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Ecologically Sustainable Development Report

600-660 Elizabeth St, Redfern Precinct

NSW Land and Housing Corporation

February 26, 2020

Quality information

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1. Executive Summary

NSW Land and Housing Corporation (LAHC) has engaged AECOM to undertake a Utilities and Infrastructure Servicing Strategy for 600-660 Elizabeth Street, Redfern. The main purpose of the Ecologically Sustainable Development (ESD) Report (this Report) is to assess the relevant ESD Planning Proposal requirements focusing on the environmental sustainability aspects, including water waste, energy and carbon considerations associated with the proposed development for the Site.

In developing this Report, a context review was carried out to understand constraints and opportunities specific to the Site in the light of its demographics, relevant policy, physical and socioeconomic context and sustainability trends and drivers. This provided an understanding of the sustainability needs for the development which in turn informed the identification of sustainability targets and initiatives.

Where appropriate, this Report highlights both 'minimum' goals for consideration in the planning process and 'stretch' goals for consideration in design development and tender specifications, with the aim of ensuring minimum standards are met whilst also incentivising best practice measures. Sustainability initiatives to address those targets are proposed, including a general discussion of advantages and disadvantages to justify the implementation or non-implementation of initiatives in further stages.

The targets and initiatives defined in this report are intended to support decision making along the development cycle and inform the next steps of the Elizabeth St, Redfern development. These have been selected with consideration to ease of implementation and ability to provide an environmental, social and economically sustainable solution.

Several recommendations are provided to support sustainability initiatives selection during the development application stage and ensure minimum sustainability performance is achieved. Where suitable, this report identifies the use of sustainability rating/performance tools to underpin the future sustainability performance of the development. This report identifies initiatives requiring further evaluation to establish feasibility in the context of the development application.

2. Introduction

2.1 Purpose of this Report

The Ecologically Sustainable Development Report (this Report) has been prepared by AECOM on behalf of NSW Land and Housing Corporation (LAHC) to accompany a Planning Proposal to be lodged with the City of Sydney (CoS).

This Planning Proposal relates to land at 600-660 Elizabeth Street, Redfern (the Site). The Planning Proposal seeks to rezone the Site to allow redevelopment for a mix of social, affordable and private housing in an integrated residential community. The aims of the Planning Proposal are to rezone the Site to R1 General Residential.

An indicative reference scheme and urban design report has been prepared by Architectus, Silvester Fuller and Tyrell (the Project Team) to support the Planning Proposal and demonstrates how the Site may be redeveloped. The indicative reference scheme comprises:

- Approximately 327 dwellings, with building heights ranging between 6 and 14 storeys;
- A mixed-use development, with over 1,500m^2 of non-residential floor space for local shops, cafes, community space and other services; and
- Three ground floor communal courtyard spaces.

The purpose of this report is to address the relevant ESD Planning Proposal requirements focusing on the environmental sustainability aspects, including water waste, energy and carbon considerations associated with the proposed development for the Site. Table 1 outlines these Planning Proposal requirements and indicates the relevant sections of the report responding to each of them.

Table 1: Planning Proposal Requirements for the Site addressed in this Report

Elizabeth St, Redfern Planning Proposal Requirements	Refer to:
Sustainability and Environmentally Sustainable Development	
Demonstrate how the proposal contributes to the NSW Government's transition to net-zero emissions by 2050 as described in the District Plan	**Section 7.3**
Develop an Environmentally Sustainable Development Strategy that identify precinct-scale and individual development strategies and measures to meet or exceed benchmarks for environmental performance (e.g. BASIX 40, NABERS target for commercial uses with commitment agreements, waste reduction and recycling measures, integrated water management, etc.)	**Whole Report, particularly Section 7**
Urban canopy cover and tree retention strategy (including assessment against study requirements)	**Section 7.3.2.4**

3. Project Overview

The Site includes government-owned land of state importance for delivering government policies relating to jobs, homes, and the provision of social housing in an inner-city location and close to existing and future public transport. It will be transformed into a market leading build-to-rent redevelopment featuring contemporary urban and architectural design and creating a high-quality integrated community of social, affordable and private housing.

LAHC has initiated a rezoning investigation and Planning Proposal Requirements have been developed in collaboration with CoS and other government agencies. The requirements outline a range of investigations needed to analyse the potential impact of any planning control changes.

The project involves the residential redevelopment of the Site which occupies a discrete block bounded by Kettle Street (north) and Phillip Street (south) each with 70 m frontage, and Walker Street (east) and Elizabeth Street (west) each with 146 m frontage (refer to Figure 1).

Located approximately 3 km south of Sydney CBD in the suburb of Redfern, the Site is entirely within the CoS local government area (LGA) and has a gross site area of 10,850 sqm. The Site is part of the wider social housing estate at Redfern in the vicinity of the Waterloo Estate Precinct.

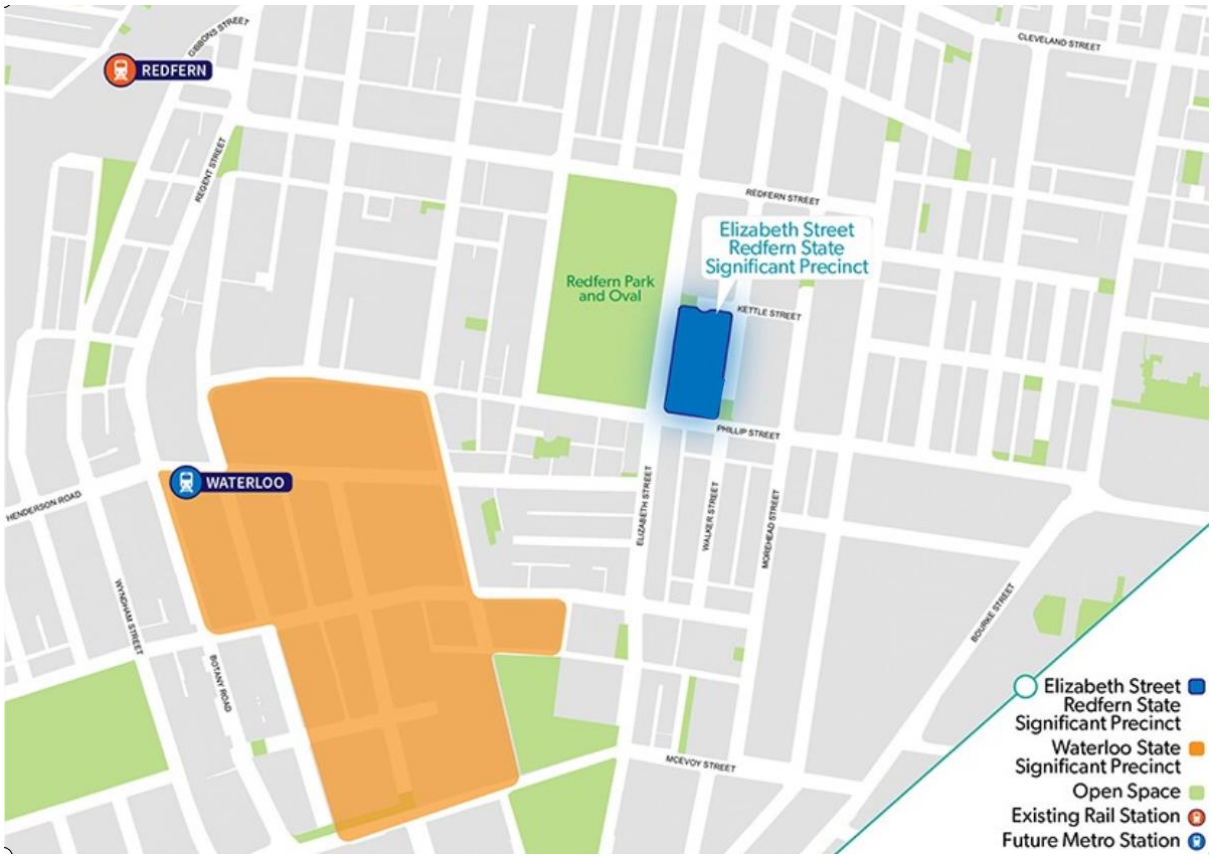

Figure 1: Map of Elizabeth Street, Redfern Site

A design, technical analysis and consultation process was undertaken to prepare a Reference Scheme for the Site which indicates how the future public domain, building form and connections could be delivered. The reference scheme (presented in Figure 2 and Figure 3) balances the challenges and opportunities of the Site, particularly the desire to deliver high quality urban design while providing new and modern social housing in an integrated mixed tenure environment.

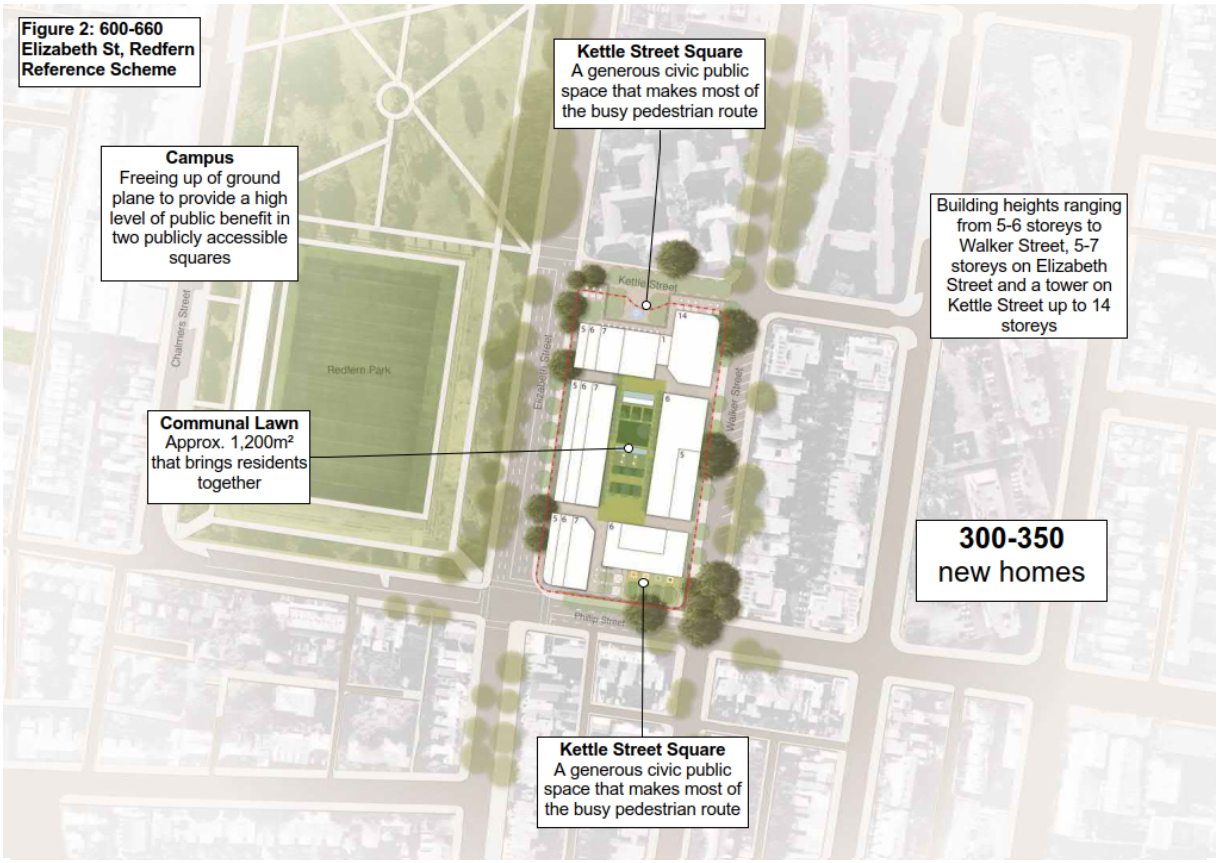

Figure 2: 600-660 Elizabeth St, Redfern Reference Scheme

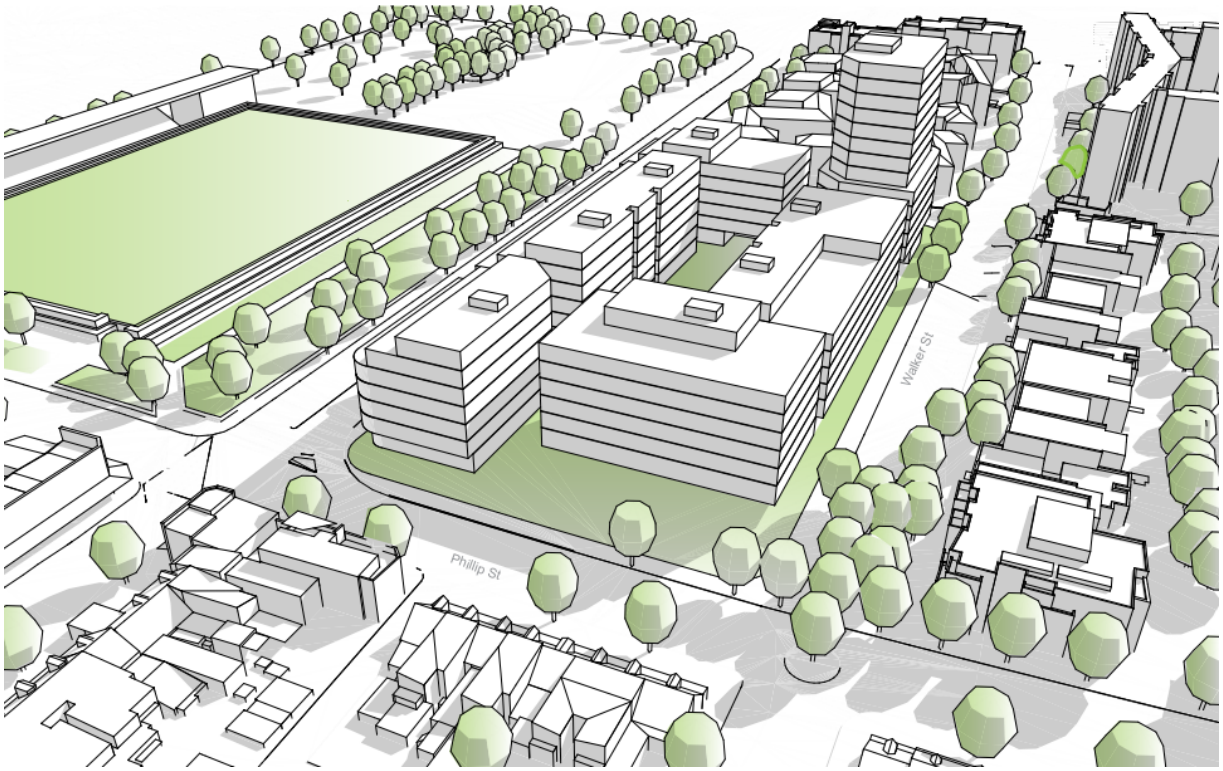

Figure 3: 600-660 Elizabeth St, Redfern Reference Scheme

The reference scheme was prepared to indicate how the Site could, rather than will, be redeveloped and has been used as a basis to prepare draft amendments to the Sydney Local Environmental Plan 2012 (including zoning, height, floor space ratio and car parking controls) and the development of a new site-specific Development Control Plan which will guide the detailed design of the Site. Any future Development Application may differ from the Reference Scheme.

The proposed planning framework has regard to:

- accessibility and connectivity of the Site to public transport, employment, shops, education and other services,
- the Site and local area's rich history and cultural significance,
- the surrounding urban form and context, and
- the environmental and servicing considerations, including flooding, stormwater, traffic, utilities, noise, air quality and wind.

The proposed planning framework will guide future development applications for the Site which are anticipated to achieve the following:

- Approximately 327 dwellings, with a maximum FSR of 2.75
- Buildings with a predominant height of 6-7 storeys with a single taller tower
- Some supporting retail and communal floor space to support the incoming population
- New public spaces on Kettle and Phillip Streets activated by shops, cafes, community space and other services.

It is expected the Site will be developed over a period of three years, once the Site has been rezoned.

3.1 Site Context

The Site is opposite Redfern Park and Oval currently comprising two thirds of vacant land with some mature trees and the remaining third portion, at the southern end, occupied with some facilities which include a building currently leased to the Police Citizens Youth Club (PCYC) and the South Sydney Aboriginal Corporation Resource Centre (refer Figure 4).

Redfern train station is located approximately 850 m to the east-north-east of the Site, and the upcoming Waterloo Metro station approximately 700 m to the east. The Site is currently directly serviced by the 301, 302, 303, 343, 355 and M20 bus routes, with a southbound bus stop on the Elizabeth Street boundary. These routes connect the Site with Sydney CBD, North Sydney and Chatswood to the north, with Waterloo, Zetland, Roseberry, Mascot and Botany to the south, with Newtown and Marrickville to the west, and with Moore Park and Bondi Junction to the east.

Figure 4: Aerial photograph of the Site[1]

[1] Land and Housing Corporation, *Communities Plus Industry Briefing* presentation, 27 February 2018.

The vacant land was previously occupied by 18 duplexes, until their demolition in mid-2013 (refer Figure 5). While the Site is still in the design phase it is expected to feature approximately 327 dwellings, of which up to 30% are expected to be social housing.

Figure 5: Aerial imagery 600-660 Redfern taken 30/3/2013 (left) and 6/11/13 (right)[2]

3.2 Communities Plus Build-to-Rent model

Communities Plus is a key program under NSW Government's *Future Directions for Social Housing in NSW*, delivering integrated social, affordable and private housing by partnering with the private and not-for-profit sectors including registered Tier 1 or Tier 2 Community Housing Providers (CHPs).

The Redfern project aligns with Future Directions, by providing innovative options for private sector investment in social housing under a long-term lease. The project presents an opportunity to renew and increase social housing in a well-located integrated community with good access to education, training, local employment, and close to community facilities such as shopping, health services and transport.

On 6 July 2018, the NSW Government announced the Site as the pilot for Communities Plus build-to-rent. The Project provides an opportunity for the private sector, in partnership with the not-for-profit sector, to fund, design, develop and manage the buildings as rental accommodation under a long-term lease.

Build-to-rent is a new residential housing delivery framework that is capable of providing access to broader housing choices. Established in overseas markets such as the UK and the USA, locally, build-to-rent has significant scope to provide increased rental housing supply and the opportunity for investment in residential housing in NSW.

[2] Google Earth v7.3.2.5491

4. Approach

In addressing the Planning Proposal Requirements listed in Table 1, a sustainability context review was undertaken to identify stakeholder needs, policy and regulatory requirements, as well as constraints and opportunities in the redevelopment of the Site. This context review forms the basis for identification of sustainability targets and initiatives.

To facilitate multidisciplinary collaboration and integration of ESD principles into building and public domain design, AECOM organised a workshop with LAHC, the design team and key consultants. In the workshop, AECOM presented key findings from the sustainability context review. AECOM presented key sustainability trends and drivers relevant to the Site as well as the results from a preliminary climate risk assessment to be considered in the development of concept options and to inform future decision making in regards to best-practice sustainability initiatives.

Attendees provided input on desirable ultimate sustainability outcomes (2050) for the Site, identifying short and long-term actions required to achieve those outcomes. In addition, attendees validated preliminary assessment climate risks in terms of their likelihood and consequence, identifying both existing measures and required adaptation actions to address key climate impacts. Results of these activities are provided in Appendix A.

Based on the context review and the outputs of the Sustainability and Resilience workshop, precinct-wide targets and initiatives have been proposed to guide the implementation of best practice solutions for water, energy, waste and carbon emissions at design, construction and operation stages. The precinct-wide targets were also developed in consultation with CoS. The proposed initiatives will be considered for integration in future stages of the development.

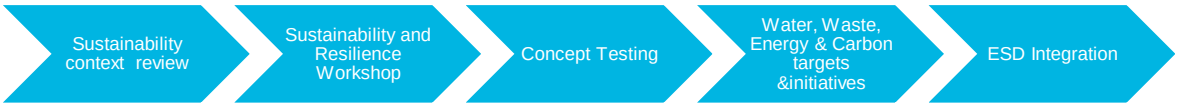

Figure 6: General approach followed for ESD integration

5. Policy and Regulatory Context

This section provides an overview of the key strategic policy, documents and frameworks relevant to ESD for the Site. It includes an analysis of strategic policy, statutory planning controls and best practice sustainability frameworks with the aim of guiding implementation of best practice initiatives in the proposed development.

5.1 LAHC's Sustainability Programs and Policy

LAHC's sustainability policies and programs are currently under review. LAHC's vision is to create and deliver sustainable environmental and social communities that promote integrated living. LAHC is committed to improving the environmental sustainability of the social housing sector by improving resource efficiency in key areas of energy, water and waste, minimising environmental risks and adapting to climate change.

5.1.1 Sustainable Design Guidelines (2014)

The Design Standards provide LAHC's mission and role in the housing sector, which is to facilitate:

- *The planning and building of housing that is fit for purpose*
- *Managing the housing portfolio to maintain properties at an acceptable level and prolonging their useful life*
- *Funding and maintaining tenancy management services delivered by Housing NSW*

To help achieve this, LAHC have developed a number of design standards and operational guidelines.

5.1.2 Asset Performance Standards (2009)

The Asset Performance Standards are used to assess the state of wear and tear on social dwellings. The Standards describe three criteria that need to be considered; safety, function and appearance, which are applied using a 'common sense' approach. The three assessment criteria allow the prioritisation of responses, with safety failures generating an urgent response, function failures requiring a planned response and appearance failures generating a discretionary response. The Standards are most often applied to existing assets, but they can also be used to accept new assets into the asset base.

The development of this Standard highlights the significance of whole-of-life considerations in the design of residential units and selection of fixtures and appliances. Assets that have high maintenance requirements add additional costs imposed on the residents and LAHC. Similarly, assets that fail with short life spans require costly retrofitting or replacement.

5.1.3 LAHC Design Standards

LAHC's primary role is to provide housing for people who cannot meet their own housing needs, and aims to:

- *Have safe workplaces and sites*
- *Become a financially sustainable business*
- *Be valued by their stakeholders*
- *Develop the culture, capabilities and systems to deliver their role successfully*
- *Have a housing portfolio strategy*
- *Contribute to whole of government reform initiatives*

The Design Standards have been developed to encourage design, performance and functional innovation to create new homes. It applies to all new LAHC housing and major refurbishments. For privately funded projects undertaken by the affordable housing or community housing sector, or are Aboriginal Housing Office projects, the Standard may be taken as guidance rather than as prescriptive requirements.

For new housing developments and major refurbishments, the following LAHC Design Principles are non-negotiable and must be met/demonstrated:

- *Compliance with National Code of Construction (NCC)*
  - *All LAHC developments and refurbishments must comply with the NCC performance requirements as a minimum through either the deemed-to-satisfy solutions or through acceptable alternative solutions*

- *Compliance with the COAG Energy Council Report for Achieving Low Energy Homes*
- *Whole of Life Cost effectiveness balanced with innovation*
  - *Achieve directed site yields, reducing operating and maintenance costs, ad aim for long-life spans by:*
    - *Utilising cost management throughout the planning and development process*
    - *Using economic analysis to evaluate construction alternatives, confirming the lowest cost structure that meets the program*
    - *Recognising LAHC's 'designing out maintenance' approach to construction to reduce recurrent maintenance expenditure*
  - *Cost-effective innovative solutions including alternative building systems, finishes and wall systems meeting the NCC performance requirements are welcomed*
- *Functionality*
  - *Dwellings must be fit for purpose and flexible by meeting a variety of household sizes through appropriate space provision and storage*
  - *Dwellings must be suitable for later modifications to suit tenants with a disability whilst meeting the NCC access requirements*
- *Energy and Water Sustainability*
  - *Dwellings must be BASIX compliant*
  - *Dwellings must achieve a 6 star NatHERS rating*
- *Aesthetics and a sense of home*
  - *Projects must contribute positively to the streetscape and neighbourhood as well as recognise tenant needs for security, privacy and safety*
  - *All buildings must address the design qualities contained in the Residential Flat Design Code* (superseded by the Apartment Design Guide)

5.1.4 Component Requirements (2018)

New LAHC housing developments are subject to the Components Requirements which apply to appliances, fixtures and fittings (known as Components). It is not a comprehensive list that contains all materials used in buildings. The document outlines the performance requirements of selected components with which LAHC has both direct interest and experience with. By defining minimum performance criteria, LAHC can better ensure installed equipment are of acceptably high quality and maximise whole-of-life value.

Performance criteria for product selection for use in LAHC properties include, but not limited to, the following:

- *Proven performance*
- *Proven quality and/or endorsement from reputable organisation(s) in the industry*
- *"Standards Mark" accreditation (where possible)*
- *"Code Mark" certification (where possible)*
- *Best value for money*
- *Low maintenance*
- *Assurance of supply*
- *Warranty*
- *Origin of product*

5.1.5 Health, Safety and Savings at Home

Family and Community Services (FACS) have tips for residents on how to reduce energy and water bills, managing the household and reducing health risks at home on their website[3]. Advice and tips are available on the following topics:

- *Reducing water and energy bills*
- *Solar hot water systems*
- *Treating mould in the home*
- *Fire safety and smoke alarms*
- *Fire Safety Program*
- *Gardening, waste and recycling*
- *Unwanted household items*
- *Food and family expenses*
- *Asbestos*
- *Lead paint*

While not all of the above topics have sustainability benefits, those that are relevant seek to educate residents on means to prolong the effective lifetime of the built asset and also reduce the cost of living. It demonstrates LAHC's commitment in whole-of-life considerations in their asset management strategy.

5.1.6 Communities Plus Program

Communities Plus is a building program for the delivery of more social housing, a better social housing experience, and more opportunities and support for social housing tenants. The Communities Plus Program supports the Future Directions for Social Housing in NSW:

- *Deliver more housing and a better social housing experience, with more opportunities and incentives to avoid or move beyond social housing.*
- *Develop new mixed communities where social housing blends in with private and affordable housing, with better access to transport and employment, improved community facilities and open spaces.*
- *Partner with the private and not for profit sectors to fast track the redevelopment of sites in metropolitan Sydney and regional NSW.*

The Redfern project aligns with Future Directions, by providing innovative options for private sector investment in social housing under a long-term lease. The project presents an opportunity to renew and increase social housing in a well-located integrated community with good access to education, training, local employment, and close to community facilities such as shopping, health services and transport.

5.2 Local Controls and Guidelines

5.2.1 City of Sydney Sustainable Sydney 2030

Sustainable Sydney 2030 is the overarching program for the development of the city to 2030 and beyond. The overall themes within the strategy are 'Green', 'Global', and 'Connected'. The strategy ties together a number of plans covering the economy, carbon neutrality, green infrastructure, renewable energy, decentralised water, sustainable transport, light rail and car sharing. Some of the key targets set out are:

- Reduce carbon emissions within the Sydney LGA by 70% on 2006 levels by 2030, and by 2050 achieve carbon neutrality;
- 50% of electricity demand met by renewable sources;
- Zero increase in potable water use from 2006 baseline; and
- Total canopy cover increased by 50% from 2008 baseline.

[3] https://www.facs.nsw.gov.au/housing/living/health-safety-savings/reducing-bills

5.2.2 City of Sydney Environmental Action Plan 2016-2021

The Environmental Action Plan falls under the Sustainable Sydney 2030 strategy and sets out the short and medium-term priorities and actions for the City. It focuses on defining actions to 2021 on the way to achieving 2030 environmental targets. By 2021, the City is committed to reducing emissions in its operations by 44% from 2006 levels and move to 50% renewable energy. And across the local government area, the City has set targets for 50% renewables by 2030, 70% reduction in 2006 greenhouse gas emissions levels by 2030 and net-zero emissions by 2050.

The areas of impact of the Action Plan are:

- **Excellence in new building design** – which sets guidance on voluntary standards for excellence in environmental performance in new buildings, detailed in Table 2

Table 2: City of Sydney guidance on voluntary standards for excellence in environmental performance in new residential development (as at 2017)

Energy and Emissions	Water Efficiency
Residential development • Single dwellings: BASIX 60+ • Apartments 2-3 storeys: BASIX 50+ • Apartments 4-5 storeys: BASIX 50+ • Apartments 6+ storeys: BASIX 40+ • Green Star Design & As-Built – 5 Stars+	Residential development • BASIX 50 • BASIX 60 where recycled water is available • Green Star Design & As-Built – 5 Star+

- **Low-carbon city** – sets a 2030 target to reduce emissions both across the City and in our operations by 70% below 2006. The identified reductions pathway is illustrated in Figure 7:

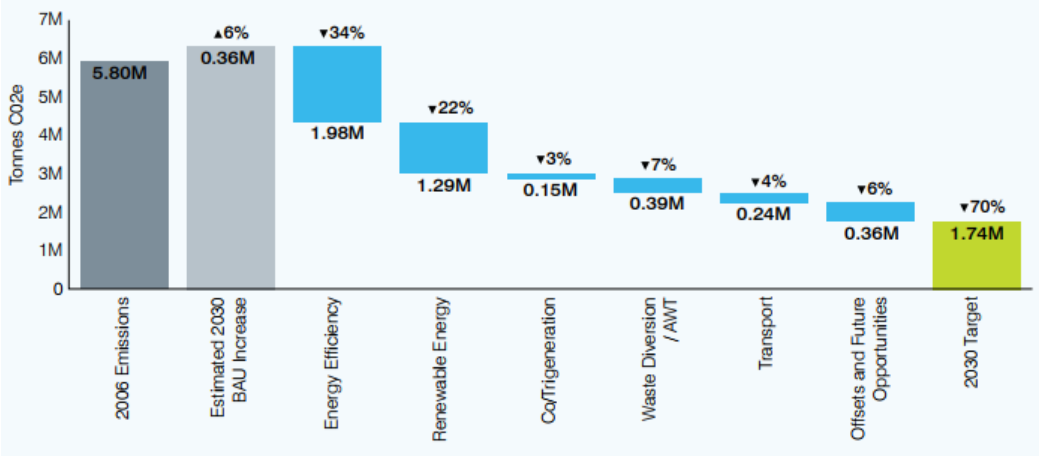

Figure 7: Local government area greenhouse gas emissions

- **Water sensitive city** – an approach to drought-proof the city to ensure available water supply when it is hot and dry:

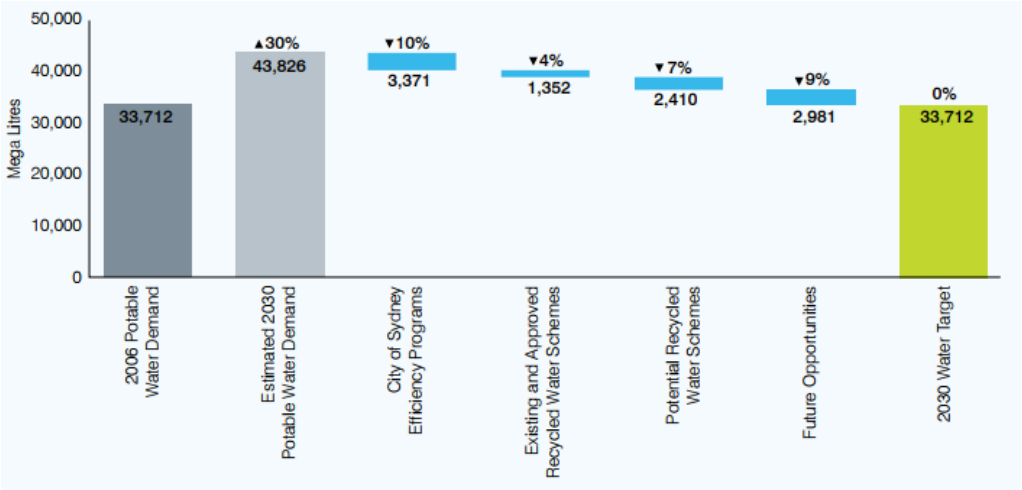

Figure 8: Local government area potable water use

- **Green and cool city** – aims to mitigate the urban heat island effect through increased urban canopy, raingardens, green roofs and walls. The City has set the following targets that are relevant to the energy and water scopes:
  - *Average total canopy cover is increased by 50% by 2030 and increased by 75% by 2050 from a 2008 baseline.*
  - *Plant 700 street trees each year until 2021.*
  - *Tree species diversity will not consist of more than 40% of any particular plant family, 30% of any genus or 10% of any one species by 2021.*
  - *Plant 50,000 new trees and shrubs in City parks and street gardens each year until 2021.*

5.2.3 City of Sydney Urban Forestry Strategy

In 2013, the City adopted an Urban Forestry Strategy, which aims to provide healthy and diverse landscaping into streets and parks, and to create beautiful streets and public spaces that contribute to the health and wellbeing of everyone in the community. The Urban Forestry Strategy helps adaptation to climate change by reducing the urban heat island effect, generating fresh air, absorbing stormwater, and providing cool spaces and respite during extreme heat. The City's Greening Sydney Plan has overseen 10,250 new street trees planted since 2005 and 49,664 square meters of landscaping installed throughout the City of Sydney's streets and parks since 2008.

5.2.4 City of Sydney Climate Change Adaptation Plan

The City of Sydney developed a Climate Change Adaptation Plan to provide a pathway towards improved resiliency. The rezoning of the Site will result in an increased population and intensity of use. In the context of climate and community resilience, this means the impacts of existing risks for the Site are likely to increase, and the interdependencies of the Site with the surrounding urban and natural environment must be considered. It is recognised that the City's Climate Change Adaptation Plan is likely to play into energy, water and waste thus should be considered.

5.2.5 City of Sydney Guidelines for Waste Management in New Developments

Building on the City of Sydney's 2005 Policy for Waste Minimisation in New Developments, the City has produced Guidelines for Waste Management in New Developments which falls under other sustainability polices including the City of Sydney's Sustainable Sydney 2030 Plan, the Environmental Action Plan 2016-2021, and Waste Strategy and Action Plan 2017-2030.

The Guidelines aim to assist architects, designers, developers, planners, consultants, builders and building managers to manage a building's waste outputs. They provide specific advice depending on development type and include provisions to address space, access and amenity requirements, safety, waste services and waste management systems.

The principals and practices presented in the Guidelines are relevant for consideration in the design for waste management in new buildings in Waterloo South. In particular, the Guidelines detail waste and recycling

requirements for multi-unit residential developments with shared waste and recycling bins. This includes space for waste segregation and storage within individual dwellings and within the residential building and the design of waste disposal chute systems.

5.2.6 Development Control Plans (DCPs)

The Sydney DCP 2012 is a consolidation of the previously separate DCPs and policies in force within the City of Sydney LGA. The proposed planning framework will be a new part inserted into Section 5: Specific Areas of the Sydney DCP 2012 and include detailed controls to inform future development of the Site.

Additionally, the Site is surrounded by land that is bound by the Sydney DCP. To enable connection with the surrounding urban fabric, there are several general provisions that will have a measurable effect on the physical quality of the environment at the Site. In the context of energy, water and waste, the following general provisions should be considered:

- Streets, Lanes and Footpaths;
- Defining the Public Domain;
- Urban Ecology;
- Ecologically Sustainable Development;
- Water and Flood Management; and
- Waste

5.3 Regional Controls and Guidelines

5.3.1 Greater Sydney Region Plan - A Metropolis of Three Cities

The Greater Sydney Region Plan (GSRP) was released by the Greater Sydney Commission in March 2018, building upon the directions provided in *A Plan for Growing Sydney* and *Towards our Greater Sydney 2056 – a draft amendment*, the previous regional planning documents in place.

The GSRP sets the 40-year vision (to 2056) and a 20-year plan to manage growth and change for Greater Sydney. The plan envisions rebalancing growth and delivering its benefits more equally and equitably to residents across the region. An integrated planning approach has been used to develop the plan so that it is aligned with *Future Transport 2056* and the State Infrastructure Strategy on land use, transport and infrastructure planning.

The vision is to reshape Sydney into three highly connected cities, the Western Parkland City, the Central River City and the Eastern Harbour City. Strategic planning will be at the core to deliver three cities that are liveable, productive and sustainable, where most residents live within 30 minutes of their jobs, education and health facilities, services and quality public spaces.

The plan encompasses a liveability, productivity and sustainability framework, structured in ten directions that establish the aspirations for the region over the next 40 years and are a core component of the vision. Each direction comprises a number of objectives for the delivery and implementation of the plan, as well as indicators to provide a measure of the plan's performance.

Each objective addresses specific aspects of infrastructure, liveability, economic progress and sustainability that are essential to achieve the vision. Strategies for the achievement of the different objectives are also provided.

The below are of particular importance for sustainability to be achieved:

5.3.1.1 Infrastructure

Objective 4: *Infrastructure use is optimised. Before implementing new infrastructure responses, the demands on existing infrastructure need to be evaluated and managed. To maximise asset utilisation, new precincts and new developments need to incorporate demand management, and where appropriate, be sequenced to be contiguous with existing developments so that existing demand management initiatives can be extended.*

5.3.1.2 Liveability

Objective 6: *Services and infrastructure meets communities changing needs such as education, health care and accessibility.*

Objective 7: *Communities are healthy, resilient and socially connected. This objective addresses safety, walkability, active transport, co-locating schools, health, aged care, sporting and cultural facilities and access to healthy fresh food and supporting local fresh food production.*

Objectives 8-9: *Communities are culturally rich with diverse neighbourhoods and celebrate the arts and supports creative industries and innovation.*

Objectives 10-11: *Housing supply is provided in line with principles for housing strategies defined and affordable, diverse housing is provided. This objective sets housing targets for the different cities. The 20-year strategic housing target (2016-2036) for Eastern Harbour City is 157,500 dwellings.*

Objective 13: *Environmental heritage is identified, conserved and enhanced.*

5.3.1.3 Sustainability

Objective 30 & 32: *Urban tree canopy coverage is increased and the Green Grid links parks, open spaces, bushland and walking and cycling paths.*

Objective 31: *Public open space is accessible, protected and enhanced. The network of open spaces, including sportsgrounds, is a form of green infrastructure which supports sustainable, efficient and resilient communities.*

Objective 33: *A low carbon city contributes to net-zero emissions by 2050 and mitigates climate change. In Greater Sydney, the sectors that contribute most to greenhouse gas emissions are energy (electricity and gas) used in buildings, transport and waste.*

Objective 34: *Energy and water flows are captured, used and re-used.*

Objective 35: *More waste is re-used and recycled to support the development of a circular economy*

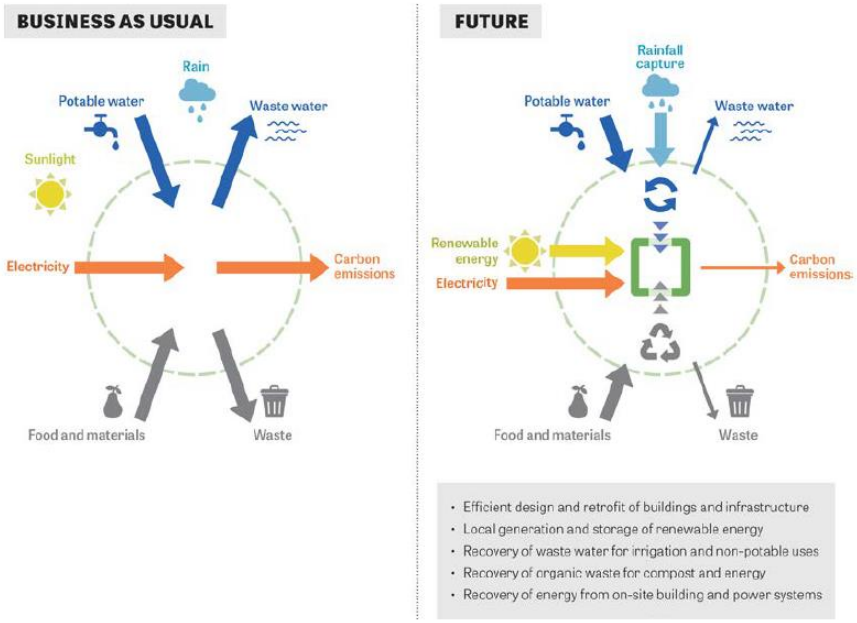

Figure 9: Circular economy[4].

Objectives 36-38: *Address resilience, including management of heat waves and extreme heat.*

5.3.2 Eastern City District Plan 2018

The Greater Sydney Commission (GSC) is an independent organisation formed to coordinate and align the planning to shape Greater Sydney in a 'one government' approach. The aim is to give rise to a productive, liveable and sustainable Sydney. The commission is underpinned by an environmental, social and economic commissioner with a focus on planning for improved futures across the triple bottom line. The Site falls within the Eastern City District Plan which is characterised with high concentrations of jobs, with good road and public

[4] Greater Sydney Region Plan – A Metropolis of Three Cities

transport connectivity and high levels of interaction between business and people. The corridor contributed two-thirds of the State's economic growth over the 2015-16 financial year.

The District Plan recognises that anticipated urban renewal within the City of Sydney will drive an increase in population of 102,600 people by 2036. Urban renewal projects provide opportunity to improve the energy and water efficiency of new and existing buildings, incorporate building and precinct-scale renewables, and manage waste more efficient to reduce greenhouse gas emissions and costs, and appeal to building owners and tenants. Better and more integrated design of such systems can encourage a more circular economy that focuses on improve efficiency.

The District Plan also identifies that people will want to live closer to jobs and services thus housing and jobs will need to be aligned with new or improved transport, education, health and other infrastructure. Better transport means people will be close to knowledge-intensive jobs, city-scale infrastructure and services, and lifestyle features. Walking and cycling will become an increasingly important part of daily travel, with well-designed paths in popular thoroughfares improving the sustainability of the region and the wellbeing of residents.

The Eastern City District Plan includes the following planning priorities which are relevant for consideration for Elizabeth St, Redfern:

- *Planning Priority E14 - Protecting and improving the health and enjoyment of Sydney Harbour and the District's waterways*
- *Planning Priority E19 - Reducing carbon emissions and managing energy, water and waste efficiently*

Under these two planning priorities, there are a number of objectives and corresponding strategies. The relevant objectives include:

- *Objective 33: A low-carbon city contributes to net-zero emissions by 2050 and mitigates climate change*
- *Objective 34: Energy and water flows are captured, used and re-used*
- *Objective 35: More waste is re-used and recycled to support the development of a circular economy*

Some of the relevant actions for consideration include:

- *Support initiatives that contribute to the aspirational objective of achieving net-zero emissions by 2050, especially through the establishment of low-carbon precincts in Planned Precincts, Collaboration Areas, State Significant Precincts and Urban Transformation projects.*
- *Support precinct-based initiatives to increase renewable energy generation, and energy and water efficiency, especially in Planned Precincts, Collaboration Areas, State Significant Precincts and Urban Transformation Projects.*
- *Encourage the preparation of low-carbon, high efficiency strategies to reduce emissions, optimise the use of water, reduce waste and optimise car parking provision where an increase in total floor area greater than 100,000 square metres is proposed in any contiguous area of 10 or more hectares.*

5.4 NSW Controls and Guidelines

5.4.1 Environmental Planning and Assessment (EP&A) Act 1979 and Regulation 2000

The redevelopment of the Site is subject to the requirements set under the EP&A Act 1979 and the regulations supporting the Act. The EP&A Regulation includes the following relevant ESD principles:

(4) 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.***

5.4.2 NSW Climate Change Policy Framework

The aim of the NSW Climate Change Policy Framework is to *maximise the economic, social and environmental wellbeing of NSW in the context of a changing climate and current and emerging international and national policy settings and actions to address climate change*. The Framework sets out several policy directions that will underpin the NSW Government's policies and actions:

- *Create a certain investment environment by working with the Commonwealth to manage transition;*
- *Boost energy productivity, put downward pressure on household and business energy bills;*
- *Capture co-benefits and manage unintended impacts of external policies;*
- *Take advantage of opportunities to grow new industries in NSW;*
- *Reduce risks and damage to public and private assets in NSW arising from climate change;*
- *Reduce climate change impacts on health and wellbeing;* and
- *Manage impacts on natural resources, ecosystems and communities*.

The development of the Site should be aligned with the above policy directions, where relevant. Through sustainable design integration, renewable energy and energy efficiency measures can boost energy productivity and lower energy bills, reduce climate change impacts on health and wellbeing, as well as grow the sustainability industry in NSW through improving workforce capability.

5.4.3 Building Sustainability Index (BASIX) SEPP

The Requirements identify performance benchmarks to allow sustainability to be considered in site planning, building design and in the construction and operational phases of the development to achieve best practice sustainability outcomes. BASIX controls are prescribed under a State Environmental Planning Policy (SEPP), which in turn is implemented under the *Environmental Planning and Assessment Act 1979*. It is a statutory requirement for all residential developments including new constructions and renovations worth $50,000 or more in NSW.

BASIX is one of the most stringent energy and water planning tools within Australia for residential development. BASIX is a sustainability planning instrument that sets energy and water design standards for all residential dwelling types in NSW. Energy and water efficiency is achieved through specific design strategies for lighting, heating, cooling and ventilation.

BASIX mandates sustainability standards in residential developments by assessing the consumption of mains-supplied water, energy and thermal performance. BASIX Targets were revised in June 2017. The following tables provide the current minimum statutory requirements for residential developments in Sydney.

Statutory BASIX Targets

Table 3: Statutory BASIX Energy Targets

Building Type	BASIX Target
Detached and semi-detached	50
Low-rise (3-storey units)	45
Mid-rise (4-5 storey units)	35
High-rise (6-storey units and higher)	25

Table 4: Statutory BASIX Water Targets

Building Type	BASIX Target
Detached and semi-detached	40
Low-rise (3-storey units)	40
Mid-rise (4-5 storey units)	40
High-rise (6-storey units and higher)	40

BASIX Energy and Water targets will influence overall electrical demand at the Site, with an increase in BASIX targets implying decreased demand and more thermally efficient building envelopes and services required at later stages of development. This will ensure an extent of future-proofing from climate change and related temperature increases. The Planning Proposal Requirements also request a consideration of how the development may meet or exceed the BASIX targets.

5.4.4 SEPP 65 and the Residential Apartment Design Guide

The State Environmental Planning Policy No 65 – Design Quality of Residential Apartment Development (SEPP 65) (2015) promotes better apartment design across NSW through the establishment of a consistent approach to the design and assessment of apartments and the way they are assessed by councils. SEPP 65 provides guidance on features for apartment buildings through a number of key design criteria relating to the sustainability performance of the development including:

- Bicycle and car parking
- Solar and daylight access
- Natural ventilation
- Apartment size and layout
- Universal design
- Energy efficiency
- Water management and conservation
- Waste management
- Building maintenance

The Residential Apartment Design Guide can provide guidance on overall apartment building design within the Site to drive sustainable design for the benefit of the residents as well as reduce energy and water demand and waste generation.

5.4.5 Affordable Rental Housing SEPP

The Affordable Rental Housing SEPP provides consistency across the state in affordable rental housing provision and facilitates the effective delivery of new affordable rental housing by providing incentives such as expanded zoning permissibility, floor space ratio bonuses and non-discretionary development standards. These initiatives vary depending on housing type. It also facilitates the retention and mitigation of the loss of existing affordable rental housing.

5.4.6 NSW Energy Efficiency Policy

The Energy Efficiency Action Plan was developed with the goal of reducing the cost of living in NSW. It aims to put downward pressure on electricity bills by assisting households to reduce their energy use and improve energy productivity for business. The Plan aims to reach the following targets:

- *Achieve 16,000 GWh in energy savings per year by 2020;*
- *Support 220,000 low income households to reduce energy use by up to 20% by 2014; and*

- *Assist 50% of NSW commercial floor space achieve 4-star NABERS and water rating by 2020 through the delivery of high-standard building retrofit programs.*

The Energy Efficiency Action Plan sets out a number of actions ranging from educational programs, formation of partnerships with industry, and provides financial incentives for homes and businesses to participate in energy reduction schemes.

5.4.7 NSW Electricity Strategy

The NSW Electricity Strategy was released by the NSW Government and aims to provide a "pathway for a reliable, affordable and sustainable electricity future". The Strategy aims to encourage over $8 billion of new private investment in the NSW electricity system; deliver coordinated Renewable Energy Zones; save energy during peak demand; develop new electricity generators; and set a target to boost NSW's energy resilience. Renewable Energy Zones are delivered in line with the aims of the NSW Transmission Infrastructure Strategy to unlock a pipeline of large-scale renewable energy and storage projects. The zones will deliver significant amounts of new energy supply, increase energy affordability and reduce emissions.

The NSW Government intend the Strategy to:

1. improve the efficiency and competitiveness of the NSW electricity market by reducing risk, cost, Government caused delays and by encouraging investment in new price-reducing generation and energy saving technology;
2. prompt Government to act if there is a forecast breach of the EST which private sector projects are unlikely to address. This should be done in a way that minimises costs to consumers and taxpayers and does not give rise to moral hazard risk; and
3. ensure that there are appropriate powers available for Government to analyse and respond to electricity supply emergencies, if they arise.

The Strategy sets out 10 actions that will support a competitive electricity market with more resilient supplies. The actions were chosen to support an efficient, competitive and low cost electricity market and making it easier to invest in clean energy; avoid electricity emergencies caused by capacity constraints; and having a strong emergency response to electricity system failures. The Strategy also outlines NSW's Energy Security Target position: *"AEMO forecasts the 1-in-10 year peak demand for the summer of 2019-20 to be 14,373 MW. 57 The firm supply rating for each of the two largest generating units in the State is 680 MW. Accordingly, the EST is 15,733 MW. NSW's firm capacity for 2019-20 is estimated at 15,545 MW. Therefore, this places NSW 188 MW short of its EST. In this respect, the State's capacity shortfall on its EST is expected to be addressed by the summer of 2021, with additional projects providing further capacity increases through to 2022-23".*

Whilst the Strategy takes a state-wide focus, it should be considered in the context of the increased population and electricity demand on the Site. Energy efficiency measures and onsite renewable energy may be initiatives that can be implemented at the Site to compliment the Strategy.

5.4.8 Urban Green Cover in NSW Technical Guidelines

The Office of Environment and Heritage (OEH) Urban Green Cover in NSW Technical Guidelines (2015) are part of the NSW Government's aim to minimise and accommodate the impacts of climate change to communities, health services and local infrastructure.

The Guidelines recognise the need for urban environments to withstand projected increase in extreme heatwaves, intense storms and localised flooding. Among urban green cover, the Guidelines include a range of strategies such as vegetated and reflective roofs, green walls, street plantings, permeable and reflective road surfaces, and cool open spaces and parks. These are mostly low-cost approaches to cooling urban environments while providing ecosystem services such as stormwater management, clean air and biodiversity habitat in addition to reduced energy costs for cooling. The guidelines are meant for integration in strategic plans, development control plans, public domain guidelines or urban design studies.

5.4.9 NSW Waste Avoidance and Resource Recovery Strategy (WARR) 2014-21

The NSW Waste Avoidance and Resource Recovery (WARR) Strategy provides a clear framework for waste management over the next few years and aligns with the NSW Government's waste reforms set out in '*NSW 2021: A Plan to make NSW number one'*.

The vision set in the WARR Strategy is to "*enable all of the NSW community to improve environment and community well-being by reducing the environmental impact of waste and using resources more efficiently. Using resources more efficiently and keeping materials circulating in the productive economy can also help to create jobs and grow the NSW economy*".

The WARR Strategy is financially supported by the '*Waste Less, Recycle More'* initiative. It has supported significant new recycling and waste infrastructure, litter programs and illegal dumping reduction strategies across the state.

The WARR Strategy's key objectives and targets are to: increase recycling across municipal, commercial/industrial and construction & demolition waste streams; divert waste from landfill; better manage problem wastes[5], reduce litter and illegal dumping.

Table 5: Waste Avoidance and Resource Recovery Strategy Targets

WARR Strategy 2014-21 Targets

Avoidance and reduction of waste generation	
By 2021–22, reduce the rate of waste generation per capita	
Reduce household chemicals, e-waste, organics and support collection for safe disposal and recycling drop-off facilities	
Increase recycling	**Divert from landfill**
Municipal solid waste from 52% (in 2010–11) to 70%	By 2021–22, increase the waste diverted from landfill from 63% (in 2010–11) to 75%
Commercial and industrial waste from 57% (in 2010–11) to 70%	
Construction and demolition waste from 75% (in 2010–11) to 80%	

As part of WARR, a draft WARR Infrastructure Strategy (2017-2021) was developed to guide planning and decision making to ensure NSW gets the correct mix of infrastructure to meet future needs. It is imperative to understand the gap in existing capacity and the need for resource recovery facilities. The projected population growth is assumed to be the major driver for an increase in waste generated across the state. Should the 2021 75% target for resource recovery diversion not be met, the demand for landfill capacity could increase. This could put a strain on the existing waste infrastructure; hence there is an apparent need to increase the number of waste processing facilities. The Planning Proposal Requirements require identification and implementation of strategies to meet or exceed benchmark for environmental performance, including waste reduction and recycling measures, which warrants alignment with the WARR Strategy.

5.4.10 Waste Less, Recycle More

The Waste Less, Recycle More initiative provides funding for business recycling, organics collections, market development, managing problem wastes, new waste infrastructure, local councils and programs to tackle illegal dumping and litter. The program seeks to encourage local communities to think differently about waste avoidance, recycling, littering and illegal dumping, deliver conveniently located, value-for-money waste infrastructure to make it easier to 'do the right thing', and drive innovative regulatory approaches to protect the environment and support investment in new waste programs.

5.4.11 Better Practice Guide for Resource Recovery in Residential Developments

The Better Practice Guide for Resource Recovery in Residential Developments (2019) was released by the NSW EPA as a guide to assist local planners, architects, urban designers, developers and other professionals to incorporate better waste and recycling management design practices in residential developments. It applies only to residential developments, and does not cover commercial, retail or industrial premises. As such, the Guide can be referenced during the design of the Site's residential buildings to ensure the best waste management outcomes are realised.

The Guide provides information on how make the collection of waste and recycling convenient and safe for all involved, how to improve the performance of waste collection systems and how to minimise the visual amenity impact of such systems. The Guide includes four waste and resource recovery design principles:

[5] For example, by providing appropriate facilities for disposal of household problem waste such as paint, batteries, gas bottles and hazardous household products

4. **Environmental and sustainability best practice**: Developments meet requirements for long-term sustainability and best practice when:
    a. systems are designed to maximise waste separation and resource recovery
    b. innovative and best practice waste management collection systems and technologies are supported where appropriate
    c. flexibility in design allows for future changes in waste generation rates, materials collected and methods of collection
5. **Effective waste and resource management:** Developments achieve effective waste and resource management when:
    a. waste services can occur in a safe, seamless and timely manner
    b. access to waste disposal and resource recovery services are safe and convenient for all residents
    c. functional and adequate storage spaces are provided for all waste and recycling streams, including temporary storage areas for bulky materials like cardboard boxes and oversized household waste.
6. **Clean, safe and healthy living environments:** Developments protect and enhance the quality of life for the community when:
    a. negative impacts on amenity for residents, neighbours and the public, such as visually unpleasant waste storage areas, bad odours and noise from waste collection are minimised
    b. illegal dumping and litter from bins are minimised through good planning and installation of adequate storage and waste recovery infrastructure
    c. safe and easy access to waste and resource recovery storage areas is provided for residents, building managers and collection contractors.
7. **Affordability**: Developments allow residents to engage in cost-effective waste services when:
    a. careful design and construction prevents costly retrofits
    b. flexibility in design allows for the collection of all waste and recycling streams to be cost-effective for residents.

5.5 National and International Context

5.5.1 United Nations Sustainable Development Goals (SDG)

In 2015, the United Nations General Assembly passed a resolution on the global agreement of 17 Sustainable Development Goals (SDGs) to form a roadmap for global development efforts to 2030 and beyond (Figure 10[6]). While non-binding for Australia, the 2030 Agenda will be highly influential, shaping commitments, development cooperation and finance flows as well as global government and private sector reporting. Each SDG has been assigned to a particular federal agency for action and reporting.

Figure 10: UN Sustainable Development Goals

[6] UN Department of Public Information, 'Guidelines for the use of the SDG logo, including the colour wheel, and 17 icons;, December 2017.

Some of the SDG's have particular relevance to the Site. As an overarching theme, Australia's commitment includes engagement with SDG 11 (Sustainable Cities and Communities). Efforts are being led the Department of Infrastructure, Regional Development and Cities who is providing input into Australia's Voluntary National Review on progress towards SDG 11. SDG 11 particularly refers to "by 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience...".

Other relevant SDG's include:

SDG 12 – Responsible consumption and production

- *12.1 Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries*
- *12.2 By 2030, achieve the sustainable management and efficient use of natural resources*
- *12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse*

SDG 7 - Affordable and clean energy

- *7.1 By 2030, ensure universal access to affordable, reliable and modern energy services*
- *7.2 By 2030, increase substantially the share of renewable energy in the global energy mix*
- *7.3 By 2030, double the global rate of improvement in energy efficiency*

SDG 6 - Clean water and sanitation

- *6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity*
- *6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate*
- *6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes*

5.5.2 Renewable Energy Target (RET)

The Renewable Energy Target is a legislated target designed to ensure the increased uptake of renewable energy in Australia, and in the process, reduce overall GHG emissions. The current target is for 23.5% of Australia's energy, the equivalent of 33,000 GWh of electricity, to come from renewable sources such as wind, solar, and hydroelectric by 2020.

The RET allows both large-scale power stations and small-scale systems to create certificates for every megawatt-hour of energy generated. Energy retailers purchase and surrender the certificates to the Clean Energy Regulator to meet their legal obligations under the RET. This creates a market that provides financial incentives to both large-scale renewable energy power stations and the owners of small-scale renewable energy systems.

The RET, though not directly relevant to the Site sets out the overall trajectory on renewable energy uptake from a policy perspective. The RET also enables any on-site renewable generators to claim certificates to improve its overall business case.

5.5.3 National Energy Productivity Plan (NEPP)

The National Energy Productivity Plan aims to improve Australia's energy productivity[7] by 40% by 2030. The energy market is undergoing rapid disruptive changes with new technologies, new customer expectations, rising prices, falling demand and pressure from climate change impacts. Energy supply has moved away from predictable patterns and energy markets have struggled to forecast and plan for this change. The inability to plan effectively has resulted in inefficient investment which has led to higher costs for customers.

Over recent years, Australia's energy productivity has improved, growing at around 1.8% per annum over the last decade. However, Australia is still lagging behind other countries such as Japan, Germany and the UK. To meet

[7] Energy productivity is increasing the output using the same amount, or less, energy

the 40% target, a doubling of the rate of energy productivity improvement compared to business-as-usual is required.

The NEPP itself does not mandate any particular development to achieve certain energy productivity targets. However, it acts as general guidance for energy efficiency and energy productivity measures that could be considered for the Site.

5.5.4 National Carbon Offset Standards (NCOS) for Buildings and Precincts

The Department of Environment and Energy released the final version of the National Carbon Offset Standards (NCOS) for Buildings and Precincts in October 2017. The Department collaborated with the National Australian Built Environment Rating System (NABERS), the Green Building Council of Australia (GBCA), carbon accounting experts and property sector businesses to develop the NCOS. These voluntary standards set rules for measuring, reducing, offsetting and reporting emissions required to make carbon neutral claims for building and precinct operations. Within precinct operations this includes energy, water, waste and transport emissions. These standards will frame the due diligence process and future carbon measurement and reporting efforts for the Site.

5.5.5 National Construction Code

The National Construction Code (NCC) is an initiative developed by the Coalition of Australian Governments to incorporate all on-site building and plumbing requirements into a single code.

The Code sets the minimum necessary requirements for safety, health, amenity and sustainability in the design and construction of new buildings (and new building work in existing buildings) throughout Australia. It is a standardisation of technical provisions for building work and plumbing and drainage installations whilst allowing for variations in climate and geological or geographical conditions.

Although developed at the national level, administration of the NCC is the responsibility of Australian States and Territories, which provide the legal framework to support the design and construction of buildings.

The NCC is published in three volumes. Volumes 1 and 2 are the Building Code of Australia, and Volume 3 is the Plumbing Code of Australia These updates include changes to commercial building energy efficiency requirements including new verification methods for demonstrating compliance with the relevant performance requirements in NABERS and Green Star ratings. New heating and cooling load limits using the NatHERS compliance pathway for residential buildings have also been introduced for building classes 1, 2 and 4.

Section J is of importance on the Site as it will drive building energy efficiency and have an impact on the net carbon position of the precinct.

5.5.6 Sustainability Rating Tools

There are a number of rating tools available to assess the sustainability performance of buildings and precincts that are relevant to the Site. NABERS and NatHERS are government initiatives while Green Star is an industry developed suite of rating tools.

Nationwide House Energy Rating Scheme (NatHERS)
The Nationwide House Energy Rating Scheme (NatHERS) rates the energy efficiency of a home on a 10-star rating system. NatHERS primarily focuses on the potential heating and cooling energy use, centred on thermal comfort of the building's inhabitants. NatHERS is integrated into the Building Code of Australia (BCA) under which multi-residential units must:

- *Collectively achieve an average energy rating of not less than 6 stars; and*
- *Individually achieve an energy rating of not less than 5 stars*

NatHERS will provide greater opportunity for the reduction of energy used in buildings for thermal comfort as well as provide means for better future-proofing from climate change and related temperature increases.

Green Building Council of Australia (Green Star)
Green Star is an internationally recognised rating system that delivers independent verification of sustainable outcomes throughout the life cycle of the built environment. It is designed to be a voluntary rating tool to incentivise better practice within the property development industry.

The Green Star – Communities rating tool was released in 2012 and evaluates the sustainability attributes of the planning, design and construction of large-scale development projects at a precinct, neighbourhood and/or community scale. It provides a rigorous and holistic rating across five impact categories; Governance, Liveability, Economic Prosperity, Environment, and Innovation. Green Star - Communities also rewards credit points for buildings on the precinct that are certified under building-scale rating tools.

Green Star – Design & As Built assesses the sustainability outcomes from the design and construction of new buildings or major refurbishments, across nine holistic impact categories. Green Star – Design & As-Built works to provide sustainability in the design and construction of buildings specifically. The credits covered by this tool are:

- Management;
- Indoor Environmental Quality;
- Energy;
- Transport;
- Water;
- Materials;
- Land use and Ecology;
- Emissions; and
- Innovation.

Green Star - Design & As Built can be applied to the retail and residential building elements within the development, but due to economies of scale, it may not be appropriate to consider for the Site.

5.6 Conclusion

This review of the policy and regulatory context for the Site is a valuable consideration for addressing the Planning Proposal requirements. The strategic policy frameworks and targets outlined are important to review and consider to ensure best practice ESD initiatives are considered and implemented, where possible, during the rezoning, design and development of the Site.

6. Sustainability Trends and Drivers

6.1 Build-to-Rent

'Build-to-rent' refers to residential dwellings built and designed specifically to be rented out by a long-term single owner, either private or institutional. Internationally, build-to-rent forms a very significant part of institutional investors' portfolios in many developed markets (see Figure 11). The United States is the largest build-to-rent market in the world and accounts for approximately a quarter of all institutional investment in real estate.

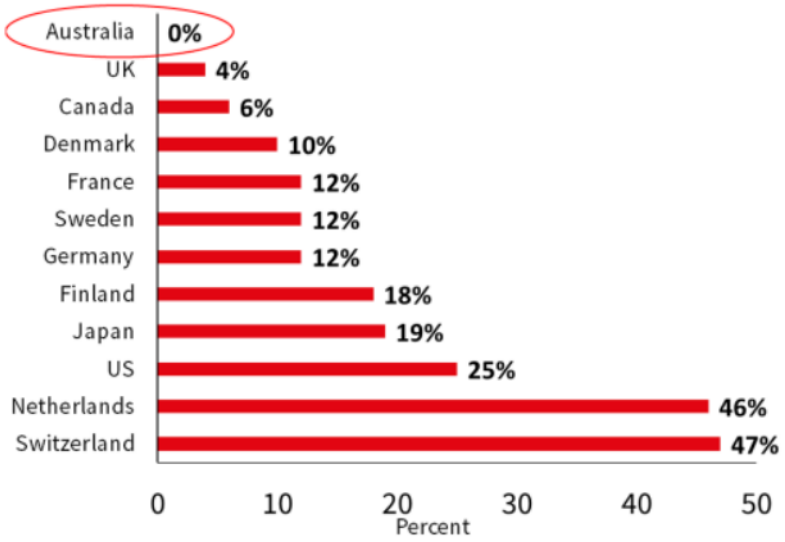

Figure 11: Residential Build-to-Rent as a Percentage of Institutional Real Estate Portfolios

Source: JLL (2017), Build to Rent Residential: Australia's Missing Sector

Building properties to own and rent long-term, rather than sell off, can incentivise developers to build higher quality, more efficient buildings and precincts as returns on investment are made through whole of life considerations[8]. These benefits may include cost savings from reduced energy, water and resource consumption, and savings on maintenance associated with increased durability of fixtures and fittings.

Due to the longer timeframe that the developer is responsible for the building and the tenant's experience, ensuring the buildings are resilient to future shocks and stresses also becomes a more important consideration.

The build-to-rent model has increasingly been used in the US, Europe and the UK, for example in the former Olympic village site in London which has been re-created as The East Village, owned and operated by a single landlord (Get Living London). The promoted benefits of living in The East Village include longer-term, secure leases with no fees as well as community events, maintenance and on-site security.

The East Village example also demonstrates that build-to-rent models can encourage an increased focus on community within the buildings themselves, and a focus on social cohesion and interaction through the provision of 'community' facilities and spaces.

The build-to-rent market in Australia is still emerging. Mirvac recently announced the formation of the Australian Build-to-Rent Club (ABTRC) providing wholesale investors access to Australia's build-to-rent sector. The Clean Energy Finance Corporation (CEFC) has committed to the ABTRC as a cornerstone investor with a 30% stake, equivalent to $50 million in the first tranche.

In their first purpose-built build-to-rent asset in Australia, Indigo at Mirvac's Pavilions project at Sydney Olympic Park, Mirvac has committed to dedicated on-site leasing and management, high-quality amenities, a resident program and leading sustainability features. The building has been designed to achieve a minimum of 40% less greenhouse gas emissions compared to a typical apartment building. This will be achieved through implementing

[8] Build-to-rent: a potential solution to Australia's housing problem https://www.smh.com.au/national/build-to-rent-a-potential-solution-to-australia-s-housing-problem-20180904-p501of.html

features such as upgraded glazing, LED lighting throughout, energy efficient appliances, solar PV, water efficient taps, toilets, and showers[9].

The Communities Plus build-to-rent model , announced by the NSW Government in July 2018, provides an opportunity for the private sector, in partnership with the not-for-profit sector, to fund, design, develop and manage the buildings as rental accommodation under a long-term lease. It will incentivise the inclusion of social and environmental sustainability initiatives from the early design and planning stages, and these long term benefits will be shared by tenants, investors, government and the broader community.

Considerations should be made on building design features that reduce energy and water consumption through passive design, as well as initiatives such as LED lighting, solar PV, energy and water efficient appliances including hot water systems, taps, toilets and showers. Planning and design consideration should also include the creation of community spaces and areas for social interaction.

6.2 Retail Electricity Prices

Retail electricity prices are projected to remain steady or grow very steadily at up to 2.6%[10] per annum under a neutral scenario. Between 2017 and 2020, retail electricity prices are expected to grow at a relatively fast rate due to the withdrawal of significant generators such as Hazelwood (brown coal-fired power plant in Victoria) from the National Electricity Market. The tightening supply is expected to drive prices up. From 2020 to 2030, falling demand due to the impact of energy efficiency schemes, increasing distributed generation and carbon price are expected cause price decline by up to 3%. Projections predict this trend to reverse from 2030 and beyond due to retightening of supply, stabilising retail electricity prices.

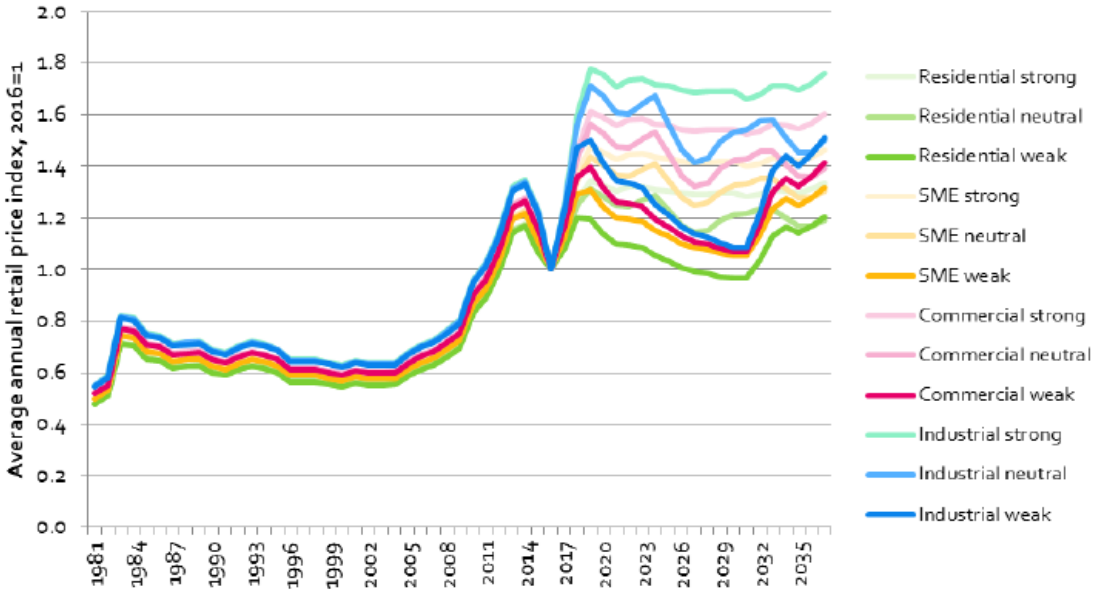

Figure 12: Comparison of NSW retail electricity prices by scenario and market

As retail electricity prices increase in the long run, price signals are created signalling the market to pursue other forms of energy generation such as on-site renewable generation and waste-to-energy initiatives.

6.3 Electric Vehicle Uptake

Electric vehicles have rapidly gone from concept through to market emergence, with prices declining year on year. The primary driver behind the price reduction has been the mass production of lithium-ion batteries which EVs are dependent on.

While EVs made up only 0.2% of 2015 annual vehicle sales in Australia, this is anticipated to sharply increase in coming years as cost of production is expected to decline, availability and range capacity of electric vehicles improve, and public charging infrastructure is developed. Under a neutral scenario, forecasted electric vehicle

[9] https://www.mirvac.com/About/News/Mirvac-Launches-its-First-Build-To-Rent-Club-in-Australia-
[10] AEMO, Jacobs, 'Retail electricity price history and projected trends. Retail price series development', June 19 2017

sales vary from 16% to 45%[11] of new light vehicle purchases, representing 9% to 33% of Australia's vehicle fleet under varying economic scenarios.

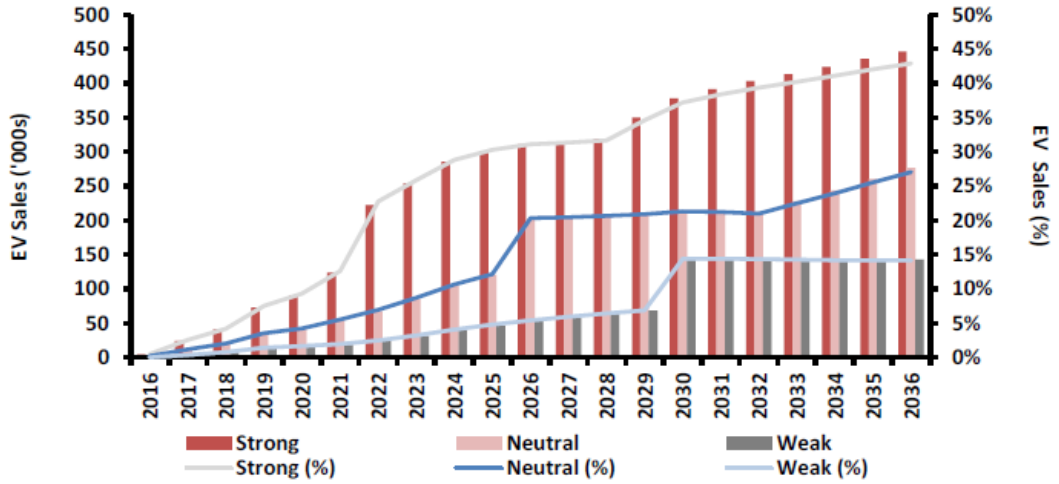

Figure 13: EV annual sales by sensitivity (NEM) [12]

Considerations should be made for the provision of electric vehicle charging infrastructure for the Site. However, this needs to be carefully managed with the impact of peak demand on electrical infrastructure. There is potential for EV charging behaviour to contribute to daily peak periods requiring costly augmentation of infrastructure. This can be managed through initiatives such as staggering of charging throughout the day or night to coincide with off-peak periods.

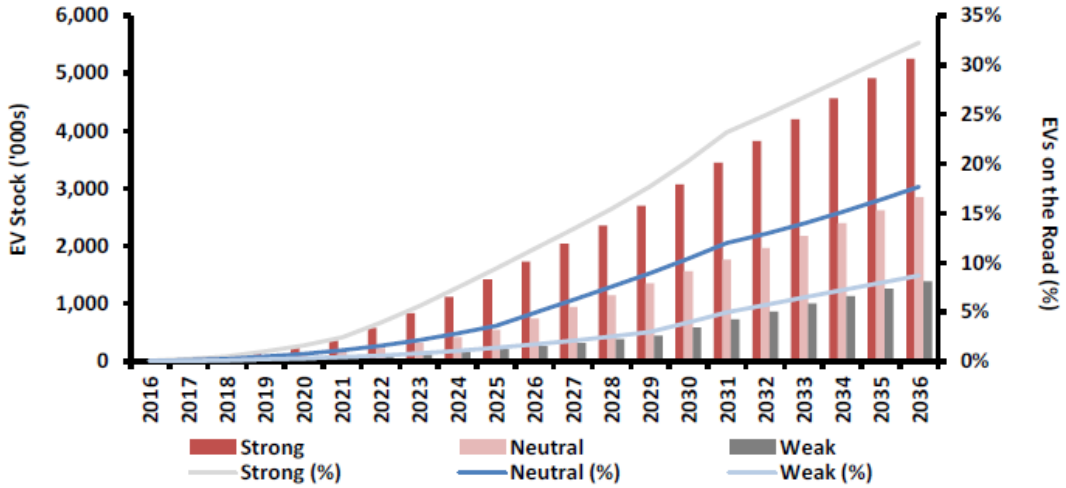

Figure 14: EV uptake by sensitivity (NEM)[10]

6.4 Renewable Generation

Solar PV and wind generation have been in the market for some years. The price of solar PV panels has already reduced to a quarter of what it did in 2009 and is predicted to fall by another 66% by 2040. Similarly, the cost of onshore wind generation which has already declined by 30% over the past 8 years is anticipated to fall by a further 47% by 2040[13].

Over 850 MW of wind energy was installed in Australia in 2018, the largest installation rate to date[14] making up nearly 34% of Australia's renewable energy generation and over 7% of total Australian electricity generation.

[11] AEMO, Energeia, 'AEMO Insights: Electric Vehicles', August 2016
[12] AEMO, Energeia, 'AEMO Insights: Electric Vehicles', August 2016
[13] BNEF, 'Solar Power will Kill Coal Faster Than You Think', June 15 2017, https://about.bnef.com/blog/solar-power-will-kill-coal-sooner-than-you-think/
[14] Clean Energy Council of Australia, 'Clean Energy Australia Report 2019', 2019

Small-scale solar systems (up to 100kW) are responsible for 20% of Australia's renewable energy generation, producing over 4% of Australia's generated electricity[15]. Installations of medium-scale solar (100kW to 5MW) also grew by 80% in 2018. Medium-scale installations are commonly found on shopping centres, schools and commercial buildings.

In 2018, 15% of NSW's electricity came from renewable sources. As of March 2019, NSW has over 3800MW, representing a $4,714 million investment, solar projects under construction or financially committed. In Waterloo South there is potential to explore rooftop solar generation as a pathway to achieve 50% renewable energy generation.

6.5 Domestic Gas Supply

Australia is a major exporter of liquefied natural gas (LNG) with increased development of LNG infrastructure across all three major Australian gas markets. However, increasing local demand and tightening gas supply resulting in higher gas prices is likely to signal the market to explore other forms of energy. Waste-to-energy is likely an important factor as waste-generated methane can be a direct substitute for gas.

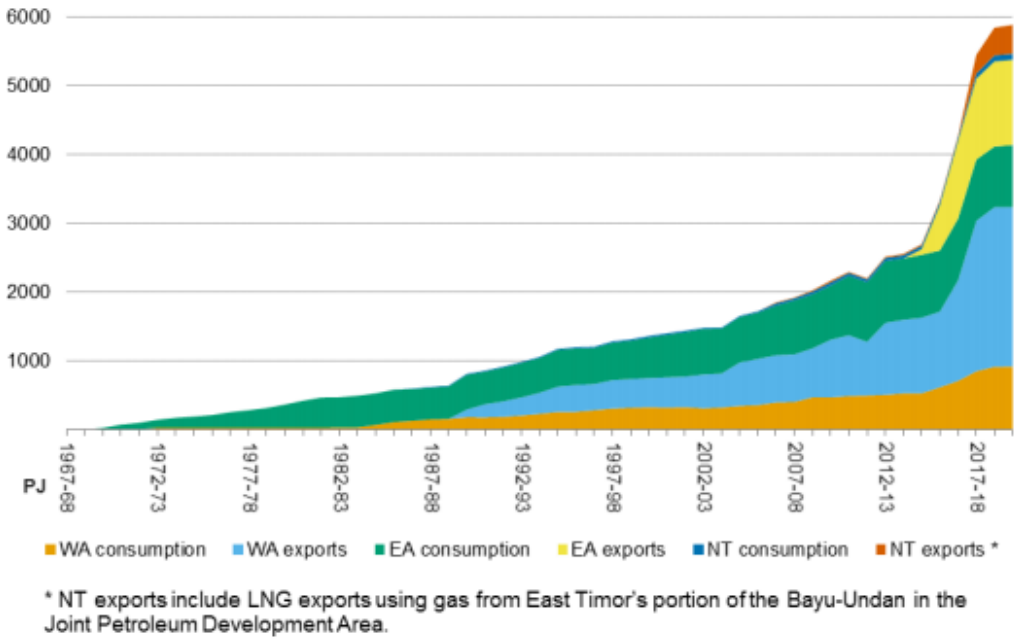

Figure 15: Domestic gas consumption and LNG exports[16]

6.6 Grid Electricity Carbon Intensity

Grid electricity carbon emissions peaked in 2009 and are expected to fall until 2020, driven by the Renewable Energy Target, and the closure of high emissions intensity power plants such as Hazelwood in Victoria.

After 2020, absolute carbon emissions are projected to grow steadily, but more slowly than historical rates. The retirement of coal-fired generators is expected to be replaced with existing coal and gas fired generators. In combination with increasing demand due to electric vehicles, overall electricity sector emissions are anticipated to rise by a small amount.

[15] Clean Energy Council of Australia, 'Clean Energy Australia Report 2019', 2019
[16] Oakley Greenwood, 'Gas Price Trends Review', February 2016, https://industry.gov.au/Energy/Energy-information/Documents/Gas-Price-Trends-Report.pdf

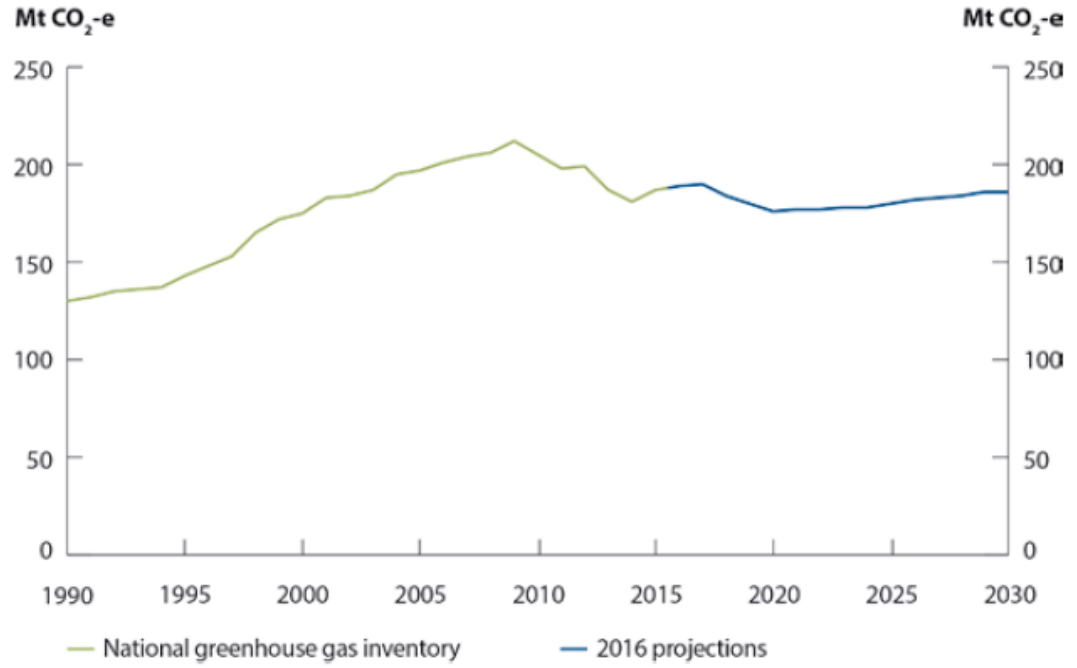

Figure 16: Electricity emissions from 1990 to 2030[17]

On a $kgCO_{2\text{-}e}$ per kWh generated basis, the grid is seen to be decarbonising. Under a low decarbonisation scenario, NSW grid electricity intensity is projected to be $0.74kgCO_{2\text{-}e}$/kWh and $0.55kgCO_{2\text{-}e}$ per kWh under a high decarbonisation scenario by 2030. Under either scenario, the NSW grid is unlikely to be completely decarbonised unless there is a radical shift in energy policy between now and 2050 to create a step-change in the carbon trajectory.

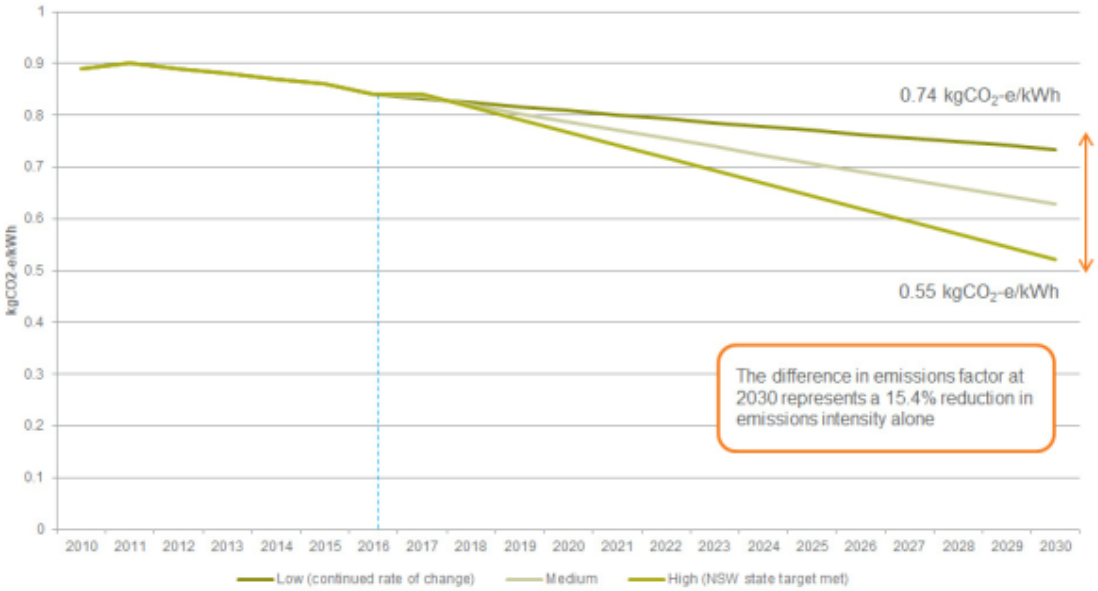

Figure 17: NSW electricity grid emissions factor (kgCO¬2e/kWh)[18]

With the Paris Agreement setting Australia on a net zero carbon trajectory by 2050, continued reliance on grid electricity under the current projections will leave the Site exposed to carbon liability. However, there is the opportunity to set the Site onto an appropriate trajectory to become carbon neutral by 2050 during the early planning stages (refer to Section 7.3 for further detail on low carbon and energy efficient opportunities for the Site).

[17] Department of the Environment and Energy, 'Australia's emissions projections 2016'
[18] Energetics, 2017

It is also worth noting that the current carbon intensity of the grid does not fully account for all of the current growth in renewable energy as the current carbon pricing and RET mechanism effectively hides this carbon from the grid intensity as the carbon is accounted for elsewhere. If the policies change on the RET or carbon pricing (which is likely) the relative intensity of the carbon on the grid would change.

6.7 Water Consumption

For Sydney Water, there are a number of potential future consumption scenarios being considered. The chart below presents some of the future water consumption scenarios forecast to 2022 based on existing consumption and projected future consumption.

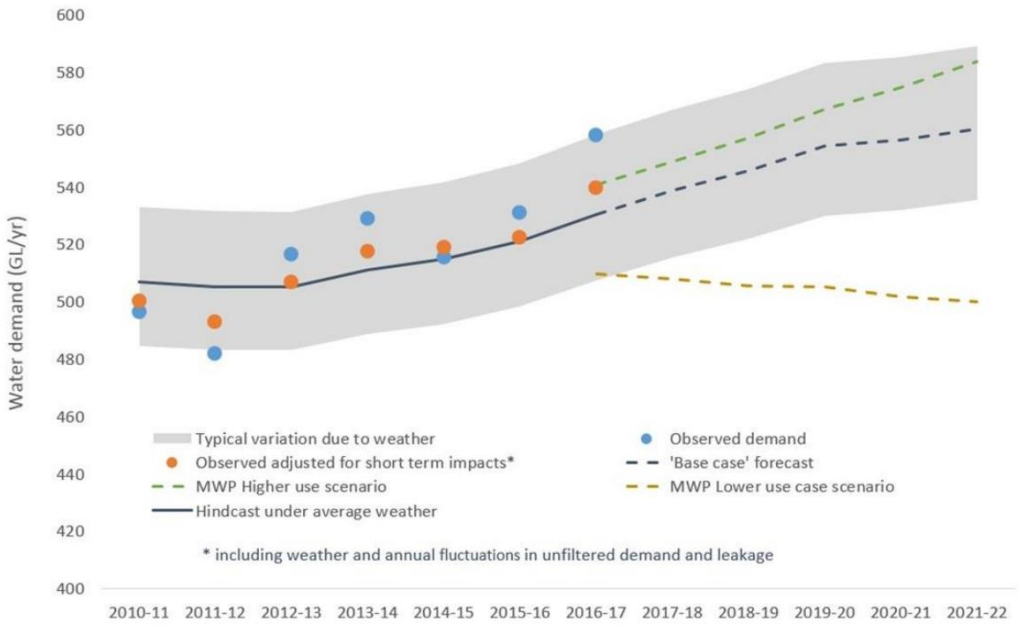

Figure 18: Water Consumption Future Scenarios[19]

It is important to note that average weather has a significant impact on potable water consumption with dryer weather leading to increased reliance on potable supply as water tanks run out and irrigation increases. Hot weather also has an impact on water consumption. As we move into warmer and more intermittent wet/dry periods this is likely to impact water consumption.

6.8 Waste Generation

In 2014-15 total waste generated in NSW fell by 4% from its peak in 2010-11. Per capita waste generation also fell 6% between 2012-13 to 2014-15[20]. While recycling rates have increased, progress towards the NSW recycling targets has been steady but slow particularly in construction and demolition waste due to the recent significant increase in construction and demolition waste being produced in NSW.

[19] Sydney Water Water Conservation Report 2016-2017
http://www.sydneywater.com.au/web/groups/publicwebcontent/documents/document/zgrf/mdq3/~edisp/dd_047419.pdf
[20] NSW EPA, 'NSW State of the Environment 2018', 2019

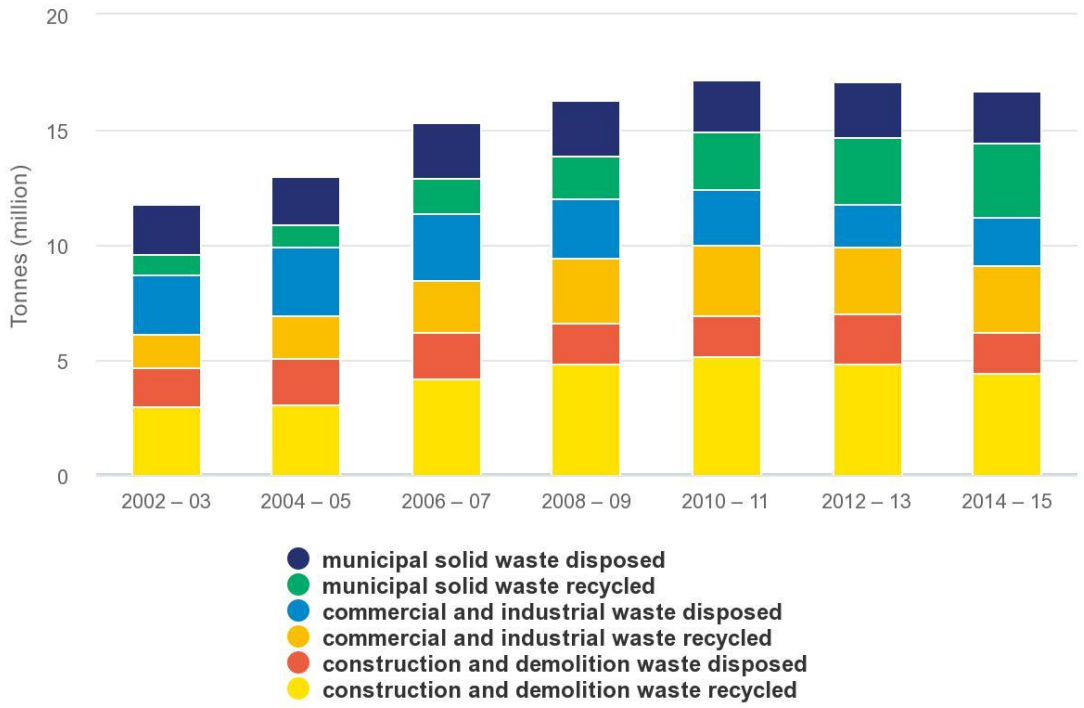

Figure 19: Waste disposed and recycled by waste stream in NSW (NSW EPA)

Waste generation rates are significantly linked to population growth and increased economic activity. By 2021, it is expected nearly 20 million tonnes of waste will need to be process a year in NSW.. Globally, foreign markets have restricted the import of Australian mixed recycling material meaning there is an increased impetus to ensure Waterloo South is able to effectively management the waste generated by the new population and divert waste from landfill.

6.9 Green Infrastructure

Green infrastructure is comprised of standalone and strategically networked photosynthetic elements incorporated into the urban landscape for environmental, social and economic benefits. It plays a critical role in the health and wellbeing of the population and urban ecosystem, with an increasing body of research also demonstrating its tangible economic benefits. Trees filter air pollution, lower building energy demand and urban heat island effect by shielding buildings and paved surfaces from the sun, provide shade for cyclists and walkers, support urban fauna, reduce stormwater pollution and transform the built environment into more appealing places to live, play and work.

Current regulation and business models treat green infrastructure as a cost and do not recognise its benefits in a healthy urban landscape. However, industry perception is changing, and its true value for urban environments is increasingly recognised. In cities such as Vancouver, Manchester and Singapore, long-term approaches to green infrastructure are being adopted with significant social, economic and environmental benefits being demonstrated.

In the context of the Site, it is important to identify and prioritise opportunities to integrate green infrastructure at a level that delivers positive impacts for the community and assists in addressing issues such as urban heat island effect, temperature rise, air pollution and stormwater management (refer to Section 7.3.2.4 for further details on green infrastructure opportunities for the Site). Green infrastructure should be responsive to the specific development context and priorities in terms of sustainability.

The Greater Sydney Region Plan includes an objective for increasing urban tree canopy cover as part of the sustainability direction for the region. It highlights the importance of new development to achieve the NSW target to increase tree canopy cover from 23% to 40%.

6.10 Transport trends

Rapid innovation is transforming the way we travel, the transport modes we use to travel and the way the different modes of transport operate. Cheaper, more flexible and more reliable technologies are accelerating the

automation of buses, trains, cars and trucks. Data sharing and mobile technology are enabling smarter, cheaper and faster ways to plan trips and travel, with ridesharing, car share, hire car, Uber and smart parking being some of the best examples.

Strategic planning of communities and precincts is shifting the transport mode split towards public and active transport modes, reducing dependency on private vehicles and the need for parking. New transport modes such as new personalised devices for short trips reduce the need for larger transport infrastructure. The need for more sustainable transport is acknowledged by encouraging use of public transport, walking and cycling, while ensuring easy access and accessibility for everyone.

Sustainable precinct design needs to be sensitive to current transport trends to enable their incorporation into precinct design. Flexibility should be incorporated to cater for future trends and technologies such as electric vehicles, the use of drones for parcel delivery and driverless vehicles.

Key current trends include:

- Transit-oriented development
- 'Last mile' transport modes
- Active transport modes
- Car share
- Hire car
- Smart parking

Sustainable transport strategies to respond to these trends range from enhancing amenity and lowering traffic speeds for increased walking, to providing secure bicycle storage and connected bike paths for higher uptake of cycling, to pedestrianizing streets for achieving private car-free development, where only public and special-purpose transport is allowed. The Greater Sydney Region Plan and the Future Transport Strategy 2056 outline other key trends and considerations that will be useful in framing a strategy for sustainable transport.

Precincts in close proximity to train stations and Transit Oriented Developments (TODs), such as the Site, present enormous opportunity for the incorporation of sustainable transport measures that recognise current and future trends. In order to determine and prioritise the best options for the development, the input from a site-specific traffic and transport assessment is essential. The Transport and Traffic Impact Assessment prepared by Jacobs addresses this recommendation.

6.11 Conclusion

This section provides the context on the macro trends that influence the selection of sustainability initiatives implemented during the development of the Site. The established context is then used to guide the following sections of the ESD Report. By analysing the sustainability trends and drivers, recommendations can be made as to the appropriate ESD measures to consider for the Site. For example, the increase in electric vehicle uptake means that infrastructure to accommodate them should be a key consideration in the planning for the Site.

7. Sustainable Design Integration

The principles of ecologically sustainable development as defined in clause 7(4) of Schedule 2 of the EP&A Regulation 2000 are as follows:

- *the "precautionary principle", namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:*
  - *careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and*
  - *an assessment of the risk-weighted consequences of various options,*
- *"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*
- *"conservation of biological diversity and ecological integrity", namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration*
- *"improved valuation, pricing and incentive mechanisms", namely, that environmental factors should be included in the valuation of assets and services, such as:*
  - *Polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,*
  - *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,*
  - *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.*

To facilitate the integration of ESD principles into precinct design, construction and operation, a context review was undertaken (see Section 5 and Section 0), identifying sustainability needs and priorities for the Site.

This context was presented to LAHC, the design team and key consultants at a Sustainability & Resilience workshop to inform the development of concept design options. In turn, the workshop outputs along with the context review findings provided the basis for sustainability targets and initiatives.

7.1 Sustainability & Resilience Workshop

The Sustainability and Resilience workshop facilitated by AECOM and attended by LAHC and key project members, sought to achieve the following objectives:

- Present priority climate risks and adaptation options to deal with extreme heat, rainfall and storms for group review and comment.
- Present recommended community resilience options for group review and comment.
- Present the sustainability context for the Site to inform building/precinct design. This included key stakeholder needs, policy and regulatory requirements, sustainability trends and drivers and site constraints and opportunities.
- Identify short, medium and long-term actions needed to achieve desired outcomes for the Site.
- Provide a platform for cross-disciplinary discussion, collaboration and integrative design for innovation and identification of new additional initiatives.

The measures discussed in the workshop have been considered in the shortlisting of targets and initiatives for the Precinct. Where not explicitly mentioned within the main body of this report, those initiatives are expected to be further investigated at the detailed design stage. Identified initiatives and actions discussed in the workshop are provided in Appendix A.

7.2 Sustainability Targets and Planning Controls

A number of targets have been developed to inform planning controls with the aim of achieving sustainable outcomes at the Site. These targets are developed in line with:

- Statutory and Planning Proposal requirements;
- Local and state policy;
- LAHC programs and policy;
- Best-practice sustainability frameworks; and
- Industry best-practice for buildings and precincts.

For each target, two sets of goals have been identified for the following purposes:

- A '*minimum goal*' is nominated to outline minimum commitments for the development application and planning approvals;
- A *'stretch goal'* is nominated to guide property developer/tenderer options and enable a point of sustainability differentiation among developers/tenderers.

Sustainability targets for Elizabeth St., Redfern are provided under Table 6. Table 7 provides source abbreviations for cross referencing of targets.

In addition, the Site is targeting:

- A 6 Star Green Star Communities Rating; and
- A 5 Star Green Star Design and As-Built rating for certain buildings.

Table 6. Sustainability targets for the Site.

Target	Minimum Goal	Stretch Goal	Target source minimum/stretch	Comments
Environmental				
BASIX Energy targets			BASIX SEPP / EAP	Targets are expressed as a percentage reduction over NSW benchmarks.
Mid-rise (4-5 storey units)	35	40+		
High rise (6 storey units or higher)	25	40+		
NABERS Energy Rating (commercial)	5.5 stars	-	AECOM	
NatHERS rating for social and affordable dwellings	6 star	7 star	DS / AECOM	
Low carbon precinct		100% (net-zero carbon by 2050)	GSRP	Target expressed as a percentage reduction in scope 1 and 2 emissions.
BASIX Water target	40	50	BASIX SEPP / EAP	
NABERS Water rating (commercial)	4.5 stars	-	AECOM	
Stormwater flow and pollutant load reduction			DCP / AECOM	
Stormwater peak flow increase	0%	0%		
Nitrogen	45	65		
Phosphorus	65	85		
Suspended solids	85	90		
Gross pollutants	90	90		
Operational waste diverted from landfill	70%	70%+	WARR / WARR	

Target	Minimum Goal	Stretch Goal	Target source minimum/stretch	Comments
Construction & demolition waste diverted from landfill	80%	90%+	WARR / GSC	
Tree canopy cover	15%	25%	DCP / City of Sydney Urban Forest Strategy	% of the Site
Social				
Provision of bicycle parking: Residential Residents Visitors	 1 0.1	 - -	DCP	Expressed as parking spots per dwelling
Economic				
Dwellings with access to fibre to the premises (FTTP)	-	100%	GSC	
Dedicated car share spaces	-	4%	D&AB	

Table 7 Source Abbreviations

Source Abbreviation	Document
ARHT	Greater Sydney Commission's Affordable Rental Housing Targets
BASIX SEPP	BASIX State Environmental Planning Policy
CPP	Communities Plus Program
DS	LAHC Design Standards 2014
DCP	City of Sydney Development Control Plan 2012
D&AB	Green Star – Design & As Built v1.2
EAP	City of Sydney Environmental Action Plan 2016-2021
GSC	Green Star – Communities v1.1
GSRP	Greater Sydney Region Plan – A Metropolis of Three Cities
WARR	NSW Waste Avoidance and Resource Recovery Strategy 2014-21

7.3 Energy and carbon emissions

The following minimum targets have been set to deliver energy and carbon reductions:

- **BASIX Energy rating: Mid-rise 35%; high-rise 25%**
- **NABERS rating (commercial): 5.5 stars**
- **NatHERS rating: 6 star for all social and affordable dwellings**
- **Tree canopy cover: Minimum 15%**

Additionally, the Green Star targets will assist in facilitating energy and carbon reductions:

- **6 Star Green Star Communities**
- **5 Star Green Star Design and As-Built**

Proposed initiatives to meet these targets are described below.

7.3.1 Carbon Neutral Pathways

The Planning Proposal Requirements specify demonstrating how the Site *contributes to the NSW Government's transition to net-zero emissions by 2050 as described in the District Plan* and to *identify precinct-scale individual development strategies and measures to meet or exceed benchmarks for environmental performance,* including BASIX and NABERS.

Developing pathways towards a net-zero precinct by 2050 will require a longer-term view on the market with respect to energy, water, transport and waste as it is possible that the most suitable technologies and applications have not been invented or commercialised. This likely outcome will be influenced by several external factors which the project team have very limited control over at this stage of planning. As such, potential pathways towards carbon neutrality were developed under the assumption of a number of conditions.

Assumptions

The following assumptions for the market in the year 2050 are as follows, and will be the scenario under which the pathways will be developed under.

- NSW electricity grid will be 100% carbon neutral, through renewable generation or residual carbon offsetting;
- All private vehicles will be electric powered vehicles (either powered or shared);
- Sydney Metro operation is 100% carbon neutral in operation;
- No mains gas consumption, or gas consumption is carbon neutral; and
- Waste is converted to energy, with residual emission offsetting.

While the above assumptions define the end goal at 2050, the primary purpose of planning at this stage is to enable the appropriate transitionary pathway towards net zero carbon.

In the journey towards 2050, solar PV technology is expected to improve in efficiency through research breakthroughs which are brought to market. Commercialisation of new applications of solar PV such as building-integrated solar PV (BIPV) is expected to introduce new means of renewable generation in a precinct aside from conventional solar panel systems. In combination with ongoing improvements in energy efficiency of appliances, lighting, HVAC, hot water systems, the proportion of renewable energy serving the precinct will increase.

At the current stage of planning, the initiatives that are unlikely to be impacted by future technological changes need to be considered for incorporation and locked in. Considerations such as optimising the passive design (building orientation and massing) elements of buildings within the precinct will have the same impact today as it will in 2050. Shading devices on the building façade can be considered later at detailed design, but it is important that the façade and building envelope designs do not preclude future installation or retrofitting of BIPV.

Identification of potential locations for future expansion of solar PV systems is a worthy consideration so as to earmark opportunities to increase on-site renewable generation. Unconventional locations such as on building envelopes enabled by BIPV or airspace above buildings should be considered and not excluded. Consideration should examine experimental applications of solar PV to identify potential future locations at the Site.

Under the assumption of no gas or carbon neutral gas consumption, it is likely that hot water heating will be serviced by heat pumps which can achieve significantly higher coefficients of performance than conventional gas boiler systems. While gas infrastructure may be installed in time for Site operation, it should be designed with disassembly in mind if (or when) gas becomes an unviable fuel source from a carbon perspective. Spatial provisions should also be made or identified for the siting of heat pump systems which can be installed later in the project lifecycle. Risers should also be designed to not preclude future retrofitting of centralised thermal networks to accommodate for the heat pump system.

The future position of transport is assumed to be fully electric. Internal combustion engine vehicles will become uncompetitive compared to electric vehicles due to a price on carbon emissions. Car parking spaces in 2050 will require EV charging infrastructure, thus spatial considerations should be made at the current planning and design stages to ensure that charging of EVs at the Site is not precluded.

Scenarios

A set of assumptions have been made about the carbon intensity of grid electricity, cost of renewable energy, transport emissions and waste emissions (offset or utilised). Assumptions also need to be made about a carbon pricing market operating at that time. It is also recognised that the policy environment is likely to change significantly between now and 2050; for example, the current Renewable Energy Target (RET) is likely to change and impact on the current carbon accounting mechanisms. In seeking out the Site's role in supporting this pathway, it is primarily about identifying initiatives to enable transition rather than achieve it now.

The following visions have assumed potential future positions that are inherently uncertain. The idea is to provide valuable insight into what the Site needs to consider now to enable the proposed visions.

Table 8: Visions and pathways to carbon neutrality by 2050

Scenario	Description
Net-zero emission electricity grid	Under the 2050 net-zero emissions target, the NSW electricity network has become zero emissions through transition of the generation mix. Therefore, all electricity consumption is carbon neutral. Any waste emissions are offset through purchase of accredited Australian carbon offsets.
Grid still running with low carbon intensity.	By 2050, energy efficiency improvements at the Site will generate a 40% reduction energy use in comparison to today's levels. There will be a 20% increase in on-site generation through super-efficient solar PV or other on-site renewables installed at the Site. The development may now generate more electricity than it can use on an average day. A cheap battery pack is now needed to store the excess energy generated during the day for use within the Site at night. The Site is still connected to the grid for security and resilience however the grid has a small amount of carbon left on it. With the improved energy efficiency and solar with the battery, the Site is operating at net-zero carbon over the year.
Grid still running at high carbon intensity	Significant energy efficiency actions and on-site renewable energy measures have been adopted on-site as high energy prices drastically improve feasibility and shorten payback periods. However the development still relies on the grid for a portion of its power needs. Residual carbon emissions from grid electricity use and waste will be offset through purchase of accredited Australian carbon offsets.
Micro-grid ESCO	The Site has had a micro-grid operator for the last 20 years who sells energy as a service rather than as kilowatt hour (kWh) to all users. This micro-grid operator manages all the carbon intensity and is, like all reputable micro-grid operators, certified 100% renewable. The operator is also fundamentally incentivised to reduce the kWh for the unit of service as the kWh's are so incredibly expensive so the Site is operating at very high energy efficiency.

Options

The pathway towards net-zero carbon will likely occur via a combination of energy efficiency measures, low emission transportation, uptake of on-site and off-site renewable energy, and purchase of accredited carbon offsets. As discussed in Section 6.6, the NSW electricity grid is expected to gradually decarbonise through the increasing penetration of large-scale renewable generation and withdrawal of fossil-fuel generators. This is expected to contribute to the journey towards a net-zero carbon economy. Increasing availability of renewable

technologies such as hydrogen fuel cells and waste-to-energy generators will provide a greater variety of options to the market to decarbonise, as well as place downward pressure on renewable energy prices.

For reference, the City of Sydney Environmental Action Plan (EAP) has set a target of 70% reduction in greenhouse gas emissions by 2030 based on 2006 levels and net zero emissions by 2050 which is in alignment with the Requirements. The City's identified pathway to achieving this is primarily through implementing energy efficiency measures and increasing renewable energy generation, as shown in Figure 20. It focuses strongly on improving energy efficiency and procurement of renewable energy.

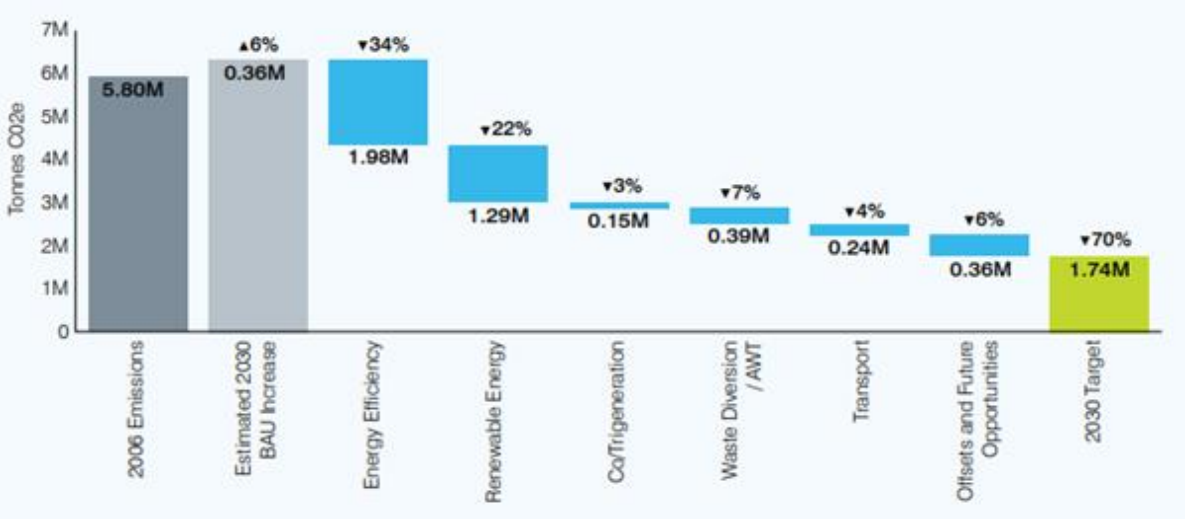

Figure 20: City of Sydney Greenhouse Gas Emissions Reduction - Estimated contribution of initiatives[21]

The following section discusses the potential options available for the Site to adopt in achieving net-zero carbon buildings and a net-zero carbon precinct:

- Maximising energy efficiency – The adopted pathway should utilise the most cost-effective technologies available at the given time with an appropriate staging program and payback to match the development schedule. As a result, energy efficiency measures should be pursued and maximised before renewable energy technologies are considered. This is in line with the energy management hierarchy, which prioritises energy reduction, then energy efficiency, followed by renewable energy. Energy efficiency can be achieved through attainment of high BASIX, NatHERS, and Green Star - Design and As-Built ratings and scores.
- Elimination of carbon intensive gas consumption – At present, mains natural gas has lower carbon intensity than NSW grid electricity for thermal end-use purposes. However, this is expected to change over the next 20 to 30 years as large-scale renewables continue to come online in the electricity network and drive down grid carbon intensity. While there are early investigations into the decarbonisation of the gas network, it is still in its infancy and much more research is still required. The market will also take additional time to adopt and commercialise low carbon gas. There is currently still too little information available to make an informed decision on whether the development should be committed to natural gas or not. Commitment to the use of gas may be of benefit in the short term from a carbon reduction perspective but detrimental in the long term should the electricity network decarbonise.
- Zero-emissions transportation – Efforts to lowering the Site's transport emissions is helped by significant current availability of public transport servicing the Site in addition to the Site's proximity to a future Sydney Metro station at Waterloo, which has targeted 100% carbon neutral operation. Other low emission transportation can be encouraged through the provision of appropriate cycle infrastructure, end-of-trip facilities, and pedestrian-oriented design. A below average provision of car parking spaces can discourage private car ownership. However, allocation of car-share only parking spaces can be an effective means to reduce transport emissions while still providing residents the option of vehicle travel on an as-needed basis. Where private vehicle car parking is provided, electric vehicles (EVs) should be preferenced through designated 'EV only' parking spaces with charging infrastructure. The car share provider should be encouraged to consider including offset electric vehicles as part of their start-up fleet.

[21] *City of Sydney Environmental Strategy and Action Plan 2016-2021*

- Waste to Energy – Waste to energy is a technology that may be implemented at the Site. Waste-generated gas can be captured from precinct waste to be used as a carbon neutral substitute for mains gas. There are many significant factors to consider including the spatial requirements of the necessary infrastructure, air quality impacts, and overall feasibility of the technology in this application.

7.3.2 Initiatives

7.3.2.1 Passive Design

Passive design responds to the local climate and site conditions to maintain comfortable conditions within a building while minimising resource use. It focuses on taking advantage of the available renewable energy sources such as sunlight and wind to provide cooling, heating, ventilation and lighting. Important elements of passive design strategies include consideration of building orientation, layout, shading, thermal mass, natural ventilation, insulation, window placement and design, and skylighting.

Table 9: Benefits and challenges of passive design

Benefits	Challenges
• Can significantly lower energy use whilst improving and maintaining acceptable human comfort levels • Relatively low cost to implement as it takes advantage of existing site conditions • Alignment with prevailing winds can enable natural ventilation and reduce artificial ventilation requirements • Optimises penetration of desirable natural daylighting to reduce indoor lighting energy use and improve human comfort and experience • Manage the impacts of street/urban canyons and public domain shading	• Requires consideration at very early stage design as once building forms and the shapes and sizes are locked in, there is very little scope for adjustment • Needs careful modelling to manage trade-off with energy consumption, e.g. excessive daylighting can lead to unwanted solar gain and increased cooling loads, or overshadowing of public domain areas • May impose constraints on floor plate sizes and requires careful material selection to ensure desired outcomes

Key considerations

Whilst there are many benefits to passive design, it must be carefully considered, as improper application can increase energy consumption rather than reduce it. For instance, the placement of large westerly windows in an effort to improve natural daylighting can introduce unwanted solar heat gain into the building in the afternoon. This can increase annual cooling load by approximately 10-20% (indicative), which is typically larger than the reduced lighting loads, resulting in a net increase in energy consumption. Many passive design measures can assist in the achievement of beyond compliance BASIX Energy and Thermal Comfort scores.

The incorporation of passive design measures, including natural ventilation and solar heat gain, should be analysed and efficiencies considered during future planning in site layout. The Reference Scheme for the Site (illustrated in Figure 2 and Figure 3) demonstrates early consideration of passive design including physically porous design to enable natural ventilation through the Site and building height variation.

Table 10 outlines indicative cooling and heating efficiencies versus a business-as-usual building typology. Note that orientation and ratio are just two of the several variables which will affect heat and cooling efficiencies and that actual building efficiency will be subject to a number of building design measures.

Table 10: Indicative heating and cooling energy efficiencies associated with building orientation and aspect ratio

Aspect Ratio (length/width)	Building Orientation	Annual Cooling Energy (kWh/m^2)	Annual Heating Energy (kWh/m^2)	Annual Cooling Energy	Annual Heating Energy
1:6 Ratio	0º	17.50	5.52	20%	2%
	45º	16.84	5.83	15%	7%
	90º	15.52	5.16	6%	-5%
	315º	16.70	5.31	14%	-2%

1:4 Ratio	0º	16.11	5.48	10%	1%
	45º	15.65	5.75	7%	6%
	90º	14.66	5.23	0%	-4%
	315º	15.56	5.36	7%	-1%
1:2 Ratio	0º	14.60	5.43	0%	0%
	45º	14.46	5.65	-1%	4%
	90º	13.92	5.31	-5%	-2%
	315º	14.43	5.45	-1%	0%
1:1 Ratio	0º	13.92	5.38	-5%	-1%
	45º	14.08	5.55	-4%	2%
	90º	13.92	5.38	-5%	-1%
	315º	14.08	5.55	-4%	2%

During detailed design, location of building openings, building facades and shading structures should be considered to further provide opportunities for passive cooling measures.

Table 11: Typical development timing

Development Feature	Planning/Design Stage
Orientation and built form	Concept Design
Building openings/spaces, facades and shading structures	Detailed design

Impacts on energy use

Passive design takes advantage of the climate to maintain a comfortable temperature range in the home and harnesses daylight to reduce the need for electric lighting. Passive design reduces or eliminates the need for auxiliary heating and cooling which accounts for about 22% of energy use on the average household[22]. It also reduces usage of electric lighting which accounts for about 9% of total annual use in a typical home[22]. Maximising passive design is essential to achieve beyond BASIX Energy scores.

7.3.2.2 Energy Efficiency

Energy efficiency measures are improvements that reduce the energy consumption while maintaining the same level of functional output. Integration of energy efficiency measures in buildings will be essential to achieve the energy targets proposed for the Site. Achieving energy efficiency may require a combination of different initiatives to reduce energy use and peak demand. Initiatives include solar water heating, insulation, efficient lighting and HVAC systems, thermal zoning, appropriate material selection, shading devices and highly rated appliances among others. Selection of the best initiatives must be done based on modelling and feasibility.

[22] Ausgrid 2019, https://www.ausgrid.com.au/Your-energy-use/Save-energy-at-home

Table 12: Benefits and challenges of energy efficiency measures

Benefits	Challenges
• Significantly reduces energy use and associated carbon emissions • Can reduce impact on peak demand • Reduced energy consumption and peak demand can defer need for electricity infrastructure augmentation • Payback times in the short to medium term • Low to moderate upfront costs	• Final efficiencies depend on how systems are operated • Some initiatives may have maintenance requirements

Key considerations

There are a variety of energy efficiency and optimisation measures available on the market – from efficient appliances through to integrated energy systems. However, their effectiveness and life cycle benefits depend on the appropriate application of the initiative in the appropriate context. Utilising ratings systems such as BASIX, NABERS, NatHERS and Green Star rating tools can help to achieve the most appropriate energy efficiency measures, either standalone or in combination with other initiatives.

Infrastructure required for the use of distributed energy and microgrids should be evaluated for feasibility in the context of the development in future planning and detailed design (prior to DA lodgement) for implementation. Building specific energy efficiency measures will be determined at detailed design stage.

Table 13: Typical development timing

Development Feature	Planning/Design Stage
Use of microgrids/distributed technologies	Detailed Design
Selected building energy efficiency measures	Detailed design

Impacts on energy use

Energy efficiency measures enable electricity reductions in both common property and individual apartments. The extent to which energy use is reduced depends on the initiatives proposed. As an example, an efficient LED lighting system may lead to savings in electricity consumption from lighting of around 75%. Energy efficiency measures are essential to achieve beyond BASIX Energy compliance.

7.3.2.3 Solar PV

Solar photovoltaics (PV) can be either rooftop mounted or integrated into building materials. Solar PV converts sunlight into electricity which can be consumed locally or exported into the grid. This is not to be confused with 'solar thermal' which refers to the collection of solar heat for heating purposes.

Table 14: Benefits and challenges of solar PV

Benefits	Challenges
• Converts sunlight into electricity – a renewable source of energy • Appropriate for a large number of climates • Very low maintenance requirements, if appropriately designed (tilt > 10° for self-cleaning) • Long asset lifetime (solar PV cells > 25 year lifetime) • High scalable system sizes due to modularity of PV panels • Fast payback periods (~5 years), increasing as grid electricity prices rise	• Requires sunlight to generate energy – does not generate electricity in the evening • Operational effectiveness is subject to impact of shading on the solar PV collecting surface, such as from nearby buildings, trees, or clouds • Moderate to significant spatial requirements and placement considerations needed • Relatively high upfront capital cost (~$1.14/W) • Tricky for strata blocks due to metering requirements, roof space availability, long cable runs and mix of stakeholders involved.

Solar PV installations are increasingly considered standard amongst best practice precincts and buildings. While they automatically generate renewable electricity during sunshine hours, much consideration needs to be put into the placement and technology adopted to ensure optimal operation.

Key considerations

Typically, feasible on-site renewable energy generation for precincts includes solar PV or solar water heating systems. There is anticipated to be limited roof space available for solar units in the buildings due to competition for rooftop space with community uses and building plant and equipment. The Reference Scheme (refer to Figure 2 and Figure 3) does not currently include solar generation and prioritises space for a series of interconnected roof gardens. However, PV could be mounted on top of awnings where appropriate.

During the planning stage, important considerations include identifying potential locations for solar installations and ensuring surrounding structures allow solar access. For example, establishing maximum tree heights below maximum building heights can avoid shading issues. Equally space available for the PV system should be considered in the context of rooftop community uses and chillers.

At finalisation of the development application, space available for the PV system should be considered and allocated where appropriate with consideration to competing uses including community uses and chillers. Roof top structural stability (if roof-mounted) should also be assessed. System sizing should be estimated in future design development and confirmed for Detailed Design.

Table 15: Typical development timing

Development Feature	Planning/Design Stage
Solar PV System	Design development options to identify spatial layout and open space provisions for PV installation. PV system energy generation estimated during future planning and detailed design.

Impacts on energy use

PV systems reduce the grid electricity used in a building and assist in managing peak demand. The extent to which grid energy is reduced depends on the PV array size and associated operational losses such as shading, ambient temperature and wiring resistance. PV systems support the achievement of beyond BASIX compliance.

7.3.2.4 Green Infrastructure and Tree Canopy Cover

Green infrastructure refers to standalone and strategically networked photosynthetic elements incorporated into the urban landscape for environmental, social and economic benefits. In short, the term encompasses trees, plants and grasses located in the Site's area to achieve enhanced sustainability outcomes in the triple bottom line. Adequate green infrastructure provision may include tree preservation, enabling schemes for green roofs and vertical gardens and maximising opportunities for incorporation of native vegetation plantings.

Green infrastructure plays a critical role in the health and wellbeing of the population and urban ecosystem, with tangible economic benefits demonstrated by an increasing body of research.

Trees have a positive effect on reducing energy usage from buildings as they shield paved surfaces and buildings from the sun. In addition, vegetation can assist in mitigating heat island effect, filter air pollution, provide shade for cyclists and walkers, support urban fauna, reduce stormwater pollution and improve the amenity and aesthetics of the built environment.

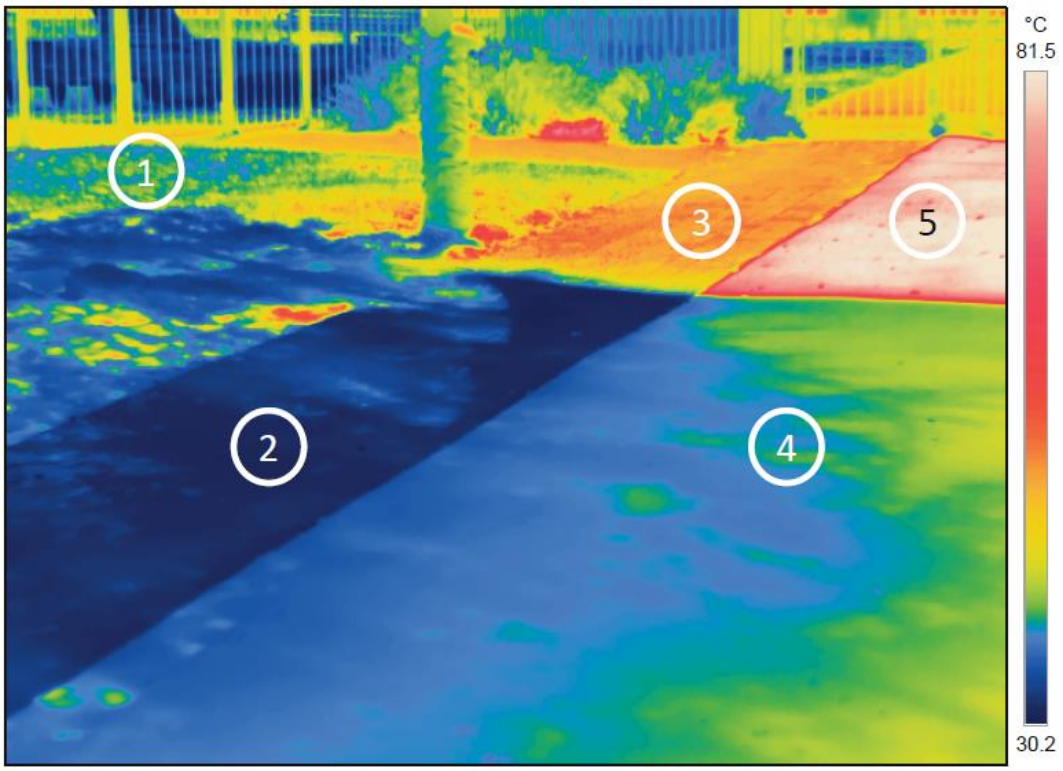

Figure 21 Thermal image showing impact of vegetation on urban heat island mitigation.

1. Sun-lit grass (40 °C); 2. Shaded concrete bricks (32 °C); 3. Sun-lit concrete bricks (52 °C); 4. Shaded soft fall (40 °C); 5. Sun-lit soft fall (83 °C). Source: Cool Schools, Western Sydney University, 2018.

Table 16: Benefits and challenges of green infrastructure and tree canopy cover

Benefits	Challenges
• Provide local habitat and boost ecosystem health • Mitigate urban heat island effect • Provide amenity and urban greening • Improve air quality and public health • Have tangible economic benefits, including property value premiums, lower stormwater management expense, improved public health, etc. • Reduce total and peak energy demand (and burden on energy utilities) • Potential ecosystem benefits such as noise mitigation , local air quality and stormwater quality benefits • Improves liveability outcomes and aesthetics • Green roofs prevent noise infiltration and offer hail protection • Reduce volume of stormwater runoff • Lessens demand on storm drains • Provide aesthetically pleasing sitting or walking area to residents.	• Require spatial provision for green infrastructure elements • Require ongoing maintenance • Compete with other infrastructure for space • Trees compete with homes and solar systems for solar access. • Seen as a cost due to ongoing maintenance and water demands • Green roofs require deep soil on rooftops which may increase structural design requirements • Inappropriate plants and species can damage underground infrastructure

Key considerations

Opportunities to connect vegetation and planting at the Site to the Sydney Green Grid should be explored for improved habitat connectivity, enhanced biodiversity and ecological resilience. Although tree offsets may be considered to meet the tree canopy cover target for the Site, the energy use reduction may not be realised. The Reference Scheme (refer to Figure 2 and Figure 3) identifies opportunities for communal green space, a series of interconnected roof top gardens and additional tree planting.

Trees should be planted along Elizabeth St. to shield the buildings from excessive heat gain from the western façade. Provision of space for trees should be made when assessing building setbacks and pavement widths to allow for tree root growth without disruption of services. This should be assessed during development application design planning with consideration of urban design, street layout and specific tree species selection to maximise shading potential.

Table 17: Typical development timing

Development Feature	Planning/Design Stage
Green spaces/roofs	Development application options to identify spatial layout and open space provisions for green spaces/roofs
Tree planting	Development application options to identify tree planting locations and percentage canopy cover.

Impacts on energy use

Trees and green infrastructure in general have a cooling effect on buildings and public domain. This directly translates into reduced energy use for cooling in buildings. The extent to which energy use is reduced depends on the amount, location and orientation of trees. Best practice includes shielding the northern and western facades with deciduous trees which avoid extreme solar thermal loads in summer but not in winter when passive heating from the sun is desirable. Green infrastructure may reduce the burden for buildings to achieve beyond BASIX Energy ratings.

7.3.2.5 Cool Roofs and Pavements

Cool roofs and pavements use additives to reflect solar radiation which, unlike conventional roofs and pavements, prevent the urban heat island effect and reduce the need for cooling. Conventional dark pavements may contribute to urban heat islands as they absorb 80–95% of sunlight and warm the surrounding air.

According to the 'Cooling Western Sydney' study conducted by Sydney Water, the CRC for Low Carbon Living and UNSW, while green infrastructure is effective for cooling urban environments, the most effective urban heat mitigation technologies use a combination of cool materials such as cool roofs and pavements in conjunction with water-based technologies such as fountains.

Table 18: Benefits and challenges of cool roofs and pavements

Benefits	Challenges
• Reduces urban heat island effect • Increases resilience to heat waves • Reduces energy demand from buildings • Increases living affordability through reduced energy bills • Improves indoor thermal comfort • Extends service life of roofs • Lowers peak electricity demand	• May cause unwanted glare to neighbouring properties • May require additional cleaning / maintenance

Key considerations

Measures to mitigate the effects of extreme heat events and urban heat island effect are important for the Site, as it is in a dense urban environment. Opportunities to deliver cool pavements in the public domain should be explored in combination with shading structures (i.e. awnings) and tree canopies. Cool roof materials or green roofs should be prioritised.

Consideration of 'cool' roofs, pavements and materials are typically identified at detailed design stage.

Table 19: Typical development timing

Development Feature	Planning/Design Stage
'Cool' roofs, pavements and materials	To be defined in Detailed Design

Impacts on energy use

Cool roofs allow reflection of solar radiation by up to 85%, effectively reducing the thermal load on the building in that extent. This directly effects energy consumption from cooling and support the achievement of beyond BASIX Energy compliance.

7.3.3 Recommendations

The following section summarises the recommendations to reduce energy use and carbon emissions.

Planning controls

- Commitment to beyond compliance target for BASIX Energy and Thermal Comfort.
- Engage with energy utilities to incentivise development peak shifting, reducing need for network augmentation.

Management alternatives/initiatives

- Consider the design to either enable, or not preclude, future energy technologies and initiatives.
- Consider a micro-grid operator to manage peak demand and carbon emissions. An additional step may be to consider an 'energy services company' (ESCO) instead of a 'traditional' electricity retailer.
- Consider the design to either enable, or not preclude, future energy technologies and initiatives.
- Recognise technology is going to change, so through procurement, specify intended outcomes rather than specified technologies.
- Permit residents to air dry laundry on balcony. Design measures such as screened outdoor areas on balconies should be considered.
- Consider seeking a NABERS Energy rating for the residential apartments.

Design Considerations (undertaken during the detailed design phase)

- Consider designing building systems to enable future retrofitting of new technologies such as building integrated PV.
- Consider designing the Site to be 100% electric for the buildings (i.e. no gas).
- Maximise opportunities for the installation of solar PV systems and identify potential future sites for solar installations as the price reduces and the need increases.
- Design the risers with capacity and accessibility to enable future additions of thermal or water networks.
- Consider heat pumps to achieve the required hot water demand.
- For thermal comfort within the development, consider:
  - Designing residential units to achieve optimal thermal comfort conditions in such a way that minimises the need for active systems.
  - Prioritising passive design measures in the buildings such as optimised orientation, western shading devices, minimised glazing and using high thermal performance glazing to reduce overall energy consumption.
- Provide mixed mode HVAC for retail with maximised coefficient of performance ratios to drive energy efficiency.

7.4 Water

The following targets have been set to ensure best practice stormwater management measures are implemented and potable water demand is reduced to best practice levels in the Site:

- **Post-development stormwater peak discharge event does not exceed the pre-development event;**
- **Stormwater pollutant load is reduced when compared to untreated:** Total suspended solids: 85%; total phosphorous: 65%; total nitrogen: 45%; and gross pollutants: 90%;
- **BASIX Water target of 40**
- **NABERS Water rating (commercial) of 4.5 stars**

The following initiatives are proposed for implementation and further investigation in order to address the above targets.

7.4.1 Preliminary Water Assessment

The Planning Proposal Requirements require the development and identification of *precinct-scale and individual development strategies and measures to meet or exceed benchmarks for environmental performance*, including BASIX, NABERS and integrated water management.

The dwelling yield within the Site is around 327 apartments. The majority of recycled water schemes allow garden and toilet end use only, however some also allow connection for laundry (cold water washing machine) use. Recycled water sources may include reticulated recycled water, collected rainwater/stormwater or recycled graywater/wastewater.

The *City of Sydney Decentralised Water Masterplan* provides a basis for determining the split of potable and non-potable water use in multi dwelling apartments. This study found that multi-unit dwellings consume approximately 156 kL/dwelling/year and approximately 42% of these demands could be supplied by non-potable water. Applying this water usage rate to the proposed dwelling yield gives an indicative water usage volume for the proposed development. A breakdown of typical potable and non-potable water demands is provided in Table 20 which includes the volume of potable water that can be reduced through ESD measures like rainwater harvesting and stormwater recycling.

Table 20. Potable water demand

Water Uses (kL/dwelling/yr)		Residential Water Split	Adopted Total Demand for Precinct	Potable Water Substitution by ESD Measure	Residual Potable Water Dmand	Waste Water	BASIX Benchmark for Potable Water Use	BASIX Target for Potable Water Use
Non Potable	Toilet	18%	28.1	28.1	0	28.1	32.5	19.5
	Washing	15%	23.4	23.4	0	23.4	27.1	16.3
	Irrigation	4%	6.2	6.2	0	0	7.2	4.3
	Outdoor	5%	7.8	7.8	0	0	9.0	5.4
	Total	42%	**65.5**	**65.5**	**0**	**51.5**	**75.9**	**45.5**
Potable	Basin	5%	7.8	0	7.8	7.8	9.0	5.4
	Kitchen	5%	7.8	0	7.8	7.8	9.0	5.4
	Leaks	5%	7.8	0	7.8	7.8	9.0	5.4
	Shower	37%	57.7	0	57.7	57.7	66.8	40.1
	Bath	4%	6.2	0	6.2	6.2	7.2	4.3
	Dishwasher	2%	3.1	0	3.1	3.1	3.6	2.2
	Total	**58%**	**90.5**	**0**	**90.4**	**90.4**	**104.8**	**62.9**
Total Usage / Dwelling (kL/yr)			**156**	**65.5**	**90.4**	**141.9**	**180.7**	**108.4**
Total Usage for 500 dwellings (ML/yr)			**78**	**33**	**45**	**71**	**90**	**54**

Notes:

1 The BASIX benchmark for potable water use is 90,340 L/person/year. Assuming a slightly conservative occupancy ratio of 2 people per dwelling and 500 dwellings at the Site, this is 90.34 ML/yr for the Site.

2 Substituting recycled water for all non-potable water uses would achieve a reduction in potable water consumption of 36% when measured against the BASIX benchmark. This will support the achievement of the BASIX Water target of 40%.

Further information is provided in the Utilities and Infrastructure Servicing Strategy.

7.4.2 Initiatives

7.4.2.1 Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) features are typically evaluated on their ability to improve water quality, increase attenuation, reduce stormwater flows and provide urban design benefits. WSUD measures commonly include raingardens, sediment basins, constructed wetlands, vegetated swales and porous pavements.

Table 21: Benefits and challenges of WSUD

Benefits	Challenges
• Can improve local habitat and ecosystem health. • Mitigates urban heat island effect. • Urban greening and vegetation can improve amenity. • Improve flood and drought resilience. • Improves stormwater quality through treatment before discharging to the environment • Attenuates excessive stormwater flows through stormwater detention and retention measures. • Reduces burden on stormwater drainage infrastructure.	• Requires appropriate spatial provision for precinct and building WSUD elements. • Requires ongoing maintenance of WSUD elements such as landscaping and vegetation management.

Key considerations

Best practice WSUD will require a number of initiatives to be implemented to address flooding, which is one of the key development constraints of the Site. Specific WSUD measures will be determined based on flooding and hydraulic assessments and incorporated into the Site's design. These measures will need to be designed for ease of maintenance.

Incorporating WSUD principles to accommodate flooding and stormwater detention is a key consideration in the planning phase, and the recommendations of the Stormwater Strategy (AECOM, 2019) for the Precinct have been incorporated into the reference scheme.

Table 22: Typical development timing

Development Feature	Planning/Design Stage
Water sensitive urban design	Development application options to identify spatial provisions for WSUD

Impact on water use

Implementation of WSUD measures enables effective stormwater flow and quality management. WSUD does not have a direct impact on potable water use unless coupled with treatment that enables stormwater consumption for approved uses.

7.4.2.2 Rainwater/Stormwater Harvesting

Rainwater storage from buildings can assist in reducing potable water demand and managing the impacts of excessive stormwater flow. Collected rainwater and stormwater (after appropriate treatment) can be used in toilet flushing, irrigation and laundry washing, significantly reducing potable water demand.

Rainwater tanks can be installed centrally to collect water from the whole precinct or distributed for each building. Rainwater harvesting is typically preferred over stormwater recycling as it is less energy intensive due to the fewer water treatment requirements.

Table 23: Benefits and challenges of rainwater/stormwater harvesting

Benefits	Challenges
• Rainwater harvesting is more cost effective to operate (compared with other recycled water sources). • Rainwater/stormwater retention tanks scalable to building/precinct recycled water demand. • Reduces potable water demand. • Reduces impact of stormwater flow	• Spatial requirements for rainwater and stormwater tanks. • Treatment of stormwater can be energy/carbon intensive. • Cannot be used to replace all potable water demands unless treated to an appropriate level (typically not feasible at precinct scale)

Key considerations

For the Site, rainwater harvesting and reuse is recommended with the option of stormwater retention and reuse. It is noted that there is no reticulated recycled water available on the Site and as such, rainwater tanks on multi-unit building sites is only likely to provide a fraction of the water demands (around 16% according to preliminary calculation from Section 7.4.1).

It is recommended that rainwater tanks be prioritised for the non-potable demands to ensure that stormwater runoff volumes are reduced. Any shortfalls in supply are to be met by potable water being supplied directly to the rainwater tank.

Installation of recycled water piping in buildings and public domain is required to enable rainwater/stormwater use in toilet flushing and irrigation. Rainwater and stormwater systems are typically less energy intensive than greywater/wastewater systems due to the lower water quality requirements. As such, stormwater and rainwater reuse are deemed as suitable and potential alternatives to potable water in certain uses.

To appropriately incorporate rainwater harvesting and reuse, adequate spatial provision should be considered in development of the development application. This includes water balance considerations to establish supply and demand quantities for recycled water at the Site.

Table 24: Typical development timing

Development Feature	Planning/Design Stage
Rainwater tanks and associated infrastructure	Development application options to identify spatial provisions for rainwater tanks. Detailed Design stage to identify appropriate supporting infrastructure.

Impact on potable water use

Rainwater and stormwater collection effectively reduces the burden on potable water infrastructure and enables reductions in potable water use. The extent to which potable water consumption is reduced depends on the rain patterns and size of the storage tanks. Rainwater/stormwater collection supports beyond BASIX Water compliance.

7.4.2.3 On-Site Water Treatment

On-site water recycling systems allow reuse of greywater and wastewater from the Site or from a sewer mining scheme. Greywater and blackwater must be treated to very high standards before it can be reused due to the potential health risks. The water treatment process at the precinct or building scale can be more energy intensive than that of mains potable water. Depending on the treatment level and the source of water treated, recycled water can be used for toilet flushing, irrigation and other internal water uses.

Table 25: Benefits and challenges of on-site recycled water

Benefits	Challenges
• Reduces potable water consumption. • Reduces pressure on sewer infrastructure if engaging in sewer mining. • Improves water supply resilience.	• Potentially high spatial requirements required for water treatment infrastructure. • Water treatment is potentially more energy/carbon intensive than mains potable water • Water treatment infrastructure may have specialised maintenance requirements • Reused wastewater has limitations for irrigation on some locations depending on soil type, dampness or presence of shallow water. • High upfront capital investment. • Requires approval from relevant bodies.

Key considerations

Feasibility of on-site recycled water systems depends on a number of factors, including:

- Short, medium and long-term economic feasibility;
- How it relates to other targets, including affordability;
- Extent to which it provides resilience benefits to the development;
- GFA uptake/land use and associated opportunity costs;
- Social opportunity costs (open space, community facility, etc.);
- Environmental benefits in comparison to alternative options;
- Local emissions and waste streams;
- Energy consumption;
- Reduction in carbon and methane emissions; and
- Recycled water demand

On-site water treatment plants are not likely to be feasible due to space constraints and anticipated high capital costs which do not align with the overall business case for the development. Additionally, the sustainability benefits of on-site wastewater treatment are ambiguous and may result in a net disadvantage due to its high energy and carbon intensity.

Further consideration of on-site water treatment options and its feasibility should be considered at development application finalisation.

Table 26: Typical development timing

Development Feature	Planning/Design Stage
On-site water treatment	Options to be further considered in the development application

7.4.2.4 Third Pipe Network

Opportunities may exist for connection to a regional third pipe network in the future, however no reticulated recycled water networks exist currently in the immediate vicinity of the proposed development. To safeguard for future recycled water networks, the proposed development may choose to provide connections for future recycled water networks. An internal rainwater harvesting and use system is proposed to reduce potable water demand. This may be supplemented with a third pipe network in the future as regional systems become available, reducing the reliance on rainwater harvesting and use alone.

Table 27: Benefits and challenges of third pipe network

Benefits	Challenges
• Enables connection to alternative supply of water for non-potable water uses. • Provides a reliable recycled water supply. • Supports achievement of beyond BASIX Water compliance if connected to non-potable water source.	• Increases construction costs and complexity. • May be seen as a burden for private development. • There may be costs associated with additional riser space required for 'third pipe'.

Key considerations

Identified uses of recycled water include toilet flushing, laundry washing, car washing and irrigation. Enabling infrastructure for a third pipe connections should be considered to avoid the need for future retrofitting for recycled water reticulation in buildings. Further considerations should include demand for recycled water in developing the business case for connection and plumbing of the reticulated recycled water system.

Further consideration of nearby recycled water networks, their capacity and additional infrastructure required for connection should be further considered in the development application.

Table 28: Typical development timing

Development Feature	Planning/Design Stage
Third pipe network	Options to be further considered in the development application

7.4.3 Recommendations

Planning controls

- Commitment to beyond compliance target for BASIX Water.
- Detail water sensitive urban design considerations into the DCP, such as bio-retention systems (rain gardens), grassed swales, porous paving, wetlands, vegetated roofs and vertical gardens (green roofs and walls) to improve stormwater quality flowing into waterways.

Management alternatives/initiatives

- Consider servicing options that may allow for a public or private water utility for the Site.
- Consider inclusion of a 'third pipe' reticulation system within buildings to enable connection to a future recycled water scheme.
- Consider seeking a NABERS Water rating for the residential apartments.

Design Considerations

- Selection of drought-tolerant, low water use vegetation in gardens, green roofs and green walls to reduce irrigation needs.
- Provision of high efficiency water fixtures (4, 5, 6-star WELS), inclusion of high water efficiency appliances as part of apartment package, or offering financial incentives for residents to purchase high efficiency appliances.
- Consider spatial provision for rainwater/stormwater harvesting tanks and pumps and piping.

7.5 Waste

The following targets have been set to ensure best practice waste management is implemented in line with the NSW *Waste Avoidance and Resource Recovery Strategy 2014-21*(WARR):

- **Construction & demolition waste:** 80% diverted from landfill
- **Operational waste:** 70% diverted from landfill

The Planning Proposal Requirements require the development and identification of *precinct-scale and individual development strategies and measures to meet or exceed benchmarks for environmental performance*, including waste reduction and recycling measures. Future stages of design will need to consider relevant documentation including, but not limited to, the following:

- Waste Not Development Control Plan Guidelines (2008)
- Better Practice Guide for Resource Recovery in Residential Developments (2019)
- Better Practice Guide for Public Place Recycling (2005)
- Better Practice Guidelines for Waste Management in Commercial and Industrial Facilities (2012)
- Guidelines for Waste Management in New Developments

The WARR Strategy sets out overarching waste and recycling targets for NSW out to 2021. The '*Waste Less, Recycle More'* initiative provides the funding under which the EPA can modernise the NSW waste sector and deliver waste and recycling services to the community. In parallel, there are other EPA waste and recycling programs to facilitate, coordinate and implement waste reduction and recycling initiatives with the relevant stakeholders, including the 'Return and Earn: *NSW Container Deposit Scheme'* and provide educational material to the public to improve waste management practices. The City of Sydney's 'zero waste city' targets under their '*Environmental Action Strategy and Action Plan*' are aligned with the WARR targets.

The following initiatives are proposed for implementation and further investigation in order to address the above targets and align with the WARR Strategy.

7.5.1 Initiatives

7.5.1.1 Construction and Demolition Waste

To increase the resource recovery at the Site, waste should be segregated into component parts to assist with disposal, recycling or reuse where possible. Considerations at demolition and construction phases are proposed below.

Demolition phase:

- Take advantage of opportunities for beneficial reuse on-site for soils generated from any excavation works if possible;
- Identify a suitable area for sorting and segregating demolition waste to ensure efficient re-use and recycling of wastes;
- Store waste on-site appropriately to prevent cross-contamination and/or mixing of different waste;
- All demolition waste unable to be reused on-site sent to licensed recycling or waste disposal facilities with waste delivery receipts retained in the project files for use in supporting obtaining Green Star points.

Construction phase:

The Site is targeting 95% diversion of construction waste from landfill. To do so, the following should be undertaken to avoid waste generation during construction:

- Apply practical building designs and construction techniques which minimise generation of waste;
- Store waste streams on-site separately to prevent cross-contamination and/or mixing of different waste;
- Exercise a preference for long lifespan and/or high potential for re-use in selecting construction materials;
- Reduce packaging waste across procurement and supply chain.

Key considerations

Identification of an area for sorting and temporary storage of various waste streams at the planning stage will facilitate waste recycling during demolition and construction phases of the project.

Construction waste management will typically be defined during detailed design or on appointment of the construction contractor.

Table 29: Typical development timing

Development Feature	Planning/Design Stage
Construction waste management	Detailed Design (On appointment of developer).

7.5.1.2 Waste Minimisation and Diversion from Landfill

There are several opportunities that can be considered during the design stage that can influence operational waste behaviours and management. These opportunities are outlined below:

- **Co-located, separate waste chutes:** To reduce the rate of municipal solid waste generation, separate recycling chutes should be co-located with regular waste chutes within the apartment buildings. The recycling chutes must be easily accessible with clear signage and posters to educate residents on recyclable materials. The chutes may feed into carousels with compactors located in the waste disposal rooms located at ground level.
- **Separate waste rooms:** Waste rooms for retail tenants should be separate from the residential waste disposal rooms to prevent overloading of either waste system. Mobile Garbage Bins (MGBs) for residual and recyclable waste could be provided and located within separate waste rooms servicing the retail stores.
- **Public Domain Recycling**: Recycling services are commonly expected in public spaces and this has increasingly become part of everyday life. Residual waste and recycling bins should be provided in the public domains to discourage littering and detracting from the development's quality of open space.

Recycling bins should be positioned next to a residual waste bin, ideally in a 3-bin configuration (with the recycling bin in the centre) to help avoid contamination of recycling waste streams. Where only 2-bin configurations are reasonable, the residual waste bin should be located closest to the high traffic area.

- **In-Apartment Waste Separation:** To further reduce waste generation rates, the apartment fitouts can include built-in small residual waste bins to discourage waste generation and incentivise reuse of waste.
- **'Return and Earn' Container Collection:** The detailed design should consider the provision of 'Return and Earn' container collection points within the Site to service the community and promote recycling rates for plastic bottles and aluminium cans. Partnerships with local retail stores to serve as 'over-the-counter collection points' or locating a 'reverse vending machine' are some options that can be considered.

7.5.1.3 On-Site Food Organic Waste Treatment

On-site waste treatment options could be considered to minimise food organic waste and improve diversion from landfill rates. Some treatment systems need to be considered during building design. On-site food waste treatment and collection options include:

- Pre-treatment options (for examples dehydrators)
- Use of in-sink grinders for pre-treatment of food waste before disposal to sewer
- Organics processing options (for example worm farms and in-vessel composting)

Dehydrating or decomposing food waste at the Site may reduce costs associated with waste collection and minimise the frequency at which garbage trucks need to be on-site to collect waste. Depending on the type of equipment chosen, treated food waste may be suitable for use in community gardens or sent off-site for other uses. These initiatives align with key objectives outlined in the NSW Circular Economy Policy 'Too Good to Waste', such as: 'Support innovation'.

On-site organics treatment systems depend on the effectiveness of source-separation of waste into different streams, and as such, it would be beneficial to have a dedicated program for organic waste separation.

Table 30: Benefits and challenges of on-site food organic waste treatment

Benefits	Challenges
• Reduces volume of organic waste going to landfill. • Reduces cross-contamination of other waste streams. • Supports the NSW Circular Economy Policy. • Supports NSW Waste Avoidance and Resource Recovery Strategy (WARR) 2014-21. • Organic waste may be used on-site in community gardens	• Spatial provisions required for processing facilities. • Potential air quality concerns relating to on-site organic waste processing. • Ongoing maintenance requirements.

Key considerations

Identification and earmarking of potential locations for on-site organic waste processing facilities will need to consider potential air quality impacts and may require extensive community consultation.

On-site waste treatment facilities have been considered in the Reference Scheme basement design to allocate suitable spatial provision. Options will typically include small scale worm farms and smaller in-vessel composting systems rather than large-scale on-site treatment options.

Table 31: Typical development timing

Development Feature	Planning/Design Stage
On-site food organic waste treatment	Options to be further considered in the development application

7.5.2 Recommendations

From the assessment above, we recommend that the following commitments are made at this planning stage:

Planning controls

- Commitment to operational and construction and demolition waste targets

Management alternatives/initiatives

- Planning and design of the Site to facilitate and prioritise waste management practices in line with the waste hierarchy
- Consider incentives to encourage reduction of waste generation rates, potentially through reduced waste levies and fees
- Consider creating a 'Return and Earn' container collection point to allow the community to access a new income stream and promote recycling rates

Design Considerations

- Consideration of the NSW EPA Better Practice Guide for Waste Management in Multi-unit Dwellings in the preparation of the DCP
- Provision of waste and recycling bins in the public domain to reduce littering and promote recycling
- Design in smaller residential waste bins into the residential apartment fitout to disincentive waste generation
- Residential and commercial/retail waste disposal rooms separate to avoid overloading issues
- Provision of space for residents to temporarily store unwanted bulky items to be disposed.

7.6 Next steps

All the recommendations listed in this Report will require consideration and review during the Development Application phase. Further details on the exact initiatives for adoption and their timings for implementation will need to be assessed and further detail provided to ensure a pathway for these initiatives' implementation. The targets and recommendations made in this Report will act as guidance for the initiatives selection.

Appendix A – Sustainability and Resilience Workshop minutes

A Sustainability and Resilience workshop was organised by AECOM in order to facilitate ESD integration into concept options design. Meeting minutes of this workshop are provided below. Refer to Section 7.1 for further details.

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Minutes of Meeting

Elizabeth St., Redfern

Subject	Sustainability and Resilience Workshop	Page	1
Venue	AECOM - Sydney Office	Time	9 am - 12 pm
Participants	Lindsey Noble, LAHC Katrina Burley, Architectus Ivan Ip, Architectus James Herbert, AECOM Stephen Read, Jacobs Ulises Demeneghi, AECOM Stacey Atkinson, AECOM Dan Sharp, Tyrell Studio Joshua Atkinson, AECOM Harley Lewington, AECOM Roger Swinbourne, AECOM		
Apologies	Nigel Macdonald, LAHC Daniel Fettell, AECOM Penny Fuller, Silvester Fuller Jane Freeman Roberto Fattoretto, Silvester Fuller		
		Date	03-Oct-2018
Distribution	As above		

No	Item
1.	**Introductions and agenda outline**
2.	**Project overview presented by LAHC (LN)** • Site is mostly vacant. Previous duplexes existed but were demolished due to a number of issues including flooding. • EOI underway to get partner developer to deliver housing targets. • Development will follow build-to-rent model where developer leases the land for a long period after which the government retains the land (and assets). • Lease period has not yet been defined • New PCYC facility on site is part of the development. • Up to 500 dwellings being contemplated, from which 130-140 are social housing. • The site is considered to assist Waterloo development with social housing relocations. • LAHC operates off-budget i.e. any development needs to be funded by rent they

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No	Item
	receive. Any expenditure reduces the opportunity to deliver more social housing. • The build-to-rent model introduces an opportunity to trial sustainability.
3.	**Three concept options presented by Architectus (KB)** In developing the options: • ESD measures considered include passive design (solar access, cross ventilation), flood mitigation provisions and tree canopy cover. • Overshadowing on Redfern Park and noise from Elizabeth St are important constraints considered. • Public open space on site not a priority considering adjacency to Redfern Park Summary of options: • Option 1 consists of a series small floor plate 8 storey buildings arranged around a central court yard. • Option 2 consists of north facing apartment focusing to max out solar access and natural ventilation. Provides maximum roof top space to leverage views to the city, acknowledging roof top space is contested and may need to accommodate flooding infrastructure. • Option 3, buildings are arranged around two through site links to maximise permeability.
4.	**Sustainability context & trends presentation by AECOM (RS)** Topics presented: socioeconomic context, physical context, policy and stakeholder needs. Slides are provided in Power Point file attached, named *ESD & Resilience presentationrev1*. **Extracts for consideration in design:** • Site is within area of highest index of socioeconomic disadvantage in Sydney, highlighting the importance of: - Designing our crime - Housing & living affordability - Community facilities for the delivery of education and training programs - Potentially reduced carpark requirements • Existing site demographics (SA1) skewed towards the aged with median age of 61. This will change though after the development is delivered, but stresses importance of: - Accessible buildings and public domain - Inclusive open space - Indoor thermal comfort - Good access to public transport - Flexible design - Affordability

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No	Item
	• Contested roof space (infrastructure, PV, green/community space), and solar access (trees, homes, building heights). • Illegal waste dumping may be a potential issue considering dominant tenure type is renting (72.9% currently) • A transport summary was provided by Jacobs (SR): - Site has good access to public transport including several bus routes and Redfern train station. - However, buses may go out of capacity in the future as Green Square grows. - New train metro line, but vague where it will go - Future Waterloo Station nearby - City of Sydney is strict on carpark provision - Danks St. precinct nearby - Intersections work well - Existing cycle/walking route running along Kettle St. - No access on Elizabeth St. hence Walker St. will be the access port (although closed to Phillip St. and suggests to keep it that way). • Biggest constraint is impacts associated with flooding. There will be a need to attenuate so not to increase flooding risk in surrounding areas. • ESD opportunity areas for further investigation include: ○ **Reducing potable demand**: rainwater collection & reuse; high efficiency water fixtures, stormwater harvesting. ○ **Wastewater recycling**: Blackwater/greywater use including split system, and wastewater recycling. ○ **Renewable energy & low energy/carbon technologies:** PV, building orientation, natural ventilation, EVs, centralised heat extraction system, geothermal cooling, smart metering and glazing options to improve thermal comfort and reduce heating and cooling loads, using a sustainable electrical supply rather than gas for heating and cooking. <u>Other key topics discussed:</u> • Potential demand for recycled water is small and may not justify upfront capital costs of recycling initiatives. • Trees on the site are not significant. • Key considerations include living affordability, flooding constraints, contested roof space • Demand management solutions may be funded by Ausgrid where they demonstrate reliable peak load demand reduction. Examples include energy storage and microgrids.
5.	**Sustainability workshop** In the workshop, attendees discuss desired project outcomes by 2050 using the themes

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No	Item
	below, including short and long term actions that should be included/not precluded to achieve those outcomes. • Socioeconomic • Energy & carbon • Transport • Water • Waste Results are provided in Table 1.
6.	**Climate risk and adaptation presentation by AECOM (SA)** Key topics were: • Climate change context of the site is provided highlighting the following risks: - Urban heat island and increasing temperatures - Flooding • The directions of *Resilient Sydney – A strategy for city resilience 2018* are provided for context to understand the acute shocks and stresses for Sydney (and the site). • Low income households are more sensitive to heat related risks highlighting the importance of greening and cool places for respite, building orientation, cool roofs and pavements and insulation. • Newleaf Community at Bonnyrigg is presented as a case study, highlighting the importance of factoring in demographics and site context to include appropriate climate adaptation responses. • Flood management strategies of Cloudburst Management Plan (Copenhagen) are also presented as a case study.
7.	**Climate risk and adaptation workshop** • AECOM carried out a preliminary climate risk assessment of the site, utilising a series of standards and guidelines that include ISO31000 and Green Star to identify and prioritise risks. Results of this assessment are provided to the attendees for validation and input on likelihood and consequences of the different risks. Top priority risks are discussed, including flooding, urban heat island effect and increasing temperatures. • A second activity is conducted where attendees are asked to identify current design considerations/controls that address key climate impacts for the site, then provide their input on additional adaptation actions recommended for applicability across the concept design options. Results are provided in Table 2.

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Table 1. Proposed 2050 outcomes and actions for the development

Theme	2050 outcome	Short term actions	Long term actions
Socioeconomic	• Integrated, cohesive, productive, connected, inclusive, vibrant and active community • Services to support the community: employment, health, education, child care • Long term homes with spaces to interact with neighbours • Equitable access to opportunity, e.g. no divide between social and private community members • Healthy community • Resilient community cognisant of most vulnerable members	• Required social/affordable mix • Variety of spaces built into design + flexible framework to deliver community spaces: PCYC, gardens, communal spaces, health/consulting room • Employment opportunities for residents: construction, operation. E.g. program for upskilling residents, leveraging PCYC facilities • Diverse education programs and community groups to attract all members of the community • Consider Resilient Sydney Strategy themes and actions • Prepare resilience and community engagement plans	Consideration of long term benefits over short term costs
Energy & carbon	• Carbon neutral precinct/buildings • 100% renewable energy supply (on or off-site) • Minimal expense for social housing residents (and all tenants) • Diversified energy supply for resilience • Minimum embodied energy • Climate appropriate development • Flatten peak demand • Reduce the need for additional infrastructure investment • LAHC is handed back an asset without electricity costs • Localised microgrid	• Energy and carbon plan identifying peaks, supply, security and diversification, and focusing on reduction • Maximise/balance space for PV • Investigate nearby renewables • Investigate battery power opportunities and backup for critical infrastructure, including options for reduced CAPEX associated with substation upgrades • Establish materials targets • Reduce heating and cooling demand through naturally ventilated, cooled and heated apartments, aiming for 100% • Alternate energy supply for supplemental heating/cooling • Landscaping to provide shading and heat reduction	• Revise maintenance schedules for inclusion of retrofit opportunities and uptake of new or cost effective technologies • Align to city wide heat island reduction through vegetation and landscaping • Precinct wide energy infrastructure. Explore opportunities to link with Waterloo development
Transport	• Maximised active transport with facilities to encourage/support it.	• Plan for adaptive reuse of basement	

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Theme	2050 outcome	Short term actions	Long term actions
	• Minimum private vehicles (aim to car-free development) • Accessibility to public transport for all demographics giving high priority to vulnerable community members • Provisions for sustainable transport options, e.g. electric vehicles, autonomous vehicles, on-demand rideshare • Near zero demand for car parking spaces	• Car charging • Car share • Bike parking/storage • Designing accessible pathways • Transport information	
Water	• Water cycle supporting liveability • Affordable water • Development resilient to flood and drought • Maximised collection and reuse of rainwater from rooftops • A greywater system that supplies the development with water for toilets, gardens, etc. • A site that responds to flooding and reduces flooding impacts • Water neutral development resulting from a combination of low demand, rainwater collection, water recycling. • Reduced wastewater production • Development contributes to water quality improvement in the Cooks River • Recycled water in all buildings and features across the site in a functional and interpretive way	• Provision of space for water and water storage • Design multifunctional spaces • Consider water treatment systems in the context of future Redfern Estate renewal • Net benefit to flooding impacts that are designed into the development and contribute to place i.e. more than just a tank	
Waste	• Reduced quantities of waste • Waste awareness among residents • Optimised of waste streams, reuse • Circular economy (consider carbon, energy, water) • Towards zero operational waste • Problem wastes appropriately managed	• Education strategy/program • Encourage trading of items among community - consider appropriate spaces • Identify offsite opportunities for co-funding with nearby communities • Investigate vacuumed waste - centralisation for collection • Community garden - use of onsite composting of	• Vacuum waste • Community reuse program

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Theme	2050 outcome	Short term actions	Long term actions
	(chemicals, batteries, etc.)	organic waste • Establish construction waste targets and develop a management plan • Incentivise waste reduction • Provision for waste stream separation • Zero waste in construction (use of sustainable materials)	

Table 2: Example adaptation actions identified by workshop participants

Hazard	Potential adaptation actions
Flooding	• Rising floor levels above 100yr ARI + 30% climate change provision or PMF • Raise critical infrastructure above 100yr ARI + 30% climate change provision or PMF • Creation of breaks in built structures to allow water to drain through north-south corridor • Green rooftop spaces to assist with runoff reduction • Provision of onsite flood attenuation and storage • Incorporation of WSUD principles to site design • Incorporation of flood detention areas and sacrificial land • Creation of communal spaces on ground level that can accommodate flooding and stormwater detention • Safe points and building access/egress designed above flood levels • Flood emergency response plan/strategy, and SES contingency planning • Consider building access points in relation to flood risk
Extreme heat	• High performance façade design (including insulation, glazing ratios) • Use of reflective/insulated facades and windows • Rooftop gardens and tree canopies to provide respite and cool buildings • Orientation of buildings – more north facing and less west facing • Optimisation of passive cooling and natural ventilation • Installation of louvres for external shading • All options include a series of communal spaces for external respite for occupants • Use of high albedo materials and surfaces • Use of natural materials including wood • Potential awnings for respite along the street frontage • Communal spaces will provide access to vegetation and shade for respite of staff

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Hazard	Potential adaptation actions
	• Appropriately sizing HVAC to consider future climate • Provision of respite areas where no active cooling is provided • Aim to over comply with NatHERS and BASIX requirements • Adhere to CoS green canopy requirements to reduce urban heat • Increase management controls for extreme heat events such as doorknocking, particularly for single occupant dwellings. • SSPs require efficiency measures and alternative supplies are being investigated and they will as part of ESD report • Constitution of building in regards to material selection and levels of insulation/wall construction • Naturally ventilated apartments (single aspect) with external space for circulation, plants and shading • Communal spaces and community facilities that are air conditioned to provide respite to residents without air conditioning • Avoiding west facing building orientation and provide shading on western facades • Design risers for future retrofitting and upgrade of cooling systems • Passive design measures such as cross ventilation, orientation, and shading • Design for appropriate solar access • Precinct wide energy strategy and network if policy allows • Building management of power centralised cooling to reduce high levels of demand • Limit minimum temperature of cooling systems to reduce peak demand • Western facing apartments along Elizabeth St – pressure on cooling in apartments in summer • Opportunities to max out tree canopy cover to be investigated
Relative Humidity	• Climate appropriate material selection
Storms	• Use of durable materials that are resilient to storms • Design communal areas to accommodate groups seeking refuge at times of storm events

Appendix B – Discussion with City of Sydney for management of waste

The project team met to discuss management of waste for the proposed development with City of Sydney on 09/09/2019.

This appendix will be updated with the meeting minutes of discussions once finalised.