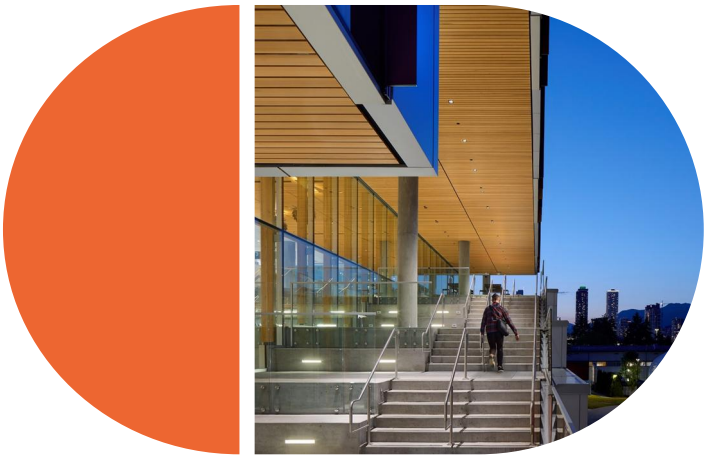
Ecologically Sustainable Development Report

SEED Stage 1B



04/03/2026

Ref: 301351808

PREPARED FOR:

Mirvac Projects Pty Limited

PREPARED BY:

Madhu Muthumalai, Stantec

Stantec

Revision Schedule

Revision No.	Date	Description	Prepared by	Quality Reviewer	Project Manager Final Approval
001	19/12/2025	Draft Issue for Review	Madhu Muthumalai	Rebecca Dracup	Rebecca Dracup
002	19/02/2026	Final Issue	Madhu Muthumalai	Rebecca Dracup	Rebecca Dracup
003	02/03/2026	Final Issue – Update with Revised Masterplan	Madhu Muthumalai	Rebecca Dracup	Rebecca Dracup
004	04/03/2026	Final Issue – Update with Standard Consultant Text	Madhu Muthumalai	Rebecca Dracup	Rebecca Dracup

Disclaimer

This report has been developed based on the development level of information provided to Stantec. Stantec has taken every effort to ensure the information presented in this report is an accurate reflection of the development but cannot guarantee the final performance of the building. The content of the development, including systems, materiality and finishes is subject to final architectural and client approval and subject to change.

Contents

Revision Schedule i

Disclaimer i

Contents i

1. Executive Summary 1

2. Introduction 2

2.1 Project Description 2
2.2 Site Description 4
2.3 Purpose of this Report 4

3. Sustainable Design Framework 6

3.1 Secretary's Environmental Assessment Requirements 6
3.2 The NSW Environmental Planning and Assessment Regulation 2000 7
3.3 State Environmental Planning Policy (Sustainable Buildings) 2022 7
3.4 National Construction Code (NCC) 2022 8
3.5 Penrith Development Control Plan (DCP) 2014 8
3.6 Penrith Local Environmental Plan (LEP) 2010 9
3.7 Western Sydney Aerotropolis Plan 10
3.8 Western Sydney Aerotropolis DCP 2022 – Phase 2 10
3.9 Western Sydney Aerotropolis Precinct Plan 11

4. Project Design Response 14

5. ESD Opportunities & Initiatives 15

5.1 Australian ESD Framework Green Star 15
5.2 Greenhouse Gas & Energy Efficiency 15
5.3 Water Efficiency 19
5.4 Indoor & Outdoor Environmental Quality 21
5.5 Building Management 24
5.6 Circular Economy and Waste Management 24
5.7 Climate Change Resilience 26

6. Summary of Design Response 32

List of tables

Table 1 Legal Description 1
Table 2 SEARs Requirements & Government Agency Comments 4
Table 3 Projected annual average temperature increase- Metropolitan Sydney (Source: NARClim 2.0) 26
Table 4 Projected increase in average annual number of hot days- Metropolitan Sydney (Source: NARClim 2.0) 27
Table 5 Projected change to average rainfall – Metropolitan Sydney (Source: NARClim 2.0) 28
Table 6 Projected increase in average annual number of severe fire weather days- Metropolitan Sydney (Source: NARClim 2.0) 29

List of figures

Figure 1 SSDA Materplan – SEED Stage 1B (Source: SBA Architects) 3
Figure 2 The Site 4
Figure 3 Energy Efficiency Strategy Hierarchy 16
Figure 4 Mirvac's Planet Positive (Source: Mirvac) 17
Figure 5 Rooftop Solar PV (Source: Google images) 17
Figure 6 Illustration of WELS rating label. 20
Figure 7 Illustration of a Rainwater Harvesting System. 20
Figure 8 Drainage Reserve within the SSDA Masterplan Stage 1B Drawing (Source: SBA Architects) 21
Figure 9 Effect of roofing solar absorption (SA). 22
Figure 10 Illustration of a light coloured (reflective) roof sheeting. 22
Figure 11 Effects of opening placement in relation to wind direction (Source: Autodesk Sustainability Workshop) 22
Figure 12 Thermal Chimney Effect *(http://www.windowwarehouseqld.com.au/windows/louvres)* 23
Figure 13 Motorised smoke exhaust fans can enable hot air to escape through roof, facilitating air ventilation. 23
Figure 14 Amenity area within the precinct masterplan (Source: SBA Architects) 23
Figure 15 The "Waste Hierarchy" 25
Figure 16 Historical and projected average temperature change – Metropolitan Sydney (Source: NARClim 2.0) 26
Figure 17 Historical and projected change in annual number of hot days – Metropolitan Sydney (Source: NARClim 2.0) 27
Figure 18 Historical and projected change to average rainfall- Metropolitan Sydney (Source: NARClim 2.0) 28
Figure 19 Historical and prjected change to annual number of severe fire weather days- Metropolitan Sydney (Source: NARClim 2.0) 29

1. Executive Summary

This Ecologically Sustainable Development (ESD) Report has been prepared by Stantec to accompany a State Significant Development Application (SSDA) SSD-99079487 which supports the staged development of SEED Stage 1.

The SEED Stage 1 Concept Proposal (SSD-19618251) and detailed stage development identified as the Stage 1A Development has been approved on 4 February 2026. SEED Stage 1 (SSD-19618251) establishes a Concept Masterplan for seven (7) industrial buildings and a café, subdivision at 1669-1723 and 1669A Elizabeth Drive Badgerys Creek. SEED Stage 1A includes site preparation works, the bulk earthworks, road construction, construction and operation of two (2) warehouse buildings (Warehouses 2 and 6).

Mirvac is seeking approval for a new DA for the construction and operation of Warehouses 1, 4, 5, 7 and 8, a café and regional stormwater basin at 1669-1723 and 1669A Elizabeth Drive, Badgerys Creek. This forms the second stage of development works envisaged under the SEED Stage 1 Concept Proposal (SSD-19618251) and is referred to as the "SEED Stage 1B".

A concurrent modification application to SEED Stage 1 Concept Proposal and SEED Stage 1A (SSD-19618251) is proposed to update civil design elements and FFL to align with proposed design for SEED Stage 1B.

The legal description of the site as it pertains to SEED Stage 1B is outlined in Table 1 below.

Table 1 Legal Description

Property Address	Title Description
1669-1732 Elizabeth Drive, Badgerys Creek	Lot 100 in DP 1283398
1669A Elizabeth Drive, Badgerys Creek	Lot 741 in DP810111

This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued (dated 8th December 2025) for the project (SSD-99079487).

This report concludes that the proposed development is suitable and warrants approval subject to the implementation of the following mitigation measures.

- Ensure compliance with NCC 2022 Section J requirements through all stages of design development by reviewing design and services documentation and flagging any non-compliances.
- Ensure compliance with Green Star requirements through all stages of design development, construction up until practical completion by reviewing design and services documentation and flagging any non-compliances, providing suitable recommendations or alternatives, and liaising with the Green Building Council of Australia (GBCA) on any proposed alternative approach.

Following the implementation of the above mitigation measures, the remaining impacts are appropriate.

2. Introduction

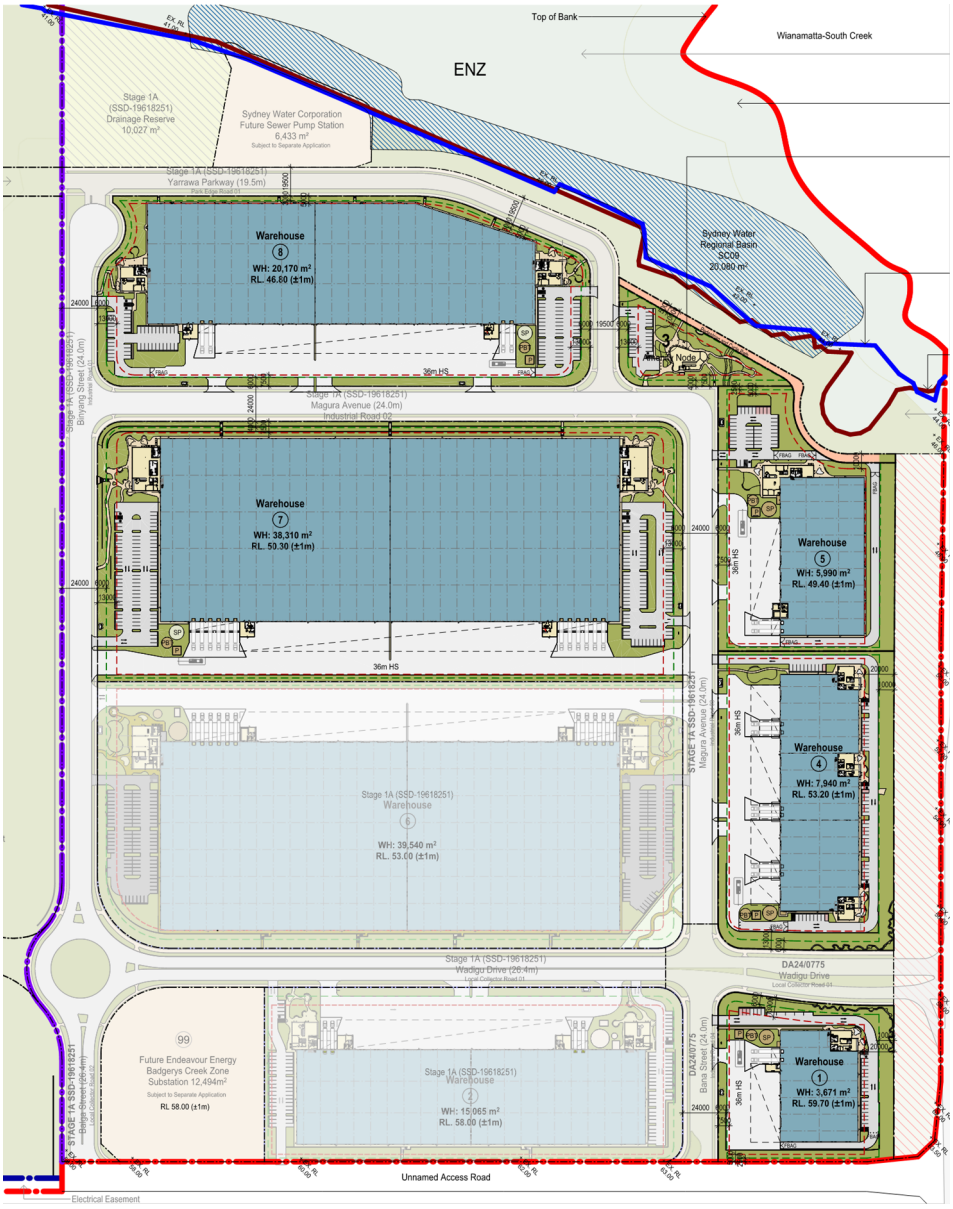
Mirvac is seeking approval for a new DA for the construction and operation of Warehouses 1, 4, 5, 7 and 8, a café and regional stormwater basin at 1669-1723 and 1669A Elizabeth Drive, Badgerys Creek. This forms the second stage of development works envisaged under the SEED Stage 1 Concept Proposal (SSD-19618251) and is referred to as the "SEED Stage 1B".

2.1 Project Description

The SEED Stage 1B Development seeks approval for the following:

- Construction of the following warehouse buildings for the purpose of warehouse and distribution centres (including warehouse building GFA, ancillary office GFA, hardstand areas for loading/ unloading/ vehicular manoeuvring and on-lot car parking):
  - Warehouse 1 (Lot 1) comprising 4,130sqm of GFA and 31 car parking spaces;
  - Warehouse 4 (Lot 4) comprising 8,990sqm of GFA and 55 car parking spaces;
  - Warehouse 5 (Lot 5) comprising 6,840sqm of GFA and 42 car parking spaces;
  - Warehouse 7 (Lot 7) comprising 40,410sqm of GFA and 183 car parking spaces;
  - Warehouse 8 (Lot 8) comprising 21,370sqm of GFA and 98 car parking spaces; and
  - Operating hours for Warehouse Buildings 1, 4, 5, 7 and 8 for 24 hours, 7 days a week.
- Estate café comprising 150sqm of GFA, 24 car supporting parking spaces as part of the Edge Amenity node. Operating hours for the Estate café from 5am to 5pm, 7 days a week;
- Construction of Sydney Water Regional Stormwater Basin SC09;
- Landscaping, including on-lot landscaping and amenity areas, street reserve landscaping and estate amenity nodes; and
- Construction of some new on-lot retaining walls to manage level differences between development lots; and
- Estate wayfinding signage.

This proposal concerns the construction and operation of remaining warehouse buildings established under the SEED Stage 1 Concept Masterplan and further to the site preparation works approved under the Stage 1A Development approval.



STAGE 1 DEVELOPMENT DATA (GFA)	
Site 1 Area	12,900 m²
Warehouse	3,671 m²
Office	409 m²
Dock Office	50 m²
Building GFA	4,130 m²
Car Required	25
Car Provided	31
Site 2 Area	33,202 m²
Warehouse	15,065 m²
Office	1,060 m²
Dock Office	200 m²
Building GFA	16,325 m²
Car Required	84
Car Provided	84
Site 3 Area (Amenity Node)	4,077 m²
Cafe	300 m²
Car Required	8
Car Provided	24
Site 4 Area	23,907 m²
Warehouse	7,940 m²
Office	1,050 m²
Building GFA	8,990 m²
Car Required	54
Car Provided	55
Site 5 Area	18,155 m²
Warehouse	5,990 m²
Office	750 m²
Dock Office	100 m²
Building GFA	6,840 m²
Car Required	42
Car Provided	42
Site 6 Area	70,705 m²
Warehouse	39,540 m²
Office	1,900 m²
Dock Office	200 m²
Building GFA	41,640 m²
Car Required	186
Car Provided	188
Site 7 Area	69,372 m²
Warehouse	38,310 m²
Office	1,900 m²
Dock Office	200 m²
Building GFA	40,410 m²
Car Required	181
Car Provided	183
Site 8 Area	39,877 m²
Warehouse	20,170 m²
Office	1,000 m²
Dock Office	200 m²
Building GFA	21,370 m²
Car Required	98
Car Provided	98

Figure 1 SSDA Materplan – SEED Stage 1B (Source: SBA Architects)

Modifications to SEED Stage 1

- Re-distribution of warehouse and ancillary office GFA across Warehouse Buildings 1, 4, 5, 7 and 8 to align with the proposed SEED Stage 1B designs (net-zero change to the total GFA across these warehouse buildings);
- Minor increase to the café GFA by 150sqm for consistency with SEED Stage 1B requirements;
- Refinement to the approved levels and retaining walls for consistency with SEED Stage 1B requirements. This includes adjustment to Lot 8s FFL as well as refinements to the design of some approved retaining walls;
- Update to the cumulative stormwater management strategy for SEED to reflect changes to the intended development outcome at the Aspect Industrial Estate (AIE) site that is being progressed under a separate application; and
- An optional contingency to modify the interim evaporation basin within the SEED Stage 2 land.

The development sought as part of this proposal and the development under SSD-19618251 will deliver a unified, staged development of the overall Precinct.

2.2 Site Description

The site is located at 1669-1732 Elizabeth Drive (Lot 100 in DP1283398) Badgerys Creek within the Penrith Local Government Area (LGA) (refer to Figure 2 below).

Figure 2 The Site

2.3 Purpose of this Report

This report has been prepared in response to the requirements contained within the Secretary's Environmental Assessment Requirements (SEARs) dated 8th December 2025 and issued for the SSDA (SSD-99079487). Specifically, this report has been prepared to respond to the SEARs requirement and government agency comments issued below.

Table 2 SEARs Requirements & Government Agency Comments

Item	Description of Requirement	Section Reference (this Report)
ESD-01	Identification of how ESD principles (as defined in section 193 of the EP&A Regulation) are incorporated in the design and ongoing operation of the development.	Section *4 Project Design Response*
ESD-02	Demonstration of how the development will meet or exceed the relevant industry recognised building sustainability and environmental performance standards.	Section *5.1 Australian ESD Framework Green Star*
ESD-03	Demonstration of how the development minimises greenhouse gas emissions (reflecting the Government's goal of net zero emissions by 2050) and consumption of energy, water (including water sensitive urban design) and material resources.	Sections *5.2 Greenhouse Gas & Energy Efficiency*, *5.3 Water Efficiency*, and *5.6 Circular Economy and Waste Management*

Item	Description of Requirement	Section Reference (this Report)
ESD-04	If Chapter 3 of State Environmental Planning Policy (Sustainable Buildings) 2022 applies: - demonstrate how the development has been designed to address the provisions set out in in Chapter 3.2(1) - provide a NABERS Embodied Emissions Material Form to disclose the amount of embodied emissions attributable to the development in accordance with section 35BA of the EP&A Regulation.	Section *5 ESD Opportunities & Initiatives*

3. Sustainable Design Framework

The proposed sustainability response for the project includes various associated drivers, including the following regulatory frameworks:

- The Secretary's Environmental Assessment Requirements (SEARs) for the development (SSD-99079487);
  - Ecologically sustainable development,
  - Greenhouse gas and energy efficiency,
  - Water conservation measures.
- The NSW Environmental Planning and Assessment Act 1979;
- The NSW Environmental Planning and Assessment Regulation 2000;
- State Environmental Planning Policy (Sustainable Buildings) 2022;
- Penrith Council Development Control Plan (2014); and
- Penrith Council Local Environmental Plan (2010).
- Western Sydney Aerotropolis Plan
- Western Sydney Aerotropolis Development Control Plan 2022- Phase 2; and
- Western Sydney Aerotropolis Precinct Plan

3.1 Secretary's Environmental Assessment Requirements

Secretary's Environmental Assessment Requirements (SEARs) for the proposed development (SSD-99079487) issued on 8 December 2025 states the following:

The Environmental Impact Statement (EIS) must address the following specific matters:

Ecologically Sustainable Development – including:

- *identification of how ESD principles (as defined in section 193 of the EP&A Regulation) are incorporated in the design and ongoing operation of the development*
- *demonstration of how the development will meet or exceed the relevant industry recognised building sustainability and environmental performance standards*
- *demonstration of how the development minimises greenhouse gas emissions (reflecting the Government's goal of net zero emissions by 2050) and consumption of energy, water (including water sensitive urban design) and material resources*
- *if Chapter 3 of State Environmental Planning Policy (Sustainable Buildings) 2022 applies:*
  - *demonstrate how the development has been designed to address the provisions set out in in Chapter 3.2(1)*
  - *provide a NABERS Embodied Emissions Material Form to disclose the amount of embodied emissions attributable to the development in accordance with section 35BA of the EP&A Regulation.*

3.2 The NSW Environmental Planning and Assessment Regulation 2000

Schedule 2 7(4) of the Environmental Planning and Assessment Regulation 2000 states:

"The principles of ecologically sustainable development are as follows:

a) 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,

b) 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,

c) conservation of biological diversity and ecological integrity, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,

d) improved valuation, pricing and incentive mechanisms, namely, that environmental factors 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."

3.3 State Environmental Planning Policy (Sustainable Buildings) 2022

Section 3.2 and 3.3 of the State Environmental Planning Policy (Sustainable Buildings) 2022 states the following:

3.2 Development consent for non-residential development

(1) In deciding whether to grant development consent to non-residential development, the consent authority must consider whether the development is designed to enable the following-

(a) the minimisation of waste from associated demolition and construction, including by the choice and reuse of building materials, (Refer to Section 5.6 Circular Economy and Waste Management for project design response)

(b) a reduction in peak demand for electricity, including through the use of energy efficient technology, (Refer to Section 5.2 Greenhouse Gas & Energy Efficiency for project design response)

(c) a reduction in the reliance on artificial lighting and mechanical heating and cooling through passive design, (Refer to Section 5.2 Greenhouse Gas & Energy Efficiency for project design response)

(d) the generation and storage of renewable energy, (Refer to Section 5.2 Greenhouse Gas & Energy Efficiency for project design response)

(e) the metering and monitoring of energy consumption, (Refer to Section 5.5 Building Management for project design response)

(f) the minimisation of the consumption of potable water. (Refer to Section 5.3 Water Efficiency for project design response)

(2) Development consent must not be granted to non-residential development unless the consent authority is satisfied the embodied emissions attributable to the development have been quantified.

3.3 Other considerations for large commercial development

(1) In deciding whether to grant development consent to large commercial development, the consent authority must consider whether the development minimises the use of on-site fossil fuels, as part of the goal of achieving net zero emissions in New South Wales by 2050. (Refer to Section 5.2 Greenhouse Gas & Energy Efficiency for project design response)

(2) Development consent must not be granted to large commercial development unless the consent authority is satisfied the development is capable of achieving the standards for energy and water use specified in Schedule 3. (Refer to Section 5.2 Greenhouse Gas & Energy Efficiency and Section 5.3 Water Efficiency for project design response)

(3) For the purpose of subsection (2), development is capable of achieving a standard specified I Schedule 3 if there is a NABERS commitment agreement in place to achieve the standards. (Refer to Section 5.2 Greenhouse Gas & Energy Efficiency for project design response)

3.4 National Construction Code (NCC) 2022

The project will be required to demonstrate compliance with the NCC 2022 Section J energy efficiency provisions.

Section J outlines the minimum performance requirements including:

- Maximum greenhouse gas emissions (GHG) levels;
- Minimum thermal envelope performance for building elements such as walls, floors, roof, and external glazing.
- Minimum performance requirements for building sealing;
- Maximum lighting power densities for internal lighting design;
- Minimum performance levels for building air conditioning and ventilation systems;
- Minimum requirements for energy and water data collection; and
- Minimum access for maintenance requirements.

The proposed façade for Section J (NCC 2022) will outline the thermal performance requirements fir code compliant façade designs, meaning consideration must be shown for the amount if exposed glazing included within the façade design.

The development will need to seek to optimize energy efficiency and thermal performance via design elements which improve the building façade performance including façade design, thermal envelope, HVAC system selection and lighting design.

3.5 Penrith Development Control Plan (DCP) 2014

The Penrith Development Control Plan 2014 has been prepared in accordance with Section 74C of the Environmental Planning and Assessment Act 1979 and clause 16 of the Environmental Planning and Assessment Regulation 2000.

Chapter ***C1 Site Planning and Design Principles*** of the Penrith Development Control Plan 2014 states:

1.2. Design Principles

B. Objectives

b) To ensure that development is designed on a 'whole of building' approach by:

ii. responding to climatic and contemporary environmental conditions by:

- *encouraging passive solar building design;*
- *allowing reasonable daylight access to all developments and the public domain;*
- *reducing the necessity for, or improve the control of, mechanical heating and cooling;*
- *reducing the energy consumed by installed appliances and equipment;*
- *improving the indoor environmental quality of occupants;*
- *minimising greenhouse gas emissions;*

1.2.2. Built Form – Energy Efficiency and Conservation

a) The selection criteria for construction materials, including internal fit-out work, should include detailed documentation of their energy efficiency properties.

b) Buildings should be designed on passive solar design principles which:

i. Respond to orientation to maximise the northerly aspect and solar access in the cooler periods;
ii. Reduce overheating in summer and promote solar gain in winter; and
iii. Ensure there is adequate cross flow of air by utilising natural ventilation, resulting in a reduction in the use of mechanical ventilation and/or air-conditioning systems.

c) The future use and occupants of the building should be considered in the design and location of building services/equipment to ensure that:

i. The thermal comfort of occupants is optimised through zoning sections of the floor area to
ii. of building services is provided enable individual control of heating and cooling;
iii. Lighting systems and fittings have reduced energy consumption that are also appropriate for the use/activity located in that part of the building;
iv. The equipment or service will be used and its future use will not affect other elements of sustainability; and
v. Sub-metering to individual tenancies within the development to enable individual monitoring of consumption performance.

d) Common and service areas in the building should incorporate energy and water efficiency/conservation measures in their design and location.

Chapter ***C3 Water Management*** of the Penrith Development Control Plan 2014 states:

C. Controls

3) Proposed Industrial Land Uses

The following controls apply to new industrial buildings and significant alterations/additions to industrial buildings:

b) All proposed industrial sites with a hard surface area (including roof area, driveways, parking areas, loading bays, covered storage areas, etc.) greater than 1,000m2 shall submit a water management plan which estimates required water needs, and includes an investigation into the feasibility of the measures listed below, outlines those to be adopted on the site and explains why any measures not adopted were unable to be implemented:

i. Rainwater tanks connected to roof and gutter systems and installed to enable reuse of rainwater for irrigation, industrial processes, toilet flushing or other non-drinking purposes;
ii. Stormwater detention systems installed and maintained to enable the reuse of stored water for irrigation, industrial processes, toilet flushing or other non-drinking purposes, and to minimise the impact of runoff from the site;
iii. Roof gardens, either for recreational purposes or as a means to reduce hard stand area.

3.6 Penrith Local Environmental Plan (LEP) 2010

Part 7.4 of the Penrith Local Environmental Plan 2010 states:

Part 7 Additional local provisions

7.4 Sustainable development

In deciding whether to grant development consent for development, the consent authority must have regard to the principles of sustainable development as they relate to the development based on a "whole of building" approach by considering each of the following—

a) conserving energy and reducing carbon dioxide emissions,
b) embodied energy in materials and building processes,
c) building design and orientation,
d) passive solar design and day lighting,
e) natural ventilation,
f) energy efficiency and conservation,
g) water conservation and water reuse,
h) waste minimisation and recycling,
i) reduction of vehicle dependence,

j) potential for adaptive reuse."

3.7 Western Sydney Aerotropolis Plan

The Western Sydney Aerotropolis Plan (September 2020) establishes the strategic vision and planning framework to guide the creation of a connected, innovative, and sustainable precinct for Western Sydney.

1.2 Purpose of the Plan

1.2.1 Aerotropolis-shaping objectives and principles

Sustainability

Objective 4 – A landscape-led approach to urban design and planning

- *SU2 Integrate Blue Green Infrastructure links with public open spaces and the Green Grid, maximizing opportunities for connections, an urban tree canopy and active use of the floodplain.*
- *SU3 Retain water in the landscape by maximizing appropriate permeable surfaces, reusing water and developing appropriate urban typologies.*
- *SU13 Plan stormwater and wastewater in the Wianamatta-South Creek Catchment to minimize potential hydrologic and hydraulic impacts on ecology, creek structure, infrastructure, water quality and the natural water cycle. Integrate water sensitive urban design and use stormwater or recycled water to irrigate streets and public open space to support public amenity and urban cooling. Co-locate industrial water users, where appropriate.*

(Refer to Section 5.3.1 Water Sensitive Urban Design (WSUD) for project design response)

Objective 5 - A sustainable low carbon Aerotropolis that embeds the circular economy.

- *SU 14 Use low carbon, high efficiency strategies to reduce emissions and energy use in line with NSW net zero emissions target and mitigate urban heat through urban development and building design. Use innovative and integrated approaches to achieve higher standards of resource recovery, waste management, water management and renewable energy.*

(Refer to Section 5 ESD Opportunities & Initiatives for project design response)

3.8 Western Sydney Aerotropolis DCP 2022 – Phase 2

The Western Sydney Aerotropolis DCP 2022- Phase 2 outlines the planning principles and controls which guide the project's design framework in achieving a sustainable development.

Section 2.12 (Sustainability) of the DCP identifies the following objectives:

O1. Minimise the energy consumption and achieve net zero energy emissions by 2030.

Performance Outcome		***Benchmark Solution***
PO1	*Incorporate renewable energy systems to ensure all buildings can achieve a 100% renewable energy supply by 2030.*	*1. All developments demonstrate how 100% renewable energy supply can be achieved by 2030, whether on or off site.* *2. Where the net zero energy target cannot be accommodated on site, the proponent must provide an offset e.g., with a Power Purchase Agreement.*

Section 3.3.4 (Building and architectural design) of the DCP identifies the following performance outcomes and benchmark solutions:

Performance Outcome		Benchmark Solution
PO1	*To ensure buildings achieve a high level of sustainability and environmental performance.*	*1. Buildings should take advantage of a north-easterly aspect to maximize passive solar illumination, heating and natural cross-ventilation for cooling.* *2. Development proposals shall demonstrate Ecological Sustainable Design (ESD) measures have been incorporated into the design, including a consideration of:* *a. Building and window orientation;* *b. Window size and glass type;* *c. Insulation;* *d. Natural ventilation and light with generous, all weather openings;* *e. Utilise extensive roof areas for energy and water collection;* *f. Air flow, ventilation and building morphology to support cooling; and* *g. Circular economy in the design, construction and operation of buildings, public domain, infrastructure, and energy, water and waste streams.*

3.9 Western Sydney Aerotropolis Precinct Plan

The Precinct Plan outlines the vision for the Aerotropolis, as well as the intended development outcomes, planning principles, and design controls to realise that vision across Sustainability, Connectivity, Productivity, Liveability, and Built Form. The development lies within the Wianamatta-South Creek and Badgerys Creek precincts of the Aerotropolis, to which this plan applies to.

The established framework for the Aerotropolis outlines the relevant performance criteria for the development under key framework elements, extracted below:

Blue-Green Infrastructure Framework

This includes the following planning guidelines and design controls:

- To integrate blue and green systems across the Aerotropolis for water quality management, biodiversity and recreation.
- Protect, maintain and/or restore waterways, riparian corridors, water bodies and other water dependent ecosystems.
- Provide a landscape-led approach to integrated stormwater management and water sensitive urban design.
- Establish a network of multifunctional stormwater assets that support stormwater management and contribute to broader objectives for waterway health, biodiversity, urban greening and cooling, recreation and amenity.
- Protect, restore and maintain vegetated riparian zones adjacent to creeks and other water bodies in accordance with the Water Management Act and related Guidelines.
- Manage impacts of development on waterways to achieve and maintain established waterway health targets.
- Enable people to have safe contact with water in the landscape for recreation and access to urban cooling.
- Achieve an interconnected and accessible network of open space that meet the recreational and amenity needs of residents and workers.

- Achieve the targets in the region Plan of 40% canopy cover across the Aerotropolis by 2036.
- Use the green and blue framework to form connected networks of open space.
- Provide equitable access to open space for people living or working in the Aerotropolis.
- The design of streets and other public places contributes to management of urban heat and provides for the comfort and amenity of residents and workers.
- Achieve the objectives of, and implement, the Cumberland Plain Conservation Plan.
- Achieve the vision of a Western Parkland City and maintain Wianamatta-South Creek Corridor as a regionally significant ecological corridor.
- Protect areas of high biodiversity value including watercourses and riparian zones, Existing Native Vegetation and remnant vegetation and habitat of the Cumberland Plain.
- Increase and improve landscape connectivity through conservation and restoration of native vegetation to enable plant and animal communities to survive in the long term.
- Support long-term viability and ecological connectivity by ensuring development does not encroach on protected land and any ecological restoration program selects species that are resilient to a changing climate.
- Ridgeline and hilltop vegetation is preserved or reinstated.
- Creek lines, ridgelines and hilltops are connected through green streets that create a network of tree canopy.

Land Use and Built Form Framework

This includes the following planning guidelines and design controls:

- Develop and support a hierarchy of centres to create a 30-minute Western Parkland City with metropolitan, specialised, local and neighbourhood centres.
- Identify the Aerotropolis Core and the specialised centre in the northern Gateway as higher order centres with social infrastructure and higher employment and residential densities.
- Locate Local and Neighbourhood Centres in areas of high amenity linked to public transport.
- Link all centres to, and prioritise, active and public transport access over private vehicles.
- Suitably space local centres to provide sufficient services to enable walkable residential and working communities.
- Ensure sufficient distance between existing and proposed centres to ensure economic viability.
- To allow building heights that align with the role of each centre, its typology and residential/employment density needs.
- Facilitate height and urban density in the Aerotropolis Core and Northern Gateway around the Metro stations.
- FSR controls are to create an appropriate mix of employment, business, social and residential development in the Mixed Use zone, and Local and Neighbourhood Centres.
- Achieve a density of employment in mixed use areas to ensure residential uses are not the predominant use.
- Locate higher intensity mixed use development and residential densities within the 800m of the Metro station.
- Provide a mix of uses in the Mixed Use Zone, which supports employment and residential uses, and ensures employment generating development is prioritised while residential development occurs in suitable locations.
- Development contributes towards achieving the strategic employment density targets of the Aerotropolis Plan.

- Employment generating development in the Aerotropolis contributes to achieving the following indicative employment densities:
  - City Centre: 130 – 400 jobs/ hectare
  - Urban Services: 25 – 35 jobs/ hectare
  - Office Park: 130 – 250 jobs/ hectare
  - Campus Style Business Park: 75 – 130 jobs/ hectare
  - General Industrial: 25 – 30 jobs/ hectare
  - Large Logistics: 18 – 25 jobs/ hectare
  - Education/ Community: 30 – 50 jobs/ hectare
- Allow flexibility for development and land uses to evolve as precincts mature and the Airport consolidates within the Aerotropolis.
- Provide guidance to applicants and consent authorities on the carrying out of architectural design competitions.

Sustainability and Resilience Framework

- Development is to support the transitioning to a net zero or net positive outcome over the medium to long term. This will be measured around performance regarding waste management, water management and carbon consumption benchmarks that are provided in the DCP or other relevant legislation.
- Development should seek to exceed the water and energy requirements of BASIX.
- Green infrastructure is effectively used through the provision of water treatment and retention, urban cooling, ecosystem services and amenity and integrated into built, landscaped and natural environments.
- Buildings, infrastructure and public domain elements maximise the recycling and reuse of materials.
- Facilitate the design, construction and operation of environmentally sustainable buildings and precincts, including energy efficiency, renewable energy, efficient resource and energy use and reduced emissions and waste.
- Effectively uses waste as a resource through its collection, transport and recycling in a manner that is safe, efficient, cost effective and does provide a positive impact on liveability and the environment.
- Measures to mitigate urban heat island effects are integrated in the design of the built form and public domain, for example the use of light-coloured roofs.
- Planning is to provide sustainable and resilient approaches to development and is to incorporate circular economic principles found in the NSW Circular Economy Policy Statement.
- Plan for, and achieve, leading industry targets by 2025 and from 2026 beyond to achieve sustainable regenerative targets:

Description	Leading industry practice Target 2020 and 2025	Sustainable regenerative Target 2026 and beyond
Non-residential uses (subject to final modelling)	Green Star Communities – 5+ stars Green Star – 5+ stars	Green Star Communities – 6+ stars Green Star – 6+ stars
Circular economy targets	10% reduction of waste generation 85% reduction in construction waste	100% recovery and re-use of organic waste 90% reduction in construction waste

4. Project Design Response

The project team has assessed the energy use profile and impact of climate change on the development and will implement a number of energy efficiency and climate resilience measures that will reduce significantly the greenhouse gas emissions and footprint of the project and improve its resilience to the predicted climate risks. Also, as listed below, a series of best practice sustainable initiatives will be incorporated so that potential environmental impacts are mitigated substantially.

The development will consider potential environmental impacts by reducing it through application of best practice design and processes such as the many ESD commitments and initiatives listed in the following Section. The documented initiatives to be implemented – which are the basis for the response to the Sustainable Design Frameworks outlined above - include:

- Buildings to be net positive for carbon emissions where determined by Mirvac to be appropriate;
- On-site renewable energy production with rooftop solar PV on each building;
- Environmental outcome equivalent to a 4 Star Green Star commitment and 5 Star Green Star target;
- Smart metering;
- Electric car and truck charging future provisioning;
- Rainwater harvesting and reuse;
- Energy Efficient lighting systems (internal and external) and lighting controls;
- Best practice façade thermal performance / Building thermal mass;
- Natural ventilation to majority of the warehouse floor area;
- Solar gain reduction / shadings;
- Efficient HVAC system equipment (office spaces);
- Explore opportunities to reduce embodied energy reduction associated to construction material selection;
- Increased access to natural daylight where possible;
- Water efficient fixtures and fittings (WELS rating);
- Selection of native and low water plants / trees;
- Application of Water Sensitive Urban Design (WSUD) principles;
- Increased indoor and outdoor environmental quality;
- Waste Management Plan;

Any further concerns will be addressed through development of a Construction Environmental Management Plan that incorporates mitigation measures to ensure that environmental impacts to the site are minimised during construction. Contractors will also be requested to provide and abide by an Environmental Management System to be in accordance with NSW Environmental Management Systems Guidelines or a similar standard. This places a value on environmentally responsible building practices to ensure they are held responsible for the environmental management of the building site as they complete their work. Once the new development is under activity, operational guidelines, best practice procedures and appropriate monitoring and control measures will be defined by the building owner. This will be in accordance with the sustainable strategies adopted by the development and will be distributed to the tenants to ensure environmental impacts associated with operational processes are minimised wherever possible.

5. ESD Opportunities & Initiatives

The following section addresses the greenhouse gas, energy efficiency and ecologically sustainable development aspects in response to the Sustainable Design Frameworks (as per Section 3) for the project. It uses best practice sustainable design principles and borrows elements from external sustainability tools to develop a set of metrics for the site.

There are several ESD opportunities and initiatives that will be implemented in the project. The following examples are to be read in conjunction with design documentation prepared by SBA Architects. Stantec note the design is in its very early stages, and the following concepts will be considered going forward.

Fundamental to the success of improving the ESD outcome for the project is the adoption of a strong design philosophy. Passive design features can:

- Lower operational energy demand via improved thermal performance;
- Promote greater indoor environmental quality;
- Reduce the requirements for artificial lighting & power;
- Reduce the buildings' reliance on HVAC systems;
- Improve building occupant comfort; and
- Improve the project's capacity to deliver a responsible development.

The warehouses design will include several passive design options and provide a robust and environmentally sensitive framework. Furthermore, several energy efficiencies measures and intelligent selection of systems are being proposed in order to improve the environmental outcome of the development while maintaining occupant level comfort and well-being.

5.1 Australian ESD Framework Green Star

The project is committed to achieving 4 Star Green Star ratings but targeting 5 Star (subject to final modelling) as per the Western Sydney Aerotropolis Precinct Plan. As proposed by the Green Star framework, a holistic approach will be taken towards the environmental performance of the development, where relevant ESD principles from the Green Star scheme will be applied so that the project can achieve the targeted standard.

5.2 Greenhouse Gas & Energy Efficiency

A variety of greenhouse gas and energy efficiency measures are applicable to the proposed development and form part of the initial design and operation plan for the warehouses. The final strategy will be a combination of sustainability, operational feasibility, architectural intent and site-specific appropriateness.

The energy efficiency strategy follows the hierarchy pyramid below. Best practice energy conservation dictates that in the first instance demand is reduced. This has a much greater benefit to the overall long-term sustainability of the site compared to efficiency measures or renewables/offsets. As such, the focus will be on the elements that provide the greatest impact and return on investment.

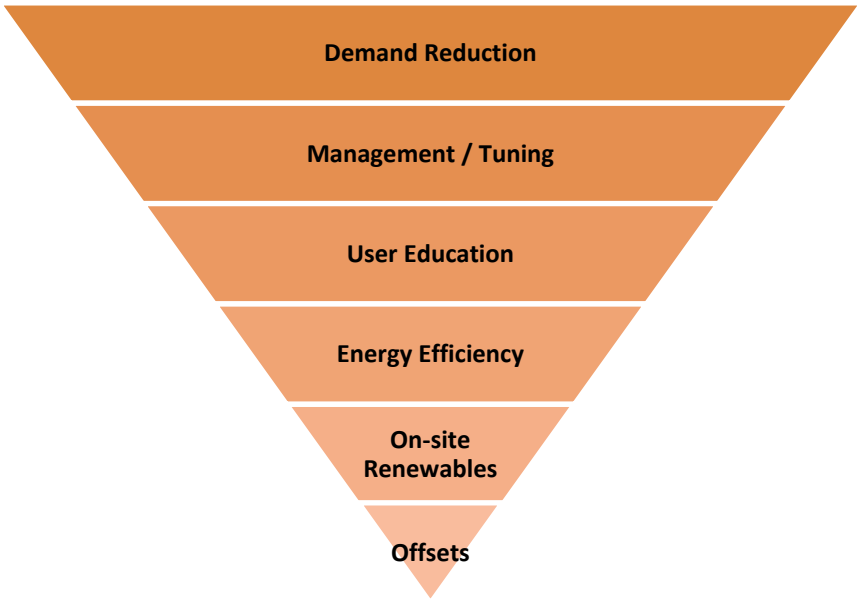


Figure 3 Energy Efficiency Strategy Hierarchy

5.2.1 Site-wide Energy Strategies

Methods to achieve the greenhouse gas and energy efficiency goals of the project will go above and beyond the regulatory requirements and industry benchmarks. The below is proposed to be implemented:

- **Buildings to be net positive for carbon emissions**

  The development is proposed not only be net carbon zero but to potentially go above and beyond industry benchmark and deliver a net positive development for embodied carbon emissions. This accounts for scope 1 and 2 greenhouse gas (GHG) emissions from the development. Mirvac has achieved this Net Positive Carbon goal for its existing assets in 2021, which is nine years ahead of schedule. This is outlined in Mirvac's plan released in November 2022.

  "Today, Mirvac is proud to announce that as of the first quarter of this financial year (1 July 2021), we have become net positive for Scope 1 and 2 emissions within our operational control- which means we now eliminate more carbon than we emit… We've been able to meet our net positive target early by maximising energy efficiency, transitioning away from fossil fuels by building all-electric, and investing in a small amount of high-quality, community focussed, nature-based carbon offsets." Planet Positive- How we achieved our Net Positive Carbon goal by 2021.

Figure 4 Mirvac's Planet Positive (Source: Mirvac)

- **On-site renewable energy production**

  On-site renewable energy production will be implemented in the design to minimise utilisation of energy from the grid system. The system will be designed so that renewable energy is prioritised for use. Consideration can also be given to selling excess energy back into the grid or storage on site for peak reduction.

  Further feasibility will be completed regarding the ideal system configuration, sizing, annual energy generation, etc., but it is anticipated that there will be a rooftop solar system provided to each building. It is noted the electricity consumption from the site is still to be estimated where the appropriate renewable energy contribution will depend on the final architectural design, industrial arrangement, building services design and tenants operational requirements.

Figure 5 Rooftop Solar PV (Source: Google images)

- **Energy efficient lighting systems (internal and external):**

  Energy efficient lighting selection (LED lighting) and system can reduce the electrical load on the grid significantly for the same illuminance output in comparison to traditional incandescent lights. Further, LED globes have a longer life, reducing replacement periods which demands less maintenance, as well as reducing landfill of precious materials. Mirvac will be utilising LED lighting throughout all buildings for the precinct.

- **Controls of lighting systems:**

  This can include zoned switching, lighting control systems with time clocks and may include lighting sensors where appropriate. This will reduce base building energy consumption by assuring artificial lighting is turned off when not required.

- **Façade Thermal Performance / Building Thermal Mass:**

  Building envelope thermal performance to comply with NCC 2022 Section J requirements (conditioned spaces). This will reduce reliance on mechanical cooling and heating and therefore bringing down HVAC operational energy consumption.

  The warehouses roof material and colour will be reflective of solar radiation, and consideration will be given to building overall thermal mass and to application of thermal insulation appropriate to the local weather profile.

- **Natural ventilation to majority of the warehouse floor area:**

  This will reduce drastically any dependence on HVAC systems and spaces conditioning, thus reducing significantly the project energy demand (and automatically reducing greenhouse gas emissions). Passive design strategies to be applied in order to treat indoor environment to enhance thermal comfort of the occupants.

- **Solar Gain Reduction / Shadings:**

  External shading devices will be implemented in the architectural design adjacent to conditioned spaces in order to reduce solar exposure / solar gains thus reducing the reliance on mechanical systems for internal conditioning. Awnings will be provided at each access point to the warehouses. This will be provided on the warehouse edge where trucks load/unload to provide sun protection for employees.

  The building roof is designed to be light coloured (low solar absorptance), which also reduces solar gains by reflecting light and is beneficial to the local heat island effect.

- **Efficient HVAC System Equipment (Office spaces):**

  Efficient and bespoke HVAC systems with high COPs will be appropriately designed and sized for the development. This will include high efficiency centralised plant.

- **Embodied Energy reduction associated with construction material selection.**

  Construction materials are a highly carbon intensive component of any development. They often involve energy intensive production processes, large amounts of raw materials including water and energy, and long transport distances to reach the location of the development. However, there are a number of environmentally friendly practices starting to become accepted by the construction industry. Depending on the materials selected for the constructions, and the options available in the area, use of low embodied energy and water materials with preference for sourcing from local or sustainable materials suppliers will be adopted – where possible – during material selection and pre-construction process. This can also include materials with high recycled content.

- **Electric car and truck charging future provisions:**

  By including conduit provisions in the design for allowance of future Electrical Vehicle charging stations, the development will provide incentive to the use of low-emissions vehicles, which reduces the harmful air pollution associated to vehicles exhaust emissions. Further consideration will be given to implementing a number of Electrical Vehicle charging units. Furthermore, if renewable energy is used to feed the stations (either through the solar systems or Green Power) then this can represent a complete transition away from fossil fuels related to transport.

5.2.2 Warehouse Areas

The warehouses are responsible for the significant component of energy consumption within the site. A number of initiatives are proposed to reduce the greenhouse gas emissions and environmental impacts associated with the warehouse component on the development. These include:

- Energy efficient lighting systems (internal and external);
- Controls of lighting systems, including zoned switching, motion sensors and time clocks / lighting sensors as appropriate;
- Natural ventilation of the warehouses, except where for functional reasons this is not practicable (i.e. potential refrigeration rooms, freezer rooms, or other spaces with conditioning required for functional reasons);
- Roof ventilators are proposed to provide effective air changes to the space. This reduces the build-up of heat in the space and encourages air circulation, thus increasing occupant thermal comfort. This also helps control humidity in the space, reducing concerns of mould in the space. Note feasibility on such systems will be reliant on the industrial processes that will take place within the warehouses.
- Encouraging natural lighting where possible (e.g. where internal thermal comfort is not compromised), through application of translucent roof materials across the warehouse roofing components. This reduces reliance on artificial lighting and supports an energy efficient design.

By providing an unconditioned space with natural ventilation, the key energy sources are lighting and plug loads. Plug loads are generally required for the function of the space and therefore reduction is proven unfeasible in most cases. Lighting loads can be reduced significantly by the introduction of zoned switching, time clocks and/or motion sensors. As such, the above provides an energy efficient solution to the warehouse component of the Stage 2 development.

5.2.3 Office Areas

The office has been analysed for a number of different design elements and configurations. These include:

- Energy efficient lighting systems (internal and external);
- Controls of lighting systems, including zoned switching, motion sensors and time clocks / lighting sensors as appropriate;
- High thermally performing glazing and general façade materials – to meet NCC 2022 Section J requirements;
- Increased mechanical equipment performance;
- Zoned mechanical systems (centre/perimeter);
- Wider temperature control band.

NABERS Energy

Through the above energy efficiency measures incorporated in the project design, the energy consumption of offices over 1,000m^2 will be capable of achieving a 5.5 star NABERS energy rating. The office areas commit to undertaking NABERS Energy rating assessments in accordance with the Sustainable Buildings SEPP requirements.

Combining all the above elements within the office design, there is a potential for the office energy consumption to be reduced significantly in comparison to a standard office space (considering business as usual systems in line with the BCA and standard operational procedures).

5.3 Water Efficiency

A variety of water efficiency measures can be applied to the proposed development. These best practice water efficiency measures implemented to reduce water consumption include:

- **Water efficient fixtures and fittings (WELS rating):**

  By implementing low-flow water fixtures, the consumption associated with amenities can be reduced. This includes taps, wash basins, WCs, Urinals, showers and supplementary water uses.

- **Water efficient appliances (WELS rating):**

Where applicable, priority will be given to efficient water appliances, such as dishwashers for the office spaces.

- **Rainwater harvesting and reuse:**

  A rainwater tank will be implemented as required. Further feasibility will be completed regarding the ideal tank sizing, capture area and end-use for any non-potable water collected. Rainwater on this site is particularly advantageous given the significant collection area across the building roofs. The captured water can offset irrigation water consumption, wash down and potentially toilet flushing and industrial processes. The rainwater tank volumes will be designed to meet at least 80% of non-potable water demand.

- **Water use metering and monitoring:**

  Which can identify leaks and amend losses before greater loss occurs.

- **Selection of native & low water plants / trees:**

  Native plants are designed to thrive in the Australian environment and are typically more resilient than their exotic counterparts. Low water species will reduce even more irrigation demand.

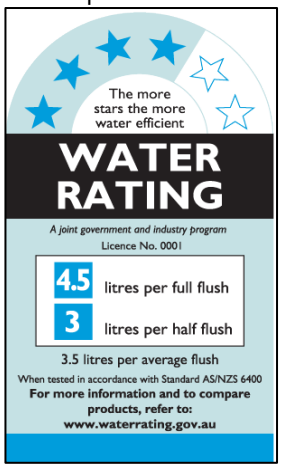


Figure 6 Illustration of WELS rating label.

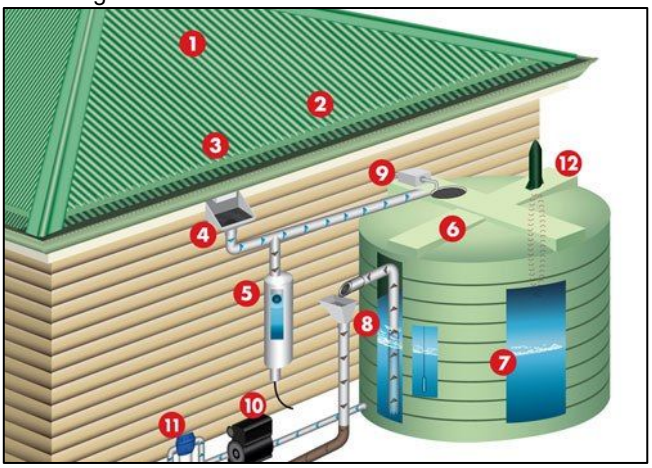


Figure 7 Illustration of a Rainwater Harvesting System.

- **NABERS Water**

  Through the above water efficiency measures incorporated in the project design, the water consumption of the development will be capable of achieving a 3-star NABERS water rating. The office areas commit to undertaking a NABERS Water rating assessment in accordance with the Sustainable Buildings SEPP requirements.

The above initiatives are sufficient to allow the project to meet best practice consumption benchmarks considering the HVAC mechanical design will most likely apply waterless heat rejection systems due to the size and volume of the commercial office spaces within the development.

5.3.1 Water Sensitive Urban Design (WSUD)

The WSUD principles outlined in Chapter C3 Water Management - Water Sensitive Urban Design - of the Penrith DCP will be considered for implementation by the project. These include:

- To maintain the natural water balance;
- To make more efficient use of water resources by conserving water, particularly potable (drinking) water;
- To reduce general flood risk;
- To reduce erosion of waterways, slopes and banks;
- To control stormwater and waste water pollution and improve water quality in waterways and groundwater;

- To integrate stormwater management with water supply and waste water treatment; and
- To integrate stormwater treatment into the landscape so as to maximise the visual and recreational amenity of urban development.

The following stormwater control measures have been proposed to be adopted within the site to meet the stormwater strategy objectives:

- **Rainwater tanks** which can contribute to minimising stormwater runoff by retaining a significant amount off the roof areas, in addition to harvesting this water for non-potable water use.
- Proprietary **gross pollutant traps,** such as Ocean Protect OceanSave, are proposed to be used as a means of primary stormwater flow treatment before discharging into the proposed bioretention basin.
- Proprietary **bio-retention system**, such as Filterra units, is proposed for the development to filter and remove pollutants from surface water runoff as it flows through the vegetation layer and underlying filter media.
- **Onsite stormwater detention** basin with surcharge pits, drainage pipes and weirs across basin crests for managing stormwater flows

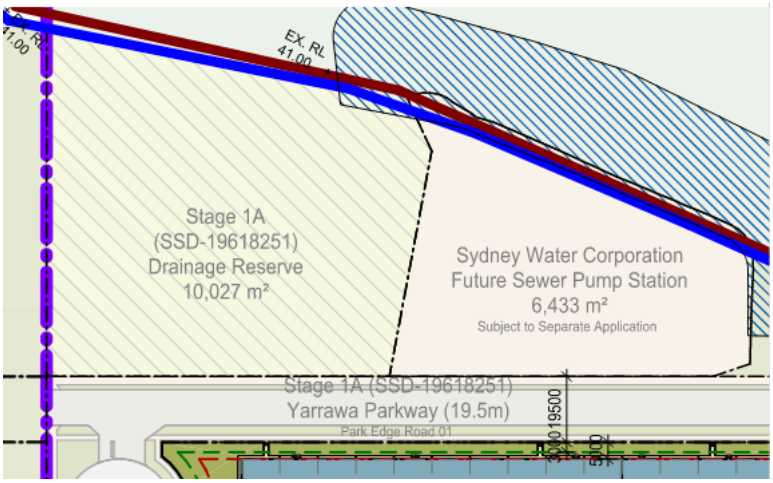


Figure 8 Drainage Reserve within the SSDA Masterplan Stage 1B Drawing (Source: SBA Architects)

5.4 Indoor & Outdoor Environmental Quality

Internal Environmental Quality and occupant comfort will be a key consideration in the warehouses design. A comfortable workplace encourages greater productivity, workplace satisfaction and tangible health benefits. These benefits range from reduction in stress, increased physical and mental health and general quality of life. Therefore, provision of more thermally comfortable spaces for employees and allowance to natural daylight are being envisaged.

Initiatives being contemplated that would improve overall occupants' comfort and internal environmental quality include:

- **Preference for reflective roof sheeting:**

  Solar heat is expected to be passively absorbed by the warehouse's roof sheeting, which shall drive the internal temperatures of the building up. By using a more reflective roofing material – which has a lower solar absorptance (SA) – the internal heat gains are reduced, thus reducing the average internal temperature of the building throughout the year.

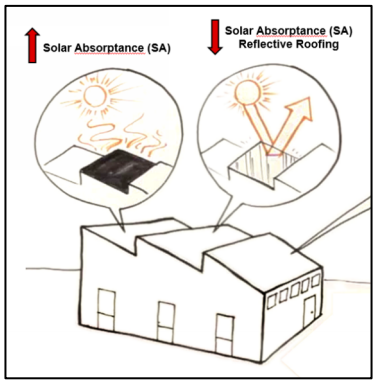


Figure 9 Effect of roofing solar absorption (SA).

Figure 10 Illustration of a light coloured (reflective) roof sheeting.

- **Application of translucent skylights:**

  Skylights are an excellent source of natural light. Natural light is preferred over artificial light because it falls in a more natural spectrum, is energy efficient and connects occupants to the outside.

  Considerations will be given to skylights sizing and heat transmissivity (HT), given these may allow more heat transfer to the warehouse interior, which is not desirable. Therefore, products with lower heat transmissivity will be prioritized.

  It may be preferable to reduce the skylight proportion over the staging areas, while leaving skylights in place in the storage areas. This allows a diffuse light into non-critical operation areas.

- **Increased natural ventilation:**

  Louvres or other openings in the walls/roof will allow cross-ventilation in the work zone, manageably increasing the air velocity and air change rates, what will passively reduce heat build-up in the space. The increased air movement provides a lower apparent temperature for the employees, as well as continuous introduction of fresh air.

  Even though outdoor air will eventually carry higher temperatures than the indoor air, the increased air speed allowed by louvres / openings can bring the occupants a greater thermal comfort than stagnant indoor air. This occurs because when the human body starts to overheat, it loses its capacity to remove that heat. Air movement is an important factor in thermal comfort and across the skin will remove the perspiration (sweat) heat very fast and offer a rapid drop in temperature. A lack of air movement can give a feeling of stuffiness.

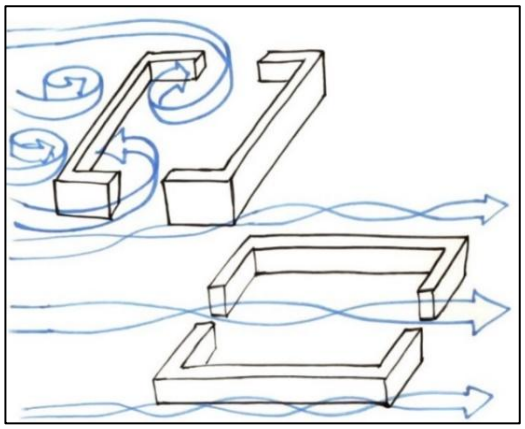


Figure 11 Effects of opening placement in relation to wind direction (Source: Autodesk Sustainability Workshop)

Another efficient way to naturally cool a space is to locate exhausts at high levels. This can be through clerestory waterproof louvres, or preferably smoke exhaust fans can carry out the role. This is effective because rising hot air

is able to escape the space through the high up fans, helping to keep the space cool. Roof exhaust fans effectively double the length of possible cross-ventilation by allowing exhaust air to exit at half the building's width.

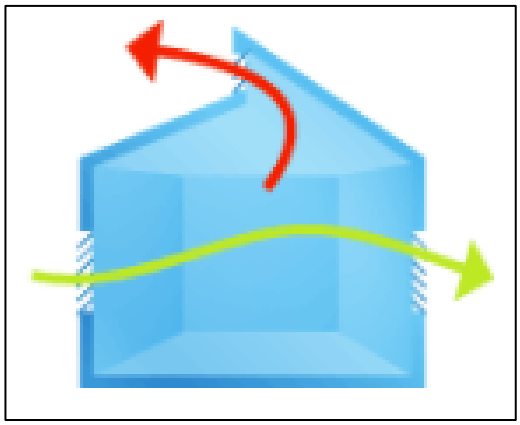


Figure 12 Thermal Chimney Effect
(http://www.windowwarehouseqld.com.au/windows/louvres)

Figure 13 Motorised smoke exhaust fans can enable hot air to escape through roof, facilitating air ventilation.

Note: Consideration will need to be given to the nature of the warehouse and its contents. In spaces where specific levels of air quality are required or strict humidity control, the design of louvres / openings must be more carefully considered. Additionally, there may be pollution, acoustic or dust issues with installation, which must be considered by the appropriate professional. Wind-driven rain may also provide a path for water ingress if louvres are not designed appropriately for their location.

- **Amenity Area & Public Open Space**

An outdoor amenity area is currently being considered within the precinct masterplan. This could be incorporated within the site to allow for occupants' amusement, health, and well-being. An open landscaped area and Café amenity could be included in such amenity zone. Pedestrian and cycle pathways will be made available within the site landscaped spaces within the precinct. These could facilitate social interaction and would provide break-out spaces with increased levels of natural daylight, fresh air and landscaped terrain.

In addition, the 'Public Open Space / Drainage Reserve' will also provide open space amenity to general public and operators within the estate.

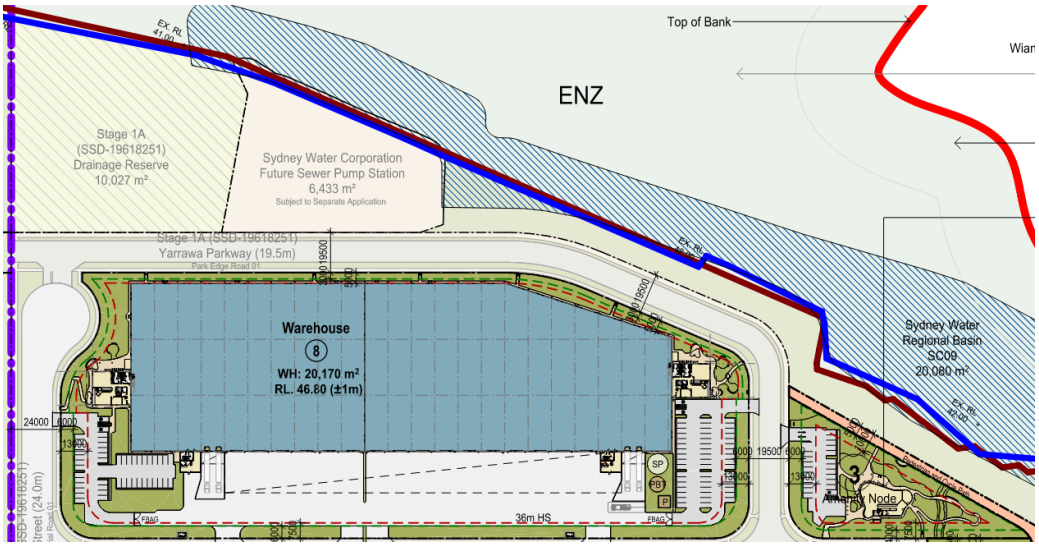


Figure 14 Amenity area within the precinct masterplan (Source: SBA Architects)

5.5 Building Management

In line with industry recognised best practice frameworks, the project design and built form will seek to respond to the ongoing environmental challenges of urban development and ensure the project implements a range of ESD initiatives aimed at improving ongoing building management.

Through specific contractual commitments and documented design intent the project proposes to address environmental management and building operational performance through the following initiatives.

- **Building Commissioning & Tuning Procedures**

  Prior to practical completion, the building will undergo commissioning to check that all new building systems are operating in line with the design criteria. A tuning period can then take place for the first 12 months post practical completion to check that key plant is operating as intended. By implementing this via project contract documents the project ensures operational efficiency and building operation is optimised in accordance with the intended building design.

- **Smart Metering**

  Smart metering will provide relevant data for the use and management of building staff. This will provide detailed information about the project energy use and profile on a regular basis and through an easily accessible online platform. This information will help in the understanding of the usage profile so that adjustments can be made to guarantee optimal performance. This ensures operational efficiency is maintained and also facilitates detection of systems failures, thus improving maintenance and tuning processes.

- **Waste provisions**

  Appropriate waste provisions are going to be included within the project to ensure recycling rates and reduced waste to landfill is optimised.

5.6 Circular Economy and Waste Management

In order to facilitate sustainable waste management within the City of Penrith in accordance with the principles of Ecologically Sustainable Development, waste minimisation, resource recovery and circular economy principles. This includes ensuring easy access to waste systems, pollution prevention associated with waste management practices. The approach aims to keep materials in use for as long as possible, reduce reliance on virgin resources, and design out waste wherever feasible.

The proposed development is targeting to increase on-site recycling and resource optimisation through adoption of the Waste Management Hierarchy with the ultimate goal of reducing waste going to landfill, which is in line with *The Waste Avoidance and Resource Recovery Act, 2001* and the *NSW Waste Avoidance and Resource Recovery Strategy 2014-21*. The waste reduction strategy follows the hierarchy pyramid below.

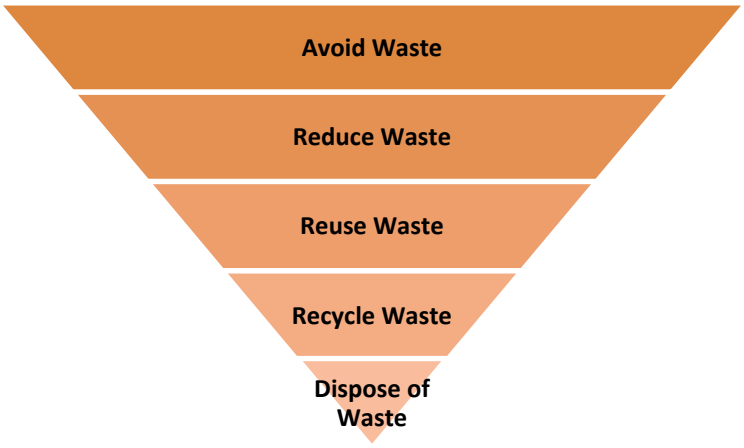


Figure 15 The "Waste Hierarchy"

Best practice initiatives will be explored through development of a Waste Management Plan, which will address Demolition, Early Works, Construction and Operation Waste Management Strategies, where appropriate.

The key objectives for the management of waste generated by the demolition, early works and construction and incorporating circular economy principles will include:

- Minimise waste generation on site;
- Segregate waste on site to maximise recycling and enable material recovery for reuse;
- Store wastes on site appropriately to prevent cross-contamination and/or mixing of different waste and maintain material value;
- Segregate hazardous waste for appropriate treatment and disposal, where applicable;
- Where appropriate, set targets for demolition and construction waste diversion from landfill, the following targets are set by the Western Sydney Aerotropolis Precinct Plan
  - 100% recovery and re-use of organic waste
  - 90% reduction in construction waste
- Where appropriate, analyse the potential operational waste generation profile from the warehouses and propose best practice strategies that support circular economy outcomes, such as material recirculation and product stewardship.
- Provide space and infrastructure to support source-separated food organics for businesses required to comply with the NSW Food Organics and Garden Organics recycling mandate, and for business who wish to voluntarily separate organics to divert them from landfill.
- Preference will be given to materials with high recycled content, such as recycled steel, concrete with supplementary cementitious materials, and recycled plastic products.
- Preference will be given to products that provide Environmental Product Declarations (EPDs) or demonstrate sustainable sourcing practices.

5.7 Climate Change Resilience

The SEARs requirement calls for a sustainability strategy that considers the impact of climate change and how the development will meet or exceed the relevant industry recognised building sustainability and environmental performance standards. The NSW and Australian Regional Climate Modelling (NARClim) data has been used to determine predicted climate change projections. NARClim2.0 offers 150 years of continuous climate-modelled data, including historical data and future projections, spanning from 1951 to 2100. NARClim2.0 adopts the latest global greenhouse gas emissions scenarios from the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report, including low (SSP1-2.6) and high (SSP3-7.0) emission scenarios.

Given its location, the site is found within the Metropolitan Sydney Region, and thus the corresponding region has been analysed. Known for its large natural harbour and its status as a global city, the Metropolitan Sydney Region encompasses the Cumberland plain and extends west to the Blue Mountains in the Great Dividing Range. The Metropolitan Sydney Region extends from Broken Bay in the north to Garie Beach in the Riyal National Park in the south. With over 4 million people, the Metropolitan Sydney Region is the most populous region in New South Wales. NARClim's modelling is on a regional basis.

5.7.1 Temperature & Heat Projections and Project Design Responses

Temperature Projections

Table 3 Projected annual average temperature increase- Metropolitan Sydney (Source: NARClim 2.0)

	2050		2090	
	Low-emissions	High-emissions	Low-emissions	High-emissions
Temperature	**1.0°C** (0.6–1.7°C)	**1.8°C** (1.0–2.8°C)	**1.2°C** (0.5–2.0°C)	**3.4°C** (2.3–5.0°C)
Maximum Temperature	**1.1°C** (0.6–1.9°C)	**1.9°C** (1.1–3.1°C)	**1.3°C** (0.5–2.2°C)	**3.5°C** (2.4–5.3°C)
Minimum Temperature	**1.0°C** (0.6–1.6°C)	**1.7°C** (0.9–2.6°C)	**1.1°C** (0.6–1.8°C)	**3.5°C** (2.4–5.0°C)

Note: The bold number is the ensemble average for the period. Underneath the average is the ensemble range.

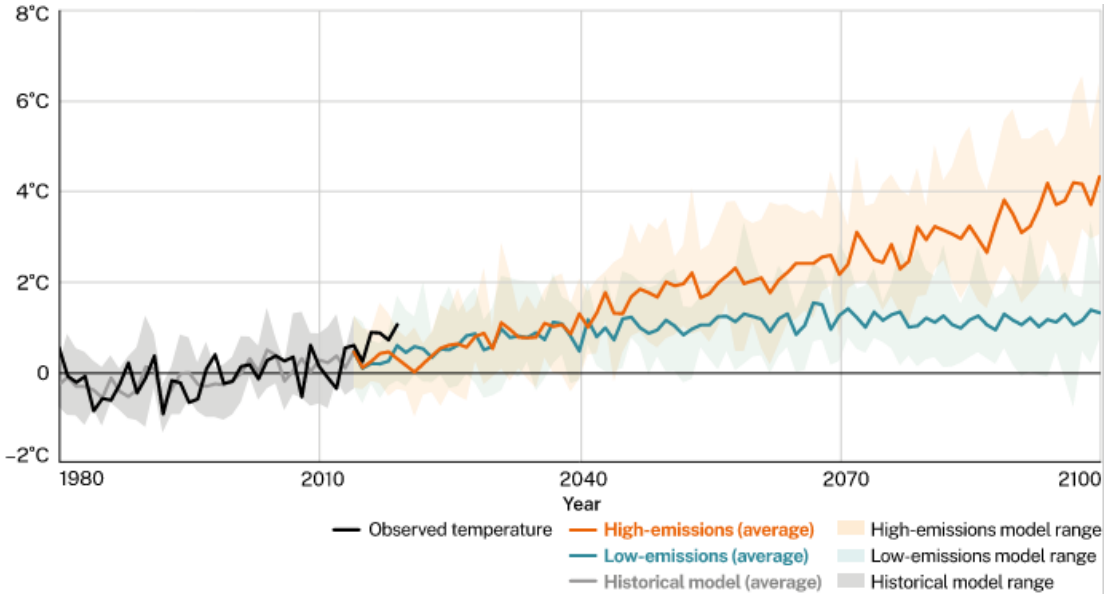


Figure 16 Historical and projected average temperature change – Metropolitan Sydney (Source: NARClim 2.0)

Heat Projections

Table 4 Projected increase in average annual number of hot days- Metropolitan Sydney (Source: NARClim 2.0)

2050		2090	
Low-emissions	**High-emissions**	**Low-emissions**	**High-emissions**
6.2 days (2.6–11.1 days)	**9.7 days** (3.7–20.4 days)	**7.3 days** (1.9–16.5 days)	**20.4 days** (9.5–37.2 days)

Note: The bold number is the ensemble average for the period. Underneath the average is the ensemble range.

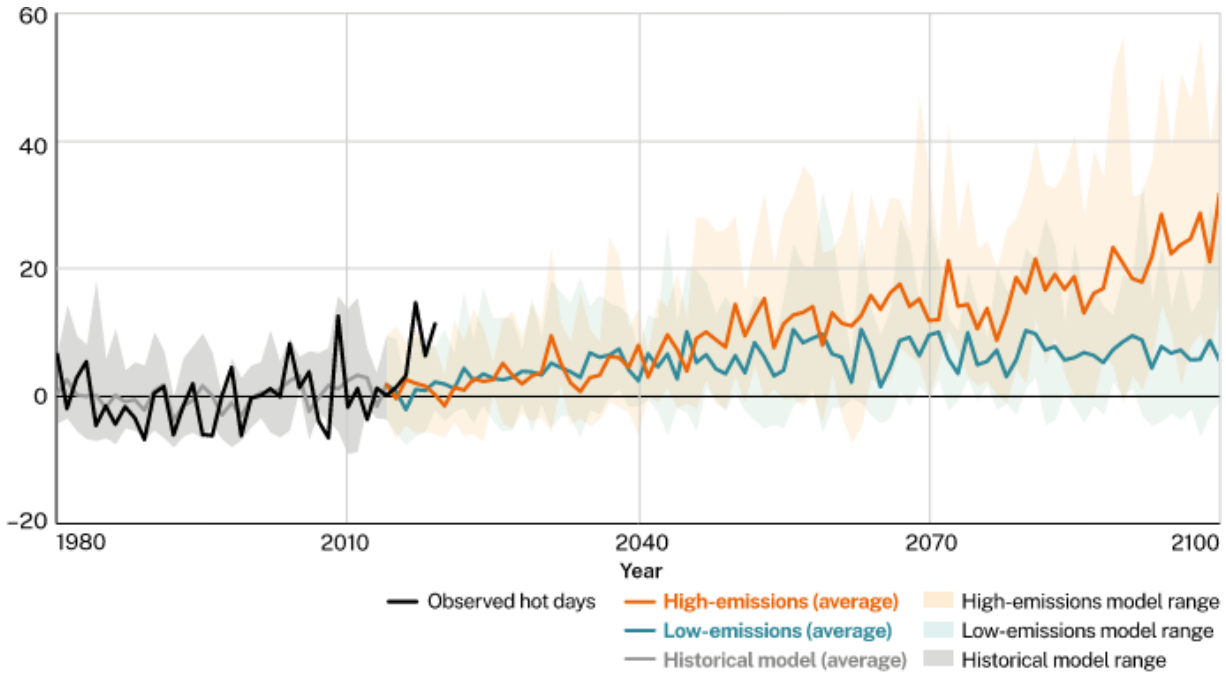


Figure 17 Historical and projected change in annual number of hot days – Metropolitan Sydney (Source: NARClim 2.0)

Project's Design Responses to Temperature and Heat Projections

Since NARClim's projections are showing an overall increase in temperature, the project's design responses for climate projections of temperature and heat significantly overlap. These are outlined below:

Building Envelope

- Well insulated building fabric (walls, roof, floors) to reduce external heat gains.
- Provision of high-performance glazed systems in conjunction with reasonable façade window-to-wall area ratio to avoid excessive solar heat gains.
- Façade design incorporates external shading devices adjacent to conditioned spaces to reduce solar exposure.
- Building roof is designed to be light coloured (low solar absorptance) which also reduces solar gains and is beneficial to local heat island effect.

Project Design

- Louvres or other openings in the walls and roof have been designed to allow cross-ventilation in the work zone, manageably increasing the air velocity and air change rates and passively reduce heat build-up in the space.

Mechanical Air Conditioning System

- Efficient and bespoke HVAC systems with high COPs will be appropriately designed and sized for the development. This will include a high efficiency centralised plant.
- Roof ventilators and exhaust fans have been proposed to the warehouse areas to reduce the build-up of heat and encourage air circulation.

5.7.2 Rainfall Projections and Project Design Responses

Table 5 Projected change to average rainfall – Metropolitan Sydney (Source: NARClim 2.0)

	2050		2090	
	Low-emissions	**High-emissions**	**Low-emissions**	**High-emissions**
Annual	**-7.2%** (-18.5% to +12.6%)	**-16.3%** (-28.6% to +1.3%)	**-9.7%** (-22.4% to +5.7%)	**-9.2%** (-36.9% to +24.6%)
Summer	**-9.9%** (-21.0% to +4.1%)	**-18.8%** (-39.8% to +5.0%)	**-12.4%** (-31.1% to +13.8%)	**-2.6%** (-42.0% to +33.6%)
Autumn	**-0.5%** (-22.3% to +16.7%)	**-10.1%** (-29.4% to +14.2%)	**-1.7%** (-24.7% to +19.6%)	**-1.5%** (-19.6% to +41.6%)
Winter	**-17.2%** (-41.0% to +36.5%)	**-33.0%** (-51.7% to -2.7%)	**-20.3%** (-38.9% to -2.1%)	**-35.1%** (-65.5% to +11.3%)
Spring	**-2.8%** (-13.4% to +15.4%)	**-4.2%** (-28.9% to +15.8%)	**-6.6%** (-24.4% to +12.3%)	**-7.4%** (-34.8% to +16.4%)

Note: The bold number is the ensemble average for the period. Underneath the average is the ensemble range.

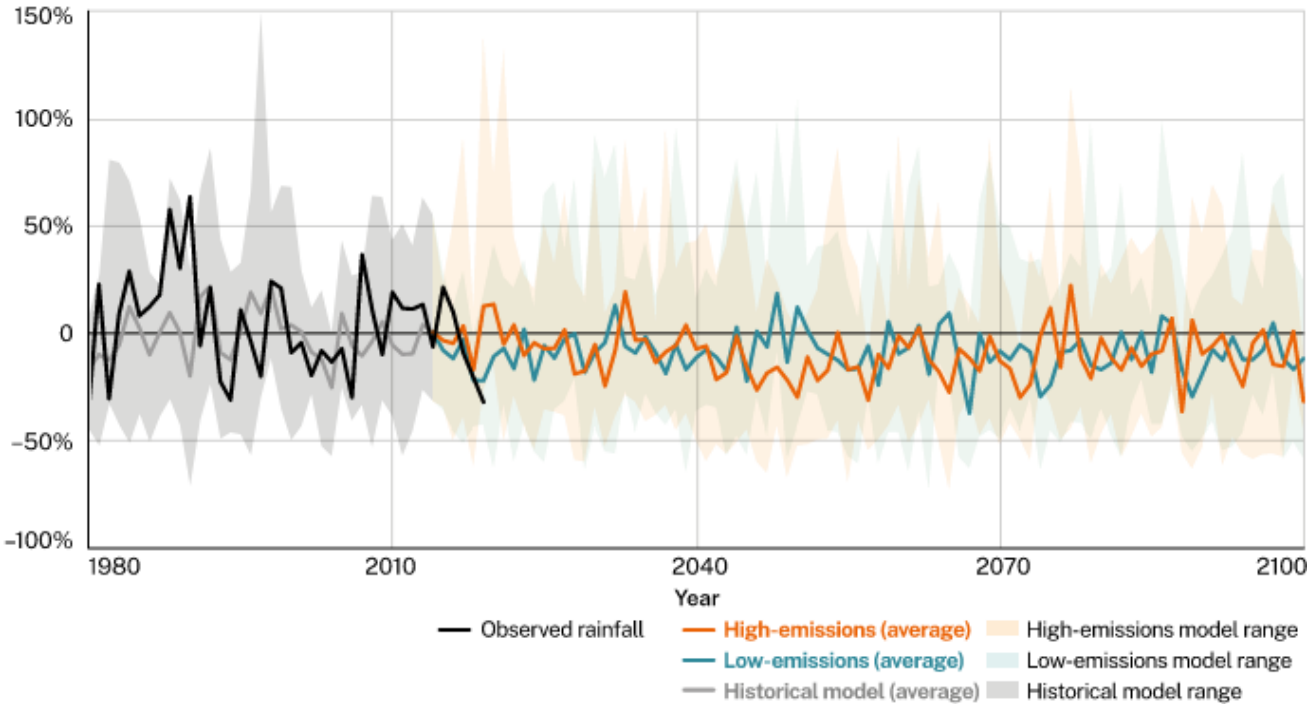


Figure 18 Historical and projected change to average rainfall- Metropolitan Sydney (Source: NARClim 2.0)

Project's Design Responses to Rainfall Projections

Although an average decrease in annual rainfall is expected, rainfall is expected to come in infrequent short downpours. Therefore, water conservation management between rain events and flood management are important and are addressed below.

Water Conservation

- Use of drought tolerant and native plants will be used where possible.
- A rainwater tank for rainwater reuse for toilet flushing and landscape irrigation will be installed.
- Water efficient appliances and hydraulic fixtures will be installed.

Flood Mitigation

- On-site stormwater tank will be incorporated in the project to assist in reducing peak discharge and mitigate stormwater run-off.
- Rainwater tanks will be installed which can contribute to minimising stormwater runoff.

5.7.3 Fire Projections and Project Design Responses

Table 6 Projected increase in average annual number of severe fire weather days- Metropolitan Sydney (Source: NARClim 2.0)

2050		2090	
Low-emissions	**High-emissions**	**Low-emissions**	**High-emissions**
0.7 days (0.1 to 1.8 days)	**1.2 days** (0.1 to 3.1 days)	**0.8 days** (-0.7 to 2.5 days)	**2.5 days** (0.1 to 6.2 days)

Note: The bold number is the ensemble average for the period. Underneath the average is the ensemble range.

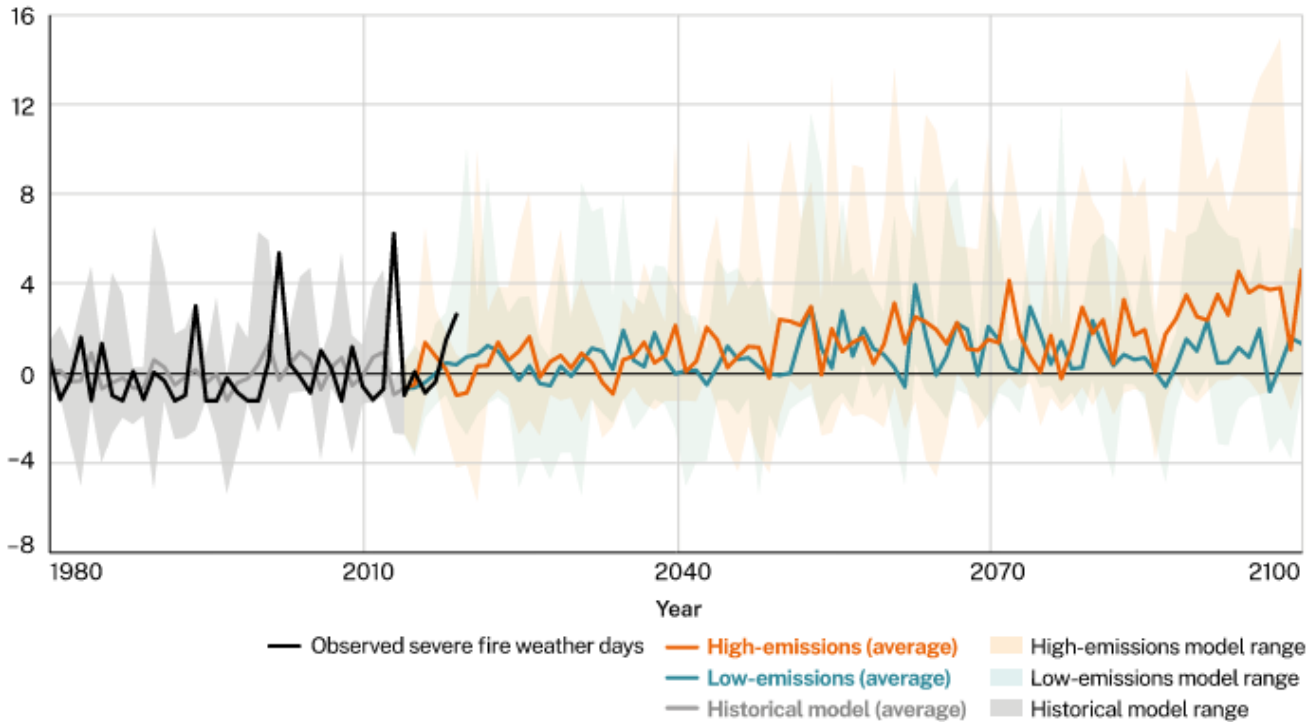


Figure 19 Historical and prjected change to annual number of severe fire weather days- Metropolitan Sydney (Source: NARClim 2.0)

Project's Design Response to Fire Projections

- Provisions of compliant fire and life safety design of the building to protect fire and life safety strategy (e.g. provisions of exits and egress, fire hydrant systems, smoke hazard management, etc.)
- Provide multiple access routes to the site.

5.7.4 Risk Matrix in Response to NARClim Projections

Risk	2050	2090	Comment	Design Response
Extreme temperatures within the building causing discomfort to indoor occupants	Low	Medium	Peak temperatures increasing and becoming more common creating larger loads upon HVAC to maintain thermal comfort inside. Also, can lead to deterioration and failure of HVAC equipment.	High performance building envelope and façade. HVAC system to support natural ventilation during extreme external conditions, sized with sufficient spare capacity to maintain acceptable comfort conditions during peak days.
Increase in temperatures causing discomfort to occupants outdoors	Medium	High	Peak temperatures increasing and becoming more common creating outdoor amenity space to exceed thermal comfort.	Well shaded outdoor spaces blocking summer sun.
Heat island effect	Low	Medium	The number of days a year with temperature > 35˚C, will increase slightly and will mostly occur during summer break so it's not considered a high risk in the short term. However, the risk increases in the 2090s scenario so reducing heat at local scale is critical.	To reduce heat island effect during peak days, the project will reduce hard surfaces where possible and increase landscaping, and the building roof will be designed to be of a light color with low solar absorptance.
Access to site blocked, preventing, or restricting access and egress to the site caused by flooding	Low	Medium	The site is not located in a flood prone area therefore, this is considered a low risk. However, stormwater management strategy should be set to mitigate the 8.9% projected annual rainfall increase for the 2070s scenario.	An OSD tank will be installed to mitigate stormwater runoff and the project will ensure multiple access points above flood plain level.
Structural integrity of the buildings undermined by extreme weather events	Low	Low	Instances of flooding in the area with high erosion soils are low, therefore it is considered a low risk.	Structural works to plan foundations accordingly.
Increased costs of mains potable water due to hotter and drier climate	Low	Medium	Projections depict hotter drier climate with short intense storms. This suggests water scarcity between storms and therefore an increase in price.	A rainwater tank to be implemented for toilet flushing and irrigation.

Risk	2050	2090	Comment	Design Response
Access to site blocked, preventing, or restricting access to the site caused by bushfire	Low	Medium	Due to the nature of the site, localised bushfire is unlikely in the short-term projection. However, the risk increases toward the 2070s scenario where temperatures and number of hot days during summer increase.	Ensure multiple access points to site.

6. Summary of Design Response

Ecologically Sustainable Design continues to be a driving consideration in the ongoing development of the SEED Stage 1B development. The proposed development will incorporate several ESD initiatives - which are aligned with the applicable drivers - to complement the initiatives undertaken to reduce the greenhouse gas emissions, potable water consumption and material resources of the site. These constitute the sustainability response from the project to the site applicable sustainable design frameworks, as listed within Section 3 Sustainable Design Framework.

The ESD initiatives outlined in this report are intended to be used as a design guide for the development. The specific initiatives that will be installed across the precinct will be determined throughout the development application stage for each individual building and will be subject to feasibility analysis, including that of the final use and layout. The initiatives are being designed to comply with the guidelines set out by the relevant authorities.

The development's commitment to reducing the overall environmental impact is evident of the holistic approach taken to long-term sustainability. Documented initiatives cover a range of categories including:

- Energy and greenhouse gas emissions reduction
- Potable water reduction
- Minimising waste to landfill
- Indoor environment
- Occupant amenity and comfort
- Building management
- Climate change resilience

We trust this report provides sufficient overview of the project commitment to environmentally sustainable design and greenhouse gas and energy efficiency vision for the SEED Stage 1B development.

Stantec

Stantec is a global leader in sustainable architecture, engineering, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.

Level 9, The Forum,
203 Pacific Highway
St Leonards NSW 2065
Tel +61 2 9496 7700
stantec.com/au