Australian Government

NSW GOVERNMENT

sydney METRO

Sydney Metro – Western Sydney Airport

Chapter 17
Sustainability, climate change and greenhouse gas

Table of Contents

List of tables

List of figures

17 Sustainability, climate change and greenhouse gas

This chapter assesses the project in terms of sustainability, and how it meets, and would continue to meet, relevant sustainability requirements. This chapter also summarises the initial climate change risk, greenhouse gas and resource use assessments undertaken for the project.

The resource use assessment in this chapter considers resources that would be consumed by the project. Chapter 18 (Resource management) provides an overview of the waste and resources generated by the project, including the spoil management approach for the project.

17.1 Overview

Sydney Metro is preparing a Sustainability Plan for the project which will set out the sustainability policy and objectives and identify key activities so that sustainability considerations are embedded across the project life cycle.

Six principles have been developed to govern environmental and socio-economic outcomes and performance for the project based around demonstrating leadership, tackling climate change, managing resources efficiently, driving supply chain best practice, valuing community and customers and respecting the environment. Targets and initiatives would be developed to support these sustainability principles.

17.2 Legislative and policy context

17.2.1 Sustainability overview

Sustainability governance and policy context

Ecologically Sustainable Development is defined in Australia's *National Strategy for Ecologically Sustainable Development* (Ecologically Sustainable Development Steering Committee, 1992) as: 'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased. 'The four principles that underpin this definition include the precautionary principle, inter-generational equity, conservation of biological diversity and ecological integrity, and improved valuation, pricing and incentive mechanisms for environmental resources.

One of the objectives of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) is to 'facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment'. The *Transport Administration Amendment (Sydney Metro) Act 2018* (NSW) also calls for Sydney Metro projects to exhibit a 'sense of social responsibility' for the community in which it operates as well as to 'conduct its operations in compliance with the principles of ecologically sustainable development'.

Chapter 28 (Conclusion) outlines how the project addresses these principles.

Sydney Metro sustainability approach

Sydney Metro addresses sustainability by developing effective and appropriate responses to the key challenges of today and tomorrow such as climate resilience, energy security, water security, resource scarcity, land use, liveability, employment, diversity and inclusion.

Transport for NSW's *Environment and Sustainability Policy* (Transport for NSW, 2020a) (the Policy) applies to the transport cluster including Sydney Metro. The Policy includes the following commitments:

- leadership – contributing to and influencing the strategic environment and sustainability agenda of the NSW Government
- environmental protection – being accountable for addressing and minimising the environmental impacts of our activities to satisfy the expectations and legislative requirements of the NSW Government and community

- energy and carbon – improving energy efficiency and working towards net zero carbon emissions
- resilience – embedding climate risk and resilience considerations in our activities
- sustainable procurement – procuring and delivering sustainable, efficient and cost effective transport options, including responsible supply chains
- whole of life – considering whole of life benefits and impacts from our activities across all life cycle stages - demand/need, plan, acquire, operate/maintain and disposal
- social – recognising the social impacts and benefits of our activities, and working for healthy liveable communities
- awareness – raising the awareness and capacity of our workforce to be accountable for implementing the Policy through their activities to achieve enhanced environmental outcomes and a culture of environmental responsibility
- communication – communicating openly, responsively and empathetically with our customers, partners and stakeholders on environmental matters and report on our performance.

The Sydney Metro – Western Sydney Airport Sustainability Plan is currently being developed and will include the sustainability objectives, initiatives and targets that have been informed by the above policies and legislation. These initiatives and targets would be benchmarked against past Sydney Metro projects, and international best practice on similar infrastructure projects to ensure continual sustainability improvements are made across Sydney Metro projects. They would be integrated during further design development, construction and operation of the project.

Key focus areas of the Sydney Metro – Western Sydney Airport Sustainability Plan and the sustainability assessment for the project are resource use and efficiency, and reducing potential energy use and associated emissions (refer to Chapter 18 (Resource management) for an assessment of resources generated by the project and Section 17.5 for the greenhouse gas assessment for the project).

Sustainability was a key consideration in the design development and consideration of project alternatives. A ‘sustainable and deliverable solution’ is one of the project objectives against which options for station locations were assessed. Sustainability was also considered in the development of the construction approach for the project. Further details on the options assessment process and design refinements to enhance sustainability and minimise environmental impacts are provided in Chapter 6 (Project development and alternatives).

Sustainability assessment approach

The legislation and policies summarised in the following sections will be used to inform the Sydney Metro – Western Sydney Airport Sustainability Plan and the objectives, initiatives and targets that are embedded in that Plan. The Plan would apply project-wide (on-airport and off-airport). The Plan will be prepared in consultation with Western Sydney Airport to the extent it relates to on-airport, and would be consistent with, and not hinder the achievement of, the initiatives identified in the Western Sydney Airport Sustainability Plan (see Section 17.2.2 for a description of this Plan).

The sustainability assessment in this chapter considers the application of the sustainability principles for the project, and the opportunities to achieve sustainability targets and outcomes aligned with best practice infrastructure projects.

Cumulative sustainability issues between the project and other projects including Western Sydney International, St Marys Intermodal and the future M12 Motorway, would be managed through their respective sustainability plans which are tailored to the nature of each asset. Consultation would continue to be undertaken with Western Sydney Airport and the Transport for NSW cluster in regard to cumulative impacts.

17.2.2 Commonwealth legislation and policies

The Commonwealth legislation and policies relevant to the sustainability, climate change risk and greenhouse gas assessment for the project include:

- *National Greenhouse and Energy Reporting Act 2007* (Cth) (NGER Act)

- *Trajectory for Low Energy Buildings* (Council of Australian Government's (COAG) Energy Council, 2019)
- *National Greenhouse Gas Accounts Factors* (DoEE, 2019)
- *United Nations Framework Convention on Climate Change – Paris Agreement 2016.*

Western Sydney Airport Sustainability Plan

Western Sydney Airport has also prepared the *Western Sydney Airport Sustainability Plan* (Western Sydney Airport, 2020) for Western Sydney International Stage 1.

The sustainability, climate change risk and greenhouse gas initiatives to be identified in the project's Sustainability Plan would be consistent with, and not hinder the achievement of, the initiatives identified in the Western Sydney Airport Sustainability Plan.

17.2.3 NSW legislation and policies

NSW legislation and policies relevant to the sustainability and climate change risk assessment for the project include:

- *Future Transport 2056* (NSW Government, 2018)
- *NSW Net Zero Plan 2020 – 2030* (NSW Department of Planning, Industry and Environment (DPIE), 2020)
- *TfNSW Climate Risk Assessment Guidelines* (TfNSW, 2019a)
- *TfNSW Carbon Estimate and Reporting Tool* (TfNSW, 2017)
- *Sydney Metro Corporate Plan 2019 – 21*.

The regional policies relevant to the climate risk assessment for the project include:

- *Western City District Plan* (Greater Sydney Commission 2018b)
- *Western Sydney Regional Organisation of Councils (WSROC) Turn Down the Heat Strategy and Action Plan (2018)*
- *Western Sydney Aerotropolis Plan* (NSW Government, 2020).

17.2.4 Other policies and guidelines

The Transport Authorities Greenhouse Gas Group (TAGG) consists of state road authorities within Australia and the New Zealand Transport Agency. The *Greenhouse Gas Assessment Workbook for Road Projects* (TAGG, 2013) outlines a process for estimating greenhouse gas emissions for all major activities that were found to contribute significantly to the overall emissions arising from a road project including emissions associated with land clearing.

17.3 Sustainability objectives and initiatives

The project-wide initiatives and targets that would be integrated into the design, construction and operation of the project, following confirmation during further design development, are summarised in Table 17-1. These initiatives and targets would be included in the Sustainability Plan for the project. To the extent these initiatives and targets relate to the on-airport construction and operation of the project, they would be finalised in consultation with Western Sydney Airport and would not hinder the achievement of the targets outlined in the Western Sydney Airport Sustainability Plan.

Table 17-1 Project sustainability objectives and potential initiatives

Sustainability objective	Potential sustainability initiatives and targets
Demonstrate leadership	
Embedding sustainability objectives into decision making	• ensure environmental and social principles are integrated into the project decision making framework • establish collaborative working relationships with stakeholders to drive innovation and efficiencies in approach to environmental and social sustainability.
Transparency and assurance	• develop performance targets across all sustainability focus areas, based on best practice benchmarking and responding to policy and regulatory context • achieve a best practice level of performance using market leading sustainability rating tools (for example ISCA, Green Star, or equivalent) • develop an assurance framework and reporting system to assist Sydney Metro and contractors in reliably reporting against sustainability targets • monitor sustainability performance and provide public sustainability plans and reports.
Capture sustainability benefits	• documentation and ongoing evaluation of environmental and social costs and benefits • adopt a whole-of-life costing model to maximise benefits • optimise station precincts and other residual land developments to deliver better sustainability outcomes where practicable.
Tackle climate change	
Infrastructure and operations to be resilient to the impacts of climate change	• identify and implement mitigation measures to reduce all very high and high risks (to at least a medium) and address all medium and low climate risks for the project (see Section 17.4.2) • continued engagement with key stakeholders to develop and implement appropriate responses to dependent and interdependent climate change risks.
Reduce energy use and carbon emissions	• identify and prioritise areas where the greatest reductions in carbon and energy can be achieved and develop appropriate targets • use energy efficient equipment, methods and practices for design and construction • local sourcing of materials where feasible • offset 100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation • target minimum 20 per cent of all parking spots to be electric vehicle spots with charging points, to be provided and/or safeguarded for at all permanent off-airport station car parks.
Establish energy efficiency and renewable energy targets	• offset 25 per cent of the greenhouse gas emissions associated with consumption of construction electricity • target to source at least 10 per cent of the low voltage electricity required at above ground stations, service facilities and stabling and maintenance facility from onsite renewable energy sources.
Efficient use of resources	
Minimise the use of potable water	• set targets and monitor potable water use • integrate current best-practice water-efficient features, equipment and appliances at stations, stabling and maintenance facility, service facilities and construction sites • avoid use of potable water for non-potable purposes if non-potable water is available.

Sustainability objective	Potential sustainability initiatives and targets
Maximise opportunities for reuse of non-potable water sources	• identify and implement opportunities for treatment of water for reuse on the project, including water from tunnelling works, concrete batching and casting facilities • set targets and monitor non-potable water use • connect to district recycled water networks during construction and operation where feasible • harvest and reuse rainwater and groundwater at permanent and temporary facilities where feasible.
Minimise waste through the project lifecycle	• target 95 per cent construction and demolition waste recycling • optimise operational efforts for waste collection and recycling • implement a variety of waste collection streams including organics, comingled recycling and general waste.
Reduce the embodied carbon and increase use of recycled materials	• minimise the embodied impacts of concrete through the adoption of lower carbon alternatives • minimise the embodied impacts of steel through maximising the use of recycled steel and steel produced using energy-reducing processes • identify and implement best practice low-impact alternative materials in the construction supply chain including recycled materials and engineered timber • undertake lifecycle assessments and minimise the embodied impacts of materials, through the selection of low carbon alternatives and considering durability and local sourcing • prioritise products made from recycled content.
Spoil management	• 100 per cent beneficial reuse of usable spoil generated by the project, in accordance with the project spoil management hierarchy.
Environmentally responsible sourcing	• source timber products from either re-used timber, post-consumer recycled timber, Forest Stewardship Council or Programme for the Endorsement of Forest Certification certified timber suppliers where feasible • prioritise local sourcing of materials, where feasible.
Drive supply chain best practice	
Influence contractors, subcontractors and materials suppliers	• ensure procurement strategies are consistent with ISO:20400 Sustainable Procurement Guidelines • ensure supply chain sustainability objectives are adopted downstream including sustainability training to high impact suppliers.
Increase supply chain transparency and responsibility	• adopt environmental product declarations and eco-labelling • conduct due diligence to ensure supply of materials and equipment aligns with human rights legislation and environmental standards.

Sustainability objective	Potential sustainability initiatives and targets
Workforce development and industry participation	• industry and jobs participation – increase opportunities for employment of local people, participation of small and medium enterprises, including recognised Aboriginal businesses, and support industry to compete in home and global markets through active participation in client-led programs • workforce skills development – enable targeted and transferable skills development in areas with local and national skills shortages, support changing job roles and increased skill requirements, and embed transferable skills in the workforce • diversity and inclusion – establish initiatives to increase diversity within the workforce and supply chain through collaborative partnerships • inspiring future talent and developing capacity – engage young people via education and work experience, and through higher and vocational education and institutions to encourage interest in STEM and infrastructure related careers • collaboration – Sydney Metro will continue to collaborate with organisations that have a shared interest in driving skills, diversity, jobs and industry capacity through infrastructure projects.
Value customers and community	
Protect and promote Aboriginal and non-Aboriginal heritage and culture	• ensure key Aboriginal stakeholders are meaningfully engaged • develop and integrate Aboriginal cultural design principles into project design, delivery and operations • avoid or minimise impacts to Aboriginal and non-Aboriginal heritage and culture • identify and implement opportunities to enhance heritage and cultural values via design and interpretation • develop partnerships with relevant stakeholders to identify heritage and cultural places to promote social values • create opportunities for archaeological research and interpretation.
Enable and promote active transport access and public transport usage	• integrate with surrounding active transport network such as footpaths, public and green spaces, and bicycle corridors • design to enhance connectivity to green and blue corridors for active transport corridors.
Community and customer wellbeing	• design in accordance with best practice urban design principles (refer to Appendix E (Design Guidelines)) • design to minimise urban heat island and associated health risks • ensure efficiency and durability of built infrastructure that requires minimum expenditure in maintenance and upkeep.
Deliver community benefits	• deliver projects that benefit local communities and provide social outcomes during construction and operation
Respect the environment	
Provide and promote green infrastructure	• contribute to Greater Sydney Commission's tree canopy cover targets where possible: – target 15 per cent or more urban tree canopy in CBD areas – target 25 per cent or more tree canopy in urban medium to high density residential and light commercial areas – target 40 per cent or more tree canopy in suburban areas – provide a high level of open green space at precincts • use native and climate resilient species in landscaping and prioritise use of indigenous knowledge (six seasons) • integrate water sensitive urban design solutions.

Sustainability objective	Potential sustainability initiatives and targets
Promote ecological functions	• avoid or minimise impacts on biodiversity, particularly with regard to endangered, vulnerable and threatened species, habitats and communities • contribute to the restoration and conservation of local ecological communities.
Minimise environmental impact	• target zero major pollution incidents • reduce sources of pollution through the development and implementation of a Construction Environmental Management Framework (Appendix F).

17.4 Climate change adaptation

The peak body for climate change research, the Intergovernmental Panel on Climate Change (IPCC), has confirmed that increasing global greenhouse gas concentrations are influencing earth's climate (IPCC, 2014). Climate change has the potential to alter the frequency, intensity, and distribution of extreme weather-related natural hazards, including more intense and extreme heat, droughts, flood and storm surges. The risk of climate change impacts on the project needs to be considered as part of the design process, as it needs to be resilient to these potential impacts.

Infrastructure assets, including rail networks, are vulnerable to climate change because of their long design lives, during which the potential impacts of climate change would become more significant. Therefore, infrastructure design and planning needs to incorporate mitigation measures, based on the identified climate change risks to an asset.

17.4.1 Climate change risk assessment methodology

A climate change risk assessment has been undertaken for the project which considered risks and mitigation measures that apply to both on-airport and off-airport components of the project.

The climate change risk assessment has used the methodology outlined in the TfNSW Climate Risk Assessment Guidelines. These guidelines are based on the Australian Standard *AS 5334-2013 Climate change adaptation for settlements and infrastructure* and follow the principles of risk management outlined in the International Standard ISO31000:2018 *Risk management – Principles and Guidelines.*

The climate risk assessment involved:

- determining the climate change context using current climate change science and projections
- identifying potential climate risks to the project and developing risk statements
- assessing each climate change risk by:
  - determining the consequence of each risk occurring
  - determining the likelihood of each risk occurring
  - considering the existing controls expected to be applied through design and construction
  - determining the risk rating
- identifying appropriate mitigation measures to treat potential climate risks and assessing the residual risk to the project.

The initial climate change risk assessment was informed by two multi-disciplinary workshops held during the project's design phase. The climate change risks and adaptation options that are discussed in this section are based on the current design and construction information for the project, and the mitigation options suggested in the multi-disciplinary workshops.

Climate change risks and mitigation will continue to be reassessed and addressed throughout the project lifecycle.

Climate change projections

Climate projections for the project are available at regional scales, and therefore the study area for the climate change risk assessment is the Western Sydney region. Climate change projections for the study area have been sourced from the Climate Futures Tool underpinned by the climate model evaluation by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM) (2015). These projections are based on the IPCC Fifth Assessment Report (AR5) and use the latest emissions scenarios (referred to as 'representative concentration pathways' (RCPs)). The high emissions scenario (called RCP8.5) has been selected to inform the project's climate change risk assessment.

Climate data and climate change projections were investigated for the following time periods to assess impacts over the design life of the project:

- 1995 (Baseline climate), representing the 40-year average for the period 1976–2015
- 2030 (Near future), representing the 40-year average for the period 2010–2049
- 2070 (Far future), representing the 40-year average for the period 2050–2089
- 2090 (Late century), representing the 40-year average for the period 2070–2109.

The baseline reference period used by CSIRO and BoM (1986–2005) has been extended for this assessment (to 1976–2015) to account for the increases in average temperatures experienced in recent years.

Future climate

Changes in the climate for Western Sydney are expected to include increasing average and extreme temperatures, shifting rainfall patterns, more intense storms and extreme rainfall events, and increasing bushfire risk (NSW Office of Environment and Heritage (OEH), 2014). Detailed climate change projections are presented in Table 17-2.

Table 17-2 Climate change projections for the study area for a high emissions scenario (RCP8.5)

Climate variable	Baseline climate (centred on 1995)[1]	Future climate[2,3]		
		2030 (Near future)	2070 (Far future)	2090 (Late century)
Temperature (°C)[3]				
Average annual temperature	17.8	18.8	20.6 – 21.3	21.4 – 22.6
Average maximum temperature	23.4	24.3	26.0 – 26.9	27.2 – 28.2
Highest recorded temperature	45.1	45.7	47.8 – 49.6	48.8 – 49.6
Average minimum temperature	12.2	13.3	15.1 – 15.7	15.7 – 17.0
Lowest recorded temperature	-0.8	0.4	1.9 – 3.0	2.7 – 3.9
Extreme heat days (number of days per year)[3]				
Average daily maximum temperature ≥35°C	11.8	15.9	25.5 – 33.3	33.0 – 44.1
Average daily maximum temperature ≥40°C	1.4	2.4	4.7 – 7.3	6.8 – 10.4
Average daily maximum temperature ≥45°C	0.0	0.1	0.3 – 0.7	0.7 – 1.1
Average daily maximum temperature ≥50°C	0.0	0.0	0.0	0.0
Cold days (number of days per year)				
Average days per year ≤0°C	0.2	0.0	0.0	0.0

Climate variable	Baseline climate (centred on 1995)[1]	Future climate[2,3]		
		2030 (Near future)	2070 (Far future)	2090 (Late century)
Rainfall (mm)[2,3,7]				
Mean annual rainfall	881	934	804 –- 789	604 –- 628
2.5% AEP daily rainfall event	321	339	372 –- 384	389 –- 404
Change in extreme rainfall events (%)[4,7]	-	+5.6%	+15.8%	+21.3%
Potential evapotranspiration (percentage change)[2,7]				
Change in annual average potential evapotranspiration (%)	-	4.2%	n/a	14.3%
Humidity (percentage change)[2,7]				
Average relative humidity	-	-0.6%	n/a	-1.5%
Wind speed (percentage change)[2,7]				
Average wind speed	-	-0.5%	n/a	-1.1%
Atmospheric concentration of CO_2 (parts per million (ppm))[5]				
Atmospheric concentration of CO_2	369 (in 2000)	449	541	935
Sea level rise (metres)[2,6,7]				
Mean sea level rise	-	+0.14 (0.10-0.19)	n/a	+0.66 (0.45-0.88)

Notes:
1. The historical baseline climate uses a 40 year reference period centred on the year 1995. Baseline data were extracted from the BoM Climate Data Online portal for the Prospect Reservoir site (no.67016) (the nearest site to the study area with continuous historical records of temperature and rainfall data).
2. Projections for future climate are presented as absolute values for the study area unless otherwise stated.
3. Projections for 2070 and 2090 are presented for models that represent the median (50th percentile) (left) and the 90th percentile (right) of model results for temperature to demonstrate the uncertainty in the magnitude of change between climate models for the far future and late century time periods. Note that the selection of models on the basis of projected changes in temperature may not necessarily align to the 50th and 90th percentiles for rainfall.
4. Data for change in extreme rainfall events sourced from ARR 2019 which uses projections from CSIRO and BoM (2015) to estimate change in design rainfall intensity frequency duration and design flood events under climate change.
5. Based on IPCC data (2013) for RCP8.5.
6. Change in mean sea level, showing the median (50th percentile) of model results, with the range of model results shown in brackets (5th and 95th percentiles).
7. "n/a" and "-" denotes climate projection data and baseline historical data not available.

The flood modelling undertaken for the project, summarised in Chapter 14 (Flooding, hydrology and water quality) and presented in Technical Paper 6 (Flooding, hydrology and water quality), considers the potential impact of climate change on rainfall using the approach recommended in *Australian Rainfall and Runoff (ARR): A guide to flood estimation 2019* (Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, and Testoni I (Editors), 2019). Drainage infrastructure has been designed to incorporate considerations of climate change for the late century (2090). The project railway track levels have been designed to achieve flood immunity during a one per cent AEP event inclusive of climate change.

The project also generally meets the flood impact criteria for the project which has also been developed for the one per cent AEP event inclusive of climate change (refer to Section 3.1.1 of Technical Paper 6 (Flooding, hydrology and water quality). The one per cent AEP event with climate change indicates that this flood event could be exceeded in any one year including allowing for changes associated with climate change. This is based on the CSIRO and BoM high emissions scenario for 2090, as recommended in the *Australia Runoff and Rainfall Guidelines* (Commonwealth of Australia (Geoscience Australia), 2019).

17.4.2 Climate change risk assessment results

The climate change risk assessment process identified:

- nil very high ('unacceptable') or high ('undesirable') risks
- 30 medium ('tolerable') risks in 2070; and 31 medium ('tolerable') risks in 2090
- 28 low ('acceptable') risks in 2070; and 27 low ('acceptable') risks in 2090.

Climate change risk will be assessed throughout design development and risk treatments will be progressively incorporated as appropriate. Of the medium risks identified, the potential risks described in Table 17-3 were considered to present the most material risks to the operational performance of the project in terms of service disruption, passenger and income reduction, increased maintenance costs and concerns for passenger and staff safety.

The material risks reflect the susceptibility of the Western Sydney region to extreme heat and extreme rainfall and flooding events, which aligns with the priorities identified in the regional climate planning documents identified in Section 17.2.

While the increase in severe fire weather days was not identified as a medium or high risk, potential bushfire risks and relevant mitigation measures are discussed in Chapter 23 (Hazard and risk).

Table 17-3 Summary of potential climate change risks identified as 'Medium' and proposed risk treatments

Risk statement	Pre-mitigation risk rating		Risk treatment
	2070	2090	
An increase in rainfall intensity leading to flooding (surface and subsurface) and damage to track, landscaping and supporting infrastructure	Medium, tolerable	Medium, tolerable	Drainage infrastructure would be designed to achieve the operational flooding performance outcomes for the project, which includes limits for changes to peak flood levels and duration for the one per cent AEP event. The rail alignment has been designed to achieve one per cent AEP flood immunity inclusive of climate change.
An increase in extreme weather events (lightning, high winds and intense rainfall) damaging infrastructure which causes an unsafe environment for customers and staff	Medium, tolerable	Medium, tolerable	Adequate shelter would be included in station, service facilities and stabling and maintenance facility design. In addition, drainage infrastructure would be designed to achieve the operational flooding performance outcomes for the project which includes limits for changes to peak flood levels and duration for the one per cent AEP event.
An increase in average temperatures and extreme heat days resulting in a reduction in passenger comfort and service reliability	Medium, tolerable	Medium, tolerable	The following risk treatments would be applied: • adequate shelter would be included in station, service facilities and stabling and maintenance facility design • urban design to consider extreme heat and thermal load in and around stations, service facilities and stabling and maintenance facility • building configurations to maximise air circulation where possible and consider potential for misting and evaporative cooling technologies

Risk statement	Pre-mitigation risk rating		Risk treatment
	2070	2090	
			• ensure selection of materials considers reflectance and transmissivity values to reduce contribution to extreme heat and thermal load • landscaping and green cover to produce cooler microclimates in and around stations, and to include drought and heat tolerant species • testing the sensitivity of air-conditioning and ventilation systems to increased temperatures for passenger comfort and service reliability impacts. See mitigation measures in Table 17-10.
An increase in average temperatures and the number of extreme heat days impacting the integrity, life and operation of critical infrastructure and assets, especially those served by air conditioning and ventilation systems	Medium, tolerable	Medium, tolerable	Testing would be completed for the sensitivity of air-conditioning and ventilation systems to increased temperatures to maintain passenger comfort and service reliability.
An increase in temperatures due to urban development and increased hard surfaces onsite and in neighbouring communities leading to urban heat island effects, increasing heat stress on the project and the broader community	Medium, tolerable	Medium, tolerable	The following risk treatments would be applied: • adequate shelter would be included in station, service facilities, and stabling and maintenance facility design • urban design to consider extreme heat and thermal load in and around stations, service facilities, and stabling and maintenance facility • building configurations to maximise air circulation where possible and consider potential for misting and evaporative cooling technologies • ensure selection of materials considers reflectance and transmissivity values to reduce contribution to extreme heat and thermal load • landscaping and green cover to produce cooler microclimates in and around stations, and to include drought and heat tolerant species

Risk statement	Pre-mitigation risk rating		Risk treatment
	2070	2090	
Decreased winter and spring rainfall combined with increased temperatures affecting the health, condition and coverage of vegetation and landscaping used to control other climate risks such as extreme heat days and increased fire risk	Medium, tolerable	Medium, tolerable	Landscaping and green cover would be incorporated within the project where possible (subject to compliance with airspace safety requirements as discussed in Chapter 23 (Hazard and risk) to produce cooler microclimates in and around stations. Species selection of landscaping and green cover to include drought and heat tolerant species.
An increase in rainfall variability, leading to subsurface geotechnical and groundwater fluctuations, impacting the structural integrity of subsurface infrastructure or the foundations of surface infrastructure	Medium, tolerable	Medium, tolerable	Further design development would include geotechnical assessment to determine soil properties and potential impacts of rainfall variability on structural elements (refer to Chapter 15 (Groundwater and geology) for details on geotechnical conditions and mitigation measures to manage groundwater and geology impacts such as settlement).

17.5 Greenhouse gas and energy

17.5.1 Greenhouse gas assessment methodology

The greenhouse gas assessment and reporting area is based on the ability to control emissions and the generation of emissions by the project, in accordance with the NGER Act. The assessment approach does not differ between on-airport and off-airport.

While the effects of climate change vary based on local context, the cause of anthropogenic climate change, being the increased generation and concentration of greenhouse gas emissions in the atmosphere, occurs on a global scale. As a result, the estimate of greenhouse gas emissions generated by the project is considered as a contribution to global climate change.

The Climate Change 2014 Synthesis Report produced by the Intergovernmental Panel on Climate Change (IPCC) confirms that human activity is influencing earth's climate resulting in flow-on impacts that have been observed across all continents and oceans. Continued increases in global greenhouse gas emissions contribute to a warming climate which is projected to cause more extreme weather events. Longer term climatic changes include higher average temperatures, changes to rainfall patterns and sea level rise.

The Paris Agreement was agreed under the United Nations Framework Convention on Climate Change (UNFCCC) at the 21st Conference of the Parties in Paris in December 2015. Australia ratified its commitment to the Paris Agreement in November 2016 with targets of reducing greenhouse gas emissions to 26-28 per cent below 2005 levels by 2030, with a goal to contributing to limiting the global average temperate increase to below 2 degrees Celsius.

The greenhouse gas assessment was prepared following the principles and guidance outlined in *AS ISO 14064-1:2018 Specification with guidance at the organisation level for quantification and reporting of greenhouse gas emissions and removal* (ISO, 2018).

In addition, the following guidelines and tools were used for the assessment:

- *National Greenhouse Gas Accounts Factors* (DEE, 2018a)
- *TfNSW Carbon Estimate and Reporting Tool* (TfNSW, 2017)
- *Greenhouse Gas Assessment Workbook for Road Projects* (TAGG, 2013).

Project-wide greenhouse gas emissions have been categorised into direct and indirect emission sources as defined by the *Greenhouse Gas Protocol* (WRI and WBCSD, 2012). The Greenhouse Gas Protocol classify direct emissions into Scope 1 and indirect emissions into Scopes 2 and 3 as follows:

- **Scope 1** – direct greenhouse gas emissions released into the atmosphere as a result of the project. These emissions consider construction and operational activities such as emissions from burning diesel fuel within trucks or equipment to build or maintain the project
- **Scope 2** – indirect greenhouse gas emissions are released into the atmosphere from indirect consumption of energy. An example of these would be purchased grid electricity for the project activities such as construction activities or operational phase lighting, where actual emissions are generated elsewhere
- **Scope 3** – other indirect greenhouse gas emissions that are indirectly influenced by the project but are generated within the wider economy. While these emissions are a consequence of the project, they are not controlled by the project operators. Scope 3 emissions would include greenhouse gas emissions associated with the extraction, production and transport of purchased materials, waste and fuels used during construction and operation.

This greenhouse gas assessment is based on current indicative design and construction information and should be considered as preliminary estimates. Greenhouse gas emissions calculations can be validated and/or updated during further design development following approval of the project.

The key inputs for the assessment were resource use estimates, for example, electricity consumption and construction materials. Default emissions factors, based on guidance documents and policies outlined in Sections 17.2.2 and 17.2.3, were used to estimate greenhouse gas emissions.

Resource use estimates

Estimates for fuel and electricity consumption and materials use (such as concrete and steel) during the construction and operation of the project were estimated based on the current design as detailed in Chapter 7 (Project description – operation) and proposed construction methodology in Chapter 8 (Project description – construction).

The methodology outlined in the Greenhouse Gas Assessment Workbook for Road Projects was used to calculate the carbon within the vegetation that would be cleared for the project and the loss of future carbon sequestration potential.

To estimate construction and demolition waste, it was assumed that five per cent of material delivered to site (excluding fill and aggregates) would become offcuts. It was also assumed that 100 per cent of this waste would be transported to landfill for disposal. These are conservative estimates in the absence of more detailed waste estimates, and some of this material is likely to be reused or recycled based on the sustainability initiatives in the Sustainability Plan for the project.

Transport of materials to and from site can contribute significantly to a project's greenhouse gas emissions. Default transport distances and modes of transport from the *Carbon Estimate and Reporting Tool* (TfNSW, 2017) were used for the haulage of material to site as well as the transport of waste to landfill. The estimates used are considered a worst-case, and in practice are likely to be less than has been assumed, based on the sustainability initiatives in the Sustainability Plan for the project.

Water usage was estimated during construction based on standard requirements for construction activities including earthworks, concreting, tunnelling, site facilities and dust suppression.

17.5.2 Estimated greenhouse gas emissions during construction

Resource use

The construction of the project would require a significant amount of resources including fuel, electricity and construction materials including concrete and steel. Table 17-4 provides a summary of the estimated quantities of resources that would be required for construction of the project. Construction resource quantities would be refined during further design development for the project.

Table 17-4 Indicative quantities of resources required to construct the project

Resource	Estimated quantity
Diesel	63,000 kilolitres
Concrete	520,000 cubic metres
Precast concrete (including segments)	75,000 tonnes
Cement grout	70,000 tonnes
Epoxy (waterproof) grout	10 kilolitres
Rail steel	6,700 tonnes
Reinforcing steel and other steel products	133,000 tonnes
Structural steel	12,000 tonnes
Aluminium	650 tonnes
Asphalt	65,000 tonnes
Sand and aggregates	250,000 tonnes
Ballast	71,000 tonnes
Electrical cables	1,400 tonnes
Structural fill	875,000 tonnes
Electricity consumption	513,000 mega-watt hour
Water	524,651 kilolitres

The consumption of these resources is unavoidable when delivering infrastructure projects. The long design life of the project means the upfront consumption of these resources would enable the construction of an asset that would support communities and the economic growth of Sydney in the long-term.

Water required for the construction of the project would be associated with activities such as dust suppression, and would be sourced from water treatment plants, sedimentation basins and rainwater tanks where feasible. The project would maximise the use of non-potable water for non-potable uses and prioritise opportunities to use recycled water on-site. The project would also consider current water use restrictions at the time of construction of the project.

Sydney Metro is committed to the implementation of initiatives through construction to enhance sustainability outcomes, such as effective water management and resource efficiency. Section 17.3 provides specific initiatives for resource efficiency and reuse, including for water usage that would be incorporated during further design development and construction of the project.

Estimated greenhouse gas emissions

Potential Scope 1, 2 and 3 greenhouse gas sources for construction of the project, as well as estimated emissions by scope, are provided in Table 17-5.

Table 17-5 Greenhouse gas emission sources broken down by scope for construction

Scope	Construction	Greenhouse gas emissions (tCO2-e)
Scope 1	Diesel fuel combusted onsite from mobile construction plant and equipment including on-site generators	170,460
	Removal of vegetation (including the release of carbon existing within this vegetation when it is cleared and the loss of its potential to act as a carbon sink in the future), in accordance with the methodology outlined in the Greenhouse Gas Assessment Workbook for Road Projects.	14,041

Scope	Construction	Greenhouse gas emissions (tCO2-e)
	Subtotal	**184,501**
Scope 2	Electricity generated offsite to power construction plant, equipment (including tunnel boring machine operation) and site offices	420,490
	Subtotal	**420,490**
Scope 3	Emissions associated with the extraction and production of materials used during the construction of the project	670,800
	Transport emissions associated with the delivery of plant, equipment and construction materials	29,510
	Transport emissions associated with the removal of construction and demolition waste from site	35,800
	Decomposition of construction and demolition waste taken to landfill	19,250
	Emissions associated with fuel extraction, transmission and distribution associated with electricity which is used for the project	8,740
	Emissions associated with fuel extraction and processing for fuel supplied to construction plant and equipment	51,280
	Subtotal	**815,380**
Total		**1,420,371**

The greenhouse gas emissions from Scope 1, 2 and 3 emissions for construction activities of the proposed project are estimated to be a total of around 1,420,400 tonnes of carbon dioxide equivalent (tCO_2-e).The estimated Scope 1, 2 and 3 emissions are shown by percentage in Figure 17-1.

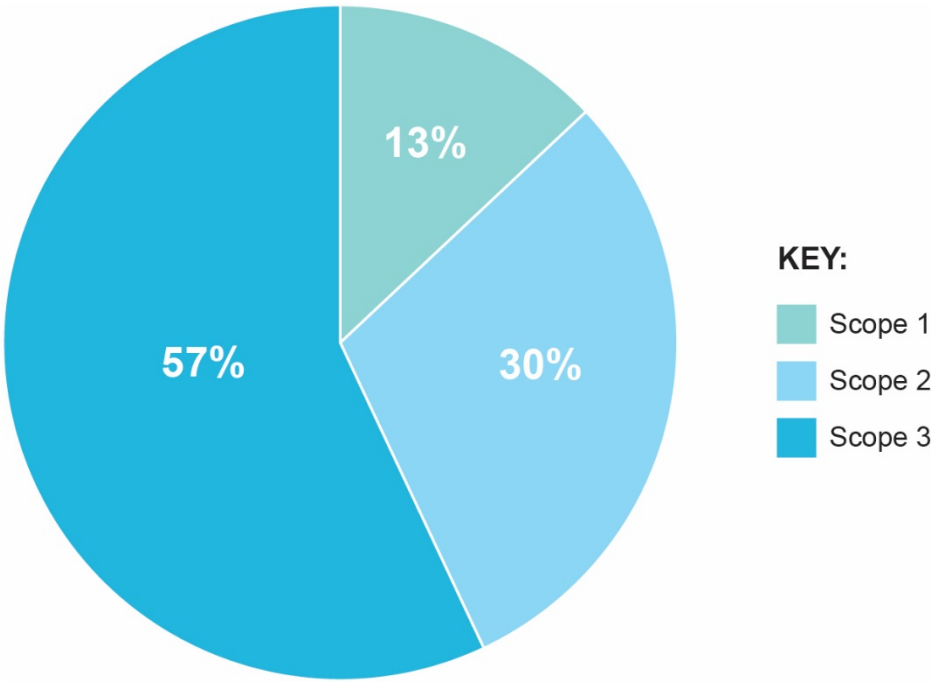

Figure 17-1 Estimated construction greenhouse gas emissions by scope

Table 17-6 provides a breakdown of the greenhouse gas emissions associated with material required for the construction of the project (included in Scope 3 emissions). Concrete and steel have the highest material impact accounting for around 34 per cent and 63 per cent of total embodied carbon emissions respectively.

Table 17-6 Estimated embodied carbon emissions within construction materials

Material	Greenhouse gas emissions (tCO2-e)	Per cent (%)
Reinforcing steel and other steel products	370,660	55.2%
Ready mix concrete	215,940	32.2%
Precast concrete	12,510	1.9%
Structural steel	34,640	5.2%
Steel rail	19,470	2.9%
Other	17,590	2.6%
Total	**670,810**	**100%**

The National Greenhouse Gas Inventory estimates that approximately 128.9 million tonnes of greenhouse gas emissions were produced in NSW in 2017 (DEE, 2017) with approximately four per cent of these emissions resulting from manufacturing and construction practices. The project would likely be constructed over a five-year period, therefore the construction emissions are estimated to be approximately 284,074 tCO_2-e per annum. This would be equivalent to approximately 0.2 per cent of NSW total emissions and five per cent of the manufacturing and construction sector emissions.

The introduction of initiatives to improve the efficient use of materials on the project and reduce the embodied emissions within these construction products, particularly concrete and steel, would have the most significant impact on reducing the project's construction carbon footprint. Section 17.3 outlines initiatives and targets for reducing the embodied carbon of construction materials, increasing resource efficiency and diverting resources from landfill during construction of the project.

The use of energy efficient plant and equipment and the use of alternative fuel/electricity supply during construction would also contribute to the reduction of the project's carbon footprint. The project is committed to the implementation of initiatives through design, construction and operation to enhance sustainability outcomes. These outcomes would be captured in the Sustainability Plan for the project.

17.5.3 Estimated greenhouse gas emissions during operation

Resource use

Resource use (and associated greenhouse gas emissions) during operation would be predominantly associated with electricity consumption to power the trains, stations, stabling and maintenance and service facilities. Other resource use during operation would also be associated with maintenance activities and the replacement of materials over the life of the project. These resource use estimates are based on information available at the preliminary planning stage and will be reviewed during further design development.

The annual operational energy demand has been estimated for the following operational scenarios:

- initial condition – with peak service of 12 trains per hour and off-peak service of six trains per hour with up to three train car sets
- ultimate condition – with peak service of 20 trains per hour and off-peak service of 10 trains per hour with up to four train car sets.

See Table 17-7 for a summary of estimated annual energy demand for the two operational scenarios.

Table 17-7 Estimated annual energy demand for the two operational scenarios

Load type	Annual energy consumption – Initial condition (MWh)	Annual energy consumption – Ultimate condition (MWh)
Train operations	14,800	30,300
Stations and service facilities	19,100	19,100
Total	**33,900**	**49,400**

Approximately 44 per cent of the initial operating demand is expected to be for the operation of trains and the remaining energy demand would be associated with the operations of the stations, service facilities and stabling and maintenance facility. This would increase to approximately 61 per cent of the operating demand under the ultimate operating condition.

Sydney Metro is committed to the implementation of initiatives through design and operation to enhance sustainability outcomes, such as energy efficiency. These outcomes would be captured in the Sustainability Plan for the project, which Sydney Metro is currently developing.

Water use during operation would be associated with station operation and maintenance activities such as wash down and general maintenance of trains at ancillary facilities. Section 17.3 provides resource efficiency measures that would be adopted during operation. These measures include avoiding the use of potable water for non-potable purposes if non-potable water is available.

Estimated greenhouse gas emissions

Potential Scope 1, 2 and 3 greenhouse gas emission sources for operation of the project, under both initial and ultimate operation scenarios, are provided in Table 17-8. These greenhouse gas emissions estimates are preliminary and based on the current design and therefore may be subject to change as the design progresses.

Table 17-8 Greenhouse gas emission sources broken down by scope for operation

Scope	Operation	Initial operation annual greenhouse gas emissions (tCO_2-e)	Ultimate operation annual greenhouse gas emissions (tCO_2-e)
Scope 1	N/A	N/A	N/A
Scope 2	Electricity generated offsite to power the operation of metro trains, stations, service facilities, stabling and maintenance facility, signalling and communication systems, tunnel ventilation and waste treatment plants.	27,800	40,510
Scope 3	Emissions associated with fuel extraction, transmission and distribution associated with the generation of electricity that is used for the project.	3,390	4,940
Total		**31,190**	**45,450**

In line with the ISO14064-1 exclusion requirements, the following operational related greenhouse gas emission sources have been excluded from this assessment since detailed information was not available at this stage of the project to enable calculation:

- emissions associated with mobile equipment used for maintenance activities
- emissions associated with the extraction and production of materials used for maintenance activities and replacement of materials over the life of the asset
- decomposition of operational waste.

The operational greenhouse gas emissions over the life of the project are likely to be significantly more than the emissions associated with the construction of the project due to the long operational life of the asset (around 80 to 120 years). Operational greenhouse emissions would predominately be associated with electricity consumption to power the trains, stations, stabling and maintenance and service facilities.

The emissions associated with the operation of the project would be equivalent to approximately 0.035 per cent of NSW total annual greenhouse gas emissions. Although the project would increase greenhouse gas emissions through the consumption of electricity, the project would contribute to the Future Transport 2056 aim to increase access to, and the level of service of, public transport as an alternative means of transport to vehicles on the road network.

Similar to the existing Sydney Metro network, 100 per cent of the project's greenhouse gas emissions associated with the consumption of electricity during operation would be offset. This means the 0.035 per cent emissions increase is neutralised, and will also contribute to the NSW Premier's aspirational target of net-zero emissions by 2050, as well as DPIE's Net Zero Plan 2020 – 2030, which is forecast to deliver a 35 per cent emissions reduction in NSW by 2030 compared to 2005.

Sydney Metro is committed to improving energy efficiency and reducing greenhouse gas emissions, in line with the COAG Energy Council's Trajectory for Low Energy Buildings document which aims to optimise demand side energy efficiency and transition towards net zero carbon.

17.6 Proposed management and mitigation measures

Environmental management for the project would be undertaken through an environmental management approach as detailed in Chapter 25 (Environmental management and mitigation). The construction and operational environmental management frameworks are discussed in Section 25.2 and 25.3 respectively.

Under these broad frameworks, a series of performance outcomes have been developed to define the minimum environmental standards that would be achieved during construction and operation (detailed in Section 17.6.1), and mitigation and management measures that would be applied during construction and operation to mitigate potential identified impacts (detailed in Section 17.6.2).

17.6.1 Performance outcomes

Performance outcomes have been developed consistent with the requirements of the Secretary Environmental Assessment Requirements for the project. Performance outcomes for sustainability, climate change and greenhouse gas for the project are listed in Table 17-9.

Table 17-9 Performance outcomes - sustainability, climate change and greenhouse gas

SEARs desired performance outcome	Project performance outcome	Timing
Sustainability, climate change and greenhouse gas		
The project reduces the NSW Government's operating costs and ensures the effective and efficient use of resources Conservation of natural resources is maximised	The project achieves a minimum 'Design' and 'As built' rating score of 65 to 75, using the Infrastructure Sustainability Council of Australia infrastructure rating tool or equivalent	Operation
	Sustainability initiatives are incorporated into the planning, design and construction of the project	Construction and operation
	100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation are offset	Operation
	25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction are offset	Construction

SEARs desired performance outcome	Project performance outcome	Timing
The project is designed, constructed and operated to be resilient to the future impacts of climate change	The project is designed to be resilient to the long-term consequences of climate change	Construction and operation

17.6.2 Mitigation measures

A Construction Environmental Management Framework (CEMF) (Appendix F) describes the approach to environmental management, monitoring and reporting during construction. Specifically, it lists the requirements to be addressed by the construction contractor in developing the Construction Environmental Management Plans (CEMP), sub-plans, and other supporting documentation for each specific environmental aspect.

The Sydney Metro – Western Sydney Airport Sustainability Plan is currently being developed and will include the sustainability objectives, initiatives and targets that have been informed by the above policies and legislation, and would be integrated during further design development, construction and operation of the project.

Mitigation measures that would be implemented under the provisions of the CEMF to achieve sustainability objectives, address climate change risks and potential greenhouse gas impacts are listed in Table 17-10.

Table 17-10 Sustainability, climate change and greenhouse gas mitigation measures

Ref	Mitigation measures	Applicable location(s)
Construction		
SUS1	A Sustainability Plan would be developed to be consistent with the Western Sydney Airport Sustainability Plan, and would be implemented during construction of the project. It would inform the preparation of Sustainability Management Plans	All
SUS2	Protect sensitive construction equipment from the effects of extreme weather and climate, such as direct exposure to the sun on extreme heat days and flooding	All
SUS3	Address climate change impacts in emergency management procedures for the construction of the project, such as consideration of impacts of flash flooding on evacuation procedures	All
GHG1	Carry out an iterative process of greenhouse gas assessments and design refinement prior to construction to identify opportunities to minimise greenhouse gas emissions Performance would be measured in terms of a percentage reduction in greenhouse gas emissions, and assessed against a baseline inventory calculated at the design development and construction planning stage	All
Operation		
SUS4	A Sustainability Plan would be developed to be consistent with the Western Sydney Airport Sustainability Plan, and implemented during operation of the project	All
SUS5	Climate change risk treatments would be confirmed and incorporated during further design development	All

Ref	Mitigation measures	Applicable location(s)
GHG2	Carry out an iterative process of greenhouse gas assessments and design refinement during detailed design to identify opportunities to minimise greenhouse gas emissions Performance would be measured in terms of a percentage reduction in greenhouse gas emissions, and assessed against a baseline inventory calculated at the design development stage	All

17.6.3 Consideration of interaction between measures

Mitigation measures in other chapters that are relevant to the achievement of sustainability objectives and the management of potential climate change risks and greenhouse gas emissions include:

- Chapter 14 (Flooding, hydrology and water quality), specifically measures that address potential flooding impacts and an outline of flood impact criteria that would be adhered to for the project, as well as potentially the management and treatment of wastewater during construction and operation
- Chapter 18 (Resource management), specifically measures that address potential resource and waste generation impacts, including spoil management and reuse targets, and water recycling
- Chapter 20 (Landscape and visual), specifically measures that address mitigating and minimising vegetation removal impacts, including by increasing the number of trees within the study area defined for the landscape and visual assessment to minimise adverse landscape impacts
- Chapter 23 (Hazard and risk), specifically measures that address potential bushfire risks.