Report

Greenhouse Gas, Energy Efficiency and Ecologically Sustainable Development

QANTAS FLIGHT TRAINING CENTRE

Qantas Airways Ltd.

Report

CONFIDENTIAL

Revision: 2.0 – For Information
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Norman Disney & Young
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Table of Figures

1 EXECUTIVE SUMMARY

Norman Disney & Young (NDY) has been commissioned by Qantas Airways Ltd (Qantas) to prepare this sustainability report in accordance with the technical requirements of the Secretary's Environmental Assessment Requirements (SEARs), for the development of a new flight training centre at 297 King Street, Mascot.

The principal objective of this report is to outline how the project will address the following specific SEARs matters:

- *"**Greenhouse Gas and Energy Efficiency** – Including an assessment of the energy use on-site, and demonstrate the measures proposed to ensure the development is energy efficient"*; and
- *"**Ecologically Sustainable Development** – Including:*
    - *an assessment of how the development will incorporate ecologically sustainable development principles in all phases of the development"*;
    - *the use of green walls, green roof and/or cool roof into the design; and*
    - *climate change projections developed for the Sydney Metropolitan area and how they are used to inform the building design and asset life of the project,*

Greenhouse Gas and Energy Efficiency

The following summarises the key Greenhouse Gas (GHG) efficiency and energy reducing measures that have been pursued by the Qantas Flight Training Centre:

- 100% of electricity supplied is sourced from trigeneration plant;
- 100% of the cooling and heating requirement are to be met by chilled water and heating water supplied by the trigeneration plant;
- Building fabric thermal performance that meets or exceeds the Deemed to Satisfy Requirement of Section J of the National Construction Code (NCC) 2016;
- High efficiency and area specific mechanical systems to provide effective and energy efficient solutions;
- Energy efficient lighting (typically LED) with lighting controlled by motion and/or daylight sensors;
- Energy efficient equipment selections;
- Controls measures to ensure equipment is switched off after hours

Ecologically Sustainable Development

In addition to the energy efficiency measures outlined above, Ecologically Sustainable Development (ESD) initiatives are being targeted through benchmarking against the Green Star Design & As Built v1.2 framework. Whilst a formal rating is not currently targeted, the Project intends to achieve the design intent of a number of credits. An indicative Green Star scorecard can be found in Section 7 of this report.

The Project has also adopted the cool roof strategy to reduce the heat island effect using roof materials not exceeding 0.6 solar absorptance value. Green roof will also be incorporated over the bus stop, and green climbing planting to the precast wall of the Emergency Procedure (EP) area at the entryway to the centre.

The climate change projections for the Sydney Metropolitan area has been reviewed and the predicted impacts have been assessed in terms of likelihood and consequences. Design Responses to mitigate the impacts have been formulated in the Climate Change Risk Register in Section 8.3.3.

In pursuing the energy efficiency and ESD initiatives identified above, The Qantas Flight Training Centre has sufficiently demonstrated compliance with the Planning Secretary's Environmental Assessment Requirements for ***Greenhouse Gas and Energy Efficiency,*** and ***Ecologically Sustainable Development***.

2 BACKGROUND

2.1 Purpose

This sustainability report has been prepared in accordance with the Planning Secretary's Environmental Assessment Requirements for State Significant Developments to demonstrate how the project will meet the following:

- *"**Greenhouse Gas and Energy Efficiency** – Including an assessment of the energy use on-site, and demonstrate the measures proposed to ensure the development is energy efficient"*; and
- *"**Ecologically Sustainable Development** – Including:*
    - *an assessment of how the development will incorporate ecologically sustainable development principles in all phases of the development"*;
    - *the use of green walls, green roof and/or cool roof into the design; and*
    - *climate change projections developed for the Sydney Metropolitan area and how they are used to inform the building design and asset life of the project,*

2.2 Information Sources

The following information sources have been used in the preparation of this report:

- Planning Secretary's Environmental Assessment Requirements for the Qantas flight training centre project – Draft – issued 17th Jan 2019;
- NCC 2016 Section J;
- Green Star Design & As Built v1.2 Submission Guidelines;
- Architectural drawings prepared by Noxon Giffen;
- Discussions and workshops with the design team.

2.3 Revision History

Revision	Date	Reason for Issue
1.0	22/02/2019	For Information
2.0	11/04/2019	For Information

3 DEVELOPMENT DESCRIPTION

Normand Disney & Young has been commissioned by Qantas Airways Ltd (Qantas) to prepare this report in accordance with the technical requirements of the Secretary's Environmental Assessment Requirements (SEARs), and in support of the SSD 10154 for the development of a new flight training centre at 297 King Street, Mascot

3.1 Description of Site and Locality

The site is located at 297 King Street, Mascot and comprises land known as Lots 2-5 DP 234489, Lot 1 DP 202747, Lot B DP 164829 and Lot 133 DP 659434. The site is identified in Figure 1.

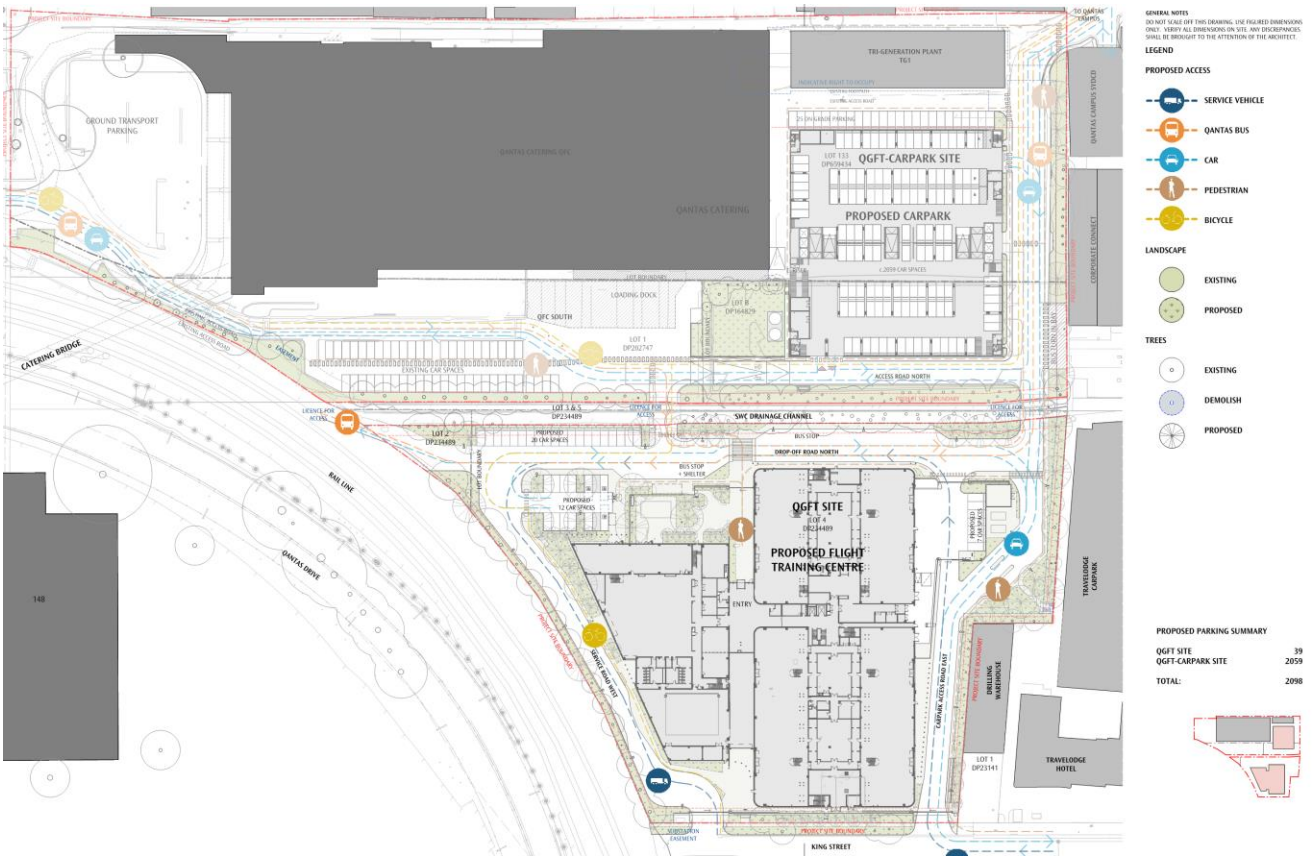
Key features of the site are as follows:

- The site is approximately 5.417ha and is an irregular shape. It is approximately 240m in length and maintains a variable width of between approximately 321m in the northern portion of the site and approximately 93m along the King Street frontage (refer to Figure 1).
- The site possesses a relatively level slope across the site. An open Sydney Water drainage channel bisects the northern portion of the site in an east-west direction. There are some isolated changes in level immediately adjacent to this channel. A Site Survey Plan accompanies the application which details the topographic characteristics of the site.
- Multiple mature Plane Trees are scattered throughout the site. A variety of native and exotic tress and vegetation also exist around the perimeter of the site which help screen the site from surrounding uses.
- Site improvements include at-grade car parking for Qantas staff, an industrial shed to store spare aviation parts, a substation, a disused gatehouse, a Sydney Water Asset with two driveways over it, the Qantas catering facility and Qantas tri-generation plant.
- The site forms part of a larger land holding under the ownership of Qantas that generally extends between Qantas Drive to the west, Ewan Street to the south, Coward Street to the north, with the Qantas "Corporate Campus" fronting Bourke Road.
- Vehicular access to the site from the local road network is available from King Street. The site has intra-campus connections along the northern boundary in the form of two connecting driveways in the north-eastern and north-western corner of the site along the northern boundary which link it to the broader Mascot Campus.
- The site is located within the Bayside LGA.

Key features of the locality are:

- **North**: The site is bounded to the north low scale industrial development, beyond which is Coward Street. Further north of the site is the Mascot Town Centre which is characte rised by transport-oriented development including high density mixed-use development focussed around the Mascot Train Station.
- **East**: The site is bordered to the east by commercial development including a newly completed Travelodge hotel which includes a commercial car park. Additional commercial development to the east includes the Ibis Hotel and Pullman Sydney Airport fronting O'Riordan Street.
- **South**: The site is bounded to the south by King Street, beyond which is Qantas owned at-grade car parking and other industrial uses. Further south is the Botany Freight Rail Line and Qantas Drive beyond which is the Domestic Terminal at Sydney Airport.
- **West**: The site is bordered to the west by the Botany Freight Rail Line and Qantas Drive, beyond which lies Sydney Kingsford Smith Airport and the Qantas Jetbase (location of the current Flight Training Centre).

Figure 1: Site Plan



3.2 Project Description

Safety is Qantas' first priority. The flight training centre is a key pillar of this value. The facility enables pilots and flight crews to undertake periodic testing to meet regulatory requirements by simulating both aircraft and emergency procedural environments. The Project seeks consent for the construction and operation of a new flight training centre, and associated ancillary uses including a multi-deck car park. The Project is comprised of the following uses:

Flight Training Centre

The proposed flight training centre will occupy the southern portion of the site. It is a building that comprises 4 core elements as follows:

- An emergency procedures hall that contains;
  - cabin evacuation emergency trainers,
  - an evacuation training pool,
  - door trainers,
  - fire trainers
  - slide descent towers,
  - security room,
  - aviation medicine training and equipment rooms.
- A flight training centre that contains:

- a flight training hall with 14 bays that will house aircraft simulators,
- integrated procedures training rooms, computer rooms, a maintenance workshop, storerooms, multiple de-briefing and briefing rooms, pilot's lounge and a shared lounge.

- Teaching Space that contains
  - training rooms,
  - classrooms and two computer-based exam rooms.
- Office Space
  - Office space for staff and associated shared amenities including multiple small, medium and large meeting rooms think tank rooms, informal meeting spaces, a video room and lunch/tea room.
- Ancillary spaces including the reception area at the ground floor, toilets, roof plant and vertical circulation. The external ground floor layout will include a loading dock, at-grade car parking for approximately 35 spaces and a bus drop-off zone at the northern site boundary.

Carpark

The proposed multi-deck car park will be located to the north-east of the flight training centre and adjacent the existing Qantas catering facility and tri-generation plant. The car park is 13 levels and will provide 2,059 spaces for Qantas staff. Vehicle access to the car park will be provided via King Street, Kent Road and from Qantas Drive via the existing catering bridge.

4 GLOSSARY AND ABBREVATIONS

4.1 Glossary

Term	Definition
The Site	Qantas Airways Limited owned land in Mascot to the north of Sydney Kingsford Smith Airport consisting of Lots 2-5 DP 234489, Lot 1 DP 202747, Lot B DP 164829 and Lot 133 DP 659434. Current site improvements include including at-grade car parking for Qantas staff, an industrial shed to store spare aviation parts, a substation, a disused gatehouse, a Sydney Water Asset with two driveways over it, the Qantas catering facility and Qantas tri-generation plant.
The Project	The construction of a new Flight Training Centre and ancillary uses to replace the existing facility on the Qantas Jetbase that will be impacted by RMS' Sydney Gateway Project.
Mascot Campus	Over 19ha of Qantas Airways Limited controlled land in Mascot to the north of Sydney Kingsford Smith Airport consisting of freehold and leased land. The following lots are owned by Qantas: Lot 133 DP 659434; Lots 4 & 5 DP 38594 Lot 23 DP 883548; Lots 1 & 2 DP 738342; Lot 3 DP 230355; Lot 4 DP 537339; Lots 2 & 4 DP 234489; Lot 4 234489; Lot 1 DP 81210; Lot 1 DP 202093; Lot 1 DP 721562; Lot 2 DP 510447; Lot 1 DP 445957; Lot B DP 164829 and Lot 1 DP 202747 and equates to 16.5ha of land. The following lots are leased by Qantas: Lot 14 DP 1199594 and Lot 2 DP 792885 and equates to 2.7ha of land.
Jetbase	Qantas leased land within the boundaries of Sydney Kingsford Smith Airport.
Sydney Gateway Project	A RMS Project including a road and rail component that is intended to increase capacity and improve connections to the ports to assist with growth in passenger, freight and commuter movements across the region, by expanding and improving the existing road and freight rail networks.

4.2 Abbreviations

Acronym	Definition
NDY	Norman Disney & Young
SEARs	Secretary's Environmental Assessment Requirements
GHG	Greenhouse Gas
NCC	National Construction Code
ESD	Ecologically Sustainable Development
HVAC	Heating, Ventilation and Air-Conditioning
ABCB	Australian Building Codes Board
DtS	Deemed-to-Satisfy
kWh	Kilowatt-hours
Uv	U-Value
SHGC	Solar Heat Gain Coefficient
FCU	Fan Coil Unit

Acronym	Definition
AHU	Air Handling Unit
VAV	Variable Air Volume
CO_2	Carbon Dioxide
BMS	Building Management System
GBCA	Green Building Council of Australia
EP	Emergency Procedure
IPCC	Intergovernmental Panel on Climate Change
CSIRO	The Commonwealth Scientific and Industrial Research Organisation
GCM	Global Climate Model
RCP	Representative Concentration Pathway
AP	Sydney Airport
BOM	Bureau of Meteorology
ENSO	El Niño Southern Oscillation

5 SUSTAINABILITY PLANNING REQUIREMENTS

The table below identifies the projects specific sustainability SEARs and outlines how they have been satisfied. For a detailed breakdown of how the SEARs for ***Greenhouse Gas Efficiency*** and ***Ecologically Sustainable Development*** have been met, refer to section 6 and section 7 respectively.

Table 01: Qantas Flight Training Centre SEARs

Sustainability SEARs	Project Response
Greenhouse Gas and Energy Efficiency – *Including an assessment of the energy use on-site, and demonstrate the measures proposed to ensure the development is energy efficient*	■ 100% of electricity supplied is sourced from trigeneration plant powered by natural gas with lower greenhouse gas emissions intensity. ■ 100% of the cooling and heating requirement are to be met by chilled water and heating water supplied by the trigeneration plant. ■ Building fabric thermal performance that meets or exceeds the Deemed to Satisfy Requirement of the Section J of the National Construction Code (NCC) 2016. Energy modelling based on the NCC Section J JV3 methodology was performed to demonstrate annual energy consumption reductions of the proposed building through improvements to the building fabric (glazing, shading and insulation); ■ High efficiency and area specific mechanical systems to provide effective and energy efficient solutions; ■ Energy efficient lighting (typically LED) with lighting controlled by motion and/or daylight sensors; ■ Energy efficient equipment selections; ■ Controls measures to ensure equipment is switched off after hours
Greenhouse Gas and Energy Efficiency – *Including the use of green walls, green roof and/or cool roof into the design*	■ Green planting to the carpark (ground floor and upper most level) ■ Green roof to the bus stop ■ Green climbing to the precast wall of the Emergency Procedure area at the entry of the training centre. ■ The training center is proposed to have roof sheeting of 0.58 SAR instead of a green roof or terrace due to the risk to the simulators.

Sustainability SEARs	Project Response
Greenhouse Gas and Energy Efficiency *– Including climate change projections developed for the Sydney Metropolitan area and how they are used to inform the building design and asset life of the project*	The process has identified a number of additional adaptation measures which will be adopted to reduce risk to ALARP (as low as reasonably practicable) levels. The assessments of the risk comprise of the likelihood of an event occurring and the consequences of that event. Key design responses include those listed below: ■ HVAC system and equipment will include review of chilled water reticulation capacity to meet cooling demand during heat wave and projected climate change in detailed design. ■ Selection of drought tolerant plants and irrigation strategy to account for high temperatures or drought. ■ Measures to reduce potential damaged caused to building electrical boards and equipment by increased annual rainfall and the potential of flash flooding in the detailed design. ■ Design of rainwater and stormwater drainage systems to accommodate for drought and periods of heavy rainfall. ■ Ensure wind/hail impact resistance, secure attachment of roof and externally mounted equipment/claddings, and adequate supports to mitigate risk caused by the increased intensity of cyclones and storms. ■ Fire protection design to take into account an increase in fire incidents.
Ecologically Sustainable Development *– Including an assessment of how the development will incorporate ecologically sustainable development principles in all phases of the development*	The project will focus on incorporating ecologically sustainable development principles through measures that reduce greenhouse gas emissions, the use of cogeneration and low emission energy source, reduction of potable water use, waste recycling, improved environment quality, bio diversity and reduced environmental impact of materials. The targeted Ecologically Sustainable Development (ESD) initiatives will be benchmarked against the Green Star Design & As Built v1.2 framework. The project will target equivalency to 5 star Green Star and a 6 star aspiration. A completed Green Star scorecard can be found in Section 6 of this report.

6 SUSTAINABILITY GUIDELINES AND LEGISLATION

To demonstrate how the proposed development meets the SEARs performance measures, the Building Council of Australia's NCC 2016, and the Green Building Council's Green Star Design & As Built v1.2 Submission Guidelines have been used as benchmarking tools.

6.1 Building Code of Australia - NCC 2016

The National Construction Code (NCC) is produced and maintained by the Australian Building Codes Board (ABCB) on behalf of the Australian Government with the aim of achieving nationally consistent, minimum necessary standards of relevant health and safety, amenity and sustainability objectives efficiently. The NCC contains mandatory technical provisions for the design and construction of buildings and other structures, and plumbing and drainage systems through Australia

Volume 1, Section J outlines energy efficiency provisions required for NCC class 5 and class 9b buildings. There are eight (8) Deemed-to-Satisfy subsections, J1 to J8, focusing on different aspects of energy efficiency as follows:

- J1 - Building Fabric (i.e. the ability of the roof, walls and floor to resist heat transfer)
- J2 - Glazing (i.e. the resistance to heat flow and solar radiation of the glazing)
- J3- Building Sealing (i.e. how well parts of a building are sealed to ensure comfortable indoor environments are efficiently maintained)
- J5 - Air Conditioning and Ventilation Systems (i.e. the efficiency and energy saving features of heating, ventilation and air-conditioning systems)
- J6 - Artificial Lighting and Power (i.e. power allowances for lighting and electric power saving features)
- J7 - Hot Water Supply and Swimming Pool and Spa Pool Plant (i.e. the efficiency and energy saving features of hot water supply)
- J8 – Facilities for Energy Monitoring (i.e. access to certain energy efficiency equipment for maintenance purposes)

6.2 Green Building Council of Australia – Green Star Design & As Built v1.2

The Green Star Design & As Built v1.2 Submission Guidelines is a holistic rating tool developed by the Green Building Council of Australia used to verify the environmental attributes or performance of a building, enabling buildings in similar sectors to be benchmarked against one another.

Projects are rated based on their performance against 8 environmental impact categories, plus innovation. The environmental impact categories include Management, Indoor Environment Quality, Energy, Water, Transport, Ecology, Emissions and Materials.

Whilst the Qantas flight training centre is not currently targeting formal Green Star rating, the tool has been used to benchmark the project and demonstrate compliance with the project specific SEARs.

7 GREENHOUSE GAS EFFICIENCY AND ENERGY REDUCTION

The following section addresses the ***Greenhouse Gas and Energy Efficiency*** SEARs requirement, including an assessment of the energy use on site and proposed measures to ensure that the Qantas flight training centre is energy efficient.

7.1 JV3 Verification

The JV3 verification method has been used to assess the energy saving derived from improving the thermal performance of building fabrics proposed for Qantas Flight Training Centre compared to the minimum performance prescribed in the Section J NCC 2016.

The JV3 verification method involves modelling a reference building with the NCC Deemed-to-Satisfy (DtS) provisions. When simulated this reference model provides an annual energy consumption benchmark.

The proposed building is then modelled per the reference building; however, the building fabric is adjusted to reflect the proposed material selection of the actual building. When modelled the annual energy consumption of the proposed building must be less than the reference building. As all inputs except fabric are the same between proposed and reference models, the reductions in annual energy consumption can be attributed to the improvements in proposed building fabric.

Table 02 below identifies the modelled annual energy consumption of the proposed building against a DtS compliant reference building.

Table 02: JV3 Verification Method Results

System/Component	Reference Building (DtS Compliant Fabric and Services)	Proposed Building (Proposed Fabric, DtS Compliant Services)	Proposed Building with Re-claimed Energy
Heating thermal energy (kWh)	337,981	325,440	60% recovered energy
Cooling thermal energy (kWh)	911,558	911,088	40% recovered energy
Heating gas (kWh)	422,476	406,800	162,720
Cooling electricity (kWh)	182,312	182,218	109,331
Total GHG Emissions ($kgCO_2$-e)	272,814	269,095	142,624
Reduction	3,719		130,190
Reduction Percentage	1.36%		**48%**

The above table includes the energy saving benefit of utilising the trigeneration system to provide chilled water and heating water to air handling and fan coil units. This is in line with JV3 clause (b):

> *(b) The annual energy consumption of the proposed building in (a) may be reduced by the amount of energy obtained from —*
>
> *(i) an on-site renewable energy source; or*
>
> *(ii) another process as reclaimed energy.*

The energy reducing initiatives to the building fabric identified through the JV3 modelling are as per the following (or equivalent):

- High performance low-e coated windows [Uv 4.9 SHGC 0.33 or better).
- Roof total R-value at R4.2, with improved solar absorptance performance to parts of the buildings.

- Addition of horizontal shading devices to Northern glazed façade.

7.2 Mechanical Equipment

Table 03 provides estimated annual greenhouse gas emission for the main mechanical equipment. The electricity supply to the mechanical equipment will be provided by the trigeneration plant at 100% demand.

Table 03: Mechanical Equipment Greenhouse Gas Emission Estimate

System/Component	Reference Building	Proposed Building	Note
Fans (kWh)	643,364	643,364	
Pumps (kWh)	181,462	181,462	
Total electricity (kWh)	824,826	824,826	
Electricity emission factor ($kgCO_2$/kWh)	0.96	0.537	Based on 43.1% electrical generation efficiency
Total GHG emissions ($kgCO_2$-e)	791,833	442,995	
Reduction	348,838		
Reduction Percentage	**44%**		

The mechanical design is in preliminary stages, as such, the values in the table above were estimated using DtS compliant services (i.e. worst-case).

The following mechanical energy efficient options will be considered to provide further energy savings and emission reductions:

- Level 2 classrooms to use chilled water FCU's to enable on and off switching to match occupancy, additional outside air fans will be paired with CO_2 sensors to reduce unnecessary usage of fans.
- Main AHU's to be paired with CO_2 sensors to turn down where necessary.
- Low temp VAV system for sim bays.
- Air conditioning equipment (fans and pumps) selected will have energy efficiency ratios in excess of the minimum DtS requirements stated in NCC Section J.
- Zoning for air conditioning system set per each thermal zone (each perimeter and central).

As such, with the implementation of some or all the measures identified above , the actual mechanical energy consumption and consequent greenhouse gas emissions would be considerably less than those identified in Table 03.

7.3 Lighting

Table 04 below identifies the estimated lighting energy consumption for the Qantas flight training centre. This assessment has been based on class 9b training facilities and class 5 office areas utilising energy efficient LED luminaires. This has been compared to an NCC DtS compliant lighting design to demonstrate energy savings. As electricity is supplied by trigeneration plant, further emissions saving is expected.

Table 04: Lighting Greenhouse Gas Emission Estimate

System/Component	Reference Building (as Per NCC Part J6)	Proposed Building (LED - Office and training facilities at 6W/m²)	Note
Lighting (kWh)	788,622	581,970	
Electricity emission factor ($kgCO_2$/kWh)	0.96	0.537	Based on 43.1% electrical generation efficiency
Total GHG emissions ($kgCO_2$-e)	757,077	312,562	
Reduction	444,515		
Reduction Percentage	**58.7%**		

It is expected that the proposed lighting design with LED luminaires will have maximum lighting power density of 6W/m² in offices, training facilities and simulation bays. This is estimated to result in a 26.2% energy reduction when compared to a maximum allowable lighting power density as specified by NCC Part J6. Combined with the lower emissions of electricity supplied by the trigeneration plant, the overall greenhouse gas emission saving is estimated at 58.7%.

The following measures will be considered where appropriate to reduce the energy consumption and greenhouse gas emissions further:

- Occupant detection and / or daylight sensor controls to reduce the operation of artificial lighting when not required;
- Control measures to ensure all lights are switched off after hours; and
- Reduced size of lighting zones.

7.4 Equipment

Table 05 below provides an estimated annual energy consumption from office and flight simulator equipment, based on Specification JV equipment power density. It is expected that the energy consumed by specific / process related equipment will be higher than the figure estimated. However, energy saving measures should be aimed at reducing the standby power and other wasted energy without obstructing the functionality of the process/ equipment.

Table 05: Equipment Greenhouse Gas Emission Estimate

System/Component	Reference Building	Proposed Building	Note
Equipment (kWh)	999,357	999,357	
Electricity emission factor ($kgCO_2$/kWh)	0.96	0.537	Based on 43.1% electrical generation efficiency
Total GHG emissions ($kgCO_2$-e)	959,383	536,731	
Reduction	422,652		
Reduction Percentage	**44%**		

The following energy reducing control measures will be considered where appropriate to further reduce energy consumption and greenhouse gas emissions:

- Equipment switched to standby mode when inactive;
- Equipment programmed to switch off after hours;
- Higher energy efficient equipment options selected (where available).

7.5 Miscellaneous Base Building Equipment

Table 06 below provides an assessment of the annual energy consumption from miscellaneous base building equipment including lifts, domestic hot water, miscellaneous ventilation and other base building equipment such as BMS and fire control system. Estimates have been made using benchmarked data from similar projects.

Table 06: Miscellaneous Equipment Energy and Greenhouse Gas Emission Estimate

System / Component	Annual Energy density (kWh/m²/annum)	Estimated Annual Energy Consumption (kWh/annum)
Lifts	6	101,980
Domestic Hot Water	2	33,993
Miscellaneous Ventilation, BMS, Fire Control System	2	33,993

System/Component	Reference Building	Proposed Building	Note
Equipment (kWh)	169,966	169,966	
Electricity emission factor ($kgCO_2$/kWh)	169,966	169,966	Based on 43.1% electrical generation efficiency
Total GHG emissions ($kgCO_2$-e/)	0.96	0.537	
Reduction	71,883		
Reduction Percentage	**44%**		

The following energy reducing measures are currently being investigated by the project team:

Lifts

- Destination control;
- Regenerative braking;
- Low standby power consumption;
- Lift car lights turned off when lift unoccupied.

Domestic Hot Water

- Energy efficient heat pumps;
- Highly insulated storage tanks;

Miscellaneous Ventilation

- Linked to occupancy sensors to minimise unnecessary use;

- Energy efficient fans;

The following table summarises the estimated greenhouse gas emission reduction, indicating that the proposed measures potentially reduces greenhouse gas emissions by 48.2%.

Table 07: Greenhouse Gas Emission Estimate - Summary

System/Component	Reference Building	Proposed Building
Heating and Cooling (kWh)	272,814	142,624
Fans and Pumps (kWh)	791,833	442,995
Lighting (kWh)	757,077	312,562
Equipment (kWh)	959,383	536,731
Miscellaneous Equipment (kWh)	163,167	91,285
Total GHG emissions ($kgCO_2$-e)	2,944,274	1,526,197
Reduction	1,418,078	
Reduction Percentage	**48.2%**	

8 ECOLOGICALLY SUSTAINABLE DEVELOPMENT

8.1 Green Star Framework

To address the SEARs requirement for ***Ecologically Sustainable Development***, the Qantas flight training centre will use initiatives from the GBCA's Green Star framework to help benchmark the design.

While a formal rating is not currently targeted, the project intends to achieve the design intent of several relevant initiatives as summarised in Table 07 below. As the development is a specialist training facility, the standard Green Star framework is expected to be stretched, and a number of assumptions and benchmark modifications are expected to be applied to meet various credits.

The project is targeting equivalency to a 5 star Green Star benchmark with a 6 star aspiration. The project will utilise the current version of Green Star, Design & As Built v1.2 to benchmark the development.

Table 07: Green Star Design & As Built v1.2 Pathway

Credit	Initiative	Pts
Management		**14**
01	**Accredited Professional:** engaged to provide support and advice on ESD matters.	1
02	**Commissioning and Tuning:** commissioning, handover and tuning initiatives to maximise potential of building services.	4
03	**Adaptation and Resilience:** building design adapted for climate change resilience.	2
04	**Building Information:** building information that facilitates operator and user understanding of building systems and their operation and maintenance.	1
05	**Commitment to Performance:** environmental building performance targets and monitoring strategies.	2
06	**Metering and Monitoring:** energy and water metering and monitoring systems.	1
07	**Responsible Construction Practices:** construction practices that manage environmental impacts, enhance staff health and wellbeing, and improve sustainability knowledge on site.	2
08	**Operational Waste:** waste management plans that facilitate the re-use, upcycling, or conversion of waste into energy.	1
Indoor Environment Quality		**11**
09	**Indoor Air Quality:** high indoor air quality provided for building occupants.	3
10	**Acoustic Comfort:** appropriate and comfortable acoustic conditions are provided for building occupants.	3
11	**Lighting Comfort:** well-lit spaces to minimize glare and maximise visual interest.	1
12	**Visual Comfort:** well-lit spaces for visual comfort.	2

13	**Indoor Pollutants:** reduced internal air pollutant levels for occupant health.	2
Energy		**12**
15	**Greenhouse Gas Emissions:** energy efficient buildings and the reduction of greenhouse gas emissions associated with the use of energy in building operations.	10
16	**Peak Electricity Demand Reduction:** reduction of peak demand load on the electricity network infrastructure.	2
Transport		**6**
17	**Sustainable Transport:** design and operational measures to reduce carbon emissions arising from occupant travel to and from Qantas Training Facility.	6
Water		**4**
18	**Potable Water:** building design minimizes potable water consumption in operations.	4
Materials		**12**
19	**Life Cycle Impacts – Concrete:** Portland cement content in all concrete reduced by replacing it with supplementary cementitious materials.	6
20	**Responsible Building Materials:** building materials are responsible sourced or have a sustainable supply chain.	3
21	**Sustainable Products:** a proportion of materials used in the project meet transparency and sustainability requirements.	2
22	**Construction and Demolition Waste:** construction waste going to landfill is reduced by reusing or recycling building materials.	1
Land Use & Ecology		**4**
23	**Ecological Value:** ecological value of the site is improved.	1
24	**Sustainable Sites:** sites are developed that have limited ecological value or are previously developed land.	2
25	**Heat Island Effect:** the contribution of the site to the 'heat island effect' is reduced.	1
Emissions		**3**
26	**Stormwater:** peak storm water and pollutant outflows from the site are minimized.	1
28	**Microbial Control:** systems in place to minimize the impacts associated with harmful microbes in building cooling systems.	1
29	**Light Pollution to Night Sky:** environmental impacts of light pollution are minimized	1

Innovation		**9**
	Innovative Technology	1
	Market Transformation	5
	Improving on Green Star Benchmarks	1
	Innovation Challenges	2
Total		**75**

8.2 Green Walls, Green Roofs and/or Cool Roofs

To address the SEARs requirement for ***Ecologically Sustainable Development***, the use of green walls, green roof and/or cool roof in the design of the Qantas Group Flight Training Centre and associated carpark was considered.

Qantas Group Flight Training Centre is to have a green roof over the bus stop and green climbing planting to the precast wall of the Emergency Procedure (EP) area at the entryway to the centre. Additional climbing planting to the north wall of the ground floor was considered, however it was determined that the area contained sufficient planting.

A green roof or terrace was also considered for the training centre, however due to the highly sensitive nature of the flight simulators, this was deemed to be too much of a risk and as such, shall not be incorporated. Instead, a cool roof strategy will be adopted using roof materials not exceeding 0.6 solar absorptance value. The project is currently considering the Kingspan *Windspray* roof sheeting (with a 0.58 solar absorptance value).

For the carpark, the design incorporates green climbing planting to the ground floor and green planting to the uppermost floor.

8.3 Climate Change Projections

8.3.1 Climate Change Context/Scenarios

8.3.1.1 Greenhouse Gas Emissions Scenarios

Although future emissions growth is complex and uncertain, the Intergovernmental Panel on Climate Change (IPCC) developed a range of potential future greenhouse gas emissions scenarios to address this uncertainty and represent a plausible set of future economic and social conditions on which emission levels were generated (Australian Government Department of Climate Change, 2009).

The following IPCC climate change scenarios from the CSIRO's Climate Change in Australia Projections (as at 2015) were used in this impact assessment. These reflect the global climate model (GCM) simulations, as defined by the Representative Concentration Pathways (RCPs) used by the IPCC, with a particular focus on RCP4.5 and RCP8.5.

Representative Concentration Pathway 4.5 (RCP4.5)
This scenario represents a pathway consistent with low-level emissions, which stabilise the carbon dioxide concentration at about 540 ppm by the end of the 21st century and assumes that global annual GHG emissions (CO_2-e) peak around 2040 before declining (CSIRO Climate Change in Australia Projections, 2015).

Representative Concentration Pathway 8.5 (RCP8.5)
This scenario is representative of a high-emission scenario, for which the carbon dioxide concentration reaches about 940 ppm by the end of the 21st century and assumes that global annual GHG emissions (CO_2-e) continue to rise through to 2100 (CSIRO Climate Change in Australia Projections, 2015).

8.3.1.1 Justification for Selecting these RCP Scenarios

As per guidance in the AGO's Guide, "Climate Change Risks and Impacts: A Guide for Government and Business", Section B4.1, a limited number of scenarios covering the most plausible future climate changes was used for this analysis. This was deemed necessary to gain a holistic picture of predicted climate change impacts for this site.

These include the high emissions scenario (RCP8.5) which represents 'business as usual' and combines assumptions regarding the absence of climate change policies with higher world populations and modest rates of technological change or energy intensity improvements which culminate in higher energy demands and therefore Greenhouse Gas emissions increasing year on year.

The other, more optimistic emissions scenario utilised in this assessment includes emissions peaking at around 2040 and then declining due to rapid stabilization of Greenhouse Gas emissions in the global economy as a result of implementation of effective climate change policies (such as a price on emissions) and swift introduction of new, more resource efficient technologies that balance renewable energy sources with fossil-fuel sources and keep global mean warming within a 2 °C increase from pre-industrial levels.

8.3.2 Key Projections Applicable for the Qantas Group Flight Training Centre

In summary the following are key projections for the East Coast (South) Sub-cluster (CSIRO Climate Change Projections, East Coast Cluster Report 2015):

8.3.2.1 Temperature

Continued increases in mean, daily maximum and daily minimum temperatures are projected for the East Coast cluster with *very high confidence* with the near future (2030) projected increase of mean annual temperature around 0.4 to 1.3 °C above the climate of 1986–2005, with only minor differences between RCPs (CSIRO Climate Change Projections, East Coast Cluster Report 2015). For late in the century (2090), there is a large difference between scenarios, with projected warming of 1.3 to 2.5 °C for RCP4.5 and 2.7 to 4.7 °C for RCP8.5 (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

Table 1: Sydney Airport (AP) Average 3pm Seasonal Temperature (Bureau of Meteorology) and Future Projections (CSIRO Climate Change Projections, East Coast Cluster Report 2015)

Season	Baseline (1981-2010)	2030 @ RCP4.5	2090 @ RCP8.5
Summer	25.1° C	26.0° C *(+0.9° C)*	28.8° C *(+3.7° C)*
Autumn	21.7° C	22.5° C *(+0.8° C)*	25.4° C *(+3.7° C)*
Winter	16.9° C	17.8° C *(+0.9° C)*	20.5° C *(+3.6° C)*
Spring	21.1° C	22.0° C *(+0.9° C)*	25.0° C *(+3.9° C)*

The temperature change values indicated in grey (Table 1) are the simulated changes for the 2020-2039 (2030) and the 2080-2099 (2090) periods relative to the 1986-2005 period for the East Coast Cluster (CSIRO Climate Change Projections, East Coast Cluster Report 2015). The 1981-2010 temperatures from the BOM have been utilized as the baseline temperatures as they align most closely with the base case climate data used in the Climate Change Projections (1986-2005).

A substantial increase in the temperature reached on the hottest days, the frequency of hot days and the duration of warm spells are projected with *very high confidence* and as a result an expected decrease in the frequency of frost-risk days is projected with *high confidence* (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

The risk of line outages, blackouts and asset failures is likely to increase (IPCC, IPCC WGI AR5 Climate Change 2013: The Physical Science Basis, 2013). This is due to increases in peak demand from increased air-conditioning use exceeding base load increases. Although the main drivers for energy consumption are demographic and socio-economic factors, climatic conditions are also linked to average and peak energy demands. (CSIRO Climate Change in Australia Projections, 2015).

Higher rates of infectious and water borne disease as well as increased rates of heat-related stress and mortality, particularly among the aged and vulnerable populations, are likely outcomes (Grose et. al, 2015).

The frequency of hot days and the frequency of high fire risk weather is likely to increase. The East Coast (South) currently experiences temperatures above 35°C, on average, 3.1 days per year. Studies have highlighted that by 2030 this is predicted to increase to 4.3 days per year and by 2090 to between 6 and 11 days per year (CSIRO Climate Change Projections, East Coast Cluster Report 2015). This has important ramifications for air pollution and health, with ozone pollution events linked to the frequency of hot, sunny days, and with the highest particle pollution concentrations linked to the presence of bushfire smoke (Grose et. al, 2015).

8.3.2.2 Precipitation

There is *medium confidence* that the time spent in drought will increase over the course of the 21st century in line with changes to mean rainfall, but *low* confidence in projecting the frequency and duration of extreme droughts (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

There is *high confidence* that whilst the intensity of heavy rainfall extremes will increase, the magnitude of change cannot be reliably projected (CSIRO Climate Change Projections, East Coast Cluster Report 2015). The trend of annual mean rainfall is unclear and tending toward decrease whilst increased magnitudes of extreme

rainfall events is projected. The magnitude of the anticipated extremes of rainfall are highly reliant on emission scenario and the future time period.

Rainfall has not shown any long-term trends, rather the East Coast cluster has experienced intermittent wetter and drier periods. The observed trends in rainfall throughout the East Coast cluster are not very significant, with *low confidence* in both the magnitude and sign of observed trends. (CSIRO Climate Change Projections, East Coast Cluster Report 2015)

Rainfall is projected to decrease in winter, consistent with a reduction in the number of storms (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

8.3.2.3 Sea Level Rise

Relative sea level has risen around Australia at an average rate of 1.4 mm per year between 1966 and 2009, and 1.6 mm per year after the influence of the El Niño Southern Oscillation (ENSO) on sea level is removed (CSIRO Climate Change Projections, East Coast Cluster Report 2015). Increasing global temperatures has a direct impact on sea level as water expands with temperature and increases can also be expected from melting glaciers and ice caps. As temperatures are virtually certain to rise, so are sea levels virtually certain to rise, in line with IPCC predictions (CSIRO Climate Change in Australia Projections, 2015). There is *very high confidence* that sea level will continue to rise during the 21st century. In the near future (2030) the projected range of sea level rise for the cluster coastline is 0.08 to 0.18 m above the 1986–2005 level, with only minor differences between RCPs (CSIRO Climate Change Projections, East Coast Cluster Report 2015). As the century progresses, projections are sensitive to emissions pathways. By 2090, RCP4.5 gives a rise of 0.30 to 0.65 m, and RCP8.5 gives a rise of 0.44 to 0.88 m (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

The Qantas Flight Training Centre is located approximately 6m above sea level (Google Earth) – well above even the most extreme CSIRO Climate Change Projections. Sea level rise is therefore not an impact that is relevant to the project.

8.3.2.4 Gustier Wind Conditions

There is *high confidence* in little change to mean wind speed under RCP4.5 and RCP 8.5 scenarios by 2030. For 2090 changes are projected to remain small with *medium confidence* under RCP4.5 and winter wind speed is projected to reduce with *medium confidence* under RCP8.5. These reduced winter wind speeds are assumed to be due to a projected southward movement of storm tracks and the subtropical ridge thus weakening westerly winds. There is *medium confidence* that there will be a reduction in extreme wind speeds (CSIRO Climate Change Projections, East Coast Cluster Report 2015).

8.3.3 Mitigation Measures and Environmental Risk Assessment

This analysis comprises a qualitative assessment consistent with AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines (Standards Australia 2009). The level of risk was assessed by considering the potential impacts of the proposed development prior to application of any mitigation or management measures. Risk comprises the likelihood of an event occurring and the consequences of that event. For the proposal, the following descriptors were adopted for 'likelihood' and 'consequence'.

Table 2: Risk Descriptors

LIKELIHOOD		CONSEQUENCE	
A	Almost certain	1	Widespread and/or irreversible impact

LIKELIHOOD		CONSEQUENCE	
B	Likely	2	Extensive but reversible (within 2 years) impact or irreversible local impact
C	Possible	3	Local, acceptable or reversible impact
D	Unlikely	4	Local, reversible, short term (<3 months) impact
E	Rare	5	Local, reversible, short term (<1 month) impact

The risk levels for likely and potential impacts were derived using the following risk matrix.

Table 3: Risk Matrix

CONSEQUENCE \ LIKELIHOOD	A	B	C	D	E
1	High	High	Medium	Low	Very Low
2	High	High	Medium	Low	Very Low
3	Medium	Medium	Medium	Low	Very Low
4	Low	Low	Low	Low	Very Low
5	Very Low	Very Low	Very Low	Very Low	Very Low

Based on the aforementioned climate change projection variables, the impacts to the Project have been identified and assessed in terms of the risk likelihood and consequences. Design responses has been formulated to mitigate the risk to Low or Medium.

It is considered that with the mitigation measures required, the impacts resulting from the proposal will be acceptable.

Project	Qantas Flight Simulation	Date	10/04/2019
		Revision	1.0

Climate Change Risk Register

Item No.	Change in Climate Variable	Impact	by 2030			by 2070 or 2090			Design Responses	Responsibility	Residual risk - (current design)		
			Consequence	Likelihood	Risk	Consequence	Likelihood	Risk			Consequence	Updated likelihood	Overall residual risk
1	Higher temperatures, longer heatwaves	Higher air conditioning load, AC plant can not maintain internal temperature	Moderate	Possible	Medium	Moderate	Likely	High	Detailed design will include review of chilled water reticulation capacity to meet cooling demand during heat wave (using future weather data). This will be reviewed against cooling capacity available at the trigen plant.	Mechanical consultant	Major	Rare	Low
2	Higher temperatures, longer heatwaves	Soft landscape damage due to high temperatures or drought	Minor	Possible	Medium	Minor	Likely	Medium	Detailed design will include specification of rought tolerant plant selection and irrigation to include subsoil drippers with moisture sensors.	Landscape consultant and Noxon Giffen	Minor	Rare	Low
3	Higher temperatures, longer heatwaves	Cracking and/or failure of seals due to stronger solar radiation and/or extreme temperatures.	Moderate	Possible	Medium	Moderate	Possible	Medium	Detailed design will include specification of seals to be have a 10 year warranty. When they need to be replaced, it is anticipated that the market will have shifted to a new technology that is more UV stable to accommodate higher solar radiation.	Noxon Giffen	Minor	Unlikely	Low
4	Higher temperatures, longer heatwaves	Utility blackout	Moderate	Rare	Low	Moderate	Rare	Low	Thermal plant in the Qantas facility provides power to Qantas Sim building. No impact	Qantas FM	Moderate	Rare	Low
5	Increased annual rainfall, increased mean sea level, Increased intensity of cyclones and storms	Flash flooding causing damage to building electrical boards and electrical equipment	Catastrophic	Possible	High	Catastrophic	Likely	Extreme	Detailed design will include the requirement for plinths to be raised around electrical boards and equipment. Consideration will be given to provide emergency pumping to essential service plant room.	Electrical consultant and Noxon Giffen	Catastrophic	Unlikely	Medium

Project	Qantas Flight Simulation	Date	10/04/2019
		Revision	1.0

Climate Change Risk Register

Item No.	Change in Climate Variable	Impact	by 2030			by 2070 or 2090			Design Responses	Responsibility	Residual risk - (current design)		
			Consequence	Likelihood	Risk	Consequence	Likelihood	Risk			Consequence	Updated likelihood	Overall residual risk
6	Increased annual rainfall, increased mean sea level, Increased intensity of cyclones and storms	Excessive storm water run off , causing flood to adjacent road and ground.	Moderate	Possible	Medium	Moderate	Likely	High	Detailed design will include stormwater management to cope with increased intensity of rain. Discussion with Sydney airport and Council on managing street run-off.	Hydraulic consultant and Noxon Giffen, Qantas FM	Moderate	Unlikely	Medium
7	Increased intensity of cyclones and storms	Extreme wind and hails damaging roof, wall cladding, shadings, windows etc	Moderate	Possible	Medium	Moderate	Likely	High	Detailed design will include the requirement for wind and hail impact resistance and secure attachment of external claddings (roof, walls, glazing) against extreme wind and hails.	Façade consultant and Noxon Giffen	Moderate	Unlikely	Medium
8	Increased intensity of cyclones and storms	Extreme wind and hails damaging roof/ externally mounted equipment and signages.	Major	Possible	High	Major	Likely	High	Detailed design will include the requirement for wind and hail impact resistance and secure attachment of roof and externally mounted equipment (anchorage etc) against extreme wind and hails.	Mechanical consultant/contractor Hydraulic, and Noxon Giffen	Moderate	Unlikely	Medium
9	Increased intensity of cyclones and storms	Hail frozzen in gutter causing excessive weight damaging the structure ==>	Moderate	Possible	Medium	Moderate	Likely	High	Detailed design will include details of supports to box gutters to cope with additional weight.	Hydraulic consultant and Noxon Giffen	Moderate	Unlikely	Medium
10	Increase number of days a year Forest Fire Danger Index (FFDI) >51	Increased occurrence of state wide fire incidents reducing water supply pressure for fire protection system	Moderate	Unlikely	Medium	Moderate	Possible	Medium	Detailed design will include adequate fire tank water and fire pumps	Fire Protection Consultant	Moderate	Unlikely	Medium

9 CONCLUSION

This report identifies the sustainability measures being pursued or investigated by the project team, and demonstrates how the project specific SEARs for ***Greenhouse Gas and Energy Efficiency,*** and ***Ecologically Sustainable Development*** have been addressed.

Table 08 below summarises how the SEARs for the Qantas flight training centre have been met.

Table 08: Qantas Flight Training Centre SEARs

Sustainability SEARs	Project Response
Greenhouse Gas and Energy Efficiency – *Including an assessment of the energy use on-site, and demonstrate the measures proposed to ensure the development is energy efficient*	■ 100% of electricity supplied is sourced from trigeneration plant powered by natural gas with lower greenhouse gas emissions intensity. ■ 100% of the cooling and heating requirement are to be met by chilled water and heating water supplied by the trigeneration plant. ■ Building fabric thermal performance that meets or exceeds the Deemed to Satisfy Requirement of the Section J of the National Construction Code (NCC) 2016. Energy modelling based on the NCC Section J JV3 methodology was performed to demonstrate annual energy consumption reductions of the proposed building through improvements to the building fabric (glazing, shading and insulation); ■ High efficiency and area specific mechanical systems to provide effective and energy efficient solutions; ■ Energy efficient lighting (typically LED) with lighting controlled by motion and/or daylight sensors; ■ Energy efficient equipment selections; ■ Controls measures to ensure equipment is switched off after hours
Greenhouse Gas and Energy Efficiency – *Including the use of green walls, green roof and/or cool roof into the design*	■ Green planting to the carpark (ground floor and upper most level) ■ Green roof to the bus stop ■ Green climbing to the precast wall of the Emergency Procedure area at the entry of the training centre. ■ The training center is proposed to have roof sheeting of 0.58 SAR instead of a green roof or terrace due to the risk to the simulators.

Sustainability SEARs	Project Response
Greenhouse Gas and Energy Efficiency *– Including climate change projections developed for the Sydney Metropolitan area and how they are used to inform the building design and asset life of the project*	The process has identified a number of additional adaptation measures which will be adopted to reduce risk to ALARP (as low as reasonably practicable) levels. The assessments of the risk comprise of the likelihood of an event occurring and the consequences of that event. Key design responses include those listed below: ■ HVAC system and equipment will include review of chilled water reticulation capacity to meet cooling demand during heat wave and projected climate change in detailed design. ■ Selection of drought tolerant plants and irrigation strategy to account for high temperatures or drought. ■ Measures to reduce potential damaged caused to building electrical boards and equipment by increased annual rainfall and the potential of flash flooding in the detailed design. ■ Design of rainwater and stormwater drainage systems to accommodate for drought and periods of heavy rainfall. ■ Ensure wind/hail impact resistance, secure attachment of roof and externally mounted equipment/claddings, and adequate supports to mitigate risk caused by the increased intensity of cyclones and storms. ■ Fire protection design to take into account an increase in fire incidents.
Ecologically Sustainable Development *– Including an assessment of how the development will incorporate ecologically sustainable development principles in all phases of the development*	The project will focus on incorporating ecologically sustainable development principles through measures that reduce greenhouse gas emissions, the use of cogeneration and low emission energy source, reduction of potable water use, waste recycling, improved environment quality, bio diversity and reduced environmental impact of materials. The targeted Ecologically Sustainable Development (ESD) initiatives will be benchmarked against the Green Star Design & As Built v1.2 framework. The project will target equivalency to 5 star Green Star and a 6 star aspiration. A completed Green Star scorecard can be found in Section 6 of this report.

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