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APPENDIX M

Environmentally Sustainable Design Strategy + Life Cycle Assessment

LCI + Lendlease

Sydney Football Stadium Redevelopment 01/05/2019

Environmentally Sustainable Design Strategy

Prepared for

Infrastructure NSW

Revision 02

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Revision Information

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Title	Environmentally Sustainable Design Strategy
Client	Infrastructure NSW
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Contents

1 Introduction

This report supports a State Significant Development (SSD) Development Application (DA) for the redevelopment of the Sydney Football Stadium, which is submitted to the Minister for Planning pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The redevelopment is being conducted in stages comprising the following planning applications:

- **Stage 1** – Concept Proposal for the stadium envelope and supporting retail and functional uses as well as development consent for the carrying out of early works, including demolition of the existing facility and associated structures.

- **Stage 2** – detailed design, construction and operation of the stadium and supporting business, retail and functional uses.

Development consent was granted for the Concept Proposal and detailed approval to carry out early works and demolition (SSD 18_9249) by the Minister for Planning on 6 December 2018.

This report relates to the Stage 2 application and considers the detailed design, construction and operation of the new Sydney Football Stadium pursuant to the approved Concept Proposal.

Infrastructure NSW is the proponent of the Stage 2 DA.

2 Background

The Sydney Football Stadium (SFS) is a significant component of the sports facilities that comprise the Sydney Cricket and Sports Ground. Completed in 1988, the SFS has hosted numerous sporting events in its 30 years of operation for a number of sporting codes including football (soccer), rugby league and rugby union as well as occasional music concerts.

The NSW Stadia Strategy 2012 provides a vision for the future of stadia within NSW, prioritising investment to achieve the optimal mix of venues to meet community needs and to ensure a vibrant sports and event environment in NSW. A key action of the strategy included development of master plans for Tier 1 stadia and their precincts covering transport, integrated ticketing, spectator experience, facilities for players, media, corporate and restaurant and entertainment provision. SFS is one of three Tier 1 stadia within NSW, the others being Stadium Australia (Olympic Park) and the Sydney Cricket Ground.

In order to qualify for Tier 1 status, a stadium is required to include:

- Seating capacity greater than 40,000;
- Regularly host international sporting events;
- Offer extensive corporate facilities, including suites, open-air corporate boxes and other function/dining facilities; and
- Be the home ground for sporting teams playing in national competitions.

On 6 December 2018, development consent was granted for the Concept Proposal and Early Works/ Demolition stage of the SFS redevelopment (SSD 18_9249). This consent permitted the completion of demolition works on the site and established the planning and development framework through which to assess this subsequent Stage 2 application. Specifically, State Significant Development Consent SSD 18_9249 encompassed:

1. A Concept Proposal for:
    - A maximum building envelope for the stadium with capacity for 45,000 seats (55,000 patrons in concert mode) and 1,500 staff.
    - Urban Design Guidelines and a Design Excellence Strategy to guide the detailed design of the stadium at Stage 2.
    - General functional parameters for the design and operation of the new stadium, including:
        - Range of general admission seating, members areas, premium box/terrace, function/lounge and corporate suite options;
        - Administration offices;
        - New roof with 100% drip-line coverage of all permanent seating;
        - Flood lighting, stadium video screens and other ancillary fittings;
        - Food and beverage offerings;
        - Facilities for team, media, administration and amenity such as changing rooms, media rooms and stadium; and
        - Provision for ancillary uses within the stadium and surrounds.
    - Principles and strategies for transport and access arrangements.
    - Indicative staging of the development.

2. Detailed consent for the following works:
    - The demolition of the existing SFS and ancillary structures, including the existing Sheridan, Roosters, Waratahs and Cricket NSW buildings down to existing slab level.
    - Site and construction management, including use of the existing MP1 car park for construction staging, management and waste processing, and provisions for temporary pedestrian and vehicular access management.
    - The protection and retention of Tree 125 (Moreton Bay Fig adjacent to Moore Park Road) and Tree 231-238 cluster (Hills Weeping Fig and others near Paddington Lane) and all existing street trees located outside of the site boundary, with the removal of all other vegetation within the proposed future building footprint.
    - Works to make the site suitable for the construction of the new stadium (subject to this separate Stage 2 application).

3 Site Description

The site is located at 40-44 Driver Avenue, Moore Park within the Sydney Cricket Ground Precinct. It is bound by Moore Park Road to the north, Paddington Lane to the east, the existing SCG stadium to the south and Driver Avenue to the west. The site is located within the City of Sydney local government area.

The site is legally described as Part Lots 1528 and 1530 in Deposited Plan 752011 and Lot 1 in Deposited Plan 205794. The site is Crown Land, with the SCSGT designated as the sole trustee under the *Sydney Cricket and Sports Ground Act 1978*. The site is wholly contained within designated land controlled by the Sydney SCSGT under Schedule 2A of the *Sydney Cricket and Sports Ground Act 1978*.

In a broader context, the site is largely surrounded by Centennial and Moore Parks, the Fox Studios and Entertainment Quarter precincts and the residential suburb of Paddington. Located approximately 3km from the Sydney CBD and approximately 2km from Central Station, the site is connected to Sydney's transport network through existing bus routes and will benefit from a dedicated stop on the soon to be completed Sydney CBD and South East Light Rail.

The locational context of the Site is shown in Figure 1, whilst the site boundaries and existing site features are shown in Figure 2.

Figure 1: Regional site context

Figure 2: Site area and local context

4 Overview of Proposed Development

The application represents the next phase in the SFS redevelopment. It seeks consent for the detailed design, construction and operation of the new stadium as 'Stage 2' of the redevelopment, which includes:

- Construction of a new stadium with up to 45,000 seats (55,000 capacity in concert-mode), including playing pitch, grandstands, sports and stadium administration areas, food and drink kiosks, corporate facilities and all other aspects of a modern stadium;
- Operation and use of the stadium and surrounding site area for a range of sporting and entertainment events;
- Vehicular and pedestrian access and circulation arrangements, including excavation to deliver a partial basement level for storage, internal loading and servicing at the playing pitch level;
- Reinstatement of the MP1 car park following the completion of construction, including enhanced vehicle rejection facilities and direct vehicular connection to the new stadium basement level;
- Public domain improvements within the site boundary, including hard and soft landscaping, to deliver a range of publicly accessible, event and operational areas;
- Provision of new pedestrian and cycling facilities within the site;
- Signage, including building identification signage, business identification signage and a wayfinding signage strategy; and
- Extension and augmentation of physical infrastructure/ utilities for the development within the site.

The proposed development is consistent with the approved Concept Proposal pursuant to State Significant Development Consent SSD 9249.

5 Assessment Requirements

5.1 SEARs

The Department of Planning and Environment have issued Secretary's Environmental Assessment Requirements (SEARs) to the applicant for the preparation of an Environmental Impact Statement for the proposed development. This report has been prepared having regard to the SEARs as follows:

- **SEAR 2 | Policies**

  Address the relevant planning provisions, goals and strategic planning objectives in the following:

  - NSW Energy Efficiency Action Plan
  - NSW Resources Efficiency Policy (GREP)
  - Sustainable Sydney 2030

- **SEAR 14 | Ecologically Sustainable Development (ESD)**

  - Detail how ESD principles (as defined in clause 7(4) of Schedule 2 of the Environmental Planning and Assessment Regulation 2000) will be incorporated in the design and ongoing operation phases of the development.
  - Demonstrate how the future development will be designed to achieve LEED rating using the previous stadium as the "reference building" for the assessment or any other equivalent sustainability rating tool as listed in section 5.3 of the Sydney Football Stadium Redevelopment Environmentally Sustainable Design Strategy prepared by Aurecon dated 11 May 2018 (SSD 9249).
  - Undertake an analysis of the likely service demands for drinking water, wastewater and recycled water services and outline the Integrated Water Management principles detailing any proposed alternative water supplies, proposed end uses of potable and non-potable water, and water sensitive urban design. This should include preliminary details of sustainability initiatives that will minimise/reduce the demand on supplies.
  - Address the implementation of water sensitive urban design and energy conservation and efficiency measures, including sizing of key elements. Measures could include (but not be limited to):
    - Rainwater harvesting and re-use;
    - Water efficient fixtures;
    - Installation of rooftop solar photovoltaic arrays for on-site electricity generation;
    - Storage of surplus energy generated by rooftop solar photovoltaic arrays; use of electric vehicles for dedicated on site transport tasks (where possible); and energy efficient electrical equipment, fittings and fixtures.

- **SEAR 15 | Environmental Risk**

  Include preliminary consideration of the management of environmental risks to all persons utilising the future facility, including but not limited to:

  - Extreme heat
  - Storms and flooding
  - Terror attacks (not relevant to this report)
  - Building performance and mitigation of climate change, including consideration of Green Star performance

- **SEAR 16 | Design of Resilience to Climate Change**

  Provide a statement regarding how the design of the future development is responsive to the CSIRO projected impact of climate change. Specifically:

  - Hotter days and more frequent heatwave events
  - Extended drought periods
  - More extreme rainfall events
  - Gustier wind conditions
  - How these will material selection and social equity aspects (respite/ shelter areas)

5.2 Conditions of Consent

In addition, this report addresses the future assessment requirements set out in Schedule 2 Part B of the State Significant Development Consent SSD 9249 in Table 1.

Table 1: Conditions of Consent for the SFSR

Condition	Section in Report
C1c(v) The future development application must demonstrate design excellence having regard to the following matters: v) the achievement of the principles of ecologically sustainable development	**Section 10**
C27 The future development application must include a detailed report which address the key principles and recommendations identified in the Sydney Football Stadium Redevelopment Environmentally Sustainable Design Strategy prepared by Aurecon dated 2018 have been incorporated in principle into the design, construction and on-going operation of the new buildings.	**Section 10**
C28 The future development application must include the results of a whole of life assessment (Life Cycle Assessment) undertaken to identify material impacts and opportunities for improvement, in accordance with the Response to Submissions. The report must identify, the extent to which sustainability measures have been incorporated to address any identified hotspots informed by the whole of life assessment.	**Section 10**
C29 The future development application must include a report identifying the extent to which the proposal can comply with the greenhouse gas, energy and carbon targets identified in Sustainable Sydney 2030.	**Section 10**
C30 The future development application must include a report which addresses how the proposed development is capable of achieving Gold Leadership in Energy and Environmental Design (LEED) rating using the existing stadium as the “reference building” for the assessment or any other equivalent sustainability rating tool as listed in section 5.3 of the Sydney Football Stadium Redevelopment Environmentally Sustainable Design Strategy prepared by Aurecon dated 2018.	**Section 10**

Condition	Section in Report
C31 The future development application is required to address the implementation of water sensitive urban design and energy conservation and efficiency measures, including but not limited to: a) rainwater harvesting and re-use; b) water efficient fixtures; c) installation of rooftop solar photovoltaic arrays for on-site electricity generation; d) storage of surplus energy generated by rooftop solar photovoltaic arrays; e) use of electric vehicles for dedicated on site transport tasks (where possible); and f) energy efficient electrical equipment, fittings and fixtures.	**Section 10**

6 SEAR 2 | Policies

6.1 NSW Energy Efficiency Action Plan

The NSW Energy Efficiency Action Plan (EEAP) was developed in 2013 as means to contend with current and future increases in energy costs in NSW. The plan includes targets and actions to:

- Realise annual energy savings of 16,000GWh by 2020
- Support 220,000 low income households to reduce energy use by up to 20% by 2014 (not applicable as the project is not a residential development)
- Deliver high standard building retrofit programs so 50% of NSW commercial floor space achieves a 4-Star NABERS energy and water rating by 2020 (not applicable as the project is not a commercial office development)

6.1.1 SFSR's Contribution to the EEAP

The Sydney Football Stadium Redevelopment provides energy savings strategies to help achieve the 16,000GWh reduction target and contributes to the overall outcome of the EEAP. This will be done by reducing energy consumption and improving energy efficiency through:

- Incorporating energy efficiency measures through building fabric and services to meet and exceed National Construction Code (NCC) Section J requirements;
- Committing to achieving a LEED v4 Gold rating which incorporates energy efficiency measures
- Provision of an on-site photovoltaic (PV) system to offset stadium energy usage

6.2 NSW Government Resources Efficiency Policy (GREP)

The NSW Government Resources Efficiency Policy (GREP) outlines specific requirements for the EEAP.

The GREP aims to reduce the operating costs of the NSW government through efficient use of resources; particularly energy consumption, water consumption and waste management.

The measures and targets within the GREP that are relevant to the Sydney Football Stadium are provided in Table 2. How these measures are achieved by the SFSR are also included.

Table 2: GREP Measures met by the SFSR design

GREP Measure	Description	Contribution from the SFSR
Energy		
E1: Targets to undertake energy efficiency projects	All clusters will undertake energy efficiency projects at sites representing 90% of their billed energy use by the end of 2023–24, with an interim target of 55% for Health and 40% for other clusters by the end of 2017–18.	As the Sydney Football Stadium is a 'new building' this measure will be met by addressing measure E4: Minimum standards for new buildings. The stadium is targeting a LEED Gold rating.
E3: Minimum standards for new electrical appliances and equipment	All new electrical equipment purchased by the government must meet minimum energy efficiency ratings.	Selection of electrical equipment will meet minimum energy efficiency ratings to comply with NCC and/or LEED. Final equipment selection will be addressed during detailed design.

E4: Minimum standards for new buildings	New buildings must be designed and built so that energy consumption is predicted to be at least 10% lower than if built to minimum compliance with National Construction Code requirements.	The stadium is committed to achieving a high level of energy efficiency and is committed to exceeding this target. This measure will be addressed during detailed design.
E6: Minimum fuel efficiency standards for new light vehicles	Improve minimum fuel efficiency standards for new light vehicles	Future provision of electric car charging facilities is proposed for the stadium to assist in improving fuel efficiency standards.
E7: Purchase 6% GreenPower	Purchase a minimum of 6% GreenPower.	Purchase of GreenPower is part of the Stadium's LEED strategy as shown in Appendix A.
Water		
W1: Report on water use	All agencies will report on water use.	Extensive water meter and monitoring system is proposed for the stadium. The monitoring system will have the capability to report on water uses.
W3: Minimum standards for new water-using appliances	All new water-using appliances, shower heads, taps and toilets purchased by agencies must achieve specified levels of water efficiency.	The stadium is committed to achieving a high level of water efficiency. This measure is addressed in the Stadium's LEED strategy as shown in Appendix A.
Waste		
P1: Report on top three waste streams	All agencies will report on their top three waste streams by total volume and by total cost.	The stadium will have dedicated waste facilities that will be designed to facilitate effective waste management during operation.
Clean Air		
A2: Low-VOC surface coatings	All surface coatings will comply with the Australian Paint Approval Scheme (APAS) where fit for purpose	The stadium is committed to achieving excellent indoor environmental quality. This measure is addressed in the Stadium's LEED Strategy as shown in Appendix A.

6.3 Sustainable Sydney 2030

In 2008, in response to extensive community consultation, the Council of the City of Sydney adopted the Sustainable Sydney 2030 plan that would express sustainable development for Sydney in 2030 and beyond.

The vision set by the plan is for Sydney in 2030 to be green, global and connected. The city will reduce greenhouse gas emissions; attract global talent and investment; provide ease of access between communities; and encourage diversity and inclusiveness.

The ten targets for 2030 from the Sustainable Sydney 2030 plan are:

1. 70% reduction in greenhouse gas emissions based on 2006 levels by 2030 and by 2050, achieve a net zero emissions city.
2. 50% of electricity demand met by renewable sources; zero increase in potable water use from 2006 baseline, achieved through water efficiency and recycled water; total canopy cover increased by 50% from 2008 baseline
3. There will be at least 138,000 dwellings in the city (including 48,000 additional dwellings compared to the 2006 baseline) for increased diversity of household types, including greater share of families.
4. 7.5% of all city housing will be social housing, and 7.5% will be affordable housing, delivered by not-for-profit or other providers.
5. The city will contain at least 465,000 jobs (including 97,000 additional jobs) compared to the 2006 baseline) with an increased share in finance, advanced business services, education, creative industries and tourism sectors.
6. Trips to work using public transport will increase to 80%, for both residents of the city and those travelling to the city from elsewhere.
7. At least 10% of total trips made in the city are by bicycle and 50% by pedestrian movement.
8. Every resident will be within reasonable walking distance to most local services, including fresh food, childcare, health services and leisure, social, learning and cultural infrastructure.
9. Every resident will be within a 3-minute walk (250 m) of continuous green links that connect to the harbour foreshore, harbour parklands, Moore or Centennial or Sydney parks.
10. The level of community cohesion and social interaction will have increased based on at least 65% of people believing most people can be trusted.

6.3.1 SFSR's Contribution to the Sustainable Sydney 2030

The SFSR will help realise the Sustainable Sydney 2030 plan as outlined in Table 3.

Table 3: Sustainable Sydney 2030 goals met through the SFSR

Sustainable Sydney 2030 Goals	Contribution from the SFSR
70% reduction in greenhouse gas emissions based on 2006 levels by 2030 and by 2050, achieve a net zero emissions city	Provision of on-site photovoltaic array, reduced peak electricity demand measures, potential purchasing GreenPower or carbon offsets, high energy efficiency HVAC plant equipment and electrical equipment
50% of electricity demand met by renewable sources; zero increase in potable water use from 2006 baseline, achieved through water efficiency and recycled water; total canopy cover increased by 50% from 2008 baseline	Provision of on-site photovoltaic array and , potential purchasing GreenPower or carbon offsets. High efficiency water fixtures and provision of a rainwater capture and reuse system.
At least 10% of total trips made in the city are by bicycle and 50% by pedestrian movement	Provision of pathways to interconnect with surrounding pedestrian and cyclist networks. Cycling to and from the SFSR is encouraged through cyclist parking and end-of-trip facilities for staff.

7 SEAR 14 | Ecologically Sustainable Development (ESD)

7.1 Clause 7(4) of Schedule 2

The ESD principles that are to be incorporated into the proposed development must be aligned with Clause 7(4) – Schedule 2 – Environmental Planning & Assessment Regulation (2000).

7.1.1 The Precautionary Principle

The proposed development will be constructed on a previously developed site. This will not have an adverse environmental impact and therefore alleviates concern of serious or irreversible environmental damage. Proactive measures to prevent environmental degradation have been included within the design, construction and operational phases of the proposed development. During the design and construction phases the main contractor will implement an Environmental Management System that follows NSW Environmental Management System Guidelines. Throughout the building's operation adherence to procedures that account for environmental risk and mitigation measures will be met.

7.1.2 Inter-Generational Equity

To uphold inter-generational equity, the proposed development minimises the consumption of energy and water resources while reducing waste.

The ESD principles incorporated into the proposed development facilitates the conservation of energy and water resources through energy and water efficiency measures. Energy consumption will be less than a similar building as proven through a minimum 5% improvement above ASHRAE 90.1-2010 standards and a minimum 10% improvement above NCC 2019 requirements. The reduction in water use has been established through high WELS equivalent water fixtures and fittings.

Waste generated during the construction and operational phases will be diverted from landfill to be recycled. An Environmental Management System (EMS) will be established and adhered to throughout construction. Operational waste streams will be separated to maximise recycled waste.

Reducing energy, water and waste ensures that the health, diversity and productivity of the environment is maintained for the benefit of future generations.

7.1.3 Conservation of Biological Diversity and Ecological Integrity

The surrounding area of the Sydney Football Stadium Redevelopment is a mixture of existing buildings, parklands and roads. However, the project will be constructed on a previously developed site without disturbing surrounding areas. As a result, the project has no impact to the surrounding biodiversity and ecological integrity.

The project's ESD principles to reduce energy, water and waste consumption have an indirect impact to conserve biodiversity and ecological integrity to the surrounding area. By minimising demand on energy and water resources, the need for land-clearing and the pollution generated from new utility infrastructure to support the surrounding area will be minimised.

7.1.4 Improved Valuation

The valuation of the project's assets and services consider environmental factors through the implementation of various ESD initiatives. An Environmental Management System will be adhered to during construction to ensure that contractors are responsible for costs associated with generating excessive pollution and waste. The project team will bear the extra cost of providing recycling and landfill waste streams during construction and operational phases. This creates a system where the polluter pays and creates and incentive to reduce pollution and waste.

The establishment of NCC and LEED requirements provides environmental goals for the project. Project requirements stipulate design teams are contractually required to deliver energy efficient building services which

provide a minimum 5% improvement above ASHRAE 90.1-2010 standards. A LEED v4 certified Gold rating target provides a goal for environmentally sustainable building design which is comparable with other LEED certified stadiums across the world.

7.2 Framework to Reflect Best Practice Sustainable Design Principles

7.2.1 Leadership in Energy and Environmental Design (LEED)

The SFSR has committed to achieving a LEED v4 certified Gold rating which is deemed 'Australian Best Practice'. The Leadership in Energy and Environmental Design (LEED) rating system provides a framework to assess how a building reduces its impact on the environment while meeting the economic and social needs for its occupants and surrounding communities.

The LEED rating system assessing buildings through the following categories:

- Integrative Process
- Location and Transport
- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environment Quality
- Innovation
- Regional Priority

Points are awarded for a building project's ability to secure as many credits from each category. Each credit targets the environmental impact of a specific design feature. The total number of points awarded determines if the project earns a LEED Certified, Silver, Gold or Platinum rating as shown in Figure 3.

Figure 3: Available LEED Certification ratings

7.2.2 Sustainable Design Principles at SFSR

The following sustainable design principles have been proposed for the SFSR and can be addressed through the categories outlined within the LEED v4 rating system.

- **Location and Transport**
    - Commitment to the provision of cyclist parking and end-of-trip (EOT) facilities for Sydney Cricket and Sports Ground Trust (SCGT) staff
    - Commitment to the provision of cyclist parking and EOT for Event Day stadium staff
    - Commitment to allocating spatial capacity for future provision of 10 electric vehicle charging points

  LEED v4 captures these requirements through the following credits:

  - Bicycle Facilities
  - Green Vehicles

- **Sustainable Sites**
    - Commitment to ensuring 95% of new vegetation to be native to the Australian bioregion
    - Heat Island Effect to be minimised through a light-coloured roof and paving, landscaping and shaded areas
    - Commitment to ensuring stormwater peak event discharge to not exceed predevelopment levels
    - Commitment to ensuring stormwater pollution targets are in accordance with the Construction Best Practice standards for urban stormwater quality published by the CSIRO/ Victoria Stormwater Committee
    - Testing of contamination in soil and ground water. Remediation to take place if required

  LEED v4 captures these requirements through the following credits:

  - Heat Island Effect
  - Rainwater Management
  - Site Development- Protect or Restore Habitat
  - Open Space

- **Water Efficiency**
    - In general, maximise operational water efficiency
    - Commitment to providing non-potable water supply through rainwater harvesting and bore water supply
    - Commitment to 80% reduction in irrigation demand from Pitch and Playing Surface demand
    - Where possible, additional non-potable water supply for the purposes of toilet flushing, maintenance wash-down and general cleaning purposes
    - Temporary storage for 80% of the routine fire protection system test water and maintenance drain-downs for reuse on site.

  LEED v4 captures these requirements through the following credits:

  - Outdoor Water Reduction
  - Indoor Water Reduction
  - Water Metering
  - Cooling Tower Water Use

- **Materials and Resources**

    - In general minimising the impact on the environment during both construction and operational phases
    - In general minimising construction and demolition waste
    - Commitment to 90% of all demolition and construction waste will be diverted from landfill for recycling

  LEED v4 captures these requirements through the following credits:

  - Building Life-cycle Impact Reduction
  - Storage and Collection of Recyclables
  - Construction and Demolition Waste Management

- **Energy**

    - In general, maximise operational energy efficiency and limiting overall greenhouse gas emissions.
    - High efficiency HVAC plant and light fittings
    - On-site photovoltaic system

  LEED v4 captures these requirements through the following credits:

  - Optimize Energy Performance
  - Enhanced Commissioning
  - Advanced Energy Metering
  - Demand Response
  - Renewable Energy Production
  - Enhanced Refrigerant Management
  - GreenPower and Carbon Offsets

- **Social Sustainability**

    - An ESD Management Plan will be developed and implemented which address the following issues:
        - Promotion of diversity within the Stadium
        - Modern slavery with in the supply chain
        - Community engagement

  LEED v4 captures these requirements through the following credits:

  - Pilot Credit: Social Equity within the Supply Chain
  - Pilot Credit: Community Outreach and Involvement

7.2.3 Whole of Life Assessment

A Whole of Life Assessment for the SFSR has been undertaken in accordance with the LEED Credit: *Building Life-cycle Impact Reduction*. The assessment is shown in Appendix B.

7.3 Water and Energy Management

7.3.1 Water Demand

The likely service demands for drinking water, wastewater and recycled water services will be outlined during Detailed Design by the Hydraulic consultant. Integrated Water Management principles will be included detailing any proposed alternative water supplies, proposed end uses of potable and non-potable water, and water sensitive urban design. Preliminary sustainability initiatives for minimises water demand are identified below.

7.3.2 Water Management

- **Rainwater Collection and Reuse**

  The project has proposed a rainwater tank to utilise rainwater harvested from the stadium roof for irrigation. The size and location of the proposed rainwater tank will be confirmed during detailed design.

- **Efficient Use of Water through Selection of Fittings and Fixtures**

  The flow rates of the proposed water efficient fixtures for the project has been listed in the following table. The flow rates of the proposed fixtures are lower than the minimum flow rates outlined in the LEED Credit: Indoor Water Use Reduction. The final fixtures and flow rates will be confirmed during detailed design.

Table 4: Comparison of Flow Rates between Proposed and 'Reference Building' Water Fixtures

Fixture	Minimum Fixture Flow Rate	Proposed Fixture Flow Rate
Dual Flush WC	6.00 lpf	3.82 lpf
Urinals	3.80 lpf	0.80 lpf
Showerheads	9.50 lpm	9.00 lpm

Note: lpf = litres per flush, lpm = litres per minute

- **Native Vegetation**

  95% of new vegetation will be native to the local Australian bioregion; minimising irrigation demand

7.3.3 Energy Management

- **Installation of Rooftop Solar Photovoltaic Arrays for On-site Electricity Generation**

  An on-site photovoltaic array has been proposed to be installed on the stadium roof. The final capacity and location of the system will be confirmed during detailed design.

- **Storage of surplus energy generated by rooftop solar photovoltaic arrays**

  The new development will consider installing on-site battery bank to store excess generation of solar electricity. This provision will be confirmed during detailed design.

- **Use of electric vehicles for dedicated on site transport tasks**

  The project will provide spatial capacity for future provision for the addition of 10 electric vehicle charging points.

- **Energy Efficient Electrical Equipment, Fitting and Fixtures**

  The project will meet the energy efficiency requirements as stipulated by the NCC 2019 Section J. The LEED pathway for the project is targeting at least 3 points under the Optimize Energy Performance LEED credit. The final number of points will be confirmed during detailed design.

  Lighting to general lighting, stadium lighting and pitch grow lighting will be LED to reduce energy use for lighting.

7.4 Stormwater Assessment

Refer to the Stage 2 DA Stormwater Management Plan.

8 SEAR 15 | Environmental Risk

The occurrence of extreme climate events presents environmental risks to the safety of those who will occupy and use the proposed facility in the future. These risks and corresponding impacts to occupants are listed in Table 5.

Table 5: Environmental Risks for Occupants of SFSR

Environmental Risk	Mitigation Strategies
Extreme Heat	- Shading through landscaping and high thermal performance building fabric will be utilised to mitigate heat discomfort and heat stress. A high ratio of replacement planting will contribute to the urban tree canopy - Mechanical system will be designed to provide adequate thermal comfort to occupants and ensure safe operation of equipment during extreme heat
Storms and Flooding	- Refer to the DA Stage 2 *Stormwater Management Plan*
Building Performance and Mitigation of Climate Change	- The stadium design will incorporate shading and high thermal performance building fabric to mitigate climate change risks (extreme heat) - Energy efficient plant and equipment will be selected to reduce greenhouse gas emissions - A Whole-of-Life Assessment will be undertaken for the SFSR to identify opportunities to reduce the carbon emissions across the life of the project. Refer to Appendix B.

9 SEAR 16 | Design for Resilience to Climate Change

The project requires design features that will future-proof itself from the impacts of climate change. NSW and ACT Government Regional Climate Modelling (NARCLiM) has identified the following climate change projections:

1. More hot days and fewer cold nights
2. Increase the number of heatwave events
3. More hot days above 35°C; particularly in Spring and Summer
4. Rainfall will increase in Summer and Autumn and decrease in Winter and Spring
5. Change in rainfall patterns will affect drought and flooding events

These projections will have an impact on operational costs and occupancy comfort and safety. Hotter days with more heatwaves will particularly affect patients and the operation of building services equipment. This will also require higher capacity and operational costs for mechanical services to maintain occupancy comfort. Increased drought events will require provisions to supplement shortages in potable water. Stronger and reinforced façade components will be required to withstand increased rainfall and wind gust events.

The design initiatives in the following table aim to mitigate the effect of future climate change while maximising efficiency in energy, water and material use. These measures should allow the project to meet the difficulties predicted by the CSIRO's climate change projections while maintaining occupancy comfort and operational efficiency.

Table 6: Climate change projections and response initiatives for the SFSR

Climate Change Projections	Climate Change Design Initiatives
Hotter days and more frequent heatwave events	- Minimise solar heat gain into habitable spaces by utilising low-E glazing - Improve efficiency for mechanical services - Optimise shading devices across façade to reduce summer heat gain from direct sunlight - On-site photovoltaic system to reduce peak demand on electricity infrastructure
Extended drought periods	- Provision and maximising of rainwater capture and storage for reuse - Utilise on-site bore water supply to reduce potable water demand for irrigation - Landscaping with native low-water plant species
More extreme rainfall events	- Increase peak stormwater discharge capability - Increase over-flow drainage from site - Maximise the planting of mature trees to prevent soil erosion
Gustier wind conditions	- Reinforced façade and drainage of the building, respite and shelter areas - Improved air filters for mechanical services

10 Compliance with Conditions of Consent

The Mitigation Measures that address the above Conditions of Consent are shown in Table 7.

Table 7: Response to Conditions of Consent for SFSR

Conditions of Consent
C1.c.v The future development application must demonstrate design excellence having regard to the following matters: v) the achievement of the principles of ecologically sustainable development **Response** See Section 7.
Condition C27 The future development application must include a detailed report which address the key principles and recommendations identified in the Sydney Football Stadium Redevelopment Environmentally Sustainable Design Strategy prepared by Aurecon dated 2018 have been incorporated in principle into the design, construction and on-going operation of the new buildings. **Response** The key ESD principles outlined in the Aurecon report have been addressed as follows: Energy - High Levels of Efficiency The project will meet the energy efficiency requirements as stipulated by the NCC 2019 Section J. The LEED pathway for the project is targeting at least 3 points under the Optimize Energy Performance LEED credit. The final number of points will be confirmed during detailed design. - LED Lighting Lighting to general lighting, stadium lighting and pitch grow lighting will be LED to reduce energy use for lighting. - Onsite Renewable Energy Generation An on-site photovoltaic array has been proposed to be installed on the stadium roof. The final capacity and location of the system will be confirmed during detailed design. Water - Efficient Use of Water through Selection of Fittings and Fixtures The flow rates of the proposed water efficient fixtures for the project has been listed in the following table. The flow rates of the proposed fixtures are lower than the minimum flow rates outlined in the LEED Credit: Indoor Water Use Reduction. The final fixtures and flow rates will be confirmed during detailed design.

Conditions of Consent

Fixture	Minimum Fixture Flow Rate	Proposed Fixture Flow Rate
Dual Flush WC	6.00 lpf	3.82 lpf
Urinals	3.80 lpf	0.80 lpf
Showerheads	9.50 lpm	9.00 lpm

Note: lpf = litres per flush, lpm = litres per minute

- Rainwater Collection and Reuse

  The project has proposed a rainwater tank to utilise rainwater harvested from the stadium roof for irrigation. The size and location of the proposed rainwater tank will be confirmed during detailed design.

Materials

- Life Cycle Assessment to Inform Material Selection

  The Main Contractor has committed to undertake a Life Cycle Assessment for the project. This is capable of providing three points under the LEED Credit: Building Life-cycle Impact Reduction.

- Demolition and Construction Waste Management

  The project will aim to divert 90% of construction waste from landfill.

  Reuse of Existing Materials

  ICT equipment and LED screens may be repurposed to the Sydney Cricket Ground.

- Operational Waste Management

  During stadium events, waste facilities will be adequately located and sized to assist patrons properly dispose of waste. Waste storage facilities will separate waste streams between general waste, recyclables and paper and cardboard.

Transport

- Provision of Bicycle Parking and Associated Facilities

  The project will provide cyclist parking and end-of-trip (EOT) facilities for Sydney Cricket and Sports Ground Trust (SCGT) staff and Event Day stadium staff.

- Improved Pedestrian Access

  The space surrounding the new development will include pedestrian-orientated paving allowing access around the stadium perimeter and connects Moore Park road to the facilities throughout the SCSGT precinct.

- Electric Vehicle Infrastructure

  The project will provide spatial capacity for future provision for the addition of 10 electric vehicle charging points.

- Promotion of Green Vehicles

  The project will provide spatial capacity for future provision for the addition of 10 electric vehicle charging points.

Sustainable Sites

- Native Vegetation

  95% of new vegetation will be native to the local Australian bioregion.

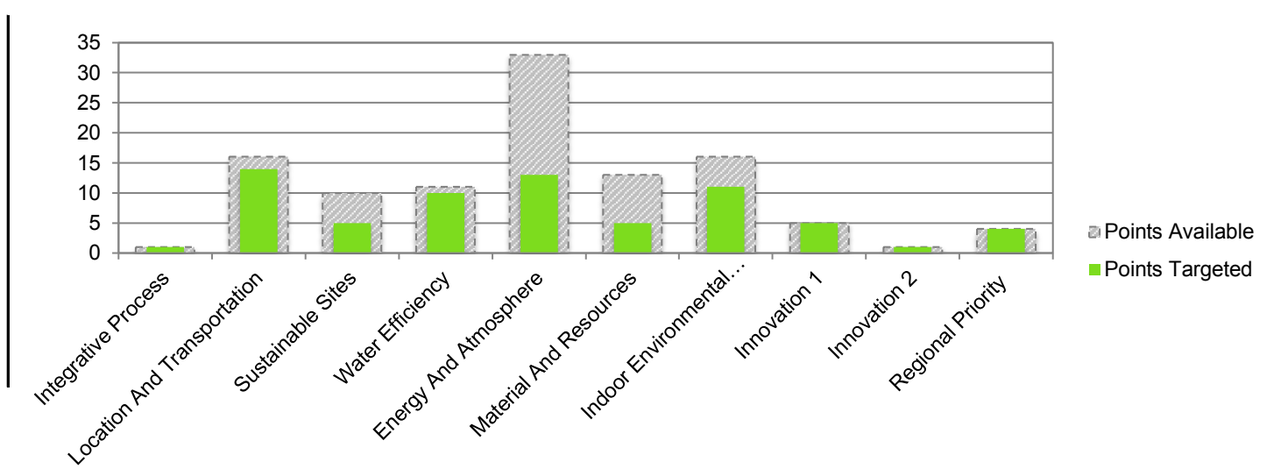
Conditions of Consent
- Reduction of Urban Heat Island Effect Heat Island Effect to be minimised through a light-coloured roof and paving, landscaping and shaded areas. - Stormwater Quantity and Quality Stormwater peak event discharge will to not exceed predevelopment levels. The Works must meet stormwater pollutant reduction targets in accordance with the Construction Best Practice standards for urban stormwater quality published by the CSIRO/ Victoria Stormwater Committee. Social Sustainability - Community Engagement The new stadium will remove fencing that closes off pedestrian access to the current site. This will provide an open space around the site and create a communal setting that connects the community with the site. The development is also targeting the LEED Innovation Credit: Community Outreach and Involvement. This will involve the development team engaging with community stakeholders for input during Predesign and Preliminary Design phases. Communication with community stakeholders will be ongoing throughout design, construction and post-construction phases. - Design for Diversity Adequate toilet facilities will be provided for males, females and people with physical disabilities. Access throughout the site will accommodate people with all physical abilities. A prayer room will be available to all stadium staff and patrons. - Modern Slavery The new development is targeting the LEED Innovation Credit: Social Equity within the Supply Chain. The credit requires an assessment of suppliers to ensure: o No-child/ force bonded labour o Health and safety procedures and training o Right of freedom of association o Non-discrimination o Discipline/ harassment and grievance procedures o Fair working hours and compensation o Anti-corruption and bribery A LEED v4 pathway has been developed and has targeted a LEED Gold rating. This pathway is available in Appendix A.
Condition C28 The future development application must include the results of a whole of life assessment (Life Cycle Assessment) undertaken to identify material impacts and opportunities for improvement, in accordance with the Response to Submissions. The report must identify, the extent to which sustainability measures have been incorporated to address any identified hotspots informed by the whole of life assessment.

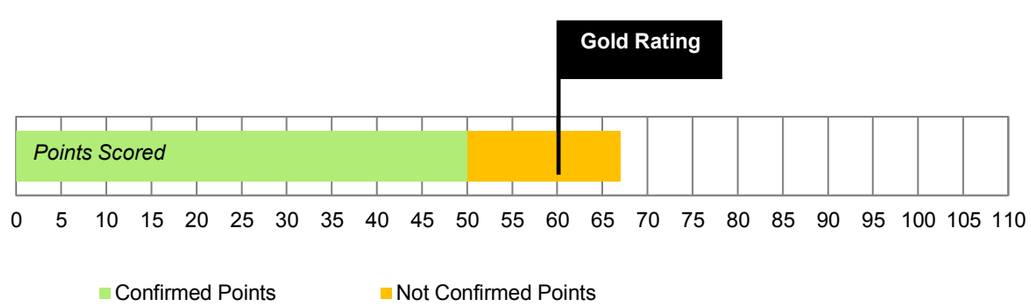
Conditions of Consent
Response A whole of life assessment has been undertaken and shown in Appendix B.
Condition C29 The future development application must include a report identifying the extent to which the proposal can comply with the greenhouse gas, energy and carbon targets identified in Sustainable Sydney 2030. **Response** Refer to Section 6.3.1.
Condition C30 The future development application must include a report which addresses how the proposed development is capable of achieving Gold Leadership in Energy and Environmental Design (LEED) rating using the existing stadium as the "reference building" for the assessment or any other equivalent sustainability rating tool as listed in section 5.3 of the Sydney Football Stadium Redevelopment Environmentally Sustainable Design Strategy prepared by Aurecon dated 2018. **Response** This report details a LEED v4 pathway in order to achieve a LEED Gold rating. This pathway is available in Appendix A.
Condition C31 The future development application is required to address the implementation of water sensitive urban design and energy conservation and efficiency measures, including but not limited to: a) rainwater harvesting and re-use; b) water efficient fixtures; c) installation of rooftop solar photovoltaic arrays for on-site electricity generation; d) storage of surplus energy generated by rooftop solar photovoltaic arrays; e) use of electric vehicles for dedicated on site transport tasks (where possible); and f) energy efficient electrical equipment, fittings and fixtures. **Response** a) Rainwater Harvesting and Re-Use See Condition 27 for Response to *Rainwater Collection and Reuse* b) Water efficient fixtures See Condition 27 for Response to *Efficient Use of Water through Selection of Fittings and Fixtures* c) Installation of rooftop solar photovoltaic arrays for on-site electricity generation See Condition 27 for Response to *Onsite Renewable Energy Generation* d) Storage of surplus energy generated by rooftop solar photovoltaic arrays The new development will consider installing on-site battery bank to store excess generation of solar electricity. This provision will be confirmed during detailed design.

Conditions of Consent
e) Use of electric vehicles for dedicated on site transport tasks See condition 27 for response to *Electric Vehicle Infrastructure* f) Energy Efficient Electrical Equipment, Fitting and Fixtures See Condition 27 for Response to *High Levels of Efficiency* and *LED Lighting* A LEED v4 pathway has been developed and has targeted a LEED Gold rating. This pathway is available in Appendix A.

11 Appendix A: LEED v4 Gold Rating Pathway

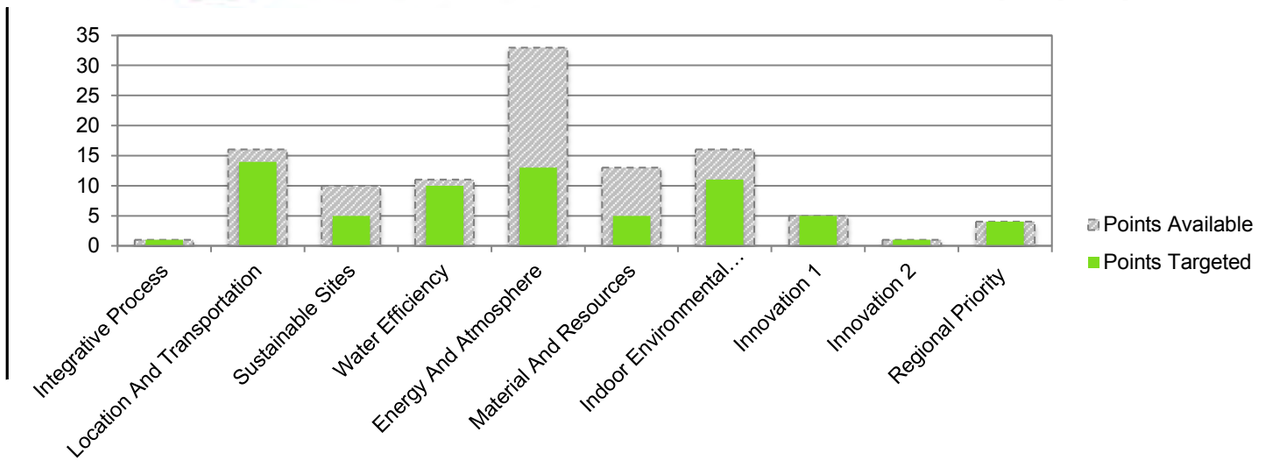
Sydney Football Stadium - LEED Pathway

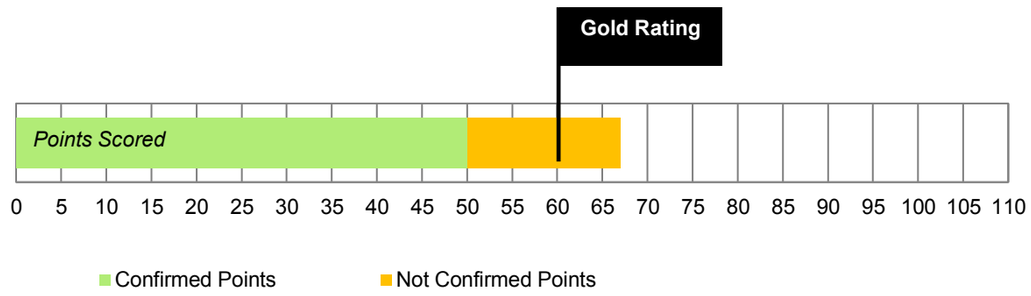




Credit	Available Points	Targeted Points	Confirmed	To Be Confirmed
INTEGRATIVE PROCESS				
IP102: Integrative Process	1	1	1	0
Category Total	**1**	**1**	**1**	**0**
LOCATION AND TRANSPORTATION				
Credit LT101 Not Targeted	12	12	0	0
LT102: Sensitive Land Protection	1	1	1	0
LT103: High Priority Site	2	0	0	0
LT104: Surrounding Density and Diverse Uses	5	5	5	0
LT107: Access To Quality Transit	5	5	5	0
LT108: Bicycle Facilities	1	1	0	1
LT110: Reduced Parking Footprint	1	1	1	0
LT111: Green Vehicles	1	1	1	0
Category Total	**16**	**14**	**13**	**1**
SUSTAINABLE SITES				
SS101: Construction Activity Pollution Prevention	Prerequisite			
SS104: Site Assessment	1	1	1	0
SS105: Site Development - Protect or Restore Habitat	2	0	0	0
SS107: Open Space	1	0	0	0
SS108: Rainwater Management	3	2	0	2
SS110: Heat Island Reduction	2	2	1	1
SS112: Light Pollution Reduction	1	0	0	0
Category Total	**10**	**5**	**2**	**3**

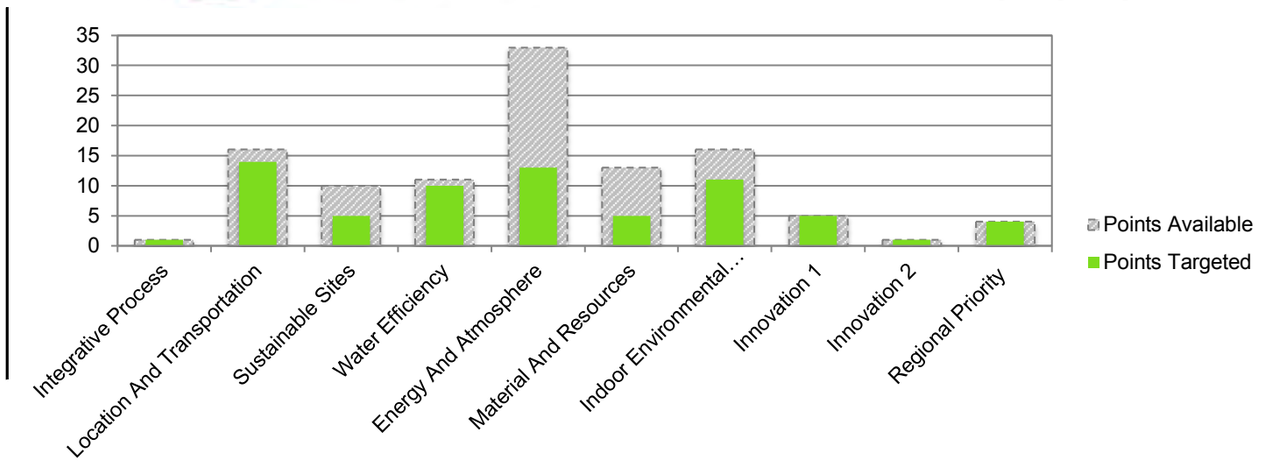
LEED Pathway - Sydney Football Stadium Redevelopment

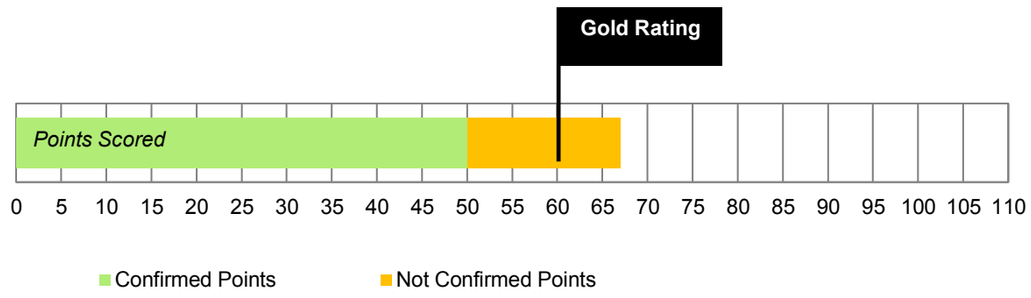




Credit	Available Points	Targeted Points	Confirmed	To Be Confirmed
WATER EFFICIENCY				
WE101: Outdoor Water Use Reduction	Prerequisite			
WE901: Outdoor Water Use Reduction	2	2	2	0
WE102: Indoor Water Use Reduction	Prerequisite			
WE902: Indoor Water Use Reduction	6	6	6	0
WE104: Building-level Water Metering	Prerequisite			
WE110: Cooling Tower Water Use	2	1	0	0
WE112: Water Metering	1	1	1	0
Category Total	**11**	**10**	**9**	**0**
ENERGY AND ATMOSPHERE				
EA101: Fundemental Commissioning and Verification	Prerequisite			
EA103: Minimum Energy Performance	Prerequisite			
EA903: Optimize Energy Performance	18	4	3	1
EA106: Building-level Energy Metering	Prerequisite			
EA108: Fundementals Refrigerant Management	Prerequisite			
EA110: Enhanced Commissioning	6	4	4	0
EA118: Advanced Energy Metering	1	1	1	0
EA121: Demand Response	2	0	0	0
EA123: Renewable Energy Production	3	1	0	1
EA126: Enhanced Refrigerant Management	1	1	1	0
EA128: Green Power and Carbon Offsets	2	2	0	2
Category Total	**33**	**13**	**9**	**4**

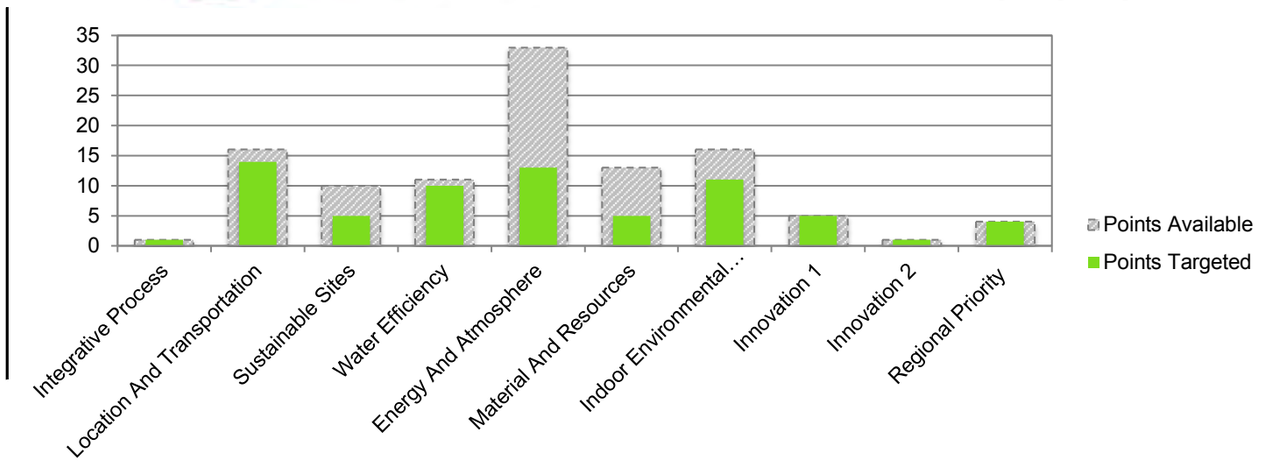
LEED Pathway - Sydney Football Stadium Redevelopment

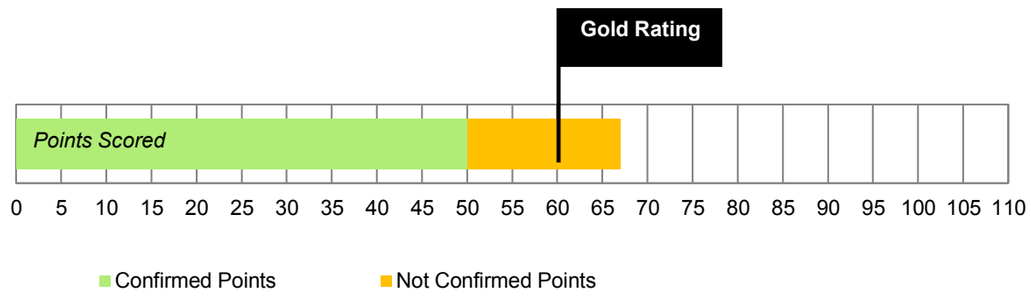




Credit	Available Points	Targeted Points	Confirmed	To Be Confirmed
MATERIAL AND RESOURCES				
MR101: Storage and Collection of Recyclables	Prerequisite			
MR103: Construction and Demolition Waste Management Planning	Prerequisite			
MR108: Building Life-cycle Impact Reduction	5	3	3	0
MR112: Building Product Disclosure and Optimisation - Environmental Product Declarations	2	0	0	0
MR112: Building Product Disclosure and Optimisation - Sourcing of Raw Materials	2	0	0	0
MR114: Building Product Disclosure and Optimisation - Material Ingredients	2	0	0	0
MR123: Construction and Demolition Waste Management	2	2	2	0
Category Total	**13**	**5**	**5**	**0**
INDOOR ENVIRONMENTAL QUALITY				
EQ101: Minimum Indoor Air Quality Performance	Prerequisite			
EQ104: Environmental Tabacco Smoke Control	Prerequisite			
EQ110: Enhanced Indoor Air Quality Strategies	2	2	2	0
EQ112: Low-emitting Materials	3	3	0	3
EQ113: Construction Indoor Air Quality Management Plan	1	1	1	0
EQ114: Indoor Air Quality Assessment	2	1	0	1
EQ115: Thermal Comfort	1	1	0	1
EQ117: Interior Lighting	2	2	2	0
EQ121: Daylight	3	0	0	0
EQ123: Quality Views	1	0	0	0
EQ124: Acoustic Performance	1	1	0	1
Category Total	**16**	**11**	**5**	**6**

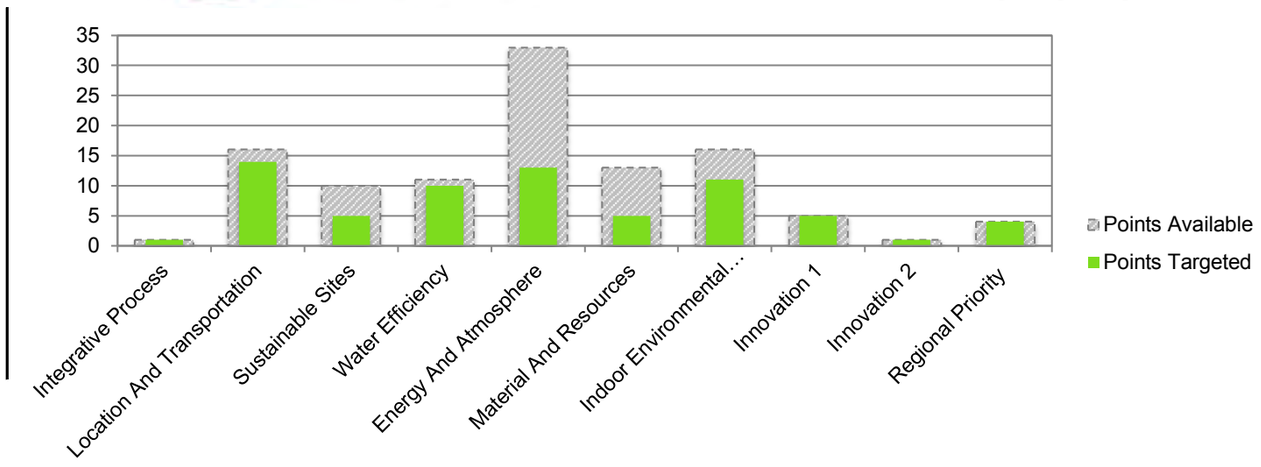
LEED Pathway - Sydney Football Stadium Redevelopment

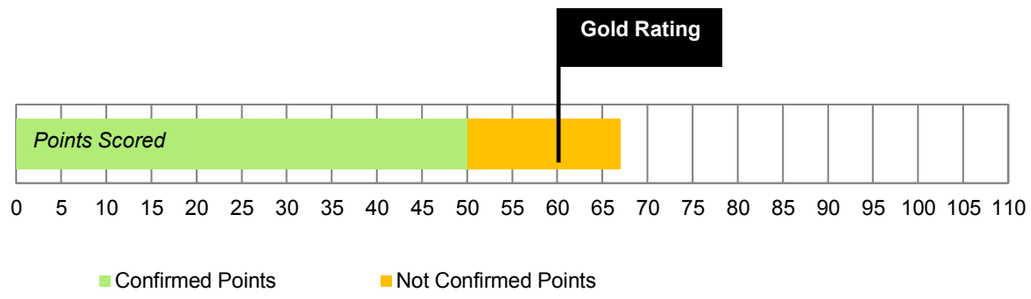




Credit	Available Points	Targeted Points	Confirmed	To Be Confirmed
INNOVATION 1				
Pilot Credit - Triple Bottom Line	1	1	1	0
Pilot Credit - Social Equity within the Supply Chain	1	1	0	1
Innovation - Community Outreach and Involvement	1	1	0	1
Exemplary Performance - MR123: Construction and Demolition Waste Management	1	1	1	0
Exemplary Performance - LT110: Reduced Parking Footprint	1	1	1	0
Category Total	**5**	**5**	**3**	**2**
INNOVATION 2				
LEED Accredited Professional	1	1	1	0
Category Total	**1**	**1**	**1**	**0**
REGIONAL PRIORITY				
RP Credit 1.1: Regional Priority - Renewable Energy Production	1	1	0	0
RP Credit 1.2: Regional Priority - Green Power and Carbon Offset	1	1	0	1
RP Credit 1.3: Buidling product disclosure and optimization - material ingredients	1	0	0	0
RP Credit 1.4: Open Space	1	0	0	0
RP Credit 1.5: Regional Priority - Outdoor water use reduction	1	1	1	0
RP Credit 1.6: Regional Priority - Indoor water use reduction	1	1	1	0
Category Total	**4**	**4**	**2**	**1**

LEED Pathway - Sydney Football Stadium Redevelopment





Credit	Available Points	Targeted Points	Confirmed	To Be Confirmed

LEED Credit Category	Points Available	Points Targeted	Confirmed Points	Not Confirmed Points
Integrative Process	1	1	1	0
Location And Transportation	16	14	13	1
Sustainable Sites	10	5	2	3
Water Efficiency	11	10	9	0
Energy And Atmosphere	33	13	9	4
Material And Resources	13	5	5	0
Indoor Environmental Quality	16	11	5	6
Innovation 1	5	5	3	2
Innovation 2	1	1	1	0
Regional Priority	4	4	2	1
TOTAL POINTS	**110**	**69**	**50**	**17**

12 Appendix B: Whole-of-Life Assessment

REPORT

SYDNEY FOOTBALL STADIUM

LIFE CYCLE ASSESSMENT
DESIGN STAGE GUIDANCE

lendlease

Document History

Prepared by	Hien Lam
Checked by	Darryl Stuckey
Approved by	Darryl Stuckey

Version	Comments	Date
1.0	Initial Draft	19/03/19
2.0	Draft	02/04/19
3.0	Draft	17/04/19
4.0	Issued	18/04/19

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1.0 Introduction

This report has been prepared to provide design stage guidance for the Sydney Football Stadium (SFS) project in Moore Park, New South Wales. The aim is to provide insight into the life cycle impacts of the project that can be used by Lendlease to identify opportunities to improve the environmental performance of the development, specifically the embodied carbon associated with materials.

This report is intended for submission to the Department of Environment and Planning to support the SFS Stage 2 Development Application. It will also be issued to internal Lendlease stakeholders to help communicate project performance and inform future project design decisions. All life cycle assessment modelling underpinning this interim report has been conducted in accordance with leading standards for Life Cycle Assessment, ISO 14040:2006[1], ISO 14044:2006[2] and EN 157978:2011[3].

1.1 Project description

In 2017, the NSW Government announced its commitment to build a new sporting stadium on the site of the existing Allianz Stadium located in the Moore Park sports and entertainment precinct in Sydney, New South Wales. The SFS will have a 45,000 seating capacity and gross floor area (GFA) of 85,171m^2. The stadium will be an Australian tier-one multi-use venue providing sports, entertainment, retail and function spaces throughout. The design is a concrete and steel construction with a hybrid roof structure clad in tensile membrane made up of Polytetrafluoroethylene (PTFE) and Ethylene Tetrafluoroethylene (ETFE).

Figure 1 Sydney Football Stadium Render

[1] ISO 14040:2006, *Environmental management – Life cycle assessment – Principles and framework,* 2006
[2] ISO 14044:2006, *Environmental management – Life cycle assessment – Requirements and guidelines, 2006*
[3] EN15978:2011, *Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method, 2011*

1.2 Method of assessment

The LCA underpinning this interim report is conducted in accordance with the standard *EN15978 Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method* and assesses all impacts of input and output materials and processes over the building's lifetime – from raw materials extraction to end-of-life management for the SFS project. The system boundary covers all life cycle stages as outlined in EN15978, where appropriate, including the benefits and loads beyond the building lifecycle (Figure 2). The environmental indicators covered by this report are those required for submission to the USGBC for LEED certification, and therefore do not cover all the environmental indicators outlined within EN15978.

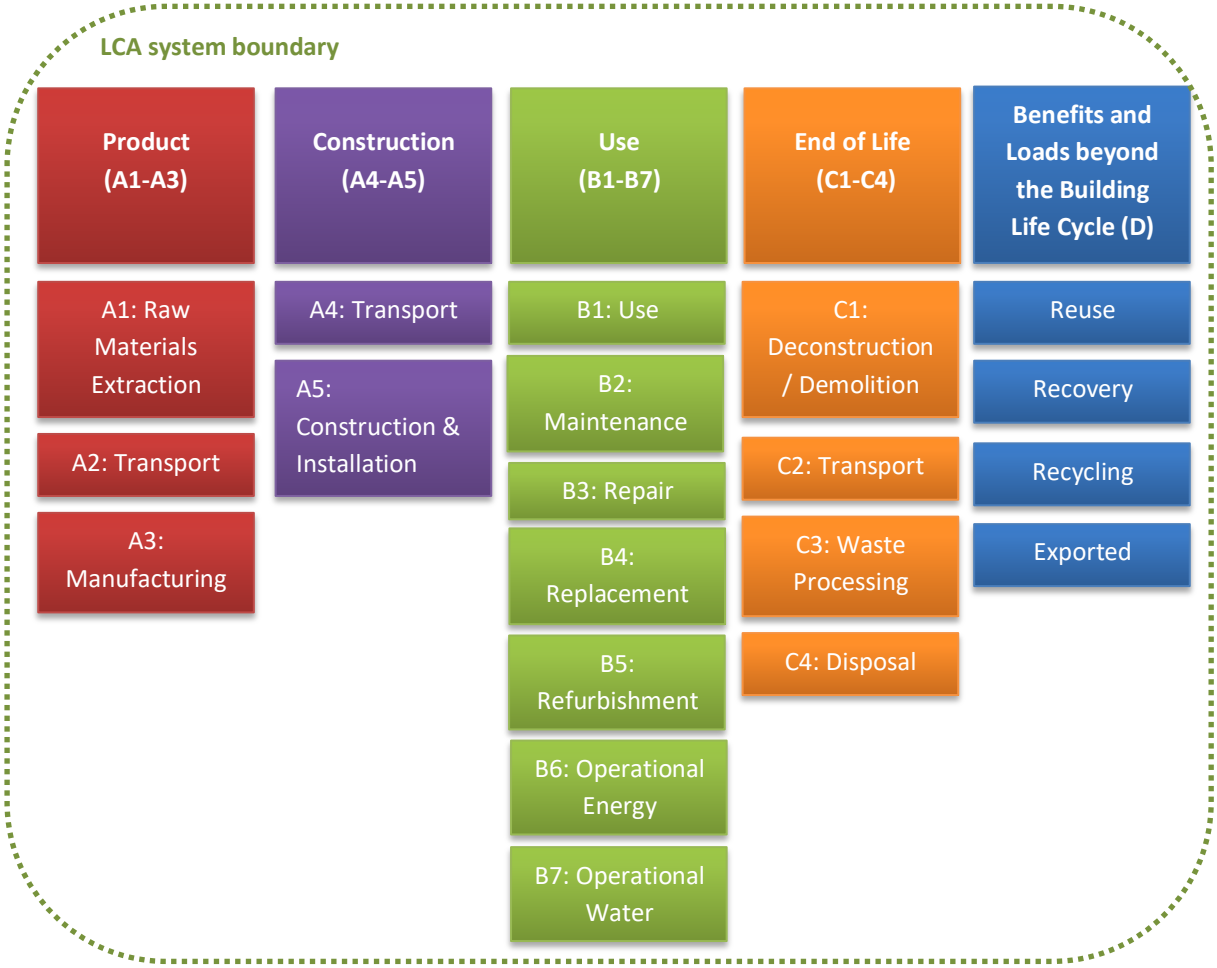

Figure 2 System Boundary

The functional unit for the study is one square meter (m^2) of gross floor area (GFA) and the building service life is defined to be 60 years. Data inputs for the LCA study are gathered from project documentation (cost plan, schedules, drawings, specification, etc.). The study is based on current concept design stage documentation. Where data is not yet available, the study uses estimated inputs based on similar projects. The designs were modelled in a licensed LCA software program, Gabi ts, to complete the life cycle inventory and calculate total environmental impacts.

2.0 Interim Life Cycle Assessment

LCA is a decision-making tool that can be used by the project team to inform building design, materials selection, procurement and other project features. This interim LCA study helps assess the environmental impacts of the proposed stadium and identify key opportunities for life cycle impact reductions.

The Reference Case for this LCA study is the SFS concept design proposed in the Stage 1 Development Application. The Reference Case is used as a benchmark to evaluate the benefit of design initiatives and material selection options which will be explored during Detailed Design. Table 1 below outlines the key features of the Reference Case.

Table 1 Key features of the SFS Reference Case

Building Element	Reference Case
Concrete	Concrete with no cement replacement
Steel	Steel manufacture and fabrication in Asia
Stadium Roof	Steel, PTFE and ETFE used for stadium roofing
Construction Waste	Targeted project recycling rate of 90% diversion from landfill
Operational Energy	Current energy model with efficient lighting design and high performance mechanical systems
Solar PV	Solar PV system

To understand and assess the impact of key materials and predicted energy models, the following assumptions have been used to conduct this interim LCA for SFS. These are listed below.

- Products (A1-A3) – In the absence of specific concrete data during this interim assessment stage, concrete mix designs provided in the Green Building Council of Australia (GBCA) Green Star Design and As Built V1.1 User Guide has been assumed for the Reference Case. The GBCA provides detailed mix designs for a range of concrete strengths that are recognised as an industry benchmark.
- Construction Energy and Water (A5) – Values are representative of monthly energy and water consumption rates of number of similar construction projects. These values were extrapolated out according to the planned construction schedule of SFS.
- Operational Energy (B6) – Energy modelling for the Reference Case assumes all HHW and DHW are generated by gas fired boilers and heaters.
- Construction and End of Building Life (C1-C4) – It is assumed the recycling facility is the Eastern Creek Resource Recovery Park with transportation mode to be via road freight within a 45km local radius. These are identical for both the Reference Case and the Design Case.

2.1 Summary of results

Table 2 provides a summary of the impacts per square meter of GFA of the SFS (Reference Case) across 7 environmental indicators.

Table 2 SFS LCA Results (A-D) Mandatory Indicators per m2 GFA

Environmental Indicator	Unit of Measure	Reference Case
Global Warming Potential (GWP)	kg CO_2-Equiv.	5.32E+03
Ozone Layer Depletion Potential (ODP)	kg R11-Equiv.	3.18E-04
Acidification Potential (AP)	kg SO2-Equiv.	1.53E+01
Eutrophication Potential (EP)	kg Phosphate-Equiv.	2.49E+00
Photochem. Ozone Creation Potential (POCP)	kg Ethylene-Equiv.	8.83E-01
Mineral depletion (ADP Elements)	kg Sb-Equiv.	1.33E-03
Fossil fuel depletion (ADP Fossil)	MJ	5.63E+04

2.1 Contribution Assessment

A contribution assessment highlights the life cycle stages and elements of the stadium which have the most significant contribution to environmental impacts. In the following analyses, Global Warming Potential (GWP) is used as a basis to evaluate the performance of the Reference Case. Although GWP is only one of many available life cycle impact indicators, it does serve as a good proxy for other indicators and the overall performance of the stadium.

Figure 4 provides a breakdown of life cycle stage impacts within the context of the building system boundary (Modules A-D). Operational energy (Module B6) has the largest contribution to GWP across the building's life cycle, accounting for 79.1% of total impacts. The product stage (A1-A3) is the second largest contributor to GWP, accounting for a total of 12.0% of impacts.

Further analysis of the products stage (A1-A3) identifies the building materials that have the largest contribution towards the overall impact of the SFS (See Figure 5). The following five building elements of the stadium have the largest contribution to GWP: concrete, reinforcement, structural steel, PTFE and ETFE and the glazing and façade.

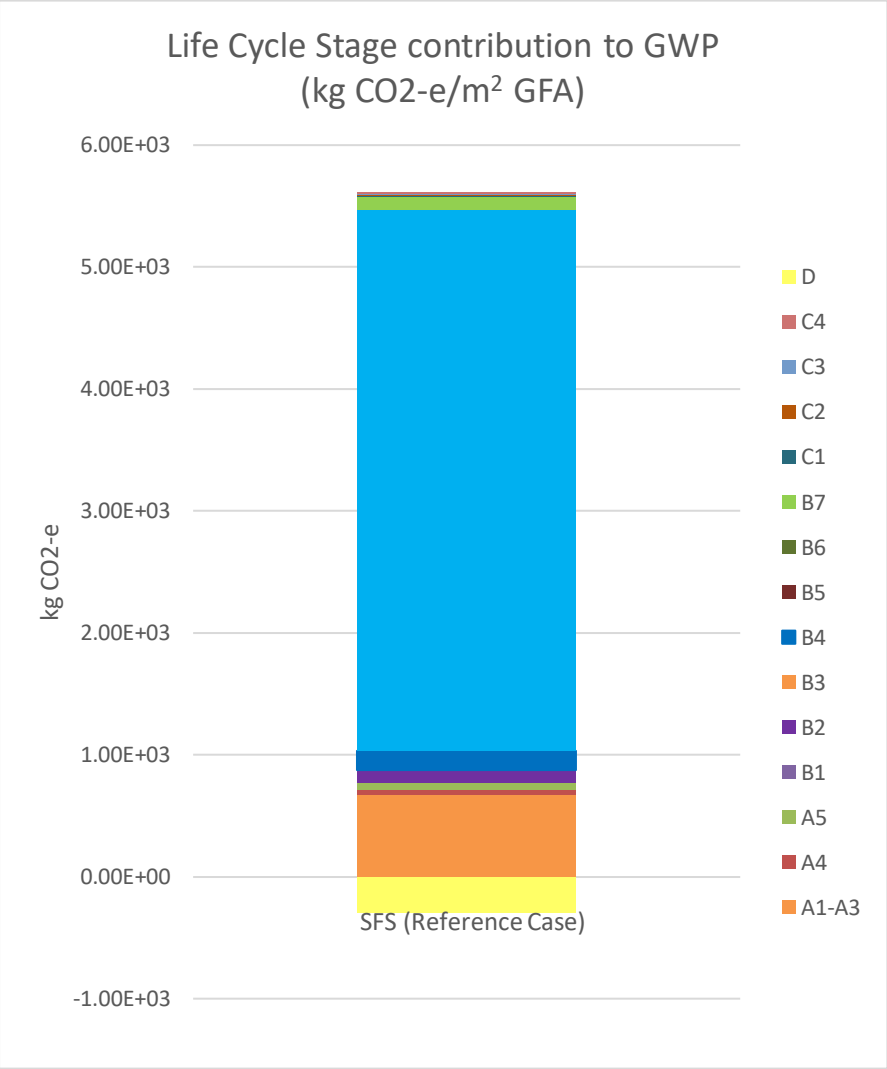

Figure 3 Life Cycle Stage Impacts per m2 GFA

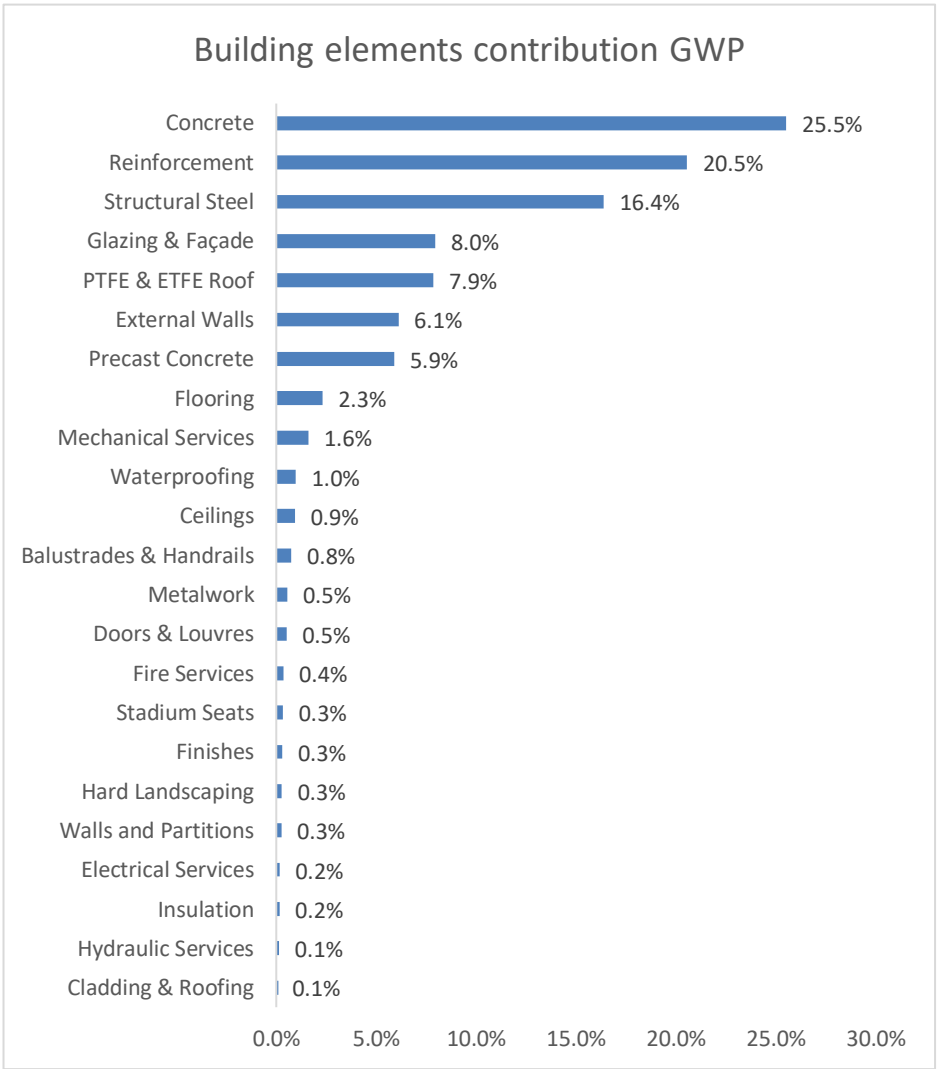

Figure 4 Impacts of building elements

3.0 Materiality Recommendations

This section highlights key opportunities to reduce the embodied carbon impacts of the building materials used in the construction of SFS. Minimising the embodied carbon impacts will require product and construction innovation and careful collaboration throughout the planning, detailed design, procurement and construction phases.

A full list of detailed material recommendations and initiatives under investigation can be found in Appendix 1 of this document. These recommendations offer a potential pathway to reduce the embodied carbon impacts of the stadium and to maximise the life cycle benefits of the project. To explore the degree of influence these opportunities have on the stadium's environmental performance, a number of these were benchmarked against the Reference Case. The following five design initiatives were assessed:

1. Specifying concrete mixes to achieve a 40% cement replacement using supplementary cementitious materials such as fly ash and ground granulated blast furnace slag.

2. Using geopolymer concrete in non-structural building elements such as hard landscaping benches, stormwater pits and pipes, wheel stops and stairways.

3. Reducing reinforcement requirements by 5%, using high strength steel to reduce lap lengths, ligatures and overall reinforcing requirements

4. Designing to achieve a 5% reduction in structural steel requirements through structural design efficiencies

5. Reduce aluminium content in external louvres and shading devices by dematerialisation or substitution. A 20% reduction in aluminium requirements for construction of the shading elements in the stadium facade was modelled.

Table 3 Improvement to GWP relative to Reference Case

Opportunity	Improvement to GWP
40% Cement Replacement	8.80%
Geopolymer Concrete	1.06%
5% Reinforcing Reduction	1.13%
5% Steel Reduction	0.75%
20% Aluminium Reduction in the façade louvre	1.06%
TOTAL	**12.57%**

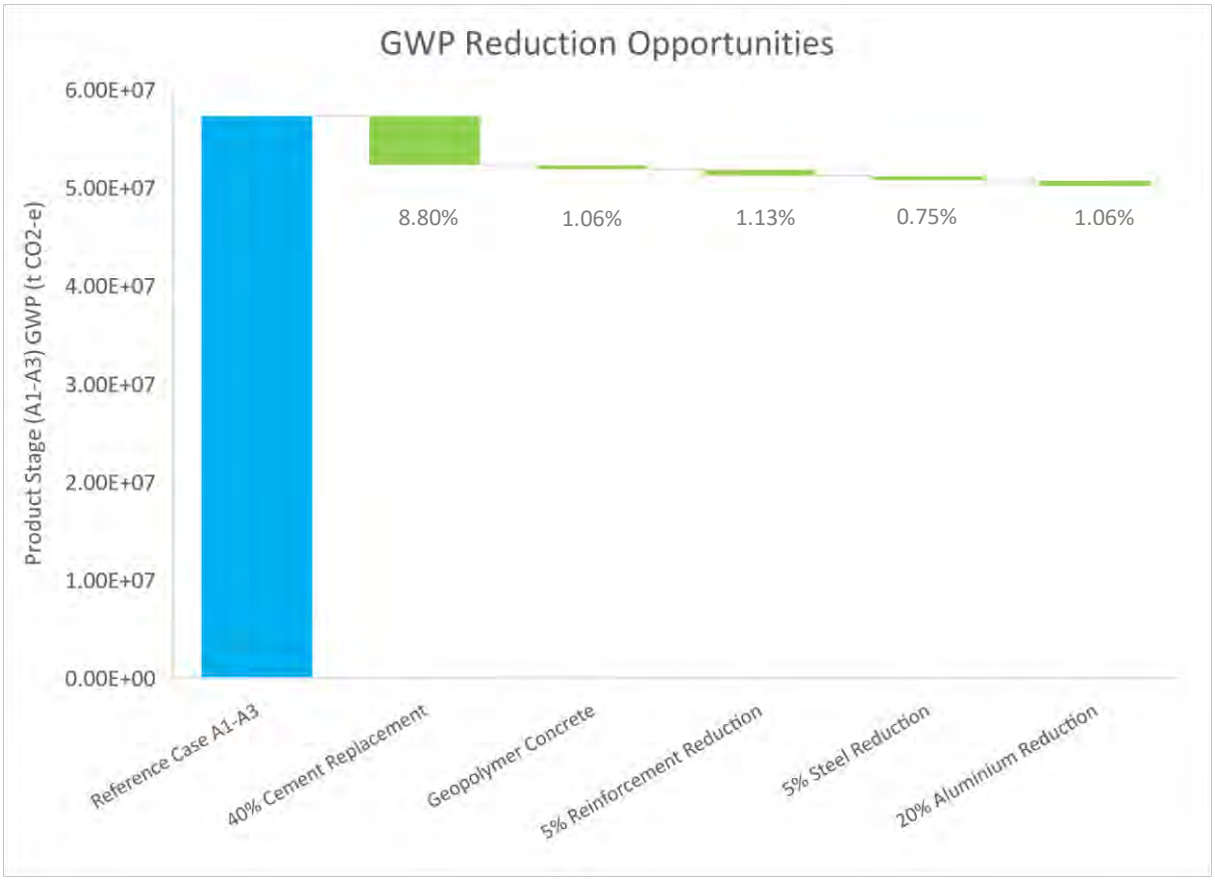

Figure 5 - Contribution of design initiatives towards GWP reduction

Overall, the material changes explored in this section contributed to a cumulative reduction in the products stage (A1-A3) GWP of 12.57% when compared to the Reference Case. The design initiatives that reduced the volume of Portland Cement within the stadium construction led to the greatest improvements, with the 40% cement replacement and geopolymer concrete substitution showcasing 8.80% and 1.06% improvements to GWP respectively.

Geopolymer concrete has a significantly lower carbon footprint than traditional concrete, however it can present constructability issues when cast in-situ, lending itself more suited to precast elements. The assessment has only explored the benefits of using geopolymer concrete in non-structural, precast building elements which in total accounts for less than 5% of the total volume of concrete used in the stadium construction. It is recommended that the SFS design team explore further opportunities to substitute concrete with geopolymer concrete to maximise life cycle benefits.

Reducing reinforcement by 5% led to a 1.13% improvement to the products stage GWP, whilst a 5% reduction in structural steel led to a 0.75% improvement. There are a range of opportunities to significantly reduce the embodied carbon associated with the production and supply of both reinforcement and structural steel. Sourcing steel and reinforcement from low carbon intensive manufacturers and maximising recycled content in steel and reinforcement can dramatically reduce the embodied carbon impacts of the stadium. Similar improvements can be achieved by exploring opportunities to implement hybrid façade systems which minimise aluminium use by utilising alternative materials such as timber composites.

The initiatives discussed above and identified within Appendix 1 will be reviewed and considered by the SFS design team during detailed design. Due to the level of design information available at the time of writing, this interim LCA has not yet explored the life cycle benefits of improving efficiencies in operational energy and water which together account for 81.1% of the stadium's life cycle impacts, however these will be progressively evaluated and tested as the project moves into the detailed design phase.

4.0 Appendix 1 – Opportunity Roadmap

In addition to the opportunities explored in Section 3.0 Materiality Recommendations, the following reduction measures will be reviewed and considered by the SFS design team. This Opportunity Road Map is a living document which will be periodically reviewed, added to and confirmed as the project design and delivery progresses.

Table 4 Opportunity Roadmap for improvement

Building element	Recommendation
Concrete	Reduce Portland cement content of concrete mixes through use of slag, fly ash or admixtures (e.g. Envisa and geopolymer concretes)
	Reduce overall concrete volume through design and constructability optimisation including prefabrication and use of void-forms e.g. bubble deck
	Specify and install low carbon structural elements (Cross Laminated Timber)
Reinforcing and metal work	Reduce overall steel volume through design of connections, structural sections and types and through e-scheduling to minimise lap lengths
	Sourcing local reinforcing / structural steel (supply chain efficiencies & initiatives)
	Specify and install reinforcing steel within high recycled content
	Specify certified green power in production
	Specify high strength steel to reduce overall demand (e.g. High strength ligatures)
	Source reinforcing steel from low carbon manufacturers
	Source structural steel from low carbon manufacturers
Hard Landscaping	Reduce hard landscaping materials for soft landscaping materials
	Specify recycled or alternative aggregates or permeable pavements
	Use geopolymer or recycled plastics for tree and stormwater pits
	Source paving products from low carbon manufacturers
	Review paving thicknesses for foot-traffic / low load areas to minimise material demand
Services	Reduce materials through optimised service routes
	Specify light weight steel spiral ducting over standard box ducting
	Use low carbon or alternative materials for ducting, piping and fixtures
	Use geopolymer precast culverts, pits and pipes for inground stormwater
Facade	Reduce glass and aluminium in window frames and wall systems through detail design and loading requirements including detail analysis of structural and wind loading
	Specify and source aluminium from low-carbon manufacturers / smelters
	Specify and install low carbon cladding alternatives, external louvres or shading options

Building element	Recommendation
Cladding and Roofing	Reduce impacts through the volume of solid roofing and cladding by using non-rigid light weight alternatives
	Avoid cladding exterior surfaces and use off-form concrete finishes
	Specify standing seam roofing profiles, rolled onsite to reduce transport impacts
	Preferential sourcing from low carbon manufacturers
Finishes – Ceiling	Reduce overall materials through exposed services or reduced suspended ceiling grid systems
	Specify and install carbon neutral suspended ceiling systems
	Specify and install low embodied carbon materials
Finishes – Floors	Reduce material requirements – maximise use of polished concrete finishes
	Specify and install carbon neutral access flooring
	Specify and install carbon neutral, or high recycled content carpet
	Specify and install FSC timber to reduce carpet requirements
	Specify carpet tile in lieu of broadloom
Finishes – Walls and Partitions	Specify and install carbon neutral plasterboard
	Reduce material through optimising steel stud spacing
	Reduce volume of materials by using hollow core block or geopolymer products
Stadium Seating	Specify and install local or low carbon options
	Reduce the volume of steel, aluminium and support structures through detailed design and planning
Structure – Blockwork	Reduce impacts by using low cement content mix designs in core filling
Transport	Engage with suppliers to optimising transport routes and fuels
Onsite Construction	Switch fuel types for biodiesel or efficient electric hybrid plant, over diesel
	Specify 100% green power purchasing to minimise grid electricity impacts
	Substitute temporary lighting for LED temporary lighting

13 Appendix C: Green Travel Plan