ENVIRONMENTAL RISK ANALYSIS

CHAPTER TWENTY-EIGHT

28.3 Key issues identified

Various environmental risk identification and analyses have been undertaken throughout the development of the project (refer to Chapter 4 (Project development and alternatives) for a summary of the planning history of the project). Of most relevance to this environmental risk analysis is the risk analysis carried out as part of the *Chatswood to Sydenham State Significant Infrastructure Application Report* (Transport for NSW, 2015b).

This document, along with the assessments carried out as part of this Environmental Impact Statement identified the environmental issues associated with the project as:

- Construction traffic and transport
- Operational traffic and transport
- Construction noise and vibration
- Operational noise and vibration
- Land use and property
- Business impacts
- Non-Aboriginal heritage
- Aboriginal heritage
- Landscape character and visual amenity
- Groundwater and geology
- Soils, Contamination and water quality
- Social impacts and community infrastructure
- Biodiversity
- Flooding and hydrology
- Air quality
- Hazard and risk
- Waste management
- Sustainability
- Cumulative impacts.

28.4 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 31000:2009 Risk Management – Principles and Guidelines*. This involved:

- Ranking the risk of each identified potential impact by identifying the consequences of the impact and the likelihood of each impact occurring
- Considering the probable effectiveness of the proposed mitigation measures to determine the likely residual risk of each impact.

The first step in the risk analysis involved the identification of the consequence, should an impact occur. The definitions of the consequences used are provided in Table 28-2 and the definitions of likelihood are provided in Table 28-3. The risk rating was then determined by combining the consequence and likelihood to identify the level of risk as shown in the matrix in Table 28-4.

Table 28-2 Risk analysis consequence definitions

Consequence level	Definition
Catastrophic	• Long-term (greater than 12 months) and irreversible large-scale environmental, social or economic impacts • Extended substantial disruptions and impacts to stakeholder(s) or customers.
Severe	• Long-term (6 to 12 months) and potentially irreversible impacts • Extensive remediation required • Severe disruptions or long-term impacts to stakeholder(s) or customers.
Major	• Medium-term (between 3 and 6 months) and potentially irreversible impacts • Considerable remediation required • Major impacts or disruptions to stakeholder(s) or customers.
Moderate	• Medium-term (between 1 and 3 months), reversible and / or well-contained impacts • Minor remedial actions required • Moderate impacts or disruptions to stakeholder(s) or customers.
Minor	• Short-term (less than 1 month), reversible or minor impacts that are within environmental regulatory limits and within site boundaries • Minor or short-term impacts to stakeholder(s) or customers.
Insignificant	• No appreciable or noticeable changes to the environment • Negligible impact to environment, stakeholder(s) or customers.

Table 28-3 Risk analysis likelihood definitions

Likelihood	Definition	Probability
Almost certain	Expected to occur frequently during time of activity or project (10 or more times per year)	>90%
Likely	Expected to occur occasionally during time of activity or project (1 to 10 times per year)	75% to 90%
Possible	More likely to occur than not occur during time of activity or project (once per 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%
Rare	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	Consequence					
	Insignificant	Minor	Moderate	Major	Severe	Catastrophic
Almost unprecedented	Low	Low	Low	Low	Medium	Medium
Rare	Low	Low	Low	Medium	Medium	High
Unlikely	Low	Low	Medium	Medium	High	High
Possible	Low	Medium	Medium	High	High	Very high
Likely	Medium	Medium	High	High	Very high	Very high
Almost certain	Medium	High	High	Very high	Very high	Very high

28.5 Environmental risk analysis

Using the framework described above, an environmental risk analysis for the project is presented in Table 28-5. 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. The risk analysis also identifies the residual risk rating is arrived at after the application of mitigation measures developed and recommended by this Environmental Impact Statement.

Table 28-5 Environmental risk analysis

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Construction traffic and transport							
Pedestrians and cyclists							
• Diversions of pedestrian and cyclist facilities • Reduced pedestrian and cyclist access or flows due to construction • Pedestrian and cyclist safety	Major	Likely	High	Refer to mitigation in Chapter 8 (Construction traffic and transport)	Minor	Likely	Medium
Public transport							
• Relocation of bus stops • Impacts on reliability of public transport services (Sydney Trains and buses) • Increased travel times for customers during rail possessions	Moderate	Likely	High	Refer to mitigation in Chapter 8 (Construction traffic and transport)	Minor	Likely	Medium
Road network							
• Deterioration of traffic performance on surrounding road network due to construction vehicles • Deterioration of traffic performance due to road or lane closures • Loss of parking spaces or loading zones • Impacts on access to private property • Traffic safety and impacts on marine traffic	Major	Likely	High	Refer to mitigation in Chapter 8 (Construction traffic and transport)	Moderate	Likely	High

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Operational traffic and transport							
Pedestrians and cyclists							
• Additional pedestrian load on existing infrastructure resulting in less efficient pedestrian movements at Victoria Cross and Martin Place • Provision of facilities to provide for cyclist interchange at or around stations	Major	Likely	High	Refer to mitigation in Chapter 9 (Operational traffic and transport)	Moderate	Likely	High
Public transport							
• Improved public transport system capacity and efficiency • Provision of facilities to provide for public transport interchange at or around stations	Positive						
Motorists							
• Deterioration in intersection performance at Pacific Highway / Mowbray Road • No material change in intersection performance at all other locations • Provision of kiss-and-ride facilities to provide for motor vehicle interchange at or around stations • Wider road network benefits including reduced road congestion	Minor	Likely	Medium	None beyond project design	Minor	Likely	Medium

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Construction noise and vibration							
Ground-borne noise							
• Ground-borne noise from tunneling exceed the criteria	Moderate	Likely	High	Refer to mitigation in Chapter 10 (Construction noise and vibration)	Minor	Likely	Medium
Air borne noise							
• Unacceptable airborne noise impacts from surface construction sites during standard construction hours • Unacceptable airborne noise impacts from surface construction sites outside standard construction hours • Construction traffic results in an increase in traffic noise greater than 2 dB	Major	Likely	High	Refer to mitigation in Chapter 10 (Construction noise and vibration)	Moderate	Likely	High
Vibration							
• Vibration from tunneling works exceed human comfort or damage levels • Vibration from surface works exceed human comfort or damage levels	Major	Likely	High	Refer to mitigation in Chapter 10 (Construction noise and vibration)	Minor	Likely	Medium

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Operational noise and vibration							
Ground-borne noise							
• Unacceptable ground-borne noise impacts	Major	Possible	High	Refer to mitigation in Chapter 11 (Operational noise and vibration)	Minor	Unlikely	Low
Air borne noise							
• Unacceptable airborne noise impacts due to the number of trains and proximity to receivers • Unacceptable airborne noise impacts at stations or other at-surface ancillary infrastructure from fresh air ventilation, mechanical and electrical equipment, substations, public address systems, etc	Major	Possible	High	Refer to mitigation in Chapter 11 (Operational noise and vibration)	Major	Unlikely	Low
Vibration							
• Unacceptable vibration impacts resulting in exceedance of human comfort levels • Unacceptable vibration impacts resulting in exceedance of building or structure damage levels	Major	Possible	High	Refer to mitigation in Chapter 11 (Operational noise and vibration)	Minor	Unlikely	Low

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Property and land use							
Onsite (direct)							
• Residual land use and ability for appropriate reuse or development • Property acquisition • Direct impacts on other infrastructure during construction including utilities and Sydney Trains property	Major	Likely	High	Refer to mitigation in Chapter 12 (Land use and property)	Minor	Likely	Medium
Surrounding (indirect)							
• Potential restrictions on future development within defined corridor due to subsurface tunnels	Major	Likely	High	Refer to mitigation in Chapter 12 (Land use and property)	Minor	Likely	Medium
Surrounding (indirect)							
• Uplift potential • Potential change in land use and zoning provisions surrounding new station sites	Positive. The project would likely be a catalyst for uplift which is consistent with the strategic planning documents such as *A Plan for Growing Sydney*.						

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Business impacts							
Businesses directly impacted (removed)							
• Permanent loss of business due to acquisition	Major	Likely	High	Refer to mitigation in Chapter 13 (Business impacts)	Minor	Likely	Medium
Business amenity during construction							
Altered access and visibility to businesses (deliveries, patrons, employees) during construction Impacts on businesses during construction (due to loss of amenity)	Major	Likely	High	Refer to mitigation in Chapter 13 (Business impacts)	Moderate	Possible	Medium
Increased trade for food and beverage during construction	Positive						
Business amenity during operation							
• Altered access and visibility to businesses (deliveries, patrons, employees) during operation • Impacts on businesses during operation (due to changes in amenity)	Minor	Likely	Medium	Refer to mitigation in Chapter 13 (Business impacts)	Minor	Unlikely	Low
• Increased commercial rents during operation	Moderate	Unlikely	Medium	N/A	Moderate	Unlikely	Medium
Indirect outcomes for businesses during operation							
• Enhanced business connectivity during operation • Staff access, recruitment and retention during operation • Enhanced access for customers during operation • Development stimulus during operation	Positive						

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Non-Aboriginal heritage							
Direct impacts to non-Aboriginal heritage items							
• Direct impacts on world heritage and / or Commonwealth or National heritage items • Direct impacts on State, section 170 (of the Heritage Act, 1979) or locally listed heritage items • Change to the values of a heritage conservation area.	Major	Almost certain	Very high	Refer to mitigation in Chapter 14 (Non-Aboriginal heritage)	Moderate	Likely	High
Potential direct impacts to non-Aboriginal heritage items							
• Change to the values of a heritage conservation area during operation • Damage to heritage items from vibration during construction or operation	Major	Almost certain	Very high	Refer to mitigation in Chapter 14 (Non-Aboriginal heritage)	Moderate	Possible	Medium
Indirect impacts to non-Aboriginal heritage items							
• Unsympathetic design that detracts from the heritage significance of a nearby item • Project elements that impact the landscape character or heritage context of heritage items	Moderate	Likely	High	Refer to mitigation in Chapter 14 (Non-Aboriginal heritage)	Minor	Possible	Medium
Potential impacts to archaeology							
• Impacts on unknown heritage items (eg archaeological items) during construction.	Major	Possible	High	Refer to mitigation in Chapter 14 (Non-Aboriginal heritage)	Moderate	Unlikely	Medium

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Aboriginal heritage							
• Impacts on known Aboriginal heritage items	Major	Almost unprece-dented	Low	Refer to mitigation in Chapter 15 (Aboriginal heritage)	Moderate	Rare	Low
• Impacts on areas of known Aboriginal cultural sensitivity	Major	Possible	High	Refer to mitigation in Chapter 15 (Aboriginal heritage)	Major	Rare	Medium
• Impacts on unidentified Aboriginal heritage items	Major	Possible	High	Refer to mitigation in Chapter 15 (Aboriginal heritage)	Major	Rare	Medium
Landscape character and visual amenity							
Construction							
• Adverse visual impacts due to the presence of construction activities and compounds • Adverse impacts on landscape character during construction • Light spill from out-of-hours works during construction	Moderate	Likely	High	Refer to mitigation in Chapter 16 (Landscape character and visual amenity)	Moderate	Possible	Medium
Operation							
• Adverse visual impacts associated with the introduction of new stations • Adverse visual impacts associated with the introduction of other surface infrastructure (tunnel portals, fresh air tunnel ventilation facilities, etc) • Adverse impacts on landscape character during operation • Light spill from stations at night	Minor	Likely	Medium	Refer to mitigation in Chapter 16 (Landscape character and visual amenity)	Minor	Possible	Medium

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Groundwater and geology							
Groundwater levels							
• Impacts on groundwater flows and levels during tunnel construction and station excavation • Ongoing operational changes to ground-water flows and levels from underground stations and other drained structures	Minor	Likely	Medium	Refer to mitigation in Chapter 17 (Groundwater and geology)	Minor	Unlikely	Low
Settlement							
• Ground movement / settlement due to tunnelling and other excavations	Moderate	Likely	High	Refer to mitigation in Chapter 17 (Groundwater and geology)	Insignificant	Likely	Medium
Soils, Contamination and water quality							
Soils							
• Erosion of soils resulting in offsite sedimentation during construction • Exposure of acid sulfate soils during construction • Exposure of soil salinity / saline soils during construction	Major	Likely	High	Refer to mitigation in Chapter 18 (Soils, contamination and water quality)	Moderate	Possible	Medium
Contamination							
• Contamination of groundwater due to spills and leaks during construction and operation • Contamination of land due to spills and leaks during construction and operation • Disturbance of contaminated land during construction	Major	Likely	High	Refer to mitigation in Chapter 18 (Soils, contamination and water quality)	Moderate	Possible	Medium

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Water quality							
• Water quality impacts due to spills and erosion from the project site during operation • Water quality impacts due to discharge of captured groundwater during construction and operation • Water quality impacts on nearby watercourses due to runoff from the project site resulting in sedimentation to waterways during construction • Water quality impacts on nearby watercourses due to Contamination / spills from the project site during construction • Water quality impacts associated with the Sydney Harbour ground improvement works	Major	Likely	High	Refer to mitigation in Chapter 18 (Soils, contamination and water quality)	Moderate	Possible	Medium

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Social impacts and community infrastructure							
Social infrastructure							
• Loss of community facilities / open space for construction purposes • Impacts on community facilities due to changes to access during construction	Moderate	Likely	High	Refer to mitigation in Chapter 19 (Social impacts and community infrastructure)	Moderate	Likely	High
Broader social impacts							
• Improved public transport to regional community infrastructure during operation	Positive						
• Impacts on access to areas / community facilities of regional significance during construction	Moderate	Likely	High	Refer to mitigation in Chapter 19 (Social impacts and community infrastructure)	Moderate	Possible	Medium
Health							
• Electromagnetic fields from operational substations • Potential impacts associated with long term construction noise	Moderate	Likely	High	Refer to mitigation in Chapter 19 (Social impacts and community infrastructure)	Minor	Likely	Medium
• Health benefits associated with public transport	Positive						

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Biodiversity							
Flora							
• Impacts on threatened ecological communities within the construction footprint • Impacts on threatened ecological communities outside of the construction footprint • Impact on native vegetation (non-threatened ecological communities) outside of the construction footprint • Significant impacts on threatened flora species • Impacts on previously unidentified threatened flora species	Moderate	Rare	Low	Refer to mitigation in Chapter 20 (Biodiversity)	Minor	Rare	Low
Fauna							
• Impacts on groundwater dependent ecosystems • Significant impacts on threatened fauna species and endangered populations • Impacts to aquatic ecology associated with Sydney Harbour crossing works	Moderate	Rare	Low	Refer to mitigation in Chapter 20 (Biodiversity)	Minor	Rare	Low
Hydrology and flooding							
Impacts of flooding on the project							
• Flooding of the tunnels during construction and operation • Impacts on construction activities due to flooding	Moderate	Possible	Medium	Primarily incorporated into project design. Also refer to mitigation in Chapter 21 (Flooding and hydrology)	Moderate	Rare	Low
Impacts on flooding due to the project							

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
• Impacts on flood-prone areas (eg increase flooding outside the project site) during construction and operation	Moderate	Likely	High	Primarily incorporated into project design. Also refer to mitigation in Chapter 21 (Flooding and hydrology)	Minor	Possible	Medium
Air quality							
Construction							
• Impacts on local air quality due to construction plant and equipment and increase in vehicle movements • Impacts on local air quality due to dust generation from exposed surfaces, spoil stockpiles or spoil haulage	Minor	Likely	Medium	Refer to mitigation in Chapter 22 (Air quality)	Minor	Unlikely	Low
Operation							
• Impacts on local air quality during operation	Minor	Possible	Medium	Refer to mitigation in Chapter 22 (Air quality)	Minor	Rare	Low
Hazard and risk							
Construction							
• Transport and storage of hazardous substances and dangerous goods during construction • Potential for tunnel collapse during construction	Major	Unlikely	Medium	Refer to mitigation in Chapter 23 (Hazard and risk)	Major	Almost unprece-dented	Low
Operation							
• Transport and storage of hazardous substances and dangerous goods during operation	Major	Rare	Medium	Refer to mitigation in Chapter 23 (Hazard and risk)	Moderate	Rare	Low

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Waste management							
Construction							
• Impacts associated with the management of waste during construction • Impacts associated with the management and disposal of excess spoil from tunnel construction	Moderate	Likely	High	Refer to mitigation in Chapter 24 (Waste management)	Moderate	Unlikely	Medium
Operation							
• Impacts associated with the management of waste during operation	Minor	Likely	Medium	Refer to mitigation in Chapter 24 (Waste management)	Minor	Unlikely	Low
Sustainability							
Greenhouse gas							
• Emissions of greenhouse gases from operational energy use and embodied energy in materials • Emissions of greenhouse gases from construction activities including energy use for tunnel boring machines	Minor	Possible	Medium	Refer to mitigation in Chapter 25 (Sustainability)	Insignificant	Possible	Low
Climate change adaptation							
• Impact of climate change on rail operations and infrastructure • Impact of climate change on customer and staff comfort	Major	Unlikely	Medium	Refer to mitigation in Chapter 25 (Sustainability)	Moderate	Unlikely	Medium

Potential impact	Unmitigated consequence	Unmitigated likelihood	Unmitigated risk rating	Proposed mitigation	Residual consequence	Residual likelihood	Residual risk rating
Resource use							
• Increased electricity use during operation • Increased demand on electricity and water supply during construction • Increased demand on local and regional resources including sand and aggregate during construction • Increased diesel use during construction	Minor	Possible	Medium	Refer to mitigation in Chapter 25 (Sustainability)	Insignificant	Possible	Low
Cumulative impacts							
• Construction noise and traffic associated with CBD and South East Light Rail • Construction noise and traffic associated with WestConnex • Spoil management and disposal from multiple tunnelling projects in Sydney (ie WestConnex and NorthConnex) • Other stages of Sydney Metro such as Sydney Metro Northwest and Sydenham to Bankstown upgrade • Construction noise and traffic associated with other developments in proximity to the construction sites	Major	Likely	High	Refer to mitigation in Chapter 26 (Cumulative impacts)	Moderate	Likely	High

28.6 Conclusion and next steps

The environmental risk analysis has identified that the following issues would have a high residual risk after the incorporation of the mitigation measures proposed in this Environmental Impact Statement:

- Construction traffic and transport, specifically potential impacts to the road network
- Operational traffic and transport, specifically pedestrian movement impacts
- Construction noise and vibration, specifically potential airborne noise impacts
- Non-Aboriginal heritage, specifically direct impacts to heritage items
- Social impacts and community infrastructure, specifically the loss of open space during construction
- Cumulative impacts, especially construction noise and traffic within the Sydney CBD.

This suggests that an increased focus would be required on these aspects throughout the construction of the project to meet an acceptable risk level.

Other issues that would have a moderate residual risk include:

- Land use and property and land use
- Business impacts
- Aboriginal heritage
- Landscape character and visual amenity
- Groundwater and geology
- Soils, Contamination and water quality
- Flooding and hydrology
- Hazard and risk
- Waste management
- Sustainability.

The level of assessment carried out for these issues has determined the likely extent of impacts and recommended appropriate mitigation required to ensure that the risk would be abated.

Operational noise and vibration, biodiversity and air quality have a low residual risk. It is expected that these issues can be adequately managed through detailed design and construction, and by the implementation of standard management measures aimed at ensuring that all necessary environmental criteria and guidelines would be achieved.