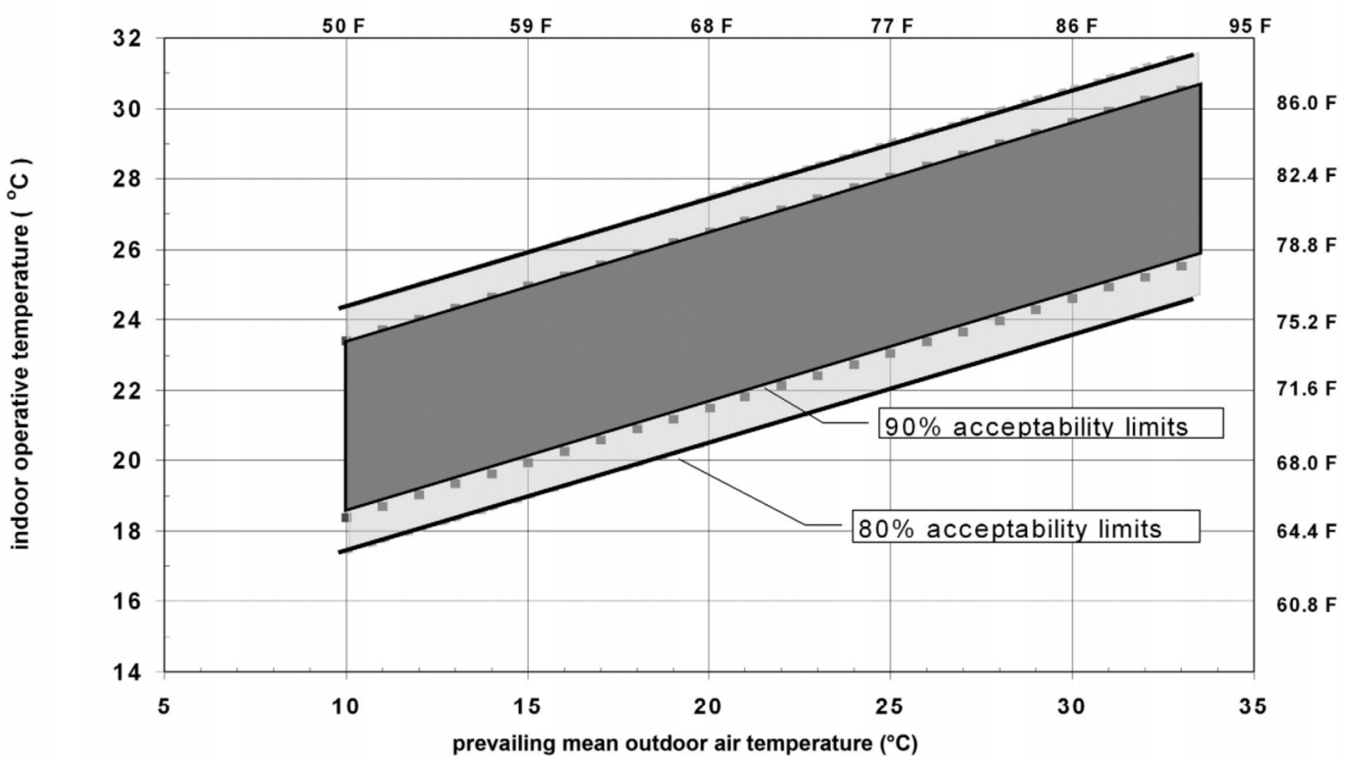
4. Mechanical ESD Strategies

The mechanical systems detailed in this section are only a suggestion. When the mechanical systems are determined, further comment from the ESD team will be necessary.

4.1 Temperature Set Points

In addition to the air temperature of a space, thermal comfort is also affected by other factors including metabolic rate, clothing level, relative humidity, air movement and draft, radiant temperature asymmetry, floor surface temperature and vertical air temperature difference. By controlling these factors, one could potentially relax the (air or water) temperature set points without reducing thermal comfort. As a rule of thumb, widening air temperature set points range by 1 degree Celsius will reduce the amount of energy consumed by the HVAC system by up to 10%.

Allowing internal temperatures to increase when it is warmer outside, in conjunction with increasing dead bands on control strategies, can allow significant reduction in energy associated with the air conditioning system.



Adaptive comfort – when the comfortable indoor temperature range varies according to outdoor air temperature.
Known as adaptive comfort, it has been shown that people relate to their environment relative to their previous environmental conditions. Fundamentally, this means that people entering the facility when the outside conditions are warm, can be comfortable in an internal environment with higher temperature set point. Clothing levels of patrons contribute to this also.

4.2 Space Conditioning

The space conditioning system should be of high efficiency and use energy recovery where possible. Control measure should be taken to optimise efficiency, passive heating and cooling. Overall reducing energy consumption and operation costs. BMS and energy monitoring system should be installed.

4.2.1 Option 1: VRF – HR

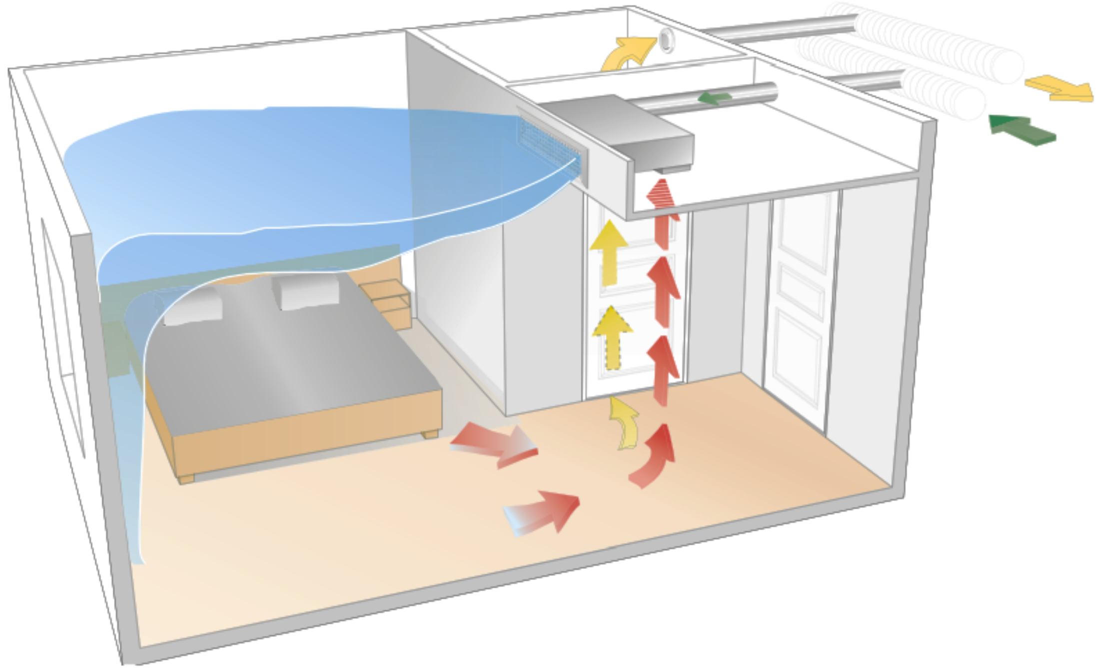
Variable refrigerant flow systems with heat recovery (VRF-HR) can simultaneously provide heating and cooling. The mixed mode operation generates energy saving as both ends of the thermodynamic cycle are delivering heat recovery. VRF-HR can provide an operating COP as high as 7. However, the perfect balance between heating and cooling is only likely to occur for a small proportion of hours during the year. Heat recovered from spaces being cooled can be used in for space heating, domestic hot water, leisure applications.

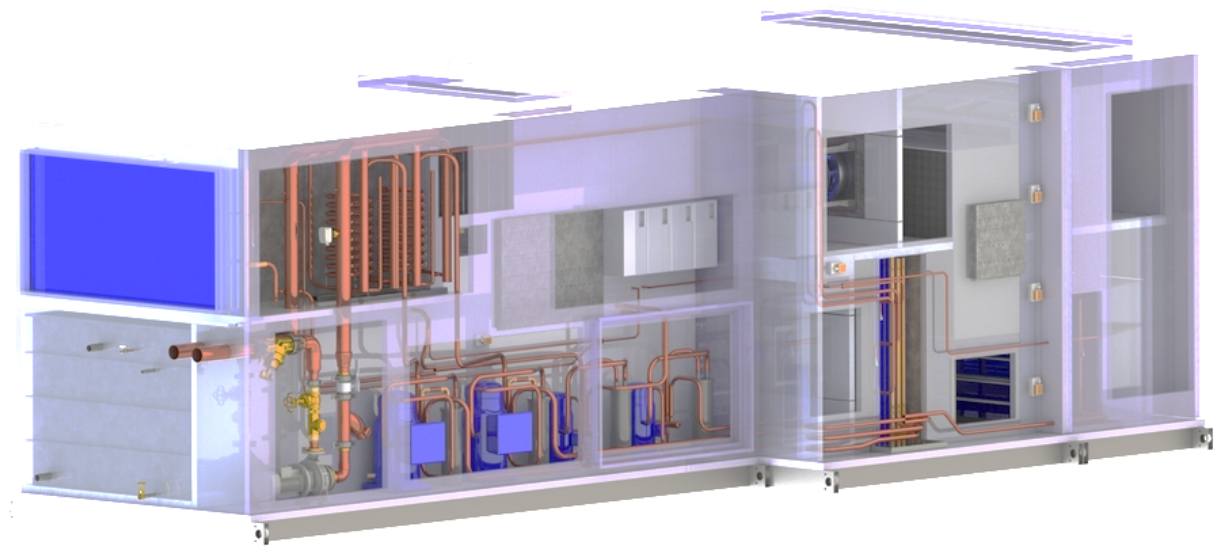
4.2.2 Option 2: Single system heating, cooling and ventilation

Swegon offer single system hotel solutions for heating cooling and **v**entilation. The system includes a multifunction unit for simultaneous and independent cooling and heating, an air-handling unit AHU and an indoor comfort module for demand control ventilation with cooling and heating for hotel guest rooms.
The central multifunction unit supplies the entire property with cold water and hot water. While an AHU provides the system with supply air and extract air. The unit is includes a cooler for cooling and dehumidification, and a heater for reheating the supply air. The supply and extract air flow is constantly controlled to perform and the lowest possible air flow and pressure. The indoor comfort module is located in the ceiling of the entrance to each guest room. It has the ability to recirculate room air to improve efficiency and it has window contact function that stops heating and cooling if a window is open. Room temperature and air flow can be controlled by:

- Room thermostats
- Key cards
- Reception
- BMS
- Local room control unit

The image following image represents a typical hotel room with the Swegon system.



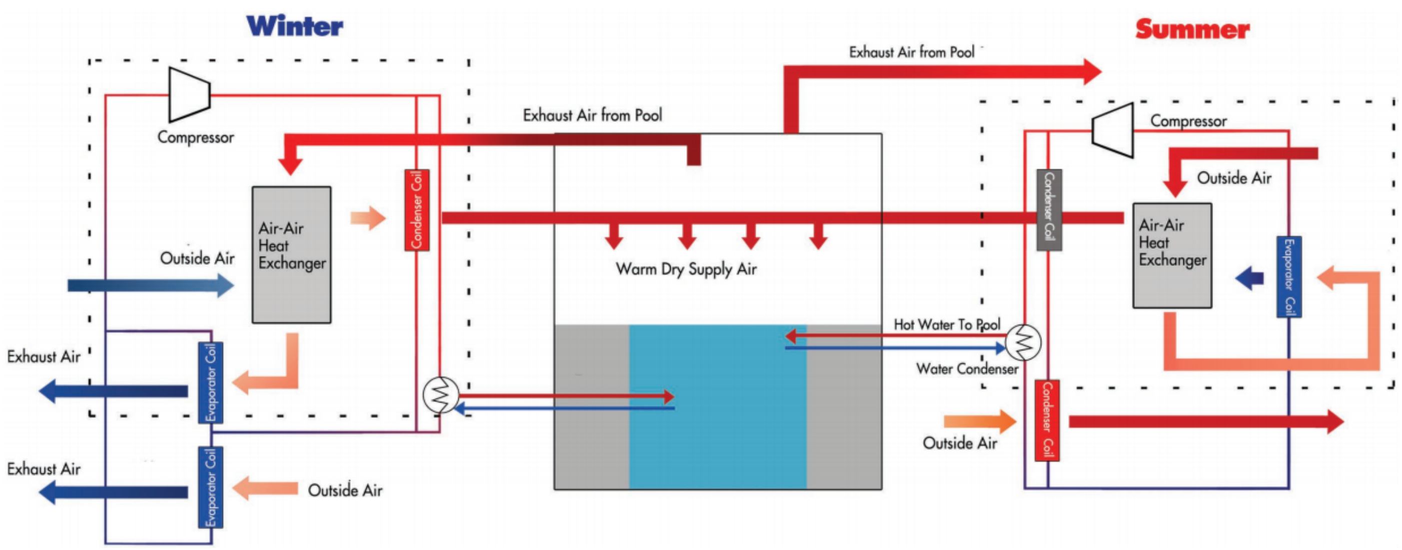


4.2.3 Indoor Swimming Pool Hall Conditioning

Air Change Group have developed a direct expansion heat pump system designed to control pool hall air temperature and humidity while simultaneously providing heat to maintain pool water temperature, called PoolPac Plus. The system has been designed to improve pool hall environments, reduce energy consumption and operational costs.

In winter, the heat exchanger preheats cold outdoor air using the hot moist air being expelled from the building reducing the air heating load. The heat pump refrigeration recycles the remaining exhaust air to raise the supply air to its desired temperature to maintain water temperature.

In summer, humid outdoor air must be lowered before entering the building to prevent adding to the humidity caused by pool water evaporation. In this cycle, all heat required for the air and water heating is derived from the dehumidification of outdoor air, using the heat exchange to precool and reheat the air for effective energy efficiency.



4.3 Ventilation

Ventilation system should include heat recovery. Passive ventilation strategies should be used to assist mechanical ventilation to reduce energy consumption and lower operational costs.

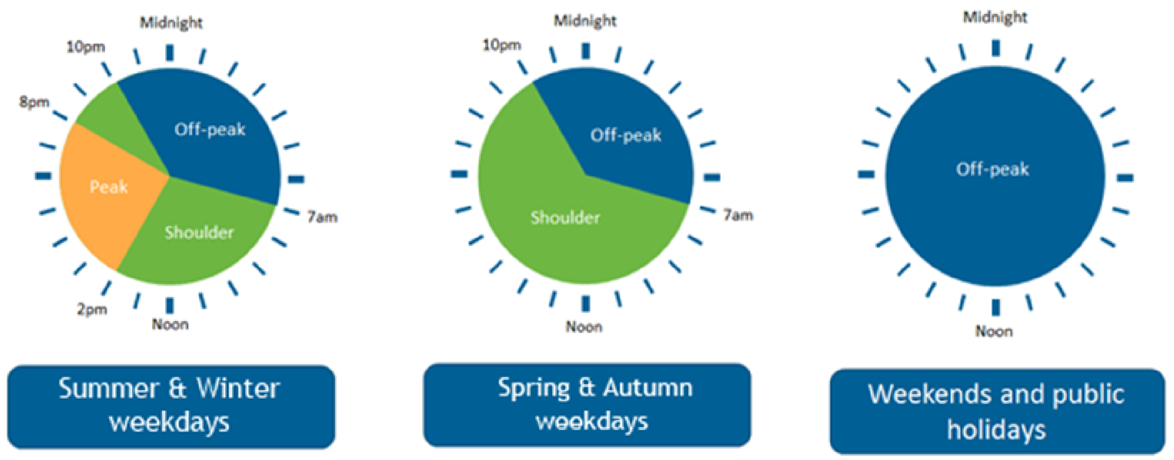
4.4 Tri-generation

A in depth analysis of a possible tri-generation system was conducted. The final conclusion was that based on the transient nature of Hotel occupants and the energy controls required by the Building Code of Australia that the embodied energy alone would take many years to recover. Several factors were considered and the main deciding factors were;

- A VRV system better manages the total demand as it will not require a thermal circulation loop and can readily step down to support for example a 30% occupancy rate. Equally anticipating and statistically a high degree of rooms unoccupied during the day the VRV system prevent any wasted energy by effectively being shut down. The tri-generation system would require a wet pipe system of Hot & Cold loops constantly retained at temperature regardless of the varying demand. Hence wasted energy would be continually consumed but not utilised.

- Acoustic and EPA requirements for treatment of noise and Nitrogen Oxides from the burnt fuel emissions also raised concerns in relation to proximity to the Grey-headed Flying Fox colony.

- Financially with NSW having Off Peak energy periods of 10pm to 7am weekdays and weekends at Off Peak tariffs the Gas consumption and Maintenance costs exceed any saving and with variances in occupancy unlike a Hospital waste energy could represent up to 40% of energy produced.



4.5 Recommendations

- ☑ Wider temperature set points should be considered.
- ☑ Heat recovery should be optimised throughout HVAC systems.
- ☑ Intelligent HVAC controls should be used throughout the HVAC design. Like occupancy, temperature, CO_2 and/or flow rate sensing (except for bedrooms).

5. Hydraulics

5.1 Solar Thermal

Solar thermal is a form of renewable energy that harnesses solar energy from the sun to generate thermal energy. The thermal energy produced can be used for space heating, domestic hot water or pool heating.

5.2 Rainwater Harvesting

Rainwater harvesting involves the collection, storage and distribution of rainwater from the roof, for use inside and outside of a development. It can help reduce water consumption and store and improve sustainability. Collected rainwater can be used for irrigation, toilet flushing, back of house services, pool top-up.

The developments roof space has potential to provide adequate rainwater to serve back of house (BOH) services, common amenities and drip irrigation.

5.3 Water Efficient Appliances

All water appliances should be highly efficient. Plumbing pipes and fitting should be insulated to prevent heat loss. Water meters should be installed to monitor consumption and can identify leakages.

5.4 Recommendations

- ☑ Rainwater harvesting should be considered BOH services, Common amenities and drip irrigation.
- ☑ Efficient water fittings should be used throughout the development.
- ☑ All pipes and fittings should be insulated to prevent heat loss.
- ☑ Water meters should be installed to monitor consumption.

6. Electrical ESD Strategies

6.1 Lighting and Controls

Lighting accounts for a significant amount of energy usage in a building. Good practice lighting design generally includes for energy efficient fluorescent and LED lighting. LED lighting is becoming a popular cost effective choice of light fitting in building design as it offers a reduction in energy consumption and operational costs.

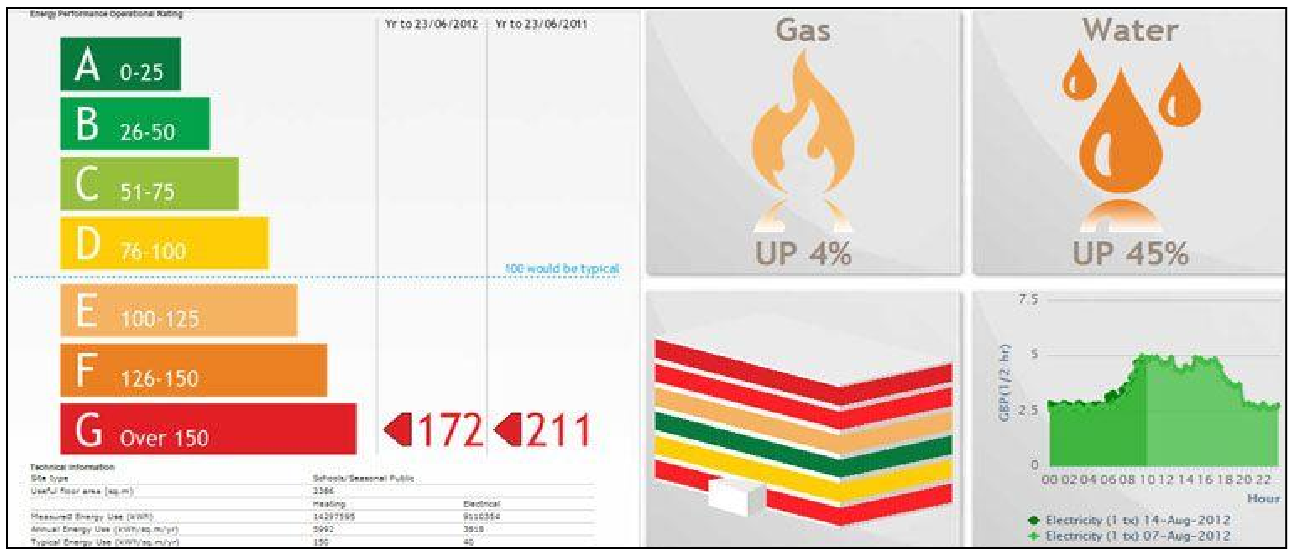
The use of occupancy sensors, daylight sensing time and zone control should be incorporated throughout the development.

6.2 Energy Management System (BMS)

BMS system is a real time control system for HVAC, DHW, lighting and small power. BMS can be used to improve indoor environment quality, optimise HVAC equipment and in reducing energy consumption throughout a building. In recent years, the cost of installing real time consumption monitoring has decreased and the user interface has improved as the industry matures. In addition to main utilities being metered, benefits can be seen by metering major energy equipment (air conditioning, lighting, hot water etc.). Monitoring allows spikes in energy use to be identified quickly and rectified if required.

6.2.1 Energy Consumption Display

To promote sustainability and raise awareness around energy consumption, real time energy consumption from the BMS could be displayed in the reception. It could show real-time consumption for Water, HVAC, Lighting, Solar PV and Rain Water usage levels. To display this information would have little additional cost to BMS system. It may prove to be a good marketing incentive. As an example, the display could look like the following.



6.3 Photovoltaic Panels

A solar photovoltaic system harnesses solar energy to generate electricity, electricity produced can be used on site. When installing photovoltaic panel, a diverter should be included. A diverter is used to maximise the energy consumed by the building, this is done by sending excess energy generated to domestic hot water thank.

6.4 Recommendations

- ☑ Photovoltaic panels should be considered for this development.
- ☑ BMS and energy monitoring should be considered to improve HVAC, DHW and lighting operation, improve efficiency and reduce energy consumption.
- ☑ LED lighting should be used throughout, assisted by occupancy, daylight, time and zone controls.

7. Summary

This ESD report for the proposed Parramatta Leagues Club Hotel has demonstrated the principles of Ecologically Sustainable Development as defined in clause 7(4) of Schedule 2 of the Environmental Planning and Assessment Regulation 2000 have been incorporated in the design planning, proposed construction and operational management of the development.

This development is being designed in accordance with a wide range of ESD strategies that apply to the design, construction and operational stages. The design team will ensure that the building minimises the impact on the environment in the areas of energy, water and materials. A strong focus passive design, building fabric, Health & Wellbeing, electrical and mechanical systems contributes to significant strides towards minimising climate change impacts. The design team is benchmarking the environmental performance of the proposed building to equivalent to a 4 star Green Star standard.

The development will not cause any significant impact on the health, diversity and productivity of the environment. The project will contribute to a lively community environment and add architectural interest to the surrounding area. It is located on a brown field site (existing car park) adjacent to the Parramatta Leagues Club, Parramatta parkland, a main road, in an urban environment in a western suburb of Sydney. Conservation of the biological diversity and ecological integrity will be a high priority throughout the development.