

28 Environmental risk analysis

28 Environmental risk analysis

This chapter provides an environmental risk analysis for the Concept and Stage 1.

28.1 Secretary's environmental assessment requirements

The Secretary's Environmental Assessment Requirements relating to environmental risk analysis, and where these requirements are addressed in this Environmental Impact Statement, are outlined in Table 28-1.

Table 28-1: Secretary's Environmental Assessment Requirements – Environmental risk analysis

Reference	Secretary's Environmental Assessment Requirements	Where addressed
3. Key issues		
3.3	For each Stage 1 key issue, the Proponent must: d. identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including realistic worst case scenario) of the impact (comprehensive risk assessment), the impacts of concurrent activities and cumulative impacts (parallel and sequential) with other projects	Section 28.3 Section 28.5

28.2 Environmental risk analysis methodology

The environmental risk analysis was undertaken in accordance with the principles of the Australian and New Zealand standard AS/NZS ISO 31000:2018 Risk Management – Guidelines. This involved identifying foreseeable risks of the Concept and Stage 1 and understanding the implications that could occur from each risk, that is, the potential impact. The risk of each potential impact was evaluated by identifying the consequence of the potential impact and the likelihood of each impact occurring.

The first step in the risk analysis involved evaluating the consequence of an identified potential impact, which requires making professional judgements about the possible results of an impact if it occurs. The definitions of the consequences used are provided in Table 28-2. This is followed by identifying the likelihood of the potential impact occurring with the definitions of likelihood provided in Table 28-3. The consequence and likelihood are combined to identify the level of risk of the potential impact, as shown in the risk matrix in Table 28-4.

Table 28-2: Consequence definitions

Consequence level	Definition
Catastrophic	<ul style="list-style-type: none"> Long-term (greater than 12 months) and irreversible large-scale environmental impact with loss of valued ecosystems Extended substantial disruptions and impacts to stakeholder(s) or customers.
Severe	<ul style="list-style-type: none"> Long-term (6 to 12 months), long-term environmental impairment in neighbouring or valued ecosystems. Extensive remediation required Severe disruptions or long-term impacts to stakeholder(s) or customers
Major	<ul style="list-style-type: none"> Medium-term (between 3 and 6 months), impacts external ecosystem and considerable remediation is required Major impacts or disruptions to stakeholder(s) or customers.
Moderate	<ul style="list-style-type: none"> Medium-term (between 1 and 3 months), short-term and/or well-contained environmental effects. Minor remedial actions probably required Moderate impacts or disruptions to stakeholder(s) or customers.
Minor	<ul style="list-style-type: none"> Short-term (less than 1 month), change from normal conditions within environmental regulatory limits and environmental effects are within site boundaries Minor or short-term impacts to stakeholder(s) or customers.
Insignificant	<ul style="list-style-type: none"> No noticeable or visible changes to environment and/or highly localised event Negligible impact to environment, stakeholder(s) or customers.

Table 28-3: Likelihood definitions

Likelihood	Definition	Probability
Almost certain	Expected to occur frequently during time of activity or project (10 or more times every year)	>90%
Very likely	Expected to occur occasionally during time of activity or project (1 to 10 times every year)	75% to 90%
Likely	More likely to occur than not occur during time of activity or project (once each year)	50% to 75%
Unlikely	More likely not to occur than occur during time of activity or project (once every 1 to 10 years)	25% to 50%
Very unlikely	Not expected to occur during the time of activity or project (once every 10 to 100 years)	10% to 25%
Almost unprecedented	Not expected to ever occur during time of activity or project (less than once every 100 years)	<10%

Table 28-4: Risk matrix

Likelihood	Definition					
	Insignificant	Minor	Moderate	Major	Severe	Catastrophic
Almost certain	Medium	High	High	Very high	Very high	Very high
Very likely	Medium	Medium	High	High	Very high	Very high
Likely	Low	Medium	Medium	High	High	Very high
Unlikely	Low	Low	Medium	Medium	High	High
Very unlikely	Low	Low	Low	Medium	Medium	High
Almost unprecedented	Low	Low	Low	Low	Medium	Medium

28.3 Identification of key issues

Various environmental risk identification and analyses have been carried out during the development of Sydney Metro West – refer to Chapter 3 (Sydney Metro West development and alternatives). Most relevant to this chapter is the risk analysis carried out for the Sydney Metro West Scoping Report – Westmead to The Bays and Sydney CBD (Sydney Metro, 2019). This document, along with the assessments in this Environmental Impact Statement, identifies the key environmental issues associated with the Concept and Stage 1.

28.4 Environmental risk analysis – Concept

Using the framework described above, a preliminary environmental risk analysis was carried out for the Concept. A preliminary risk analysis workshop was held on 13 December 2018 to categorise issues as 'key' or 'other' to form the basis of the Scoping Report in seeking the Secretary's Environmental Assessment Requirements.

The risk analysis identifies an initial risk rating for each of the environmental issues and provides a description of how the risk ratings were derived. Further details regarding the existing environment and potential impacts associated with each environmental issue are provided for the Concept in Chapter 8 (Concept environmental assessment).

A further risk workshop and follow up risk analysis was carried out once results from the impact assessment and the detailed specialist investigations were available.

This enabled the risk analysis to be refined and performance outcomes to be assigned to each environmental issue. Performance outcomes for each of the potential risks are provided for the Concept in Chapter 8 (Concept environmental assessment).

The purpose of the Concept risk assessment is to identify key and other issues for assessment of future stages. The following guiding principles were applied:

- Risk ratings were considered at the broader issue level (for example construction noise and vibration). This allows for a focus on these issues during the design, development and assessment of subsequent stages of the Concept

- Only initial risk ratings were considered. Mitigation measures to inform a residual risk rating would be identified as part of assessments of future stages. Based on performance outcomes in Chapter 27 (Synthesis) and experience on previous projects, the potential risks and impacts can be appropriately managed to acceptable levels.

This risk analysis will be re-examined at key stages during future environmental assessments for subsequent stages of the Concept.

The environmental risk analysis for the Concept is shown in Table 28-5.

Table 28-5: Environmental risk analysis – Concept

Potential risks	Risk rating			Discussion
	Consequence	Likelihood	Risk rating	
Operational road transport and traffic				
<ul style="list-style-type: none"> • Potential deterioration of traffic performance on surrounding road network due to permanent altered traffic arrangements, road or lane closures • Potential changes to availability, location and number of parking spaces or loading zones • Potential alterations to existing pedestrian and cyclist arrangements to enable safe and convenient access and egress from the new metro stations • Changes to bus stop locations, routes and timetables to provide transport integration with metro stations • Potential for permanent changes to property access, particularly adjacent commercial and retail properties 	Minor	Unlikely	Low	<p>The Concept would improve the transport system by providing a stand-alone railway network with the capacity to operate 30 trains an hour in each direction. It would integrate with the existing transport network, help to relieve congestion on the existing rail network and stations, and reduce the number of cars on the surrounding road network.</p> <p>Changes to the network would likely include alterations to bus stop locations or the provision of a small number of kiss-and-ride and/or taxi spaces around the stations to enhance transport interchange.</p> <p>The Concept would not involve the provision of any major traffic generating features such as park-and-ride.</p>
Construction transport and traffic				
<ul style="list-style-type: none"> • Potential temporary deterioration of traffic performance on surrounding road network to an unacceptable level of service, due to construction vehicles and temporary road or lane closures • Temporary loss of parking spaces or loading zones potentially affecting accessibility to transport, services and/or businesses • Potential temporary reduced pedestrian and cyclist access or flows due to construction • Potential temporary impacts on access to private (commercial and/or residential) property • Potential temporary reduced safety and amenity for traffic, pedestrians and cyclists due to construction activities, including within existing stations, and due to potential conflicts with construction vehicles. This would be managed through implementation of measures such as manual supervision, physical barriers, temporary traffic signals and modifications to existing signals • Potential temporary impacts on reliability of public transport services (Sydney Trains and buses), including relocation of bus stops, bus diversions and activities within the rail corridor 	Moderate	Almost certain	High	<p>A substantial number of heavy vehicles would be temporarily required to transport material to and from construction sites.</p> <p>Additionally, construction activities may require:</p> <ul style="list-style-type: none"> • The temporary or permanent closure of some sections of roadways • Temporary alterations to pedestrian and cyclist facilities • Temporary alterations to existing public transport infrastructure or timetables.
Operational noise and vibration				
<ul style="list-style-type: none"> • Potential exceedances of airborne noise criteria from the stabling and maintenance facility • Potential exceedances of airborne noise criteria from stations or other surface infrastructure for fresh air ventilation, mechanical and electrical equipment, substations, public address systems • Potential exceedances of human comfort vibration levels from train operations • Potential exceedances of building or structure damage vibration levels from train operations • Potential exceedances of ground-borne noise criteria from train operations 	Moderate	Very unlikely	Low	<p>Operational noise and vibration levels are anticipated to comply with relevant guidelines.</p> <p>Train operation would mainly occur underground within twin tunnels. Ground-borne noise and vibration levels from operating trains are anticipated to be minor with the implementation of standard environmental management measures.</p> <p>The Clyde stabling and maintenance facility would be located aboveground, but within an industrial area with minimal sensitive receivers except the Rosehill Gardens racecourse and the stables which are located nearby.</p>
Construction noise and vibration				
<ul style="list-style-type: none"> • Potential temporary exceedances of airborne noise management levels from tunnelling and surface construction sites during standard construction hours • Potential temporary exceedances of airborne noise management levels from tunnelling and surface construction sites outside standard construction hours • Potential temporary construction traffic potentially resulting in an increase in traffic noise greater than 2 dB • Potential temporary exceedances of human comfort or damage vibration levels from tunnelling or surface activities • Potential temporary exceedances of ground-borne noise criteria from tunnelling 	Major	Almost certain	Very high	<p>Temporary construction activities would occur across multiple construction sites. Some construction sites would be directly adjacent to residential areas/properties – including at Westmead, North Strathfield, Burwood North and Five Dock.</p> <p>Construction activities would likely temporarily exceed the relevant noise management levels for at least some locations and for some of the construction period.</p> <p>Additionally, activities outside of standard daytime construction hours would likely be required at some locations.</p>

Potential risks	Risk rating			Discussion
	Consequence	Likelihood	Risk rating	
Non-Aboriginal heritage				
<ul style="list-style-type: none"> Potentially unsympathetic design of operational infrastructure that detracts from the heritage significance of nearby heritage item(s) Potential direct and indirect impacts on local and s170 register listed items during construction Potential direct and indirect impacts on State Heritage Register listed items during construction Potential indirect impacts on Commonwealth, or National heritage during construction Potential damage to heritage items from vibration and settlement during tunnelling, construction and operation Potential temporary change to the values of a heritage conservation area during construction Potential impacts of temporary construction activities within the curtilage of listed items, but with no direct impacts on the significant components Potential impacts on unknown heritage items (e.g. archaeological items) during construction 	Moderate	Almost certain	High	Components of the Concept may impact heritage listed items or conservation areas during construction and operation but would be designed to minimise potential impacts.
Aboriginal heritage				
<ul style="list-style-type: none"> Potential impacts on known Aboriginal heritage items Potential impacts on areas of known Aboriginal cultural sensitivity Potential impacts on unidentified Aboriginal heritage items 	Major	Likely	High	Components of the Concept may impact on previously recorded Aboriginal heritage sites. Construction activities are expected to avoid or minimise impacts to known Aboriginal heritage items, however there would be potential impacts to items within the Parramatta Sand Body (a resource known to contain high potential for Aboriginal archaeology).
Property and land use				
<ul style="list-style-type: none"> Potential incompatibility between Concept infrastructure and facilities and intended future surrounding land use (including restrictions on future development due to subsurface tunnels conflicting with a strategic plan) Property acquisition Potential direct impacts on other infrastructure during construction including utilities and Sydney Trains managed property 	Major	Likely	High	The proposed stations would support planned growth and provide opportunities to integrate with existing or planned land use objectives. Several of the stations would be located within existing (or future) major commercial/strategic centres, and the proposed stations could potentially influence the development and delivery timeframes of surrounding precincts. Station place and design principles have been identified that will be supported by the Sydney Metro Design Quality Framework, Design Review Panel, and Design Guidelines. Acquisition of properties would be undertaken in accordance with the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> and the land acquisition reforms announced by the NSW Government. Sydney Metro has appointed Personal Managers to offer residents and small businesses assistance and support throughout the acquisition process.
Landscape character and visual amenity				
<ul style="list-style-type: none"> Potential changes (potentially positive and negative) to visual setting and landscape character during operation associated with the introduction of new stations, new public spaces, and other surface infrastructure (stabling facility, fresh air tunnel ventilation facilities, etc.) Potential temporary impacts on landscape character during construction due to activities associated with new stations, ancillary infrastructure, and the stabling and maintenance facility (e.g. loss of street trees, parking/use of plant and equipment etc.) Potential temporary impacts on visual amenity from private/public places as a result of acoustic sheds or other acoustic measures and hoardings associated with construction sites Potential temporary light spill from construction sites at night Potential light spill from stations, the stabling and maintenance facility and other operational infrastructure 	Major	Likely	High	The stations, stabling and maintenance facility and ancillary infrastructure would introduce new built elements into the surrounding environment. The introduction of a new metro stations is expected to result in a positive landscape character impact and improved visual amenity during operation for areas surrounding stations, particularly where new stations are replacing building stock with unsympathetic visual design or which is old and in poor condition. Demolition of buildings for surface infrastructure would be required, resulting in a change to the current visual environment. The introduction of construction sites and use of acoustic sheds or other acoustic measures would result in a temporary change in the visual landscape.
Groundwater and ground movement				
<ul style="list-style-type: none"> Potential groundwater drawdown/lowering of the water table due to dewatering during tunnel and station excavations and/or drawdown incurred by bed cracking or interference with geological features beneath surface-water bodies and drainage lines Potential impacts on groundwater users due to reduced groundwater yields, reduced groundwater quality and/or direct impacts and damage to existing groundwater bores Potential reduced baseflow in surface creeks or other surface water features due to groundwater drawdown Potential ground movement/settlement due to tunnelling and other excavations Potential ongoing operational changes to groundwater flows and levels from underground stations and other untanked structures 	Moderate	Likely	Medium	The excavation of the tunnels and underground stations during construction may result in localised changes to the hydrogeological environment associated with groundwater drawdown. The tunnels and the majority of stations are proposed to be tanked, which would limit the potential impacts of this component of the Concept to the construction phase. Ground movement and settlement is expected to be negligible.

Potential risks	Risk rating			Discussion
	Consequence	Likelihood	Risk rating	
Soils and water quality				
<ul style="list-style-type: none"> Potential temporary erosion of soils resulting in offsite sedimentation of waterways and exceedances of water quality criteria during construction Potential exposure of acid sulfate soils during construction resulting in off-site discharge of acidic water Potential exposure of soil salinity/saline soils during construction resulting in off-site discharge of saline water resulting in exceedances of water quality trigger levels Potential water quality impacts on nearby watercourses due to discharge of treated groundwater, contaminated water, or spills during construction and operation Potential contamination of land or groundwater due to spills and leaks during construction 	Minor	Unlikely	Low	<p>Potential impacts such as erosion and sedimentation, and spill or leaks are anticipated to be manageable through the implementation of standard environmental management measures. Groundwater captured from the tunnel excavation would be treated prior to discharge. Acid sulfate soils are likely to occur, and would need to be managed at the Parramatta, Clyde stabling and maintenance facility, and The Bays construction sites.</p>
Contamination				
<ul style="list-style-type: none"> Disturbance of contaminated land during construction potentially causing impact to human health or receiving environments Disturbance of contamination (soil or groundwater) potentially exacerbating existing contamination risks by mobilising otherwise stable contamination and potentially causing contaminated media to migrate across sites or off-site Potential contamination of groundwater and land due to spills and leaks during operation 	Major	Likely	High	<p>Known contaminated sites could be encountered and disturbed at Clyde stabling and maintenance facility, Silverwater services facility, Sydney Olympic Park and The Bays construction sites. Localised contaminated soils could also be encountered at other locations. Appropriate management approaches would be developed to manage contamination.</p>
Social impacts and community infrastructure				
<ul style="list-style-type: none"> Health and liveability benefits associated with increased access to public transport during operation Improved access to employment, education and entertainment opportunities during operation Potential temporary changes to the way of life for residents close to the construction sites Potential permanent loss of community facilities/open space, and changes in access to community facilities during operation Potential community concern and disruption to people from property acquisition and/or termination of existing residential or commercial leases Potential community concern with proposed changes to the character of local areas Potential temporary social impact on broader community from construction activities Potential temporary impacts, or temporary loss of, community facilities/open space due to construction activities and/or changes to access during construction 	Major	Likely	High	<p>The Concept would facilitate transit-oriented development through the generation of new rail catchment areas. Health and liveability benefits would primarily be associated with increased active transport opportunities around stations.</p> <p>Acquisition of residential and commercial properties is required for the proposed station sites and construction areas and would be managed in accordance with the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> and the land acquisition reforms announced by the NSW Government. Sydney Metro has appointed Personal Managers to offer residents and small businesses assistance and support throughout the acquisition process. Construction activities may result in some temporary social impacts, both for individuals and the community at various sites along the corridor.</p> <p>Construction activities may result in the temporary or permanent loss of community facilities and/or public open space.</p> <p>Opportunities to minimise these impacts (such as replacement of facilities within the local area) would be explored.</p>
Business impacts				
<ul style="list-style-type: none"> Potential alterations to access, visibility and amenity of business premises during operation Potential temporary disruptions to servicing, deliveries and access during construction (including from traffic congestion) Potential temporary loss of power and utilities by planned or accidental shutdowns during construction Potential temporary reduced visibility during construction activities, due to hoardings and other structures Potential temporary reduced amenity (particularly due to noise, vibration, visual and air quality impacts) during construction Property acquisition or termination of existing leases, and associated business impacts 	Major	Likely	High	<p>Operation of the Concept would provide benefits for some businesses located close to new metro stations. Acquisition of premises owned or leased by businesses is required for the proposed station sites and construction areas. This would be managed in accordance with the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> and the land acquisition reforms announced by the NSW Government. Sydney Metro has appointed Personal Managers to offer residents and small businesses assistance and support throughout the acquisition process.</p> <p>Businesses adjacent to construction sites may also be temporarily impacted by changes to amenity, access and visibility of the business.</p> <p>Businesses that supply to the construction sector and certain business types near construction sites may experience increased business activity.</p>
Hydrology and flooding				
<ul style="list-style-type: none"> Potential alterations to existing stormwater flows and the existing stormwater drainage infrastructure Potential impacts on construction activities due to changes to flooding regimes Potential impacts on flood-prone areas (e.g. increase in flood risk outside the construction sites) due to new structures or displacing flood storage areas Potential temporary flooding of the tunnels or other infrastructure during construction and operation 	Moderate	Likely	Medium	<p>A number of sites are located within flood prone land. The protection of the infrastructure from potential floods and any potential impacts on off-site flood behaviour are anticipated to be manageable through appropriate project design.</p>

Potential risks	Risk rating			Discussion
	Consequence	Likelihood	Risk rating	
Biodiversity				
<ul style="list-style-type: none"> Potential impacts on threatened ecological communities within or proximate to the construction footprint Potential impacts on groundwater dependent ecosystems Potential impacts on native vegetation Potential impacts on threatened flora species Potential impacts on threatened fauna species, migratory and endangered populations due to clearing of habitat, demolition of existing buildings and structures and/or as a result of collisions with construction plant and vehicles Potential indirect impacts on biodiversity values such as from light and noise impacts, sedimentation, spread of weeds 	Minor	Likely	Medium	<p>The potential for biodiversity impacts is anticipated to be limited.</p> <p>While construction sites may provide suitable habitat for some threatened fauna species and endangered populations, the potential removal of this habitat is considered to be minor and these species are likely to be highly mobile.</p> <p>Any species present are likely to be accustomed to impacts such as noise and light spill which are already occurring.</p> <p>Loss of mangrove and riparian vegetation would occur in sections of Duck Creek and A'Becketts Creek, however these impacts would be minimised as much as possible. Any residual impacts would be offset in accordance with the <i>Biodiversity Conservation Act 2016</i>.</p>
Air quality				
<ul style="list-style-type: none"> Potential impacts on local air quality around stations, services facilities and at the stabling and maintenance facility from train operations (brake wear and metal wear), routine maintenance activities and emergency conditions (e.g. in-tunnel fire) Potential temporary impacts on local air quality due to construction plant and equipment and increase in vehicle movements during construction Potential temporary impacts on local air quality during construction due to dust generation from exposed surfaces, spoil stockpiles or spoil haulage 	Minor	Unlikely	Low	<p>The operation of the Concept could contribute to long-term improvements in air quality associated with a potential mode shift by customers from road to rail.</p> <p>Potential temporary air quality impacts during construction and operation are anticipated to be minor and similar to other infrastructure projects of this nature and scale. These impacts would be manageable through the implementation of standard environmental management measures.</p>
Greenhouse gas and energy				
<ul style="list-style-type: none"> Emissions of greenhouse gases from embodied energy in materials Emissions of greenhouse gases from construction activities including energy use for tunnel boring machines over and above emissions for similar projects of a comparable scale 	Minor	Unlikely	Low	<p>The Concept could contribute to a long-term reduction in greenhouse gas emissions associated with a potential mode shift by customers from road to rail.</p> <p>The generation of greenhouse gas emissions during construction would be similar to other infrastructure projects of this nature and scale. These impacts would be manageable through the implementation of standard environmental management measures.</p> <p>Options to reduce greenhouse gas emissions and energy use when compared to other metro projects would be investigated.</p>
Climate change adaptation				
<ul style="list-style-type: none"> Impact of climate change on rail operations and infrastructure Impact of climate change on customer and staff comfort 	Moderate	Very unlikely	Low	<p>Potential climate change impacts have been considered through design development and would be managed through the implementation of appropriate design standards.</p>
Spoil, waste management and resource use				
<ul style="list-style-type: none"> Potential impacts associated with inappropriate management of waste during construction and operation Potential temporary impacts associated with the management and disposal of excess spoil from tunnel construction Potential increased demand on electricity and water supply during construction and operation Potential temporary increased demand on local and regional resources including sand and aggregate during construction Potential temporary increased diesel use during construction 	Minor	Unlikely	Low	<p>Spoil generated during the construction of the Concept would be classified in accordance with NSW Waste Classification Guidelines (Environment Protection Authority, 2014) and managed consistently with the adopted hierarchy of management options (reuse on Sydney Metro sites, reuse off site, recycling, disposal).</p> <p>The generation of waste and the anticipated resource consumption during construction would be similar to other infrastructure projects of this nature and scale. These impacts would be managed through the implementation of standard environmental management measures (such as application of the waste management hierarchy).</p> <p>Waste generated by the construction and operation of the Concept would be managed in accordance with the Sydney Metro West Sustainability Plan, and waste hierarchy outlined in the <i>Waste Avoidance and Resource Recovery Act 2001</i>.</p> <p>Construction activities would be unlikely to result in any resource becoming scarce or in short supply.</p>

Potential risks	Risk rating			Discussion
	Consequence	Likelihood	Risk rating	
Hazards				
<ul style="list-style-type: none"> • Potential incidents associated with transport and storage of hazardous substances and dangerous goods during construction • Potential for tunnel collapse during construction • Potential impacts to utilities • Potential hazards to customers and public safety and security • Potential unauthorised access to the rail corridor 	Major	Almost unprecedented	Low	Potential hazards and risks during construction and operation would be managed through the implementation of appropriate design standards and construction methodologies.
Cumulative impacts				
<ul style="list-style-type: none"> • Potential temporary cumulative construction noise and traffic associated with other major projects • Temporary spoil management and disposal from multiple tunnelling projects in Sydney • Temporary construction fatigue of local communities affected by multiple projects either at the same time or occurring consecutively 	Major	Almost certain	Very high	Construction activities may be carried out concurrently with, or consecutively to, a number of other major infrastructure projects in Sydney. This may result in temporary cumulative impacts associated with noise and traffic during construction, particularly around Parramatta and The Bays. Strategies for spoil management and community engagement would consider coordination with other projects.

28.5 Environmental risk analysis – Stage 1

Following the environmental risk analysis for the Concept, issues relevant to Stage 1 have been subjected to a further risk analysis of the specific Stage 1 impacts and mitigation measures.

The purpose of the Stage 1 risk analysis was to provide early identification of high residual impacts to allow a focus on these areas during the refinement of the design and the development of construction planning and methodologies. As a result, the risk analysis for Stage 1 was carried out at a greater level of detail than the Concept. The following considerations guided the risk analysis:

- Risk ratings were considered at a more detailed issue level (for example construction airborne noise and vibration from daytime works)
- Industry standard practice was considered in determining initial risk ratings, and project-specific mitigation and performance outcomes were applied for residual risk ratings.

Further details regarding the existing environment and potential impacts associated with each environmental issue are provided for Stage 1 in Chapters 10 to 26. The environmental risk analysis for Stage 1 is documented in Table 28-6.

Table 28-6: Environmental risk analysis – Stage 1

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures ¹	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Construction transport and traffic							
Potential temporary deterioration of traffic performance on surrounding road network to an unacceptable level of service due to construction vehicles and temporary road or lane closure	Moderate	Almost certain	High	Mitigation measures in relation to minimising construction vehicle movements in peak periods and during school drop off and pick up times would reduce the likelihood of traffic conflicts and congestion	Moderate	Likely	Medium
Temporary loss of parking spaces or loading zones undermining accessibility to transport, services and/or businesses. While impacts to on-street car parking would be minimal, the Parramatta metro station construction site would require the demolition of the City Centre car park and some off-street parking spaces - a loss of 850 parking spaces. The demolition of the City Centre car park was previously identified in the Draft Parramatta CBD Public Car Parking Strategy (City of Parramatta, 2017) along with measures to offset potential loss of car parking in Parramatta CBD. Parking spaces would also be lost from streets near Westmead, Parramatta, Silverwater, North Strathfield, Burwood North, and Five Dock construction sites	Moderate	Almost certain	High	Minimising the demand for parking at construction sites would reduce the consequence of impacts from loss of parking at construction sites	Minor	Almost certain	High
Potential temporary reduced pedestrian and cyclist access or flows due to construction	Moderate	Likely	Medium	Provision and management of alternative routes, including signage, would reduce the consequence of impacts on cyclists and pedestrians	Minor	Likely	Medium
Potential temporary changes to access to private property	Moderate	Likely	Medium	Maintaining access to adjacent properties and buildings would reduce the consequence and likelihood of impacts	Minor	Unlikely	Low
Potential temporary reduced safety and amenity for traffic, pedestrians and cyclists due to construction activities, including within existing stations, and due to potential conflicts with construction vehicles	Major	Unlikely	Medium	Measures at site access points and additional road safety enhancements for pedestrian, cyclist and motorist safety near the construction sites would reduce the likelihood of impacts	Major	Very unlikely	Medium
Potential temporary impacts to the availability of on street parking in local streets surrounding construction sites	Moderate	Likely	Medium	Minimising demand for parking at construction sites would reduce the consequence and likelihood impacts	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures ¹	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Potential temporary delays to emergency vehicles in the vicinity of the Westmead metro station construction site	Severe	Likely	High	Access for emergency vehicles would be maintained at all times and emergency service providers would be consulted during construction. This would reduce the likelihood of impacts	Severe	Almost unprecedented	Medium
Potential temporary impacts on reliability of public transport services (Sydney Trains and buses), including temporary relocation of bus stops, bus diversions and activities within the rail corridor, particularly in Westmead, Parramatta, North Strathfield and Burwood North	Minor	Almost certain	High	Consultation with the relevant council and public transport service operators, and use of wayfinding signage would reduce the consequence of impacts	Insignificant	Almost certain	Medium
Construction noise and vibration							
Potential temporary exceedances of airborne noise management levels from tunnelling and surface construction sites during standard construction hours impacting sensitive receivers	Major	Almost certain	Very high	Application of feasible and reasonable noise mitigation measures, including use of low noise equipment, acoustic sheds and respite periods would reduce the likelihood and consequence of noise impacts	Moderate	Very likely	High
Potential temporary exceedances of airborne noise management levels from tunnelling and surface construction sites outside standard construction hours impacting sensitive receivers	Major	Almost certain	Very high	Minimising noisy activities at night-time and offering additional mitigation measures as outlined in the Sydney Metro Construction Noise and Vibration Standard (Appendix E) would reduce the likelihood and consequence of night-time noise impacts	Moderate	Very likely	High
Temporary construction traffic resulting in a potential increase in traffic noise greater than 2 dB	Moderate	Likely	Medium	Minimising truck movements past sensitive receivers and during night-time periods would reduce the likelihood and consequence of traffic noise impacts	Minor	Unlikely	Low
Potential temporary exceedances of human comfort or damage vibration levels from tunnelling or surface activities	Moderate	Very likely	High	Further assessment of relevant structures to determine appropriate vibration levels and adjusting work methods where required would reduce the consequence of potential impacts	Minor	Very likely	Medium
Potential temporary exceedances of ground-borne noise criteria from tunnelling	Moderate	Very likely	High	Measures such as scheduling of noisy activities, prior notification to receivers, monitoring, and the additional mitigation measures outlined in the Sydney Metro Construction Noise and Vibration Standard (Appendix E) would reduce the consequence of impacts	Minor	Very likely	Medium

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures ¹	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Non-Aboriginal heritage							
Potential direct and indirect impacts on local and s170 register listed items during construction	Major	Likely	High	Use of low impact demolition methods would reduce the likelihood of indirect impacts on heritage items. Archival reporting and heritage interpretation would reduce the consequence of direct impacts on heritage items	Minor	Likely	Medium
Potential indirect impacts associated with views and vibration on State significant items during construction including the Roxy Theatre (Parramatta) and White Bay Power Station (The Bays)	Major	Likely	High	Use of low impact demolition methods would reduce the likelihood of impacts on State significant heritage items	Major	Very unlikely	Medium
Potential direct and indirect impacts on the State significant State Abattoir (Sydney Olympic Park).	Moderate	Very likely	High	Reinstatement of the garden in accordance with the Conservation Management Plan would reduce the consequence of impacts	Minor	Very likely	Medium
Potential damage to heritage items from vibration and settlement during tunnelling and construction	Moderate	Unlikely	Medium	Feasible and reasonable measures would be informed by detailed assessments and condition surveys to reduce the likelihood of vibration impacts on heritage items	Moderate	Very unlikely	Low
Temporary impacts on the values of The Valley heritage conservation area near The Bays Station construction site	Minor	Likely	Medium	Measures to reduce the visual impacts to The Bays Station construction site would also reduce the likelihood of impacts to the conservation area	Minor	Very unlikely	Low
Potential impacts of temporary construction activities within the curtilage of listed items, but with no direct impacts on the significant components	Moderate	Unlikely	Medium	Use of low impact demolition methods would reduce the likelihood of indirect impacts on heritage items	Moderate	Very unlikely	Low
Potential impacts during construction on unknown heritage items (e.g. archaeological items) associated with the earliest phases of European settlement, including convict huts, yards and gardens at Parramatta CBD	Moderate	Very likely	High	Archaeological research design(s) informing archaeological testing, monitoring and mitigation measures, prepared in consultation with the NSW Heritage Division, including in situ conservation of State significant archaeology where feasible and reasonable, would reduce the consequence of impacting archaeological items	Minor	Very likely	Medium
Aboriginal heritage							
Potential impacts on a known Aboriginal heritage item (at the Parramatta metro station construction site)	Major	Almost certain	Very high	Archaeological test excavation, including salvage when required, and interpretation, would reduce the consequence of the impact	Minor	Almost certain	High

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures ¹	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Potential impacts on areas of known Aboriginal cultural sensitivity such as the Parramatta Sand Body	Major	Very likely	High	Archaeological test excavation, including salvage when required, and interpretation, undertaken in consultation with Aboriginal parties would reduce the consequence of the impact	Minor	Very likely	Medium
Potential impacts on unidentified Aboriginal heritage items, particularly in areas with potential archaeological sensitivity such as Clyde stabling and maintenance facility and The Bays Station construction sites.	Major	Likely	High	Archaeological test excavation, including salvage when required, and interpretation, carried out in consultation with Aboriginal parties would reduce the likelihood and consequence of impacts on unidentified Aboriginal heritage items	Moderate	Unlikely	Medium
Property and land use							
Potential restrictions on future development due to subsurface tunnels and other infrastructure	Minor	Unlikely	Low	In most cases, subsurface acquisition does not affect the continued existing or intended future uses of property at the surface. As such, mitigation measures are not required	Minor	Unlikely	Low
Landscape character and visual amenity							
Potential temporary impacts on landscape character during construction activities associated with new stations, ancillary infrastructure, and the stabling and maintenance facility (e.g. loss of street trees, use of plant and equipment etc.)	Major	Almost certain	Very high	Design of construction sites, including location of structures and buildings, design of hoardings, public art opportunities, and retention and replacement of trees would reduce the consequence of impacts on landscape character	Moderate	Almost certain	High
Potential temporary impacts on visual amenity from private/ public places as a result of acoustic sheds (or other acoustic measures) and hoardings associated with construction sites	Major	Almost certain	Very high	Design of acoustic measures and hoardings would seek to reduce the impact on views, would be maintained and kept free of graffiti, and would incorporate public art where appropriate to reduce consequence of impacts to visual amenity	Moderate	Almost certain	High
Potential temporary light spill from construction sites at night	Moderate	Very likely	High	Lighting of construction sites would be orientated to minimise glare and light spill, thereby reducing the consequence and likelihood of light spill impacts on adjacent receivers	Minor	Unlikely	Low
Business impacts							
Potential temporary disruptions to servicing, deliveries and customer access during construction (including from traffic congestion and loss of parking)	Major	Likely	High	Access to businesses would be maintained for customers, servicing and deliveries, reducing the likelihood of business disruption	Major	Unlikely	Medium
Potential need for some businesses to find new suppliers	Minor	Very unlikely	Low	Engagement with small business owners adversely impacted by construction would reduce the consequence of the potential impact	Insignificant	Very unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures ¹	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Potential temporary loss of power and utilities during planned or accidental shutdowns during construction	Moderate	Likely	Medium	Planned power and utility interruptions would be scheduled to outside of typical business hours where feasible and reasonable, reducing the likelihood of impacts	Moderate	Very unlikely	Low
Potential temporary reduced business visibility through the presence of construction activities, hoardings and other structures	Major	Likely	High	Appropriate design and location of hoarding, clear pathways, signage and lighting would maximise visibility of businesses. Engagement with small business owners adversely impacted by construction would be undertaken. These measures would reduce the likelihood and consequences of reduced business visibility	Minor	Unlikely	Low
Potential temporary reduction in amenity at nearby business premises (particularly due to noise, vibration, visual and air quality impacts)	Moderate	Likely	Medium	Noise, visual and air quality mitigation measures would minimise local amenity impacts of construction, reducing the consequences of these impacts for businesses. Engagement with small business owners adversely impacted by construction would reduce the consequence of the potential impact	Minor	Likely	Medium
Impacts to businesses located within properties being acquired	Minor	Very unlikely	Low	Sydney Metro manages property acquisition in accordance with the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> , and has appointed Personal Managers to support small businesses throughout the acquisition process. As such no further mitigation measures are required	Minor	Very unlikely	Low
Social impacts							
Potential temporary impacts on the way of life for local communities, local employees and visitors due to travel disruptions and changes to routines	Moderate	Likely	Medium	Access would be maintained to local services, business and public transport infrastructure. Consultation with the relevant council and public transport service operators, and use of wayfinding signage would minimise disruptions reducing the consequence of impacts	Minor	Likely	Medium
Potential community concern with proposed changes to the character of local areas	Moderate	Likely	Medium	The development and implementation of a community benefit plan would provide local benefits to counteract and reduce the likelihood of potential impacts	Moderate	Unlikely	Medium
Potential community concern and disruption to people from property acquisition	Major	Likely	High	Sydney Metro manages property acquisition in accordance with the <i>Land Acquisition (Just Terms Compensation) Act 1991</i> , and has appointed Personal Managers to support residents throughout the acquisition process, reducing the consequence and likelihood of impacts	Moderate	Unlikely	Medium

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures ¹	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Potential temporary impacts on community facilities or open space due to construction activities including changes to access and amenity during construction	Moderate	Likely	Medium	Noise, traffic, access and local amenity mitigation measures would reduce the consequence and likelihood of impacts affecting the useability of social infrastructure, including community facilities and open space	Minor	Unlikely	Low
Groundwater and ground movement							
Potential impacts on groundwater supply due to reduced groundwater yields or reduced groundwater quality at two groundwater bores near Westmead and Burwood North	Moderate	Unlikely	Medium	Groundwater levels and quality, including existing viable water bores, would be monitored throughout construction, and make good measures would be implemented if a loss of yield were to occur, reducing the consequence and likelihood of impacts from groundwater drawdown	Insignificant	Unlikely	Low
Potential loss or changes to baseflow of surface water features due to groundwater drawdown	Moderate	Likely	Medium	Additional site investigations would be carried out at potentially affected watercourses to confirm the existing groundwater baseflow contribution to the streamflow. Where a significant reduction in baseflow is identified, design responses would be implemented to reduce potential baseflow loss reducing the consequence and likelihood of potential impacts from groundwater drawdown	Minor	Unlikely	Low
Potential ground movement/settlement due to tunnelling and other excavations	Moderate	Likely	Medium	A structural assessment of the potentially affected buildings/ structures would be carried out and specific measures implemented to address the risk of damage, reducing the likelihood of adverse impacts from ground movement/ settlement	Moderate	Very unlikely	Low
Soils and surface water quality							
Temporary erosion of soils resulting in off-site sedimentation of waterways during construction, potentially resulting in exceedances of water quality criteria	Moderate	Unlikely	Medium	Erosion and sediment control measures would be implemented in accordance with the principles and requirements in Managing Urban Stormwater - Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (NSW Department of Environment, Climate Change and Water 2008), and water collected from construction sites would be appropriately treated prior to discharge, reducing the consequences of soil erosion	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures ¹	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Potential exposure of acid sulfate soils during construction, potentially resulting in off-site discharge of acidic water	Moderate	Unlikely	Medium	Acid sulfate soil testing would be carried out to determine the presence of actual and/or potential acid sulfate soils, enabling management measures to be implemented in accordance with the Acid Sulfate Soil Manual (ASSMAC, 1998) that would reduce the likelihood of discharging acidic water	Moderate	Very unlikely	Low
Potential exposure of soil salinity/saline soils during construction resulting in off-site discharge of saline water, potentially resulting in exceedances of water quality trigger levels	Minor	Likely	Medium	Soil salinity testing would be carried out to determine the presence of saline soils, enabling management measures to be implemented in accordance with Book 4 Dryland Salinity: Productive Use of Saline Land and Water (NSW DECC 2008) that would reduce the likelihood of impacts	Minor	Very unlikely	Low
Potential temporary water quality impacts on nearby watercourses due to discharge of treated groundwater, contaminated water, or spills during construction	Major	Unlikely	Medium	Prior to discharge, water would be treated to comply with ANZECC/ ARMCANZ (2000) and ANZG (2018) default guidelines for 95 per cent species protection	Major	Very unlikely	Medium
Potential contamination of land or groundwater due to spills and leaks during construction	Moderate	Likely	Medium	Locating all fuels in a sealed bunded area, together with the use of spill kits, would reduce the likelihood of soil or groundwater contamination	Moderate	Very unlikely	Low
Contamination							
Disturbance of contaminated land during construction potentially causing impacts to human health or receiving environments	Major	Likely	High	Areas with a higher potential for contamination would be subject to a Detailed Site Investigation and, if necessary, a Remedial Action Plan to reduce contamination risks during and following completion of construction, reducing the consequence of contamination and the likelihood of impacts	Moderate	Unlikely	Medium
Disturbance of contamination (soil or groundwater) potentially exacerbating existing contamination risks by mobilising otherwise stable contamination and causing on-site and off-site migration	Major	Likely	High	Areas with a higher potential for contamination would be subject to a Detailed Site Investigation and, if necessary, a Remedial Action Plan to reduce contamination risks from throughout and following completion of construction, reducing the consequence of contamination and the likelihood of impacts	Moderate	Unlikely	Medium
Potential impacts from the management or incorrect disposal of contaminated soils	Major	Likely	High	Contaminated soils would be kept separate from other spoil, and classified for disposal, reducing the likelihood of cross-contamination or inappropriate disposal	Major	Very unlikely	Medium

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures ¹	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Potential disturbance of existing leachate and gas management systems at Sydney Olympic Park	Moderate	Likely	Medium	A Remedial Action Plan would be developed for the site and approved by an EPA accredited site auditor, to reduce contamination risks from construction and ensure that ongoing active management beyond construction is carried out, where required. This would reduce the potential consequence and likelihood of impacts	Minor	Unlikely	Low
Hydrology and flooding							
Alterations to existing stormwater flows and drainage infrastructure	Moderate	Likely	Medium	Drainage would be designed, where feasible and reasonable, to avoid or minimise obstruction of overland flow paths and limit the extent of flow diversions, reducing the likelihood of adverse alterations to local runoff conditions	Moderate	Unlikely	Medium
Potential impacts on existing flood emergency management arrangements at Parramatta, Clyde and The Bays	Major	Unlikely	Medium	Emergency flood planning would be carried out in consultation with the NSW State Emergency Service and the relevant local council, reducing the likelihood of impacts on flood evacuation routes	Major	Very unlikely	Medium
Impacts on flood-prone areas (e.g. increase in flood risk outside the construction sites) due to new structures or filling at the Clyde stabling maintenance facility and The Bays Station construction sites	Major	Likely	High	Detailed construction planning would consider flood risk at and around construction sites, including identification of measures to not worsen flood impacts, reducing the potential consequence and likelihood of off-site flood impacts	Minor	Unlikely	Low
Biodiversity							
Impacts on Cumberland Plain Woodland in the Sydney Basin Bioregion threatened ecological communities within or proximate to the construction footprint at Westmead	Insignificant	Likely	Low	The unmitigated risk rating is low because only 0.03 of a threatened ecological community is directly impacted, and this is already in poor condition represented by regrowth native species amongst plantings and weeds. No further mitigation measures are required	Insignificant	Likely	Low
Potential impacts on groundwater dependent ecosystems	Minor	Unlikely	Low	Additional investigations would be carried out to assess potential impacts to groundwater dependent ecosystems from groundwater drawdown. This would be used to inform any further mitigation measures, if required and reduce the likelihood of impacts	Minor	Very unlikely	Low
Impacts on Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion at Clyde	Moderate	Almost certain	High	Any removed vegetation would be offset reducing the consequence of vegetation clearing	Insignificant	Almost certain	Medium

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures ¹	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Impacts on habitat for the Southern Myotis (<i>Myotis macropus</i>)	Moderate	Almost certain	High	Any removed vegetation comprising Southern Myotis habitat would be offset reducing the consequence of habitat loss	Insignificant	Almost certain	Medium
Potential indirect impacts on threatened fauna species, migratory and endangered populations due to clearing of habitat, demolition of existing buildings and structures, from light and noise impacts, sedimentation, spread of weeds and/or as a result of collisions with construction plant and vehicles	Minor	Likely	Medium	The implementation of measures such as those to control light spill and minimise construction noise would reduce the likelihood of impacts	Minor	Unlikely	Low
Impacts of proposed creek crossings at Clyde including fish passage	Major	Likely	High	The creek crossings would be designed to provide sufficient fish passage where possible, incorporate suitable scour protection, avoid worsening of existing flow velocities, and incorporate a vegetated riparian zone where feasible and reasonable, reducing the consequence of impacts	Minor	Likely	Medium
Air quality							
Potential temporary impacts on local air quality due to construction plant and equipment and increase in vehicle movements	Minor	Likely	Medium	Vehicles, plant and equipment would be maintained in a proper and efficient manner, reducing the likelihood of air quality impacts from plant	Minor	Very unlikely	Low
Potential temporary impacts on local air quality during construction due to dust generation from exposed surfaces, spoil stockpiles or spoil haulage	Moderate	Likely	Medium	Best practice dust management measures would be implemented during all construction works, reducing the likelihood and consequence of air quality impacts from dust	Minor	Unlikely	Low
Potential temporary impacts on local air quality during demolition	Moderate	Likely	Medium	Best practice measures would be implemented during demolition, including demolition sequencing and water suppression, reducing the consequence and likelihood of potential impacts	Minor	Unlikely	Low
Potential temporary mobilisation of airborne hazardous materials, odours or vapours as a result of uncovering contaminated soils or hazardous materials during excavation or demolition	Major	Unlikely	Medium	Best practice odour management measures would be implemented, including minimising the disturbance of contaminated soil, use of odour suppression agents, and regular monitoring. These mitigation measures would reduce the consequence and likelihood of mobilising airborne hazardous materials, odours or vapours	Moderate	Very unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures ¹	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Spoil, waste management and resource use							
Potential temporary impacts associated with inappropriate management of waste during construction	Minor	Unlikely	Low	Waste would be assessed, classified, managed and disposed in accordance with the Waste Classification Guidelines, reducing the likelihood of impacts	Minor	Very unlikely	Low
Potential temporary impacts associated with the management and disposal of spoil from tunnel construction	Minor	Unlikely	Low	Spoil would be managed in accordance with the spoil management hierarchy, and 100 per cent of usable spoil would be reused. This would reduce the likelihood of impacts associated with spoil management	Minor	Very unlikely	Low
Potential temporary increased demand on electricity and water supply during construction	Minor	Likely	Medium	Sustainability initiatives would be incorporated into the detailed design and construction to minimise demand for water and electricity, reducing the likelihood of the potential impacts	Minor	Very unlikely	Low
Potential temporary increased demand on local and regional resources including sand, aggregate and fuel during construction resulting in resource becoming in short supply	Minor	Unlikely	Low	Sustainability initiatives would be incorporated into the detailed design and construction to minimise demand for resources, reducing the likelihood of the potential impacts	Minor	Very unlikely	Low
Hazards							
Potential incidents associated with transportation and storage of hazardous substances and dangerous goods during construction	Moderate	Very unlikely	Low	Storage and handling of dangerous goods and hazardous substances would be in accordance with the <i>Dangerous Goods (Road and Rail Transport) Act 2008</i> and <i>Dangerous Goods (Road and Rail Transport) Regulation 2014</i> , and would comply with the Australian Dangerous Goods Code. As such, no mitigation measures are required	Moderate	Very unlikely	Low
Potential damage, rupture and/or failure to shut down, isolate or otherwise appropriately manage underground utilities, resulting in the release of sewage, water, gas or electrical currents	Moderate	Very unlikely	Low	Dial before you dig searches and non-destructive digging would be carried out to identify the presence of underground utilities, and ongoing consultation would be carried out with utility providers for high pressure gas or petroleum pipelines to identify appropriate construction methodologies, reducing the likelihood of impacts to utilities	Moderate	Almost unprecedented	Low
Sustainability and climate change							
Emissions of greenhouse gases from embodied energy in materials	Minor	Likely	Medium	Sustainability initiatives, including a sustainable procurement strategy would reduce the consequence of impacts	Insignificant	Likely	Low

Potential impact	Initial risk rating (unmitigated)			Effect of key Stage 1 proposed mitigation measures ¹	Residual risk rating (with mitigation)		
	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating		Residual consequence	Residual likelihood	Residual risk rating
Emissions of greenhouse gases from construction activities, including emissions associated with energy use for tunnel boring machines	Minor	Likely	Medium	Sustainability initiatives, including offsetting 25 per cent of the greenhouse gas emissions associated with consumption of electricity during construction would reduce the potential consequence of this impact	Insignificant	Likely	Low
Cumulative impacts							
Potential temporary cumulative construction impacts, including potential construction fatigue with other major projects	Major	Almost certain	Very high	Coordination and consultation with relevant agencies and stakeholders would occur to manage the interface of projects under construction at the same time, including identifying conflicts and strategies to manage conflicts, such as making adjustments to construction program, work activities or haul routes, and coordination of traffic management arrangements between projects	Moderate	Almost certain	High

Note 1: Mitigation also includes measures proposed as part of the Construction Environmental Management Framework described in Chapter 28 (Synthesis of the Environmental Impact Statement).

28.6 Conclusions and next steps

The Concept environmental risk analysis (refer to Section 28.4) has identified the following issues as having a high or medium risk rating:

- Construction transport and traffic
- Construction noise and vibration
- Non-Aboriginal heritage
- Aboriginal heritage
- Landscape character and visual amenity
- Business impacts
- Social impacts
- Soils and surface water quality
- Contamination
- Hydrology and flooding
- Biodiversity
- Air quality
- Cumulative impacts.

These risks would be considered in greater detail during the assessment of future stages of Sydney Metro West. The risk analysis for the Concept will be re-examined during future environmental assessments for subsequent stages.

The Stage 1 environmental risk analysis (refer to Section 28.5) has identified that the following issues would have a high residual risk after implementation of the mitigation measures proposed in this Environmental Impact Statement:

- Construction transport and traffic
- Construction noise and vibration
- Aboriginal heritage
- Landscape character and visual amenity
- Cumulative impacts.

This suggests that an increased focus would be required on these aspects throughout construction of Stage 1 to reduce these risks further to meet an acceptable risk level. In particular, Sydney Metro has developed a Construction Noise and Vibration Standard (Appendix E) and Construction Traffic Management Framework (Appendix F) to manage the noise and vibration and transport and traffic related impacts respectively. The high residual risk rating for Aboriginal heritage and landscape character and visual amenity is based on the very high residual likelihood of unavoidable impacts at some of the construction sites.

Coordination and engagement with proponents for other concurrent or consecutive construction projects would continue through design and construction of Stage 1 so that opportunities to reduce or manage construction fatigue are identified. Ongoing community and stakeholder engagement would also be carried out so that potential cumulative impacts are better understood and reduced where possible.

Issues that would have a medium residual risk include:

- Non-Aboriginal heritage
- Business impacts
- Social impacts
- Soils and surface water quality
- Contamination
- Hydrology and flooding
- Biodiversity
- Air quality.

The assessment carried out for these issues has determined the likely extent of impacts can be suitably managed with the implementation of recommended feasible and reasonable mitigation measures. The implementation of the Construction Environmental Management Framework (Appendix D) would help to further reduce these potential impacts.

Issues that have a low residual risk can be adequately managed through detailed design and construction, and by the implementation of standard management measures so that all necessary environmental criteria and guidelines would be achieved. Issues with a low residual risk level include:

- Property and land use
- Groundwater and ground movement
- Spoil, waste management and resource use
- Hazards
- Sustainability and climate change.