24. Sustainability and climate change

This chapter assesses the project in terms of sustainability, and how it does, and would continue to, meet relevant sustainability requirements. It addresses the Secretary's environmental assessment requirements listed in Table 24.1. The chapter also provides a climate change risk assessment, and a greenhouse gas assessment for the project.

Table 24.1 Secretary's environmental assessment requirements – sustainability

Ref	Secretary's environmental assessment requirements - sustainability	Where addressed
12. Sustainability		
12.1	The Proponent must assess the sustainability of the project in accordance with the Infrastructure Sustainability Council of Australia (ISCA) *Infrastructure Sustainability Rating Tool* or equivalent and relevant rating tool.	Section 24.3.1
12.2	The Proponent must review the project against the current guidelines including targets and strategies to improve Government efficiency in use of water, energy and transport.	Sections 24.2 and 24.3

24.1 Assessment approach

24.1.1 Sustainability

What is sustainability?

Sustainability, or sustainable development, has many different definitions, depending on the application and context. In 1987, the Brundtland Commission defined sustainable development 'as development that meets the needs of the present, without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, 1987).

In 1992, ecologically sustainable development (ESD) was defined by the Ecologically Sustainable Development Steering Committee 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' (Ecologically Sustainable Development Steering Committee, 1992).

In NSW, the concept of ESD was introduced into planning and development legislation by the EP&A Act. One of the objectives of the EP&A Act is '(vii) to encourage ecologically sustainability development'. In accordance with part 3 of schedule 2 of the Regulation, an Environmental Impact Statement is required to include '(f) the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to … the principles of ecologically sustainable development set out in subclause (4).'

Section 6(2) of the *Protection of the Environment Administration Act 1991* states that ESD can be achieved through the implementation of:

- the precautionary principle
- intergenerational equity
- conservation of biological diversity and ecological integrity
- improved valuation, pricing and incentive mechanisms.

For infrastructure projects, 'infrastructure sustainability' is defined by the Infrastructure Sustainability Council of Australia (ISCA) as 'infrastructure that is designed, constructed and operated to optimise environmental, social and economic outcomes of the long term'.

Methodology for this assessment

The assessment summarised in this chapter considers the application of sustainability principles to the project, and the opportunities to achieve sustainability targets and outcomes aligned with best practice infrastructure projects. It considers Transport for NSW's sustainability strategy for Sydney Metro City & Southwest (provided in Appendix F), and other relevant policies and legislation.

The sustainability targets and initiatives outlined have been developed in response to various guidance documents and will be integrated into the design, construction, and operation of the project.

24.1.2 Climate change

What is climate change?

Climate change has the potential to alter the frequency, intensity, and distribution of extreme weather related natural hazards, including more intense and frequent heat waves, droughts, floods, and storm surges. The risk of climate change impacts on infrastructure (including the project) needs to be considered as part of the design process, as structures need to be designed to last for many years, and therefore need to be resilient to climate change.

Climate change adaptation planning and risk management is an evolving field. Responses to reduce the risks of climate change broadly fall into two categories: mitigation and adaptation. Using the definitions of the Inter-governmental Panel on Climate Change, mitigation aims to reduce human effects on the climate system by strategies to reduce greenhouse gas sources and emissions, and to enhance greenhouse gas sinks. Adaptation refers to adjustments in response to actual or anticipated climate changes or their effects, to moderate harm or to exploit beneficial opportunities. Infrastructure design and planning needs to incorporate adaptation measures, based on the assessed risk of climate change to a proposal.

Methodology for this assessment

The purpose of the climate change risk assessment is to:

- identify and assess the risks that climate change poses to the project
- prioritise risks that require further action as a basis for decision-making and planning.

A climate change risk assessment was undertaken by Transport for NSW in accordance with the *TfNSW* C*limate Risk Assessment Guidelines* (Transport for NSW, 2016b) and based on *AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk based approach.*

The following steps were undertaken to complete the risk assessment:

- determine the climate change context
- identify the climate risks and assess the likelihood and consequence of each risk
- identify adaptation responses.

During design development, two risk workshops were held with multidisciplinary members of the project team. The preliminary risks identified at the workshops were formalised in a risk register, and thorough risk descriptions were provided, including cause, impact/consequence, and current treatment.

Climate projections

Climate change risks associated with the operational phase of the project are much greater than during the construction phase, as there is much more time for those effects to be realised. Due to the expected design life of assets such as bridges and drainage infrastructure (60 to 100 years), the time periods selected for the assessment were 2030, 2060, and 2090. The climate models used to project future climate conditions are not an effective tool to determine near term changes, such as within the next 10 years. Construction phase climate change risks were therefore not assessed.

The climatic variables identified as potentially generating risks for the project were annual average rainfall, extreme rainfall, extreme temperature, extreme wind, storms (cyclones, hail, dust and lightning), sea level rise, and fire danger.

Climate change has the potential for direct and indirect impacts on the project. The types of potential impacts are relatively well understood, but their severity and extent is uncertain. As such, there is a need to identify these risks and develop strategies to treat them. Risks were identified and rated as either low, medium, high, or very high.

24.1.3 Greenhouse gas and energy

What are greenhouse gases?

Greenhouse gas is a collective term for a range of gases that absorb outgoing infrared radiation reflected from the earth, which in turn generate heat. This heat warms the atmosphere. This is known as the greenhouse effect, which is linked to climate change.

Human activities, including the combustion of carbon-based fuels, increase the concentration of greenhouse gases in the atmosphere. This leads to greater absorption of infrared radiation and an increase in atmospheric temperature. This is known as the enhanced greenhouse effect. The following six greenhouse gases are covered under international climate change agreements:

- carbon dioxide (CO_2)
- methane (CH_4)
- nitrous oxide (N_2O)
- hydrofluorocarbons (HFCs)
- perfluorocarbons (PFCs)
- sulphur hexafluoride (SF_6).

Identifying the likely greenhouse gas emissions associated with a project enables the scale of potential emissions to be determined, providing a baseline from which to develop and deliver greenhouse gas reduction measures.

Each greenhouse gas behaves differently in the atmosphere with respect to its ability to trap outgoing radiation and its residence time in the atmosphere. To achieve a common unit of measurement, each greenhouse gas was compared to the warming potential of carbon dioxide over a 100 year period. This provides a global warming potential for each greenhouse gas, which can be applied to the estimated emissions of the project. The resulting aggregated emissions are referred to in terms of carbon dioxide-equivalent emissions (or CO_2-e).

Methodology for this assessment

A greenhouse gas assessment was undertaken by Transport for NSW in accordance with *The Greenhouse Gas Protocol* (WRI and WBCSD, 2004), the Intergovernmental Panel on Climate Change, and Australian Government greenhouse gas accounting/classification systems.

Emissions were categorised into three different categories (known as 'scopes') to help differentiate between direct emissions from sources that are owned or controlled by a project, and upstream indirect emissions that are a consequence of project activities, but which occur at sources owned or controlled by another entity. The three greenhouse gas scopes are:

- Scope 1 emissions, also referred to direct emissions
- Scope 2 emissions, also referred to as indirect emissions
- Scope 3 emissions, includes all indirect emissions (not included in scope 2) due to upstream or downstream activities.

The objectives of the greenhouse gas assessment were to:

- identify the likely sources of greenhouse gas emissions associated with construction and operation
- quantify the greenhouse gas emissions associated with each greenhouse gas source
- identify opportunities (mitigation measures) to reduce greenhouse gas emissions.

The greenhouse gas assessment is a preliminary estimate based on current design information and construction staging. The assessment would be revised and updated as the design evolves and more accurate information becomes available.

Operational greenhouse gas emissions related to maintenance equipment use, maintenance transport, waste generation, and materials used for maintenance, are considered to be low compared with electrical consumption, and were not included in the greenhouse gas assessment.

24.2 Context for the assessment

24.2.1 Sustainability

Legislative and policy context for the assessment

Sustainability considerations have been embedded in a number of legislative and policy mechanisms, particularly in relation to resource use, waste, and energy efficiency. These include:

- *Waste Avoidance and Resource Recovery Act 2001*
- *National Greenhouse and Energy Reporting Act 2007*
- *National Strategy for Ecologically Sustainable Development* (Ecologically Sustainable Development Steering Committee, 1992)
- *National Waste Policy: Less Waste, More Resources* (Environment Protection and Heritage Council, 2009)
- *Sustainable Procurement Guide* (Australian Government, 2013)
- *NSW Government Resource Efficiency Policy* (Office of Environment and Heritage, 2014d).

The *NSW Long Term Transport Master Plan* (Transport for NSW, 2012b) acknowledges that meeting community expectations in environmental sustainability is a statewide challenge. Initiatives to manage and minimise the environmental impacts of NSW's transport system include:

- a co-ordinated approach to addressing environmental issues at all levels of transport planning
- sustainable design guidelines for transport projects
- better ways to assess the environmental benefits of projects.

The *Transport Environment and Sustainability Policy Framework* is a collective and co-ordinated approach to deliver the NSW Government's environmental and sustainability agenda across the transport 'cluster' (Transport for NSW, Sydney Trains, NSW Trains, Roads and Maritime Services, and the State Transit Authority of NSW. The framework was developed to implement the *Transport Environment and Sustainability Policy Statement* (Transport for NSW, 2013c).

Regulatory and policy drivers for the inclusion of workforce development initiatives as part of the sustainability program for the project include:

- The NSW State Priorities include creating jobs and apprenticeships for the construction sector through infrastructure investment, and increasing the proportion of people completing apprenticeships and traineeships to 65 per cent.
- The *Australian Jobs Act 2013* requires proponents of major projects, with a capital expenditure of $500 million or more, to prepare and implement an Australian Industry Participation plan, to support the development of a more diverse workforce, and future growth opportunities for Australian enterprises.
- The NSW Aboriginal Participation in Construction Policy aims to deliver more employment and business opportunities for Aboriginal people on selected NSW Government construction projects. The category of a project defines the percentage of the project spend to be directed to Aboriginal-related employment and education activities, and/or the procurement of goods or services from recognised Aboriginal businesses or other programs.

Sydney Metro City & Southwest Sustainability Strategy

Figure 24.1 shows how sustainability is governed for Sydney Metro, and Figure 24.2 shows how it is integrated into the environmental management system.

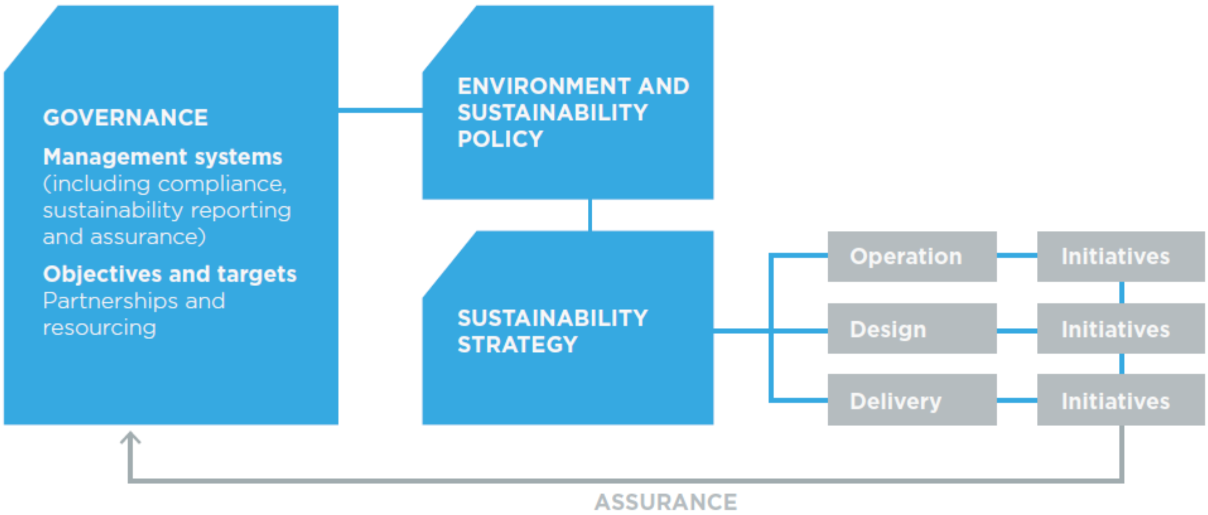

Figure 24.1 Sydney Metro sustainability governance structure

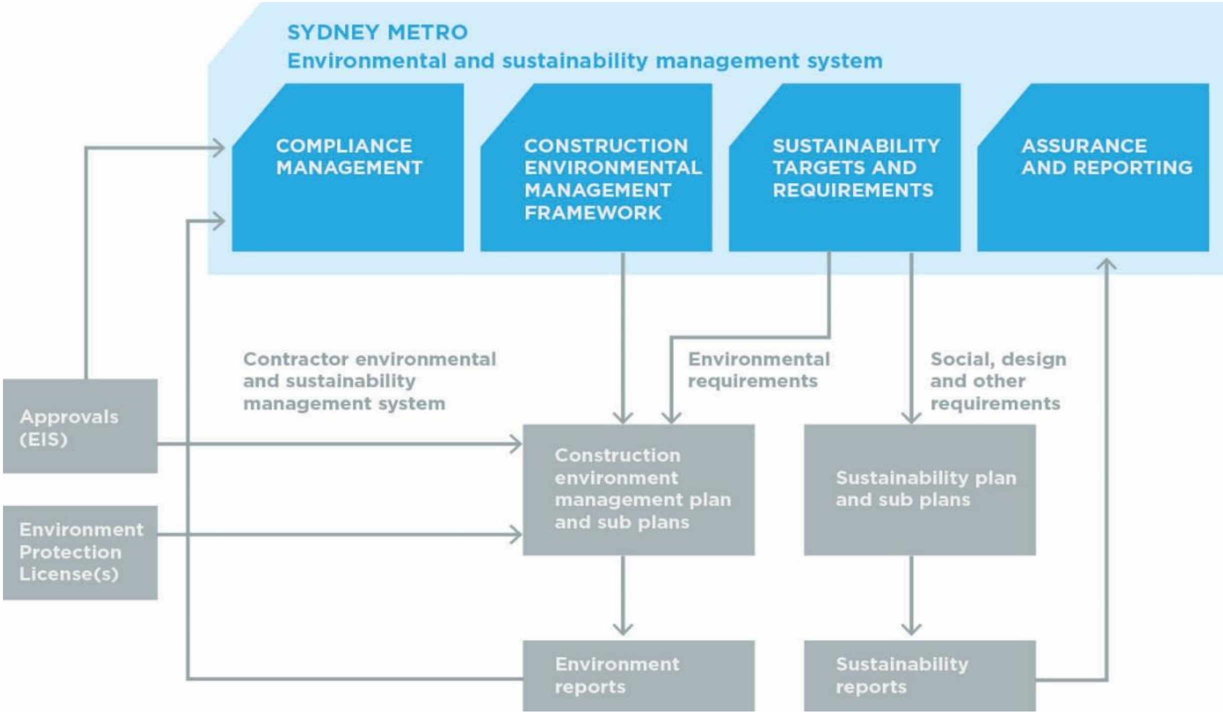

Figure 24.2 Sydney Metro environmental and sustainability management system

A sustainability strategy has been developed for Sydney Metro City & Southwest taking into account Transport for NSW sustainability commitments, and a copy is provided in Appendix F. The strategy provides an overarching framework for integrating sustainability into project planning, design, procurement, and operation. The strategy outlines objectives, targets, initiatives, and requirements for embedding sustainability across each of the following themes:

- governance
- carbon and energy management
- pollution control
- climate change resilience
- resources water efficiency
- resource waste and materials
- biodiversity conservation
- heritage conservation
- liveability
- community benefit
- supply chain
- workforce development
- economic.

24.2.2 Climate change

Legislative and policy context for the assessment

Relevant climate change policies, guidelines, and standards include:

- *Climate Change Impacts and Risk Management – A Guide for Business and Government* (Australian Greenhouse Office, 2006)
- *AS 5334:2013 Climate change adaptation for settlements and infrastructure – a risk based approach*
- *National Climate Resilience and Adaptation Strategy* (Australian Government, 2015)
- *Climate Change in Australia - East Coast Cluster Report* (CSIRO and Bureau of Meteorology, 2015)
- Office of Environment and Heritage's NSW climate change adaptation guidelines.

As noted in Section 24.2.1, the *NSW Long Term Transport Master Plan* acknowledges that meeting community expectations in environmental sustainability is a statewide challenge. Relevant actions include 'boosting our resilience to climate change and natural disasters' and 'assessing transport climate resilience'.

The Transport for NSW *Environment and Sustainability Policy Framework's* climate change resilience theme acknowledges that some level of climate change is inevitable. It focuses on Transport for NSW's efforts to adapt and build resilience into its planning, projects and operations, to minimise the impacts and costs of climate change on customers, and contribute to greater climate change resilience for NSW.

The Sydney Metro City & Southwest sustainability strategy includes an objective that infrastructure and operations are resilient to the impacts of climate change.

24.2.3 Greenhouses gases

Transport for NSW's online Carbon Estimate and Reporting Tool was used for the greenhouse gas emissions assessment. The tool was developed to provide consistency in greenhouse gas emissions assessment and reporting for the construction stage of Transport for NSW projects.

24.3 Assessment results

24.3.1 Sustainability

The ISCA's Infrastructure Sustainability framework ('the IS framework'), or equivalent, would be applied to the project. The IS framework applies a point score across 15 sustainability themes, including water and energy use, innovation, materials, management, climate change, heritage, stakeholders, and biodiversity. The IS framework's themes and aims are consistent with those in the Sydney Metro City & Southwest Sustainability Strategy. Under the IS framework, points are achieved by providing verified evidence of performance, and totalled to achieve an overall project rating. The IS rating is determined by a score out of 100 and has four rating levels – Commended (25 to 29 points); Excellent (50 to 74 points); and Leading (75 to 100 points). A rating of Commended indicates that a project is achieving better than business as usual. A rating of Excellent indicates that a project is generally achieving Australian best practice in sustainability. A Leading rating indicates that a project is close to world's best practice.

The project would comprise a number of contract packages. For those packages where the IS framework is relevant, Transport for NSW is targeting achievement of an 'Excellent' rating, with a minimum score of 65 points. Where the IS framework is not relevant, Transport for NSW would apply the principles of other equivalent guidance and rating schemes, and would target a high level of achievement under those schemes.

Sustainability initiatives and targets that would be integrated into the design, construction and operation of the project, following confirmation during the detailed design process, are summarised in Table 24.2.

Table 24.2 Sustainability initiatives and targets

Area	Project response/targets
Governance	• targeting a 65-point 'Excellent' rating under the ISCA IS framework for the design and 'as built' ratings • regular reporting of sustainability performance
Carbon and energy management	• 15 per cent station energy performance improvement over minimum Building Code of Australia requirements, including use of efficient glazing, building fabric, mechanical, electrical, and lighting systems • use of onsite solar photovoltaics renewable energy systems • offset 25 per cent of construction electricity • reducing greenhouse gases by 20 per cent compared to business as usual, using sustainable construction practices • reduction of traction electricity demand using regenerative braking • offset 100 per cent of operational electricity
Pollution control	• integration of water sensitive urban design measures • placing limits on volatile organic compounds for paints, finishes, adhesives, and sealants, and on formaldehyde for all composite wood products
Climate change resilience	• station and critical infrastructure levels and drainage design to allow for an increase in rainfall intensity
Water	• 10 per cent saving in potable water use during construction • using rainwater harvesting and reuse to reduce potable water consumption at stations • incorporating water efficient fixtures and fittings • using drought resistant species in landscaping
Waste and materials	• 90 per cent of construction and demolition waste to be recycled • 60 per cent of site office waste generated during construction to be recycled • 100 per cent beneficial reuse of usable spoil • 15 per cent reduction in the environmental impact of materials, compared to business as usual • 25 per cent reduction in Portland cement used in concrete
Biodiversity	• retention of existing trees where practicable • using drought resistant native plants for landscaping • additional street tree planting to complement existing plantings
Heritage conservation	• heritage interpretation which supports local heritage values, existing community values, and station identity
Liveability	• stations minimise distance for interchange, and prioritise pedestrians and cycle accessibility to integrate with existing or planned pedestrian and cycle networks. • stations provide secure cycle parking spaces
Community benefit	• station works include pedestrian pathway improvements and improved connections to existing cycle ways • creation of enhanced and additional public plazas • increased accessibility of existing stations
Supply chain	• use of sustainably sourced timber • responsible sourcing of steel and concrete

Area	Project response/targets
Workforce development	• increase opportunities for employment of local people, participation of local businesses, and participation of small to medium enterprises • enable targeted and transferable skills development that resolves local and national skills shortages, supports industry to compete in home and global markets, and embeds a health and safety culture within all induction and training activities, promoting continuous improvement • increased workforce diversity and inclusion, targeting Aboriginal workers and businesses, female representation in non-traditional trades, and long term unemployed • inspire future talent and develop capacity in the sector, engaging young people via education and work experience, collaborating with higher education institutions to provide programs responding to rapid transit and other infrastructure requirements, and supporting vocational career development through apprenticeships and traineeships

24.3.2 Climate change

In summary, the climate risk assessment process identified (residual risks):

- no very high ('unacceptable') risks
- no high ('undesirable') risks
- fifteen medium ('tolerable') risks
- no low ('acceptable') risks.

The fifteen medium risks comprised issues in the following categories:

- increased rainfall intensity and extreme events affecting stations and surrounds
- changed rainfall patterns affecting overland flows and drainage requirements
- effects of changes in groundwater levels and extreme rainfall events resulting in instability of cuttings and embankments
- damage of roofs and critical equipment associated with hailstorm events.

All proposed drainage works have been designed to comply with relevant guidelines as far as possible. Where necessary, drainage works have included carparks and as well as drainage in areas surrounding the stations. Flood modelling included a 10 per cent allowance for the effects of climate change. Further sensitivity analyses for additional increases in rainfall intensity would be completed during detailed design.

Retaining walls have been designed to allow for elevated ground water levels. As a result, changes in ground water levels do not represent a high risk.

To effectively manage these and other climate change risks, each stage of the design and delivery of the project would consider the most up to date climate change projections and design guidelines and would be subject to ongoing review and response by designers and constructors.

24.3.3 Greenhouse gas

Potential greenhouse gas emissions

Potential scope 1, 2 and 3 greenhouse gas sources for construction and operation are listed in Table 24.3.

Table 24.3 Potential greenhouse gas sources and categorisation

Scope	Description	Construction	Operation
Scope 1	Direct greenhouse gas emissions generated on site.	Construction equipment – use of fossil fuels, typically diesel, which would create greenhouse gas emissions. Removal of vegetation – vegetation absorbs carbon dioxide from the atmosphere by photosynthesis. Where vegetation is removed, the ability for the vegetation to act as a carbon sink would be lost.	Maintenance plant and equipment – use of fossil fuels, typically diesel, which would create greenhouse gas emissions.
Scope 2	Indirect greenhouse gas emissions associated with electricity used on-site for lighting construction sites, where actual emissions are generated elsewhere (generally at the source of the electricity generation).	Electricity and fuel use - used by site offices for lighting and security.	Traction power and rail systems electricity Electricity for station and maintenance facilities Upstream fuel and electricity usage.
Scope 3	Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities, and waste disposal.	Construction materials embodied energy – different construction materials contain varying levels of embodied emissions. For example, high-strength concrete contains a greater proportion of cement (which has a high level of embodied emissions), compared to concrete for lower-strength applications that contain fly-ash (which has a lower level of embodied emissions). Transport of construction materials and wastes – transport would create greenhouse gas emissions from the burning of fossil fuels.	Materials used for operation and maintenance – different materials contain varying levels of embodied emissions. Operations and maintenance vehicles – consumption and burning of fossil fuels.

Greenhouse gas emissions – construction estimates

Greenhouse gas emissions were estimated for the range of construction emission sources. The estimated scope 1, 2 and 3 emissions are summarised in Table 24.4.

Table 24.4 Estimated construction phase greenhouse gas emissions

Scope	Source	Greenhouse gas emissions (tCO_2e)[1,2]
Scope 1	Construction plant and equipment energy use (on site)	7,533
	Land and vegetation clearing	Not assessed – minor contribution relative to others
Scope 2	Upstream electricity and fuel use	9,940
Scope 3	Embodied emissions of construction materials	47,793
	Transport of materials	3,309

Scope	Source	Greenhouse gas emissions (tCO_2e)[1,2]
	Construction related transport to and from site	2,652
TOTAL		**71,225**

Notes: 1. tCOe = tonnes of CO equivalent.
2. These are preliminary estimates which would be further refined during detailed design. Estimates include the Sydney Metro Trains Facility South stabling yard and do not include demolition works.

In 2013, NSW's annual greenhouse gas emissions were about 146.7 million tCO_2-e (EPA, 2015b), with the transport industry sector accounting for about 8.44 per cent of the total. Construction of the project would equate to about 0.5 per cent of the transport industry's 2013 annual greenhouse gas emissions.

Greenhouse gas emissions – operation

Operational greenhouse gas emissions would mainly be associated with the scope 2 emissions, such as electricity consumption to power:

- metro trains (traction power)
- station facilities
- signalling and communications.

The annual electricity consumption during operation was estimated to be 86,576 tonnes of CO_2 equivalent. Operation of the project would represent about 0.7 per cent of NSW's transport industry's 2013 annual greenhouse gas emissions.

Operation and maintenance of the project would result in increased emissions of greenhouse gas as a result of increased electricity use. However, the project has the potential to reduce greenhouse gas emissions by providing a comfortable and efficient alternative to private car travel.

24.4 Mitigation measures

24.4.1 Approach to mitigation and management

Figure 24.2 shows how sustainability is integrated with the construction environmental management process for Sydney Metro. The project would be constructed and operated in accordance with the Sydney Metro City & Southwest sustainability strategy (described in Section 24.2) and constructed in accordance with the Construction Environmental Management Framework.

The Construction Environmental Management Framework (included in Appendix D) provides for the development and implementation of a construction sustainability management plan. The framework provides minimum requirements for the plan, which includes a:

- construction workforce development plan
- construction carbon and energy management plan
- waste management and recycling plan.

The construction sustainability plan would also incorporate the project specific mitigation measures listed in Table 24.5, and address the requirements of the Sydney Metro City & Southwest sustainability strategy. Further information on the approach to environmental management during construction and operation is provided in Section 28.4.

24.4.2 List of mitigation measures

The mitigation measures that would be implemented to address potential sustainability and climate change impacts are listed in Table 24.5.

Table 24.5 Mitigation measures – sustainability and climate change

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
SCC1	Sustainability	Sustainability initiatives and targets would be reviewed and incorporated into the detailed design to support the achievement of the project's sustainability objectives. A best practice level of performance would be targeted using relevant sustainability rating tools eg ISCA as built 'excellent' level rating.	All
SCC2		A sustainable procurement strategy would be developed and implemented to apply to Principal Contractors, their subcontractors and their suppliers.	All
SCC3		A workforce development plan would be developed covering both construction and operation.	All
SCC4	Climate change	Climate change risk treatments would be incorporated into the detailed design, including ensuring that adequate flood modelling is carried out and integrated into the design.	All
SCC5	Greenhouse gas emissions	An iterative process of greenhouse gas assessments and design refinements would be carried out during detailed design and construction to identify opportunities to minimise greenhouse gas emissions. Performance would be measured in terms of a percentage reduction in greenhouse gas emissions from a defined reference footprint.	All
Construction			
SCC6	Sustainability	Sustainability reporting (and corrective action where required) would be undertaken during construction.	All
SCC7		The construction workforce development plan would be implemented.	All
SCC8	Greenhouse gas emissions	25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would be offset.	All
Operation			
SCC9	Sustainability	Prior to operation commencing, sustainability initiatives would be reviewed and updated, and relevant initiatives would be implemented to support the achievement of the project's sustainability objectives.	All
SCC10		The operation workforce development plan would be implemented.	All
SCC11	Climate change risks	Periodic review of climate change risks would be carried out to ensure ongoing resilience to the impacts of climate change.	All
SCC12	Greenhouse gas emissions	100 per cent of the greenhouse gas emissions associated with consumption of electricity during operation would be offset.	All

24.4.3 Consideration of the interactions between mitigation measures

The relationship between key documents within the Sydney Metro environment and sustainability management system and the contractor's environment and sustainability management system is shown in Figure 24.2, notably:

- The construction environment management plan and its sub-plans would capture the construction environmental management requirements of this Environmental Impact Statement, approval conditions, and the Sydney Metro City & Southwest Sustainability Strategy.
- The sustainability plan and its sub-plans would define the governance and design requirements, as well as the sustainability initiatives under the Sydney Metro City & Southwest Sustainability Strategy.
- These plans would vary across different delivery packages.

Sub-contractors engaged by the contractor would be required to work under the contractor's environmental and sustainability management system.

25. Hazards, risks and safety

This chapter considers the potential hazard, risk, and safety impacts of the project. There are no Secretary's environmental assessment requirements specifically relevant to hazards, risks, or safety. The assessment has been undertaken as the State Significant Infrastructure Application Report identified hazards, risk and safety as a potential issue associated with the project.

25.1 Assessment approach

25.1.1 Legislative and policy context to the assessment

The assessment considered the following legislation, policies, and guidelines:

- *Australian Code for the Transport of Dangerous Goods by Road & Rail* (National Transport Commission, 2017) ('the Dangerous Goods Code')
- *Dangerous Goods (Road and Rail Transport) Regulation 2009*
- *Code of practice for the storage and handling of dangerous goods* (WorkCover NSW, 2005)
- *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (Department of Planning, 2011) ('Applying SEPP 33').

Dangerous goods and hazardous materials

Hazardous materials (or substances) are those that, following exposure, can have an adverse effect on health. Examples include materials that cause cancer, burns, skin and eye irritations, and poisons. Hazardous materials are those that meet the classification criteria specified by the *Work Health and Safety Regulations 2011* and the Globally Harmonised System of Classification and Labelling of Chemicals (an internationally agreed system of chemical classification).

Dangerous goods are classified according to their physical or chemical effects, such as fire, explosion, corrosion and poisoning, affecting property, the environment, or people. Dangerous goods are substances that, because of their physical, chemical (physicochemical) or acute toxicity properties, present a risk to people, property, or the environment. Types of substances classified as dangerous goods include explosives, flammable liquids and gases, corrosives, and chemically reactive or acutely (highly) toxic substances. Dangerous goods are defined by the Dangerous Goods Code. Many dangerous goods are also classed as hazardous substances.

As the project is critical State significant infrastructure, the guideline, Applying SEPP 33, does not apply to the project. However, Applying SEPP 33 provides a process of identifying a potentially hazardous development by identifying storage and transport screening thresholds. The thresholds in Applying SEPP 33 represent the maximum quantities of hazardous materials or substances that can be stored or transported without causing a significant off-site risk. Applying SEPP 33 defines hazardous materials as substances falling within the classification of the Dangerous Goods Code.

25.1.2 Methodology

A qualitative desktop assessment was undertaken, which included:

- reviewing the relevant regulatory framework and applicable guidelines (described in Section 25.1.1)
- identifying construction and operational activities with the potential to cause risks to health and safety
- identifying and assessing the hazards that could be encountered during construction and operation (including hazardous materials and dangerous goods)

- identifying storage and transport screening thresholds for hazardous materials and dangerous goods that may be required during construction and operation
- qualitatively assessing potential impacts to public health and safety
- providing mitigation and management measures.

The assessment focuses on those construction and operational activities with the potential to result in health and safety impacts on surrounding communities, land uses, and the environment (also known as 'off-site receivers'). The assessment does not take into account potential health and safety risks to on-site workers associated with normal construction operations, as these are regulated by workplace health and safety legislation (including the *Work Health and Safety Act 2011*), and are not relevant to approval of the project under Part 5.1 of the EP&A Act. Site management would be the responsibility of the construction contractor/s, who would be required (under the Work Health and Safety Act and applicable regulations) to manage the site in accordance with relevant regulatory requirements.

25.2 Existing environment

The urban setting of the project means that there is the potential for the community to be impacted if construction and operation activities are not properly managed. A description of existing land use patterns and sensitive receivers surrounding the project area is provided in Chapter 16 (Land use and property). Other sensitive receivers include members of the community travelling or moving in close proximity to work areas and operational areas.

25.3 Impact assessment

25.3.1 Risk assessment

Potential risks

The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Application Report, identified the following as the main risks in relation to hazards, risks and safety:

- onsite storage, use, and transport of chemicals, fuels, and materials during construction and operation
- rupture of, or interference with, underground services during construction
- construction of new traction substations which have the potential to introduce risks associated with electric and magnetic fields.

Other potential risks include:

- emissions from vehicles or plant during construction
- reduced safety for road users and pedestrians during construction
- health impacts from noise and air pollution during construction
- structural risks and exposure to hazardous materials and any contaminated soil during demolition and construction works
- potential for train strike for pedestrians and vehicles crossing the rail corridor during operation.

How potential risks and impacts would be avoided

In general, potential health and safety impacts would be avoided by:

- managing construction and operation in accordance with relevant legislative and policy requirements, including those listed in Section 25.1.1
- designing, constructing, and operating the project to minimise risks to health and safety, including the features described in Chapter 8 (Project description – operation) and summarised below
- implementing the management and mitigation measures described in Section 25.4.

Further information on the measures that would be implemented to minimise risks to the health and safety of customers and the community is provided below.

Unauthorised access to the rail corridor

Unauthorised access to the rail corridor has the potential to result in serious injury or fatality. To prevent unauthorised access, the project would incorporate the following elements (further information is provided in Chapter 8):

- security fencing installed along both sides of the rail corridor
- a trackside intruder detection system, consisting of non-mechanical protection measures to supplement the fencing, including closed circuit television.

Customer safety and security

A key metro characteristic is to provide a system that is inherently safe for customers on trains, at stations, and at the interface with the public domain. As described in Chapters 7 (Design development and place making) and 8, the safety of passengers and the general public has been, and will continue to be, a key consideration during the design process. The following metro features would contribute to the safety and security of customers:

- customer service assistants at every station and moving through the network during the day and night
- station and train design that allow for good line of sight to enable passive and active surveillance
- stations and surrounding areas that are designed to be highly visible, active spaces with good lighting and amenity
- ensuring customers can see all the way along the train and move easily between carriages, including wide, open walkways between carriages
- providing platform screen doors at stations which keep people and objects away from the edge, improving customer safety and allowing trains to get in and out of stations much faster.

Other station safety features include:

- CCTV cameras linked to the operations control centre
- emergency help points
- passenger information signage.

Further information on safety and security is provided in Chapter 8.

25.3.2 Construction impacts

Storage, handling, and transport of dangerous goods and hazardous materials

The storage and handling of dangerous goods and hazardous materials have the potential to impact the surrounding community and environment if leaks and spills occur, resulting in the potential contamination of air, soils, surface water, and/or groundwater.

Dangerous goods that may be used during construction are listed in Table 25.1. These are compared to the storage and transport thresholds in Applying SEPP 33. These thresholds represent the maximum amounts of dangerous goods that can be stored or transported to and from a construction site without causing a significant risk to off-site receptors.

In general, low volumes of dangerous goods would be stored at construction sites. The quantity of goods stored would be commensurate with the demand for those goods so that excess goods are not sitting idle.

Table 25.1 Dangerous goods volumes and thresholds

Material	Dangerous Good Code Class	Storage method	SEPP 33 thresholds		
			Storage volume	Minimum storage distance from sensitive receivers	Transport
Diesel	C11; 3 PG III2	20 litre drums/ carry cans	Greater than 5 tonnes, if stored with other Class 3 flammable liquids	5 metres	Not applicable if not transported with Class 3 dangerous goods
Petrol	C11; 3 PG III2	20 litre drums	Greater than 5 tonnes, if stored with other Class 3 flammable liquids	5 metres	Not applicable if not transported with Class 3 dangerous goods
Lubricating and hydraulic oils and greases	C2	20 litre drums	n/a	n/a	Not applicable, if not transported with Class 3 dangerous goods
Acetylene	2.1	Cylinders (up to 55 kgs) in rack	Greater than 0.1 tonnes (100 kg)	15 metres	2 tonnes; 30 times per week
Cement	n/a	Bags/pallets (in container)	n/a	n/a	Not subject to Applying SEPP 33 transport thresholds
Premix concrete	n/a	Bags/pallets (in container)	n/a	n/a	Not subject to Applying SEPP 33 transport thresholds
Concrete curing compounds	n/a	20 litre drums	n/a	n/a	Not subject to Applying SEPP 33 transport thresholds
Concrete retardant	3 PG III	205 litre drums	Greater than 5 tonnes	5 metres	10 tonnes; 60 times per week
Epoxy glue	3 PG III	Small containers	Greater than 5 tonnes	5 metres	10 tonnes; 60 times per week

Material	Dangerous Good Code Class	Storage method	SEPP 33 thresholds		
			Storage volume	Minimum storage distance from sensitive receivers	Transport
Coagulants	n/a	1,000 litre intermediate bulk containers	n/a	n/a	Not subject to Applying SEPP 33 transport thresholds
Acids	8 PG II	1,000 litre intermediate bulk containers	Greater than 25 tonnes	n/a	2 tonnes; 30 times per week
Bases	8 PG II	1,000 litre intermediate bulk containers	Greater than 25 tonnes	n/a	2 tonnes; 30 times per week
Disinfectant	8 PG III	500 litre intermediate bulk containers	Greater than 50 tonnes	n/a	2 tonnes; 30 times per week
Anti-scalent	n/a	100 litre drums	n/a	n/a	Not subject to Applying SEPP 33 transport thresholds
Membrane preser-vative	8 PG III	10 litre drums	Greater than 50 tonnes	n/a	2 tonnes; 30 times per week
De-bonding agents	n/a	Drums/ containers	n/a	n/a	Not applicable
Contamin-ated waste	Dependent on nature of material	Bunded areas or removed directly from site	Dependent on nature of material	Dependent on nature of material	Dependent on nature of material
Paint	n/a	20 litre drums	n/a	n/a	Not subject to Applying SEPP 33 transport thresholds

Underground utilities

As described in Chapter 9 (Project description – construction), a number of utilities would need to be adjusted, relocated, and/or protected to enable construction. The potential rupture of underground utilities during excavation or collision of plant and equipment with aboveground services could pose risks to public safety. Rupture or contact with services during works could also result in releases and/or short-term outages, as could relocation of utilities and services.

Health and safety impacts associated with encountering utilities would be minimised by implementing the utilities management strategy described in Section 9.10.

Working in the vicinity of utilities

If inadequately managed, works in the vicinity of utilities which are not protected or relocated (such as high voltage electricity transmission lines or gas pipelines) could result in increased risks to the workforce and/or surrounding environment/community. These potential risks would be minimised through careful construction planning and the implementation of the utilities management strategy described in Section 9.10.

Removal of buildings and structures

The project requires the removal of structures at and around stations. Hazards and risks associated with building demolition include:

- unplanned structure collapse
- falls from one level to another
- falling objects
- the location of above and underground services
- exposure to any hazardous chemicals and materials (such as asbestos fibres, lead dust, and biological material)
- noise from plant and explosives used in demolition work
- proximity of the building or structure being demolished to other buildings or structures.

To minimise exposure to these hazards and risks, a risk assessment would be carried out prior to works commencing. The risk assessment would include:

- an assessment of the structural integrity of the structure to be demolished
- an assessment of the method of demolition, including sequencing, scheduling, plant and equipment, and the layout of work areas
- a hazardous material survey for those buildings and structures suspected of containing hazardous materials (particularly asbestos).

Demolition would be carried out by licensed demolition contractors, in accordance with relevant regulatory requirements, and the project specific construction environmental management requirements described in Chapter 28 (Synthesis of the Environmental Impact Statement).

Potential contamination

Contaminants of potential concern that could be exposed during excavation include hydrocarbons, heavy metals, herbicides, and asbestos. Exposure to these contaminants could cause health and safety impacts to the community through inhalation and/or direct contact, or impacts to the environment due to contamination of land.

Health and safety impacts associated with potential exposure to contaminated and hazardous materials would be minimised through implementation of an unexpected finds protocol and waste management plan. Further information on contamination and waste, and associated mitigation measures is provided in Chapters 20 (Soils and contamination) and 26 (Waste management).

Risk of subsidence

As described in Chapter 21 (Hydrology, flooding and water quality), the potential for changes to groundwater levels as a result of construction is low, due to the generally shallow depth and limited extent of excavation. The project would also not involve the excavation of any tunnels or other sub-surface cavities. Based on the nature of the works being undertaken and the existing environment, the risk of subsidence as a result of construction is considered negligible.

Other health and safety risks

Other construction activities could result in impacts to the health and safety of site workers, users, visitors, and the local community if improperly managed. These include:

- working within an operating rail environment
- the operation of vehicles and construction equipment on site

- the transportation of equipment, excavated spoil, and material to and from site
- construction failures or incidents resulting in flooding, inundation, or excavation collapse.

In addition to the above, there is the potential for risks to pedestrians/public safety resulting from unauthorised access to construction work areas.

NSW workplace safety laws require construction sites to have adequate site security, which includes appropriate fencing. All construction work would be isolated from the general public. The construction contractor/s would need to ensure that construction sites are secure at all times, and take all possible actions to prevent entry by unauthorised persons.

Health and safety risks during construction would be managed by the implementation of standard workplace health and safety requirements. A work health and safety management plan, and safe work method statements would be developed in accordance with regulatory requirements.

The mitigation measures provided in Section 25.4 would be implemented to minimise and avoid the potential for health and safety impacts during construction.

25.3.3 Operation

Storage, handling and transport of dangerous goods and hazardous materials

The amount of hazardous materials and dangerous goods that would be used during maintenance activities would be much smaller than the volumes required during construction. Hazardous materials and dangerous goods required during maintenance would be similar to those listed in Table 25.1, and would be transported in vehicles/trucks to areas requiring maintenance. Therefore, the potential for impacts during operation associated with the storage and handling of hazardous materials and dangerous goods is considered negligible. Potential impacts would be managed through the implementation of standard mitigation measures to be developed as part of the operational environmental management plan.

Operation of traction substations and electrical wiring

The project includes the augmentation of existing power supplies, including new traction substations, feeders and overhead wiring. The possibility of adverse health effects due to the electro-magnetic fields associated with electrical equipment, including traction substations and overhead wiring, has been the subject of considerable research, and the results are still inconclusive.

The design, construction, and operation of the project's power supply would be undertaken in accordance with standard industry guidelines and codes of practice, such that conductive and semi-conductive materials effectively shield electrical fields. With regard to magnetic fields, the separation distance would be maximised between substations and public areas to minimise the potential to alter electro-magnetic field strength within the surrounding area.

The project would be designed to comply with appropriate Australian and international standards, to minimise the risk associated with electro-magnetic field exposure.

Other health and safety risks

Potential impacts to the health and safety of the community and customers during operation include:

- safety risks (e.g. unauthorised access)
- general worker health and safety issues for drivers and maintenance staff.

As described in Section 25.3.1, these risks would be mitigated through the design process which would include an appropriate emphasis on safety according to relevant design standards and requirements. The project has been designed to incorporate features which would ensure sufficient levels of safety specific to metro operations, for example security fencing, platform screen barriers, and a trackside intruder detection system. Further information is provided in Chapter 8.

Maintenance activities and other works within the rail corridor would be undertaken in accordance with Transport for NSW's standing operating procedures, reducing the potential for impacts to the health and safety of workers, visitors, and customers.

25.4 Mitigation measures

25.4.1 Approach to mitigation and management

Dangerous goods and hazardous materials

The construction environmental management plan for the project, and operational procedures for Sydney Metro as a whole, would include requirements for the storage, handling, and transport of dangerous goods and hazardous materials, in accordance with relevant regulatory requirements and standards. This would include procedures for the management of any accidental spills.

The risk of mobilising hazardous materials during construction and operation would be managed by:

- undertaking demolition and hazardous materials removal in accordance with relevant regulatory requirements and the construction environmental management plan
- transporting, storing, and using dangerous goods and hazardous materials in accordance with applicable standards
- the implementation of spill management and emergency and incident response procedures, defined by the environmental management plans for construction and operation
- managing any contaminated soils as described in Chapter 20
- incorporating bunding designed in accordance with the applicable standards into the design of relevant facilities to contain any chemical spills or leaks.

Emergency and incident response

The construction environmental management plan would include emergency and incident response procedures, as specified by the Construction Environmental Management Framework. The procedures would specify:

- roles and responsibilities
- notification and reporting protocols
- action and investigation requirements
- training programs to ensure that all staff are familiar with the plan
- design and management measures to address the potential environmental impacts of an emergency situation.

Response to emergencies during operation would be undertaken in accordance with Transport for NSW's existing procedures.

25.4.2 List of mitigation measures

The mitigation measures that would be implemented to minimise health and safety risks are listed in Table 25.2.

Table 25.2 Mitigation measures – hazards, risks and safety

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
HRS1	Public safety	A hazard analysis would be undertaken during the detailed design stage to identify risks to public safety from the project, and how these can be mitigated through safety in design.	All
Construction and operation			
HRS2	Hazardous materials and substances	All hazardous substances that may be required for construction and operation would be stored and managed in accordance with the *Code of practice* for the *storage and handling of dangerous goods* (WorkCover NSW, 2005) and the *Hazardous and Offensive Development Application Guidelines: Applying SEPP* 33 (Department of Planning, 2011).	All

25.4.3 Consideration of the interactions between mitigation measures

There are interactions between the mitigation and management measures for hazards, risks and safety, and those for traffic, transport and access (Chapters 10 and 11), noise and vibration (Chapters 12 and 13), soils and contamination (Chapter 20), water quality (Chapter 21), and air quality (Chapter 23). Together, all these measures would serve to minimise the potential for impacts to the community.

25.4.4 Managing residual impacts

With the incorporation of design features described in Section 25.3.1, and implementation of the mitigation and management measures provided in this section, no residual health and safety risks are anticipated.

26. Waste management

This chapter assesses the predicted waste generation during construction and operation, and provides a description of how waste would be managed. There are no Secretary's environmental assessment requirements specifically relevant to waste. The assessment has been undertaken as the State Significant Infrastructure Application Report identified waste management as a potential issue associated with the project.

26.1 Assessment approach

26.1.1 Legislative and policy context to the assessment

The main legislation relevant to the management of waste are the POEO Act, the *Protection of the Environment Operations (Waste) Regulation 2014* (the Waste Regulation) made under the POEO Act, and the *Waste Avoidance and Resource Recovery Act 2007* (the WARR Act).

The POEO Act establishes the procedures for environmental control, and for issuing environmental protection licences covering issues such as waste. The Waste Regulation regulates matters such as the obligations of consignors (producers and agents), transporters, and receivers of waste, in relation to waste transport licensing and tracking requirements.

The movement of controlled waste is also regulated by the *National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998*, made under the *National Environment Protection Council Act 1994*.

Definition of waste

Schedule 5 of the POEO Act defines waste as:

(a) any substance (whether solid, liquid or gaseous) that is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration in the environment

(b) any discarded, rejected, unwanted, surplus or abandoned substance

(c) any otherwise discarded, rejected, unwanted, surplus or abandoned substance intended for sale or for recycling, processing, recovery or purification by a separate operation from that which produced the substance

(d) any processed, recycled, reused or recovered substance produced wholly or partly from waste that is applied to land, or used as fuel, but only in the circumstances prescribed by the regulations

(e) any substance prescribed by the regulations to be waste.

Waste classification

The classifications that apply to waste in NSW and the descriptions of each are provided by the POEO Act, and the Waste Regulation and supporting guidelines, including the *Waste Classification Guidelines* (EPA, 2014a). Many waste types are pre-classified under the POEO Act and do not require testing. However, if a waste is not pre-classified, it may need to be tested to determine its classification.

Waste policy and strategic framework

The WARR Act aims to ensure that waste management options are considered against the following waste management hierarchy:

1. avoidance of unnecessary resource consumption
2. resource recovery (including reuse, reprocessing, recycling and energy recovery)
3. disposal.

To support the waste hierarchy, the *NSW Waste Avoidance and Resource Recovery Strategy 2014–21* (EPA, 2014b) provides a framework and targets for waste management and recycling in NSW. Targets established under this strategy comprise:

- avoiding and reducing the amount of waste generated per person in NSW
- increasing recycling rates to 70 per cent for municipal solid waste, 70 per cent for commercial and industrial waste, and 80 per cent for construction and demolition waste
- increasing waste diverted from landfill to 75 per cent
- managing problem wastes better, and establishing 86 drop-off facilities and services across NSW.

Transport for NSW, as a NSW Government agency, has a general responsibility to support these targets by:

- implementing complementary policies and programs, including sustainable procurement
- incorporating resource recovery and waste reduction objectives into its operations
- complying with relevant regulations.

26.1.2 Methodology

A desktop assessment was carried out, which involved:

- reviewing the regulatory framework for waste management
- identifying potential waste generating activities during construction and operation
- reviewing the likely waste streams and volumes, including wastewater and demolition materials
- identifying the likely classification of waste streams in accordance with relevant legislation and guidelines
- estimating the quantities of bulk earthworks and spoil balance to be generated through the construction of the project
- developing proposed management and handling techniques for key wastes streams including contingencies for managing unexpected waste volumes
- identifying lawful disposal or recycling locations.

It is noted that the waste types and quantities estimated are indicative, and have been identified for the purpose of determining potential waste management options. Although the quantities of waste actually generated by the project may differ from the estimates made, the identified waste management options would be appropriate to the final waste quantities.

Potential impacts of transport during construction (which includes the transport of construction waste) are considered in Chapter 10 (Construction traffic, transport and access). The management of any contaminated soils and hazardous materials are considered in Chapters 20 (Soils and contamination) and 25 (Hazards, risks and safety) respectively.

26.2 Impact assessment

26.2.1 Risk assessment

Potential risks

The main potential risks in terms of waste management would occur during construction. The environmental risk assessment for the project, undertaken for the State Significant Infrastructure Assessment Report, identified the following as the main risks:

- incorrect disposal of general, demolition, and construction waste generated
- incorrect disposal of any excess spoil
- incorrect disposal of any contaminated or hazardous waste.

The assessed risk level for the potential risks was low. This is because the project is unlikely to result in significant amounts of waste, with the exception of construction related waste.

How potential impacts would be avoided

In general, with respect to waste, potential impacts would be avoided by:

- managing waste in accordance with relevant legislative and policy requirements, as outlined in Section 26.1.1
- designing, constructing and operating the project so that wastes are managed according to the waste minimisation hierarchy
- implementing the waste management and mitigation measures provided in Section 26.3.

26.2.2 Construction

Waste generation

The main construction activities anticipated to generate waste are listed in Table 26.1 together with the materials that may be produced, and likely waste classifications.

Table 26.1 Indicative types of waste generated during construction

Activity	Waste streams that may be produced	Likely classification of waste stream
Excavation and general earthworks	Spoil comprising virgin excavated natural material (uncontaminated soil and crushed rock)	General solid waste (non-putrescible)
	Contaminated materials	Hazardous waste and/or special waste
	Potential acid sulfate soils	Special waste
	Ballast	General solid waste (non-putrescible)
Demolition/removal of buildings (mainly at stations) and other infrastructure (such as road overbridges)	Concrete, asphalt, bricks, tiles, timber (treated and untreated), metals, plasterboard, carpets, electrical and plumbing fittings and furnishings (such as doors and windows)	General solid waste (non-putrescible)
	Hazardous waste (such as asbestos and insulation)	Hazardous waste and/or special waste
Dust suppression, wash down of plant and equipment, and staff amenities at construction sites (such as toilets)	Sediment-laden and/or potentially contaminated wastewater, sewage and grey water	Liquid waste

Activity	Waste streams that may be produced	Likely classification of waste stream
Station fit-out and general construction activities and resource use	Concrete waste, timber formwork, scrap metal, steel, plasterboard, cable and packaging material	General solid waste (non-putrescible)
Maintenance of construction plant, vehicles and equipment	Adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses	Hazardous waste
	Tyres	Special waste
Activities at offices and crib rooms	Putrescibles	General solid waste (putrescible)
	Paper, cardboard, plastics, glass and printer cartridges	General solid waste (non-putrescible)
Clearing and grubbing of vegetation, landscaped and/or turfed areas	Green waste	General solid waste (non-putrescible)

The types and quantities of construction waste generated by the project would vary throughout construction. Of these, estimates for the main waste streams (spoil, ballast, concreate/brick, and asphalt) are provided in Table 26.2. The volumes of other wastes are expected to be comparable to similar infrastructure projects. The quantities and classifications of all waste streams would be confirmed following finalisation of the detailed design.

With respect to waste generation, based on the current design, it is estimated that:

- about 85,000 cubic metres of spoil would be required for fill
- about 45,000 cubic metres of surplus material would be generated.

Table 26.2 Indicative waste estimates for the main waste streams

Location	Spoil (tonnes)	Spent ballast (tonnes)	Concrete/brick (tonnes)	Asphalt (tonnes)
Marrickville	300	2,400	900	200
Dulwich Hill	11,000	2,400	800	700
Hurlstone Park	1,800	2,400	500	200
Canterbury	600	2,400	150	250
Campsie	4,000	2,400	500	300
Belmore	6,000	2,700	1,000	1,000
Lakemba	6,000	2,400	1,000	1,000
Wiley Park	400	2,400	50	0
Punchbowl	6,000	2,400	1,000	200
Bankstown	14,000	1,800	1,800	200
Drainage works	17,800	0	0	0
Earthworks in corridor (away from stations)	38,200	0	0	0
Bridge works	300	0	0	0
Substation works	1,250	0	0	0
Combined services route	400	0	0	0
Total	**108,050**	**23,700**	**7,700**	**4,050**

Waste management

Consistent with the waste hierarchy, the approach to spoil management for uncontaminated spoil would follow the hierarchy of options listed in Table 26.3.

Table 26.3 Spoil management hierarchy (uncontaminated spoil)

Priority	Reuse options	Potential options for reuse of spoil
1	Within the project area	• fill embankments and mounds within a short haulage distance of the source • site restoration • feed product in construction materials.
2	Environmental work	• for environmental restoration projects (such as coastal protection, flood mitigation).
3	Other development projects (including other Sydney Metro projects)	• fill embankments and mounds on projects within a financially feasible transport distance of the site • land reclamation or remediation projects • for manufacturing concrete, bricks and tiles.
4	Land restoration	• fill for disused facilities (for example mines and quarries) to enable either future development or site rehabilitation.
5	Landfill management	• capping completed landfill cells • daily covering of landfill waste.

As part of the project, the reconditioning of ballast would occur where practicable. It is estimated that about 60 per cent of ballast is likely to be suitable for reuse within the project area.

Waste handling and management measures are provided in Table 26.4 based on the waste hierarchy for the identified types of waste. Although the waste hierarchy has been considered for each waste type, not all waste management options apply to a given waste type. For example, some types of waste are non-recyclable.

Table 26.4 Management of construction waste

Waste type	Management
Spoil	Spoil comprising virgin excavated natural material (uncontaminated soil and crushed rock) would be managed in accordance with the spoil management hierarchy (Table 26.3).
Ballast	Where practicable, ballast would be reconditioned for reuse within the rail corridor. Excess ballast waste would be removed for reuse or disposal.
Contaminated spoil and acid sulfate soils	In situ testing of soils in areas of potential contamination concern would be undertaken to determine the appropriate waste classification. Contaminated spoil would be sampled and immobilised before being transported and disposed of at a suitably licensed offsite location.
Demolition waste (concrete, asphalt, bricks tiles, timber, metals, plasterboard, carpets, electrical and plumbing fittings and furnishing)	Demolition waste would be managed in accordance with the waste hierarchy. Demolition waste would be segregated and stockpiled on site, with materials such as bricks and tiles, timber, plastic, and metals separated and sent to a construction and demolition waste recycling facility. Electrical waste would be stored for collection by an authorised contractor for recycling offsite, where feasible, or disposal at an appropriately licenced facility. All demolition waste would be classified in accordance with the *Waste Classification Guidelines* (EPA, 2014a) and directed to a waste management facility that is lawfully permitted to accept that type of waste.
Hazardous waste including asbestos	The disturbance, movement, and disposal of asbestos containing materials would be undertaken in accordance with the *Work Health and Safety Regulations 2011* and applicable guidelines.
Liquid waste	Wastewater, sewage, and grey water would be disposed to sewer or transported to an appropriately licenced liquid waste treatment facility.

Waste type	Management
Adhesives, lubricants, waste fuels and oils, engine coolant, tyres	Waste from construction vehicle and plant maintenance activities would be collected and stored in designated waste storage areas for collection by an authorised contractor for offsite disposal. Where feasible, containers holding oil, grease, and lubricants would be washed prior to disposal, or stored separately for disposal as hazardous waste. Waste oil and oil filters would be stored in recycling bins and collected by an authorised contractor, and recycled offsite, where feasible. Tyres would be collected by an authorised contractor for recycling or disposal offsite at an appropriately licenced facility.
Office waste including kitchen waste, paper, cardboard, plastics, glass	Recyclable materials such as paper, cardboard, plastics, glass, ferrous, and non-ferrous containers would be stored at recycling bins for collection by an authorised contractor, and recycled offsite. Where recycling is not feasible, waste would be collected and stored in designated waste storage areas for collection by an authorised contractor for offsite disposal at a licenced waste facility.
Green waste	As far as practicable, green waste would be chipped, mulched and reused for vegetation management on site, or collected by an authorised contractor and recycled offsite. Noxious weeds would be disposed of in accordance with relevant guidelines/requirements.

26.2.3 Operation

Waste generation

The main types of activities with the potential to generate waste during operation are listed in Table 26.5, together with the likely waste materials and classifications.

Table 26.5 Indicative types of waste generated during operation

Activity	Waste streams that may be produced	Likely classification of waste stream
Disposal of general litter in station bins and cleaning activities associated with trains, stations and other infrastructure	General non-recyclable and putrescible waste (such as food waste from station rubbish bins)	General solid waste (putrescible)
	Recyclable wastes such as plastics and aluminium cans, office waste including paper and plastics	General solid waste (non-putrescible)
Infrastructure maintenance	Cable and conduit off-cuts from maintenance of electrical infrastructure	General solid waste (non-putrescible)
	Solvents, paints, adhesives, cleaning fluids, greases, acids and alkali materials, and spent spill kit absorbent materials used to clean up accidental spills during maintenance	Hazardous waste and/or special waste
Capture and treatment of stormwater	Sediment-laden and/or potentially contaminated wastewater and solids	Liquid waste
Use of station customer facilities (such as toilets)	Sewage and grey water	Liquid waste

The volumes of wastes generated during operation would be considerably lower than that generated during construction. Wastes would be typical of similar transport facilities, including the existing Sydney Trains network. Wastes would be managed by the implementation of standard waste management strategies (provided in Table 26.6 and Section 26.3).

Waste management

Waste handling and management measures are provided in Table 26.6, based on the waste hierarchy for the identified types of waste.

Table 26.6 Management of operational waste

Waste type	Management
General litter and station waste such as food waste, paper, cardboard, plastics, glass	Bins would be provided for collection by an authorised contractor for offsite recycling or disposal at a licenced waste facility.
Adhesives, lubricants, waste fuels and oils, engine coolant, tyres	Waste from maintenance activities would be collected and stored in designated waste storage areas, for collection by an authorised contractor for offsite disposal. Where feasible, containers holding oil, grease, and lubricants would be washed prior to disposal or stored separately for disposal as hazardous waste. Waste oil and oil filters would be stored in recycling bins and collected by an authorised contractor, and recycled offsite, where feasible.
Liquid waste	Wastewater, sewage and grey water would be disposed to sewer or transported to an appropriately licenced liquid waste treatment facility.

26.2.4 Recycling and disposal locations

There are a number of options for recycling and disposal of construction and operation waste generated by the project. Waste facilities in Sydney licensed to accept general solid waste (putrescible) include (but are not limited to):

- Clyde Transfer Terminal
- Eastern Creek Resource Recovery Park
- Kemps Creek Advanced Resource Recovery Park
- Lucas Heights Resource Recovery Park
- a number of waste transfer stations.

A larger number of licenced facilities in Sydney accept general solid (non-putrescible) waste and vegetation/green waste.

A number of waste facilities in Sydney are licenced to accept asbestos, including:

- Elizabeth Drive Landfill, Kemps Creek
- Eastern Creek Resource Recovery Park
- Genesis Xero Waste – Landfill and Recycling
- Horsley Park Waste Management Facility
- Jacks Gully Waste and Recycling Centre
- Kimbriki Recycling and Waste Disposal Centre
- Lucas Heights Resource Recovery Park
- Wetherill Park Resource Recovery Facility.

Recyclables such as containers (plastics, glass, cans, etc), paper and cardboard would be collected by an authorised contractor for off-site recycling. There are a number of materials recovery facilities in Sydney. The recycling facility would be determined by the contractor engaged to collect the material.

Specific facilities and collection contractors would be selected during the later stages of the project and documented in the construction environmental management plan.

26.3 Mitigation measures

26.3.1 Approach to mitigation and management

Waste during construction would be managed in accordance with the Construction Environmental Management Framework (as described in Chapter 28 (Synthesis of the Environmental Impact Statement)). The framework requires implementation of strategies to reduce waste volumes and report on waste generated, and provides for development and implementation of a waste management and recycling plan, to include (as a minimum):

- waste management measures
- responsibilities of key project personnel
- waste monitoring requirements
- a procedure for the assessment, classification, management and disposal of waste in accordance with the *Waste Classification Guidelines*
- compliance record generation and management.

Operational procedures would consider waste management in accordance with regulatory requirements and the waste hierarchy.

Project specific mitigation measures are provided in Table 26.7.

26.3.2 List of mitigation measures

The mitigation measures that would be implemented to manage waste are listed in Table 26.7.

Table 26.7 Mitigation measures – waste management

ID	Impact/issue	Mitigation measures	Relevant location(s)
Design/pre-construction			
WM1	Waste generation and recycling	Detailed design would include measures to minimise excess spoil generation. This would include a focus on optimising the design to minimise spoil volumes, and the reuse of material on-site.	All
WM2		A recycling target of at least 90 per cent would be adopted.	All
Construction			
WM3	Waste and spoil management	Spoil would be managed in accordance with the spoil management hierarchy.	All
WM4		Target 100 per cent reuse of reusable spoil.	All
WM5		Construction waste would be minimised by accurately calculating materials brought to the site and limiting materials packaging.	All
WM6		All waste would be assessed, classified, managed and disposed of in accordance with the *Waste Classification Guidelines* (EPA, 2014a).	All
WM7		Waste segregation bins would be located at various locations within the project area, if space permits, to facilitate segregation and prevent cross contamination.	All

26.3.3 Consideration of the interactions between mitigation measures

There are interactions between the mitigation measures for waste management and soils and contamination (provided in Chapter 20), and hazardous materials (provided in Chapter 25). The project-specific sustainability initiatives described in Chapter 24 (Sustainability and climate change) are also relevant to the management of waste. Together, all these measures would ensure appropriate handling of waste materials to minimise the potential for impacts to the community and environment.

26.3.4 Residual impacts

Construction waste quantities, including estimated spoil generation, spoil reuse, and spoil surplus, would be confirmed during detailed design. Classifications and reuse/recycling/disposal locations would also be confirmed at this stage. However, it is recognised that there is potential for unexpected volumes of potentially contaminated spoil to be generated. Any spoil classified as contaminated in accordance with *Waste Classification Guidelines* would be directed to a waste management facility that is lawfully permitted to accept that type of contaminated waste.

There are a number of solid waste landfills in Sydney that are licensed to accept contaminated soils. It is anticipated that the volumes of contaminated spoil generated by the project could be readily accommodated at these facilities.

Further information on the management of soils and contamination is provided in Chapter 20.

27. Cumulative impacts

This chapter considers the potential cumulative impacts of the project. It has been prepared to support the cumulative impact assessments undertaken as part of the assessments summarised in Chapters 10 to 23. The Secretary's environmental assessment requirement addressed in this chapter is provided in Table 27.1.

Table 27.1 Secretary's environmental assessment requirements – cumulative impacts

Ref	Secretary's environmental assessment requirements – cumulative impacts	Where addressed
2.1(o)	An assessment of the cumulative impacts of the project taking into account other projects that have been approved but where construction has not commenced, projects that have commenced construction, and projects that have recently been completed (for example WestConnex and approved construction in the relevant precincts).	Chapters 10 to 23 and this chapter

27.1 Assessment approach

For an environmental impact statement, cumulative impacts can be defined as the successive, incremental, and combined effect of multiple impacts, which may in themselves be minor, but could become significant when considered together.

The assessment of potential cumulative impacts has been undertaken in accordance with the Secretary's environmental assessment requirements, and considers the potential for impacts taking into account other projects in close proximity to the project (referred to as the 'Sydenham to Bankstown upgrade' for the purpose of this chapter). The assessment draws on the findings of Chapters 10 to 23, and environmental impact assessments for other projects, where these are available.

The potential for cumulative impacts for each environmental issue is considered in each of the key issue chapters (refer to Chapters 10 to 23).

27.1.1 Methodology

The following tasks were undertaken to assess the potential for cumulative impacts:

- identifying existing (approved or under construction) and proposed projects in the vicinity of the Sydenham to Bankstown upgrade, based on information available in the public domain
- screening identified projects for their potential to interact with the Sydenham to Bankstown upgrade
- identifying and assessing the significance of potential cumulative impacts by:
  - considering project-specific impacts for the key projects with the potential for cumulative impacts when combined with the construction and/or operation of the Sydenham to Bankstown upgrade (described in Section 27.2)
  - undertaking an issue-specific cumulative assessment for the key environmental issues listed in the Secretary's environmental assessment requirements, taking into account major projects being undertaken close to the project area for the Sydenham to Bankstown upgrade (described in Section 27.2).

The screening of projects took into account the following:

- The project location – projects in close proximity to the Sydenham to Bankstown upgrade where there is potential for impacts to spatially overlap. This included potential for shared use of roads for construction access, for example.
- The project timeframe and planning approval – only projects likely to be built concurrently with the Sydenham to Bankstown upgrade were assessed. This includes projects currently under construction and/or projects that have received planning approval. Projects at a conceptual or pre-approval stage were generally not able to be considered due to an absence of project and/or environmental impact details or development timeframes.
- The project size – projects considered are typically larger scale projects identified on the Department of Planning and Environment's Major Projects Register and council development application registers.

Projects considered to have the potential for cumulative impacts with the Sydenham to Bankstown upgrade are listed in Table 27.2.

Table 27.2 Projects with the potential for cumulative impacts

Project and date	Project details	Proponent	Status	Construction timeframe	Nearest project location
Sydney Metro City and Southwest: Chatswood to Sydenham	A new metro rail line, about 16 kilometres long (of which about 15 kilometres is located in underground rail tunnels) between Chatswood and Sydenham with six metro stations.	Transport for NSW	Approved	2017 – 2023	Marrickville Station
Sydney Metro City and Southwest: Chatswood to Sydenham – modification	Modification to include the upgrade of Sydenham Station and the construction of the Sydney Metro Trains Facility South	Transport for NSW	On exhibition	As above	Marrickville Station
WestConnex Stage 2: New M5 (Beverley Hills to St Peters)	Proposed new M5 to extend from the existing M5 East corridor at Beverly Hills via a tunnel to St Peters.	Roads and Maritime	Approved	2015 – 2019	Marrickville Station
WestConnex Stage 3: M4-M5 Link	Construction of an 8.5 kilometre motorway tunnel linking the M4 and M5 corridors. The alignment would provide a western bypass of the Sydney CBD Interchange.	Roads and Maritime	Pending approval	2019 – 2023	Marrickville Station

Project and date	Project details	Proponent	Status	Construction timeframe	Nearest project location
Sydney Airport	Upgrade of roads east of the airport and removal of the General Holmes Drive rail level crossing by constructing a road underpass.	Roads and Maritime	Under construction	2017 – 2018	Marrickville Station
Marrickville Metro redevelopment 34 Victoria Road Marrickville	Expansion of shopping centre by about 16,000 square metres in two stages.	Private	Under construction	Stage 1A commenced in 2016 and is due for completion in early 2017. Completion date for Stage 1B is unknown	Marrickville Station
401 Illawarra Road Marrickville	Demotion of existing building and construction of a six storey mixed use building above basement car parking containing a ground level shop and 21 dwellings	Private	Approved	Unknown	Marrickville Station
36 Floss Street & 118 Duntroon Street Hurlstone Park	Construction of a four storey mixed use development.	Private	Currently on exhibition	Unknown	Hurlstone Park Station
211-215 Canterbury Road, Canterbury	Demolition of existing structures and the construction of a new mixed-use development comprising 11 commercial tenancies and 69 residential apartments with basement car parking.	Private	Under construction	Unknown	Canterbury Station
10B Charles Street, Canterbury	Construction of a new ten storey residential flat building with two levels of basement parking.	Private	Under construction	Unknown	Canterbury Station
477 Burwood Road, Belmore	Construction of a new six storey mixed use commercial and residential development with basement parking.	Private	Under construction	Private	Belmore Station

Project and date	Project details	Proponent	Status	Construction timeframe	Nearest project location
Sydenham to Bankstown Urban Renewal Corridor	Potential redevelopment of areas along the Bankstown Line leading to increased densities	Department of Planning and Environment	Master planning	Unknown	All stations Marrickville to Bankstown

27.2 Potential cumulative impacts

Of the projects listed in Table 27.2, the Chatswood to Sydenham project (including the modification) is the only other major project considered to potential to result in cumulative impacts.

Surface works associated with WestConnex Stage 2: New M5 (Beverley Hills to St Peters) and Stage 3: M4-M5 Link are located approximately at Erskineville approximately 2.3 kilometres to the east and are unlikely to be additive to the project impacts.

The draft *Sydenham to Bankstown Urban Renewal Corridor Strategy* is relevant to the study area in which the project is located. The draft strategy proposes 35,400 new homes and 8,700 jobs over the next 20 years and associated infrastructure between Sydenham and Bankstown. However, due to the draft and strategic nature of this plan, there are no definitive works proposed, and it is not considered as part of the cumulative impact assessment.

27.2.1 Sydney Metro City & Southwest: Chatswood to Sydenham

Project details

The Chatswood to Sydenham project involves about 16 kilometres of new underground rail line and six new stations between Chatswood and Sydenham. The project includes a tunnel dive structure and a temporary construction compound to the north-east of Sydenham Station.

The Chatswood to Sydenham project was approved on 9th January 2017. A number of modifications are being prepared that would extend the project about 1.4 kilometres to the west of the tunnel dive structure, including the upgrade of Sydenham Station and development of the Sydney Metro Trains Facility South (stabling facility). Construction is due to commence in 2017 and is expected to be completed by 2023.

Location with respect to the Sydenham to Bankstown upgrade

The two projects form part of Sydney Metro City & Southwest and would interface with one another east of Marrickville Station. Although some construction activities would be undertaken concurrently, only works associated with the Sydenham Station upgrade and construction of the Sydney Metro Trains Facility South would be undertaken in the vicinity of the project.

Timing

Table 27.3 provides the indicative construction programs for the Chatswood to Sydenham and Sydenham to Bankstown projects. Potential interactions and cumulative impacts are considered in the following sections.

Table 27.3 Indicative construction programs for Chatswood to Sydenham and Sydenham to Bankstown upgrade

Project	2017	2018	2019	2020	2021	2022	2023	2024
Sydney Metro City and Southwest: Sydenham to Bankstown upgrade		■	■	■	■	■	■	■
Sydney Metro City and Southwest: Chatswood to Sydenham	■	■	■	■	■	■		

Cumulative impacts

Potential cumulative impacts that may arise as a result of both projects are summarised in Table 27.4.

Table 27.4 Cumulative impacts of the Sydenham to Bankstown upgrade with the Chatswood to Sydenham project

Environmental impact	Potential cumulative impacts without mitigation
Construction transport and access	The following potential cumulative transport and access impacts could occur during construction: • additional road closures around Sydenham Station • additional pedestrian and passenger movements around Sydenham Station as a result of station upgrade works and rail replacement buses • safety risk to pedestrians, cyclists and other motorists due to increase in vehicle movements due to construction traffic for both projects • additional loss of on street parking.
Operational traffic and transport	Once complete, the two projects would provide cumulative transport-related benefits, including a major increase in the capacity of Sydney's rail network, with the capacity to run up to 30 trains per hour through the Sydney CBD in each direction. This provides the foundation for delivering a 60 per cent increase in the number of trains operating through Sydney's CBD during peak periods, which would cater for an extra 100,000 customers per hour. Further details of the cumulative benefits of Sydney Metro as a whole are provided in Chapter 5 (Project need).
Construction noise and vibration	Construction of the project could result in additional receivers experiencing noise levels above adopted criteria. Additional construction traffic may also result in cumulative road traffic noise, depending on routes chosen.
Operational noise and vibration	Cumulative noise impacts associated with both the Chatswood to Sydenham and Sydenham to Bankstown projects are unlikely.
Non-Aboriginal heritage	The Chatswood to Sydenham project would impact on Sydenham Station, which would increase the number of stations on the T3 Bankstown Line affected by upgrades to undertake Sydney Metro City & Southwest. Overall, any changes to the heritage elements of station are considered to be as part of the latest phase of the development of the T3 Bankstown Line, which has developed over the years as new stations were added to the line. The line would continue to operate for its original use while simply adding a modern railway infrastructure context. All stations would continue to be used for the purpose they were built and therefore still hold significance.
Aboriginal heritage	Due to developed nature of both project areas, cumulative impacts on Aboriginal heritage are considered to be minimal.
Hydrology, flooding and water quality	The flooding assessment provided in Chapter 21 (Hydrology, flooding and water quality) has considered the cumulative impacts of flooding resulting from both projects. While in most locations, flooding is not expected to worsen, in some locations around Marrickville and Sydenham stations, a reduction in flooding is anticipated.

Environmental impact	Potential cumulative impacts without mitigation
Land use and property	While total acquisitions would increase as a result of both projects, the effects would be different as the Chatswood to Sydenham modification only affects industrial land uses. There would not be a cumulative loss of residential or commercial properties due to the two projects.
Business impacts	The projects would result in cumulative acquisition and lease termination. When coupled with the impacts at Marrickville near Sydenham Station, the amount of viable alternate locations for businesses to re-establish would reduce. The provision of retail opportunities at some upgraded stations might potentially offset the impacts on some businesses. During operation, the project would increase accessibility to locations along the T3 Bankstown Line due to improved train services. This would result in benefits for businesses.
Landscape character and visual amenity	Additional temporary visual impacts during construction may occur due to the presence of multiple construction sites and out-of-hours light spill around Sydenham Station and Sydney Metro Trains Facility South. Cumulative operational impacts are expected to be negligible as the combined changes would be consistent with the character of the surrounding area.
Socio-economic impacts	During construction, there is potential for additional pedestrian and customer movements in the vicinity of Sydenham Station as a result of rail replacement buses. This could lead to an increased safety risk to pedestrians, cyclists, and other motorists as a result of increased traffic in the area (including possible detours/diversions) resulting from the two projects. Increased amenity impacts (noise, traffic, visual, and dust) may also result from simultaneous construction activities, particularly where the two projects interface east of Marrickville Station. The nature of works at this location (mainly track work) means the cumulative impacts would be limited, and could be managed effectively through mitigation measures. The operation of the two projects would improve access to areas surrounding the stations and along the line, including to the Sydney CBD. The two projects would also include aspects of an active transport corridor, which would be connected with similar facilities at Sydenham Station. This would be a positive cumulative impact. The provision of this corridor and improved accessibility would encourage healthy lifestyles for communities along the T3 Bankstown Line.
Air quality	There is potential for additional dust emissions during construction. Potential cumulative impacts are not considered to be significant.

The scale of these cumulative impacts and benefits would vary but would be additional with those of the Sydenham to Bankstown upgrade. The benefits of the project would be maximised, and the adverse impacts minimised, by implementing the mitigation measures provided in Section 27.3.

27.2.2 Other projects

Potential cumulative impacts may occur as a result of construction activities occurring simultaneously with other smaller developments within the vicinity of the project area. Potential cumulative impacts could include:

- increased construction traffic travelling through the study area and on the surrounding road network
- increase in construction noise and vibration, including road traffic noise
- increased impacts on non-Aboriginal heritage
- reduced visual amenity
- increase in dust emissions.

These other cumulative impacts are unlikely to be significant and would be minimised and managed by implementing the mitigation measures provided in Table 27.5.