Part

B

Part B

Environmental assessment

Chapter 9

Traffic, transport and access

This chapter provides a summary of the traffic, transport and access assessment. It describes the existing environment, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 1 (Transport, Traffic and Access).

The SEARs and MDP requirements relevant to traffic, transport and access are listed below. Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
1	**Transport and traffic**	
1.1	The Proponent must assess construction transport and traffic (network, vehicle (including freight traffic) pedestrian and cyclists) impacts, including, but not necessarily limited to:	
	(a) a considered approach to route identification and scheduling of construction vehicle movements, with particular consideration of traffic impacts and transport movements outside standard construction hours including cumulative impacts;	Chapter 8 and section 5.1.5 of Technical Working Paper 1
	(b) the indicative number, frequency and size of construction related vehicles (passenger, commercial and heavy vehicles, including spoil management movements);	Chapter 8 and section 5.1.7 of Technical Working Paper 1
	(c) construction worker parking;	Chapter 8 and section 5.1.4 of Technical Working Paper 1
	(d) the nature of existing traffic (types and number of movements) on construction access routes (including consideration of peak traffic times, pedestrians and cyclists and parking arrangements);	Sections 9.2.2 (traffic volumes), 9.2.5 (active transport) 9.2.6 (parking)
	(e) access constraints and impacts on public transport, pedestrians and cyclists (infrastructure and services);	Sections 9.3.4 and 9.3.5
	(f) the need to close, divert or otherwise reconfigure elements of the road, pedestrian and cycle network associated with construction of the proposal and the duration of these changes;	Sections 8.3.3, 8.6.5 and 9.3.1
	(g) impacts to on street parking, including for residents and businesses;	Section 9.3.7
	(h) cumulative impacts on the road, pedestrian and cycle network from other key infrastructure proposals including but not limited to the Botany Rail Duplication and New M5.	Section 9.5.1
1.2	The Proponent must assess (and model) the operational transport impacts of the proposal, including:	
	(a) forecast travel demand and road traffic volumes for the proposal and the surrounding road, airport, freight, port, cycle and public transport network;	Sections 9.4.1 (traffic demand and volumes), 9.4.6 (public transport), and 9.4.7 (active transport)
	(b) travel time analysis for the different road transport modes	Section 9.4.2
	(c) performance of key interchanges and intersections by undertaking a level of service analysis at key locations;	Sections 9.4.3 and 9.4.4

Reference	Requirement	Where addressed
	(d) wider transport interactions (local and regional roads, cycling, public transport, airport, port and freight transport);	Sections 9.4.1 to 9.4.7
	(e) induced traffic and operational implications for public transport (particularly with respect to strategic bus corridors and bus routes) and consideration of opportunities to improve public transport;	Sections 9.1.2 and 9.4.6
	(f) property and business access and on-street parking.	Sections 9.4.8 and 9.4.9
4	**Place making and urban design**	
4.2	The Proponent must describe the accessibility elements of the proposal including relevant accessibility legislation and guidelines, including: (a) impacts on public transport infrastructure and services;	Sections 9.3.4 and 9.4.6
	(b) impacts on cyclists and pedestrian access, amenity and safety across and adjoining the proposal, including the relocation of cycle routes and delivery of new cycleways around the airport and Alexandra Canal; and	Sections 7.9, 8.6.4, 9.3.5 and 9.4.7
	(c) opportunities to integrate and enhance accessibility including the provisions for public and active transport infrastructure as a result of the proposal.	Section 9.6.2
Major development plan requirements *(in accordance with Section 91 of the Airports Act)*		
91(1)(ga)	The likely effect of the proposed developments that are set out in the major development plan, or the draft of the major development plan, on: (i) traffic flows at the airport and surrounding the airport	Section 9.4.10

9. Traffic, transport and access

9.1 Assessment approach

Constructing and operating new road infrastructure has the potential to affect existing traffic and transport conditions, and change access arrangements. This can impact the local and regional community, as well as access to critical infrastructure. It is important that these potential impacts are identified and understood prior to construction. The assessment addresses the potential impacts on all forms of transport, with a primary focus on the operation of the road network.

An overview of the approach to the assessment is provided below, including the legislative and policy context and a summary of the assessment methodology.

9.1.1 Legislative and policy context to the assessment

The assessment has been undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations
- *Traffic Modelling Guidelines* (Roads and Maritime, 2013a)
- *Guide to Traffic Generating Developments* (Roads and Traffic Authority, 2002)
- *Guide to Traffic Management: Part 3 Traffic Studies and Analysis* (Austroads, 2017)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

9.1.2 Methodology

Study area

The study area for the assessment generally extends from St Peters and Erskineville in the north to Banksia in the south-west and Botany in the south-east. It includes the road and transport networks surrounding Sydney Airport, including those within Mascot, St Peters and Tempe. The study area is shown on Figure 9.1.

A different (larger) area was used for the traffic modelling to facilitate evaluation of changes to the regional transport networks and the potential impacts these changes may have on the project in future years.

Figure 9.1 **Traffic and transport assessment study area**

Key tasks

The assessment involved:

- Identifying existing traffic conditions, including traffic patterns, mode share, public and active transport networks, car parking arrangements, and access
- Analysing existing and future traffic volumes using traffic models (described below)
- Modelling future road network performance with and without the project
- Reporting on the operational performance of the existing and future road network in the vicinity of the project site, considering the potential impacts of the project and other road projects
- Identifying measures to manage and mitigate the identified impacts.

A flowchart summary of the methodology is shown on Figure 9.2. A detailed description of the assessment methodology is provided in section 3 of Technical Working Paper 1 (Transport, Traffic and Access).

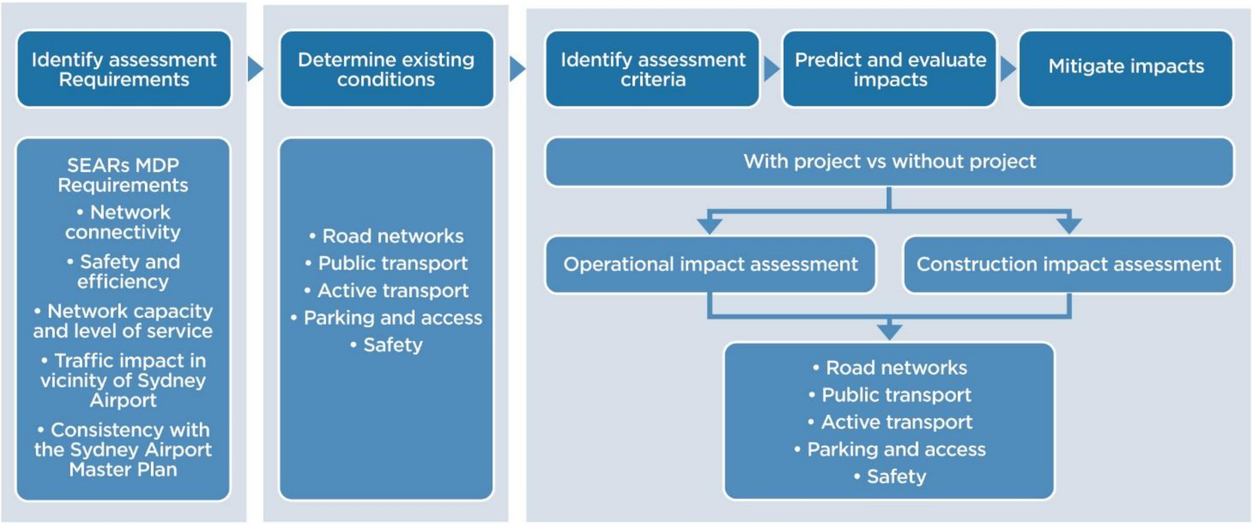


Figure 9.2 Methodology overview

Overview of traffic network modelling

Modelling approach

Traffic modelling was undertaken to make realistic predictions about the potential future traffic conditions in the study area, including travel demand and likely traffic volumes. These predictions were used to assess the operational performance of the road network, with and without the project in place.

The modelling comprised three stages using three different models. It included strategic and operational modelling to assess the potential impacts of the project at:

- The regional level – on the wider Sydney road network
- The local level – on the road network in the immediate vicinity of the project site.

The following models were used for this staged approach:

- Sydney Strategic Travel Model – this model was used for the first stage of modelling to predict travel demand as a result of future population, employment and infrastructure changes
- Strategic Motorway Planning Model – this model was used for the second stage of modelling to evaluate road travel demand across Sydney under different land use, transport infrastructure and pricing scenarios, using the forecasted travel demand from the Sydney Strategic Travel Model

- The Sydney Gateway Operational Model – this model was used for the third stage of modelling, taking the outputs from the Strategic Motorway Planning Model to predict the operational performance of the road network in the study area.

Following selection and development of a baseline model representing the baseline year, the Sydney Gateway Operational Model was calibrated and validated by matching observed traffic volumes and travel times. The model was reviewed by Roads and Maritime and deemed suitable for assessing the potential impacts of the project.

The main outputs from modelling that were used to assess the potential impacts of the project were changes to:

- Traffic volumes, patterns and travel demand
- Intersection/interchange performance (average delay and level of service)
- Vehicle travel times for a given trip distance.

The Strategic Motorway Planning Model considers induced traffic demand, including latent demand. For the project, induced demand is less relevant because the project involves completing a ‘missing link’ between the Sydney motorway network and Sydney Airport. As a result, it is unlikely that the project would generate new vehicle trips and there would be minimal latent demand associated with Sydney Airport. In other words, the primary traffic impact of the project would be to take existing traffic away from local roads and alleviate pressure on the local road network, while at the same time reducing travel time to areas in and around Sydney Airport. Any induced demand considered as part of the Strategic Motorway Planning Model has been included in the road network performance predictions in sections 9.3 and 9.4.

Construction stage modelling

The Sydney Gateway Operational Model was also used to undertake the construction traffic modelling assessment for both the morning and afternoon peak periods. A 2022 future baseline model scenario was created, excluding construction-related traffic. This baseline scenario acts as a benchmark against which the potential impacts of the project can be assessed. It takes into account future traffic volume increases and road upgrades/modifications that have occurred, or are expected to occur, without the project.

To simulate various construction activities and changes over the construction period, three construction scenarios were assessed as being representative of the most disruptive changes to traffic conditions. The location of these changes focussed on the most affected portions of the road network, in the vicinity of Terminals 2/3, Qantas Drive, Airport Drive, and the access to Marsh Street and Terminal 1. Each scenario comprised changes at or near Airport Drive/Link Road and along Qantas Drive between Robey and O’Riordan streets. The following construction scenarios were considered by the modelling:

- Scenario 1:
  - Eastbound Airport Drive traffic reduced to two lanes in the vicinity of Link Road and uses new Terminal 1 connection bridge
  - Reconfigured Airport Drive/Link Road intersection, including second northbound right turn lane at Link Road intersection removed
  - Existing westbound kerbside lane removed from Qantas Drive between Ninth Street and west of Robey Street
  - Existing southbound kerbside lane removed on Sir Reginald Ansett Drive
  - Signals removed at Lancastrian Road and intersection converted to left in/out only.
- Scenario 2 – same as scenario 1 with the addition of:
  - Left turn from Seventh Street reconfigured to double left turn slip lane, merging to a single lane
  - Median lane removed eastbound on Qantas Drive both west and east of Robey Street
  - Ninth Street deceleration and acceleration lanes removed.

- Scenario 3 – same as scenario 2 with the addition of:
  - Westbound traffic uses the Terminal 1 connection bridge to Airport Drive west of Link Road
  - Existing westbound Airport Drive carriageway removed
  - Second northbound right turn lane at Link Road intersection re-introduced.

Operational stage modelling

Operational modelling considered a number of future scenarios factoring in changes to the road network over the following years:

- 2016/18 – the adopted baseline year for the strategic and operational models
- 2022 – the adopted year in which construction impacts would be assessed
- 2026 – the adopted year of project opening
- 2036 – the period ten years after the adopted project opening year, as required by the *Traffic Modelling Guidelines* (Roads and Maritime, 2013a).

'Cumulative' scenarios were also assessed (for 2026 and 2036) to predict the potential cumulative impacts of all planned projects, including the F6 Extension Stage 1 and Western Harbour Tunnel and Beaches Link.

Table 9.1 summarises the operational stage scenarios that were modelled.

Table 9.1 Summary of model assessment scenarios

Scenario	Details
Without project (2026)	Future network without the project, including other road network improvements (NorthConnex, M4 Widening, M4 East, New M5, M4-M5 Link and Rozelle Interchange)
With project (2026)	Consistent with the 'without project (2026)' scenario, but with the project open to traffic
With project cumulative (2026)	Consistent with the 'with project (2026)' scenario, but with F6 Extension Stage 1 open to traffic
Without project (2036)	Future network without the project, including NorthConnex, M4 Widening, M4 East, New M5, M4-M5 Link and Rozelle Interchange
With project (2036)	Consistent with the 'without project (2036)' scenario, but with the project open to traffic
With project cumulative (2036)	Consistent with the 'with project (2036)' scenario, but with F6 Extension Stage 1, F6 Extension Stage 2, Rozelle Interchange, Western Harbour Tunnel and the Beaches Link open to traffic

Impact assessment

The performance of a road traffic network can be assessed in a number of ways, including:

- At a network level, which includes total vehicles using the network, their average speed and average travel time
- At a midblock level (ie the volume of vehicles crossing an arbitrary line some distance from an intersection), which represents changes to travel routes and the impacts of these changes
- At an intersection level, which represents changes to the performance of intersections.

The traffic models were used to establish baseline conditions so that changes associated with constructing and operating the project can be isolated and analysed using the above measures, to determine whether impacts can be mitigated.

Traffic volumes and patterns

Traffic volumes and patterns were assessed by comparing the changes to traffic volumes between the 2026 and 2036 conditions, with and without the project. This provides an assessment of the changes to traffic volumes as a result of the project. It also provides an indication of the potential induced or additional traffic attracted to the local area as a result of the new road infrastructure.

Outputs from the Strategic Motorway Planning Model and Operational Model have been used to show the changes to average daily traffic volumes and morning and afternoon peak traffic volumes. The traffic volumes output by the models represent average weekday volumes and exclude public and school holidays. The changes to traffic volumes also included heavy vehicles and total vehicles (light vehicles and heavy vehicles combined).

Travel demand and traffic shifts

Travel demand and traffic shifts were also assessed using outputs from the Strategic Motorway Planning Model and Operational Model to indicate average weekday traffic, and morning and afternoon peak period traffic volumes, moving across ‘screenlines’. A screenline is an imaginary line on a map (or in a model) at which point changes to traffic volumes (and patterns) can be consistently measured and compared for different scenarios. Three screenlines were analysed for the project (see Figure 9.3):

- Sydney Gateway screenline
- F6 screenline
- Port Botany screenline.

The following were analysed for each screenline, for existing and 2026/2036 conditions, with and without the project:

- Directional and two-way traffic volumes
- Proportion of the total screenline traffic volume
- Total traffic volumes crossing the screenline.

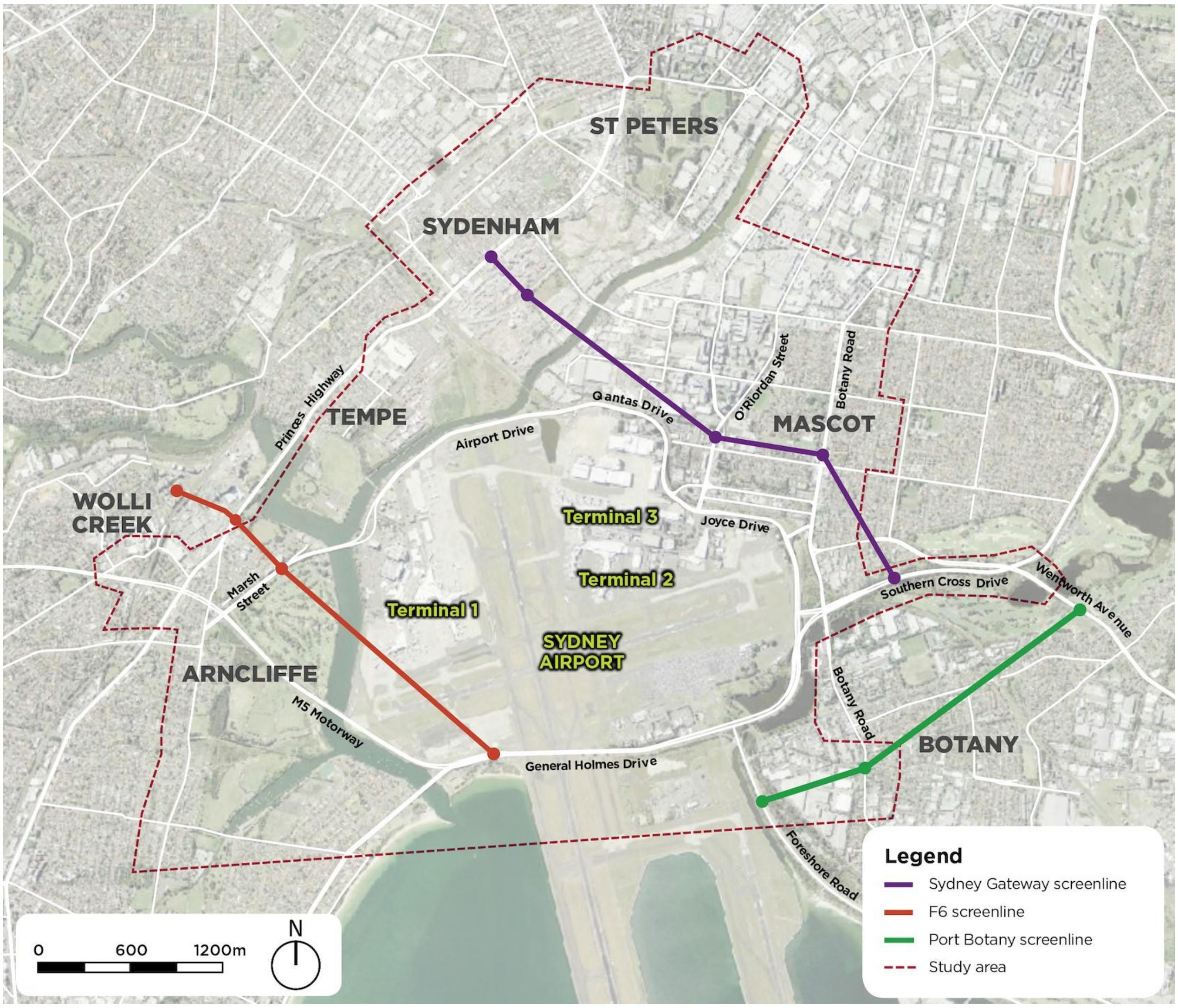


Figure 9.3 Location of assessment screenlines

Intersection assessment

The potential for impacts during both construction and operation were considered for the following key intersections, due to their proximity to the project site (shown in purple on Figure 9.4):

1. Robey Street/O'Riordan Street
2. Seventh Street/Qantas Drive
3. Joyce Drive/O'Riordan Street/Sir Reginald Ansett Drive
4. Airport Drive/Link Road.

The potential for operation impacts was considered at the following intersections (shown in red on Figure 9.4):

5. West Botany Street/Marsh Street
6. Marsh Street/M5 motorway
7. General Holmes Drive/Mill Pond Drive
8. Botany Road/Mill Pond Drive
9. Joyce Drive/General Holmes Drive
10. Botany Road/General Holmes Drive
11. King Street/O'Riordan Street
12. O'Riordan Street/Bourke Road
13. Bourke Street/Coward Street
14. Coward Street/O'Riordan Street
15. Gardeners Road/Bourke Street
16. Kent Road/Ricketty Street
17. Botany Road/Gardeners Road
18. Kent Road/Coward Street
19. Canal Road/Burrows Road
20. O'Riordan Street/Gardeners Road
21. Kent Street/Gardeners Road.

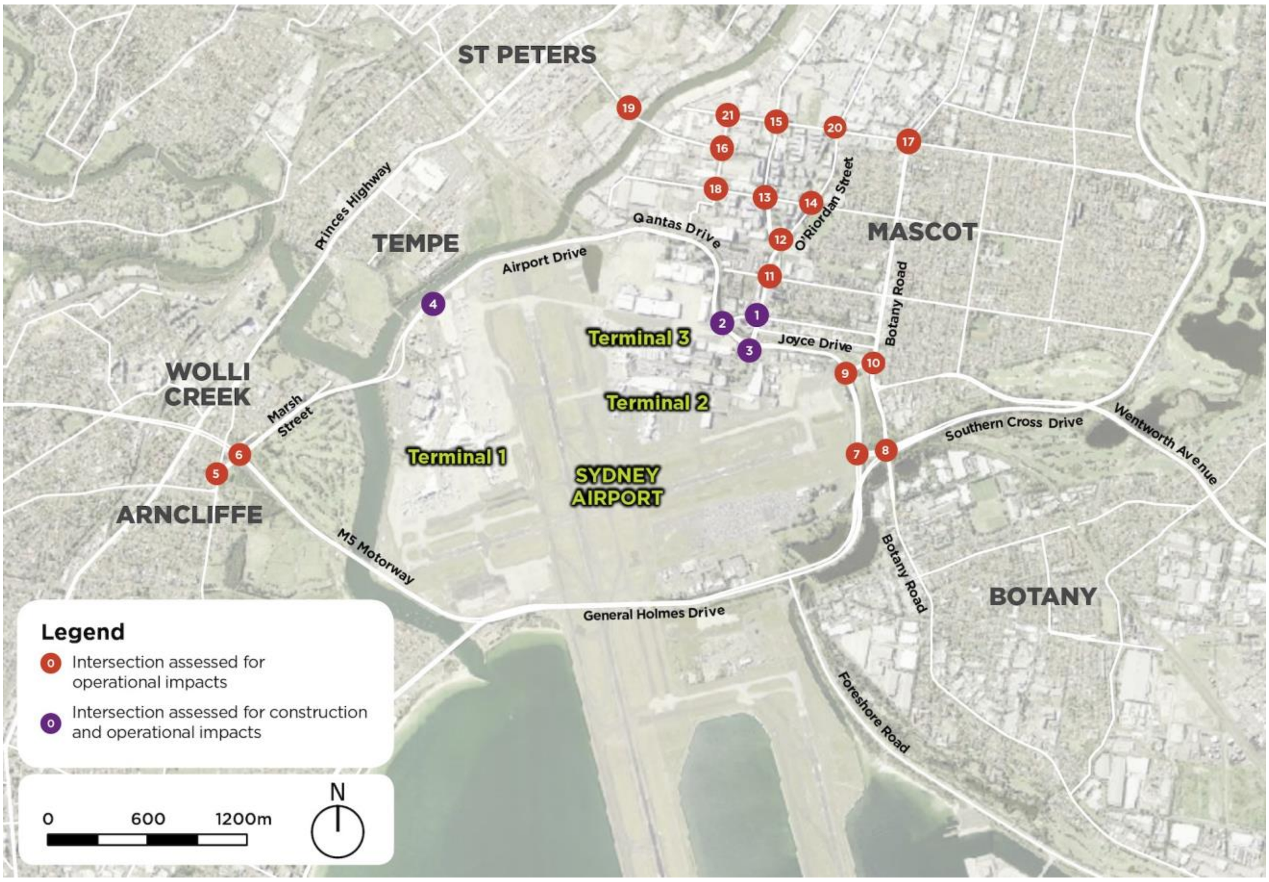


Figure 9.4 **Location of key intersections for assessment**

Travel time changes

Travel times along key routes were used to determine the relative impacts or benefits of the project by comparing changes with and without the project. Modelling of travel time was undertaken for the following routes (see Figure 9.5):

Construction stage:

- Airport Drive – Flora Street to Robey Street
- O'Riordan Street – Terminals 2/3 to Gardeners Road
- General Holmes Drive – the M5 East to Mill Pond Road.

Operational stage:

- Princes Highway – May Street (St Peters) to Wickham Street/Forest Road
- Princes Highway/West Botany Street – May Street (St Peters) to Bestic Street
- M5 East – Marsh Street to the M1 at Southern Cross Drive
- M5 East – Marsh Street to Botany Road via the M1
- Marsh Street – M5 intersection with Marsh Street to Joyce Drive/General Holmes Drive
- Canal Road – Princes Highway to Botany Road/Gardeners Road
- Botany Road – Gardeners Road to Mill Pond Drive/Botany Road
- Robey Street – Qantas Drive to Botany Road
- O’Riordan Street – Joyce Drive to Gardeners Road
- O’Riordan Street – Joyce Drive to Bourke Road
- Coward Street – Kent Road to Botany Road
- Unwins Bridge Road – May Street/Princes Highway to Railway Road.

These routes were selected as they provide good coverage of the study area and are representative of travel times experienced by road users.

The following additional routes were analysed to determine the relative impacts or benefits in terms of access to Sydney Airport and Port Botany:

- Between Sydney Airport and Mascot, via St Peters interchange
- Between Foreshore Road near Port Botany and Mascot, via St Peters interchange
- Between Foreshore Road near Port Botany and the M5 East.

Figure 9.5 Routes used for travel time analysis

Public and active transport, parking and access assessment

The following were used to identify and assess potential impacts on services or existing conditions:

- Changes to existing conditions (eg bus services, active transport routes, parking provisions or accessibility)
- Changes to connectivity with the surrounding network/other facilities
- Impact on users (eg increased walking distances, changes to travel times, etc).

9.1.3 Assessment criteria

Intersection level of service

Road network performance was evaluated using average delay and level of service. Average delay is commonly used to assess the operational performance of intersections, with level of service used as an index. Level of service is measured on a scale from A to F, with A representing optimal operating conditions and F representing the worst operating conditions. When roadway performance falls below a level of service D, investigations are generally initiated to determine if suitable remediation can be provided. However, limited road capacity and high demand often mean that a level of service E or F are regularly experienced during peak periods at pinch points on Sydney's road network.

A summary of the intersection level of service and average delay criteria is shown in Table 9.2.

Table 9.2 Level of service criteria for intersections

Level of service	Average delay/vehicle (secs)	Traffic signals/roundabouts	Give way and stop signs
A	<14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Good with acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents would cause excessive delays	At capacity; requires other control modes
F	>70	Roundabouts require other control modes	At capacity; requires other control modes

Source: *Guide to Traffic Generating Developments* (Roads and Traffic Authority, 2002)

Midblock level of service

Midblock performance is also measured using level of service. The level of service for freeway or motorway sections where the design speed is more than 70 km/h is calculated based on the vehicle density, which is the traffic volume divided by the average passenger car speed. Density is measured in passenger car units per kilometre per lane (PCU/km/lane). The level of service for freeway or motorway sections where the design speed is 70 km/h or less is calculated based on the volume/capacity (V/C) ratio, which is the traffic volume divided by the capacity of the roadway.

Table 9.3 shows the six levels of service used for midblock assessment.

Table 9.3 Midblock level of service criteria

Level of service	Definition	Multi-lane roads[1]	Freeways[2]
		V/C ratio	Density (PCU/km/lane)
A	A condition in which individual drivers are virtually unaffected by the presence of others in the traffic stream.	≤ 0.26	≤ 7.0
B	A condition where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream.	0.27 to 0.41	7.1 to 11.0
C	A conditions where most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream.	0.42 to 0.59	11.1 to 16.0
D	Drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream.	0.60 to 0.81	16.1 to 22.0
E	Traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Minor disturbances within the traffic stream would cause queuing and delays.	0.82 to 1.00	22.1 to 28.0
F	The amount of traffic approaching a point exceeds the amount which can pass it. Queuing and delays result.	> 1.00	> 28.0

Source: *Guide to Traffic Management: Part 3 Traffic Studies and Analysis* (Austroads, 2017)

Notes: 1. Free flow speed is taken as 70 kilometres per hour
2. Free flow speed is taken as 90 kilometres per hour

9.1.4 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Traffic, transport and access risks with an assessed risk rating of medium or above, identified by the environmental risk assessment, included:

- Changes to intersection and traffic performance during construction, including as a result of heavy vehicle movements, narrowing of lanes, speed restrictions and lane closures
- Disruptions and delays to public transport and emergency services during construction
- Impacts on access to commercial properties during construction
- Impacts on the shared paths in Tempe and along Alexandra Canal during construction
- Cumulative traffic and transport impacts during construction, taking into account other projects in the study area (particularly the Botany Rail Duplication)
- Impacts on access to Sydney Airport during construction and operation
- Impacts associated with the closure of Swamp Road and changes to access arrangements along Burrows Road during construction and operation.

The traffic, transport and access assessment included consideration of these potential risks.

9.2 Existing environment

Key traffic, transport and access features of the study area are described below and shown on Figure 9.6 and Figure 9.7. Further information on the regional transport context, including significant transport infrastructure in the study area (ie Sydney Airport and freight facilities), is provided in section 2.2.1.

9.2.1 Existing road network

Key roads within and adjacent to the project site are described in Table 9.4 and shown on Figure 9.6 and Figure 9.7.

The roads used by traffic accessing Sydney Airport are listed in Table 9.4 and include:

- Terminal 1 is accessed from the south and west via Marsh Street from the M5, and from the east via Airport Drive/Qantas Drive/Joyce Drive, which connects with General Holmes Drive/Southern Cross Drive (the M1)
- Terminals 2/3 are accessed via Qantas Drive from the west, Joyce Drive from the east, and O'Riordan Street from the north
- Lancastrian Road provides access to other Sydney Airport facilities off Qantas Drive. Lancastrian Road also provides access across Qantas Drive and Botany Rail Line to Qantas facilities north of the rail line.

To improve traffic flow into and out of Terminals 2/3, a one-way road system was constructed to provide access to Terminals 2/3 from Qantas Drive. Traffic enters Terminals 2/3 via Sir Reginald Ansett Drive and exits via Seventh Street and Robey Street.

Heavy vehicle routes

Many of the roads around Sydney Airport and within the study area are designated heavy vehicle routes. These roads can accommodate large vehicles, including B-doubles that are used to move road and container freight. These include routes to and from Sydney Airport and Port Botany such as the M5, General Holmes Drive, Southern Cross Drive and Foreshore Road.

Qantas Drive and Airport Drive, along with Robey and O'Riordan streets, are also used for the movement of freight to/from Sydney Airport. Airport Drive and Qantas Drive are also used by over height vehicles travelling between the M1 and M5 motorways, due to the height restrictions of the M1 tunnel under the Sydney Airport runways.

Roads identified as B-double routes are described in Table 9.4.

Table 9.4 Roads within and adjacent to the project site

Road	Description	Road function and responsible authority
M1/Southern Cross Drive/ General Holmes Drive/A1	These roads extend along the southern and eastern boundaries of Sydney Airport, connecting the M5 East and the Eastern Distributor. Southern Cross Drive is six lanes, while General Holmes Drive has up to eight lanes with a section operating as a tidal flow system for peak periods. The roads are limited access motorways with no at-grade intersections.	Motorways (Roads and Maritime) B-double access route
M5 East	The M5 East is a four-lane motorway connecting the M5 South Western Motorway to the M1 at General Holmes Drive. The M5 East runs along the southern boundary of Sydney Airport and then proceeds via a tunnel west of Marsh Street. It then emerges at Bexley Road in Kingsgrove. The interchange with Marsh Street is the primary access route from the motorway network to Terminal 1.	Motorways (Roads and Maritime) B-double access route
Princes Highway	The Princes Highway begins at the intersection of Broadway and City Road, extending south through Sydney towards Wollongong. In the vicinity of the project site, the Princes Highway is a six-lane road with sections operating as tidal flow to increase lane capacity in the peak direction.	Arterial road (Roads and Maritime) B-double access route
Marsh Street/Airport Drive/ Qantas Drive	These roads are the key accesses to Terminal 1 and Terminals 2/3 respectively. Airport Drive and Qantas Drive run along and within the northern boundary of Sydney Airport, and have two lanes in each direction. These roads provide an important east–west connection, including between Terminals 1 and 2/3, and for over-height or restricted freight vehicles that cannot use General Holmes Drive/M1 due to the low clearance tunnel under the runway. Marsh Street is a six-lane road that links Terminal 1 to the M5 East across the Cooks River	Arterial roads (Marsh Street - Roads and Maritime, Airport Drive/Qantas Drive - Sydney Airport Corporation) B-double access route (Qantas Drive/ Airport Drive)
Joyce Drive/ General Holmes Drive	Joyce Drive/General Holmes Drive is a state road beginning at the intersection of Qantas Drive and O'Riordan Street, extending to meet the M1 on the eastern side of the airport.	Arterial Road (Roads and Maritime) B-double access route
Botany Road	Botany Road is a state road and an important north–south connection between the Sydney central business district in the north and Port Botany in the south via Mascot town centre. The road is generally four to six lanes wide, with bus lanes north of Wentworth Avenue. Some sections of Botany Road are prohibited from use by heavy vehicles.	Arterial road (Roads and Maritime)
Canal Road, Ricketty Street, Kent Road and Gardeners Road	These roads provide a key east–west function across the northern edge of the study area linking the Princes Highway with the eastern suburbs at Kingsford. The road varies between four and six lanes.	Arterial road (Roads and Maritime) B-double access route
Foreshore Road	Foreshore Road is a four-lane divided road that connects Port Botany to General Holmes Drive/M1. It is an important link for road freight to and from the port.	Arterial road (Roads and Maritime) B-double access route
O'Riordan Street, Robey Street (west of O'Riordan Street)	These streets form part of the main north–south corridor between the Sydney central business district and Sydney Airport. Robey Street is a one-way couplet with O'Riordan Street, which allows traffic entering the airport to use O'Riordan Street, and traffic exiting the airport to use Robey Street.	Local road (Roads and Maritime and Sydney Airport) B-double access route

Road	Description	Road function and responsible authority
	O'Riordan and Robey streets are state roads. O'Riordan Street is generally four to six lanes wide and has many signal-controlled intersections.	
Bourke Street/ Bourke Road	Bourke Street/Bourke Road runs in a north–south direction, beginning at O'Riordan Street in Mascot, through the Mascot Station precinct and continuing north through Green Square to Alexandria/Redfern. It accommodates a separated cycleway between Coward Street and the central business district.	Local (Bayside Council) B-double access route along sections
Bellevue Street/ Swamp Road	Bellevue Street is located on both sides of the Botany Rail Line. Bellevue Street west (on western side of the rail line) provides access from the Princes Highway south towards the project site, where it becomes Swamp Road.	Local (Inner West Council) B-double access route

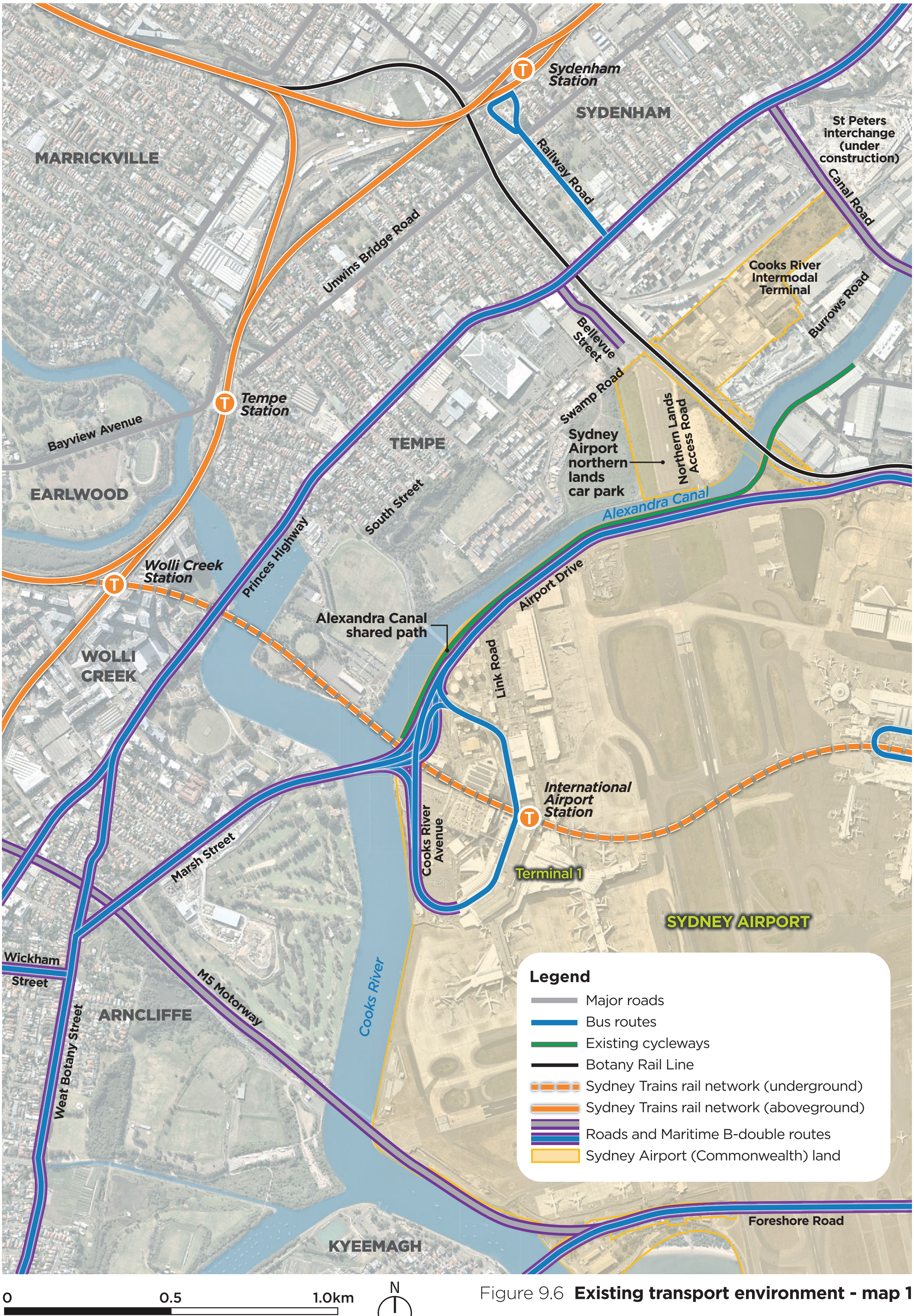


Figure 9.6 **Existing transport environment - map 1**

Figure 9.7 **Existing transport environment - map 2**

9.2.2 Traffic volumes and patterns

In addition to providing access to/from Sydney Airport and towards Port Botany, the roads around Sydney Airport play a vital role in providing north–south and east–west arterial functions within the regional road network. They also provide access to surrounding land uses in Mascot. This multitude of roles results in competition between through traffic and local traffic, leading to congestion, which is more pronounced in the morning peak period.

Traffic profiles from Roads and Maritime fixed traffic counters provide a profile of traffic volumes and patterns across a typical weekday, and are shown on Figure 9.8. The morning and afternoon peak periods are evident from these profiles and correlate with the peak periods selected for use by the Sydney Gateway Operational Model.

Figure 9.8 shows that in the morning peak, traffic volumes begin to rise steeply from 4am, peaking between 6am and 7am. This increase, which is earlier than the typical road network (commuter) peak, is a result of the earlier commencement of airport operations. In the afternoon, peak traffic volumes occur between 4pm and 7pm. The commuter peak is shown to carry more traffic than the airport peak at these locations.

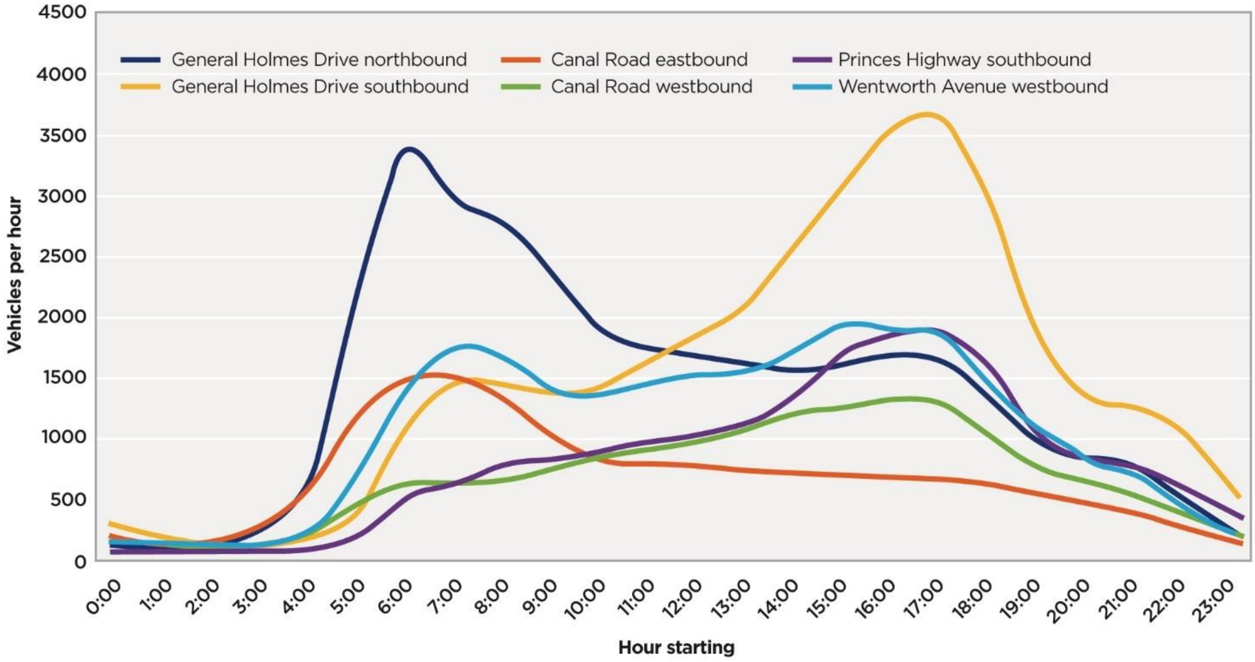


Figure 9.8 24-hour traffic volumes at fixed traffic counter locations in 2018

Morning and afternoon peak hour traffic volumes, and average weekday traffic volumes for key roads within the study area, are summarised in Table 9.5. The percentage of heavy vehicles is also provided.

Table 9.5 2016 morning and afternoon peak and average weekday traffic volumes

Location	Direction	Morning peak (8am-9am)		Afternoon peak (5pm-6pm)		Average week day volumes	
		Vehicles per hour	Heavy vehicles[1] (%)	Vehicles per hour	Heavy vehicles[1] (%)	Vehicles per day	Heavy vehicles[1] (%)
Airport Drive – west of Link Road	Eastbound	2,490	7	1,300	8	28,500	8
	Westbound	1,350	6	2,130	6	24,500	7
	Eastbound	2,420	7	1,360	7	28,700	8

Location	Direction	Morning peak (8am-9am)		Afternoon peak (5pm-6pm)		Average week day volumes	
		Vehicles per hour	Heavy vehicles[1] (%)	Vehicles per hour	Heavy vehicles[1] (%)	Vehicles per day	Heavy vehicles[1] (%)
Qantas Drive – east of Seventh Street	Westbound	1,530	5	2,080	6	24,800	6
M1/General Holmes Drive/A1	Eastbound	6,880	8	4,360	8	81,700	10
	Westbound	3,910	13	7,200	6	87,000	10
Princes Highway – west of Railway Road	Northbound	2,470	6	1,470	6	27,900	8
	Southbound	920	16	2,150	6	28,700	9
O'Riordan Street – south of King Street	Northbound	2,120	8	1,530	8	28,800	10
	Southbound	1,280	9	1,910	6	25,100	9
Bourke Street – south of Gardeners Road	Northbound	610	7	650	2	9,600	4
	Southbound	630	2	380	3	5,400	4
Princes Highway – south of West Botany Street	Northbound	1,610	6	920	5	17,400	7
	Southbound	430	12	1,590	4	17,600	7
Robey Street – west of O'Riordan Street	Eastbound	1,410	9	620	11	14,600	11
	Westbound	700	9	1,100	6	13,000	9
M1/Southern Cross Drive – east of Botany Road	Eastbound	3,850	4	3,360	4	57,500	4
	Westbound	3,520	4	4,330	3	62,500	4
O'Riordan Street – south of Church Avenue	Northbound	1,000	8	830	5	18,100	8
	Southbound	900	6	1,110	5	16,500	7
Botany Road – south of Coward Street	Northbound	1,580	8	1,020	9	16,800	9
	Southbound	890	10	1,240	8	15,600	10
Foreshore Road – south of the M1	Northbound	1,160	34	1,850	17	22,400	30
	Southbound	1,530	20	910	29	18,700	33
General Holmes Drive – south of the M5 East/M1 interchange	Northbound	4,440	3	2,100	4	44,200	5
	Southbound	1,500	7	4,820	3	45,000	5
Canal Road	Eastbound	1,450	6	630	13	13,900	12
	Westbound	670	18	1,220	7	17,200	11
Gardeners Road – east of Bourke Road	Eastbound	580	7	940	5	11,000	6
	Westbound	550	11	260	8	5,200	9

Location	Direction	Morning peak (8am-9am)		Afternoon peak (5pm-6pm)		Average week day volumes	
		Vehicles per hour	Heavy vehicles[1] (%)	Vehicles per hour	Heavy vehicles[1] (%)	Vehicles per day	Heavy vehicles[1] (%)
Burrows Road	Northbound	440	7	390	5	5,300	12
	Southbound	240	17	310	13	4,500	15

Note: 1. Heavy commercial vehicles are classified as a class 3 vehicle (a two-axle truck) or larger, in accordance with the Austroads Vehicle Classification System.

Table 9.5 shows that traffic volumes towards the Sydney central business district are typically higher during the morning peak. Conversely, traffic in the westbound and southbound directions are higher in the afternoon peak hour. This pattern indicates a strong demand for movement between employment areas in central Sydney and/or the eastern suburbs, and residential areas to the south and west. However, Foreshore Drive experiences higher southbound traffic volumes during the morning peak and higher northbound volumes during the afternoon peak, as it is a major freight route to/from Port Botany.

Table 9.5 also shows that:

- Traffic volumes in the morning peak are generally higher than during the afternoon peak, except along the M1/A1 corridor, where traffic volumes are marginally higher during the afternoon peak
- About five to 10 per cent of traffic on the network is heavy vehicles, increasing to 20 to 35 per cent on Foreshore Road
- The M1/General Holmes Drive carries the highest daily traffic volumes, with more than 80,000 vehicles per day using the corridor in each direction
- The M1/Southern Cross Drive and the A1 also carry a high proportion of daily traffic, with around 60,000 and 40,000 vehicles per day in each direction, respectively.

9.2.3 Road network performance

Network performance

Existing road network performance for the morning and afternoon peak periods are summarised as follows:

- Congested conditions are apparent throughout the study area during both the morning and afternoon peaks, with low average speeds of about 25 kilometres per hour
- Both peak periods have similar traffic demands and trip lengths
- The road network is more congested during the morning peak period than in the afternoon peak, as represented by longer average trip times due to lower average speeds and more stops.

Intersection performance

Table 9.6 shows the existing performance of intersections within the study area that may be affected by the project. Both the average delay and level of service is provided for each intersection.

Table 9.6 Existing intersection performance

Intersection	2018 morning peak (8am-9am)		2018 afternoon peak (5pm-6pm)	
	Average delay (seconds)	Level of service	Average delay (seconds)	Level of service
West Botany Street/Marsh Street	51	D	26	B
Marsh Street/M5	43	D	68	E

Intersection	2018 morning peak (8am-9am)		2018 afternoon peak (5pm-6pm)	
	Average delay (seconds)	Level of service	Average delay (seconds)	Level of service
General Holmes Drive/Mill Pond Drive	100	F	39	C
Botany Road/Mill Pond Drive	101	F	103	F
Joyce Drive/General Holmes Drive	152	F	41	C
Botany Road/General Holmes Drive	90	F	49	D
Robey Street/O'Riordan Street	56	D	26	B
Joyce Drive/O'Riordan Street	130	F	52	D
Seventh Street/Qantas Drive	108	F	64	F
King Street/O'Riordan Street	69	E	33	C
O'Riordan Street/Bourke Street	43	D	31	C
Bourke Street/Coward Street	106	F	58	E
Coward Street/O'Riordan Street	78	F	51	D
Gardeners Road/Bourke Street	56	E	43	D
Kent Road/Ricketty Street	36	C	42	C
Botany Road/Gardeners Road	81	F	65	E
Kent Road/Coward Street	103	F	59	E
Canal Road/Burrows Road	59	E	93	F
Airport Drive/Link Road	6	A	6	A
O'Riordan Street/Gardeners Road	98	F	119	F

The information in Table 9.6 shows that:

- In the morning peak, most of the intersections operate at a level of service E or F, with only four intersections operating at a level service D or better. This indicates a generally high level of delay at most intersections, which is consistent with the overall network performance
- Intersection performance improves slightly during the afternoon peak, with eight of the modelled intersections operating at a level of service D or better
- The two intersections that provide access to Terminals 2/3 (O'Riordan Street/Joyce Drive/Sir Reginald Ansett Drive and Seventh Street/Qantas Drive) experience longer delays (longer than the 120 second traffic light cycle times), which results in substantial delays to vehicle movements at these locations. Despite the delays at these intersections, the existing network is generally able to accommodate the existing traffic demands in the morning and evening peaks
- Similar to intersection performance, average delays are generally greater in the morning than the evening.

9.2.4 Public transport

Public transport within the study area includes rail and bus services. According to 2016 census data (ABS, 2016), a relatively high proportion of people use public transport within the area, predominantly rail.

Rail

The T8 Airport and South Line passes underground, with stations at Mascot (Mascot Station), Terminal 1 (International Airport Station) and Terminals 2/3 (Domestic Airport Station). The T8 line crosses under

Joyce Drive and the Botany Rail Line and follows the alignment of O'Riordan Street to the north. Services are operated by Sydney Trains. The stations in the study area are privately owned.

The location of the line and stations are shown on Figure 9.6 and Figure 9.7.

Bus networks

Several bus routes operate along key roads in the study area. In the immediate vicinity of the project site, routes 305, 400, 420 and 420N operate along Qantas Drive and Airport Drive, including stops on Qantas Drive at Lancastrian Road within the project site. These routes, which include stops at Terminal 1 and Terminals 2/3, are shown on Figure 9.6. The bus stops on Qantas Drive are used by relatively few passengers, with historical Opal card data indicating that less than 20 passengers per day use these stops.

Route 400 operates between Bondi Junction and Sydney Airport. Routes 420 and 420N operate between Burwood and Eastgardens Shopping Centre in the east. These routes have a frequency of about 20 minutes. Other bus routes are generally located around Mascot Station to the north of the project site and along Princes Highway to the west.

Botany Road serves the highest frequency of buses overall with up to 35 buses per hour in the peak period. As a major bus corridor, bus lanes are provided on Botany Road north of Wentworth Avenue. These are the only bus lanes located in the study area.

9.2.5 Active transport

Active transport (ie pedestrian and cyclist) networks within the study area are described below. Recent upgrades to these networks have improved active transport connections across the study area.

Cycle networks

The cycle network consists of a combination of types, including cycleways, shared paths, recreational and on-road facilities. The quality of this infrastructure varies from poor (most notably along parts of Qantas Drive) to excellent, such as the new facilities along the recently upgraded Marsh Street. Local councils have proposed cycling infrastructure within or adjacent to the project site. The key cycling infrastructure in the study area is made up of three off-road links:

- The Alexandra Canal cycleway
- Cooks River shared path and its connections
- The Bourke Road cycleway.

The Alexandra Canal cycleway is located within the project site (shown on Figure 9.6) and forms the main east–west and north–south connections for active transport across the study area. The path runs adjacent to Airport Drive and connects to Terminal 1 via Tempe Recreation Reserve and Wolli Creek, and surrounding areas via Marsh Street. To the east, the path continues north along Alexandra Canal before joining Coward Street to connect with the Bourke Road Cycleway in Mascot, which travels to the Sydney central business district.

Less than one per cent of journeys to work in the Bayside local government area are made by cycling. About three per cent of journeys to work within the Inner West local government area are made by cycling.

Pedestrian networks

The pedestrian network generally consists of footpaths, shared paths (pedestrian/cyclist) and dedicated road crossings. The local and arterial roads in the study area provide typical footpaths along their length. Streets in Mascot (including around Mascot Station and in Mascot generally) provide a higher degree of pedestrian amenity due to the network of small or detailed streetscapes and mix of residential and commercial land uses.

Pedestrian facilities are generally limited near Sydney Airport, with many facilities of poor quality due to uneven pavements and limited separation from busy roads.

Pedestrian accessibility to Terminal 1 via Marsh Street and Airport Drive is poor due to narrow footpaths on the Giovanni Brunetti bridge and flyovers at Airport Drive. However, there is a direct link from the Alexandra Canal shared path to the Terminal 1 precinct via a pedestrian/cycle bridge and overpass.

Terminals 2/3 is linked to the Mascot Station precinct with pedestrian access provided via Robey and O'Riordan streets. Upgrades to the pedestrian network on Seventh Street, Sir Reginald Ansett Drive and Qantas Drive have recently been completed by Roads and Maritime. There is a narrow footpath continuing from the Alexandra Canal cycleway on the northern side of Airport Drive and into Qantas Drive linking to the west of Robey Street.

A footpath on Canal Road provides access over Alexandra Canal between Ricketty Street and Princes Highway.

Nearly four per cent of journeys to work in the Bayside local government area are made by walking only. About 5.5 per cent of journeys to work within the Inner West local government area are made by walking.

Active transport activity

Roads and Maritime collected pedestrian and cyclist data along the Alexandra Canal cycleway in March 2019. The data indicates that, on average, the Alexandra Canal cycleway carries around 600 cyclists and 100 pedestrians per day. Peak usage occurs during the weekday morning and afternoon peak periods, when the cycleway carries around 90 cyclists and 10 pedestrians during the morning peak and afternoon peak hours.

9.2.6 Parking

Off-street parking

The following off-street parking areas are located within and adjacent to the project site:

- The Sydney Airport northern lands car park located on the western side of Alexandra Canal, which is accessed from Airport Drive via the Nigel Love bridge, and is used by Sydney Airport employees at times of peak demand
- A car parking area east of Terminals 2/3, located south of AMG Sydney and accessed off Ninth Street
- Two car parking areas east of Terminals 2/3, accessed off Ross Smith Avenue and Sir Reginald Ansett Drive respectively, which are leased to DHL
- Parking within the Sydney Airport Terminal 1 freight facilities.

Public car parks are also located adjacent to Terminal 1 (P7 and P9) and Terminals 2/3 (P1, P2 and P3). The car parks at Terminal 1 have capacity for about 4,000 vehicles. The car parks at Terminals 2/3 have capacity for about 4,200 vehicles. None of these car parks are located within the project site.

Recent capacity upgrades to public car parks are discussed in section 9.2.8.

On-street parking

No roadways close to the project site provide on-street parking. The following streets, along proposed haulage routes, include parking:

- Botany Road, outside of clearway and bus lane operating periods
- Ricketty Street, outside of clearway periods.

9.2.7 Future road network and upgrades

New motorway connections

WestConnex is a new regional motorway serving Western Sydney, which will improve accessibility along the employment corridor from the Sydney central business district to Sydney Airport and Port Botany. The WestConnex program of works includes:

- M4 Widening and M4 East (New M4) – Widening of the existing M4 from Parramatta to Homebush and the tunnelled extension of the M4 between Homebush and Haberfield via Concord. The M4 East project includes interchanges at Concord Road, the City West Link and Parramatta Road at Haberfield, with a future underground connection to the M4–M5 Link. The M4 Widening and M4 East are complete.
- New M5 and St Peters interchange – Duplication of the M5 through new twin tunnels from Kingsgrove to a new interchange at St Peters to the north of the project site. The St Peters interchange will provide underground connections to the M4–M5 Link and the future F6 Extension, and surface connections to Gardeners Road (via a new bridge over Alexandra Canal) and the Alexandria to Moore Park Connectivity Upgrade at Euston Road. The New M5 is anticipated to be open to traffic in 2020.
- M4–M5 Link and Rozelle Interchange – New mainline tunnels to connect the M4 East at Haberfield with the New M5 at St Peters interchange, creating a continuous motorway network in the Inner West. The Rozelle Interchange will connect the M4–M5 Link to the Anzac Bridge, Victoria Road via the Iron Cove Link, and a future connection to the Western Harbour Tunnel. The Iron Cove Link will also provide an un-tolled tunnelled bypass of the congested Victoria Road between the Anzac Bridge and the Iron Cove Bridge. Both the M4–M5 Link and Rozelle Interchange are anticipated to be open to traffic in 2023.

These projects, shown on Figure 9.9, are underway, and some will be finished before the Sydney Gateway road project opens. The Sydney Gateway road project would enable the full benefits of the above projects to be realised.

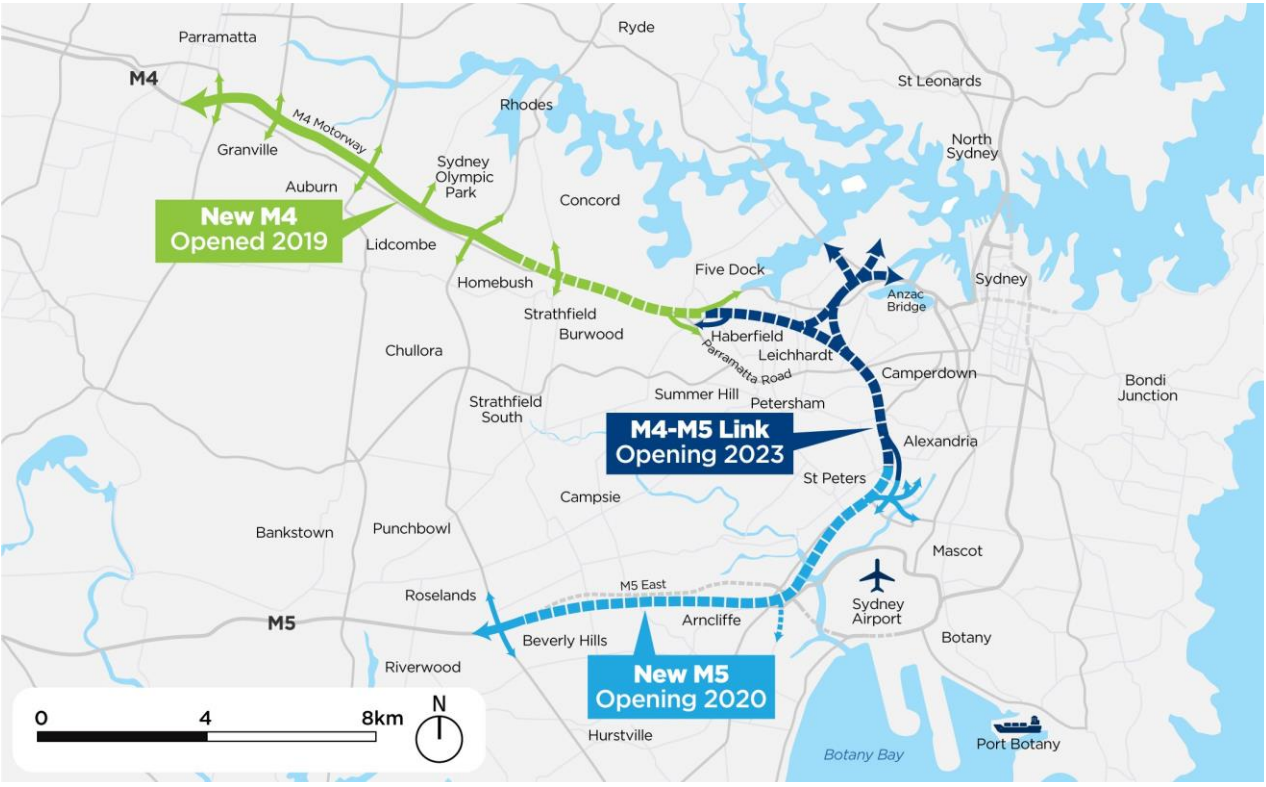


Figure 9.9 Sections of the WestConnex motorway

Other projects currently in the planning phase include (see Figure 9.10):

- Western Harbour Tunnel – A western bypass of the Sydney Harbour Bridge and Western Distributor running from the Warringah Freeway in North Sydney to the M4–M5 Link at the Rozelle Interchange
- Beaches Link – An underground bypass of Military Road and Spit Road, connecting the Wakehurst Parkway and Burnt Bridge Creek Deviation to the Warringah Freeway in North Sydney
- F6 Extension – A proposed link between the New M5 at Arncliffe and the M1 Princes Highway at Loftus. The first stage of the F6 Extension would extend to President Avenue at Kogarah with connections to Taren Point and Loftus to be delivered in future stages.

The cumulative effect of the Sydney Gateway road project, WestConnex and related projects would be to alter travel patterns across the city and unlock access and improve travel times between Sydney Airport, Port Botany and the rest of the Sydney transport network.

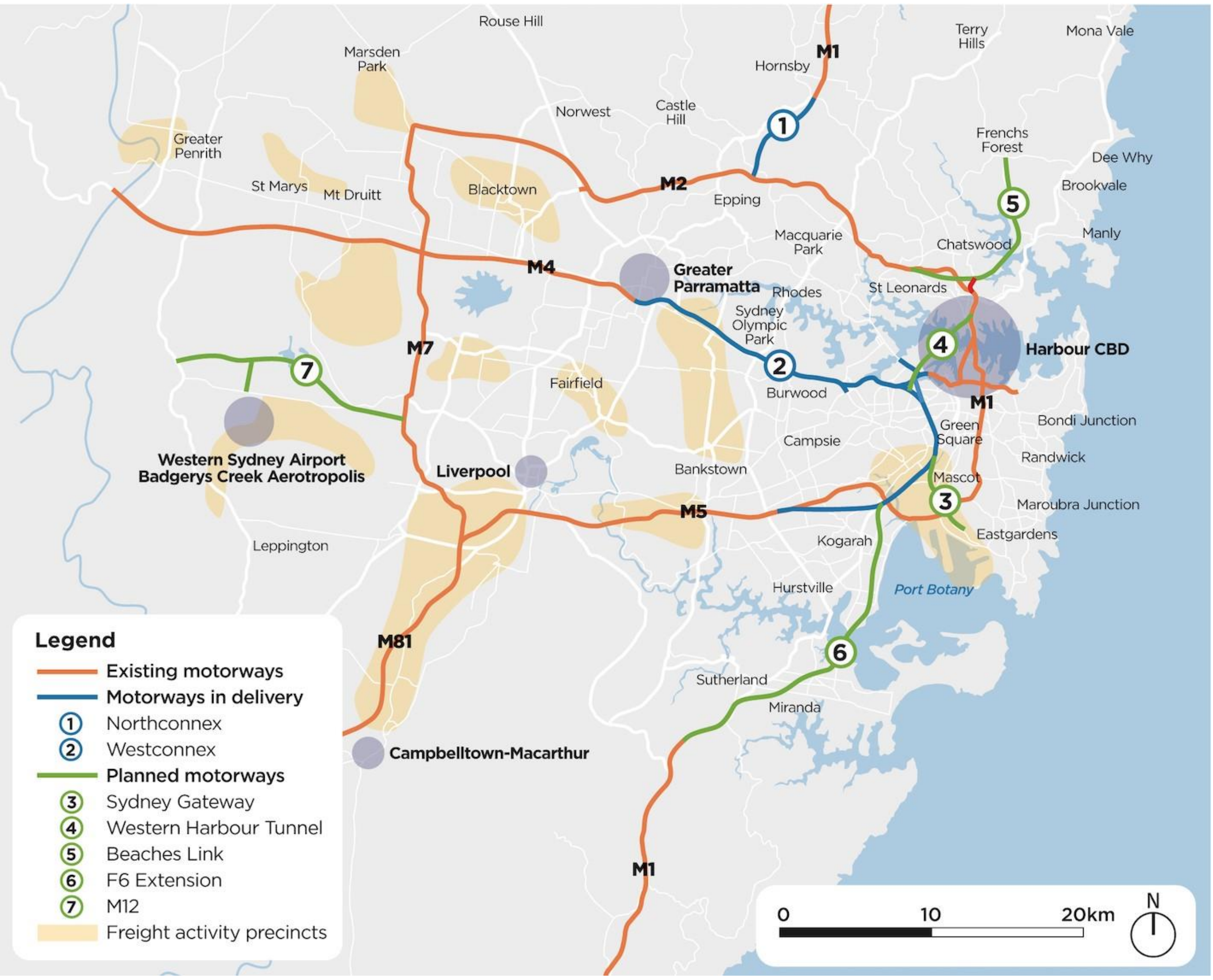


Figure 9.10 Motorway projects in Greater Sydney

Road upgrades within and around Sydney Airport

Roads and Maritime is carrying out a number of road upgrade projects around Sydney Airport to:

- Improve access to Sydney Airport, Mascot and the eastern suburbs
- Support future growth and access to Sydney Airport
- Improve traffic flow around Sydney Airport and to Port Botany

- Improve the movement of rail freight to and from Port Botany
- Reduce congestion and improve safety for road users in Mascot.

The following projects are being/have been carried out in the vicinity of the project site:

- Airport West Precinct upgrade
- Airport East Precinct upgrade
- Airport North Precinct upgrade
- Mascot intersection upgrades.

In the last few years, Sydney Airport Corporation has proposed and carried out a number of projects to improve road access and traffic flow in and out of Terminal 1 and Terminals 2/3. These projects were identified in the previous *Sydney Airport Master Plan 2033* and the *Sydney Airport T2/T3 Ground Access Solutions and Hotel Major Development Plan* (SACL, 2015).

Further information on these projects is provided in section 5.1.4.

9.2.8 Key traffic, transport and access characteristics of Sydney Airport (Commonwealth) land

The key roads and accesses to Sydney Airport have been the subject of a number of recent improvements as a result of precinct upgrades and intersection works undertaken by Roads and Maritime.

The Sydney Airport terminals are accessed from Airport Drive (Terminal 1) and Qantas Drive (Terminals 2/3). In both instances, a one-way road loop has been created to provide the necessary efficiency and capacity of movements. Link Road off Airport Drive provides access into the Terminal 1 freight facilities located to the north of Terminal 1.

The Sydney Airport terminals are serviced by both bus and train. Bus routes 305, 400, 420 and 420N operate along Qantas Drive and Airport Drive, including stops at Terminal 1 and Terminals 2/3. There are dedicated underground rail stations serving the terminals linked to the Sydney Trains network.

Public car parks are located adjacent to each of the terminal buildings with capacity for about 8,000 vehicles. Additional long-term car parking is also available at the Blue Emu car park. A staged expansion of car parking capacity, including a future new ground transport interchange, commenced in 2015, along with other roadway capacity improvements at Terminals 2/3.

Other car parks at the Sydney Airport northern lands and at Ninth Street are also used for employee parking.

9.3 Assessment of construction impacts

9.3.1 Road network changes and traffic volumes

Road network

The project can be constructed without substantial reconfiguration of the existing road network. However, there would be substantial works along Airport Drive, Qantas Drive and Sir Reginald Ansett Drive to facilitate connection of the new road links.

Two lanes would generally be maintained in each direction along Qantas Drive and Airport Drive during the operating hours of the Sydney Airport terminals when traffic volumes are highest. However, there would be a period during the day when a reduction in the number of available lanes would be required to facilitate construction, with a longer period overnight for more substantive works occupying multiple lanes.

Prolonged acceleration and turning lane reductions would occur at Airport Drive near Terminal 1 and at the Qantas Drive/Sir Reginald Ansett Drive and Seventh Street intersections. The impacts of these changes were assessed as part of the overall assessment of road network performance (see section 9.3.2).

In addition, short-term lane and carriageway closures would also be required to facilitate:

- Establishing site access points, particularly where access and egress lanes are required (eg access to the St Peters interchange connection work area and compound C1 via on Canal Road – see Figure 8.4)
- Lifting bridge segments where a crane needs to be set up in traffic lanes (eg on Qantas Drive, Airport Drive and on Canal Road, to facilitate construction of the Terminals 2/3 access viaduct, the Terminal 1 connection bridge and the Canal Road overpasses respectively)
- Connecting new roads to existing roads (eg connecting the Terminal 1 connection to Airport Drive and Terminals 2/3 connection to Qantas Drive west of Lancastrian Road)
- Widening the Qantas Drive east and westbound carriageways
- Constructing new lanes along Qantas Drive as part of the Qantas Drive upgrade and extension
- Modifying the Lancastrian Road/Qantas Drive intersection
- Traffic diversions to maintain capacity along Qantas Drive (see section 8.6.5)
- Lifting of viaduct bridge beams or segments.

To minimise the potential for traffic and access impacts, these short-term closures would be undertaken during night-time hours as far as possible. However, major crane lifts would occasionally require full weekend closures, with detours established to maintain access to Sydney Airport’s terminals, Port Botany and operation of the road network.

Closures would be managed in accordance with a Construction Traffic and Access Management Plan. This plan would define the traffic management measures and communications required to manage traffic through or adjacent to work areas to ensure that access and road functionality is maintained (see section 9.6).

Swamp Road would be permanently closed (see section 7.11.1). Once the project is operational, access to properties in this area, including the Sydney Airport northern lands, would be via the proposed northern lands access and the freight terminal access.

Traffic currently using Airport Drive would be diverted onto the new sections of roadway in stages, as shown on Figure 8.12.

Traffic volumes

Based on the indicative haulage routes and estimated construction vehicle volumes (see sections 8.6.1 and 8.6.2), the largest increases in vehicle volumes are expected along Canal Road, particularly at its western extent near the Princes Highway, and on Qantas Drive and Airport Drive.

Traffic volumes on Canal Road could increase by up to 16 per cent in the morning peak, and 29 per cent in the afternoon peak, in the westbound direction. Traffic volumes on Qantas Drive and Airport Drive could increase by up to 20 per cent in the eastbound direction in the afternoon peak. These increases are considered to be manageable given the capacity of these roads and existing traffic volumes.

Holbeach Avenue would be used by workers to access compound C3, resulting in an additional 250 vehicles using this route during the morning and afternoon peak periods. The additional construction vehicles would generally be travelling in the opposite direction to other local traffic in the area. Therefore, the additional vehicle volumes are expected to be manageable.

Most of the existing properties and traffic movements that currently use Bellevue Street would be removed as a result of the project, offsetting most of the traffic expected to be generated by construction.

9.3.2 Intersection performance and travel times

As described in section 9.1.2, three construction scenarios were assessed. The intersection performance and travel time results for each scenario were compared against the without project 2022 future baseline to quantify the relative impact of construction. A description of the traffic changes between the 2018 baseline and 2022 future baseline is provided in section 5.4.1.2 of Technical Working Paper 1 (Transport, Traffic and Access). In summary, the following notable changes in terms of intersection performance are observed in the 2022 future baseline when compared with the 2018 existing conditions:

- Qantas Drive/Robey Street/Seventh Street – predicted to deteriorate in the morning peak as a result of downstream congestion and available capacity for the left turn from Qantas Drive into Robey Street
- O'Riordan Street/Robey Street – predicted to improve in the morning peak due to increased southbound capacity on O'Riordan Street (delivered as part of the Airport North Precinct upgrade project), which would offset any increased delay associated with increased northbound demand
- Airport Drive/Link Road intersection – predicted to deteriorate in the morning peak as a result of downstream congestion and available capacity at the left turn from Qantas Drive into Robey Street
- Joyce Drive/O'Riordan Street/Sir Reginald Ansett Drive – predicted to improve in the morning peak due to increased southbound capacity on O'Riordan Street (delivered as part of the Airport North Precinct Upgrade project) and increased westbound capacity on Joyce Drive (delivered as part of the Airport East Precinct upgrade project).

Travel times in 2022 are forecast to typically increase. This would be a result of increased vehicle demand and associated congestion, except for O'Riordan Street southbound in the morning peak. This location would experience reduced travel times due to the increased capacity delivered by the Airport North Precinct Upgrade project.

The results of the construction impact assessment relative to the 2022 future baseline conditions are summarised below.

Construction scenario 1 (November 2021 to May 2022)

Intersection performance

Modelling results are provided in Table 9.7 for scenario 1. The results show that in the morning peak, all intersections would experience vehicle delays lower than the 2022 future baseline, except the Qantas Drive/O'Riordan Street and Qantas Drive/Robey Street intersections. This is due to a combination of factors, including removing the signals at Lancastrian Road and traffic using the newly opened sections of the project in the Sydney Airport northern lands. At these intersections, vehicle delays would marginally increase (by five seconds); however, the existing level of service C would be maintained. It is noted that works associated with the Botany Rail Duplication would be undertaken in the vicinity of these intersections, with the potential for cumulative impacts (see section 9.5.1).

In the afternoon peak, compared to the 2022 future baseline:

- Average delays at the Qantas Drive/Seventh Street/Robey Street and the Airport Drive/Link Road intersections would reduce
- Average delays at the O'Riordan Street/Robey Street intersection would increase by 25 seconds
- Average delays at the Joyce Drive/O'Riordan Street intersection would increase by 21 seconds.

These increased delays would result in minor travel time increases for vehicles accessing Terminals 2/3, including shuttle buses, taxis and private vehicles.

Table 9.7 Morning and afternoon peak intersection performance during scenario 1

Intersection	Morning peak				Afternoon peak			
	2022 baseline		Scenario 1		2022 baseline		Scenario 1	
	Delay (seconds)	Level of service	Delay (seconds)	Level of service	Delay (seconds)	Level of service	Delay (seconds)	Level of service
O'Riordan Street and Robey Street	36	C	41	C	78	F	103	F
Qantas Drive, Robey Street and Seventh Street	213	F	159	F	44	D	37	C
Airport Drive and Link Road	36	C	15	B	12	A	7	A
Joyce Drive, O'Riordan Street and Sir Reginald Ansett Drive	74	F	74	F	110	F	131	F

Road network performance

During the morning and afternoon peak, compared to the 2022 future baseline, minor travel time increases are predicted across the road network, with the exception of Airport Drive, which is predicted to experience a reduction in travel times in both directions as a result of removing traffic signals at Lancastrian Road.

Travel times along General Holmes Drive eastbound would increase by one minute and six seconds (a 40 per cent increase).

During the afternoon peak, travel times along O'Riordan Street southbound would increase by one minute and 55 seconds (a 41 per cent increase).

These impacts are considered to be manageable with implementation of the mitigation measures provided in section 9.6.2. Details of travel time performance along these and other routes are shown in Table 9.8.

Table 9.8 Morning and afternoon peak travel time changes during scenario 1

Route	Morning peak			Afternoon peak		
	Travel time (minutes:seconds)			Travel time (minutes:seconds)		
	2022 baseline	Scenario 1	Change (%)	2022 baseline	Scenario 1	Change (%)
Airport Drive and Qantas Drive eastbound (Flora Street – Robey Street)	13:15	9:20	−03:55 (−30%)	4:30	4:30	00:00 (0%)
Airport Drive and Qantas Drive westbound (Seventh Street – Flora Street)	8:27	6:35	−01:52 (−22%)	4:27	3:46	−00:41 (−15%)
O'Riordan Street northbound	7:16	7:21	00:05 (1%)	7:11	7:24	00:13 (3%)

Route	Morning peak			Afternoon peak		
	Travel time (minutes:seconds)			Travel time (minutes:seconds)		
	2022 baseline	Scenario 1	Change (%)	2022 baseline	Scenario 1	Change (%)
(Terminals 2/3 – Gardeners Road)						
O'Riordan Street southbound (Terminals 2/3 – Gardeners Road)	4:04	4:38	00:34 (14%)	4:39	6:34	01:55 (41%)
General Holmes Drive eastbound (A1 – Mill Pond Drive)	7:13	7:38	00:25 (6%)	2:46	3:52	01:06 (40%)
General Holmes Drive westbound (A1 – Mill Pond Drive)	2:26	2:34	00:08 (5%)	3:28	3:38	00:10 (5%)

Construction scenario 2 (October 2022 to June 2023)

Intersection performance

The assessment found that intersection performance would generally be similar to scenario 1 when compared to the 2022 future baseline. Modelling results are provided in Table 9.9.

Table 9.9 Morning and afternoon peak intersection performance during scenario 2

Intersection	Morning peak				Afternoon peak			
	2022 baseline		Scenario 2		2022 baseline		Scenario 2	
	Delay (seconds)	Level of service	Delay (seconds)	Level of service	Delay (seconds)	Level of service	Delay (seconds)	Level of service
O'Riordan Street and Robey Street	36	C	41	C	78	F	112	F
Qantas Drive, Robey Street and Seventh Street	213	F	159	F	44	D	32	C
Airport Drive and Link Road	36	C	18	B	12	A	8	A
Joyce Drive, O'Riordan Street and Sir Reginald Ansett Drive	74	F	72	F	110	F	137	F

Road network performance

During the morning and afternoon peak hours, compared to the 2022 future baseline, minor travel time increases are predicted across the road network, with the exception of Airport Drive, which is predicted to experience a reduction in travel times in both directions.

During the afternoon peak, travel times along O’Riordan Street southbound would increase by two minutes and 12 seconds (a 47 per cent increase). Travel times along General Holmes Drive eastbound would increase by 48 seconds (a 29 per cent increase).

These impacts are considered to be manageable with implementation of the mitigation measures provided in section 9.6.2. Details of travel time performance along these and other routes are shown in Table 9.10.

Table 9.10 Morning and afternoon peak travel time changes during scenario 2

Route	Morning peak			Afternoon peak		
	Travel time (minutes:seconds)			Travel time (minutes:seconds)		
	2022 baseline	Scenario 2	Change (%)	2022 baseline	Scenario 2	Change (%)
Airport Drive and Qantas Drive eastbound (Flora Street–Robey Street)	13:15	9:47	−03:28 (−26%)	4:30	4:27	−00:03 (−1%)
Airport Drive and Qantas Drive westbound (Seventh Street–Flora Street)	8:27	7:45	−00:42 (−8%)	4:27	3:50	−00:37 (−14%)
O'Riordan Street northbound (Terminals 2/3–Gardeners Road)	7:16	7:28	00:12 (3%)	7:11	6:31	−00:39 (−9%)
O'Riordan Street southbound (Terminals 2/3–Gardeners Road)	4:04	4:18	00:14 (6%)	4:39	6:51	02:12 (47%)
General Holmes Drive eastbound (A1–Mill Pond Drive)	7:13	8:01	00:48 (11%)	2:46	3:34	00:48 (29%)
General Holmes Drive westbound (A1–Mill Pond Drive)	2:26	2:26	00:00 (0%)	3:28	3:58	00:30 (15%)

Construction scenario 3 (June to December 2023)

Intersection performance

The assessment found that intersection performance would generally be similar to scenario 1 when compared to the 2022 future baseline. Modelling results are provided in Table 9.11.

Table 9.11 Morning and afternoon peak intersection performance during scenario 3

Intersection	Morning peak				Afternoon peak			
	2022 baseline		Scenario 3		2022 baseline		Scenario 3	
	Delay (seconds)	Level of service	Delay (seconds)	Level of service	Delay (seconds)	Level of service	Delay (seconds)	Level of service
O’Riordan Street and Robey Street	36	C	40	C	78	F	109	F
Qantas Drive, Robey Street	213	F	162	F	44	D	33	C

Intersection	Morning peak				Afternoon peak			
	2022 baseline		Scenario 3		2022 baseline		Scenario 3	
	Delay (seconds)	Level of service	Delay (seconds)	Level of service	Delay (seconds)	Level of service	Delay (seconds)	Level of service
and Seventh Street								
Airport Drive and Link Road	36	C	17	B	12	A	10	A
Joyce Drive, O'Riordan Street and Sir Reginald Ansett Drive	74	F	76	F	110	F	120	F

Road network performance

During the morning and afternoon peak hours, minor travel time increases are predicted across the network, with the exception of Airport Drive, which is predicted to experience a reduction in travel times in the morning peak compared to the 2022 future baseline.

During the afternoon peak, travel times along O'Riordan Street southbound would increase by two minutes and 55 seconds (a 63 per cent increase). Travel times along General Holmes Drive eastbound would increase by one minute and 15 seconds (a 45 per cent increase).

Scenario 3 is predicted to have a moderate impact on the road network, with increased travel times during the afternoon peak relative to the 2022 future baseline. Measures to minimise these potential impacts are provided in section 9.6.2. Travel time performance along these and other routes is shown in Table 9.12.

Table 9.12 Morning and afternoon peak travel time changes during scenario 3

Route	Morning peak			Afternoon peak		
	Travel time (minutes:seconds)			Travel time (minutes:seconds)		
	2022 baseline	Scenario 3	Change (%)	2022 baseline	Scenario 3	Change (%)
Airport Drive and Qantas Drive eastbound (Flora Street–Robey Street)	13:15	9:59	−03:16 (−25%)	4:30	4:39	00:09 (3%)
Airport Drive and Qantas Drive westbound (Seventh Street–Flora Street)	8:27	7:48	−00:39 (−8%)	4:27	4:29	00:02 (1%)
O'Riordan Street northbound (Terminals 2/3–Gardeners Road)	7:16	7:24	00:08 (2%)	7:11	8:22	01:11 (17%)
O'Riordan Street southbound (Terminals 2/3–Gardeners Road)	4:04	4:39	00:36 (15%)	4:39	7:34	02:55 (63%)

Route	Morning peak			Afternoon peak		
	Travel time (minutes:seconds)			Travel time (minutes:seconds)		
	2022 baseline	Scenario 3	Change (%)	2022 baseline	Scenario 3	Change (%)
General Holmes Drive eastbound (A1–Mill Pond Drive)	7:13	8:00	00:46 (11%)	2:46	4:01	01:15 (45%)
General Holmes Drive westbound (A1–Mill Pond Drive)	2:26	2:32	00:05 (4%)	3:28	3:35	00:07 (3%)

9.3.3 Impacts on freight transport

Potential impacts on freight transport along the road network in the vicinity of Sydney Airport would be generally consistent with the impacts described in section 9.3.2 for general traffic. Generally, freight transport is expected to experience delays from a reduction in road network capacity during construction compared to the future 2022 baseline. This would include impacts on travel time for vehicles accessing the freight terminal near Terminal 1 via the Airport Drive/Link Road intersection.

Access to Port Botany would be via the M5, General Holmes Drive and Foreshore Road as a result of the project. No noticeable changes are predicted on the M5 or Foreshore Road. For General Holmes Drive, the predicted increases in travel time would be only minor considering the overall duration of the trip. The predicted increases would also only occur during the peak hour periods.

9.3.4 Impacts on public transport

Construction would have the potential to impact the bus services that operate along Airport Drive, Qantas Drive and O'Riordan Street (routes 305, 400 and 420). Such impacts include increased travel times compared to the 2022 future baseline, due to proposed lane closures and changes to traffic conditions. These increased travel times are outlined in section 9.3.2.

The bus stops located on Qantas Drive near the intersection with Lancastrian Road would be removed (see section 8.6.5). Historical data indicates that less than 20 passengers use these stops daily. Following removal of these stops, the closest stops serviced by the same routes would be located within Terminals 2/3 (about 750 metres away). It is expected that the existing stops would experience lower levels of use once the Qantas Flight Training Centre relocates (see Chapter 19 (Land use and property)).

The project would not directly impact passenger rail services or stations. However, the changes to road network performance described in section 9.3.1 could increase travel times for commuters travelling to stations in surrounding areas (such as Wolli Creek and Mascot stations).

9.3.5 Impacts on active transport

Overall, the project would have minimal impacts on active transport as a result of the limited number of facilities within the project site. The proposed changes to existing pedestrian and cyclist network (described in section 8.6.5), and the potential impacts of these changes, are summarised in Table 9.13.

Table 9.13 Indicative changes to active transport networks

Location	Changes	Potential impacts
Canal Road	Short-term closures of footpaths on both sides of the road to facilitate construction. Closure would only occur on one side of the road at a time, with pedestrians redirected to the other side during each closure.	There would be a negligible increase in walking times and distances travelled where pedestrians need to cross Canal Road to continue their journey. Traffic management would be implemented to facilitate pedestrians crossing Canal Road during major road closures.
Alexandra Canal cycleway	Permanent closure of the shared path (cycleway) on the eastern side of Alexandra Canal, between the existing pedestrian bridge and the Nigel Love bridge. A temporary active transport link (described in section 8.6.4) would be established until the proposed new active transport link is operational.	The temporary path would be about 580 metres longer than the existing path. This could result in a minor travel time increase for cyclists and an additional travel time of about nine to ten minutes for pedestrians.
	Temporary short-term closures of the cycleway east of Nigel Love bridge during some construction activities (eg major crane lifts for the Qantas Drive and terminal link bridges).	No impacts are anticipated as a temporary route is planned to accommodate pedestrians and cyclists for the duration of construction.
Qantas Drive	Permanent removal of the pedestrian crossing at Lancastrian Road.	This pedestrian crossing is used to access the bus stop on Qantas Drive, which would be closed as part of the project (see section 9.3.4). As the bus stop would be removed, and there are no other destinations in the area, the crossing would become redundant.
	Permanent removal of the concrete path (informal footpath) on the northern side of Qantas Drive between Robey Street and west of Lancastrian Road.	The existing path is narrow and generally of poor quality, except for a short section near Robey Street that was recently completed. The western section of the path was historically used by Qantas employees to cross the rail line and access the Sydney Airport Jet Base facilities and bus stops at Lancastrian Road, which would be removed as part of the project (see section 9.4.6). The path is disconnected from the surrounding active transport network, does not currently serve any nearby land uses. Its use is discouraged by Sydney Airport and other agencies due to its narrow width and proximity to Qantas Drive. Removal of this path would therefore have a negligible impact on pedestrians.
	Temporary removal of the pedestrian footpath located on the northern side of Qantas Drive, between Robey and O'Riordan streets to facilitate construction of the Terminals 2/3 access viaduct.	The footpath would mainly be used by pedestrians east of Sir Reginald Ansett Drive accessing the bus stop in Robey Street. The impact is considered limited as there is a parallel footpath on the other side of Qantas Drive which would be used.
Robey Street	Adjustment of the pedestrian footpath on the northern side extending north from Qantas Drive to facilitate revised kerb alignment.	The footpath would be replaced in accordance with current design and accessibility requirements.
Link Road	Removal of the pedestrian crossing at Link Road.	The existing pedestrian crossing at Link Road would be removed, with access to the freight facilities provided by existing paths located near Terminal 1. This route would be about 775 metres longer than the current route.

9.3.6 Impacts on access

Access to properties not required for construction would generally be maintained at all times. However, some temporary impacts on access may be unavoidable during certain work periods or for some activities. In these instances, consultation would be undertaken with the property owner/occupant to ensure that satisfactory alternative access is provided and/or the impact is minimised.

The potential for impacts on access to Sydney Airport are considered in section 9.3.8.

9.3.7 Impacts on parking

On-street parking

Impacts would be limited as no on-street parking is available along roads that would be directly affected by construction (such as Airport Drive, Qantas Drive, Joyce Drive, and impacted sections of Robey Street and O'Riordan Street). Some local roads within walking distance of some construction compounds, particularly in Mascot near compounds C4 and C5, have on-street parking available. However, the on-street parking is generally restricted to up to three-hour parking, limiting the ability for construction workers to use these spaces.

As described in section 8.6.3, parking for the construction workforce would be provided within the construction footprint, including at every compound. This would avoid the need for workers to park in nearby streets. It is estimated that about 980 spaces would be provided within the construction footprint. There may be a shortfall (of about 110 spaces) during peak periods. This would be managed by the measures provided in section 9.6, including:

- Developing and implementing a worker parking strategy, including measures to encourage workers to use alternative transport arrangements, such as public transport
- Use of shuttle buses to move workers between compounds and work areas where capacity in one parking area is limited but other parking areas have capacity
- Further consideration of the need for additional parking within the construction footprint, particularly near work areas that are not directly serviced by a construction compound.

It is anticipated that there would be limited impact on on-street parking for local businesses and the community. Businesses would still be accessible and, where permitted, time restricted on-street parking would still be available. To ensure that street parking remains available, parking restrictions would need to be enforced by the relevant council.

Off-street parking

The main areas of off-street parking that would be affected during construction are described below.

Sydney Airport northern lands car park

There would be a reduction in the amount of parking available in the Sydney Airport northern lands car park, as this land would be required to accommodate part of construction compound C2 and ultimately for the project's operational footprint. This car park is used by Sydney Airport employees at times of peak demand. The car park has sufficient capacity such that the reduction of about 24 spaces during construction would have minimal impact on the overall availability of parking. Some additional spaces may also be affected due to the need to reconfigure the internal car park access roads.

Parking near Terminals 2/3

The car parking area near Terminals 2/3 that is accessed off Ninth Street and owned by Sydney Airport would be affected during construction. This car park, which currently has capacity for about 100 vehicles, would become part of construction compound C5. The temporary loss of these spaces would be managed by Sydney Airport Corporation.

Two car parking areas near Terminals 2/3 that are accessed off Ross Smith Avenue and Sir Reginald Ansett Drive respectively, used by the adjacent DHL business, would also be affected during construction. These car parks have a combined capacity for about 81 vehicles and would become part of the construction footprint. Only one of these car parks would be able to be used for construction at any one time, which would reduce the impact on the users.

Sydney Airport Terminal 1 freight facility parking

About 40 car parking spaces would be temporarily removed along the northern boundary of the mail handling facility located adjacent to Airport Drive near Terminal 1. These changes would be managed by Sydney Airport as part of the future re-leasing of this area.

There would also be a loss of an areas of about 500 square metres from the operational area of the livestock transfer facility at the Terminal 1 freight facility, which is currently used to park and queue delivery trucks.

9.3.8 Summary of impacts on Sydney Airport (Commonwealth) land

Traffic flows to/from and around Sydney Airport

As outlined in section 9.3.1, the intersections analysed would generally continue to operate with the same or better level of service to existing conditions when compared with the future 2022 baseline. The exception would be traffic flows to/from Terminals 2/3 via the key intersections of Qantas Drive/Sir Reginald Ansett Drive/Joyce Drive/O'Riordan Street and Qantas Drive/Seventh Street/Robey Street.

During construction, the average delay at the intersection of Qantas Drive/Joyce Drive/O’Riordan Street would increase by 27 seconds.

In the wider study area, construction would result in minor changes to travel times, with the exception of southbound on O’Riordan Street, where travel times would increase by around three minutes during the afternoon peak. This travel time increase would have a moderate impact on traffic and buses that use this route to access Terminals 2/3.

Impacts on the flow of traffic into and out of Airport Drive/Link Road and the freight terminal adjacent to Terminal 1 are also predicted. The results indicate that this intersection would operate with reduced capacity during some construction scenarios. However, this intersection is considered to have sufficient capacity during all scenarios.

To ensure satisfactory levels of road network capacity and accessibility to Sydney Airport terminals is maintained, potential impacts would be managed by the measures provided in section 9.6. Measures include developing and implementing a Construction Traffic and Access Management Plan and additional traffic management in the vicinity of Terminals 2/3. Communication to inform road users of changes during construction, and real time monitoring of incidents with emergency response resources would also be implemented.

Impacts on access

The results of the assessment indicate that the surrounding road network would operate similar to existing conditions. Some localised worsening of congestion would occur along O’Riordan Street.

While construction has the potential to result in some delays for traffic accessing Sydney Airport and other facilities on Sydney Airport land, access would be maintained to terminals and facilities at all times. Any short-term changes to access would be managed by implementing the measures provided in section 9.6, including the Construction Traffic and Access Management Plan and measures to provide additional traffic management in the vicinity of the Qantas Drive/Seventh Street/Robey Street intersection.

Parking

As described in section 9.3.7, there would be a minor reduction in the number of parking spaces at the Sydney Airport northern lands car park. However, there is considered to be sufficient spare capacity to meet the parking needs at this location.

Construction would also affect a Sydney Airport parking area located near Terminals 2/3, accessed off Ninth Street which provides parking for up to 100 vehicles.

Two other car parks leased to DHL (with a combined capacity of 81 spaces) would also be occupied during construction, although only one of these two car parks would be occupied at any time.

About 40 car parking spaces would be temporarily removed from within the Sydney Airport mail handling facility adjacent to Airport Drive. These changes would be managed with Sydney Airport Corporation as part of the future lease of this area.

There would also be a temporary loss of about 500 square metres from the operational area of the livestock transfer facility, which is currently used to park and queue delivery trucks.

9.4 Assessment of operation impacts

9.4.1 Forecast travel demand and traffic volumes

Overview of results

The project has been designed to provide high capacity, direct connections between Sydney Airport and the Sydney motorway network, to cater for predicted growth in travel demand to the airport and through traffic to Port Botany. Modelling indicates that the project would provide additional network capacity for up to 60,000 vehicle trips per day in 2036 and that more than half of this capacity would be airport-related.

The project is predicted to carry around 85,000 and 88,000 vehicles per day in 2026 and 2036 respectively. While modelling indicates that total traffic volumes in the study area would marginally increase, the road network would operate overall with substantially less congestion than it would have without the project being implemented. This would improve access to/from Sydney Airport, with improved travel times and reliability.

The forecast demand for the project would also attract traffic away from other local and arterial roads within the study area, resulting in lower traffic volumes on most roads compared with the volumes predicted without the project. Most of the predicted traffic demand would shift from O’Riordan Street and Botany Road in Mascot town centre. It is predicted that these roads would carry between 25 to 30 per cent less traffic in 2036 than they would have without the project. As a result, the project would allow vehicles to bypass the surrounding road network, minimising traffic through Mascot and surrounding local roads. The project would also reduce traffic growth on the M5, General Holmes Drive, Southern Cross Drive, and forecast traffic growth along local roads, including in and around Mascot.

As well as providing additional network capacity, the project would result in an increase in average vehicle speeds of between 26 and 47 per cent. Average trip times would decrease by between 15 and 22 percent in 2026 and 2036 respectively, indicating a substantial improvement in network conditions.

For freight traffic, the project would provide an alternative route for heavy vehicles accessing Sydney Airport’s freight terminals, reducing the volumes of heavy vehicles on Airport Drive. The project would also provide an alternative to the current route via Botany Road/General Holmes Drive through Mascot town centre. The new direct connection with the Sydney motorway network would be used to access Foreshore Road and Port Botany, and reduce the volume of heavy vehicles using Gardeners Road and Botany Road.

Screenline analysis

The results of the screenline analysis are summarised below. This provides an assessment of the changes to traffic movements on identified roads as a result of implementing the project.

Changes to heavy vehicle traffic patterns are similar in both 2026 and 2036 to general traffic for all screenlines assessed. It is expected that heavy vehicles would use the project, diverting from existing routes such as O'Riordan Street, Botany Road, Princes Highway and General Holmes Drive. Figures Figure 9.12, Figure 9.13 and Figure 9.14 highlight the differences between the 'with project' and 'without project' scenarios for comparison purposes.

Sydney Gateway screenline

The project is forecast to accommodate 30 per cent of two-way daily traffic crossing the screenline in both 2026 and 2036 (see Figure 9.11).

Traffic would be attracted away from parallel corridors, particularly O'Riordan Street and Botany Road, which would carry up to 30 per cent less traffic compared to without the project. The screenline results show that the project would be a preferred north–south route compared with parallel routes. This would result in some traffic bypassing Botany Road and other local roads in Mascot to travel between the Sydney motorway network and Sydney Airport.

In addition, the total north–south traffic demand across all corridors in 2026 and 2036 would be more than 15 per cent higher with the project than without the project. This indicates that the project would increase north–south capacity within the network, accommodating a greater portion of the forecast traffic demand. Traffic volumes would reduce along parallel congested corridors, thereby improving their performance.

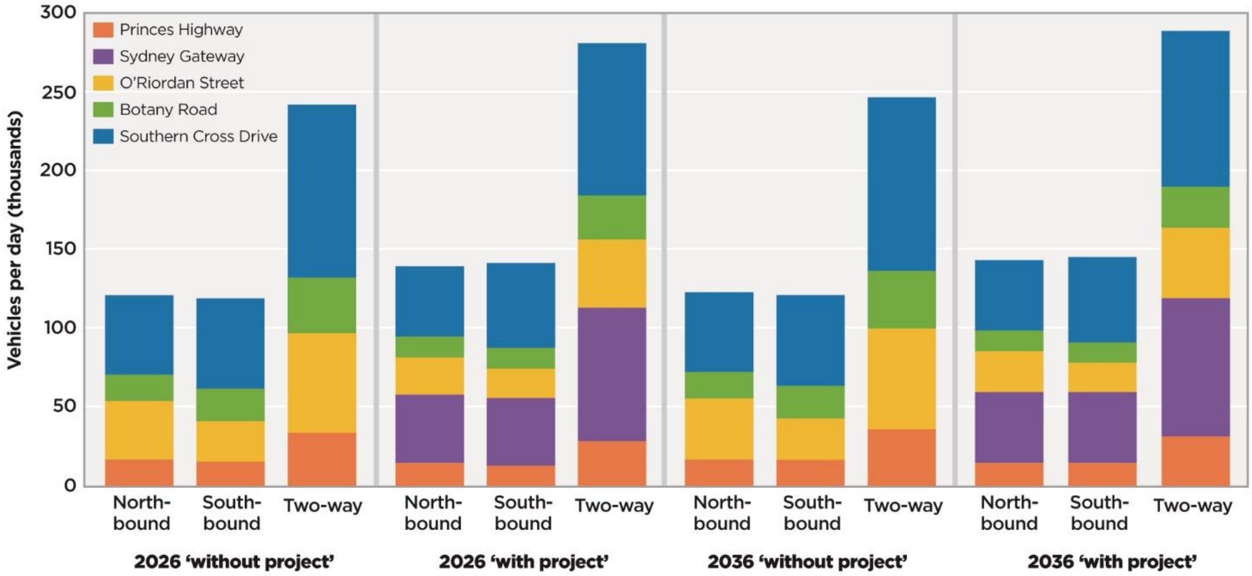


Figure 9.11 Sydney Gateway screenline analysis results

F6 screenline

The project would reduce demand on the Princes Highway by around 15 and eight per cent in 2026 and 2036 respectively (see Figure 9.12), allowing a reduction in congestion thereby improving performance. Conversely, the project would lead to a minor increase in traffic volumes along Marsh Street and the New M5 to accommodate access to/from the project.

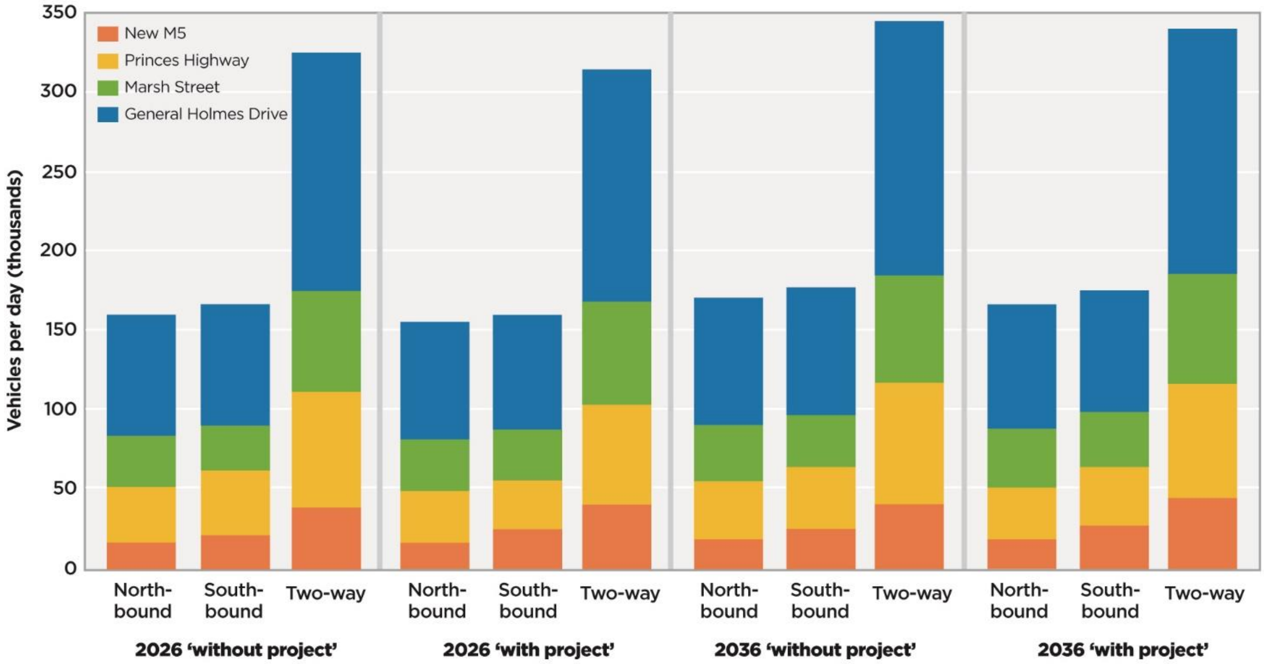


Figure 9.12 F6 screenline analysis results

Port Botany screenline

Traffic demand would increase by around five per cent along the Port Botany screenline (see Figure 9.13). However, the overall distribution of traffic across the Foreshore Road, Botany Road and Wentworth Avenue corridors would be maintained. The figure indicates that there would be no noticeable changes to port traffic along these routes. However changes to travel times (in section 9.4.2) would be substantial.

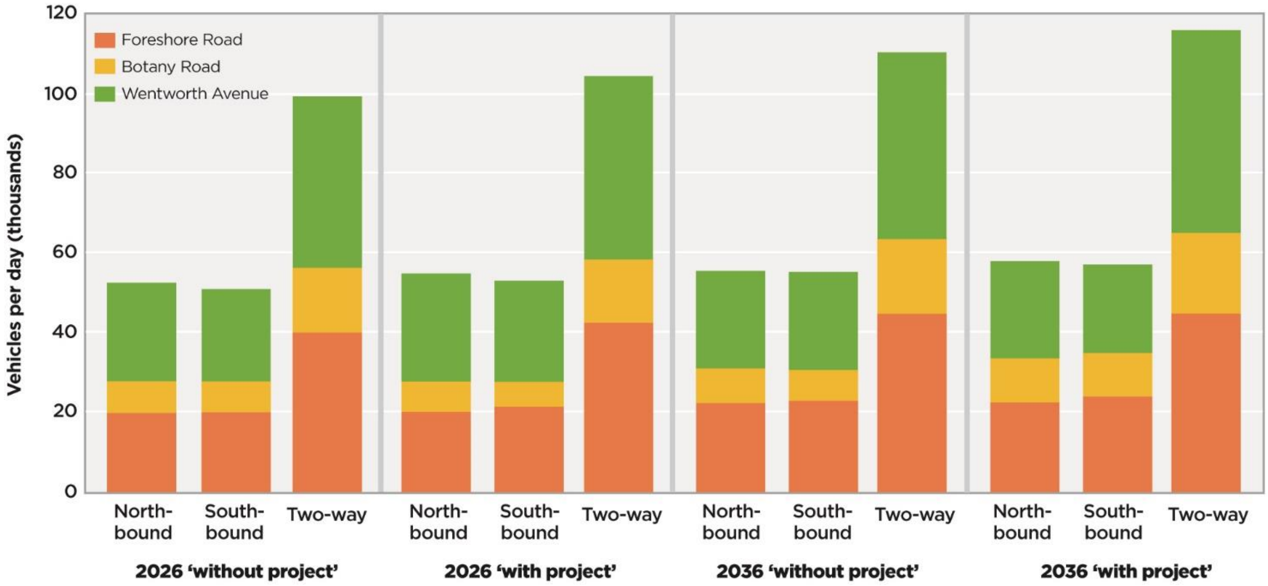


Figure 9.13 Port Botany screenline analysis results

9.4.2 Travel time analysis

Private vehicles

The forecast travel time increases in 2026 and 2036 (‘without project’) would be alleviated on most of the routes analysed in 2026 and 2036 (‘with project’) in both the morning and afternoon peaks. The travel time improvements would be more pronounced in the morning peak, with travel time improvements of between 30 to 70 per cent forecast along most of the routes, including:

- Canal Road
- Coward Street
- Botany Road
- O’Riordan Street
- Unwins Bridge Road.

These and some of the other routes that would benefit the most from the project, and indicative travel time improvements, are shown on Figure 9.14.

Conversely, eastbound travel times along Robey Street would increase by around 86 per cent in 2036 due to increased demand for this travel movement, particularly west of O’Riordan Street.

In the afternoon peak, similar travel time improvements as the morning peak are predicted, with the exception of a 22 per cent increase in travel time westbound on the M5 East to Southern Cross Drive (route 3).

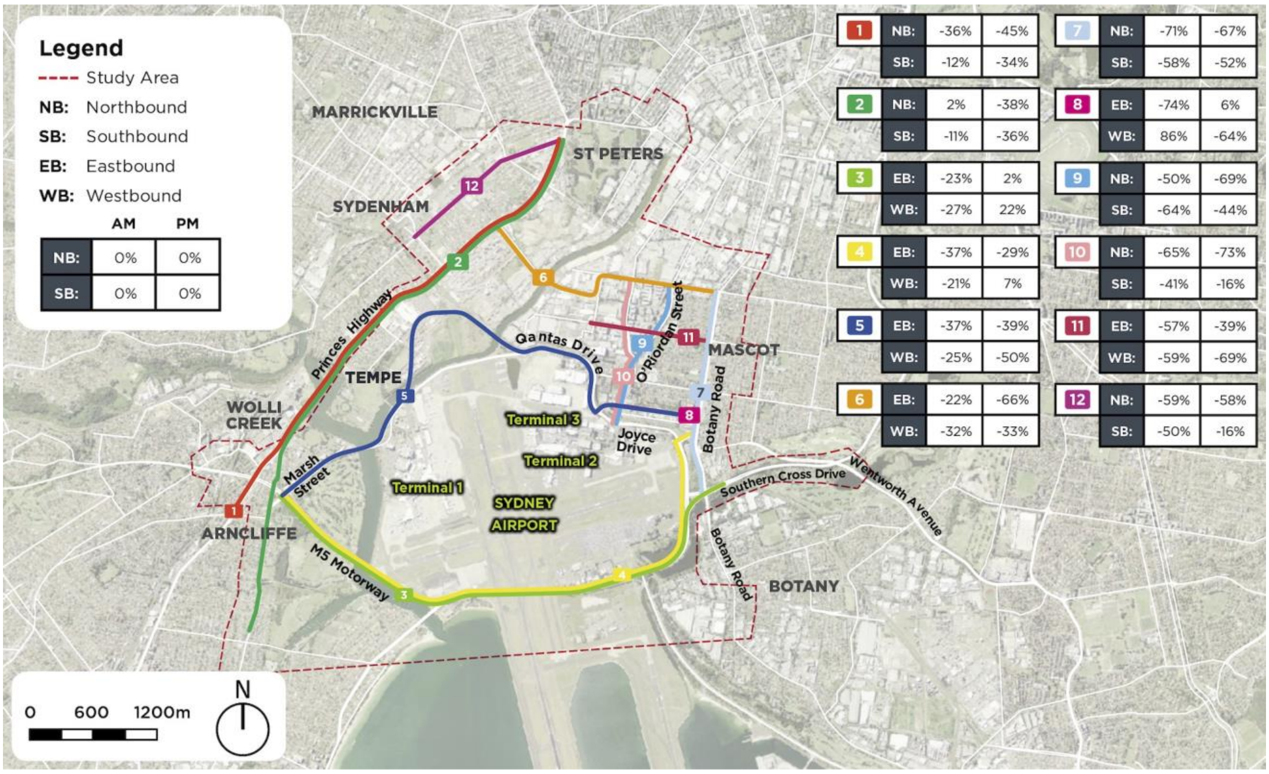


Figure 9.14 Selected 2036 travel time improvements (private vehicles)

Sydney Airport traffic

Travel times between St Peters interchange and the Sydney Airport terminals would substantially reduce with the project. In 2026, travel time improvements of up to 23 minutes would be experienced, increasing to up to 30 minutes in 2036 (see Figure 9.15 and Figure 9.16).

Vehicles travelling between St Peters interchange and Sydney Airport terminals via the project would reduce demand on the existing road network through Mascot. It is predicted that the route through Mascot (route 10) would experience travel time improvements of up to 10 minutes in 2026 and 2036 as a result of the project.

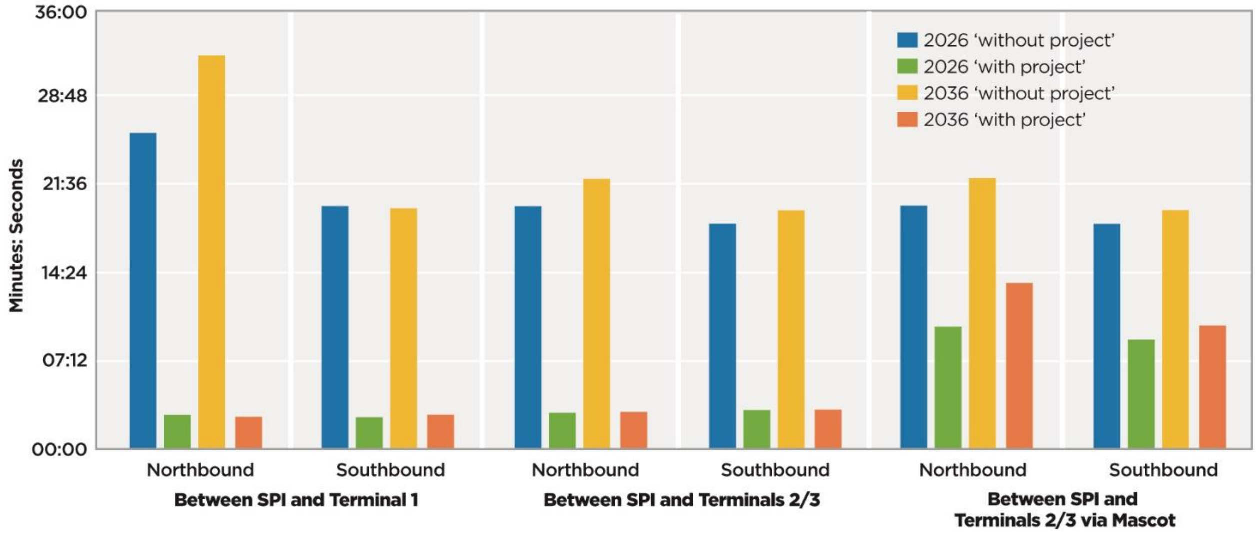


Figure 9.15 Travel time comparisons between St Peters interchange and Sydney Airport terminals in the morning peak

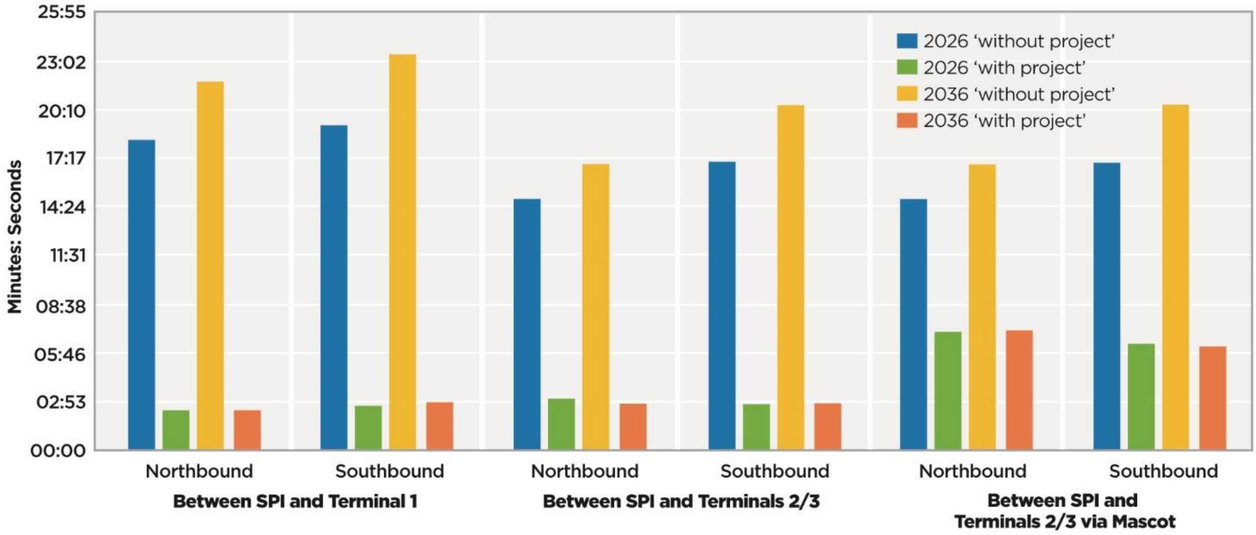


Figure 9.16 Travel time comparisons between St Peters interchange and Sydney Airport terminals in the afternoon peak

Port Botany traffic

Travel times between St Peters interchange and Foreshore Road would substantially reduce with the project (see Figure 9.17 and Figure 9.18). In 2026, travel time improvements of up to 17 minutes would be experienced, increasing to more than 20 minutes in 2036.

The project would reduce demand for the existing route between Port Botany and the M5 East via Foreshore Road. Travel times along this route would improve marginally. In particular, travel times in the westbound direction would improve by more than two minutes in 2026 and 2036.

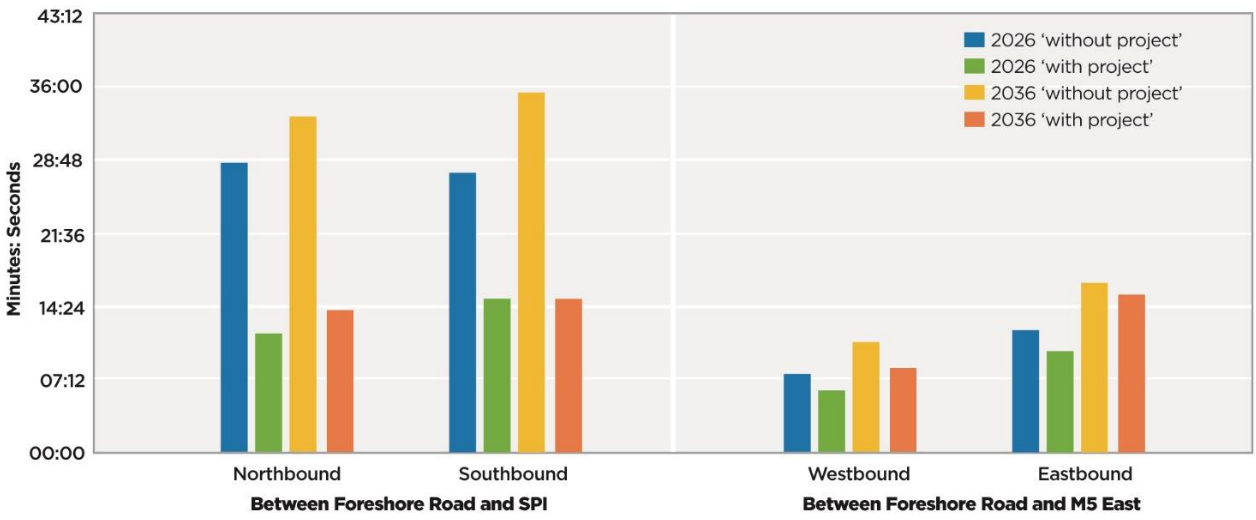


Figure 9.17 Travel time comparisons between St Peters interchange/M5 East and Foreshore Road in the morning peak

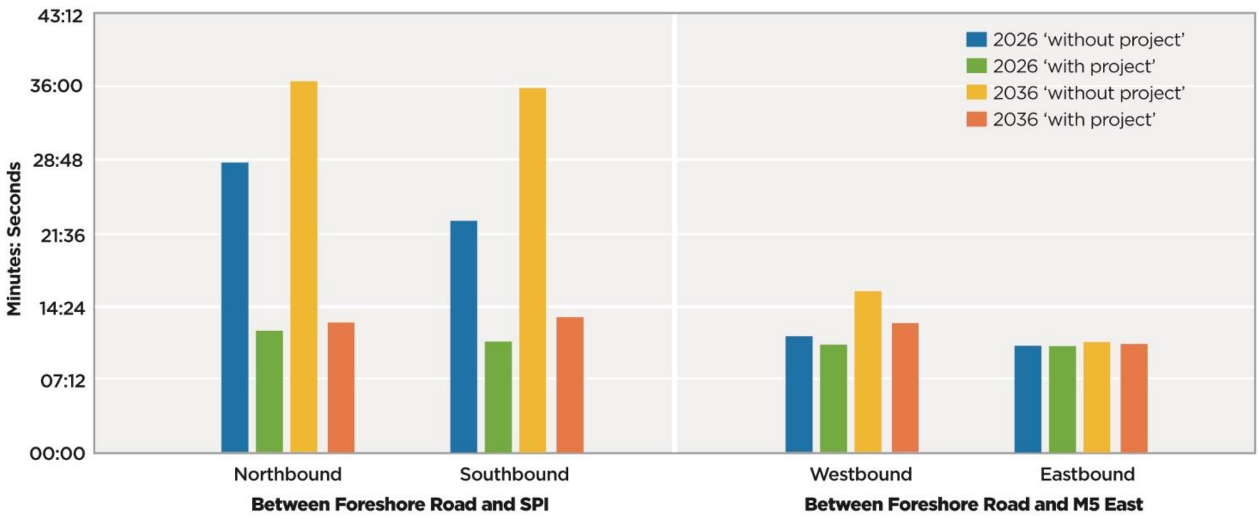


Figure 9.18 Travel time comparisons between St Peters interchange/M5 East and Foreshore Road in the afternoon peak

Public transport

No specific changes to public transport services or routes are included in the scope of the project. The identified improvements to the road network would result in improvements to public transport where buses use the assessed corridors. The project would result in substantial improvements to bus travel times along most of the assessed corridors compared to predicted travel times in 2026 or 2036 (without the project). In 2026, bus travel times would improve by a minimum of 30 per cent, with some routes experiencing improvements of up to 50 per cent. The following improvements are observed:

- Up to 50 per cent for routes M20, 309, 309X, 310 on Botany Road (Gardeners Road to Mill Pond Drive)
- Up to 30 per cent for route 303 on General Holmes Drive – Botany Road/Mill Pond Drive to the M5
- Up to 30 per cent for routes 420, 420N, and 400 on Airport Drive (Princes Highway to O'Riordan Street/Sir Reginald Ansett Drive)
- Up to 45 per cent for route 418 on Canal Road/Ricketty Street

- Up to 50 per cent for route 305 along O'Riordan Street/Qantas Drive to Gardeners Road/Bourke Road via Kent Road
- Up to 50 per cent for routes 307, 400, 420, and 420N along Coward Street (Bourke Road to Botany Road/Wentworth Avenue)
- Up to 30 per cent for routes 348 and 422 along Sydney Park Road to Brodie Spark Drive.

Additional improvements to bus travel times are forecast in 2036 and are shown on Figure 9.19.

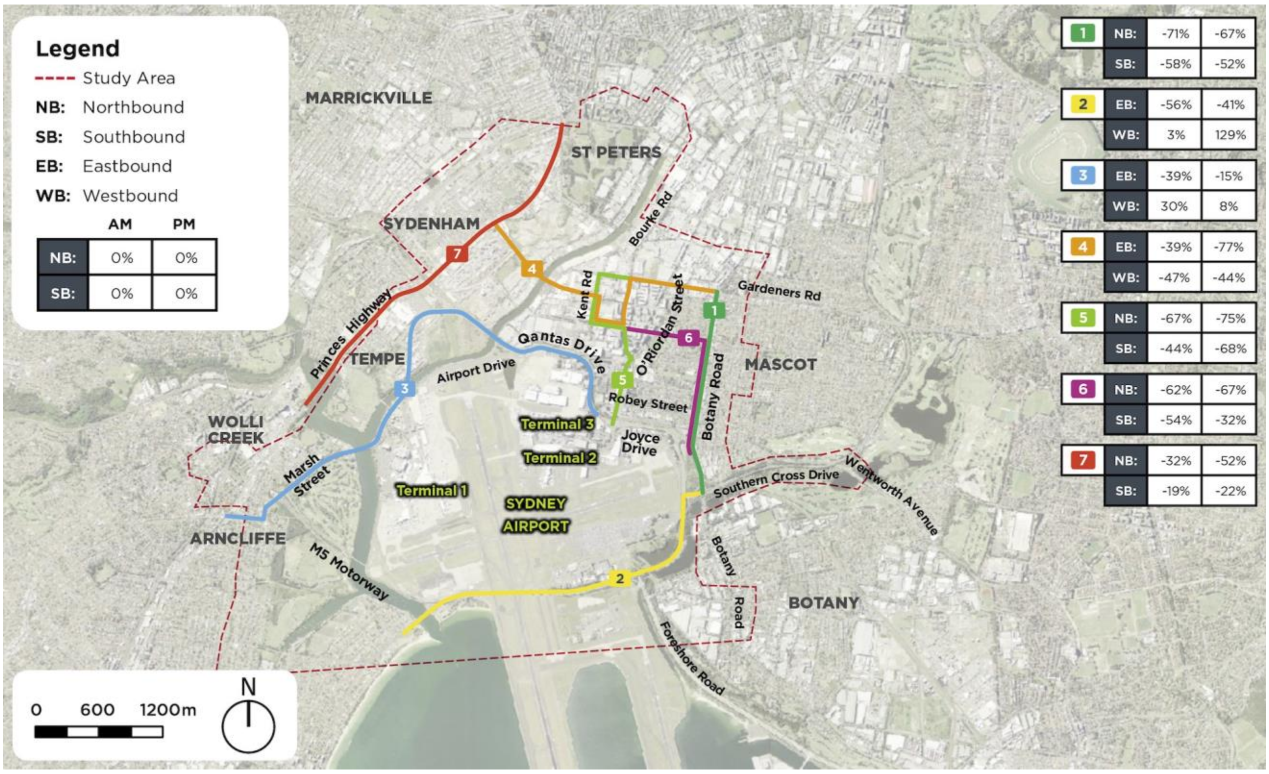


Figure 9.19 Selected 2036 travel time improvements (buses)

9.4.3 Intersection performance

Modelling shows that most intersections would continue to operate at a level of service E or F during the morning and afternoon peak periods, with and without the project, in 2026 and 2036. However, the average delay at most intersections would substantially decrease as a result of the project. Key findings in relation to intersection performance are summarised below, described in terms of changes to average delay. This provides an indication of the level of change between the 'with' and 'without project' scenarios.

As a guide to the magnitude of delays, the cycle time of a set of traffic signals (for all green and red lights to be displayed before restarting the sequence) is typically around 120 seconds for signalised intersections in the study area.

As shown on Figure 9.20, average delays would substantially improve at the following intersections in 2026:

- Joyce Drive and O'Riordan Street – decreases of 129 seconds and 189 seconds in the morning and afternoon peaks, respectively
- Qantas Drive, Robey Street and Seventh Street – decreases of 129 seconds and 81 seconds in the morning and afternoon peaks, respectively
- O'Riordan Street and Gardeners Road – decreases of 86 seconds and 82 seconds in the morning and afternoon peaks, respectively

- Botany Road and Gardeners Road – decreases of 145 seconds and 230 seconds in the morning and afternoon peaks, respectively
- Bourke Street and Coward Street – decreases of 152 seconds and 213 seconds in the morning and afternoon peaks, respectively.

As a result of these improvements, specifically at the Joyce Drive/O'Riordan Street and Qantas Drive/Robey Street intersections, the project would reduce vehicle delays and alleviate congestion that would occur at the main access points to Terminals 2/3 (without the project).

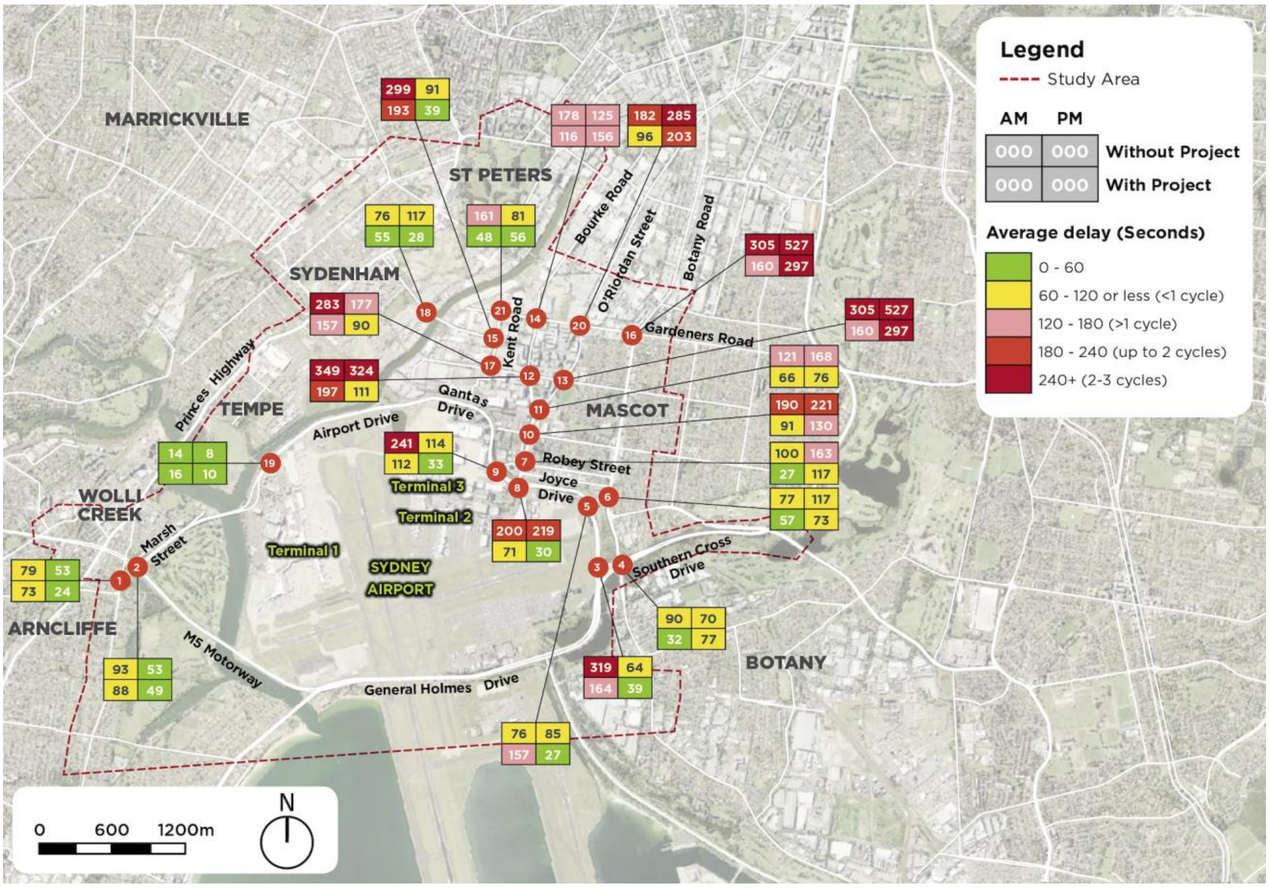


Figure 9.20 Forecast average delays at intersections with and without the project (2026)

Additional improvements would occur for the majority of the intersections in 2036. For instance, vehicle delays at the intersection of Bourke Street and Coward Street would decrease by 373 seconds and 276 seconds in the morning and afternoon peaks, respectively. This is a considerable improvement compared to the 2026 results. Figure 9.21 shows the average delays at each intersection in 2036.

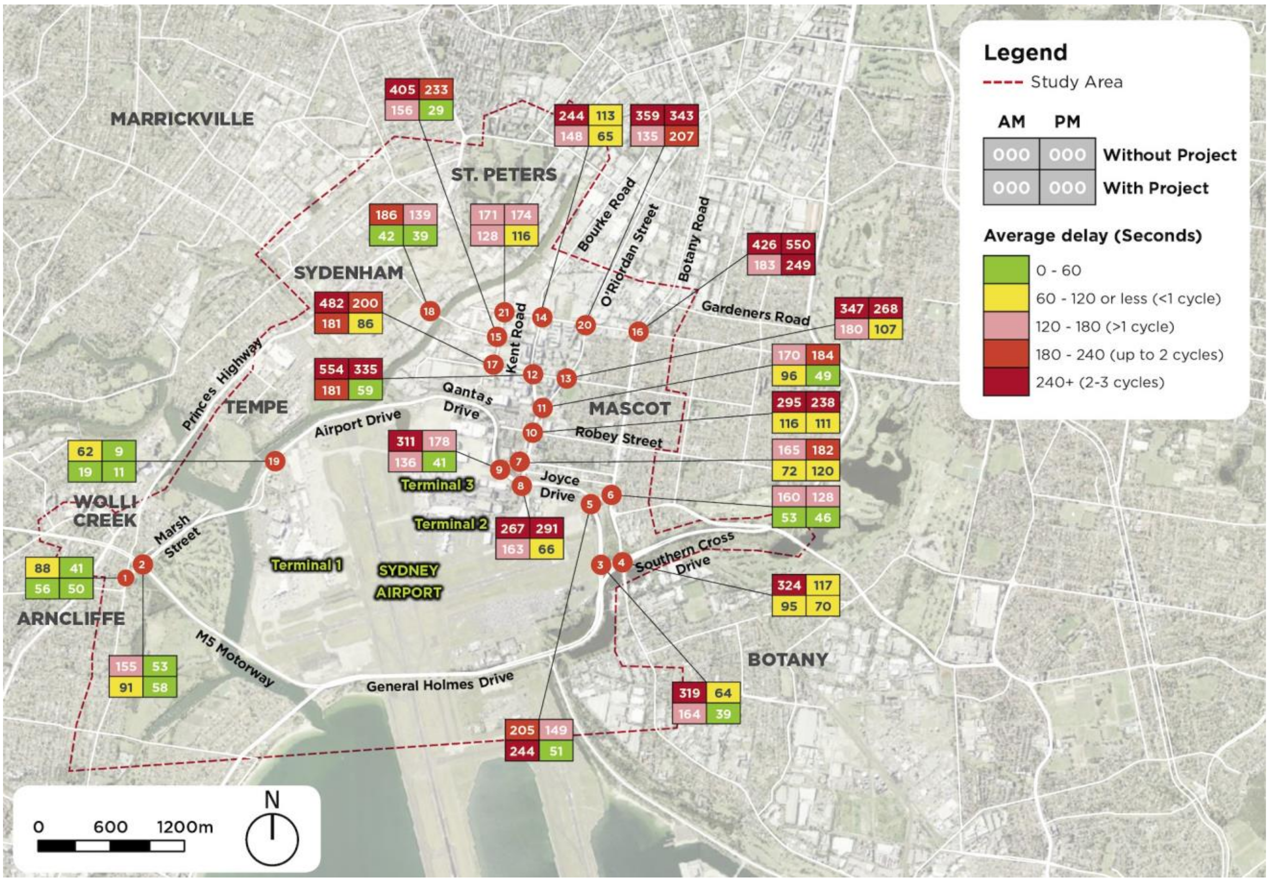


Figure 9.21 Forecast average delays at intersections with and without the project (2036)

9.4.4 Midblock performance

The 2036 density and level of service performance for the morning and afternoon periods with the project is shown on Figure 9.22 and Figure 9.23. The results are also summarised in Table 9.14.

In the morning peak, the majority of midblock locations and merge/diverge sections are forecast to operate at a level of service D or better (see Table 9.14). It is predicted that, due to network delays, the following road sections would operate at a level of service E or F:

- Merge point 10 (Airport Drive and M4 to Qantas Drive)
- Diverge point 12 (Airport Drive to Qantas Drive and M4)
- Merge point 13 (Seventh Street slip lane to Qantas Drive)
- Diverge point 14 (Qantas Drive to Terminals 2/3 access)
- M3 (Midblock Qantas Drive eastbound).

The performance of merge points 10 and 13, and the midblock location on Qantas Drive eastbound, would be affected by delays and queuing on the western approach to the intersection of Qantas Drive and Robey Street.

In the afternoon peak, all midblock locations and merge/diverge sections are forecast to operate at level of service D or better, except for merge point 15 (M5 and M4 to Airport Drive), which is predicted to perform at level of service E.

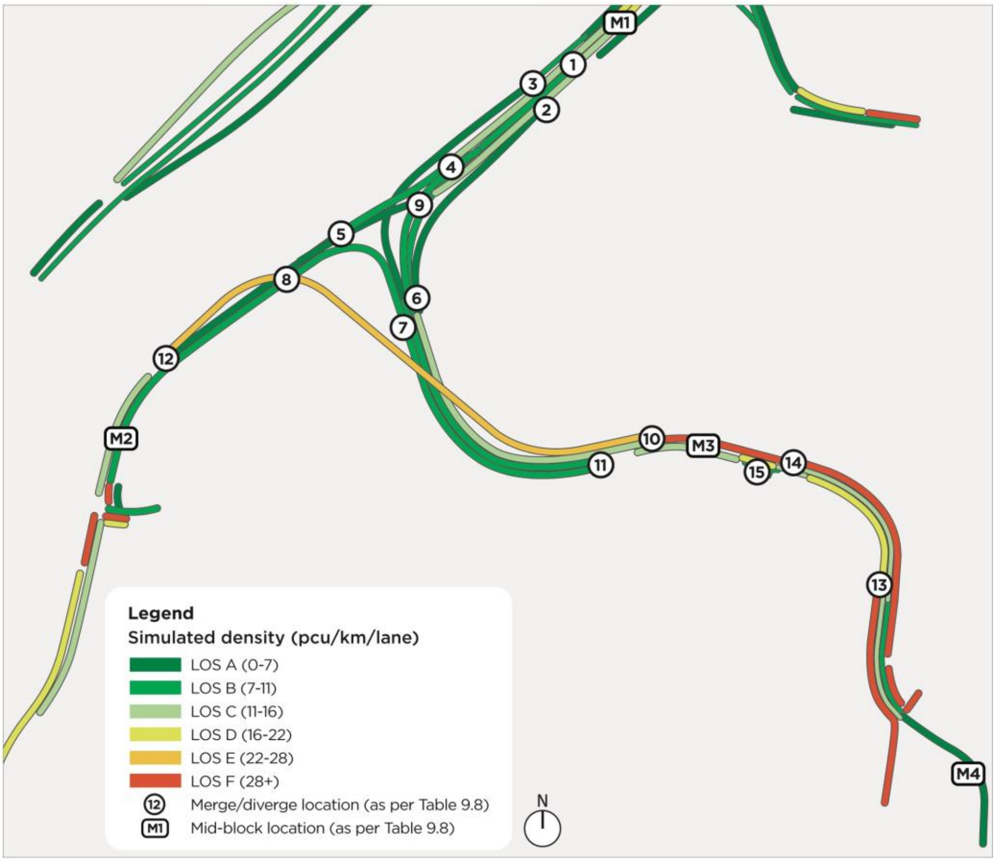


Figure 9.22 2036 morning peak density and level of service performance

Figure 9.23 2036 afternoon peak density and level of service performance

Table 9.14 Midblock performance in 2036

Segment/location[1]	Direction	Morning peak		Afternoon peak	
		Density (PCU/km/lane)	Level of service	Density (PCU/km/lane)	Level of service
Diverge 1 M4 to Airport Dive and Qantas Drive	Southbound	14	C	18	D
Diverge 2 M5 to Airport Drive and Qantas Drive	Southbound	4	A	0	A
Merge 3 Airport Drive and Qantas Drive to M5	Northbound	5	A	6	A
Merge 4 Airport Drive and Qantas Drive to M4	Northbound	12	C	10	C
Diverge 5 Airport Drive to M4 and M5	Northbound	7	B	4	A
Merge 6 M4 and M5 to Qantas Drive	Southbound	12	C	9	B
Diverge 7 Qantas Drive to M4 and M5	Northbound	11	B	13	C
Merge 8 New Airport Drive and M4 to Airport Drive	Southbound	9	B	10	B
Merge 9 M4 and M5 to Airport Drive	Southbound	14	C	18	D
Merge 10 Airport Drive and M4 to Qantas Drive	Eastbound	39	F	12	C
Diverge 11 Qantas Drive to Airport Drive and M4	Westbound	14	C	18	D
Diverge 12 Airport Drive to Qantas Drive and M4	Eastbound	23	E	7	A
Merge 13 Seventh Street slip lane and Qantas Drive	Westbound	29	F	19	D
Diverge 14 Qantas Drive to Qantas Drive and Terminals 2/3 access viaduct	Eastbound	59	F	15	C
Merge 15 M5 and M4 to Airport Drive	Westbound	19	D	23	E
M1 Midblock north of Canal Road	Northbound	12	C	10	B
	Southbound	14	C	18	D
M2 Midblock east of Link Road intersection	Eastbound	14	C	5	A
	Westbound	8	B	10	B
M3 Midblock Qantas Drive	Eastbound	39	F	12	C
	Westbound	14	C	18	D
M4 Midblock Terminals 2/3 access viaduct	Southbound	8	B	10	B

Note: 1. Segment/locations refer to those shown on Figure 9.22 and Figure 9.23.

9.4.5 Impacts on freight transport

The improvements to the road network performance described in sections 9.4.2 to 9.4.4 would benefit the movement of freight via the road network, including freight travelling to Sydney Airport and Port Botany. Specifically, these benefits would include:

- The project would become the preferred direct access to Sydney Airport, reducing heavy vehicle traffic on other roads, including the M5, General Holmes Drive, Southern Cross Drive, O'Riordan Street and Botany Road
- The project would reduce forecast traffic growth, including freight and heavy vehicle traffic, along Botany Road and other local roads in Mascot, which would benefit the amenity of the town centre and Mascot more generally
- There would be more pronounced travel time improvements in the morning peak with decreases of between 40 to 60 per cent in 2036 across most of the routes analysed
- As a result of the predicted reduction in delays at intersections, there would be reduced congestion for forecast future traffic growth, including to Sydney Airport.

As a result of the above, improvements to the safety of the local and arterial road network would also be achieved.

9.4.6 Impacts on public transport

The improvements to the road network performance detailed in sections 9.4.2 to 9.4.4 would result in improvements to public transport where buses use roads within the study area.

The project would lead to substantial improvements to bus travel times along the assessed corridors compared to the future situation without the project. Travel times in 2026 would improve by 20 to 50 per cent, with some routes experiencing improvements of up to 70 per cent. Further improvements to bus travel times would also be experienced in 2036.

The exception to these is the 303 westbound bus route on General Holmes Drive, for which travel times are forecast to increase by up to 50 per cent in 2026 and up to 130 per cent in 2036.

Section 9.4.2 provides further details of travel time savings along specific routes, which would also apply to buses using them.

The bus stops located along Qantas Drive at Lancastrian Road would be permanently closed as a result of the project. These bus stops have low usage. Removal/relocation of some buildings/facilities at the Sydney Airport Jet Base (particularly relocation of the Qantas Flight Training Centre) are expected to reduce use of these bus stops further. Alternate stops are located within Terminals 2/3 along the same routes. As a result, the overall impacts of removing these stops are considered to be minimal.

The project would not impact train services.

9.4.7 Impacts on active transport

The project includes relocating the Alexandra Canal cycleway to the western side of the canal. This would increase the length of the cycleway by about 160 metres. This increase in length would result in an additional three to four minutes travel time for pedestrians (and less than one minute for cyclists).

Existing pedestrian facilities would be maintained along all roads affected by the project (except the Qantas Drive/Lancastrian Road and Airport Drive/Link road intersections). The existing pedestrian crossing at the Lancastrian Road intersection would be removed. The impact of this change is considered minimal, because the existing crossing provides access to bus stops that would be removed as part of the project.

The new pedestrian access to the Terminal 1 freight facility at Link Road would be along the proposed freight terminal access bridge and a signalised intersection with the Terminal 1 connection. The impact of this change would depend on the point of origin. Additional travel distances could be up to 1,400 metres.

The project would also result in amenity improvements outside the project site, including in Mascot, by reducing through traffic along roads such as Botany Road and O'Riordan Street by around 26 to 30 per cent. The average delay at intersections within the study area, including within the Mascot Station precinct, would substantially improve.

The intersection of Bourke Street and Coward Street, which accommodates high pedestrian crossing activity, would experience an improvement of average delay of more than 240 seconds (70 per cent) in 2036. This has the potential to improve permeability for travel across these roads, safety for passengers accessing Mascot Station, and the amenity in Mascot more generally. Improvements to amenity would facilitate more walking and cycling opportunities.

A number of connectivity gaps exist in the current active transport network of the area. Roads and Maritime and Sydney Airport Corporation would develop an active transport strategy, with the input of relevant stakeholders, to identify potential opportunities to enhance active transport opportunities and guide the future provision of active transport infrastructure.

9.4.8 Impacts on access

Changes to access to Sydney Airport and surrounding areas

The project would improve access to Sydney Airport and surrounding areas by providing new, direct connections between the Sydney motorway network (via St Peters interchange) and Sydney Airport's terminals, avoiding Mascot town centre. It would also improve access to local roads and areas adjacent to Sydney Airport, including Marsh Street, O'Riordan Street and Joyce Drive.

The change to the way Sydney Airport is accessed would also result in benefits to access within and around the Botany town centre, which would have otherwise become congested due to vehicles accessing Port Botany via Botany Road. The project would assist in removing through traffic from local roads to other roads such as Qantas Drive and Joyce Drive.

The new elevated access to Terminals 2/3 would accommodate more than double the existing traffic volumes than the existing Qantas Drive in 2026 and 2036. Compared to the capacity of the existing access to Terminals 2/3, the new access is predicted to accommodate:

- Greater than 20 per cent more traffic during the morning peak in both 2026 and 2036
- Eighty per cent and 90 per cent more traffic in 2026 and 2036 respectively exiting Terminals 2/3 during the morning peak
- Greater than 30 per cent more traffic entering the terminals during the afternoon peak in 2026 and 2036
- Around five per cent additional traffic exiting the terminals during the afternoon peak in 2026 and 2036.

During the morning and evening peak hours, the access to/from Terminals 2/3 would generally perform satisfactorily at level of service D or better, except for the through and right turn exiting movements at Seventh Street. These movements would continue to operate at level of service F. Notwithstanding this, in the morning peak, the average delay for these movements would reduce substantially.

Removing the right turn from Qantas Drive into Sir Reginald Ansett Drive would mean that buses travelling to the Blu Emu car park would have to traverse a longer route via Robey and O'Riordan streets to access Sir Reginald Ansett Drive and Ross Smith Avenue. As a result, it is likely that the time to complete a circuit between the airport terminals and car park would increase. Other traffic would be less affected, as an alternative route from Joyce Drive into Ross Smith Avenue is available about 600 metres further east along Qantas Drive/Joyce Drive.

Changes to access for other adjacent properties

The project is not expected to directly impact access for any properties, with existing access maintained. However, the project would result in some changes to the way a number of properties are accessed. These are summarised in Table 9.15.

Table 9.15 Changes to access due to project

Land use/road	Changes to access
Airport Drive	The project would include closing a section of Airport Drive between the proposed freight terminal access and Qantas Drive. This section of Airport Drive would be replaced by roadways forming part of the project (ie the Terminal 1 connection, terminal links and the Qantas Drive upgrade and extension). This change would increase the travel distance between Terminal 1 and Terminals 2/3 by about 1 km. However, this is not considered to be significant given the overall benefits in terms of travel time.
Freight terminal at Terminal 1	The freight terminal located north of Terminal 1 is currently accessed from Airport Drive via the intersection at Link Road. The project includes a new freight terminal access from the Terminal 1 connection. The new access would increase the distance travelled by about 1 km from both the east and west.
Sydney Airport Corporation's northern lands	Sydney Airport's northern lands (south of the Botany Rail Line) and the employee car park is currently accessed via the Nigel Love Bridge off Airport Drive. With the closure of Airport Drive, this access would no longer be available. To facilitate access to the northern lands, the project includes a new northern lands access from Burrows Road (south) (see section 7.8.2). The project also includes a stub road on the proposed freight terminal access, which would facilitate future connections to the northern lands.
Sydney Airport Jet Base off Lancastrian Road	The project would include removing the traffic signals on Qantas Drive at Lancastrian Road, resulting in the removal of the right-in/right-out turning movements from Lancastrian Road from the eastbound lanes. Left in/ left out turning movements would remain without signals. Changes to this intersection would allow for improved traffic flow on Qantas Drive and contribute to a signal-free journey to and from Terminals 2/3 using the Sydney motorway network. However, it would also increase travel distances and times for people accessing Lancastrian Road from the west or exiting to the east. Operational access between Qantas Mascot (facilities to the north of the Botany Rail Line) and the Sydney Airport Jet Base would remain unchanged.
Swamp Road and Bellevue Street	The project includes closing Swamp Road south of Bellevue Street. Access to land that is currently accessed via Swamp Road would be via the proposed northern lands access and the freight terminal access. A cul-de-sac would be installed at the southern end of Bellevue Street to the north of the project site.

9.4.9 Impacts on parking

On-street parking

The project would not impact the availability of on-street parking, as none of the roads affected by the project provide formalised on-street parking. The project does not include provision of any new on-street parking.

Off-street parking

The only area of off-street parking that would be affected during operation would be the Sydney Airport northern lands employee car park, where about 24 parking spaces at the northern end of the car park would be removed. Some additional spaces may also be lost due to the need to reconfigure the internal car park access roads.

9.4.10 Summary of impacts on Sydney Airport (Commonwealth) land

Traffic flows to/from Sydney Airport

The project would provide a more direct route from the Sydney motorway network (via St Peters interchange) to the Sydney Airport terminals. As outlined in sections 9.4.1 and 9.4.2, if the project was not constructed, traffic with a destination at or near the airport would be required to use local road networks to access their destinations. This arrangement would result in traffic congestion within the Mascot area and would increase travel times to Sydney Airport.

The project would reduce this impact by allowing traffic with a destination or origin at Sydney Airport to travel on the Sydney motorway network without using local roads. With the majority of traffic accessing Sydney Airport via the project, local roads in the Mascot area would have greater capacity for local trips. Access to Sydney Airport from the local area to the north would also improve, because these vehicles would not be required to use the Sydney motorway network to access the airport.

The results of the assessment indicate that in 2026, travel time improvements to/from Sydney Airport of up to 23 minutes would be experienced, increasing to up to 30 minutes in 2036.

Average delays would substantially improve at key intersections in 2026 (decreases of up to 230 seconds). As a result of these improvements, specifically at the Joyce Drive/O'Riordan Street and Qantas Drive/Robey Street intersections, the project would reduce vehicle delays and alleviate congestion that would occur at the main access points to Terminals 2/3 ('without project'). Additional improvements (up to 373 seconds) would occur for the majority of the intersections in 2036.

The project would result in substantial improvements to bus travel times along most of the assessed corridors. In 2026, bus travel times would improve by a minimum of 30 per cent, with some routes experiencing improvements of up to 50 per cent. This would benefit public transport access to Sydney Airport.

Overall, the project would improve access to and from Sydney Airport. It would also improve traffic conditions on Qantas Drive benefitting users who have a destination other than the airport terminals.

Impacts on access to other areas of Sydney Airport

The project would improve access to other Sydney Airport facilities, particularly freight facilities at Terminal 1, because vehicles would not need to access the terminal via congested local roads. The project would also provide improved connections to the Sydney motorway network.

The new elevated access to Terminals 2/3 would have the capacity to accommodate more than double the existing traffic volumes that are forecast to use Qantas Drive in 2026 and 2036.

Removing the right turn from Qantas Drive into Sir Reginald Ansett Drive would affect the routing of the Blu Emu bus route, which would have to travel a longer route via Robey and O'Riordan Streets to access Sir Reginald Ansett Drive and Ross Smith Avenue.

The provision of a new northern lands access and freight terminal access would ensure access to Sydney Airport's existing and future freight facilities is maintained or improved.

As outlined in 9.4.8 the project includes modification of the Lancastrian Road intersection. This would result in increases to travel distances and times for vehicles accessing Lancastrian Road.

Parking

The project would result in in the permanent loss of about 24 spaces within the Sydney Airport northern lands employee car park.

Consistency with the Sydney Airport Master Plan

Transport planning within Sydney Airport is guided by the *Sydney Airport Master Plan 2039* (SACL, 2019a) (the Master Plan), which outlines the strategic direction for Sydney Airport's operations and development over the next 20 years. The key objectives in the plan that are relevant to the project are:

- Enhancing the experience of all passengers and airport users, which includes ground transport facilities, rail stations, terminal forecourts and commercial precincts
- Improving ground access to and from the airport and in the surrounding area, which includes increasing public and active transport use.

The Master Plan includes a five-year plan for ground transport. The ground transport plan identifies proposed solutions to reduce congestion, increase the efficiency of landside operations, and improve road network performance for access to and from Sydney Airport, taking into consideration expected continued growth in travel demand. In particular, these strategies consider potential changes to traffic volumes and patterns due to the opening of projects that form part of the WestConnex program of works.

The five-year ground transport plan includes the following objectives:

- Providing increased capacity on Airport Drive and Qantas Drive by providing additional traffic capacity
- Improving access to and from Terminals 2/3 by improving the performance of key access intersections at Qantas Drive and Seventh Street/Robey Street and Sir Reginald Ansett Drive/O'Riordan Street
- Providing a new Link Road landside access.

As shown on Figure 9.24, the project is the means by which the above objectives would be achieved.

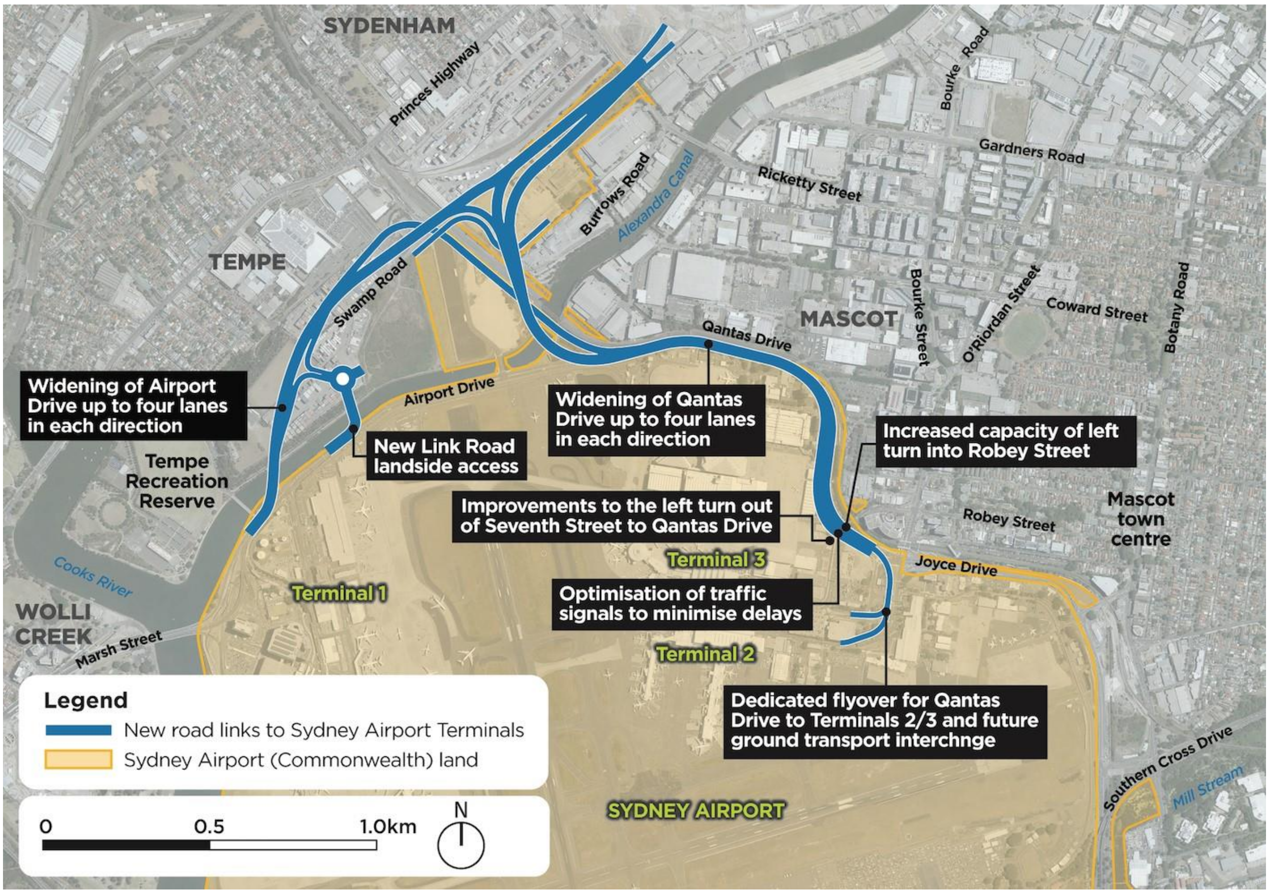


Figure 9.24 Key project features that align with ground transport solutions in the Sydney Airport Master Plan

As anticipated in the ground transport plan, the project has been developed to ensure that it meets the objectives of the Master Plan and the ground transport solutions outlined in the ground transport plan. The project would deliver the following aspects identified in the ground transport plan:

- Reconfigured access to Link Road
- Widening Airport Drive up to four lanes in each direction between Terminal 1 and St Peters interchange and Terminals 2/3
- Widening Qantas Drive to three lanes, expanding to four lanes in each direction between Terminals 2/3 and connections to Terminal 1 and St Peters interchange
- Improving the intersections of Sir Reginald Ansett Drive/O'Riordan Street/Joyce Drive and Seventh Street/Robey Street/Qantas Drive including a new dedicated access viaduct into Terminals 2/3

- Improving the left turn out of Seventh Street to Qantas Drive
- Improving the left turn from Qantas Drive to Robey Street.

The project plays a principal role in delivering the objectives of the Master Plan's five-year ground transport plan and is therefore consistent with the Master Plan.

9.5 Cumulative impacts

9.5.1 Construction

The key projects relevant to the assessment of cumulative impacts include the Botany Rail Duplication, the M4-M5 Link and the F6 Extension.

Construction traffic volumes from the above projects are summarised in section 8.7.1 of Technical Working Paper 1. These volumes represent less than three per cent of existing traffic volumes on the road network. This increase is unlikely to affect traffic network performance as it is likely within the range of daily variations currently experienced on the relevant roads. Given the minor contribution to existing traffic volumes, no significant cumulative impacts on traffic network performance are anticipated. Additionally, with the exception of the Botany Rail Duplication, construction traffic is likely to be remote from the project site.

The Botany Rail Duplication has greater potential to result in cumulative impacts during the period 2021 to 2023, because it is located directly adjacent to the project site and includes some common work areas along Qantas Drive and on Robey and O'Riordan streets. The Sydney Gateway road project would also require closures of Qantas Drive and Sir Reginald Ansett Drive for major crane lifts. Some of the rail duplication works would also need to be undertaken during rail possession periods (weekends) so as not to affect rail operations. Accordingly, a coordinated approach between the Botany Rail Duplication and the Sydney Gateway road project is required.

Potential cumulative impacts of the project and the Botany Rail Duplication include short-term closures of Robey Street and O'Riordan Street due to the reconstruction of rail bridges (and other works) over these roads. These closures would likely occur about four times a year and on weekends, which would help avoid impacts on weekday peaks when traffic volumes are at their highest. Traffic detours would be implemented during these road closures, along with communication (media) campaigns.

Modelling of travel times and intersection performance during the weekend peak, when closures of Robey and O'Riordan streets would occur and detours are needed, was undertaken. The results of modelling show that the following four intersections would experience substantially reduced performance due to the temporary closure of Robey Street:

- Qantas Drive/Robey Street – the level of service is predicted to deteriorate from D to F with an increase in delay of 141 seconds
- O'Riordan Street/Robey Street – the level of service is predicted to deteriorate from C to F with an increase in delay of 52 seconds
- General Holmes Drive/Wentworth Avenue – the level of service is predicted to deteriorate from B to F with an increase in delay of 59 seconds
- Botany Road/Wentworth Avenue – the level of service is predicted to deteriorate from C to F with an increase in delay of 146 seconds.

During the temporary closure of O'Riordan Street, the following three intersections would experience substantially reduced performance:

- Robey Street/Botany Road – the level of service is predicted to deteriorate from B to F with a predicted increase in delay of 55 seconds
- General Holmes Drive/Botany Road – the level of service is predicted to deteriorate from A to B with a predicted increase in delay of 10 seconds

- Botany Road/Wentworth Avenue – the level of service is predicted to deteriorate from C to F with a predicted increase in delay of 137 seconds.

Impacts on travel times during the use of traffic diversions would include:

- Closure of Robey Street – leading to a delay of between 8 and 20 minutes, depending on the alternative route used
- Closure of O'Riordan Street – leading to a delay of between 8 and 10 minutes, depending on the alternative route used.

Upon the completion of the Botany Rail Duplication, no further cumulative impacts are expected.

The footpaths on Robey and O'Riordan streets would be unavailable during any proposed short-term closures of Robey Street or O'Riordan Street (as long as a weekend) eg for major crane lifts for the Botany Rail Duplication. However, the potential closures would likely occur independent of each other. During the Robey Street closure, pedestrians would use O'Riordan Street, increasing walking distances by around 100 metres. Similarly, during the O'Riordan Street closure, pedestrians would use Robey Street, increasing walking distances by around 260 metres. Cyclists would also need to dismount and use these alternative routes, given that no formal cycling facilities are provided along Robey or O'Riordan streets. Where road closures are not required, pedestrians would be diverted to the opposite side of the road, via traffic control at the adjacent signalised intersections and crossings. Overall, the cumulative construction impacts to pedestrians and cyclists are considered to be manageable.

As the plans for each of the projects develop, and contractors finalise construction programs and methodologies, there would be further opportunity to co-ordinate activities likely to affect traffic in the vicinity. In addition, the proposed weekend closures of Robey and O'Riordan streets would require further clarification with the Botany Rail Duplication project team and contractor to ensure that cumulative impacts on traffic, pedestrians and cyclists are satisfactorily mitigated and managed.

9.5.2 Operation

The modelling and assessment of the potential operational impacts of the project (see section 9.4) factored in the operation of the New M4 and New M5. However, this assessment did not include the proposed F6 Extension or the Western Harbour Tunnel and Beaches Link projects, as these projects had not been approved. The following sections consider the cumulative impacts of these projects with the Sydney Gateway road project. Two modelling years were considered:

- The 2026 model, which included operation of the F6 Extension
- The 2036 model, which included both the F6 Extension and the Western Harbour Tunnel and Beaches Link projects.

Traffic volumes and patterns

Operating the F6 Extension and the Western Harbour Tunnel and Beaches Link projects, together with the Sydney Gateway road project would increase traffic volumes along the New M5 and M4-M5 Link in 2036.

Traffic volumes would decrease along the M1 (Southern Cross Drive and General Holmes Drive) and the Princes Highway (through St Peters, Sydenham and Tempe) as traffic would divert from these routes to the New M5 and F6 Extension. A marginal decrease in traffic along O'Riordan Street and Botany Road is also predicted.

The cumulative impacts of these projects would be marginal and include:

- A minor decrease in traffic volumes along Marsh Street
- A minor increase in traffic volumes to and from St Peters interchange.

Changes to heavy vehicle movements (ie on-road freight) would be similar to the changes to other traffic, with a shift to the new infrastructure, particularly from the M1 (Southern Cross Drive and General Holmes Drive) to the New M5, M4-M5 Link and F6 Extension. Overall, there would be very little change along Foreshore Road, Botany Road and Wentworth Avenue in terms of traffic volumes and proportions, with a negligible increase in traffic volumes predicted (around one to two per cent per day).

Road network performance

Operation of the F6 Extension and Western Harbour Tunnel and Beaches Link would result in a minor cumulative improvement in traffic conditions during the morning peak period. During the afternoon peak, there would be little to no change in road network performance, indicating that the network is forecast to be at capacity in 2036.

Intersection performance

The majority of intersections would operate at a similar level of performance in 2036 once the F6 Extension and Western Harbour Tunnel and Beaches Link are operating. The exception is the Bourke Road/Gardeners Road intersection, where a deterioration in the level of service (from E to F) is predicted in the afternoon peak period.

Average delays at most intersections would reduce by up to 70 seconds. However, at eight intersections, an increase in average delay by up to 45 seconds would occur in the morning peak period. In the afternoon peak period, five intersections would experience average delays of up to 26 seconds. While noticeable, these changes would be an improvement on the conditions that would exist without the project in 2036.

In summary, the results of the assessment indicate that key intersections in the road network would perform in a similar manner (in 2036) once the F6 Extension and Western Harbour Tunnel and Beaches Link are operating in conjunction with the project.

Midblock assessment

In the morning peak period, the majority of midblock and merge/diverge sections are forecast to operate at the same level of service once the F6 Extension and the Western Harbour Tunnel and Beaches Link are operational, indicating little to no change in vehicle density. Only four locations would experience a reduction in the level of service; however, these locations would still operate at a level of service D or better.

The results for the afternoon peak period also indicate that the majority of the midblock and the merge/diverge sections are forecast to operate at the same level of service once the F6 Extension and the Western Harbour Tunnel and Beaches Link are operational. There would be a reduction in the level of service, to a level of service E or F, as follows:

- Diverge 11 (Qantas Drive to Qantas Drive and M4) westbound reduces from a level of service D to E
- Merge 13 (Qantas Drive and Seventh Street slip lane) westbound reduces from a level of service D to E
- Merge 15 (M5 and M4 to Airport Drive) westbound reduces from a level of service E to F
- M3 (midblock location on Qantas Drive) westbound reduces from a level of service D to E.

These points are all located along Qantas Drive in the westbound direction. The reduction in level of service is considered to result from traffic exiting from Terminals 2/3 heading towards St Peters interchange.

Travel times

Changes to travel time due to the opening of the F6 Extension and Western Harbour Tunnel and Beaches Link would be minimal overall during the morning and afternoon peak periods. The opening of these projects would further enhance the preference for using the project, particularly from Port Botany and Terminals 2/3.

Impacts on public transport

The assessment shows that operation of the F6 Extension Stage 1 and Western Harbour Tunnel and Beaches Link projects together with the project would lead to improvements to bus travel times and reliability along most of the assessed corridors. Substantial travel time improvements would result along Sydney Park Road, General Holmes Drive and Coward Street, indicating:

- Up to a 25 per cent reduction in travel time for routes 307, 400, 420, and 420N along Coward Street (Bourke Road to Botany Road and Wentworth Avenue) in the morning peak
- Up to a 65 per cent reduction in travel time for route 303 on General Holmes Drive in the afternoon peak
- Up to 35 per cent reduction in travel time for routes M20, 309, 309X and 310 on Botany Road (Gardeners Road to Mill Pond Drive) in the afternoon peak.

The following routes indicated a substantial increase in travel time:

- Up to a 15 per cent increase in travel time for route 303 on Canal Road/Ricketty Street in the morning peak
- Up to a 55 per cent increase in travel time for routes 420, 420N, and 400 on Airport Drive
- Up to a 30 per cent increase in travel time for routes 348 and 422 along the Princes Highway in the afternoon peak

Further information about travel time changes to other routes is provided in Appendix D of Technical Working Paper 1.

Impacts on active transport

The New M5 includes a cycleway connection to Canal Road at St Peters. The F6 Extension includes new shared cycle and pedestrian pathways. Given the proximity of these projects to the project site, there would be an opportunity for a future connection between the corridors to achieve cumulative benefits and further encourage active transport.

Impacts on parking and access

Compared with the ‘with project’ option, there were no differences identified to the impacts on parking and access under the cumulative scenario.

9.6 Management of impacts

9.6.1 Approach

Approach to mitigation and management

High capacity and efficient movements from Sydney Airport and its terminals is a critical function provided by the existing road network. Construction would result in unavoidable changes to the configuration and capacity of the existing road connections. The assessment identified that the latter stages of construction would result in moderate impacts on the local road network, particularly in the vicinity of Terminals 2/3.

Certain construction activities (eg major crane lifts over roads and Alexandra Canal) would require temporary lane and road closures. These would be predominantly undertaken at night or over the weekend periods when traffic volumes are lower. Such activities would need to be co-ordinated with adjacent projects such as the Botany Rail Duplication to ensure access, satisfactory capacity and minimum levels of service are maintained through and around the project site.

Once operational, the project would provide increased capacity and direct connections from the Sydney motorway network to Sydney Airport’s terminals and remove through traffic from other local roads.

The following measures are proposed to mitigate impacts that cannot be avoided.

Approach to managing the key potential impacts identified

A Construction Traffic and Access Management Plan would be prepared and implemented as part of the CEMP. The plan would detail processes, relevant requirements and responsibilities to minimise potential traffic, transport and access impacts during construction. Further information on the CEMP, including the requirements for the Construction Traffic and Access Management Plan, is provided in Chapter 27 (Approach to environmental management and mitigation).

Careful and detailed planning would be required during detailed design and prior to construction to ensure the capacity of the road network is maintained and access to the airport is unaffected. This would require close co-ordination with a range of stakeholders, including Roads and Maritime, Transport for NSW (various divisions), ARTC, Transport Management Centre, Sydney Coordination Office, Sydney Airport Corporation, emergency services, and any infrastructure contractors working in the vicinity of the airport.

The Construction Traffic and Access Management Plan would include a requirement to conduct further network and local area analysis to reduce the identified level of impacts during construction, particularly any revised traffic staging proposed by the construction contractors. Options for re-routing traffic during periods of lane and road closures would also be further investigated to minimise travel times.

A travel demand management strategy would also be developed to promote the diversion of unnecessary traffic around the project site. This would be implemented in conjunction with a detailed communications strategy to notify drivers (including public transport, private vehicles, heavy vehicles) of construction works, potential delays, detours and other relevant information.

Close co-ordination would be undertaken with ARTC and the Botany Rail Duplication contractor, for works in the vicinity of Robey and O'Riordan streets and Qantas Drive, Seventh and Ninth streets, to minimise the potential for cumulative impacts.

Approach to managing other impacts

An active transport network strategy, developed in conjunction with relevant stakeholders, will be prepared to integrate and enhance accessibility opportunities and future active transport infrastructure provision.

Other measures are provided in section 9.6.2.

Expected effectiveness

Roads and Maritime is experienced at managing all modes of traffic throughout construction of road projects. The proposed measures outlined in Table 9.16 are based on previous road projects in urban environments and are designed to effectively mitigate and manage construction-related impacts.

The Construction Traffic and Access Management Plan would be prepared in accordance with the relevant parts of the Austroads Guide to Road Design, *Traffic control at work sites* (Roads and Maritime, 2018b) and AS 1742.3–2009: *Manual of uniform traffic control devices – Traffic control for works on roads.*

In addition, prior to the implementation of any temporary traffic management measures outlined within the Construction Traffic and Access Management Plan, a person who is qualified in Roads and Maritime's 'Design and Inspect Traffic Control Plans' course would carry out an inspection to verify that any pavement markings, road signs and other traffic control devices have been installed appropriately. The Construction Traffic and Access Management Plan would be amended as applicable should any measures not be considered effective.

Access to properties would be maintained during the construction period. While access arrangements would be outlined in the Construction Traffic and Access Management Plan, the effectiveness of those arrangements and the need for any alternative and/or temporary access arrangements would be agreed with affected property managers/owners.

For the operational phase, the traffic modelling results outlined in sections 9.4.1 and 9.4.2 shows that the project effectively caters for increased traffic demand in 2026 and 2036 when compared to the existing networks (including other approved motorway projects) performance in the future.

9.6.2 List of mitigation measures

Measures that would be implemented to address potential impacts on traffic, transport and access are listed in Table 9.16.

Table 9.16 Traffic, transport and access mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Potential for traffic, transport and access impacts during construction	TT1	A Construction Traffic and Access Management Plan will be prepared prior to construction and implemented as part of the CEMP. The plan will detail processes and responsibilities to minimise traffic and access delays and disruptions, and identify and respond to changes to road safety during construction.	Pre-construction, construction
	TT2	The Construction Traffic and Access Management Plan will include proposed road staging of construction works along Airport Drive, Qantas Drive and key accesses to Sydney Airport's terminals to ensure these key roads maintain satisfactory capacity and minimum levels of service. The proposed road staging plans and mitigation measures will be developed in conjunction with Transport for NSW (various divisions), ARTC, the Transport Management Centre, Sydney Coordination Office, Sydney Airport Corporation, emergency services, and any contractors working in the vicinity of the airport.	Pre-construction
	TT3	The communications strategy (measure SE1) will include a mechanism to inform the community of the dates and durations of specific phases within the project, including information about specific lane and road closures and the times of day and night when works will be carried out.	Pre-construction, construction
	TT4	A travel demand management strategy will be prepared to provide: ▪ A comprehensive set of travel mode options to minimise use of roads affected by construction ▪ Communication strategies to reduce the number of people using the road network in the project study area during construction, where practicable.	Pre-construction, construction
Impacts on road network performance (delays) and safety	TT5	Construction staging and temporary work plans will be prepared to: ▪ Ensure access to Sydney Airport is maintained at all times during operational hours ▪ Stage the construction works on key parts of the network, such as Qantas Drive, Airport Drive and access to Sydney Airport terminals, to enable these roads to continue to function with as minimal impact as possible ▪ Minimise conflict with the existing road network ▪ Maximise spatial separation between work areas and travel lanes.	Pre-construction, construction
	TT6	Further consideration of the construction phase road geometry and construction area operations will be undertaken with the aim of optimising road performance during construction. This will include the following considerations: ▪ Maintain a posted speed of 50 to 60 km/h along the construction zones ▪ Maintain three lanes in each direction at the Airport Drive and Link Road intersection	Construction

Impact/issue	Ref	Mitigation measure	Timing
		▪ Provide three lanes into Terminals 2/3 at Sir Reginald Ansett Drive through to Keith Smith Avenue.	
	TT7	Where reasonable and feasible, work areas, activities and construction access arrangements will be modified to address any traffic flow issues identified by key stakeholders, including the Sydney Coordination Office, Sydney Airport Corporation and the Traffic Management Centre.	Construction
	TT8	A mechanism will be provided for the community to report incidents and delays, such as a project phone number. The contact mechanism will be communicated in accordance with the project's communications strategy (measure SE1).	Construction
Impacts on access to Terminals 2/3	TT9	Further traffic management in the vicinity of the Qantas Drive/Seventh Street/Robey Street intersection will be planned and undertaken with consideration of the following potential re-routing options: ▪ Divert westbound traffic from General Holmes Drive (via Joyce Drive) onto Robey Street (via the new Wentworth Avenue link provided by the Airport East Precinct Upgrade project) and Botany Road instead of using the right turn from Qantas Drive to Robey Street ▪ Consolidate and support the function of the left turn from Qantas Drive onto Robey Street and traffic out of Seventh Street through the re-allocation of signal green time taken away from the diverted or banned right turn movement (from Qantas Drive to Robey Street) during peak periods or potentially ban the right turn movement in the peak periods ▪ Introduce an additional left turn lane into Robey Street from Qantas Drive to improve traffic flows based on traffic modelling analyses.	Pre-construction, construction
	TT10	Access to Sydney Airport will be maintained at all times during the airport's operational hours. Any temporary changes to access arrangements will be developed, communicated and implemented in consultation with Sydney Airport Corporation.	Construction
Property, cyclist and pedestrian access	TT11	Access to properties, including residences, businesses and community infrastructure, will be maintained. Where disruption to access cannot be avoided, consultation will be undertaken with the owners and occupants of affected properties, to confirm their access requirements and to identify alternative arrangements.	Construction
	TT12	Safe pedestrian and cyclist access will be maintained around or through work areas. Where disruption to access cannot be avoided, alternative routes that comply with relevant accessibility standards and guidelines will be provided, signposted and communicated.	Construction
Impacts on the availability of parking on streets surrounding construction work areas	TT13	A worker parking strategy will be developed to identify measures to minimise worker parking on local streets. Measures to be implemented during construction will include provision of designated parking areas within the project site, encourage use of public transport and implement shuttle bus arrangements.	Pre-construction, construction
Impacts on bus stops and passengers	TT14	Where required, changes to existing bus stops and/or changes to bus service patterns will be undertaken in accordance with the following requirements: ▪ Changes will be designed and implemented in consultation with Transport for NSW and bus operators ▪ The users will be informed in advance of changes.	Construction

Impact/issue	Ref	Mitigation measure	Timing
Impacts of construction haulage vehicles	TT15	Construction haulage vehicles will be managed to: ▪ Adhere to the nominated haulage routes and speeds identified in the Construction Traffic and Access Management Plan ▪ Minimise idling and queuing on public roads ▪ Minimise movement of vehicles during peak periods.	Construction
Cumulative construction traffic impacts	TT16	The potential for cumulative construction traffic impacts will be reviewed and co-ordinated with other projects. The review will include: ▪ Considering other projects with the potential to affect access and capacity, particularly in the vicinity of Terminals 2/3 ▪ Detailed reviews of programs for traffic staging, lane and road closures for all projects ▪ Co-ordinating works and identifying efficient re-routing options during periods of road and lane closures.	Pre-construction, construction
Operational road network performance including potential increased traffic on some parts of the network	TT17	A review of operational network performance will be undertaken 12 months and five years from the commencement of operation to confirm the operational traffic impacts on surrounding arterial roads and key intersections. The review will identify measures (as required) to address impacts on road network performance. The results of the review will be considered in future operational network performance planning carried out by Roads and Maritime.	Operation
Active transport opportunities	TT18	Roads and Maritime and Sydney Airport Corporation will prepare an active transport strategy to integrate and enhance accessibility opportunities. The strategy will be prepared in conjunction with relevant stakeholders and provide a guide for future active transport infrastructure provision.	Operation

9.6.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see section 6.4)
- Construction planning and management approaches to avoid and minimise impacts (see section 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 9.6.2).

Residual impacts would occur during construction and would include travel time delays along key routes within the study area as well as at key intersections. While the Construction Traffic and Access Management Plan would include measures to reduce impacts, there would continue to be impacts which the management measures cannot completely mitigate.

Chapter 10

Noise and vibration

This chapter describes the existing noise and vibration environment, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 2 (Noise and Vibration).

The SEARs and MDP requirements relevant to noise and vibration are listed below. Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
2	**Noise and vibration - amenity**	
2.1	The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must consider cumulative impacts from nearby key infrastructure proposals and take into consideration and address the noise impacts arising from the redistribution of traffic (including on local feeder roads), and operational plant and equipment. The assessment must also include consideration of impacts to sensitive receivers and include consideration of sleep disturbance (including the number of noise-awakening events), and, as relevant, the characteristics of noise and vibration (for example, low frequency noise).	The full assessment results are provided in Technical Working Paper 2 (Noise and Vibration), with a summary of the findings provided in this chapter, as indicated below.
2.2	An assessment of construction noise and vibration impacts which must address: (a) the nature of construction activities (including transport, tonal or impulsive noise-generating works, as relevant);	Section 10.1 and 10.2.1
	(b) the intensity and duration of noise (both air and ground borne) and vibration impacts. This must include consideration of extended construction impacts associated with ancillary facilities (and the like) and construction fatigue;	Sections 10.1, 10.2.1, 10.4 and 10.7
	(c) the identification of receivers, existing and proposed, during the construction period;	Section 10.3.1
	(d) the nature of the impact and the sensitivity of receivers and level of impact;	Section 10.4
	(e) the need to balance timely conclusion of noise and vibration-generating works with periods of receiver respite, and other factors that may influence the timing and duration of construction activities (such as traffic management);	Section 10.7
	(f) noise impacts of out-of-hours works (including utility works), possible locations where out-of-hours works would be undertaken, the activities that would be undertaken, the estimated duration of those activities and justification for these activities in terms of the Interim Construction Noise Guideline (DECCW, 2009);	Out-of-hours works are described in section 8.3.3. The potential impacts of out-of-hours works are summarised in section 10.4.2
	(g) a cumulative noise and vibration assessment inclusive of impacts from the proposal, including concurrent construction activities within the proposal and the construction of other relevant development in the vicinity of the proposal;	Section 10.6

Reference	Requirement	Where addressed
	(h) details and analysis of the predicted effectiveness of mitigation measures to adequately manage identified impacts, including impacts as identified in (g), and any potential residual noise and vibration impacts following application of mitigation measures; and	Section 10.7
	(i) a description of how sensitive receiver feedback received during the preparation of the EIS has been taken into account (and would be taken into account post exhibition of the EIS) in the design of mitigation measures, including any tailored mitigation, management and communication strategies for sensitive receivers.	Section 10.7.1
2.3	The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.	No blasting required
3	**Noise and Vibration - Structural**	
3.1	The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage), including cumulative impacts resulting from the Botany Rail Duplication.	The full assessment results are provided in Technical Working Paper 2 (Noise and Vibration), with a summary of the findings provided in section 10.4 and 10.5.
3.2	The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.	No blasting required
Major development plan requirements *(in accordance with Section 91 of the Airports Act)*		
91(1)(e)	If the development could affect noise exposure levels at the airport—the effect that the development would be likely to have on those levels.	Sections 10.4.6 and 10.5.2

10. Noise and vibration

10.1 Assessment approach

Major road projects have the potential to generate noise and vibration. As a result, noise and vibration assessments are a standard part of the environmental impact assessment process for infrastructure projects. The project site is located in a highly developed, urban area with a mix of transport, commercial, residential, industrial and recreational land uses. The noise environment is highly influenced by aircraft noise associated with the operation of Sydney Airport. By meeting noise and vibration management levels and implementing the recommended mitigation measures, the potential noise and vibration impacts of the project would be reduced.

An overview of the approach to the assessment is provided below, including the legislative and policy context and a summary of the assessment methodology.

10.1.1 Legislative and policy context to the assessment

The assessment has been undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations
- *Environmental Criteria for Road Traffic Noise* (NSW EPA, 1999)
- *Environmental Noise Management Manual* (Roads and Traffic Authority, 2001)
- *Interim Construction Noise Guideline* (DECC, 2009)
- *NSW Road Noise Policy* (DECCW, 2011)
- *Preparing an Operational Noise and Vibration Assessment* (Roads and Maritime, 2011a)
- *Noise Criteria Guideline* (Roads and Maritime, 2015a)
- *Noise Mitigation Guideline* (Roads and Maritime, 2015b)
- *Construction Noise and Vibration Guideline* (Roads and Maritime, 2016b)
- *At-Receiver Noise Treatment Guideline* (Roads and Maritime, 2017b)
- *Model Validation Guideline* (Roads and Maritime, 2018c)
- *Noise Policy for Industry (*NSW EPA, 2017a)
- *Assessing Vibration: A Technical Guideline* (DEC, 2006a)
- *AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors*
- *BS7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2*
- *DIN4150: Part 3-2016 Structural vibration – Effects of vibration on structures*
- *ISO 9613 Acoustics – Attenuation of sound during propagation outdoors*
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

10.1.2 Methodology

Study area

The study area for the noise and vibration assessment was developed based on the potential extent of the impacts of project activities, including:

- Construction activities at work sites and at the construction ancillary facilities (compounds), described in Chapter 8 (Construction)
- Construction haulage routes (described in Chapter 8)
- Noise generated by permanent operational infrastructure.

Once the potential extent of impacts was identified, the location of sensitive receivers was also considered. Noise sensitive receivers were identified using aerial photography and cadastral information, with discrete land uses determined by ground-truthing.

Within the study area, nine noise catchment areas were identified. These areas group receivers based on similar land uses and background noise environments.

The *NSW Road Noise Policy* (DECCW, 2011) (the Road Noise Policy) defines the assessment area for operational road traffic noise assessments as being 600 metres from the centreline of the outermost traffic lane on each side of a project alignment. The *Noise Criteria Guideline* (Roads and Maritime, 2015a) notes that the Road Noise Policy assessment area is likely to include other significant non-project roads (such as the Princes Highway in this case). As such, the assessment area may be reduced.

The study area and noise catchment areas are shown in Figure 10.1. Further information on the noise catchment areas is provided in section 10.3.2.

Key tasks

The assessment involved the following key tasks.

Tasks to define the assessment area, existing environment and potential noise sources

- Identifying and classifying sensitive receivers (including proposed receivers such as the new hotel to be constructed between Ninth and Seventh streets near Terminals 2/3), noise catchment areas and the assessment area (see Figure 10.1 and Figure 10.2)
- Characterising the existing noise environment based on attended and unattended noise measurements at representative locations in the study area (shown on Figure 10.2) in September and October 2018 – for receivers close to the project site, monitoring equipment was located (where possible) at those receivers with a direct line of sight to the project site
- Determining noise and vibration management levels/criteria in accordance with relevant guidelines
- Identifying potential noise sources during construction and operation
- Defining construction scenarios and developing representative ‘realistic worst-case’ scenarios with indicative durations (see Table 10.1), based on the assumption that several items of construction equipment would be used at the same time within individual construction scenarios
- Categorising the construction scenarios into ‘peak’ and ‘typical’ activities with ‘peak’ works representing the noisiest stages of the works involving equipment such as rockbreakers or concrete saws
- Identifying construction activities likely to occur outside standard construction hours (‘out-of-hours works’).

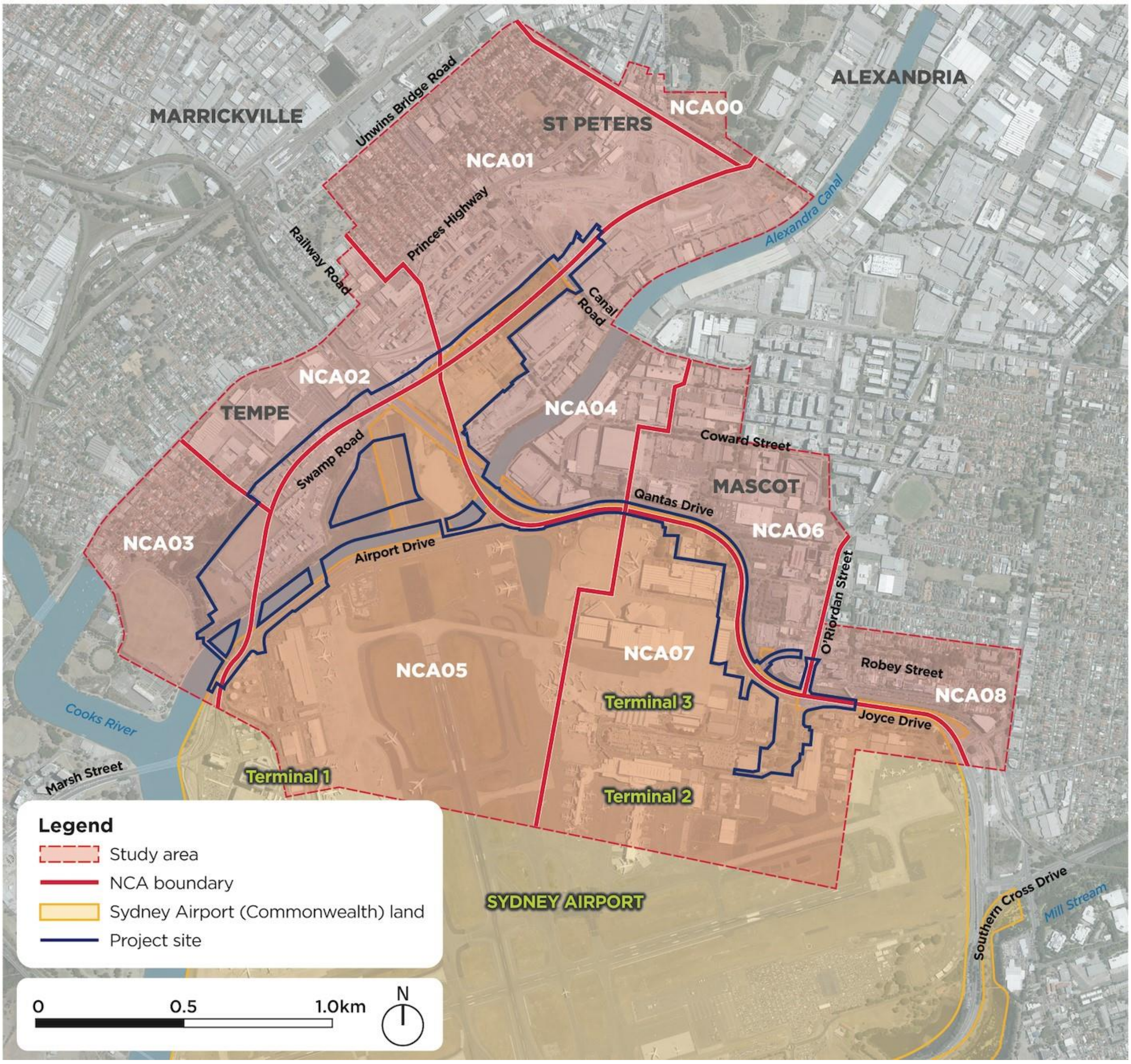


Figure 10.1 Study area and noise catchment areas

Impact assessment, including modelling tasks

- Developing a three-dimensional representation of the construction work areas and surrounding areas by digitising the local terrain, receiver buildings and structures
- Identify structures which are within the minimum vibration working distances
- Identifying noise modelling inputs and parameters
- Modelling to conservatively predict noise levels using *ISO 9613 Acoustics – Attenuation of sound during propagation outdoors* algorithms in the noise modelling software SoundPLAN
- Validating the operational road traffic noise model using existing noise measurements
- Assessing the significance of predicted noise and vibration levels by comparing them to the management levels/criteria
- Identifying the potential cumulative impacts of the project occurring with other nearby major projects consecutively (which can contribute to construction fatigue)
- Identifying feasible and reasonable measures to mitigate predicted exceedances of the management levels/criteria, including both standard and additional mitigation measures.

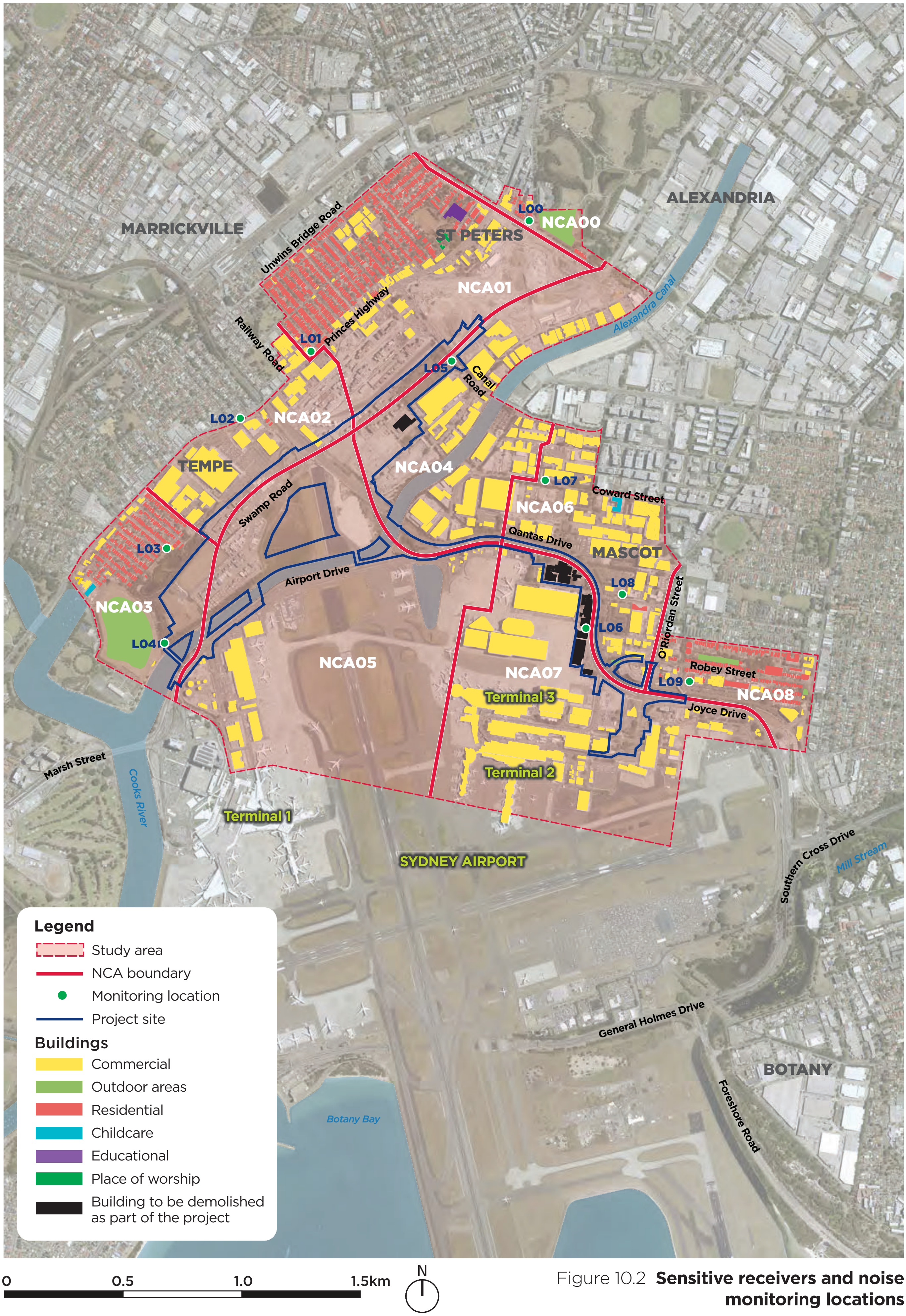


Figure 10.2 **Sensitive receivers and noise monitoring locations**

Noise modelling was also used to predict noise levels from ground-based airport activities emanating from Sydney Airport to surrounding receivers following the proposed removal of buildings south of Qantas Drive and the removal of Tyne Container Services operations to the west of Alexandra Canal. A number of scenarios were developed to assess the potential changes to noise impacts using the 'without project' and 'with project' scenarios (see section 10.2.2).

The expected duration of each construction scenario would vary depending on location. The indicative duration is shown in Table 10.1.

Table 10.1 Construction scenarios – indicative durations

Construction scenario	Activity	Noise catchment area					
		Northern lands	Works around the Botany Rail Line	Tempe Lands and Reserve	Airport Drive	Qantas Drive	Terminals 2/3 viaduct
Enabling works (including utilities)	Peak	6 months	2 months	2 months	3 months	3 months	6 months
	Typical	12 months	6 months	6 months	8 months	12 months	12 months
Compound establishment	Peak	6 months	-	1 month	-	-	1 month
	Typical	3 months	-	3 months	2 months	-	3 months
Compound operation	-	4 years	-	4 years	2.5 years	-	4 years
Site establishment	-	6 months	6 months	6 months	9 months	12 months	12 months
Demolition	Peak	6 weeks	-	-	-	18 months	6 months
	Typical	6 weeks	-	-	-	18 months	6 months
Bridges	Peak	6 months	12 months	9 months	18 months	-	6 months
	Typical	12 months	2 years	2 years	2.5 years	-	2.5 years
Road works	Peak	6 months	-	2 months	3 months	12 months	12 months
	Typical	3 years	12 months	2.5 years	12 months	18 months	2.5 years
	Dynamic compaction	-	-	3 months	-	-	-
Finishing works	-	6 months	3 months	6 months	6 months	6 months	12 months

10.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Noise and vibration risks with an assessed risk rating of medium or above, identified by the environmental risk assessment, included:

- Elevated noise and vibration levels around construction sites, compounds, site accesses and haul routes
- Noise associated with out-of-hours work
- Impacts on amenity, particularly for residents, workers, hotel guests and users of recreation areas and other community facilities
- Vibration impacts (structural or cosmetic) on buildings and other structures
- Cumulative construction noise impacts with the Botany Rail Duplication and the operation of Sydney Airport
- Removal of potential noise shielding provided by buildings at the Sydney Airport Jet Base on Qantas Drive and increases in airport noise emissions emanating outside of the airport site
- Noise associated with elevated infrastructure (such as bridges).

The noise and vibration assessment included consideration of these potential risks.

10.2 Noise and vibration criteria

A summary of the criteria used to undertake the assessment is provided in this section. Detailed information is provided in section 3 of Technical Working Paper 2 (Noise and Vibration).

10.2.1 Construction

Amenity

Noise management levels – residential receivers

Project specific noise management levels were developed for sensitive receivers based on existing background noise levels (known as rating background levels or RBLs) in the study area and in accordance with the *Interim Construction Noise Guideline* (DECC, 2009) and the *Noise Policy for Industry* (NSW EPA, 2017a). The Airports Act does not contain specific assessment criteria for noise and vibration associated with works located on Sydney Airport land. However, the Airports (Environment Protection) Regulations 1997 includes criteria which is considered generally consistent with the Interim Construction Noise Guideline highly noise affected criteria. On this basis, the potential construction impacts have been assessed against the requirements of the Interim Construction Noise Guideline.

The noise management levels are defined as an allowable exceedance of the rating background level. The rating background level for each noise catchment area has been conservatively determined from the lowest measured background noise for the area (see section 10.3.3). Where construction noise levels are predicted or measured to be above the noise management levels, feasible and reasonable work practices are proposed to minimise noise emissions (see section 10.7.2).

The interim construction noise guideline provides an approach for determining noise management levels at residential receivers as shown in Table 10.2.

Table 10.2 Interim Construction Noise Guideline noise management levels for residential receivers

Time of day	Noise management level $L_{Aeq(15minute)}$	How to apply
Standard construction hours Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	RBL + 10 dB	▪ The noise affected level represents the point above which there may be some community reaction to noise ▪ Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level ▪ The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	▪ The highly noise affected level represents the point above which there may be strong community reaction to noise ▪ Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restructuring the hours that the very noisy activities can occur, taking into account: ‣ Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools) or mid-morning or mid-afternoon for works near residences ‣ If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside standard construction hours	RBL + 5 dB	▪ A strong justification would typically be required for works outside the recommended standard hours ▪ The proponent should apply all feasible and reasonable work practices to meet the noise affected level ▪ Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Table 10.3 shows the noise management levels for residential receivers for each noise catchment area (noise catchment areas described in section 10.3.2). The representative background monitoring locations for each noise catchment area are discussed in Technical Working Paper 2 (Noise and Vibration) and shown on Figure 10.2, and the existing noise levels are discussed in section 10.3.3. The sleep disturbance screening criteria are also provided in Table 10.3 and discussed further below.

Table 10.3 Noise management levels for residential receivers

Noise catchment area	Noise management level ($L_{Aeq(15\ minute)}$ – dBA)				Sleep disturbance screening criteria (RBL + 15 dB)
	Standard[1] construction hours (RBL + 10 dB)	Out-of-hours[2] (RBL + 5 dB)			
	Daytime	Daytime	Evening	Night-time	
NCA00	64	59	50	45	55
NCA01	75	70	67	58	68
NCA02	74	69	65	53	63
NCA03	52	47	45	43	53
NCA04	68	63	59	54	64
NCA05	73	68	65	57	67
NCA06	70	65	61	55	65

Noise catchment area	Noise management level ($L_{Aeq(15\ minute)}$ – dBA)				Sleep disturbance screening criteria (RBL + 15 dB)
	Standard[1] construction hours (RBL + 10 dB)	Out-of-hours[2] (RBL + 5 dB)			
	Daytime	Daytime	Evening	Night-time	
NCA07	73	68	65	57	67
NCA08	64	69	56	50	60

Notes: 1. Standard construction hours are 7am to 6pm Monday to Friday and 8am to 1pm Saturdays.

2. Daytime out-of-hours are 7am to 8am and 1pm to 6pm on Saturday, and 8am to 6pm on Sunday and public holidays; evening out-of-hours are 6pm to 10pm Monday to Saturday; and night-time out-of-hours are 10pm to 7am Monday to Saturday and 6pm to 8am on Sunday and public holidays.

3. RBL – rating background level.

Noise management levels – other sensitive receivers

Other sensitive receivers in the study area include educational facilities, medical facilities, places of worship, outdoor recreational areas and commercial properties. The Interim Construction Noise Guideline identifies internal or external noise management levels for identified land use types. These are shown in Table 10.4.

Table 10.4 Interim Construction Noise Guideline noise management levels for ‘other sensitive’ receivers

Land use	Noise management level $L_{Aeq(15minute)}$[1]
Classrooms at schools and other education institutions	Internal noise level 45 dBA[2]
Hospital wards and operating theatres	Internal noise level 45 dBA[2]
Places of worship	Internal noise level 45 dBA[2]
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants)	External noise level 65 dBA
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion)	External noise level 60 dBA
Community centres	Refer to the recommended ‘maximum’ internal levels in AS/NZS 2107 for specific uses
Commercial	External noise level 70 dBA

Notes: 1. Applied when the property is in use.

2. The criteria is specified as an internal noise level for this receiver category. As the noise model predicts external noise levels, it has been conservatively assumed that all schools and places of worship have openable windows and external noise levels are 10 dB higher than the corresponding internal level, which is representative of windows being partially open to provide ventilation. Hospital wards are assumed to have fixed windows with 20 dB higher external levels.

The guideline also references *AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors* in terms of criteria for ‘other sensitive’ receivers not listed in the guideline, such as hotels and libraries. The criteria are shown in Table 10.5. In this assessment, fixed windows and a conservative 20 dB external to internal reduction factor have been assumed for these receiver types to convert internal noise level criteria to external facade criteria.

Table 10.5 AS/NZS 2107:2016 noise management levels for 'other sensitive' receivers

Use	Period	AS/NZS 2107 classification	Noise management level $L_{Aeq(15minute)}$
Hotel	Daytime and evening	Bars and lounges	Internal noise level 50 dBA[1]
	Night-time	Sleeping areas (hotels near major road)	Internal noise level 40 dBA[1]
Library	When in use	Reading areas	Internal noise level 45 dBA[1]

Note: 1. These receivers are assumed to have fixed windows with a conservative 20 dB reduction for external to internal noise levels.

Sleep disturbance

There is potential for sleep disturbance impacts where night works are located close to residential receivers. Where construction works are planned to extend over more than two consecutive nights, the Interim Construction Noise Guideline recommends an assessment of sleep disturbance impacts.

The Interim Construction Noise Guideline refers to the *Environmental Criteria for Road Traffic Noise* (NSW EPA, 1999) to assess the potential impacts of sleep disturbance. To limit the level of sleep disturbance, the L_1 level (or L_{Amax}) should not exceed the existing L_{A90} noise level by more than 15 dB (see Table 10.3).

Construction traffic noise

The potential noise impacts from construction traffic travelling on public roads are assessed in accordance with the Road Noise Policy and the *Construction Noise and Vibration Guideline* (Roads and Maritime, 2016b). Where existing road traffic noise levels are expected to increase by more than 2 dB as a result of construction traffic, further assessment is required (see section 10.4.4).

Ground-borne noise

Construction can also cause ground-borne noise impacts in nearby buildings when vibration generating equipment is used. The Interim Construction Noise Guideline and the Construction Noise and Vibration Guideline provide evening and night-time ground-borne noise management levels for residences to protect the amenity and sleep of affected residents. The ground-borne noise management levels are 40 A-weighted decibel (dBA) during the evening and 35 dBA during the night-time ($L_{Aeq(15minute)}$).

As the Construction Noise and Vibration Guideline does not provide guidance for acceptable ground-borne noise levels for commercial receivers, an internal noise management level of 60 dBA was adopted. This is consistent with similar recent infrastructure projects, such as M4-M5 Link. The ground-borne noise management levels only apply where internal ground-borne noise levels are higher than noise levels transmitted through the air.

Vibration – human comfort

The criteria for intermittent vibration from construction are based on the vibration dose value identified in *Assessing Vibration: A Technical Guideline* (DEC, 2006a) and are shown in Table 10.6. The vibration dose value applies to critical working areas, such as operating theatres or laboratories, residences, offices, educational institutions and places of worship, both during the day and during the night-time.

Table 10.6 Vibration dose values for intermittent vibration

Building type	Assessment period	Vibration dose value ($m/s^{1.75}$)	
		Preferred	Maximum
Critical working areas (eg operating theatres or laboratories)	Daytime or night-time	0.10	0.20
Residential	Daytime	0.20	0.40
	Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	Daytime or night-time	0.40	0.80
Workshops	Daytime or night-time	0.80	1.60

Recommended minimum working distances for typical vibration intensive construction equipment for human comfort are shown in Table 10.7. These recommended distances, however, are a guide only.

The construction activities are generally not anticipated to result in continuous or impulsive vibration impacts. If design refinements result in the need for continuous or impulsive vibration impacts, relevant criteria are provided in section 3.2.2.4 of Technical Working Paper 2 (Noise and Vibration).

Table 10.7 Recommended minimum working distances for vibration intensive equipment – human comfort

Plant item	Rating description	Minimum distance (metres)
Vibratory roller	<50 kN (1-2 tonne)	15 to 20
	<100 kN (2-4 tonne)	20
	<200 kN (4-6 tonne)	40
	<300 kN (7-13 tonne)	100
	>300 kN (13-18 tonne)	100
	>300 kN (>18 tonne)	100
Small hydraulic hammer	300 kg (5 to 12 tonne excavator)	7
Medium hydraulic hammer	900 kg (12 to 18 tonne excavator)	23
Large hydraulic hammer	1,600 kg (18 to 34 tonne excavator)	73
Vibratory pile driver	Sheet piles	20
Piling rig – bored	≤ 800 mm	4
Jackhammer	Hand held	2

Vibration impacts on buildings and infrastructure

General buildings and pipework

The levels of vibration required to cause cosmetic damage tend to be at least an order of magnitude (ten times) higher than those at which people can perceive vibration. Cosmetic damage includes cracks or loosening of drywall surfaces, cracks in supporting columns and loosening of joints. Cosmetic damage vibration limits and minimum working distances are identified in the *Construction Noise and Vibration Guideline*, British Standard BS7385 *Part 2-1993 Evaluation and measurement for vibration in buildings Part* 2 and German Standard DIN4150: *Part 3-2016 Structural vibration – Effects of vibration on structures*.

BS7385 recommends vibration limits for transient vibration which are judged to give a minimal risk of vibration induced damage to affected buildings (see Table 14 of Technical Working Paper 2 (Noise and Vibration)). DIN4150 also provides guideline vibration limits for different buildings and buried pipework. Damage is not expected to occur where the values are complied with and the values are generally recognised to be conservative. The DIN4150 values for structures are shown in Table 10.8 and short-term vibration on buried pipework shown in Table 10.9.

Table 10.8 DIN4150 guideline values for short-term vibration on structures

Group	Type of structure	Guideline values vibration velocity (mm/s)				
		Foundation, all directions at a frequency of:			Topmost floor, horizontal	Floor slabs, vertical
		1 to 10 Hz	10 to 50 Hz	50 to 100 Hz	All frequencies	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified as Group 1 or 2 and are of great intrinsic value (eg heritage listed buildings)	3	3 to 8	8 to 10	8	20[1]

Note: 1. It may be necessary to lower the relevant guideline value markedly to prevent minor damage.

Table 10.9 DIN4150 guideline values for short-term vibration on buried pipework

Pipe material	Guideline values vibration velocity at the pipe (mm/s)
Steel, welded	100
Vitrified clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
Masonry, plastics	80

Minimum working distances for typical vibration intensive construction equipment applicable for cosmetic damage are shown in Table 10.10. These criteria are specified in the *Interim Construction Noise Guideline* and must be complied with.

Table 10.10 Minimum working distances from vibration intensive equipment – cosmetic damage

Plant item	Rating description	Minimum distance (metres)	
		Residential and light commercial (BS7385)	Heritage items (DIN 4150, Group 3)
Vibratory roller	<50 kN (1-2 tonne)	5	11
	<100 kN (2-4 tonne)	6	13
	<200 kN (4-6 tonne)	12	15
	<300 kN (7-13 tonne)	15	31
	>300 kN (13-18 tonne)	20	40
	>300 kN (>18 tonne)	25	50
Small hydraulic hammer	300 kg (5 to 12 tonne excavator)	2	5
Medium hydraulic hammer	900 kg (12 to 18 tonne excavator)	7	15

Plant item	Rating description	Minimum distance (metres)	
		Residential and light commercial (BS7385)	Heritage items (DIN 4150, Group 3)
Large hydraulic hammer	1,600 kg (18 to 34 tonne excavator)	22	44
Vibratory pile driver	Sheet piles	2 to 20	5 to 40
Piling rig – bored	≤ 800 mm	2 (nominal)	5
Jackhammer	Hand held	1 (nominal)	3

Heritage buildings

As identified by BS7385, a heritage building should not be assumed to be more sensitive to vibration, unless it is structurally unsound. Heritage buildings are considered on a case-by-case basis. Where a heritage building is deemed to be sensitive, the Group 3 guidelines values in DIN4150 apply (see Table 10.8 and Table 10.10).

Sensitive equipment

Where vibration sensitive equipment (such as electron microscopes and microelectronics manufacturing equipment) is potentially affected by construction, vibration limits for the operation of the equipment should be taken from the manufacturer's data. If unavailable, generic vibration criteria values can be used (see section 3.2.2.6 of Technical Working Paper 2 (Noise and Vibration)).

10.2.2 Operation

Amenity impacts

Airborne noise

Criteria for noise and vibration in the Airports (Environment Protection) Regulations 1997 are less detailed and less stringent than those in the Road Noise Policy. On this basis, a conservative approach has been adopted and the potential road traffic noise impacts have been assessed against the more stringent requirements of the Road Noise Policy.

The Road Noise Policy is used to assess and manage potential airborne noise impacts from new and redeveloped road projects. The Noise Criteria Guideline provides a consistent approach to identifying road noise criteria for residential and 'other sensitive' land uses. The *Noise Mitigation Guideline* (Roads and Maritime, 2015b) recognises that the Noise Criteria Guideline criteria are not always practicable, and it is not always feasible or reasonable to expect that they can be achieved.

The Road Noise Policy and Noise Criteria Guideline use the following terms to describe and assess the impacts of road projects:

- 'No Build' – the assessment scenario used to predict noise levels if the project did not go ahead ('without project')
- 'Build' – the assessment scenario used to predict noise levels with the project ('with project').

The difference in noise levels between these assessment scenarios is used to determine the potential impact of the project. Both assessment scenarios undertaken for the project include the operation of other projects (the M5 East, New M5, M4-M5 Link and NorthConnex projects).

The project includes both redeveloped and new roads. The Noise Criteria Guideline provides criteria for residential receivers as shown in Table 10.11. The criteria are lower for the night-time due to the greater sensitivity of receivers to noise impacts during this period. The Road Noise Policy and Noise Criteria Guideline require noise to be assessed at project opening (indicatively year 2026 for this project) and for a future design year, typically 10 years after opening (2036). The Noise Criteria Guideline requires transition zones to be applied at the point where road categories change to provide a smooth transition in noise criteria.

Table 10.11 Noise Criteria Guideline – criteria for residential receivers

Road category	Type of project/land use	Assessment criteria (dBA)	
		Daytime (7am – 10pm)	Night-time (10pm – 7am)
Freeway/ arterial/ sub-arterial roads	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq(15\ hour)}$ 55 (external)	$L_{Aeq(9\ hour)}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	$L_{Aeq(15\ hour)}$ 60 (external)	$L_{Aeq(9\ hour)}$ 55 (external)
	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15\ hour)}$ 60 (external)	$L_{Aeq(9\ hour)}$ 55 (external)
	Existing residences affected by both new roads and the redevelopment of existing freeway/arterial/sub-arterial roads in a transition zone[1]	Between $L_{Aeq(15\ hour)}$ 55-60 (external)	Between $L_{Aeq(9\ hour)}$ 50-55 (external)
	Existing residences affected by increases in traffic noise of 12 dB or more from redevelopment of existing freeway/arterial/sub-arterial roads[2]	Between $L_{Aeq(15\ hour)}$ 42-55 (external)	Between $L_{Aeq(9\ hour)}$ 42-50 (external)
	Existing residences affected by increases in traffic noise of 12 dB or more from redevelopment of existing freeway/arterial/sub-arterial roads[2]	Between $L_{Aeq(15\ hour)}$ 42-60 (external)	Between $L_{Aeq(9\ hour)}$ 42-55 (external)
Local roads	Existing residences affected by noise from new local road corridors	$L_{Aeq(1\ hour)}$ 55 (external)	$L_{Aeq(1\ hour)}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing local roads	$L_{Aeq(15\ hour)}$ 60 (external)	$L_{Aeq(9\ hour)}$ 55 (external)
	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(15\ hour)}$ 60 (external)	$L_{Aeq(9\ hour)}$ 55 (external)

Notes: 1. The criteria assigned to the entire residence depend on the proportion of noise coming from the new and redeveloped roads.
2. The criteria at each facade are determined from the existing traffic noise level plus 12 dB.

The Noise Criteria Guideline does not consider commercial and industrial receivers as being sensitive to operational airborne road traffic noise impacts. However, criteria for 'other sensitive' receivers are identified in the Noise Criteria Guideline and are provided in Table 10.12.

Table 10.12 Noise Criteria Guideline – criteria for 'other sensitive' receivers

Existing sensitive land use	Assessment criteria (dB)		Additional considerations
	Daytime (7am – 10pm)	Night-time (10pm – 7am)	
School classrooms	$L_{Aeq(1\ hour)}$ 40 (internal)[1]	-	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in AS/NZS 2107:2016
Hospital wards	$L_{Aeq(1\ hour)}$ 35 (internal)	$L_{Aeq(1\ hour)}$ 35 (internal)	
Places of worship	$L_{Aeq(1\ hour)}$ 40 (internal)[1]	$L_{Aeq(1\ hour)}$ 40 (internal)[1]	The criteria are internal, ie the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what is in these areas that may be affected by road traffic noise.
Open space (active use)	$L_{Aeq(15\ hour)}$ 60 (external)	-	Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.
Open space (passive use)	$L_{Aeq(15\ hour)}$ 55 (external)	-	Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion (eg playing chess, reading).
Child care facilities	Sleeping rooms $L_{Aeq(1\ hour)}$ 35 (internal)[1] Indoor play areas $L_{Aeq(1\ hour)}$ 40 (internal)[1] Outdoor play areas $L_{Aeq(1\ hour)}$ 55 (internal)	-	Multipurpose spaces (eg shared indoor play/sleeping rooms) should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
Aged care facilities	-	-	The criteria for residential land uses should be applied to these facilities.

Note: 1. The criteria are specified as an internal noise level for this receiver category. As the noise model predicts external noise levels, it has been conservatively assumed that all schools and places of worship have openable windows and external noise levels are 10 dB higher than the corresponding internal level, which is representative of windows being partially open to provide ventilation.

A number of hotels are located close to the project site, with certain hotels accommodating staff as their primary residence. The Noise Criteria Guideline criteria for residential receivers has been applied to these receivers, noting that only areas of primary residence require assessment.

The Noise Mitigation Guideline provides guidance in managing and controlling road traffic noise and describes the principles to be applied when reviewing noise mitigation. As the project progresses through the early design stages, various road design features (such as adjustments to vertical and horizontal alignments, road gradient modifications, traffic management and landscape mounds) are evaluated to assist with minimising road traffic noise. Following the use of the above measures, site specific 'additional noise mitigation measures' are then required to be investigated for receivers which have residual exceedances of the criteria.

When evaluating whether a receiver qualifies for consideration of additional noise mitigation, the Noise Mitigation Guideline considers how far above the criteria the noise level is, and how much a project increases noise levels. The Noise Mitigation Guideline provides three triggers where a receiver may qualify for consideration of additional noise mitigation:

- Trigger 1 – the predicted ‘with project’ noise level exceeds the Noise Criteria Guideline controlling criteria and the noise level increase as a result of the project (ie the noise predictions for the ‘with project’ minus the ‘without project) is greater than 2 dB
- Trigger 2 – the predicted ‘with project’ noise level is 5 dB or more above the Noise Criteria Guideline controlling criteria (ie exceeds the cumulative limit) and the receiver is significantly influenced by project road noise, regardless of the incremental impact of the project
- Trigger 3 – the noise level contribution from the road project is acute (daytime $L_{Aeq(15hour)}$ 65 dBA or higher, or night-time $L_{Aeq(9hour)}$ 60 dBA or higher) even if noise levels are controlled by a non-project road.

The eligibility of receivers for consideration of additional noise mitigation is determined before the effect of low noise pavement and noise barriers is included. The requirement for the project is to provide feasible and reasonable additional mitigation to eligible receivers with the aim of meeting the Noise Criteria Guideline controlling criteria.

Surrounding road network

Noise impacts can occur on the surrounding road network due to traffic redistribution where vehicles use different routes once the project is operational. The Noise Criteria Guideline criteria for residential receivers (see above) have been applied to the surrounding road network. There is considered to be an impact if a project generates an increase in road traffic noise of more than 2 dB above the existing situation.

Noise from ground-based airport activities

The project has the potential to alter noise emissions emanating from ground-based activities at Sydney Airport through the proposed removal of buildings adjacent to Qantas Drive and the removal of shipping containers at Tyne Container Services. Noise from ground-based airport activities includes construction works, road traffic, taxiing aircraft, ground running of aircraft engines and operation of aircraft auxiliary power units. Although the maximum level of noise emissions from Sydney Airport are set out in the Airports (Environment Protection) Regulations 1997, the regulation does not contain specific criteria for noise generated by ground-based airport activities. In the absence of any defined criteria relating to noise generated by aircraft on the ground, the Noise Policy for Industry has been referenced for the assessment of potential changes to aircraft related noise impacts, including engine ground running.

The Noise Policy for Industry describes trigger levels that indicate the noise level at which feasible and reasonable noise management measures should be considered. For potential noise impacts resulting from ground-based airport activities in areas near the airport, the Noise Policy for Industry ‘intrusiveness’ criteria are considered appropriate. The ‘intrusiveness’ of an industrial noise source is generally considered acceptable if the L_{Aeq} noise level of the source does not exceed the background noise level by more than 5 dB. These criteria only apply to residential receivers as shown in Table 10.13. The Noise Policy for Industry also includes amenity criteria for ‘other sensitive’ receivers. The amenity noise levels for receivers that would potentially be affected by altered noise generated by ground-based activities at Sydney Airport are provided in Table 10.14.

Table 10.13 Intrusiveness criteria – noise related to airport activities

Noise catchment area	Period	Measured noise level (dBA)		Project noise trigger levels $L_{Aeq(15minute)}$ (dBA)	
		Rating background level	$L_{Aeq(period)}$	Standard	Engine run up[2]
NCA03 (Tempe)	Daytime	42	61	47	52
	Evening	40	60	45	50
	Night-time	38	53	43	48
NCA06 and NCA08 (Mascot)[1]	Daytime	60	68	65	70
	Evening	58	66	63	68
	Night-time	53	64	58	63

Notes: 1. The noise monitoring at this location was affected by nearby construction works during the monitoring period. The background levels and criteria for this area should be reviewed and confirmed during detailed design.
2. Engine ground running would likely occur infrequently, especially during the night-time, and high power running would not occur every night. The Noise Policy for Industry allows an increase of the trigger levels by 5 dB increase due to the infrequent nature of the noise.

Table 10.14 Amenity criteria - 'other sensitive' receivers

Receiver type	Noise amenity area	Time of day	Recommended amenity noise level (dBA)	
			Standard[1]	Engine run up[2]
Hotel	Urban	Daytime	68	73
		Evening	58	63
		Night-time	53	58

Notes: 1. Set as being 5 dB above the recommended urban amenity noise level for a residence plus 3 dB to convert to a 15 minute level, as per the procedures in the Noise Policy for Industry.
2. Engine ground running would likely occur infrequently, especially during the night-time, and high power running would not occur every night. The Noise Policy for Industry allows an increase of the trigger levels by 5 dB increase due to the infrequent nature of the noise.

Vibration impacts

Vehicles are unlikely to cause vibration impacts at adjacent receivers unless there are road irregularities. The new and upgraded roads within the project site would be designed and constructed to avoid significant irregularities (see Chapter 7 (Project description)). As such, impacts from operational vibration are not anticipated.

10.3 Existing environment

10.3.1 Sensitive receivers

The nearest sensitive residential receivers are located in Mascot and Tempe, about 40 metres and 70 metres away from the construction footprint, respectively. Once operational, the nearest sensitive residential receivers to the project site would be located about 130 metres to the north-west on Smith and South streets in Tempe, and 90 metres to the north-east on Baxter Road.

Relatively large parts of the study area are subject to commercial or industrial land uses, particularly around Sydney Airport, in the western section of Mascot near Alexandra Canal, and along the Princes Highway. These uses include retail outlets, distribution warehouses, shipping container storage and areas of heavy industry, such as the Boral concrete processing and recycling sites. Other receivers within the study area include hotels, child care facilities, places of worship, schools, a medical facility and recreation facilities. The identification of receivers includes consideration of some proposed developments in the vicinity of the project site, such as the proposed hotel between Seventh and Ninth streets.

All sensitive receivers are shown on Figure 10.2. The locations and types of 'other sensitive' receivers are described in detail in section 2.1 of Technical Working Paper 2 (Noise and Vibration) and also discussed in Chapter 19 (Land use and property) and 20 (Socio-economic impacts).

10.3.2 Noise catchment areas

Existing noise levels were determined based on monitoring undertaken at the nine noise catchment areas listed in Table 10.15 and shown in Figure 10.2.

Table 10.15 General characteristics of noise catchment areas

Noise catchment area	Description	Sydney Airport land[1]
NCA00	NCA00 is located to the north-east of St Peters interchange where the New M5 is being constructed. Residential receivers are located on Campbell Street/Road, facing St Peters interchange, but are more than 550 m from the project. Sydney Park, off Campbell Street, is also located within this catchment.	There is no Sydney Airport land within NCA00.
NCA01	This catchment is located north-west of Alexandra Canal and east of Reilly Lane, Sydenham. It is mainly residential with the exception of commercial receivers located along the Princes Highway. St Peters Anglican Church, St Peters Public School and St Peters Preschool are located in the north-east. The closest receivers to the project site are commercial receivers 160 m away on the Princes Highway.	Part of the southern boundary of the noise catchment area is located within Sydney Airport land.
NCA02	NCA02 is located in Tempe, north of Sydney Airport and west of Alexandra Canal. The southern section of the noise catchment area is mainly commercial and includes IKEA Tempe. Residential receivers are located further north of the Princes Highway. A Uniting Church, St Peter and St Paul Catholic Church and the True Buddhist Temple are located in the south-west of the catchment. Sydenham Green is located in the north-east.	There is no Sydney Airport land within NCA02.
NCA03	NCA03 is located in Tempe to the north-west of the project site. The catchment is mainly residential with the exception of commercial receivers along Princes Highway. Tempe Recreation Reserve is located about 130 m west of the project site at the closest point. The Guardian Early Learning Child Care Centre, Betty Spears Child Care Centre, Al Hijrah Mosque and numerous residential receivers are located in the north-west of the catchment.	There is no Sydney Airport land within NCA03.
NCA04	This catchment is north of Sydney Airport and Airport Drive in Mascot and includes commercial land uses. The nearest buildings are located close to the project site in the north and west of the catchment, and also along Airport Drive and Qantas Drive.	Part of the land located west of Alexandra Canal and north of Botany Rail Line is Sydney Airport land. Parts of Qantas Drive and areas to the south of the noise catchment area is Sydney Airport land.
NCA05	NCA05 covers the western section of Sydney Airport near Terminal 1.	The majority of the noise catchment area is located within Sydney Airport land with the exception of the Tyne Container Services site.

Noise catchment area	Description	Sydney Airport land[1]
NCA06	NCA06 is located to the north of Terminals 2/3 and Qantas Drive in Mascot. The catchment mainly includes commercial land uses with some residential receivers north of Coward Street. Aero Kids Early Learning Centre is located to the south of the residential receivers. Toybox Early Learning and Citygate Fellowship Church are located along Bourke Road. There are a number of hotels along the eastern border on O'Riordan Street, including the Stamford Plaza.	Land adjacent to Qantas Drive to the south and sections near Alexandra Canal to the north-west of the noise catchment area is Sydney Airport land.
NCA07	NCA07 covers the eastern and northern sections of Sydney Airport near Terminals 2/3 and includes the Sydney Airport Jet Base and Qantas Flight Training Centre. The project would include removing a number of the buildings at the Jet Base (including buildings at the Flight Training Centre). The catchment includes a number of hotels near the intersection of Qantas Drive, Joyce Drive and O'Riordan Street, including the Ibis, Mantra and a future hotel at Sydney Airport.	The majority of this noise catchment area is located within Sydney Airport land.
NCA08	This catchment is located in Mascot to the north-east of Sydney Airport. The area is mainly residential, with the nearest receivers located 90 m away on Baxter Road. The Quest, Citadines Connect and The Branksome hotels are located near O'Riordan Street. Mascot Public School is located in the north-east of the catchment on King Street. Robey Street Reserve and John Curtin Memorial Reserve are both located in the south of the noise catchment area.	There is a small section of Sydney Airport Land adjacent to Joyce Drive.

Note: 1. Sydney Airport land is described in Chapter 2 (Location and setting) and shown (with respect to the noise catchment areas) on Figure 10.1.

10.3.3 Existing noise levels

Existing noise levels in the study area are generally dominated by transportation noise, with road noise affecting most locations. Rail and aircraft noise also contribute to existing noise levels in certain areas, depending on the proximity to the Botany Rail Line and Sydney Airport. During the night-time, noise levels generally decrease due to reduced road traffic volumes on the surrounding road network and the limited number of flights occurring outside Sydney Airport's operational hours.

Existing noise levels are shown in Table 10.16. The existing noise levels were measured at those receivers considered to most represent the existing noise levels in each noise catchment area (shown on Figure 10.2). The measured noise levels were used to characterise the existing noise environment and to determine the criteria used to assess the potential impacts of the project.

Table 10.16 Existing noise levels/rating background levels

Noise catchment area	Address of the representative receiver where monitoring was undertaken	Measured noise level (dBA)		
		Day	Evening	Night
NCA00	18 Campbell Street, St Peters	54	45	40
NCA01	Princes Highway, St Peters	65	62	53
NCA02	535 Princes Highway, Tempe	64	60	48
NCA03	1 Fanning Street, Tempe	42	40	38
NCA03	Alexandra Canal, Tempe	53	53	46
NCA04	Canal Road, St Peters	58	54	49
NCA05 and NCA07[1]	Qantas Drive, Mascot	63	60	52

Noise catchment area	Address of the representative receiver where monitoring was undertaken	Measured noise level (dBA)		
		Day	Evening	Night
NCA06	39 Kent Road, Botany	60	56	50
NCA06	289 King Street, Mascot	60	58	53
NCA08	105 Baxter Road, Mascot	54	51	45

Note: 1. NCA05 and NCA07 are representative of Sydney Airport.

The existing maximum noise levels typically range from 70 to 90 dBA. Higher levels were measured at Princes Highway, St Peters (up to 96 dBA) and L06 at Qantas Drive, Mascot (up to 103 dBA) due to the proximity to adjacent roads. The higher end of the ranges would likely be from passing heavy vehicles and aircraft flyovers.

10.4 Assessment of construction impacts

10.4.1 Potential noise sources

Potential noise and vibration sources during construction include:

- Operation of mobile and stationary construction plant and equipment
- Operation of construction compounds and other ancillary facilities (known as fixed sources)
- Construction vehicle movements.

The assessment uses realistic worst-case scenarios to determine the impacts from the noisiest 15 minute period that is likely to occur for each work scenario, as required by the Interim Construction Noise Guideline. The scenarios were categorised into ‘peak’ and ‘typical’ activities, as discussed in section 10.1.2. The scenarios used to assess the potential noise impacts of construction include:

- Enabling works
- Compound establishment
- Compound operation
- Site establishment
- Demolition
- Bridge construction
- Road works
- Finishing works.

The characteristics of the noise and vibration emissions are a result of the equipment used to undertake the works. Equipment likely to be used during construction is described in Chapter 8 (Construction) and Technical Working Paper 2 (Noise and Vibration).

10.4.2 Predicted noise levels

An assessment of the predicted noise impacts was undertaken at potentially affected receivers in each noise catchment area. The predicted noise levels are representative of the worst-case situation where construction equipment is at the closest point to the most affected receiver. The calculations also assume that many items of construction equipment are used at the same time. Noise levels would, however, vary over the construction period, as the location of work would change and not all equipment would be in operation at all times.

Three categories of noise management level exceedances and associated levels of impact are shown in Table 10.17. The defined categories are associated with the likely subjective response of people affected by the impacts. The subjective response would vary, depending on the nature of the noise and the period over which the impacts occur (such as during the daytime or evening/night-time).

Table 10.17 Noise management level exceedance categories

Exceedance of noise management level	Category
1 to 10 dB	Minor
11 to 20 dB	Moderate
More than 20 dB	High

Residential receivers

Standard construction hours

The noise management level exceedances during standard construction hours are shown in Table 10.18 for each construction scenario and corresponding noise catchment area. Only receivers with the potential to experience noise levels exceeding the noise management levels in noise catchment areas are shown in the table. As shown in the table, the potential impacts are associated with the noise catchment areas with the highest number of residential receivers, being NCA03 and NCA08. This is due to the lower noise management level criteria for residential receivers compared with other receiver types.

Other catchments either have no residential receivers or the receivers are located further from the works. The highest impacts are generally observed during ‘peak’ activities, which is due to the use of noise intensive equipment such as rockbreakers and concrete saws. This includes enabling works, compound establishment, site establishment, bridge construction and road works. For most scenarios, the ‘peak’ activity would only be required for a relatively short period of the total activity duration (see Table 10.1). As shown in Table 10.18, noise generated during the ‘typical’ activity do not exceed noise management levels.

The worst-case construction impacts are predicted during enabling works, with high numbers of minor exceedances predicted in both NCA03 and NCA08, and one moderate exceedance predicted in NCA08. This is mostly during ‘peak’ activity, which is proposed to be undertaken intermittently within a two to six month period. ‘Typical’ activity would result in substantially fewer impacts over a six to 12 month period. However, some residential receivers would also experience minor exceedances of the noise management level during site establishment activities.

There are a large number of receivers within NCA03 (to the north-west of the former Tempe landfill on South Street and Smith Street) that would experience minor exceedances of the noise management level during enabling works, compound establishment, site establishment, bridge construction and roadworks. Again, this is predicted to occur during the ‘peak’ activity of these construction scenarios. No exceedances of the noise management level are predicted during the ‘typical’ scenario within NCA03. Additionally, compound establishment and site establishment are relatively short duration activities.

Table 10.18 Number of receivers with predicted noise exceedances during standard[1] construction hours

Construction scenario	Activity	Noise catchment area					
		NCA03			NCA08		
		Minor	Moderate	High	Minor	Moderate	High
Enabling works	Peak	14	-	-	10	1	-
	Typical	-	-	-	-	-	-
Compound establishment	Peak	261	-	-	-	-	-
	Typical	-	-	-	-	-	-
Compound operation	-	-	-	-	-	-	-
Site establishment	-	74	-	-	1	-	-
Demolition	Peak	-	-	-	-	-	-
	Typical	-	-	-	-	-	-
Bridges	Peak	6	-	-	-	-	-
	Typical	-	-	-	-	-	-
Road works	Peak	161	-	-	-	-	-
	Typical	-	-	-	-	-	-
	Dynamic compaction	-	-	-	-	-	-
Finishing works	-	-	-	-	-	-	-

Note: 1. Standard construction hours are 7am to 6pm Monday to Friday and 8am to 1pm Saturdays.

Outside standard construction hours

Out-of-hours works would be required to construct the project (see section 8.3.3), to sustain the operation of the existing road network and minimise the potential for aviation and rail safety hazards. The potential for noise to exceed the criteria is greater during the evening and night-time periods than during the daytime, due to the more stringent (lower) criteria that apply during these times. It is noted, however, that the predictions do not take into account whether carrying out a particular work activity outside standard construction hours at a particular location is justified (as described above).

The noise management level exceedances during out-of-hours works are shown in Table 10.19 (daytime), Table 10.20 (evening), Table 10.21 (night-time) and Table 10.22 (sleep disturbance) for each construction scenario and corresponding noise catchment area. Only receivers exceeding the noise management levels in each noise catchment area are shown in the tables.

The worst-case impacts are predicted to be high for a small number of receivers in NCA08, with moderate impacts experienced for receivers in NCA03, NCA06 and NCA08 and minor impacts for receivers in NCA00, NCA02, NCA03, NCA06 and NCA08. Similar to works during standard construction hours, the highest impacts are generally predicted in the 'peak' scenario, with the worst-case construction impacts predicted during enabling works, compound establishment, site establishment, bridge construction and roadworks. Although the predicted noise exceedances would affect many residential receivers, particularly NCA03 in Tempe, it is anticipated the majority of the works would be able to be completed during standard construction hours (such as roadworks near NCA03, compound establishment and site establishment). As detailed in section 8.3.3, the types of out-of-hours activities proposed in these locations include some works associated with the Qantas Drive upgrade and extension and Terminal 1 connection works. These may be carried out over two weeks or up to three months (dependent on the proposed works and location).

The operation of the compound would impact residential receivers in NCA03 during the evening (20 receivers) and night-time (78 receivers) period, with a minor exceedance of the sleep disturbance criteria for 29 receivers. However, the majority of works near these receivers would be able to be completed during standard construction hours. This would limit the need for compound operation during the evening and night-time period and the potential for sleep disturbance impacts for nearby receivers.

Road works are required along the entire road alignment and noise intensive works would be required at certain times in some locations.

Highly noise affected receivers

Residential receivers subject to noise levels of 75 dBA or greater are considered 'highly noise affected' by the Interim Construction Noise Guideline. The only residential receiver predicted to be highly noise affected (by 1 dB) by the project is located on Baxter Road in Mascot during 'peak' enabling works activities. Potential impacts would only occur when noise intensive works are being carried out near Baxter Road. This is only envisaged to be undertaken for relatively short periods (ie a couple of days) intermittently over a period of around three months. Works in other areas are not expected to result in highly noise affected noise levels at this receiver as a result of the increased separation distance and screening from existing structures.

Table 10.19 Number of receivers with predicted noise exceedances during daytime[1] out-of-hours works

Construction scenario	Activity	Noise catchment area								
		NCA03[2]			NCA06			NCA08		
		Minor	Moderate	High	Minor	Moderate	High	Minor	Moderate	High
Enabling works	Peak	248	-	-	1	-	-	23	2	-
	Typical	-	-	-	-	-	-	1	-	-
Compound establishment	Peak	348	29	-	-	-	-	-	-	-
	Typical	-	-	-	-	-	-	-	-	-
Compound operation	-	3	-	-	-	-	-	-	-	-
Site establishment	-	246	7	-	-	-	-	4	-	-
Demolition	Peak	-	-	-	-	-	-	-	-	-
	Typical	-	-	-	-	-	-	-	-	-
Bridges	Peak	194	-	-	-	-	-	-	-	-
	Typical	-	-	-	-	-	-	-	-	-
Road works	Peak	338	17	-	-	-	-	1	-	-
	Typical	-	-	-	-	-	-	-	-	-
	Dynamic compaction	14	-	-	-	-	-	-	-	-
Finishing works	-	-	-	-	-	-	-	-	-	-

Notes: 1. Daytime out-of-hours is 7am to 8am and 1pm to 6pm on Saturday, and 8am to 6pm on Sunday and public holidays.
2. Undertaking works outside of standard construction hours in the vicinity of this noise catchment are unlikely to be justified (for example are not within prescribed airspace) and are therefore likely to occur during standard construction hours.

Table 10.20 Number of receivers with predicted noise exceedances during evening[1] out-of-hours

Construction scenario	Activity	Noise catchment area											
		NCA00			NCA03[2]			NCA06			NCA08		
		Minor	Moderate	High	Minor	Moderate	High	Minor	Moderate	High	Minor	Moderate	High
Enabling works	Peak	8	-	-	324	-	-	1	-	-	42	6	-
	Typical	-	-	-	-	-	-	-	-	-	1	-	-
Compound establishment	Peak	-	-	-	-	-	-	-	-	-	-	-	-
	Typical	-	-	-	-	-	-	-	-	-	-	-	-
Compound operation	-	-	-	-	20	-	-	-	-	-	-	-	-
Site establishment	-	-	-	-	264	21	-	-	-	-	10	1	-
Demolition	Peak	-	-	-	-	-	-	-	-	-	-	-	-
	Typical	-	-	-	-	-	-	-	-	-	-	-	-
Bridges	Peak	-	-	-	286	-	-	-	-	-	3	-	-
	Typical	-	-	-	6	-	-	-	-	-	-	-	-
Road works	Peak	4	-	-	361	48	-	1	-	-	14	-	-
	Typical	-	-	-	3	-	-	-	-	-	-	-	-
	Dynamic compaction	-	-	-	40	-	-	-	-	-	-	-	-
Finishing works	-	-	-	-	12	-	-	-	-	-	-	-	-

Notes:
1. Evening out-of-hours is 6pm to 10pm Monday to Saturday.
2. Undertaking works outside of standard construction hours in the vicinity of this noise catchment is unlikely to be justified (for example are not within prescribed airspace) and is therefore likely to occur during standard construction hours.

Table 10.21 Number of receivers with predicted noise exceedances during night-time[1] out-of-hours

Construction scenario	Activity	Noise catchment area														
		NCA00			NCA02			NCA03[2]			NCA06			NCA08		
		Minor	Moderate	High	Minor	Moderate	High	Minor	Moderate	High	Minor	Moderate	High	Minor	Moderate	High
Enabling works	Peak	32	-	-	16	-	-	370	1	-	3	1	-	188	21	2
	Typical	-	-	-	-	-	-	-	-	-	-	-	-	7	1	-
Compound establishment	Peak	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Typical	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Compound operation	-	-	-	-	-	-	-	78	-	-	-	-	-	-	-	-
Site establishment	-	-	-	-	-	-	-	287	59	-	1	-	-	33	2	-
Demolition	Peak	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Typical	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bridges	Peak	9	-	-	3	-	-	339	1	-	1	-	-	28	-	-
	Typical	-	-	-	-	-	-	53	-	-	-	-	-	1	-	-
Road works	Peak	31	-	-	18	-	-	303	117	-	1	-	-	84	-	-
	Typical	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-
	Dynamic compaction	-	-	-	-	-	-	88	-	-	-	-	-	-	-	-
Finishing works	-	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-

Notes: 1 Night-time out-of-hours is 10pm to 7am Monday to Saturday and 6pm to 8am on Sunday and public holidays.
2. Undertaking works outside of standard construction hours in the vicinity of this noise catchment is unlikely to be justified (for example are not within prescribed airspace) and is therefore likely to occur during standard construction hours.

Table 10.22 Number of receivers with predicted noise exceedances of sleep disturbance criteria

Construction scenario	Activity	Noise catchment area														
		NCA00			NCA02			NCA03[1]			NCA06			NCA08		
		Minor	Moderate	High	Minor	Moderate	High	Minor	Moderate	High	Minor	Moderate	High	Minor	Moderate	High
Enabling works	Peak	29	-	-	4	-	-	324	-	-	1	-	-	116	17	1
	Typical	-	-	-	-	-	-	-	-	-	-	-	-	10	1	-
Compound establishment	Peak	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Typical	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Compound operation	-	-	-	-	-	-	-	29	-	-	-	-	-	-	-	-
Site establishment	-	-	-	-	-	-	-	246	7	-	-	-	-	17	1	-
Demolition	Peak	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Typical	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bridges	Peak	-	-	-	-	-	-	194	-	-	-	-	-	8	-	-
	Typical	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Road works	Peak	31	-	-	18	-	-	303	117	-	1	-	-	84	-	-
	Typical	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-
	Dynamic compaction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Finishing works	-	-	-	-	-	-	-	48	-	-	-	-	-	-	-	-

Note: 1. Undertaking works outside of standard construction hours in the vicinity of this noise catchment is unlikely to be justified (for example are not within prescribed airspace) and is therefore likely to occur during standard construction hours.

Other sensitive receivers

The predicted noise management level exceedances for 'other sensitive' receivers are shown on Figure 10.3. There were no predicted noise level exceedances for educational facilities, medical facilities or libraries within the study area.

Standard construction hours

During standard construction hours, the results show:

- Three hotels are predicted to be subject to high worst-case impacts, while two would be subject to moderate worst-case impacts in NCA06, NCA07 and NCA08
- Hotels located further north of the project site are predicted to experience a minor worst-case impact or noise below the relevant noise management level
- Coleman Reserve is predicted to experience high daytime impacts during 'peak' enabling works and moderate impacts during other works
- Three child care centres in NCA03 and NCA06 are predicted to experience minor worst-case impacts (when in use)
- Two places of worship in NCA01 and NCA02 are predicted to experience minor worst-case impacts (when in use).

It is noted that the majority of the 'other sensitive' receivers are located adjacent (or near) main roads and are already subject to relatively high existing noise levels. The unattended noise monitoring showed that existing noise levels next to main roads (65 to 75 dB during the daytime and 60 to 70 dB during the night-time) are comparable to, or higher than, the predicted construction noise levels for many of the assessed work scenarios. In this context, it is anticipated the predicted noise levels may not be noticeable to existing receivers.

Outside standard construction hours

Based on the predicted external noise levels, the closest hotels in NCA06 and NCA07 are likely to be subject to high worst-case impacts when noise intensive equipment is being used at the intersection of Qantas Drive, Joyce Drive and O'Riordan Street ('peak' activity). This is associated with 'peak' enabling works and 'peak' road works. However, the most affected hotels are expected to have high performance facades and glazing to mitigate high existing noise levels being near the airport. This will reduce construction noise to more acceptable (internal) levels during some works.

The worst-case noise levels and impacts would only be apparent for relatively short periods when noise intensive equipment is being used. There would also be periods when noise levels are lower than predicted and periods when no equipment is being used. Notwithstanding, it is still likely that regular night-time work would be required at the intersection of Qantas Drive, Joyce Drive and O'Riordan Street due to the need to maintain the function of the roads in this location.

The construction materials and insulation of the most affected rooms in the affected hotels have been recently investigated in consultation with the hotel operators to identify more realistic assumptions regarding external noise levels and the corresponding internal levels. These investigations have confirmed that for each affected hotel, the acoustic performance of the hotel facades used in the assessment is conservative (ie has underestimated the level of attenuation which would be achieved). As a result, the level of impact predicted is unlikely to be sustained at these receivers. The location-specific criteria for each hotel would be used in future construction noise assessments to inform the selection of appropriate mitigation measures (see NV4 in section 10.7.2).

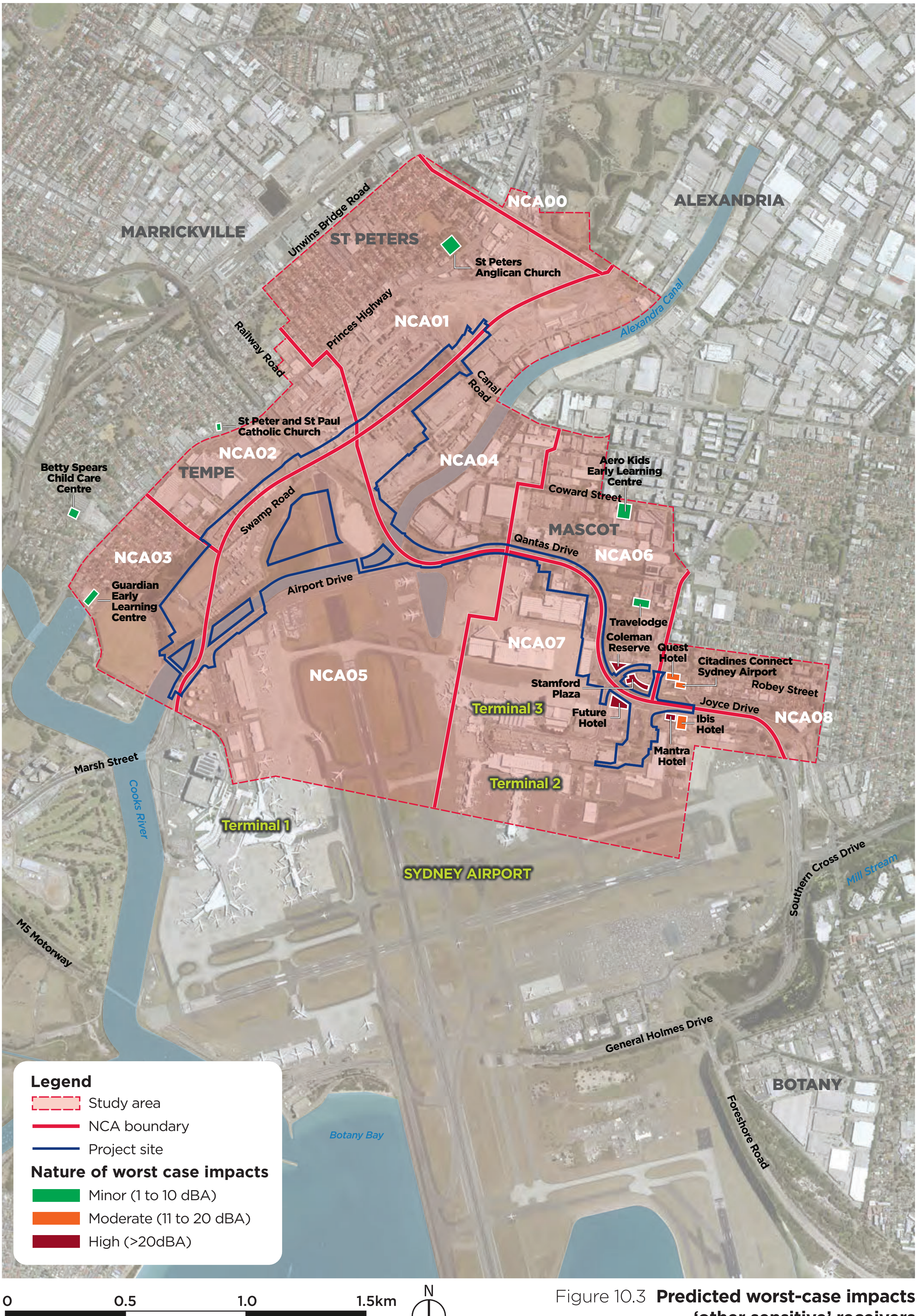


Figure 10.3 **Predicted worst-case impacts ‘other sensitive’ receivers**

Qantas Flight Training Centre

The Qantas Flight Training Centre operates 24 hours a day, seven days a week. The Flight Training Centre has several specialist flight simulators that are required to be kept operational to meet training needs. The simulators are highly sensitive to impacts from construction as they simulate aircraft warning sounds and physical feedback events that need to be easily discernible by pilots during training and certification. Other sections of the Flight Training Centre are used as training rooms, cabin crew simulation areas, pre-flight training areas and meeting/office rooms. The buildings at the Flight Training Centre would be removed during construction to allow Qantas Drive to be widened. Qantas is proposing to relocate the Flight Training Centre to a new site on the northern side of the rail corridor (see Chapter 19 (Land use and property)). There may be a period where construction noise and vibration has the potential to impact operations at the centre in its current location, particularly operation of the flight simulators.

Predicted construction noise impacts were identified for likely construction scenarios directly outside the Flight Training Centre in its current location, about 100 metres to the west of the Flight Training Centre, and about 300 metres west of the Flight Training Centre. The key findings of the assessment included:

- ‘Peak’ construction activities (comprising enabling works, demolition and road works) are predicted to result in high worst-case impacts where noise intensive equipment is used adjacent to the Flight Training Centre
- Moderate worst-case impacts are predicted during ‘typical’ activities (comprising enabling works, demolition and road works)
- The highest noise impacts are likely during building demolition activities
- When works are about 100 metres from the Flight Training Centre, the majority of the assessed scenarios resulted in no predicted exceedances or minor worst-case impacts, with the exception of moderate impacts during ‘peak’ enabling works
- When works are about 300 metres from the Flight Training Centre, there are no predicted exceedances, with the exception of ‘peak’ enabling works, where minor worst-case impacts are expected.

The impacts presented above are based on all construction equipment working simultaneously in each assessed scenario. There would frequently be periods when construction noise levels are much lower than the worst-case levels predicted. There would also be times when no equipment is being used and no impacts would occur. Conservative assumptions have also been made about the acoustic characteristics of the building and flight simulators.

Although high impacts (noise levels of 75 to 90 dB) are predicted when noise intensive works (peak activity) are occurring close to the Flight Training Centre in its current location, the Flight Training Centre is located adjacent to operational areas of the airport and a major road. Background noise monitoring in the vicinity identified existing daytime noise was regularly between 70 to 75 dBA, with maximum noise levels often above 100 dBA. The management approach for minimising impacts on the Flight Training Centre in its current location would be further developed during detailed design and construction planning in consultation with Qantas.

Commercial receivers

No commercial receivers are predicted to be subject to high worst-case impacts during construction. Moderate worst-case impacts are predicted at the nearest commercial receivers in NCA05, NCA06 and NCA07 during the ‘peak’ activities (comprising enabling works, demolition and road works). This includes DHL, the AMG Sydney and Qantas security building located at Lancastrian Road. Noise levels and exceedances are predicted to be minor or compliant with noise management levels at other times.

Ground-borne noise

There is potential for ground-borne noise impacts at nearby receivers when construction works requiring vibration intensive equipment occur nearby. The majority of the receivers in the study area are sufficiently distant from the works for ground-borne noise impacts to be minimal. Residential receivers near South and

Smith streets in NCA03 are predicted to have minor to moderate worst-case ground-borne noise impacts. However, airborne noise would likely be more dominant in this area. It is noted, however, the ground-borne noise criteria apply to works outside standard construction hours. Noise and vibration intensive works would not be justified in close proximity to these locations outside standard construction hours. As such, impacts associated with ground-borne noise outside standard construction hours at these locations are unlikely.

Stamford Plaza, The Mantra Hotel, Ibis Budget Sydney, the future airport hotel site, Quest Mascot and Citadines Connect Sydney Airport may experience high or moderate ground-borne noise impacts. High ground-borne noise impacts may also be experienced by a number of commercial buildings near the intersection of Qantas Drive, Joyce Drive and O'Riordan Street, and along Qantas Drive.

Mitigation and management measures to manage ground-borne noise impacts have been provided in section 10.7.2.

Qantas Flight Training Centre

Vibration intensive equipment would be used close to the Flight Training Centre (in its current location), such as during demolition of the adjacent building or during works to widen Qantas Drive. The Flight Training Centre may be affected by ground-borne noise. Impacts are predicted to be high when items such as rockbreakers are used (outside the centre in its current location). However, when the works are at least 100 metres away, the ground-borne noise levels are predicted to be much lower and would likely comply with the noise management levels.

Specific construction activities

Crushing and grinding

The project would use an area near the St Peters interchange connection to crush and grind material suitable for use as engineering fill. Crushing and screening already occurs near this location at Boral Recycling St Peters. Equipment likely to be required for the activity would include a rock crusher, front end loader, excavator and trucks. The assessment concluded that there would be no exceedances of noise management levels due to the separation distance from the nearest sensitive receivers.

Impact piling

Impact piling would be required during the construction of new bridge piers. This activity can generate high noise and vibration levels. However, it is generally only required for relatively short durations and would be undertaken during standard construction hours where possible. Impact piling may be required outside standard construction hours at a number of locations where the piling rigs could intrude in the prescribed airspace of Sydney Airport or where the piling rigs need to occupy existing roadways. Therefore they may be required to occur at night during the airport curfew and when traffic volumes are low.

During the daytime, the predicted worst-case impacts experienced by the nearest receivers in NCA03, NCA06 and NCA08 are generally moderate. However, the predicted worst-case impacts experienced by three receivers may be high. These receivers are located near the intersection of Qantas Drive, Joyce Drive and O'Riordan Street in NCA06 and NCA07. They include the future hotel site at Sydney Airport, AMG Sydney and DHL.

The predicted worst-case impacts at the nearest receivers when impact piling is required outside standard construction hours are predicted to be moderate. Some of the nearest receivers are commercial. However, many residential receivers in Tempe in NCA01, NCA02 and NCA03 are predicted to be impacted during piling for the freight terminal bridge.

It is noted, however, that impact methods would only be required to drive the pile sleeves into the upper layer of bedrock. The majority of the sleeve insertion would be undertaken in soft soils using non-impact methods, which would generate substantially less noise.

10.4.3 Sleep disturbance impacts

The results of the sleep disturbance screening assessment are provided in Table 10.22. The sleep disturbance criteria are likely to be exceeded when night works occur near residential receivers. The receivers that would potentially be affected by sleep disturbance impacts are generally the same receivers for which high night-time impacts have been predicted.

The highest number of residential receivers affected by night-time works are in NCA03 and NCA08. The majority of receivers would be impacted during the 'peak' activity of enabling works, site establishment, bridge construction, road works and finishing works, with moderate and minor exceedances. The exceptions to this are enabling works which would result in high exceedances of the noise management levels. These construction scenarios are of short duration with limited use of noisy equipment (peak activity). Impacts on NCA03 are considered to be reduced in number as works in the vicinity of NCA03 would likely be undertaken during standard construction periods as these works would not generally be justified being undertaken during the night-time period (eg works do not intrude into prescribed airspace or located on roads subject to high traffic volumes).

During the 'typical' activity, the number of affected receivers is substantially smaller and would experience minor exceedances, except during enabling works, when some moderate exceedances are predicted.

In addition to the peak scenarios outlined above, sleep disturbance exceedances may also be experienced during compound operation and road works as follows:

- Minor exceedances are predicted for receivers in NCA03 during compound operation
- During 'typical' road works near NCA03, only three receivers are predicted to be impacted (though such works are unlikely to be justified to occur during the night-time period).

The requirements for night-time works would be determined as the project progresses. All works outside standard construction hours that could affect the amenity of receivers would be appropriately justified. Mitigation and management measures would be implemented to reduce the potential for sleep disturbance impacts (see section 10.7).

10.4.4 Construction traffic noise

Construction related traffic has the potential to temporarily increase noise levels at receivers located close to the proposed construction haulage routes. The estimated construction traffic volumes outlined in Chapter 9 (Traffic, transport and access) have been used to determine whether a noticeable increase in road traffic noise (greater than 2 dB increase above the existing noise level) would occur.

The assessment concludes that noise generated by construction traffic is unlikely to result in a 2 dB increase. This is due to the high volumes of traffic that currently use the roads compared to the relatively small volume of construction vehicles.

10.4.5 Vibration impacts

The main potential sources of vibration during construction are from vibratory rollers, rockbreakers, vibratory piling, impact piling and during dynamic compaction. It is noted that existing ground conditions ie fill layers on top of sand would reduce the transmission of vibration, compared to rock. This may result in lower vibration levels than currently predicted at the affected receivers.

Human comfort vibration impacts

Certain receivers in the study area are within the human comfort minimum working distances (see Figure 10.4). Occupants of affected buildings may be able to perceive vibration impacts at times when vibration intensive equipment is used. Where impacts are perceptible, they would likely only be apparent during the relatively short times when equipment such as rockbreakers or vibratory rollers are used nearby.

Impact piling can also result in human comfort vibration impacts. The Construction Noise and Vibration Guideline does not provide a human comfort minimum working distance for this activity. The potential impacts would depend on the size of the equipment used.

The proximity of sensitive receivers to some of the locations where impact piling would be used means that human comfort impacts may be experienced. The majority of the piling would occur in soft soils using non-impact methods, which would generate substantially less vibration. Any perceivable vibration associated with impact piling would be short-lived.

Vibration impacts on buildings and infrastructure

Cosmetic damage

Most buildings are unlikely to suffer cosmetic damage due to the distance between work areas and the nearest receivers. However, some buildings and structures are within the recommended minimum working distances, particularly in the eastern section of the study area near Airport Drive and Qantas Drive (as shown in Figure 10.4). These include receivers in NCA06, NCA07 and NCA08. A number of buildings/items are also located within the cosmetic damage minimum working distances in NCA04 near Burrows Road South, NCA05 to the south of Airport Drive and NCA02 adjacent to the Botany Rail Line.

Impact piling, which would be required to construct bridge piers, can generate high vibration levels. The extent of the impacts would depend on the size of the equipment used. Given the proximity of certain buildings and structures to the bridge work areas, there is potential for cosmetic damage impacts from this activity.

Qantas Flight Training Centre

The Flight Training Centre, which has several specialist flight simulators and other equipment that are particularly sensitive to vibration, is located within both the cosmetic damage and human comfort minimum working distances in its current location (see section 10.2.1). Vibration intensive equipment would likely be required in close proximity to the Flight Training Centre at certain times, such as during demolition of buildings or works to widen Qantas Drive.

The requirement for vibration intensive works in this location would be reviewed during detailed design and construction planning. Alternative means of demolition, such as shear, pulveriser or ripper attachments to excavators, could be used to avoid hydraulic/pneumatic hammering. This would reduce airborne noise, ground-borne noise and potential vibration impacts.

Pipelines

As described in Chapter 8 (Construction), several pipelines are located within the project site, including:

- Jemena primary and secondary gas mains
- Qenos ethylene pipeline
- Fuel pipelines
- Sydney Airport water supply line
- Sydney desalination pipeline
- Sydney Water sewer and potable water pipelines.

Vibration intensive activities such as rockbreaking, vibratory rolling or vibratory/impact piling may occur near these pipelines. DIN4150 vibration criteria for buried pipework range from 50 mm/s to 100 mm/s depending on the pipe material and its age/condition. The potential for impact would depend on the final distance between the works and each pipeline, the type of equipment being used and the ground conditions. Consultation with the pipeline owners would also need to be undertaken to establish assessment criteria during detailed construction planning. Further information about potential risks to pipelines is provided in Chapter 23 (Health, safety and hazards).

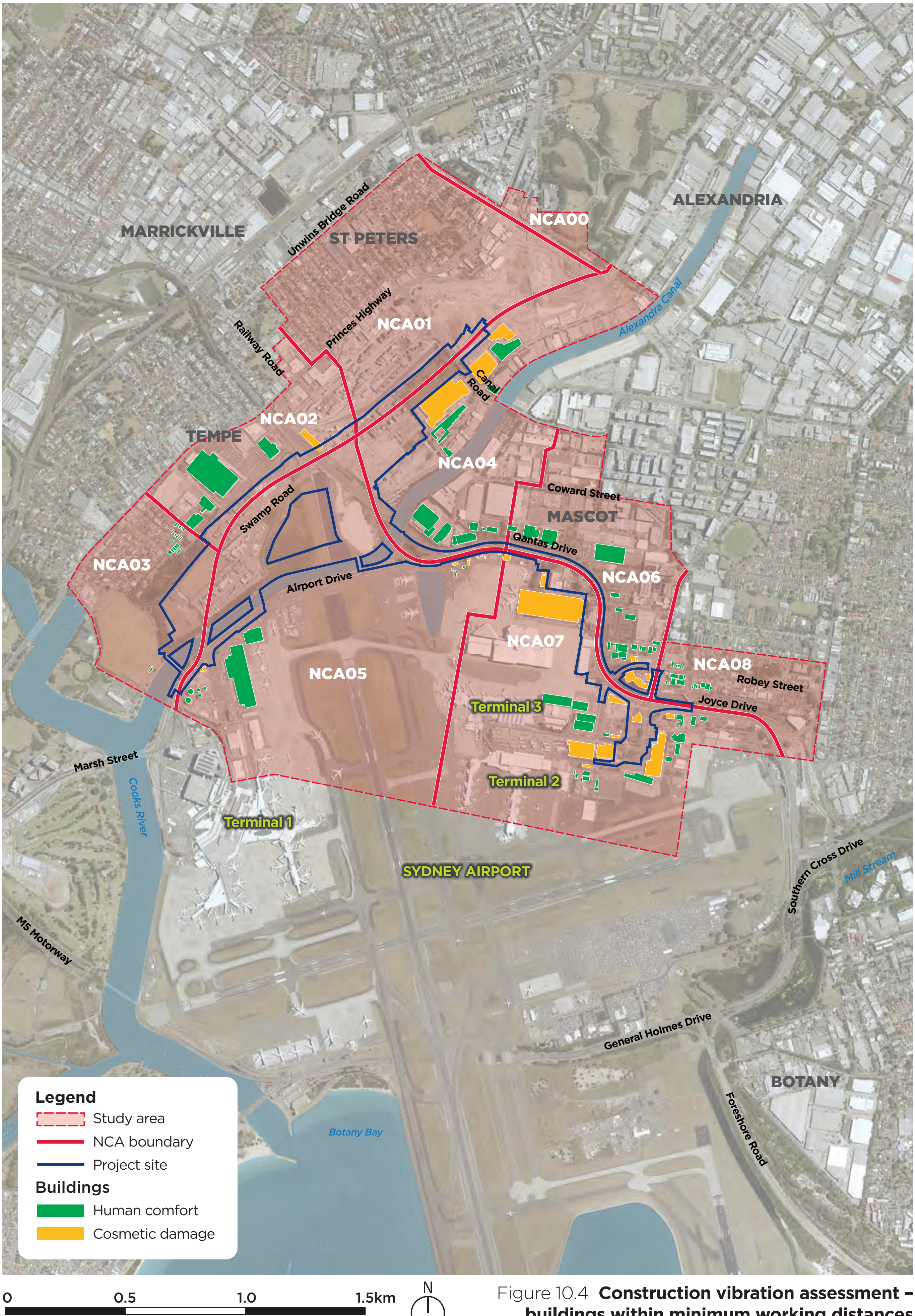


Figure 10.4 **Construction vibration assessment – buildings within minimum working distances**

Heritage structures

Heritage listed items located within the cosmetic damage minimum working distance are listed in Table 10.23. A full list of heritage items in the study area is provided in Chapter 17 (Non-Aboriginal heritage) as well as an assessment of impacts. There would be no impacts on recorded Aboriginal sites or places as none were identified within the project site (see Chapter 18 (Aboriginal heritage)).

As discussed in section 10.2.1, BS7385 specifies that a heritage building should not be assumed to be inherently more sensitive to vibration, unless it is structurally unsound. There are five heritage items within the cosmetic damage minimum working distance. Three are rail bridges and are not expected to be overly sensitive to potential vibration impacts from nearby construction works. Similarly, the Cooks River Intermodal Terminal and the features of heritage significance within are not expected to be overly sensitive to vibration.

Sections of Alexandra Canal are also within the minimum working distances. The canal walls may be susceptible to damage when vibration-generating construction works are carried out nearby, depending on the nature of the material and the distance from the activity.

Further information on potential impacts on heritage items is provided in Chapter 17 (Non-Aboriginal heritage).

Table 10.23 Heritage items within the cosmetic damage minimum working distances

Heritage item	Location
Cooks River Container Terminal	West of Canal Road, St Peters
Alexandra Canal (including sandstone walls)	Alexandra Canal, Mascot
Mascot (Sheas Creek) Underbridge	Extends over Alexandra Canal, Mascot
Mascot (Robey Street) Underbridge	Extends over Robey Street, Mascot
Mascot (O'Riordan Street) Underbridge	Extends over O'Riordan Street, Mascot

10.4.6 Summary of impacts on Sydney Airport (Commonwealth) land

Activities located adjacent to and within Sydney Airport have the potential to result in noise and vibration impacts at receivers located on Sydney Airport land. The potential noise and vibration construction impacts on Sydney Airport land would be located within NCA01, NCA04, NCA05, NCA06 and NCA07. A summary of the potential impacts identified by the assessment is provided in Table 10.24.

Table 10.24 Summary of impacts on Sydney Airport land

Area	Summary of impact
Hotels (Rydges Sydney Airport, Mantra Hotel, Ibis Budget Sydney Airport and a future hotel in NCA07)	High or moderate worst-case impacts are predicted when noise intensive equipment are used outside these receivers ('peak' activity). Impacts would be lower during 'typical' works when noise intensive equipment is not used. The hotels have been confirmed to have high performance facades such that this assessment is conservative and has overestimated the extent of impacts. This would be analysed further during detailed construction planning.
Qantas Flight Training Centre	High worst-case impacts are predicted when noise intensive equipment is used immediately outside the Flight Training Centre in its current location ('peak' activity). Where works are located at a distance of about 100 m from the centre, the impacts are predicted to comply with the noise management level, with one scenario (peak enabling works) representing the noisiest works and resulting in a moderate impact. Two scenarios (site establishment and peak road works) would result in a minor impact. Where works are located at a distance (ie greater than 300 m), the impacts are predicted to generally comply with the noise management level, with only one scenario (peak enabling works) resulting in a minor impact. This facility would be relocated by Qantas (separate to the project) during the construction period.

Area	Summary of impact
Commercial receivers (such as DHL, AMG Sydney and Qantas security building)	Construction is predicted to generally result in minor worst-case impacts at commercial receivers on Sydney Airport land. However, a number of buildings located close to work areas may experience moderate impacts during the noisiest works. Existing commercial receivers are located adjacent, or close to, main roads and Sydney Airport. As such, these receivers are subject to relatively high existing noise levels. The noise monitoring identified that the daytime and night-time noise levels are comparable to, or higher than, the predicted construction noise levels for many of the assessed work scenarios. Removing buildings adjacent to Qantas Drive would result in some receivers having line of sight to construction works on Qantas Drive (through removal of shielding). This would result in the receivers experiencing higher construction noise levels. It is noted that many of these buildings are already subject to noise generated by ground-based airport activities.
Ground-borne noise and vibration	The project would have the potential to affect structures on Sydney Airport land as a result of the use of noise intensive equipment, demolition of buildings and ground-borne noise during vibration intensive works. Certain buildings on Sydney Airport land would be potentially affected by ground-borne noise when vibration intensive works are occurring nearby. Similarly, certain buildings would be within the minimum working distances for human comfort and cosmetic damage. This means that there is potential for vibration impacts when works are occurring close to these receivers. The requirement for vibration intensive works near buildings on Sydney Airport land would be reviewed during detailed design when detailed construction planning is available.

The *Significant impact guidelines 1.2 – Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies* (DSEWPC, 2013) (Significant Impact Guidelines 1.2) is a guide to assessing whether impacts on people and communities are likely to be significant. Many of the receivers on Sydney Airport land are of commercial use with relatively low sensitivity. Certain sensitive receivers are likely to be highly impacted at certain times during construction, including a number of hotels at the intersection of Qantas Drive, Joyce Drive and O'Riordan Street. However, the number of affected receivers is relatively small and impacts would be reduced through the implementation of feasible and reasonable mitigation and management measures (see section 10.7.2). Existing noise levels around Sydney Airport are also high. Most areas are affected by traffic noise from nearby major roads, train movements on the Botany Rail Line and aircraft noise from Sydney Airport.

Overall, the potential noise and vibration impacts on Commonwealth land as a result of construction are not considered significant.

10.5 Assessment of operation impacts

10.5.1 Road traffic noise

The potential impacts of road traffic noise were predicted for sensitive receivers in the study area. Detailed information is provided in section 6.2 of Technical Working Paper 2 (Noise and Vibration).

For receivers that qualify for consideration of additional noise mitigation, potential mitigation measures would be considered in the following order of preference:

- At-source mitigation:
  - Quieter road pavement surfaces
- In-corridor mitigation:
  - Noise mounds
  - Noise barriers
- At-receiver mitigation:
  - At-property treatments.

Where additional mitigation is identified below, it would be subject to revised noise impact modelling during detailed design and a reasonable and feasible review in accordance with the Noise Mitigation Guideline.

Residential receivers

The worst-case predicted operational road noise levels (ie at the most affected residences) are summarised in Table 10.25 for the 2026 at-opening and 2036 future scenarios (2036 noise levels are shown in brackets). The table shows the predicted worst-case impacts in each noise catchment area, which typically affect receivers closest to the project site. The impacts from the project are predicted to be greatest in 2036, because of higher traffic volumes compared with 2026. The impact criteria are lower during the night-time period (10pm to 7am Monday to Saturday, and 6pm to 8am on Sunday and public holidays). As a result, this scenario will govern the requirements for mitigation.

The predicted change in noise levels in 2036 is shown in Figure 10.5 (for all receivers). This change is based on the difference between the ‘with project’ and ‘without project’ scenarios.

Many residential receivers in the study area are subject to relatively high existing road traffic noise impacts, which already exceed the Noise Criteria Guideline criteria in many cases. The project would introduce new sources of road traffic noise to some areas, with increases in road traffic noise levels greater than 2 dB predicted. To the north of the Princes Highway in NCA01, increases of up to 5 dB are predicted. The greatest increases in noise are predicted towards the north-west of the catchment, which is due to higher ground in this direction resulting in a line-of-sight to the project. A noise barrier is not considered feasible and reasonable in this location as it would provide less than 2 dB noise benefit to affected occupants.

Noise level increases of up to 13 dB are predicted in NCA03. Residential receivers on Smith Street and South Street are the most affected due to existing road traffic noise levels in this area being relatively low. These receivers would also face the roadway. A noise barrier is proposed near this location to a height of about five metres. The preliminary assessment concluded the barrier would reduce noise levels by up to 5 dB. Receivers further away from the roadway would be less affected as project noise levels reduce with distance and local noise sources become dominated by other existing roads, such as the Princes Highway.

Noise increases are predicted in NCA06, NCA07 and NCA08. The areas west of O’Riordan Street and south of the intersection of Qantas Drive, Joyce Drive and O’Riordan Street are predicted to receive increases of up to 4 dB. This is due to the increased traffic on Qantas Drive and the new viaduct to Sydney Airport Terminals 2/3. Residential receivers on Baxter Road in Mascot are predicted to experience increases of up to 3 dB due to traffic increases (particularly heavy vehicles) on Joyce Drive.

The option of providing a noise barrier at this location has been considered. However, a barrier is not considered feasible and reasonable. Utilities on the southern side of the rail corridor restrict potential locations for a noise barrier without further impacts to advertising structures. A noise barrier on the northern side of the rail corridor would require easements for maintenance access, restricting the amount of land available for future development.

Exceedances of the Noise Criteria Guideline cumulative limit criteria (see section 10.2.2) are predicted in the majority of catchments with residential receivers. The project is predicted to result in acute noise levels (daytime $L_{Aeq(15hour)}$ 65 dBA or higher, or night-time $L_{Aeq(9hour)}$ 60 dBA or higher) for residential receivers adjacent to Campbell Street in NCA00 and at one receiver in NCA06.

In summary, exceedances of the operational road traffic noise criteria are predicted at 231 residential receivers, of these:

- 215 are predicted to experience noise level increases of greater than 2 dB
- 34 are predicted to experience noise levels above the cumulative limit criteria
- Nine are subject to acute noise levels.

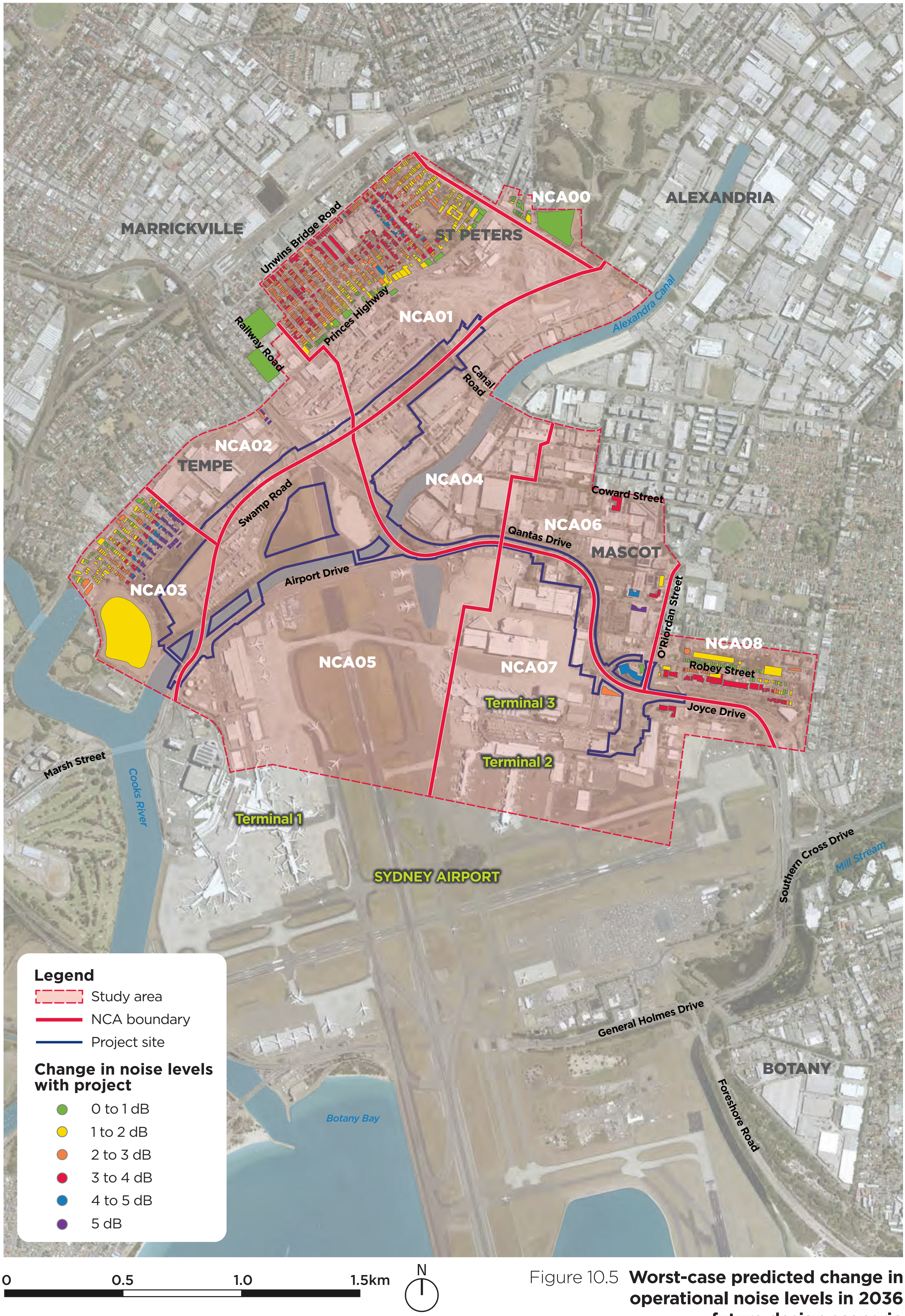


Figure 10.5 **Worst-case predicted change in operational noise levels in 2036 future design scenario**

Table 10.25 Predicted road traffic noise levels at the most affected residential receivers in each noise catchment area

Noise catchment area	Predicted noise level (dBA)[1] at the most affected receiver				Receivers eligible for consideration of additional noise mitigation			
	Without project		With project		Trigger 1 >2 dB	Trigger 2 cumulative	Trigger 3 acute	Total
	Day	Night	Day	Night				
NCA00	76 (77)	73 (73)	76 (76)	73 (73)	-	1	8	9
NCA01	59 (59)	54 (55)	60 (60)	56 (57)	71	12	-	78
NCA02	61 (61)	57 (58)	63 (63)	59 (60)	2	1	-	2
NCA03	51 (49)	47 (45)	62 (61)	58 (58)	119	19	-	119
NCA04[2]	-	-	-	-	-	-	-	-
NCA05[2]	-	-	-	-	-	-	-	-
NCA06	63 (63)	60 (59)	65 (66)	62 (63)	1	1	1	1
NCA07[2]	-	-	-	-	-	-	-	-
NCA08	67 (67)	64 (64)	69 (70)	66 (67)	22	-	-	22
Total receivers impacted								**231**

Notes: 1. Daytime and night-time are $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$ noise levels, respectively The noise levels shown are predicted noise levels at project opening (year 2026) and future design (year 2036). The future design levels are shown in brackets.
2. Noise catchment area does not contain residential receivers.

Additional mitigation would be investigated during detailed design to minimise the potential impacts where feasible and reasonable. Options to mitigate the impacts identified include low noise pavement, noise barriers and at-property mitigation. Further information is provided in section 10.7.

Other sensitive receivers

Fifteen ‘other sensitive’ receiver buildings are predicted to experience exceedances of the operational road traffic noise criteria as shown in Table 10.26. These are detailed in section 6.2.2 of Technical Working Paper 2 (Noise and Vibration). The receivers include St Peters Public School, St Peters Anglican Church, Guardian Early Learning Centre, Aero Kids Early Learning Centre, Tempe Recreation Reserve, Coleman Reserve and a number of hotels.

Table 10.26 ‘Other sensitive’ receivers triggers

Noise catchment area	Receiver	Type	Noise Mitigation Guideline triggers		
			Trigger 1 > 2 dB	Trigger 2 cumulative	Trigger 3 acute
NCA01	St Peters Public School[1]	Educational	-	Y	-
	St Peters Anglican Church[1]	Place of worship	Y	Y	-
NCA03	Guardian Early Learning Centre	Childcare	Y	Y	-

Noise catchment area	Receiver	Type	Noise Mitigation Guideline triggers		
			Trigger 1 > 2 dB	Trigger 2 cumulative	Trigger 3 acute
NCA06	Aero Kids Early Learning Centre	Childcare	Y	Y	-
	Stamford Plaza Sydney Airport	Hotel	Y	Y	Y
	Travelodge	Hotel	Y	Y	Y
	Coleman Reserve	Outdoor passive	-	Y	Y
NCA07	Ibis Budget Sydney Airport	Hotel	Y	-	Y
	Mantra Hotel	Hotel	Y	-	Y
	Future airport hotel	Hotel	Y	Y	Y
NCA08	Quest Mascot (Hotel)	Hotel	-	-	Y
	Citadines Connect Sydney Airport	Hotel	Y	-	Y

Note: 1. Receiver consists of multiple structures with each structure considered as a separate part in the assessment.

Receivers eligible for consideration of additional noise mitigation

The sensitive receivers identified as eligible for consideration of additional noise mitigation in accordance with the Noise Mitigation Guideline are summarised in Table 10.27. A total of 246 sensitive receiver buildings are predicted to experience exceedances of the Noise Mitigation Guideline triggers. It is noted the hotels have been assessed as residential on the basis that they may be the primary residence for some patrons. Further investigation of hotels would be undertaken during detailed design. Only areas of permanent residence require assessment and consideration of mitigation.

The mitigation and management measures for the project are discussed in section 10.7.

Table 10.27 Receivers considered for 'additional noise mitigation'

Noise catchment area	Number of buildings (floors)[1] eligible for consideration of additional noise mitigation	
	Residential	Other sensitive
NCA00	9 (18)	- (-)
NCA01	78 (83)	5 (9)
NCA02	2 (2)	- (-)
NCA03	119 (131)	1 (1)
NCA04	- (-)	- (-)
NCA05	- (-)	- (-)
NCA06	1 (10)	4 (33)
NCA07	- (-)	3 (25)
NCA08	22 (34)	2 (13)
Sub total	**231 (278)**	**15 (81)**

Note: 1. The count of 'floors' represents separate floors within each building (in brackets). For some receivers there would likely be multiple units within the same floor, such as in residential apartment blocks.

Maximum road traffic noise levels

The introduction of the project into the study area may result in a change to the maximum noise levels experienced as a result of traffic. The predicted worst-case change is 17 dB in NCA03 due to the proximity to the project site. In other noise catchment areas, the predicted change would be less than 10 dB. Where large increases in maximum noise levels are predicted, the affected receivers are also likely to exceed the operational road traffic noise criteria and be eligible for consideration of additional noise mitigation.

10.5.2 Changes to noise levels generated by Sydney Airport

The project would potentially result in changes to noise levels emanating from operations at Sydney Airport. This is due to the removal of several buildings along Qantas Drive and the removal of containers located at the Tyne Container Services site which currently provide shielding to off-site receivers.

The Airports (Environment Protection) Regulations 1997 does not contain specific criteria for noise generated by ground-based airport activities. In the absence of a specific guideline, the Noise Policy for Industry has been adopted.

The potential impacts from these activities are predicted to be limited to receivers north of South Street in NCA03 and near O'Riordan Street in NCA06/NCA08.

The assessment modelled six scenarios identifying the following predicted worst-case changes in existing noise levels at adjacent receivers due to ground-based airport activities:

- The removal of shipping containers is predicted to result in noise level increases at residential receivers in NCA03 by up to 3 dB
- The removal of buildings adjacent to Qantas Drive is predicted to result in noise level increases of up to 16 dB at the Travelodge hotel and up to 11 dB at King Apartments in NCA06
- The predicted noise levels from ground-based airport activities at the nearest receivers are anticipated to exceed the Noise Policy for Industry criteria, especially during high noise generating activities such as aircraft engine running (particularly during the evening and night-time).

The larger increases in noise levels are generally predicted at the lower or middle floors of the affected multi-storey buildings. Upper floors are less impacted because these locations already have line of sight to the operational areas of the airport, over the buildings that are proposed to be removed.

During certain runway maintenance works, aircraft may infrequently operate during curfew hours at the very northern end of the north-south runway. Impacts at receivers in NCA03 could be changed as a result and due to the removal of the shipping containers in this location. The potential changes in noise levels are anticipated to be similar to those predicted above.

The existing noise levels from these activities are likely to already exceed the criteria at receivers in the vicinity of the project site. Noise monitoring data indicates noise levels near Qantas Drive are high, with frequent levels of 70 to 75 dBA and occasional levels of 80 dBA. Aircraft engine running is required for safety reasons and would likely occur infrequently, but especially during the night-time. High power running would not occur every night and engine ground running typically only lasts for a short period. The options for mitigating impacts are limited due to the high noise levels associated with aircraft engine noise. Measures include the investigation of physical screening options (or partial demolition of Jet Base buildings affected by the project), to minimise the transmission of noise generated by ground-based airport activities.

10.5.3 Summary of impacts on Sydney Airport (Commonwealth) land

Once the project is operational, there would be impacts on the hotels on Sydney Airport land (including the Mantra Hotel, Ibis Budget Sydney Hotel and the future airport hotel in NCA07). It is predicted that the road traffic noise levels at these hotels would increase by around 4 dB in 2036. This is due to the combined effect of increased traffic on Qantas Drive and the elevated access to Terminals 2/3. Based on more recent specific investigations of these hotels, the attenuation of the building facades has been underestimated in this assessment such that the level of impact would be reduced.

Road traffic noise levels at the Qantas Flight Training Centre are predicted to increase by around 3 dB in 2036 (based on the Flight Training Centre's current location). However, it is unlikely that the Flight Training Centre would be still operating at this location when the project opens, as it is proposed to be relocated by Qantas as part of a separate project.

The potential impacts on the commercial uses of Sydney Airport land have been assessed by predicting the changes in road traffic noise level resulting from the project. In 2036, the project would result in predicted increases in road traffic noise levels in most areas. This is due to a change in road layouts, widened roads moving traffic closer to receivers and increased traffic volumes as a result of traffic growth between 2026 and 2036. The highest increase in noise levels (up to 10 dB) is predicted for areas immediately west of Qantas Drive between Lancastrian Road and Robey Street. Other areas are predicted to experience increases of around 1 to 4 dB, depending on location.

The project would include removing some buildings within the Sydney Airport Jet Base on Sydney Airport land, and removing containers from the Tyne Container Services site to the west of Alexandra Canal. The removal of these structures would potentially change operational noise emissions emanating from Sydney Airport land. These impacts are discussed further in section 10.5.2.

Many of the receivers on Sydney Airport land are of commercial use with relatively low sensitivity. Certain receivers near the intersection of Qantas Drive, Joyce Drive and O'Riordan Street are likely to experience moderate increases in operational road traffic noise and/or high increases in operational noise due to ground-based airport activities. However, the number of affected receivers is relatively small and impacts would be reduced through the implementation of feasible and reasonable mitigation and management measures (see section 10.7.2). At-property mitigation would also be considered for residual impacts at eligible receivers if required.

The Significant Impact Guidelines 1.2 (DSEWPC, 2013) provide a guide to assessing whether impacts on people and communities are likely to be significant, including the impacts of Sydney Airport activities on the surrounding community (eg ground-based noise noise). Overall, the potential operational noise and vibration impacts of the project are not considered significant.

Consistency with the Sydney Airport Master Plan

Noise from ground-based activities at Sydney Airport is managed separately to noise from in-flight aircraft operations. The Airports (Environment Protection) Regulations 1997 does not contain specific criteria for ground-based airport activities. It sets out matters to be considered to determine whether noise is excessive. Accordingly, in this instance, criteria in the Noise Policy for Industry have been used to assess the potential changes to aircraft-related noise impacts. Section 14.6.4 of the *Sydney Airport Master Plan 2039* (SACL, 2019a) (the Master Plan) states that noise from developments at the airport should be assessed during the development approval process.

The *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b) (the Environment Strategy) underpins Sydney Airport Corporation Limited's commitment to continual improvement of environmental performance at the airport. Section 3.5 of the Environment Strategy identifies that the main contributors of ground-based noise includes construction and development activities. Strategies have been identified that are used to manage and reduce airport ground-based noise. The following strategies relevant to this project include:

- Continue to undertake regular monitoring of noise generated by ground-based sources at the airport
- Continue to ensure that noise from ground-based airport activities is assessed and managed for the construction and operational phases of development proposals
- Carry out operational noise modelling for major developments impacting airport operations, assess noise predictions against relevant criteria and develop appropriate noise management measures
- Continue to monitor noise complaints for ground-based activities at the airport.

This assessment and the mitigation and management measures provided in section 10.7.2 are consistent with both the Master Plan and the Environment Strategy. This assessment identifies and documents these aspects for consideration by stakeholders during the development determination process.

10.6 Cumulative impacts

10.6.1 Construction

Multiple projects are proposed close to the project site with similar timing for construction and/or operation. These include the Botany Rail Duplication, New M5, M4-M5 Link, and other projects listed in sections 5.1.4 and 9.2.7.

Cumulative construction noise impacts may occur if construction on these projects is undertaken at the same time as the project. There is also the potential for consecutive impacts if certain receivers are affected by extended impacts from one project occurring after another project (which can contribute to construction fatigue). This is discussed in detail in section 7 of Technical Working Paper 2 (Noise and Vibration).

Impacts are generally limited to the eastern part of the study area in NCA06, NCA07 and NCA08 where projects may overlap. The majority of this area is commercial. However, some residential receivers are located in these catchments and 'other sensitive' receivers (such as hotels) are located near the intersection of Qantas Drive, Joyce Drive and O'Riordan Street.

Receivers in these areas have been impacted by construction works since 2016 (Airport East and North roadworks) and would potentially be impacted by a number of successive projects in the future (such as the Sydney Gateway road project, Botany Rail Duplication and Sydney Airport ground access solutions and hotel project).

Mitigation and management measures provided in section 10.7 for other sources of noise would also reduce the cumulative and consecutive impacts on receivers in the study area. More specific measures would be developed as the design progresses and impacts from other projects (such as Botany Rail Duplication) are known. Roads and Maritime would ensure the construction contractor(s) for the Sydney Gateway road project consult with the contractors for the Botany Rail Duplication, to coordinate out-of-hours work and ensure appropriate respite is provided to affected receivers as far as possible.

10.6.2 Operation

Receivers near the intersection of Qantas Drive, Joyce Drive and O'Riordan Street would potentially be affected by noise from both the Botany Rail Duplication and the project. However, operational noise from each source would be different and result in different annoyance responses from affected communities. As such, a cumulative assessment of the potential combined operational impacts from these two projects is not possible. The Botany Rail Duplication would be a more intermittent noise source, but may be more annoying than more continuous traffic noise. The final operational mitigation strategy for each project should aim to maximise the benefits of mitigation for affected receivers.

A cumulative traffic scenario was modelled to include road traffic for the project, NorthConnex, M5 East, New M5 and M4-M5 Link and other major interfacing non-approved projects that may be operational in 2036. There are 225 receivers identified as eligible for consideration of additional noise mitigation as a result of this scenario. This is a lower number of receivers than in the operational noise assessment for 2036 for this project (see section 10.5.1) because less traffic is expected to use some of the roads around the project site when these other infrastructure projects become operational.

10.7 Management of impacts

10.7.1 Approach

Approach to mitigation and management

The Interim Construction Noise Guideline identifies that due to the nature of construction, it is inevitable that there will be impacts where construction occurs near sensitive receivers. During construction, there would be noise impacts on some receivers during certain times and during certain construction activities. There is also the potential for sleep disturbance impacts and vibration impacts on some receivers and buildings. Cumulative construction noise impacts may also occur if construction on adjacent or nearby projects is undertaken at the same time as the project.

Once operational, there would be exceedances of the operational road traffic noise criteria. Receivers that qualify for consideration of additional noise mitigation have been identified. Mitigation and management measures in section 10.7.2 are proposed to mitigate impacts that cannot be avoided.

Approach to managing the key potential impacts identified

Mitigation measures have been developed with the aim of minimising or mitigating, where practicable, noise and vibration impacts described in sections 10.4 and 10.5. A CEMP will be prepared to provide a centralised mechanism to manage the potential environmental impacts of construction. The CEMP will include a Construction Noise and Vibration Management Plan, which will define the processes, responsibilities and management measures that will be implemented during construction to manage noise and vibration. Further information on the CEMP, including the Construction Noise and Vibration Management Plan, is provided in Chapter 27 (Approach to environmental management and mitigation).

The construction noise assessment identified the potential for high impacts outside standard construction hours at a number of hotels, particularly around the entrance to Terminals 2/3. Due to the amount of night-works that would be required at this location and sensitivity of the hotels, further investigations have been conducted. The noise management levels for sleeping areas in hotels relate to internal noise in the rooms. The assessment has conservatively assumed a 20 dB reduction to estimate internal noise levels from external noise levels at the facade. The buildings are, however, well insulated acoustically due to their location and the adopted 20 dB reduction is considered conservative. Therefore, the assessment has overstated the likely realistic level of impact. Along with location-specific criteria at each hotel location, alternative methods of construction would also be investigated during detailed construction planning and noise intensive works would be limited where possible.

There is a need to maintain the operation of the affected road network at all times and avoid affecting airport operations. As such, work outside standard construction hours would be required. Works or activities that cannot be undertaken during standard construction hours would be scheduled as early as possible during the evening and/or night-time periods. Respite periods would also help to alleviate ongoing high noise impacts for certain receivers.

Specific concerns were raised by the community regarding potential noise impacts in Tempe and Mascot. It is noted that the majority of works near Tempe are likely to be completed during standard construction hours, with minimal requirement for evening or night-time works.

The Tempe and Mascot communities provided suggestions for reducing construction noise, including the provision of vegetated mounds instead of noise walls to help reduce some of the noise impacts. Residents requested that vegetation be planted close to noise mounds, where possible, to help reduce the potential visual impact and support local flora and fauna.

Roads and Maritime would continue to consult with the community and relevant councils during the detailed design phase to develop the urban design and landscape plan for the project (see section 7.12). This would include confirming the appearance of noise barriers and collecting community feedback on other proposed noise mitigation measures. Potentially affected communities would be notified about the engagement process by letterbox drops and invited to participate in the development of the urban design and landscape plan. People on the contact list would also be informed of the consultation process and provided with an opportunity to input to the process.

As design progresses, the project would be refined where possible to reduce the potential operational impacts. Receivers qualifying for ‘additional noise mitigation’ once the project is built would be considered in the following order of preference:

- At-source mitigation (eg quieter road pavement surfaces)
- In-corridor mitigation (eg noise mounds and/or barriers)
- At-receiver mitigation (eg at-property treatments such as screening walls, ventilation systems, window glazing).

Noise mounds and/or barriers can provide significant noise reductions and also reduce both external and internal noise levels. Noise walls are typically most efficient when receivers are located at ground floor level. Where residual impacts remain after the use of at-source and in-corridor mitigation, or if a noise barrier is not considered feasible or reasonable, the final consideration is to use at-property mitigation.

Approach to managing other impacts

Due to the potential for high noise impacts on some hotels outside standard construction hours, location and activity specific noise and vibration impact assessments would be undertaken to confirm predicted noise impacts. The assessments would adopt the specific external noise criteria for each affected hotel (see Technical Working Paper 2) to more accurately assess the potential internal noise levels within the hotel rooms.

Other mitigation measures are provided in section 10.7.2.

Expected effectiveness

The measures provided in section 10.7.2 have been identified as an outcome of the noise and vibration assessment. The proposed mitigation measures have been developed based on best management practice, relevant standards and guidelines, and Roads and Maritime’s experience delivering major road infrastructure projects. Similar mitigation and management measures have been used on comparable large road infrastructure projects such as the F6 extension, New M5, M4-M5 Link and M4 East.

The measures provide for the management of potential noise and vibration impacts through the implementation of various strategies and plans, in addition to ongoing design development and construction planning which have as a principle, aimed to avoid and minimise risks, as well as environmental impacts as far as possible. These processes also facilitate ongoing consultation with relevant stakeholders and provide the detail required to reduce noise and vibration impacts where possible.

10.7.2 List of mitigation measures

The mitigation and management measures that would be implemented to address potential noise and vibration impacts are listed in Table 10.28. These measures are consistent with the 'standard' and 'additional mitigation measures' provided in the Construction Noise and Vibration Guideline, where appropriate.

Table 10.28 Noise and vibration mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Managing the potential for noise and vibration impacts during construction	NV1	A Construction Noise and Vibration Management Plan will be prepared as part of the CEMP and implemented during construction. The plan will detail processes, responsibilities and measures to manage noise and vibration and minimise the potential for impacts during construction, consistent with the management approach and mitigation measures in Roads and Maritime's *Construction Noise and Vibration Guideline*.	Pre-construction, construction
	NV2	Location and activity specific noise and vibration impact assessments will be undertaken prior to those works (as a minimum): ▪ With the potential to result in noise levels above 75 dBA at any receiver ▪ That need to occur outside standard construction hours and are likely to result in noise levels greater than the relevant noise management levels ▪ With the potential to exceed relevant performance criteria for vibration. The assessments will confirm predicted impacts at relevant receivers in the vicinity of the activities to assist with the selection of appropriate management measures. Monitoring will be carried out at the start of new noise and vibration intensive activities to confirm that actual levels are consistent with the predictions.	Pre-construction, construction
Potential operational noise impacts	NV3	An operational noise mitigation strategy will be developed and implemented as part of the design, including investigating the need for low noise pavements, noise barriers and at-property mitigation.	Detailed design
Potential impacts at hotels	NV4	The facades of hotels likely to be affected by construction will be assessed to confirm existing façade performance (external to internal noise transmission) in consultation with the hotel operators. Location and activity-specific noise and vibration impact assessments undertaken for works in the vicinity of hotels will adopt the results of the assessment for each affected hotel to assess potential internal noise levels within the hotel rooms more accurately (see Technical Working Paper 2).	Pre-construction, construction
Potential impacts at the Qantas Flight Training Centre	NV5	A construction strategy will be developed in consultation with Qantas to minimise potential impacts on training operations at the Qantas Flight Training Centre in its current location. It will include: ▪ Confirming appropriate internal noise criteria for sensitive areas in the facility ▪ Confirming building and simulator cabin acoustic performance ▪ External criteria for noise and vibration ▪ Working distances for noise and vibration intensive plant and activities ▪ Alternative work methods that generate less noise and vibration and minimise vibration transmission ▪ Real-time monitoring requirements.	Pre-construction, construction

Impact/issue	Ref	Mitigation measure	Timing
Construction management and scheduling	NV6	Investigate and implement alternative methods of demolition to avoid hydraulic/pneumatic hammering where high noise impacts are anticipated. Alternative methods could include shears, pulveriser or ripper attachments fitted onto the excavators.	Construction
	NV7	Noisy work and vibration intensive activities (those activities that exceed the vibration criteria) will be scheduled during standard construction hours as far as possible. Works or activities that cannot be undertaken during standard construction hours will be scheduled as early as possible during the evening and/or night-time periods. Respite measures will be implemented for noisy work and vibration intensive activities in a manner consistent with Roads and Maritime's *Construction Noise and Vibration Guideline*.	Construction
	NV8	Hoarding, or other shielding structures, will be used where receivers are impacted near fixed works areas. The barriers should be of solid construction with minimal gaps.	Construction
Management of the potential for vibration impacts during construction	NV9	Vibration generating activities will be managed to minimise the potential for impacts on structures and sensitive receivers, including maximising minimum working distances where practicable, or alternate methods to minimise vibration where minimum working distances cannot be achieved. Where alternatives cannot be implemented, vibration monitoring will be undertaken and receptors notified in advance of works. Vibration monitors will provide real-time notification of exceedances of levels approaching cosmetic damage and human comfort criteria.	Construction
Potential vibration impacts on pipelines	NV10	Prior to vibration intensive works in the vicinity of pipelines, the owners of each potentially affected pipeline will be consulted to confirm the potential for impacts from vibration and any appropriate criteria. Management protocols to protect the integrity of each affected pipeline, including monitoring requirements, will be developed in consultation with each asset owner as required, and implemented for all vibration intensive works in the vicinity of pipelines.	Pre-construction, construction
Potential impacts on buildings and structures	NV11	Building condition surveys will be completed before and after construction works where buildings or structures are within the minimum vibration working distances for cosmetic damage.	Pre-construction, construction
Potential vibration impact to heritage items	NV12	Prior to the commencement of vibration intensive works within the minimum working distances for cosmetic damage for heritage items, the potential for damage to the item will be assessed. Where there is potential for damage, alternative methods that generate less vibration will be investigated and substituted where practicable. Where residual cosmetic damage risks remain, condition surveys will be carried out and vibration monitoring with real-time notification of exceedance will occur during the activity. Site activities will be modified where practicable to avoid exceeding the cosmetic damage criteria. Any identified vibration-related damage to the items will be rectified.	Construction
Cumulative noise and vibration impacts	NV13	The likelihood of cumulative and consecutive construction noise impacts, particularly when undertaken outside standard construction hours, will be reviewed prior to construction and coordinated with other nearby projects to minimise impacts, where possible.	Pre-construction, construction
Noise impacts due to ground-based airport activities	NV14	Investigate reasonable and feasible options to reduce the propagation of noise from ground-based airport activities following removal of buildings as part of the project. This will include options to retain screening provided by existing buildings.	Detailed design

Impact/issue	Ref	Mitigation measure	Timing
Operational noise and vibration impacts of the project	NV15	Operational noise and vibration mitigation measures will be identified during detailed design. Requirements for at-property noise treatments in properties identified as 'eligible' in the noise and vibration assessment will be reviewed. The implementation of treatments will be undertaken in accordance with the *At-Receiver Noise Treatment Guideline* (Roads and Maritime, 2017b).	Detailed design
	NV16	Operational noise mitigation performance will be documented in an Operational Noise and Vibration Review conducted within 12 months of the commencement of operation. The need for additional mitigation or management measures to address identified operational performance issues and meet relevant operational noise criteria will be assessed and implemented where feasible and reasonable.	Operation

10.7.3 Managing residual impacts

Residual impacts are the impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see section 6.4 and 6.5)
- Specific measures to mitigate and manage the identified potential impacts (see section 10.7.2).

Despite the measures provided in Table 10.28, there would be some residual impacts. The urban nature of the study area means that many of the affected receivers are close to major existing roads and already subject to relatively high existing road traffic noise levels. The project would introduce new sources of construction noise and road traffic noise to some parts of the study area, mainly in the west around Tempe, while also widening and increasing traffic volumes on other existing roads, such as Qantas Drive and Joyce Drive. Standard mitigation measures during construction would aim to reduce noise levels. However, some areas may still experience noise level increases, particularly during the 'peak' activity of certain construction scenarios. The project is also predicted to result in increases in road traffic noise levels (ie greater than 2 dB) in certain areas. Some noise impacts may remain at project opening, depending on whether proposed mitigation measures are considered feasible and reasonable.

Chapter 11

Airport operations

This chapter describes the key facilities and safety requirements at Sydney Airport, identifies potential hazards and risks to aviation and the operation of the airport during construction and operation, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 3 (Airport Operations).

The relevant SEARs and MDP requirements are listed below. Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
16	**Hazards and risks**	
16.2	The EIS must outline the process for assessing the risks of the project on airport operations, including encroachment into the prescribed airspace, potential impacts to airport communication, navigation and surveillance systems, light spill and landscaping associated with the construction and operation of the project.	The assessment process is outlined in section 11.1. Potential impacts are considered in sections 11.3 and 11.4
Major development plan requirements *(in accordance with Section 91 of the Airports Act)*		
91(1)(ea)	If the development could affect flight paths at the airport – the effect that the development would be likely to have on those flight paths.	The project would not affect flight paths at Sydney Airport. The potential impacts on Sydney Airport's prescribed airspace and other aircraft operational issues are considered in sections 11.3 and 11.4

11. Airport operations

11.1 Assessment approach

Obstructions and lighting in the vicinity of an airport have the potential to create hazards to aviation and constrain the operation of the airport. The most critical areas of concern (in terms of the potential for hazards and risks) are the immediate approach and take-off areas. These potential hazards have been, and would continue to be, important considerations during the design process.

The project site is located close to Sydney Airport. Some parts of the project site are located directly within or adjacent to Sydney Airport land (Commonwealth-owned land leased by Sydney Airport Corporation). The project includes new elevated road infrastructure (such as bridges, overpasses, viaducts, abutments, ramps and lighting) and emplacement mounds close to the airport.

An assessment of the potential impacts of the project on Sydney Airport's operations (including potential hazards to aviation) was undertaken, with reference to the relevant legislation and the *National Airports Safeguarding Framework* (Department of Infrastructure, Regional Development and Cities, 2018b), 2018). An overview of the approach to the assessment is provided below, including the legislative and policy context and a summary of the assessment methodology.

This chapter focuses on the findings of this assessment in relation to the potential for hazards and risks to aviation operations. Other potential impacts on Sydney Airport land and the operation of the airport, including the potential for traffic and access, noise and vibration, air quality, contamination, water quality, flooding, heritage, land use and property, visual amenity, biodiversity and cumulative impacts, are considered in Chapters 9, 10 and 12 to 27. Other hazard and risk issues associated with the project are considered in Chapter 23 (Health, safety and hazards).

11.1.1 Legislative and policy context to the assessment

The assessment has been undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and regulations, and the Civil Aviation Act 1988 (Cth) and regulations
- *National Airports Safeguarding Framework* (Department of Infrastructure, Regional Development and Cities, 2018b)
- *Manual of Standards Part 139 – Aerodromes* (CASA, 2017)
- *Recommended Practices No. 1 – Standards for Aerodrome Bird/Wildlife Control* (International Birdstrike Committee, 2006)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

11.1.2 Methodology

Study area

The study area for the assessment was defined primarily as the project site (as described in Chapter 2 (Location and setting)) and the Sydney Airport operations area. The assessment also considered all the protected areas (ie prescribed airspace and lighting intensity zones) surrounding Sydney Airport where relevant.

Key tasks

The assessment involved:

- Undertaking a risk screening to identify hazards with the potential to affect aviation and airport operations, including issues covered by the *National Airports Safeguarding Framework* (described below)
- Assessing the potential for the project to intrude into the prescribed airspace of Sydney Airport based on review of a three dimensional model of the obstacle limitation and high intensity approach lighting surfaces (provided by Sydney Airport Corporation) and a desktop review of other publicly available information on other protected surfaces – the information on the prescribed airspace was current at the time the review was undertaken
- Assessing the potential impacts of lighting and headlight glare based on a desktop review of relevant plans and design standards
- Assessing the potential for windshear and turbulence as a result of the project (described below)
- Assessing other potential airport operational issues identified via the risk screening
- Identifying measures to manage and mitigate the identified impacts
- Preparing a report to describe the results of the assessment.

Further information on the assessment methodology is provided in section 3 of Technical Working Paper 3 (Airport Operations).

National Airports Safeguarding Framework

The *National Airports Safeguarding Framework* is a national land use planning framework that aims to:

- Improve safety outcomes by ensuring aviation safety requirements are recognised in land use planning decisions through guidelines being adopted by jurisdictions on various safety-related issues
- Improve community amenity by minimising aircraft noise-sensitive developments near airports.

The framework provides guidance on planning requirements for development with the potential to affect aviation operations. This includes building activity around airports that might penetrate an airport's operational airspace and/or affect aircraft navigational procedures.

The framework consists of nine guidelines (see Figure 11.1), with each focusing on a particular risk. Guidelines B, C, E, F, G and I are relevant to the project and were considered by the assessment.

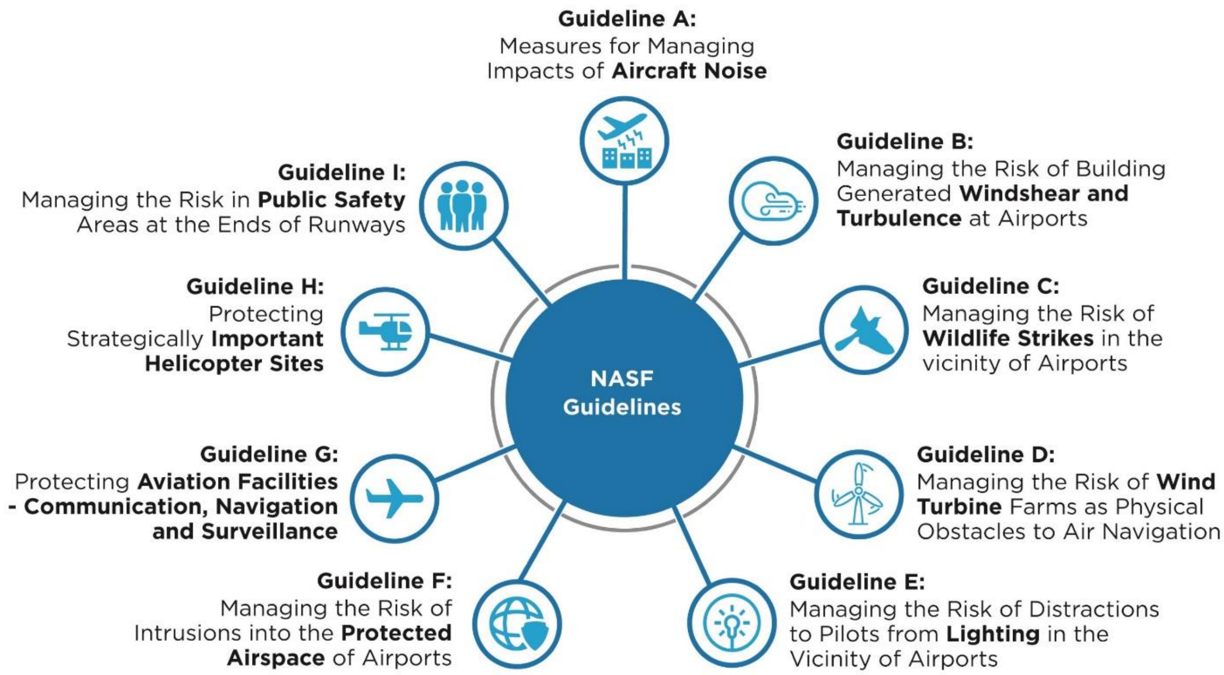


Figure 11.1 National Airports Safeguarding Framework

Windshear and turbulence

Windshear is defined as a change of horizontal wind direction and/or speed with height. Rapid changes in wind velocity encountered during the landing and take-off phases of flight can be hazardous to aircraft.

Turbulence is caused by a disruption to smooth air flow. Turbulence in the lower atmosphere is generally created by the flow of air around obstacles such as landforms or buildings. Meteorological conditions such as boundaries between different air masses can also result in turbulence.

In accordance with Guideline B of the *National Airports Safeguarding Framework*, developments proposed close to runways should be assessed for their potential to create windshear and turbulence that could affect aviation safety. Sydney Airport's windshear assessment trigger areas, prepared in accordance with Guideline B, are shown on Figure 11.2. As the project site is located within these envelopes, principally within those associated with the main north–south runway, a windshear and turbulence assessment was undertaken. This included testing a model of Sydney Airport's north–south runway approach and surrounds using a wind tunnel, and modelling a number of project scenarios (including emplacement mound options) for representative wind directions.

Further information on the windshear and turbulence assessment is provided in section 3.3 of Technical Working Paper 3.

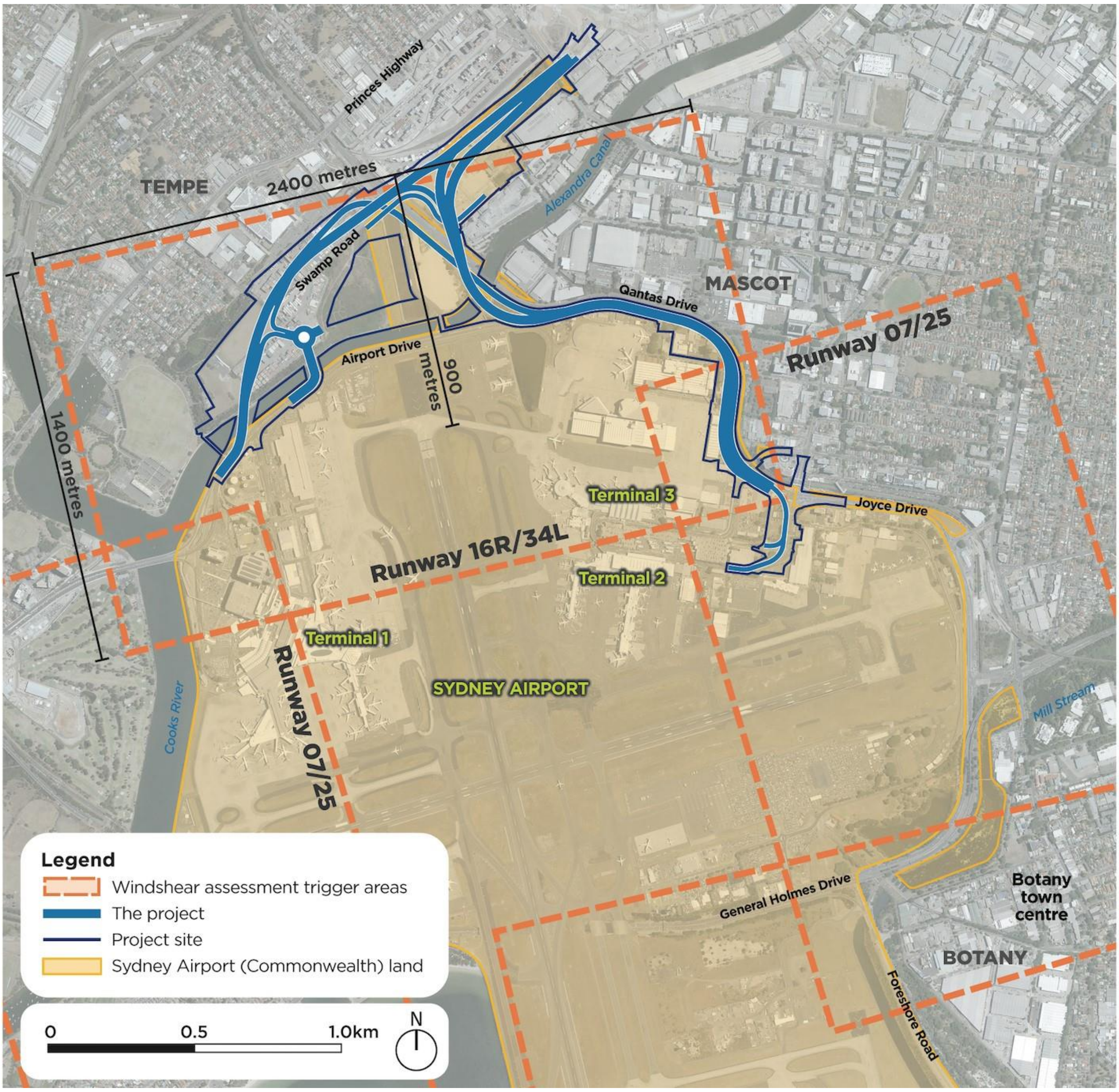


Figure 11.2 Windshear assessment trigger areas for runways near project

11.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation of the project as a whole, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Risks related to aviation with an assessed overall rating of medium or above, identified by the environmental risk assessment, included:

- Temporary or permanent intrusions into Sydney Airport's prescribed airspace
- Light spill during construction and operation, including as a result of construction lighting, new lighting on roads, and headlight glare from vehicles using bridges and overpasses
- Interference with navigational aids
- Accidental disruptions to utilities and services, which may affect airport lighting or power to navigational aids

- Windshear and turbulence caused by new infrastructure or landforms close to Sydney Airport.

The assessment included consideration of these potential risks, as well as other potential risks identified as part of the assessment. These included:

- Wildlife attraction
- Smoke or dust reducing visibility
- Flooding
- Disruption to access to Sydney Airport terminals or other airport facilities (such as freight handling) during construction (this potential impact was considered in detail by Technical Working Paper 1 (Transport, Traffic and Access) and the results of the assessment are summarised in Chapter 9 (Traffic, transport and access))
- Interference with communications or navigation equipment
- Security of Sydney Airport's airside area.

11.2 Existing environment and safety requirements at Sydney Airport

11.2.1 Sydney Airport facilities

A summary of the facilities at Sydney Airport is provided below (SACL, 2019a). These include the major infrastructure elements required to safely operate a modern and efficient international airport. Key facilities are shown on Figure 11.3.

Movement areas

The majority of the Sydney Airport site (about 558 hectares out of a total of 907 hectares) is occupied by the aircraft movement areas, described below.

Runways and safety equipment

Sydney Airport has three runways:

- Main north–south runway (Runway 16R/34L), which is located closest to the project site
- Parallel north–south runway (Runway 16L/34R)
- East–west runway (Runway 07/25).

The runways and the airport include a variety of features to assist with safe take-off and landing during low visibility conditions:

- High intensity approach lighting systems (HIAL) at both north–south runways – the northern end of the HIAL for the main north–south runway is located within and adjacent to the project site north of Alexandra Canal
- Precision approach path indicator systems to provide visual approach slope guidance
- Transmissometer units to provide accurate visibility assessments
- Instrument landing systems to permit aircraft to conduct precision approaches in poor weather
- Stop bars at runway ends
- Runway end safety areas – areas surrounding the end of runways designed to facilitate the deceleration of an aircraft in the event of an overrun.

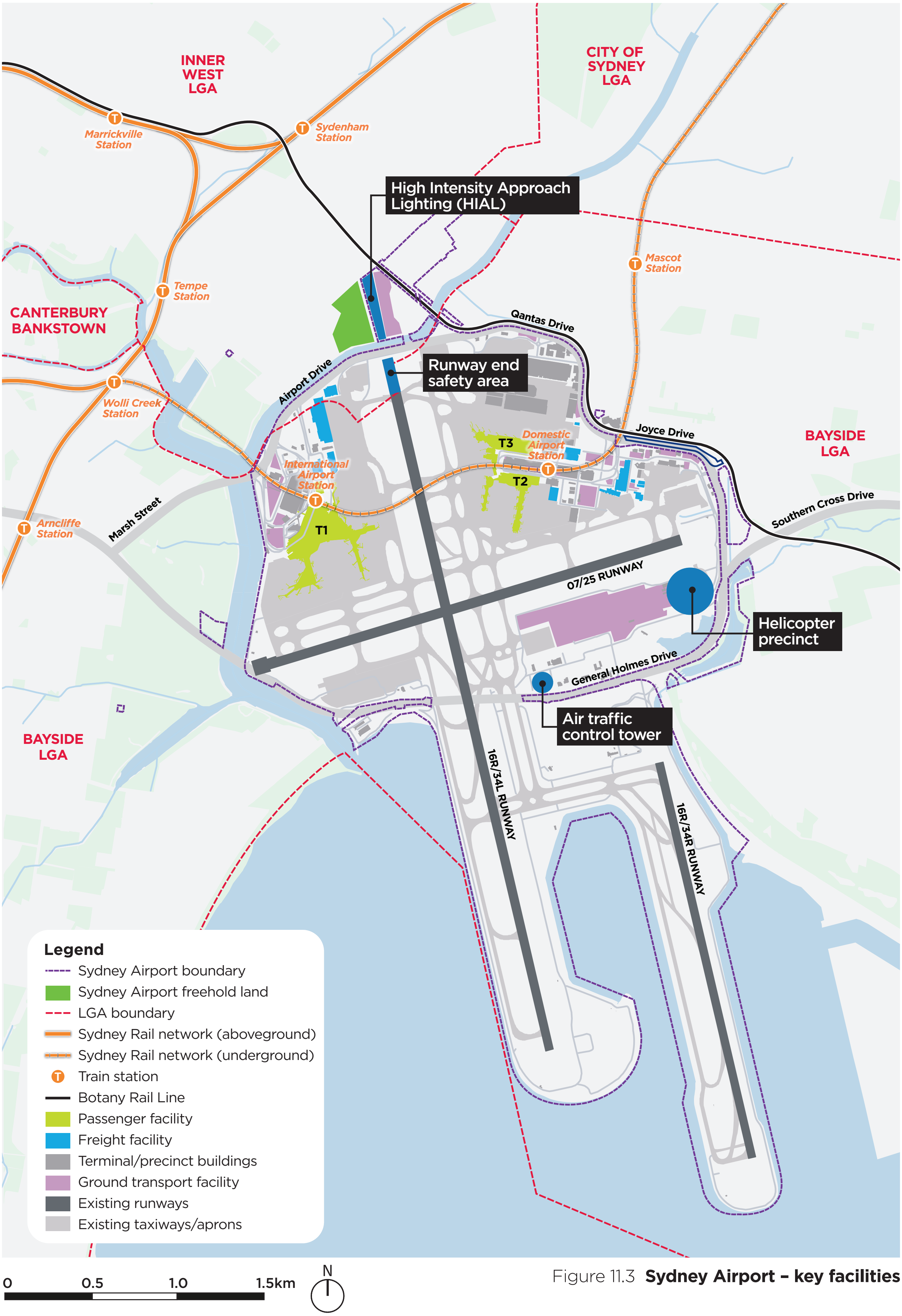


Figure 11.3 **Sydney Airport – key facilities**

Other movement areas

Other movement areas include:

- Taxiways to facilitate the efficient movement of aircraft between the runways and terminal areas
- Apron areas and stands to facilitate aircraft parking and support activities associated with the servicing of aircraft, such as baggage, freight, refuelling and flight catering
- Sydney Airport Jet Base
- Emergency facilities
- General aviation parking
- Helicopter precinct.

Terminals

Sydney Airport has three passenger terminals:

- Terminal 1 – Sydney Airport's international terminal
- Terminal 2 – one of Sydney Airport's two domestic terminals, used by a number of domestic and regional airlines including Virgin Australia, Jetstar and Rex
- Terminal 3 – Qantas' domestic terminal.

Terminal 1 is located in the North West Sector of Sydney Airport, close to the south-western end of the project site. Terminals 2/3 are located adjacent to each other in Sydney Airport's North East Sector, close to the eastern end of the project site (shown on Figure 11.3). Further information on the airport's land use sectors (as defined by the Sydney Airport Master Plan) is provided in Chapter 19 (Land use and property).

Existing road access arrangements to the terminals are described in Chapter 9.

Freight facilities

Air freight is transported in the cargo hold of passenger aircraft and in dedicated freight aircraft. Air freight facilities, which are operated by various service providers, are located on land leased from Sydney Airport Corporation. These facilities occupy a total area of about 13.7 hectares. International freight facilities, including livestock handling facilities, are located close to Terminal 1 (off Link Road) adjacent to the project site. Domestic freight facilities are located near Terminals 2/3.

Aviation support facilities

Aviation support facilities located on Sydney Airport land include fuelling facilities, aircraft maintenance facilities, ground support equipment and flight catering facilities.

Access facilities

A description of the traffic and transport environment surrounding Sydney Airport, including access arrangements and key roads, is provided in section 9.2.

Access facilities within the airport site include internal public roadways, kerbside transfer, car parking, cycling and pedestrian facilities. A number of recent ground transport improvements have been undertaken by Sydney Airport Corporation to facilitate improved access to the airport precinct (see section 5.1.4).

Communications, navigation aids and surveillance systems

The communications, navigation and surveillance infrastructure and facilities at Sydney Airport enable pilot navigation, instrument approach procedures, communication between pilots and air traffic control and monitoring of aircraft locations by air traffic control. Information regarding the location of these facilities is collated by Airservices Australia and the Australian Department of Defence and is not released to the general public.

Airport security

Sydney Airport's airside (operational) areas are surrounded by security fencing, with access to this area available at designated access gates for approved staff. Within and close to the project site, airside security fencing is located along the southern edge of Airport Drive and Qantas Drive (west of Lancastrian Drive). The Jet Base is generally located airside with the exception of a few building entrances located outside the airside area. Access to the airside area within the project site is provided via a security checkpoint located at Lancastrian Road.

Jet Base and Qantas Flight Training Centre

The Jet Base provides facilities for the maintenance and servicing of aircraft, including engineering facilities, layover parking and aviation support. It is located on an area of about 30 hectares, which is adjacent to Qantas Drive on land leased from Sydney Airport Corporation. The Qantas Flight Training Centre is located on the same site, partially on land within the project site.

The flight training centre supports the training requirements of Qantas pilots and flight crew. It includes facilities such as flight simulators, aircraft cabin mock-ups, ditching pools, and other training rooms and facilities.

11.2.2 Sydney Airport's prescribed airspace

The airspace around Sydney Airport is subject to controls (under the Airports Act and the Airports (Protection of Airspace) Regulations 1996 (Cth)) to restrict structures and/or other obstructions and obstacles from affecting the safe operation of aircraft. This protected airspace is formally known as the 'prescribed airspace'.

The prescribed airspace is defined by section 181(1) of the Airports Act as '…an airspace specified in, or ascertained in accordance with, the regulations, where it is in the interests of the safety, efficiency or regularity of existing or future air transport operations into or out of an airport for the airspace to be protected under this Part'.

Clause 6(1) of the Airports (Protection of Airspace) Regulations provides that the prescribed airspace consists of:

(a) the airspace above any part of either an OLS or a PANS-OPS surface for the airport; and

(b) airspace declared in a declaration, under regulation 5, relating to the airport.

The prescribed airspace for Sydney Airport was declared, pursuant to the Airports (Protection of Airspace) Regulations, on 20 March 2015. It consists of:

- The OLS, which defines the lower limits of an airport's airspace, which should be kept free of obstacles during the initial and final stages of flight or manoeuvring
- The Procedures for Navigational Services – Aircraft Operations (PANS-OPS), which protects aircraft flying into and out of the airport when the flight is guided solely by instruments in conditions of poor visibility (generally situated above the OLS)
- High intensity approach lighting protected surfaces
- Navigation aids protected surfaces
- Radar terrain clearance chart surfaces
- Combined radar departure assessment surfaces
- Precision approach path indicator system protection surfaces.

These surfaces are shown on Sydney Airport's airspace protection charts.

The critical protected surface in terms of the project is the OLS, which extends for a distance of about 15 kilometres from the ends of Sydney Airport's runways. The OLS in the vicinity of the project is shown on Figure 11.4.

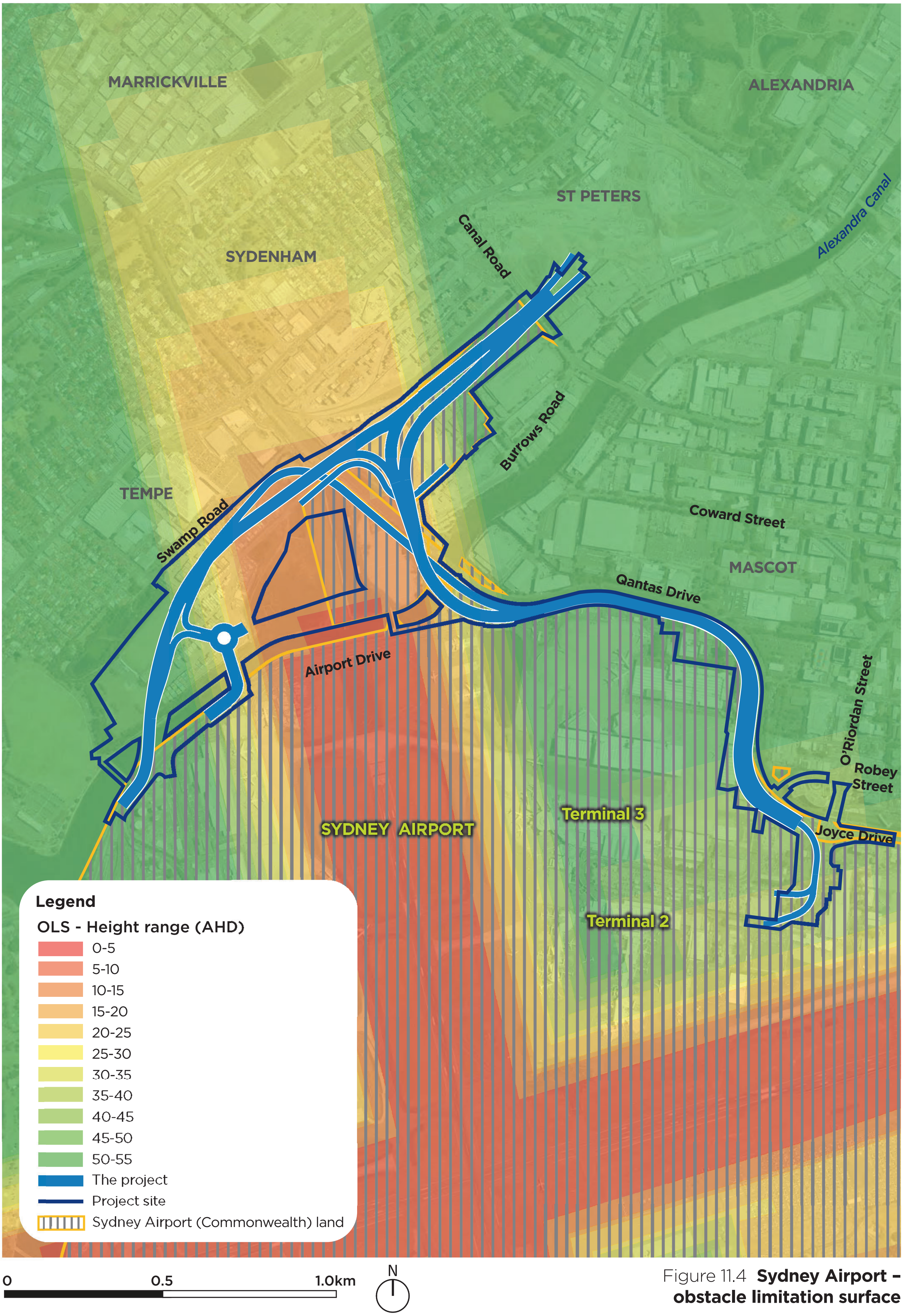


Figure 11.4 **Sydney Airport – obstacle limitation surface**

Guideline G of the *National Airports Safeguarding Framework* indicates that only specified government agencies have access to information on the location of communications, navigation aids and surveillance facilities. Where a proposed development has the potential to impact on these facilities, information about the development needs to be referred to Airservices Australia to enable the potential impacts to be assessed and appropriate mitigation measures developed. Airservices Australia will also assess the cumulative impacts of a proposed development with existing obstacles, and will provide technical advice regarding appropriate mitigation.

11.2.3 Restricted lighting zones

Lights in the vicinity of an airport can confuse or distract pilots, depending on their colour, location, direction and/or or intensity of emission. Under the Civil Aviation Regulations 1988 (Cth), Civil Aviation Safety Authority (CASA) has the authority to control ground lights where they have the potential to create a safety hazard. CASA has established guidelines (in the Manual of Standards) on the location and permitted intensities of ground lighting within a six kilometre radius of an airport. External advertising, sports field floodlighting and street lighting are some of the more likely lighting sources requiring consideration in the vicinity of Sydney Airport and the project site.

The intensity of external lighting and reflected sunlight (as well as smoke, dust or particulate matter) may be considered controlled activities under the Airports (Protection of Airspace) Regulations.

Sydney Airport's restricted lighting zones, based on CASA's requirements, are shown on Figure 11.5. These zones reflect the degree of interference that ground lights can cause as a pilot approaches landing, and specify the maximum permitted intensity of lights. The lighting intensity zones shown in Figure 11.5 are based on varying levels of intensity measured in candela (cd) units. One candela is roughly the equivalent to one common wax candle.

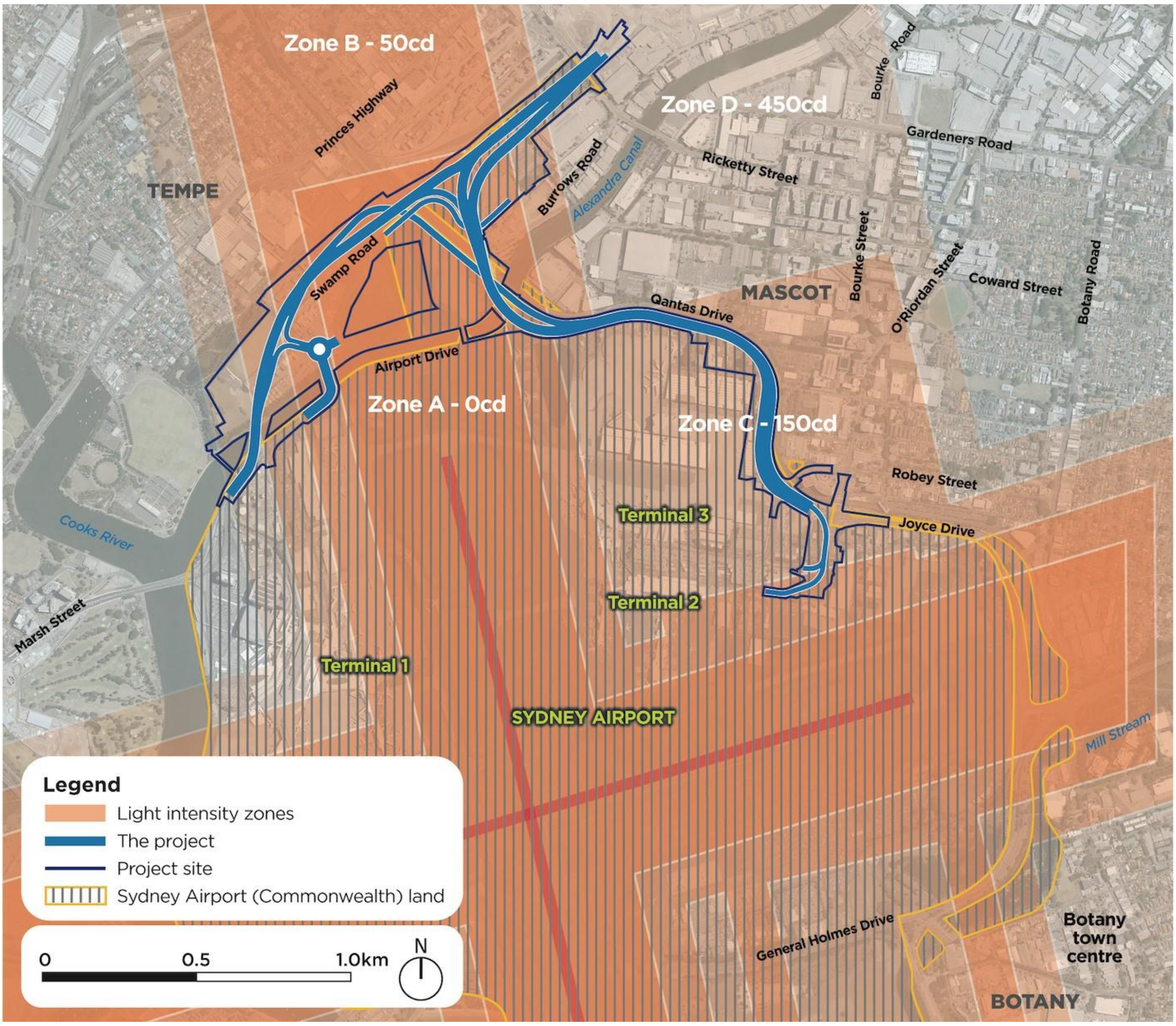


Figure 11.5 Sydney Airport – lighting intensity zones

11.2.4 Public safety areas

Guideline I of the *National Airports Safeguarding Framework* states that the way land use is managed beyond airport boundaries, specifically at runway ends, can contribute to mitigating the risk of on-ground fatalities due to aircraft incidents.

The guideline advises that the public safety areas relate to the statistical chance of an accident occurring at a particular location. In general, areas close to the final approach have a higher risk of an aviation incident occurring, and this risk reduces further from the runway, statistical analysis can be used to model the likelihood of a fatal accident occurring at a set location over a one-year period. Development within the public safety area is discouraged as it increases the risk of fatalities in the event of an aircraft accident occurring.

The public safety area at Sydney Airport in the vicinity of the project is shown on Figure 11.6. Part of the project would be located in this area. Guideline I includes considerations for transport infrastructure in public safety areas. It notes that particular sections of roads are only used by individuals for short periods of time; however, at any one point in time there may be a large number of people in the area. The density of occupation throughout a day could therefore be similar to a residential development. As such, the average density of people should be assessed for exposure to the risk. Calculations can therefore be used to predict the average density of people over a one-year period. Inputs would include numbers of vehicles using the road, average speeds, and average occupancy.

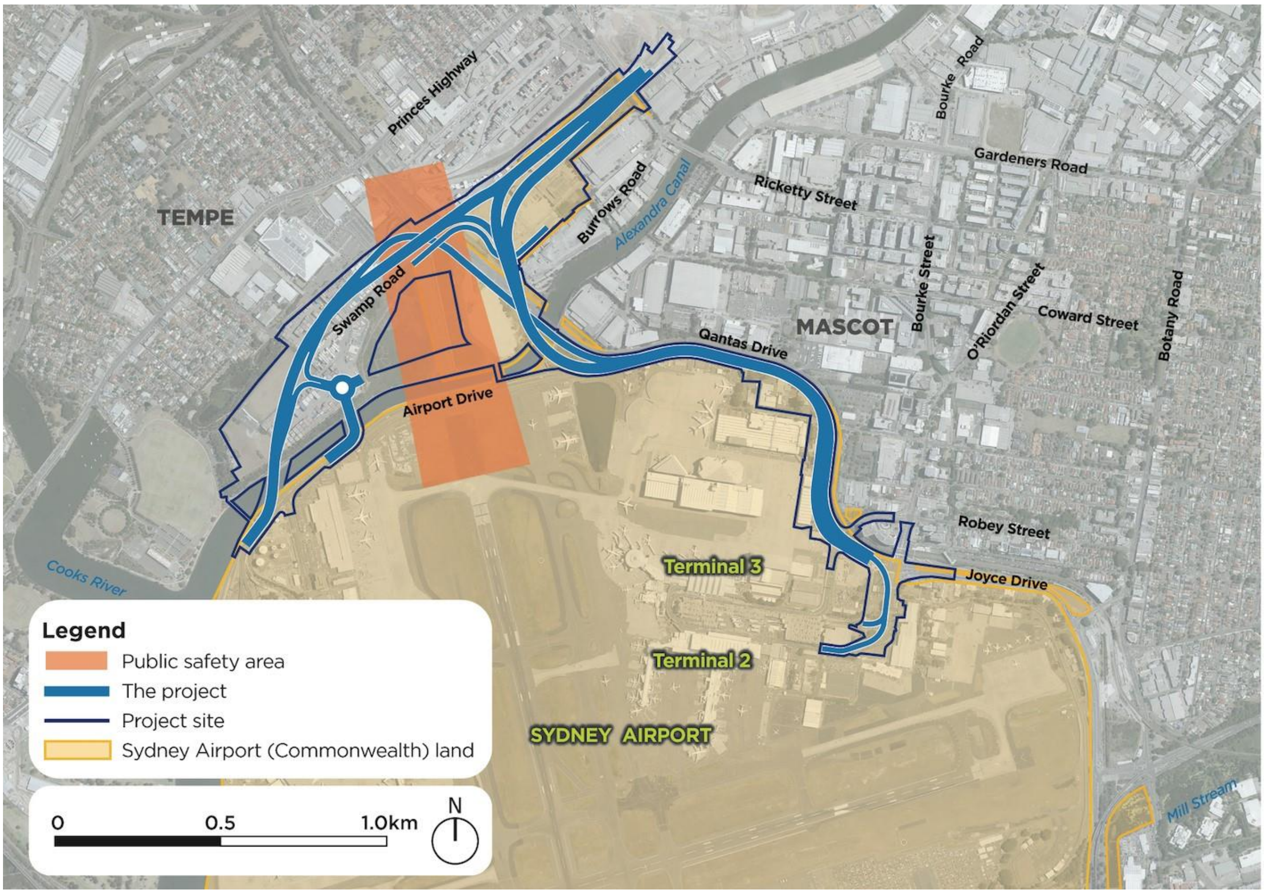


Figure 11.6 Public safety area for Runway 16R/34L at Sydney Airport

11.2.5 Wildlife attraction

The presence of wildlife (including birds and other animals such as flying foxes or bats) on or in the immediate vicinity of an airport site can create an aviation safety hazard. Wildlife strike can occur as a collision between a bird or other animal and an aircraft in flight or during take-off or landing.

Sydney Airport Corporation monitors and controls the presence of birds and other wildlife on or in the vicinity of the airport in accordance with CASA regulations. Sydney Airport's Wildlife Management Plan describes the practices and procedures for managing wildlife hazards caused by the presence of birds or animals on or near the airport.

11.3 Assessment of construction impacts

11.3.1 Impacts on Sydney Airport's prescribed airspace

The potential for temporary intrusions of the protected surfaces that form Sydney Airport's prescribed airspace are summarised in Table 11.1. Publicly available information has been used to undertake this assessment as far as possible. However, the potential impacts on some of these surfaces need to be assessed in detail by Airservices Australia (see section 11.2.2).

Table 11.1 Potential impacts on Sydney Airport's prescribed airspace during construction

Protected surface	Potential for intrusions?	Comment
OLS	Yes	Large plant and equipment (such as cranes) would likely intrude into the OLS. Further information is provided below the table.
PANS-OPS	No	There would be no temporary intrusions of this surface as the PANS-OPS lies above the OLS.
HIAL	Yes	The project site is located on land that is currently occupied by part of the HIAL. Sydney Airport Corporation would undertake the relocation of the HIAL prior to construction. This work would be undertaken in accordance with a separate approval process. There is the potential for temporary intrusions into the HIAL light plane as a result of the movement of tall vehicles or equipment. Any intrusions into the light plane would be discussed with Sydney Airport Corporation and approvals obtained as required. Where possible, any intrusions into the light plane would occur outside Sydney Airport's operating hours.
Radar terrain clearance chart surfaces	No	The radar terrain clearance chart shows the prescribed surface at a level of 152 metres. This is significantly higher than any construction activities.
Navigation aids protected surfaces Combined radar departure assessment surfaces Precision approach path indicator system protection surfaces	To be confirmed by Airservices Australia	Detailed review and assessment of the potential for impacts would be undertaken during detailed design and construction planning by Airservices Australia.

Impacts on the OLS

Construction activities involving the use of tall plant and equipment (such as piling rigs used to construct piles and cranes used to lift bridge segments) would likely result in temporary intrusions into the OLS. Where possible, construction would be undertaken in a manner that avoids such intrusions from occurring; however, some intrusions would be unavoidable. The locations of activities with the potential to intrude into the OLS are shown on Figure 8.10. It is proposed to undertake such works during Sydney Airport's curfew (ie between 11pm and 6am), staged over a number of nights. While some flights still occur during the curfew hours, there are significantly fewer flights. In addition, during these hours, flights typically arrive from and depart to the south to minimise impacts on residential areas. This arrangement means that the project is unlikely to impact aviation operations during the curfew hours.

Works with the potential to intrude into the OLS would be controlled activities for the purposes of the Airports Act (see Chapter 3 (Statutory context and approval requirements)). These works would need to occur in accordance with the conditions of a controlled activity approval to be issued by Sydney Airport Corporation for short term works (less than three months) or Department of Infrastructure, Transport, Cities and Regional Development for long term works (more than three months).

11.3.2 Impacts on communications, navigation and surveillance systems and associated utility networks

Construction may affect communications, navigation and surveillance equipment located on Sydney Airport land, due to impacts on utilities (ie power to systems) or infringements of the Sydney Airport Navigational Aids Protection Surfaces. As the location of this infrastructure is not publicly available, assessment by Airservices Australia may be required upon referral by an authorised party. This would apply to potentially affected navigation aids, radar departure assessment surfaces and the precision approach path indicator system. Roads and Maritime has undertaken early consultation with Airservices Australia and provided a briefing on this issue. Any requirements for protection of communications, navigation and surveillance equipment during construction will be confirmed by Airservices Australia.

Utility works are described in Chapter 8 (Construction). Where there is a need to re-locate utilities (such as electricity supply lines), there may be the potential for some temporary interruptions while supply is switched over. Consultation with Sydney Airport Corporation would be undertaken prior to any works with the potential to affect utilities servicing the airport's communication, navigation and radar systems. Procedures would be established as part of this consultation to ensure that any disruptions are minimised. It is noted that these systems have multiple backup systems in place currently to ensure that equipment remains operational during interruptions to supply. Therefore any disruptions are unlikely to cause interruptions to supply due to these existing systems.

As with any project, there is also the potential for unplanned/accidental interruptions to occur. The existing backup systems would ensure that there are minimal impacts on Sydney Airport's communication, navigation and radar systems as a result of unplanned/accidental utility interruption.

11.3.3 Wildlife attraction

Temporary site drainage/stormwater management infrastructure, including sedimentation ponds, would be installed during construction. In addition, the project's operational flood mitigation basin would be constructed early so that it can also be used during construction for flood mitigation.

Such infrastructure has the potential to attract wildlife, particularly birds. All sedimentation basins and other temporary project infrastructure with the potential to store water for a prolonged period would be designed and managed in accordance with Sydney Airport's Wildlife Management Plan to minimise the risk of attracting wildlife. Measures include ensuring that water does not remain on site for more than five days or placing nets over waterbodies to deter birds from using them.

Another risk relates to excavation and emplacement activities at the former Tempe landfill site. The exposure of waste material, and any odour generated by these works, may have the potential to attract birds. Notwithstanding that the waste is not expected to be of a type likely to attract birds, measures would be implemented during construction to manage waste in accordance with relevant waste management guidelines to minimise this potential risk. Further information about the management of waste during construction is provided in Chapter 24 (Waste management).

11.3.4 Pilot lighting distraction/light spill

Construction would involve some works during the night, including those with the potential to intrude into the OLS (see section 11.3.1). Parts of the project site are located within the restricted lighting zones defined by Sydney Airport's Restricted Lighting Plan. This includes works in zone A (see Figure 11.5), which covers the area to the north of the main north–south runway and is subject to the highest restrictions (ie a lighting intensity of zero candelas at three degrees below the horizontal).

Construction lighting may still be used, provided it does not exceed the specified intensity at an angle of three degrees below the horizontal. Lights would be selected and located in accordance with *National Airports Safeguarding Framework Guideline E: Managing the Risk of Distractions to Pilots from Lighting in the Vicinity of Airports.*

11.3.5 Other potential issues

Impacts to the high intensity approach lighting

The project site would require an area of land currently occupied by a number of HIAL masts for the main north–south runway.

Adjustments to the HIAL and the roadway design have been co-ordinated with Sydney Airport Corporation to ensure regulatory requirements are able to be maintained. The HIAL would be adjusted by Sydney Airport Corporation separately from the project prior to construction commencing in this area. Ongoing consultation regarding the adjustment of the HIAL would occur as part of the Airport Precinct Infrastructure Coordination Group. Any intrusions into the modified HIAL light plane would be discussed with Sydney Airport Corporation with all relevant approvals to be obtained.

Airport security

Some works along Airport Drive and Qantas Drive would need to be undertaken inside the existing secure fenced area (airside). The fence line would be relocated by Sydney Airport Corporation prior to works commencing. Sydney Airport Corporation would also manage any potential security concerns in accordance with current procedures. Consultation would be undertaken with Sydney Airport Corporation as part of the Airport Precinct Infrastructure Coordination Group to ensure the adjustment of the fence is undertaken in an appropriate manner.

Visibility

Dust generation

Construction would include ground disturbance, earthworks and other activities with the potential to generate dust. Uncontrolled dust generation has the potential to create visibility and safety issues for aviation operations. An air quality assessment, which included consideration of the potential dust impacts, was undertaken as an input to the impact assessment. This included an assessment of the potential for dust emissions to exceed regulatory limits, including those in the Airports (Environment Protection) Regulations 1997. The results of the assessment are summarised in Chapter 12 (Air quality).

Best practice air quality mitigation and management measures would be implemented during construction to minimise the potential for dust generation. These measures are standard on major infrastructure projects and are expected to be effective in reducing dust to levels that would not affect aviation safety. In the event of adverse flight crew comments with respect to dust and visibility, immediate action would be required to mitigate the issue.

Further information, including mitigation and management measures to minimise dust generation, are provided in Chapter 12.

Smoke and vehicle emissions

Smoke as a result of fires can also pose a risk to aviation safety. This is most likely to be a risk in the former Tempe landfill and Tempe Lands. These areas include vegetation and grassed areas, as well as the potential for landfill gases. As a result, accidental ignition is possible.

The risk of fire would be managed in accordance with the hot works procedures developed for the project. Any fires during construction would be managed in accordance with emergency response protocols.

Emissions from construction equipment and other vehicles would not be substantial enough to pose a hazard to aviation operations.

Sight line from the air traffic control tower

Construction would not impact the sight line from the tower to any area of the airport.

Flooding

A detailed assessment of the potential for flooding was undertaken by Technical Working Paper 6 (Flooding). The assessment confirms that any changes to existing flooding conditions during construction would either be minor or negligible. As a result, no risks to the operation of Sydney Airport are predicted during construction. Further information is provided in Chapter 14 (Flooding).

Aircraft movement areas

Some buildings within the Jet Base would be removed as part of the project. These include administration buildings and Building 167, which were formerly used for air freight but are now vacant (further information is provided in Chapter 8 and 19). However, no aircraft movement areas would be impacted by the project.

11.4 Assessment of operational impacts

11.4.1 Impacts on Sydney Airport's prescribed airspace

The potential for permanent intrusions of the protected surfaces that form part of Sydney Airport's prescribed airspace are summarised in Table 11.2.

Table 11.2 Potential impacts on Sydney Airport's prescribed airspace during operation

Protected surface	Potential for intrusions?	Comment
OLS	No	The project has been, and would continue to be, designed to ensure all operational facilities are located below the OLS. The existing design of the project (including lighting) would not result in any intrusions into the prescribed airspace. This includes no intrusions from the tallest vehicle (a 4.6 metre tall B-double truck) likely to use the new roadways.
PANS-OPS	No	The project has been, and would continue to be, designed to ensure all operational facilities are located below the PANS-OPS.
HIAL	No	The HIAL would be modified by Sydney Airport Corporation prior to construction. This work would be carried out separately from the project. This adjustment would be undertaken to ensure that the project's operational features and the movement of vehicles would not intrude into the light plane.
Radar terrain clearance chart surfaces	No	The radar terrain clearance chart shows the prescribed surface at a level of 152 metres. This is significantly higher than any permanent infrastructure.
Navigation aids protected surfaces Combined radar departure assessment surfaces Precision approach path indicator system protection surfaces	To be confirmed by Airservices Australia	Detailed review and assessment of the potential for impacts would be undertaken during detailed design and construction planning by Airservices Australia.

11.4.2 Windshear and turbulence

Windshear

In relation to windshear, Guideline B of the *National Airports Safeguarding Framework* requires that the variation in mean wind speed along a flight path due to wind disturbing structures must remain below:

- Seven knots (3.6 metres per second) parallel to the runway centreline (known as the 'seven knot along-wind' windshear criterion)
- Six knots (3.1 metres per second) perpendicular to the runway centreline (known as the 'six knot across-wind' windshear criterion).

The results of the windshear assessment indicated that the six knot across-wind criterion is the governing criterion. The lowest gust wind speeds required to exceed the criterion with the project present were between 44 and 47 knots (depending on the emplacement mound option selected).

The modelling indicated that wind speeds required to exceed the six knot across-wind criterion would also be well above the normal operating and discretionary limits for operating the main north–south runway at Sydney Airport (ie the 25 knot limit applied at Sydney Airport). In such winds, the east–west runway is likely to be used to land aircraft. As a result, the project is not expected to result in any windshear issues that would cause a hazard to landing aircraft.

Turbulence

The *National Airports Safeguarding Framework* (Guideline B) criterion for turbulence is that the standard deviation of wind velocity along a flight path must remain below four knots (2.1 metres per second). The results of modelling showed that the gust wind speeds required to exceed the turbulence criterion were generally significantly lower than those required to exceed the windshear criteria (described above).

The wind speeds required to exceed the turbulence criterion at all measured heights and for all tested wind directions were in excess of the standard 20 knot cross-wind operational limit wind speed.

At some individual measurement points, the wind speeds required to exceed the turbulence criteria were less than the local discretionary 25 knot cross-wind operational limit wind speed. The lowest wind speed required to exceed the turbulence criterion was 24 knots. It is noted however that wind tunnel testing of the existing situation (ie without the project), also showed wind speeds required to exceed the turbulence criteria that were below the 25 knot cross-wind operational limit wind speed. The differences in gust wind speeds required to exceed the turbulence criterion with project and existing situation conditions are not considered to be substantial.

The impact of the project on wind conditions on the approach to the north–south runway is considered to be minimal, based on the wind directions tested in the initial windshear and turbulence assessment.

The road infrastructure and landforms, including the emplacement mound options, were developed as part of the concept design and indicative construction methodology for the project. The road infrastructure and final landforms (including the mounds) would be reviewed and refined during detailed design to:

- Address aviation matters according to the ‘as low as reasonably practicable’ principle
- Minimise the volume of material excavated from the former Tempe landfill
- Avoid disturbance outside the project boundary
- Enable compatible uses for remaining land within the project area.

To achieve the above requirements, alternative mound locations, heights and shapes would be considered. With respect to aviation, any revised mound options would be assessed in relevant wind directions, in accordance with the *National Airports Safeguarding Framework* (Guideline B), to identify an optimal mound configuration. The optimisation process would address Sydney Airport operational requirements, and would occur in consultation with Sydney Airport Corporation, aviation stakeholders, and Australian, NSW and local government agencies.

11.4.3 Impacts on communication, navigation and radar systems

As the location of this infrastructure is not publicly available, assessment by Airservices Australia may be required upon referral by an authorised party. This assessment would be undertaken as part of detailed design with the assessment to be undertaken by Airservices Australia. Any requirements for protection of communications, navigation and surveillance equipment during operation will be confirmed by Airservices Australia.

This would apply to potentially affected navigation aids, radar departure assessment surfaces and the precision approach path indicator system.

Roads and Maritime has undertaken early consultation with Airservices Australia and provided a briefing on this issue.

11.4.4 Landscaping and wildlife attraction

The project's operational infrastructure would include a flood mitigation basin on the western side of Alexandra Canal. This basin would be designed to remain dry, except for periods immediately after rainfall and for less than five days. As a result, it is not expected to attract wildlife such that there would be an increased aviation hazard. The basin would continue to be designed to minimise the potential for water ponding and wildlife attraction.

The project would also include landscaping in appropriate locations, including the former Tempe landfill. The vegetation species, locations and design of landscaping would be defined in the urban design and landscape plan for the project, which would be prepared in consultation with key stakeholders, including Sydney Airport Corporation. The plan would include consideration of relevant requirements and species lists under Sydney Airport's Wildlife Management Plan and other relevant guidelines, including the *National Airports Safeguarding Framework* (Guideline C) and *Recommended Practices No. 1 – Standards for Aerodrome Bird/Wildlife Control* (International Birdstrike Committee, 2006). Landscaping would be designed to minimise the potential to attract wildlife at levels likely to pose a hazard to aviation.

11.4.5 Pilot lighting distraction/light spill

Vehicle headlights

As vehicles travel along a road near an airport, there is the potential that headlights can shine upwards towards incoming aircraft. Headlights can also cause dazzling and distraction of pilots if the glare is excessive. Headlights that shine upwards in the vicinity of a HIAL can cause confusion for approaching pilots.

The assessment identified that there would be a risk of headlight glare at the following locations:

- On the Qantas Drive bridge for northbound vehicles
- St Peters interchange connection in the vicinity of the southern underpass for westbound vehicles
- Northern lands access road in the vicinity of the road for westbound vehicles.

The project includes headlight glare shields on sections of Qantas Drive bridge to avoid the potential for safety issues associated with headlight glare.

The other locations do not align with the HIAL or runway. As a result, the risks associated with glare are expected to be minimal. The need for headlight glare screening would continue to be reviewed during detailed design to ensure that headlight glare is appropriately managed as required. With the ongoing consideration of glare and the implementation of appropriate mitigation, risks associated with headlight glare are considered to be minimal.

Street lights

Glare from street lights generally poses a low risk to aviation safety. Upwards light spill from street lights is controlled by Australian/New Zealand Standard AS/NZS *1158.1.1:2005 Lighting for roads and public spaces Part 1.1: Vehicular traffic (Category V) lighting – Performance and design requirements*. Adherence to this design standard would be adequate to minimise pilot distraction.

11.4.6 Other potential issues

Obstruction of the high intensity approach lighting

As noted in section 11.3.5, Sydney Airport Corporation would adjust the HIAL prior to construction. These adjustments would ensure that there are no permanent obstructions of the lighting as a result of the project's operational features.

Public safety areas

It is understood that there is no NSW legislation relevant to permissible off-airport land uses with respect to aircraft crash risk. However, Guideline I of the *National Airports Safeguarding Framework* proposes that transport infrastructure be assessed in terms of the average density of people that may be exposed to risk due to an aviation incident.

Clause 39 of NASF Guideline I refers to the risk of a person remaining in the same location for a period of a year being killed as a result of an aircraft accident around an airport. Comparisons between vehicles on a road and a person in a residence (which is an incompatible land use identified in Guideline I) can be estimated based on traffic volumes, average speeds and the surface area of the road within the public safety area.

As outlined in Clause 49 of NASF, a preliminary assessment has estimated the density of occupation (average hours/year/square metre) that vehicles using the Sydney Gateway road project would be present within the public safety area and compared that with a person present in a residential dwelling within the same area. On average, cars would be present for about 13 hours per year per square metre compared to a resident being present for about 40 hours per year per square metre. This indicates that a person in a vehicle would be at less risk in the public safety area than a person in a dwelling (an incompatible land use identified in NASG Guideline I).Further work would be undertaken during detailed design to refine this calculation. An 'as low as reasonably practicable' (ALARP) public risk assessment would also be undertaken to determine the risks associated with operating the project within the public safety area.

Sight line from the air traffic control tower

The project would not affect the sight line from the tower to any area of the airport.

Flooding risk

Flood modelling undertaken in Technical Working Paper 6 (Flooding) and summarised in Chapter 14 (Flooding) found that under a range of storm events, the potential impact of flooding on operational areas of Sydney Airport (eg to the south of Airport Drive and Qantas Drive) would generally remain the same.

Further information is provided in Chapter 14.

11.4.7 Consistency with the Sydney Airport Master Plan

Section 16 of the *Sydney Airport Master Plan 2039* (SACL, 2019a) (the Master Plan) provides strategies and requirements relevant to safeguarding at Sydney Airport. It recognises that development near the airport can affect operations at the airport. The plan recognises the *National Airports Safeguarding Framework* and includes requirements consistent with the framework and the Manual of Standards.

The design of the project has been undertaken in accordance with the *National Airports Safeguarding Framework*, the Manual of Standards and other relevant legislation and standards, and has taken into account Sydney Airport Corporation's requirements.

Consistency with the relevant guidelines of the *National Airports Safeguarding Framework* is addressed in the following sections of this chapter:

- Guideline B: Windshear and Turbulence (section 11.4.2)
- Guideline C: Wildlife Strikes (sections 11.3.3 and 11.4.4)

- Guideline E: Lighting (sections 11.3.4 and 11.4.5)
- Guideline F: Protected Airspace (sections 11.3.1 and 11.4.1)
- Guideline G: Aviation Facilities – Communication, Navigation and Surveillance (sections 11.3.2 and 11.4.3)
- Guideline I: Public Safety (sections 11.3.5 and 11.4.6).

The project is therefore considered consistent with the Master Plan.

11.5 Cumulative impacts

11.5.1 Construction

Similar to the Sydney Gateway road project, construction of the Botany Rail Duplication project also has the potential to result in intrusions of the prescribed airspace associated with construction of the proposed new rail bridges. This would be managed for both projects in accordance with required procedures under the Airports Act and the Airports (Protection of Airspace) Regulations 1996. Controlled activity approvals would be obtained as required, and works would be undertaken in accordance with the conditions of these approvals. As a result, no potential cumulative impacts are anticipated.

The Botany Rail Duplication project would also increase the amount of construction lighting in the study area. No cumulative impacts are anticipated assuming that construction lighting located within the restricted lighted zones defined by Sydney Airport's Restricted Lighting Plan would be managed in accordance with *National Airports Safeguarding Framework Guideline E: Managing the Risk of Distractions to Pilots from Lighting in the Vicinity of Airports.*

No other potential cumulative impacts on airport operations are anticipated during construction.

11.5.2 Operation

Together with the Sydney Gateway road project, operation of the Botany Rail Duplication may contribute to an additional source of pilot distraction associated with the headlights of trains moving along the rail corridor. Subject to the implementation of appropriate mitigation for each project, no potential cumulative impacts are anticipated.

No other potential cumulative operation impacts on airport operations, associated with the operation of the Sydney Gateway road project and other projects, are anticipated.

11.6 Management of impacts

11.6.1 Approach

Approach to mitigation and management

The project has been, and would continue to be, designed to minimise the potential for impacts on operations at Sydney Airport. The majority of potential aviation hazards would be avoided by ensuring the design continues to have regard to necessary safety requirements, including those defined by the guidelines and requirements described in sections 11.1.1 and 11.2.

Although the majority of potential impacts (such as intrusions into Sydney Airport's prescribed airspace) would be avoided by appropriate design, some additional management approaches and measures would be implemented:

- In the event that temporary impacts cannot be avoided (such as intrusions into prescribed airspace during construction)
- To ensure that construction is managed to minimise the potential for hazards and impacts on airport operations
- To continue to minimise the potential for hazards (such as appropriate landscaping to minimise risks associated with wildlife).

Measures to manage the potential impacts of dust and the exposure of waste materials at the former Tempe landfill during construction are provided in Chapters 12 and 24.

Other mitigation measures are detailed in section 11.6.2.

Expected effectiveness

The measures provided in section 11.6.2 have been identified as an outcome of the airport operations assessment and include the consideration of the *National Airports Safeguarding Framework* and other relevant guidelines and design standards. Due to the application and adherence to these agreed guidelines which have been applied to developments located in the vicinity of Sydney Airport and other airports within Australia, they are considered to be effective to minimise impacts on the operations at Sydney Airport.

11.6.2 List of mitigation measures

Measures that will be implemented to minimise potential impacts on airport operations (aviation hazards and risks) are listed in Table 11.3. These measures will support those provided in other chapters aimed at minimising impacts to the operation of Sydney Airport (such as measures to minimise access, air quality and flooding impacts).

Table 11.3 Airport operations (hazards and risks) mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Windshear and turbulence	AS1	The road infrastructure and final landforms (including the emplacement mounds) will be reviewed and refined during detailed design to: ▪ Address aviation matters ▪ Minimise the volume of material excavated from the former Tempe landfill ▪ Maximise open space and community use opportunities ▪ Avoid disturbance outside the project boundary. To achieve the above requirements, alternative mound locations, heights and shapes will be considered. With respect to aviation, any changes to road infrastructure and final landforms will be assessed in relevant wind directions, in accordance with the *National Airports Safeguarding Framework* (Guideline B), to identify an optimal design. The optimisation process will address Sydney Airport operational requirements, and will occur in consultation with Sydney Airport Corporation, aviation stakeholders, and Australian, NSW and local government agencies.	Detailed design

Impact/issue	Ref	Mitigation measure	Timing
Runway public safety areas	AS2	A risk assessment in accordance with the principle of 'as low as reasonably practicable' (ALARP) will be undertaken to confirm the risk associated with operating the project within the public safety area to the north of the main north–south runway. The assessment will include consideration of the *National Airports Safeguarding Framework* (Guideline I). The results of the assessment will inform the design of the project.	Detailed design
Permanent intrusions of Sydney Airport's prescribed airspace	AS3	The project will continue to be designed to avoid intrusions of Sydney Airport's prescribed airspace by permanent project infrastructure.	Detailed design
Wildlife attraction as a result of drainage and flooding management infrastructure	AS4	All temporary and permanent drainage and flood management infrastructure (including the flood mitigation basin) will be designed in accordance with Sydney Airport's Wildlife Management Plan to minimise the risk of attracting wildlife. Appropriate measures will be developed and implemented, including designing the infrastructure to ensure that water does not pond for more than five days. Drainage and flood management infrastructure will be managed during construction and operation to minimise the risk of attracting wildlife.	Detailed design, construction, operation
	AS5	The urban design and landscape plan for the project will include consideration of appropriate landscape designs and species lists to minimise opportunities to attract wildlife at levels likely to present a hazard to aviation operations. The plan will have regard to relevant requirements and species lists under Sydney Airport's Wildlife Management Plan and other relevant guidelines, including the *National Airports Safeguarding Framework* (Guideline C) and *Recommended Practices No. 1 – Standards for Aerodrome Bird/Wildlife Control* (International Birdstrike Committee, 2006).	Detailed design
Pilot distraction as a result of street lighting and headlight glare	AS6	Lighting will continue to be designed in accordance with *AS/NZS 1158.1.1:2005 Lighting for roads and public spaces Part 1.1: Vehicular traffic (Category V) lighting – Performance and design requirements.*	Detailed design
	AS7	The project will continue to be designed to minimise the risk of headlight glare and pilot distraction. This will include providing glare screens in those locations where there is an unacceptable risk of pilot distraction.	Detailed design
Interference with communication, navigation and surveillance equipment	AS8	The detailed design will be referred to Airservices Australia to confirm that there will be no impacts to navigations aids, communications or surveillance equipment.	Detailed design
	AS9	The utilities contingency management plan (measure HS2) will include measures to respond to any unplanned outages of services to critical Sydney Airport infrastructure, including navigations aids, communications and surveillance equipment.	Pre-construction, construction
Construction lighting	AS10	Construction lighting will be selected and located to meet Sydney Airport's restricted lighting zone requirements. For locations where it is not possible to achieve the required intensity levels, works requiring lighting will be undertaken in accordance with the requirements of Sydney Airport Corporation, which may involve restricting the timing of works to outside Sydney Airport's operational hours. Construction lighting will comply with section 9.21 of the Manual of Standards (CASA, 2017) and the *National Airports Safeguarding Framework* (Guideline E).	Pre-construction, construction

Impact/issue	Ref	Mitigation measure	Timing
Temporary intrusions of Sydney Airport's prescribed airspace	AS11	Construction planning will ensure that intrusions of Sydney Airport's prescribed airspace are minimised as far as practicable. Where temporary intrusions of the prescribed airspace cannot be avoided, works likely to result in intrusions will be undertaken in accordance with the requirements of Sydney Airport Corporation (for short-term works less than three months) or the Department of Infrastructure, Transport, Cities and Regional Development for long-term works (more than three months) and any controlled activity approvals for these works. This will include timing works to avoid Sydney Airport's operational hours.	Pre-construction, construction

11.6.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 11.6.2).

With the application of the measures provided in section 11.6.2, including any further assessments required by Airservices Australia, no residual impacts are expected in relation to the operation of Sydney Airport.

Chapter 12

Air quality

This chapter provides a summary of the air quality assessment. It describes the existing air quality environment, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 4 (Air Quality), Technical Working Paper 16 (Former Tempe Landfill Assessment) and Technical Working Paper 17 (Odour Assessment).

The SEARs relevant to air quality are listed below. There are no MDP requirements specifically relevant to air quality, however there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)). Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
14	**Air quality**	
14.1	The Proponent must undertake an air quality impact assessment (AQIA) for construction and operation of the proposal in accordance with the current guidelines.	Technical Working Paper 4 (Air Quality)
14.2	The Proponent must ensure the AQIA also includes the following: (a) demonstrated ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations (Clean Air) Regulation 2010*;	Section 12.1
	(b) the identification of all potential sources and types of air pollution (including PM_{10}, $PM_{2.5}$, CO, NO_x, volatile organic compounds and odour sources) during construction and operation including mechanically generated combustion and transport related emissions and potential for landfill gas generation from the Tempe Tip site;	Sections 12.4 and 0
	(c) any proposed air quality monitoring;	Section 12.7
	(d) a cumulative local and regional air quality impact assessment including impacts generated by the operation of nearby key infrastructure proposals such as (but not limited to) the New M5, M4-M5 Link and Botany Rail Duplication; and	Section 12.6
	(e) proposed construction and operational management measures.	Section 12.7

12. Air quality

12.1 Assessment approach

New road infrastructure has the potential to result in the generation and emission of pollutants into the atmosphere during both construction and operation. Exhaust from construction vehicles and dust generated from unsealed exposed earth are common air quality issues during construction, which must be minimised to avoid nuisance impacts on surrounding sensitive receivers. There is the potential for odour impacts when construction is undertaken at former landfill sites. During operation, new roads alter the source of air quality impacts as a result of moving vehicles on the road network. This can include bringing vehicles into areas that do not currently experience vehicle traffic (associated with a new road), increasing vehicles on existing roads and reducing vehicles on other parts of the network as transport routes are altered.

Modelling of potential air emissions during construction and operation is undertaken to identify and assess the likely extent of such impacts. Air quality modelling includes considering background levels of pollutants, which informs an assessment of the main contributors to existing air quality. This enables potential impacts to be identified and appropriate mitigation and management measures to be selected.

An air quality assessment was carried out for the construction and operational stages of the project, in general accordance with relevant legislation, guidelines and policies. Potential air quality impacts during construction were assessed using a semi-quantitative, risk-based approach. Operational impacts were assessed using computer dispersion modelling generally in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2016b).

An overview of the approach to the assessment is provided below, including the legislative and policy context and a summary of the assessment methodology.

12.1.1 Legislative and policy context to the assessment

The assessment was undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations, POEO Act and the Protection of the Environment Operations (Clean Air) Regulation 2010 (NSW) (the Clean Air Regulation)
- *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2016b)
- *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* (DEC, 2007a)
- *National Environment Protection (Ambient Air Quality) Measure* (the Air NEPM)
- *Technical Framework - Assessment and Management of Odour from Stationary Sources in NSW* (DEC, 2006b)
- *Guidance on the assessment of dust from demolition and construction* (Institute of Air Quality Management (IAQM), 2014)
- *Environmental Guidelines: Solid waste landfills* (NSW EPA, 2016a)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

12.1.2 Methodology

Study area

The study area for the air quality assessment is shown on Figure 12.1. This is the area where potential impacts were modelled by the operational air quality assessment. The study area extended well beyond the project site to enable potential air quality impacts associated with changes to traffic network conditions to be considered. These changes would include new motorway projects (eg M4-M5 Link and New M5) as well as other roads where traffic may be affected by the project.

The study areas for the odour and landfill gas assessments were confined to receptors immediately adjacent to the former Tempe landfill.

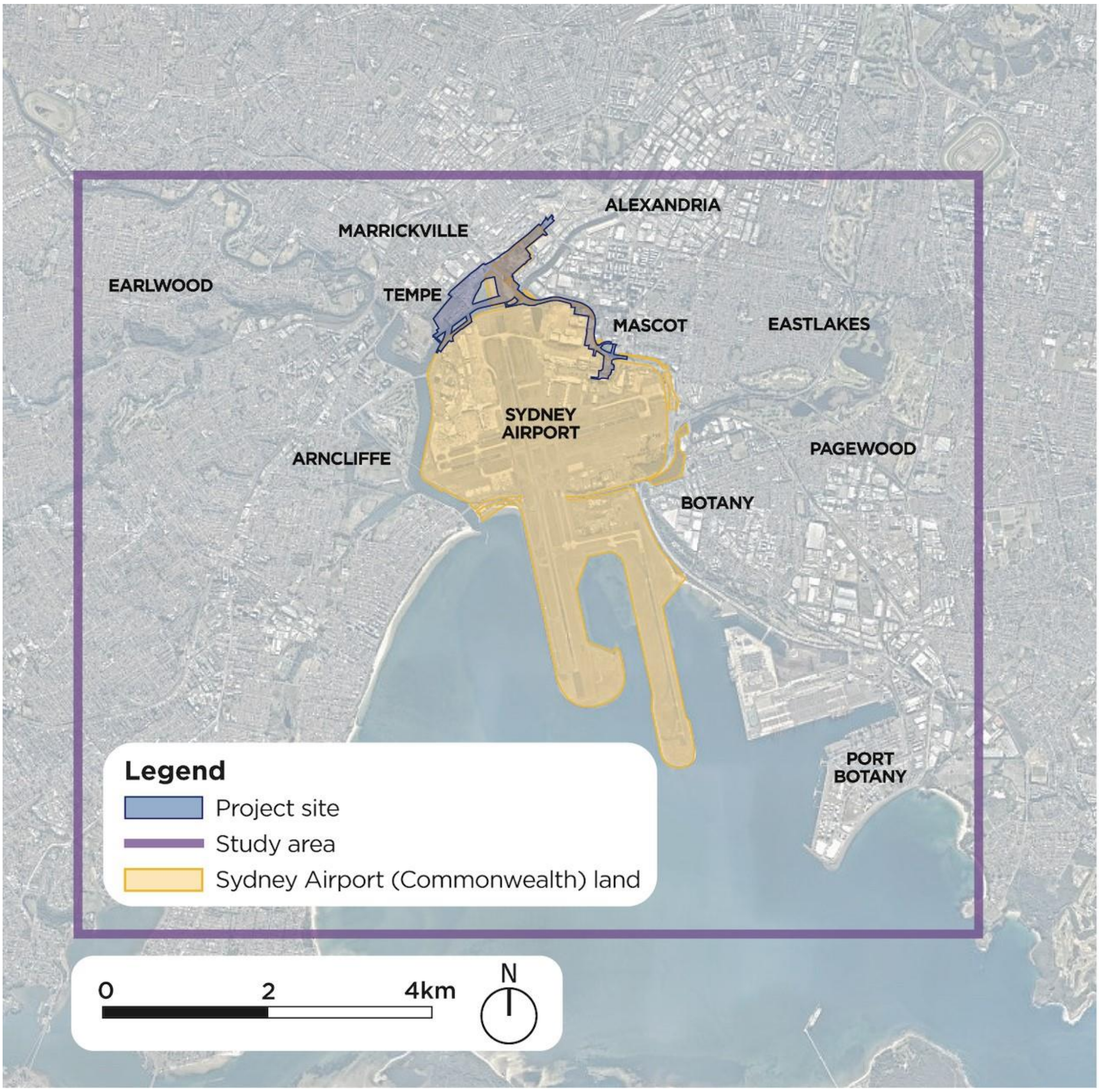


Figure 12.1 Air quality study area

Key tasks

Construction impact assessment

The assessment of potential impacts during construction considered the following emissions:

- Dust
- Exhaust emissions associated with the combustion of diesel fuel and petrol from construction plant and equipment
- Odour emissions due to the potential to uncover waste during works at the former Tempe landfill
- Landfill gas at the former Tempe landfill.

The construction assessment was desktop based. The assessment involved:

- A desktop review of the background air quality environment, including air quality and meteorological data sourced from the OEH and Roads and Maritime monitoring networks
- Identifying sensitive receptors with the potential to be adversely affected by air quality impacts
- Establishing project-specific assessment criteria
- Identifying and assessing potential construction dust impacts using a semi-quantitative, risk-based approach in accordance with *Guidance on the assessment of dust from demolition and construction* (IAQM, 2014)
- Assessing potential odour impacts (as described below)
- Modelling the potential for landfill gas production using the Landfill Emissions Assistant model
- Considering cumulative impacts
- Identifying mitigation measures.

The air quality assessment was supported by an assessment of the potential for odour impacts during works at the former Tempe landfill. The odour assessment involved:

- A site visit to verify features of the existing environment and confirm odour sources
- Collating relevant project, geotechnical bore log and potential waste composition information, and analysing the potential interaction with the project
- Developing an odour emissions inventory
- Meteorological and dispersion modelling to predict potential odour impacts at nearby receptors in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2016b) (the Approved Methods)
- A sensitivity analysis to understand the potential impacts of a range of odour emission rates.

Two scenarios were considered by the odour modelling. Scenario 1 (worst case) considered the entire area of the proposed excavation emitting odour at the same time. Scenario 2 (realistic case) considered only a portion of the proposed excavation area (equating to about 30 per cent of the total) emitting odour at any one time. Assumptions have been made about waste types that would be excavated and expected odour emission rates.

Operation impact assessment

The assessment of potential air quality impacts during operation considered emissions from road traffic (major roads) as well as background concentrations from other sources, including industry, domestic activity, natural sources and minor roads. In the assessment, background concentrations were based on measurements from air quality monitoring stations at urban background locations.

Road traffic emissions were calculated using an emission model developed by the NSW EPA. Traffic data for the emission model was taken from the Strategic Motorway Planning Model.

Air quality was modelled for seven traffic operating scenarios, including the expected base year and six expected future traffic scenarios.

No operational odour assessment was considered required for the former Tempe landfill. This is because the waste would be completely enclosed (similar to the existing condition) and no odour emissions would occur. Similarly, no operational landfill gas assessment was undertaken as the concept design includes construction of a landfill gas collection and venting system to manage operational landfill gas impacts.

The main air pollutants considered included:

- Carbon monoxide (CO)
- Oxides of nitrogen (NO_x)
- Particulate matter (PM), including particulate matter 10 micrometres or less in diameter (PM_{10}) and particulate matter 2.5 micrometres or less in diameter ($PM_{2.5}$)
- Total hydrocarbons (THC)
- Sulfur dioxide (SO_2)
- Lead (Pb)
- Photochemical oxidants as ozone (O_3)
- Benzene
- Polycyclic aromatic hydrocarbons (PAH) as benzo(a)pyrene (B(a)P)
- Formaldehyde
- 1,3-butadiene
- Ethylbenzene.

Further information on the methodology, including a description of the modelling undertaken, is provided in section 3 of Technical Working Paper 4 (Air Quality) and Technical Working Paper 17 (Odour Assessment).

12.1.3 Risks identified

An environmental risk assessment was undertaken as an input to impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Air quality risks with an overall assessed risk rating of medium or above, identified by the environmental risk assessment, included:

- Temporary increases in dust resulting in health, ecological and amenity impacts on nearby sensitive receptors during construction
- Impacts on air quality from decommissioning and demolition activities causing increased dust and particulates, including potentially hazardous material
- Temporary increases in local odorous and non-odorous emissions, such as volatile organic compounds and methane, caused by disturbing materials at contaminated sites, including the former Tempe landfill, during construction
- Impacts on air quality as a result of vehicle and plant exhaust emissions during construction and operation.

These potential risks and impacts were considered as part of the air quality assessment.

12.2 Air quality criteria

Air pollutants

No specific criteria were applied for construction air quality impacts. This is due to the difficulty in quantifying dust emissions from construction activities and the ready ability to mitigate impacts through the adoption of standard construction measures. As described in section 12.1, a semi-quantitative, risk-based approach was used for the assessment.

Relevant assessment criteria from the Approved Methods for the main pollutants associated with operation of the project are presented in Table 12.1. While the Approved Methods do not strictly apply to Commonwealth land, they have been adopted for consistency for the project as a whole. The long-term goals for $PM_{2.5}$ in the National Environment Protection (Ambient Air Quality) Measure are also shown.

It is noted that Schedule 1 of the Airports (Environment Protection) Regulations 1997 also defines ambient air quality objectives at airports. Where the values are comparable, the values in the Airports (Environment Protection) Regulations 1997 are effectively the same as those in the Approved Methods, or are less stringent. Therefore, the criteria in the Approved Methods have been adopted for the operational air quality assessment for the project as a whole to provide a conservative approach to the assessment.

Table 12.1 Air quality criteria

Pollutant/metric	Concentration	Averaging period	Source
Criteria air pollutants[1]			
CO	30 mg/m^3	1 hour	NSW EPA (2016b)
	10 mg/m^3	8 hours (rolling)	NSW EPA (2016b)
NO_2	246 µg/m^3	1 hour	NSW EPA (2016b)
	62 µg/m^3	1 year	NSW EPA (2016b)
PM_{10}	50 µg/m^3	24 hours	NSW EPA (2016b)
	25 µg/m^3	1 year	NSW EPA (2016b)
$PM_{2.5}$	25 µg/m^3	24 hours	NSW EPA (2016b)
	20 µg/m^3 (goal by 2025)	24 hours	NEPC (2016)
	8 µg/m^3	1 year	NSW EPA (2016b)
	7 µg/m^3 (goal by 2025)	1 year	NEPC (2016)
Air toxics[2]			
Benzene	0.029 mg/m^3	1 hour	NSW EPA (2016b)
PAHs (as B(a)P)	0.0004 mg/m^3	1 hour	NSW EPA (2016b)
Formaldehyde	0.02 mg/m^3	1 hour	NSW EPA (2016b)
1,3-butadiene	0.04 mg/m^3	1 hour	NSW EPA (2016b)
Ethylbenzene	8 mg/m^3	1 hour	NSW EPA (2016b)

Notes: 1. Criteria air pollutants are those air pollutants that have been regulated and are used as indicators of air quality based on criteria that relate to health and/or environmental effects

2. These compounds were taken to be representative of the much wider range of air toxics associated with motor vehicles. Air toxics are pollutants that have the potential to cause serious harm to human health and/or the environment

Odour

Assessment criteria for odour are applied at the nearest existing, or likely future, off-site sensitive receptor. Odour assessment criteria take into account the frequency of exposure (set at the 99^{th} percentile) and the intensity of the odour (set at between two to seven odour units).

The 99^{th} percentile level is a prediction of the odour level that may occur 99 per cent of the time or, expressed differently, 99 hours in 100 hours are below these levels. Odour performance criteria are designed to be precautionary so that impacts on sensitive receivers can be minimised.

The most stringent criterion of two odour units at the 99^{th} percentile was adopted for the assessment as this is considered acceptable when there is the potential to affect large populations (more than 2,000 people), as are present in the study area.

12.3 Existing environment

12.3.1 Ambient air quality

Local emission sources

Local emission sources, including industry and domestic activity, natural sources and local transport, can all contribute to existing air quality. A desktop review identified the following potential air pollution sources in the study area:

- Industrial facilities that reported air emissions
- Exhaust emissions from road and rail networks and aviation
- Commercial businesses, such as service stations and smash repairs
- Domestic activities, such as wood-fired home heaters and lawn mowing
- Emissions of methane and landfill gas from the former Tempe landfill.

General characteristics

Ambient air quality in Sydney is influenced by a number of factors, including topography, prevailing meteorological conditions (such as wind and temperature, which vary seasonally) and local and regional air pollution sources (such as motor vehicles, industrial facilities and bushfires). Consequently, regional air quality can be highly variable and impacted by events occurring a significant distance away.

Air quality in Sydney has generally improved over the last few decades. The improvements have been attributed to initiatives to reduce emissions from industry, motor vehicles, businesses and residences.

Historically, elevated levels of CO were generally only encountered near busy roads but concentrations have fallen as a result of improvements in motor vehicle technology. Since the introduction of unleaded petrol and catalytic converters in 1985, peak CO concentrations in central Sydney have plummeted, and the last exceedance of the air quality standard for CO in NSW was recorded in 1998 (DECCW, 2009b; 2010a).

While levels of NO_2, SO_2 and CO continue to be below national standards, levels of ozone and particulates (PM_{10} and $PM_{2.5}$) still exceed the standards on occasion. Ozone and particulate matter levels are affected by:

- Variability in the weather
- Natural events such as bushfires and dust storms, as well as hazard-reduction burns. A dramatic example of this was the dust storm that swept across Eastern Australia between 22 and 24 September 2009
- The location and intensity of local emission sources, such as wood heaters, transport and industry (OEH, 2015b).

In addition to the local road network, Sydney Airport is another major contributor to overall air emissions in the area. For the purposes of the air quality assessment, the resultant concentrations from Sydney Airport have been captured in the ambient air quality monitoring data.

Existing monitoring results

Table 12.2 provides an overview of historical trends in Sydney's air quality (2004 to 2017) based on hourly data from the following long-term monitoring stations operated by OEH and Roads and Maritime, and consideration of shorter term data from other air quality monitoring stations within the study area:

- OEH stations (urban background) - Chullora, Earlwood, Randwick, Rozelle
- Roads and Maritime (M5 East urban background)
- Roads and Maritime (M5 East roadside).

A detailed analysis of the results is provided in Technical Working Paper 4 (Air Quality).

Table 12.2 Long term monitoring results

Pollutant	Averaging period	Comment (for the period 2004 to 2017)
CO	Maximum 1-hour and rolling 8-hour	All values were well below the air quality criteria of 30 mg/m^3 (1-hour) and 10 mg/m^3 (8-hour). There were general downward trends in maximum concentrations, and these trends were statistically significant at most stations.
NO_2	Annual mean	Concentrations at all stations have been well below the air quality criteria of 62 µg/m^3. The long-term average NO_2 concentrations at the Roads and Maritime M5 East roadside stations were around 10 µg/m^3 higher than those at the M5 East background stations. Even so, the concentrations at the roadside stations were also well below the criteria.
	Maximum 1-hour	Although variable from year to year, maximum NO_2 concentrations have been quite stable in the longer term. The values across all stations have typically varied around 100 µg/m^3 and continue to be well below the criteria of 246 µg/m^3.
PM_{10}	Annual mean	In recent years, the annual mean concentration at OEH stations has been between 17 µg/m^3 and 20 µg/m^3. The concentrations at the Roads and Maritime background stations appear to have stabilised at around 15 µg/m^3. These values can be compared with air quality criteria of 25 µg/m^3. The measurements from the Roads and Maritime roadside sites show that PM_{10} levels are marginally higher than background levels.
	Maximum 24-hour	Maximum 24-hour PM_{10} concentrations exhibited no trend with time, and there was a large amount of variation from year to year. The roadside values were similar to the background values.
$PM_{2.5}$	Annual mean	$PM_{2.5}$ has been measured over several years at two OEH stations in the study area. Concentrations at Chullora and Earlwood showed a similar pattern, with a systematic reduction between 2004 and 2012 being followed by a substantial increase in 2013. The main reason for the increase was a change in the measurement method. The increases meant that background $PM_{2.5}$ concentrations in the study area between 2013 and 2017 were already very close to or above the standard in the Air NEPM of 8 µg/m^3, and above the long-term goal of 7 µg/m^3.
	Maximum 24-hour	There has been an underlying increase in concentrations between 2014 and 2017, such that they are currently above the NSW criteria of 25 µg/m^3. In most years, the maximum concentrations have been above the NEPM long-term goal of 20 µg/m^3.

The former Tempe landfill has a landfill gas collection and venting system to manage potential landfill gas impacts. The system extends to the boundary of the IKEA site on the northern boundary of the site. The system includes a series of six metre tall vent stacks fitted with wind-driven ventilators that extend to a sub-surface gravel filled trench and wells. During the site inspection, no observable odours were recorded.

Monitoring of methane conducted at the site indicated that landfill gas is present in the waste mass but is not produced in sufficient volumes to record gas flows or gas under pressure.

The Sydney Airport northern lands carpark area (adjacent to the former Tempe landfill) also has a gas collection and venting system, which was installed in 2015 as part of remediation works at the site. Potential impacts on this infrastructure is considered in Chapter 13 (Contamination and soils).

12.3.2 Nearby receptors

The study area includes a varied and relatively dense mix of land uses. Sydney Airport is by far the dominant land use in the study area. In addition to Sydney Airport and other transport uses (such as roads and the Botany Rail Line), the study area also includes a range of commercial and industrial land uses, residential areas and open space.

Construction

Dust

Guidance on the assessment of dust from demolition and construction specifies that a dust assessment is required where there are human receptors within 350 metres of the boundary of a site. Figure 12.2 shows receptors located within 350 metres of the project site.

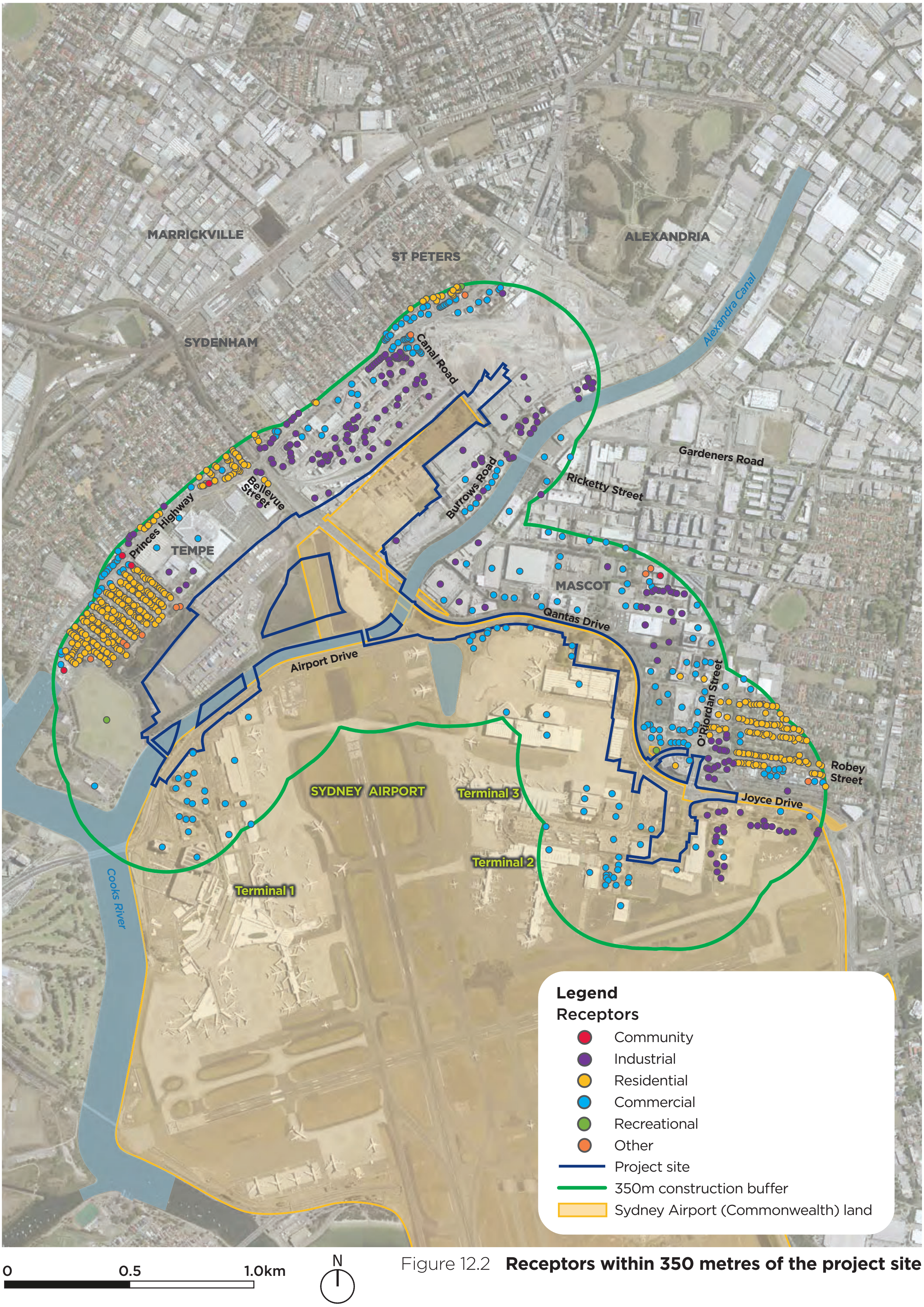


Figure 12.2 **Receptors within 350 metres of the project site**

Odour

Seventeen representative receptors closest to the project site in various directions were selected for the odour assessment (shown on Figure 12.3). If potential odour impacts during construction comply with the assessment criteria at these nearest receptors, then those situated at a greater distance are also likely to comply.

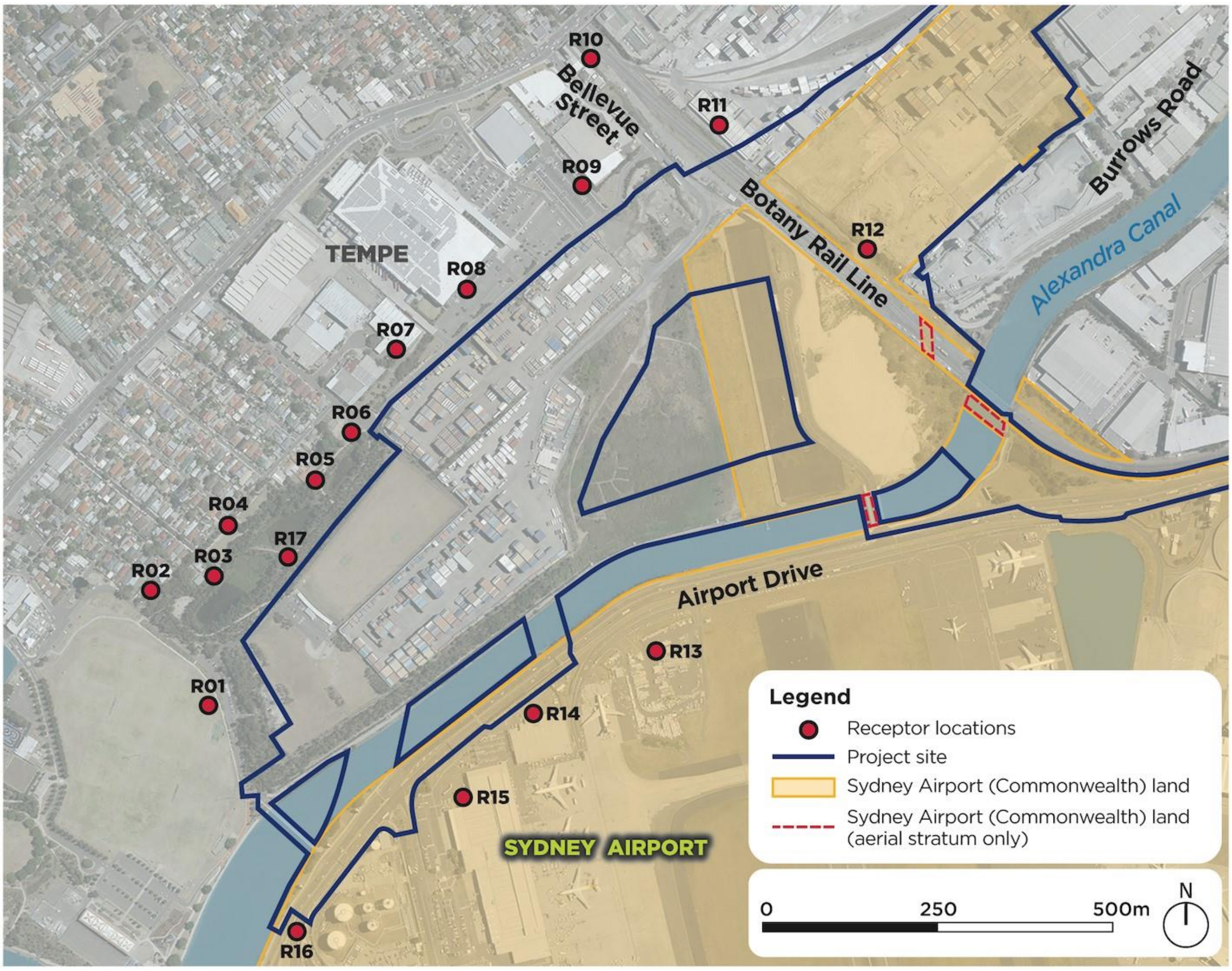


Figure 12.3 Representative receptors for odour assessment

Operation

The operational air quality assessment included consideration of impacts at two types of receptors in the vicinity of the project site and other affected roads:

- Community receptors – these represent particularly sensitive locations, such as schools, child care centres and hospitals. A total of 17 community receptors were considered.
- Residential, workplace and recreational receptors – these represent discrete receptor locations. A total of 12,145 residential, workplace and recreational receptors were considered.

It should be noted that community receptors are a subset of residential, workplace and recreational receptors however they have also been considered separately to ensure a robust assessment is undertaken. Furthermore, any community receptor not specifically identified have still been assessed under the grouping of residential, workplace and recreational receptors.

Figure 12.4 shows the locations of receptors considered by the assessment.

Figure 12.4 **Modelled air quality receptors for operational assessment**

12.4 Assessment of construction impacts

12.4.1 Potential emission sources

Potential emissions sources during construction include:

- Dust from demolition, earthworks, construction works and vehicle movements
- Exhaust emissions from construction plant and equipment
- Odour and landfill gas emissions following removal of sections of the cap at the former Tempe landfill.

12.4.2 Dust generation risk

Construction activities can be categorised into four types to reflect the potential for impacts:

- Demolition – any activity that involves the removal of existing structures
- Earthworks – ground disturbance activities such as soil stripping, ground levelling, excavation and landscaping which involve excavating material, stockpiling, processing excavated material, haulage and tipping
- Construction – any activity that involves providing new structures or modifying existing structures, including buildings and roads
- Track out – the movement of dust and dirt by construction vehicles from a project site onto a public road network.

The risk of dust arising in sufficient quantities to cause annoyance and/or the potential for health and ecological impacts was determined for each activity type by considering the scale and nature of the works and the sensitivity of the area.

The construction dust risk assessment considered both human receptors and areas of ecological significance (see Figure 12.2).

Table 12.3 provides a summary of the results of the construction dust risk assessment. A detailed description of the ratings used is provided in Technical Working Paper 4 (Air Quality).

Table 12.3 Summary of construction dust risk assessment

Activity	Potential for dust emission	Sensitivity of area			Risk of dust impact		
		Dust soiling	Human health	Ecological	Dust soiling	Human health	Ecological
Demolition	Large	High	High	Medium	High	High	High
Earthworks	Large	High	High	Medium	High	High	Medium
Construction	Large	High	High	Medium	High	High	Medium
Track out	Large	High	High	Medium	High	High	Medium

For all activities, the potential for dust emissions was determined to be large, and the sensitivity of the assessment area for different dust impacts was determined to be high or medium. Based on these factors, the risk of dust impacts was also determined to be high or medium for all construction activities.

Uncontrolled dust generation has the potential to create visibility issues for aviation operations. In addition, impacts from construction and demolition could include the release of asbestos fibres, heavy metals, silica dust or other pollutants during the demolition of buildings, where these buildings contain hazardous materials, or the removal of contaminated soils.

Consequently, management and mitigation measures included in the Construction Air Quality Management Plan (described in section 12.7.1) would be implemented to minimise dust and mitigate the effects of construction on local air quality. Measures relating to the inspection and removal of hazardous materials, should they be present, are regulatory procedures which govern the actions taken to minimise the risk of harm due to release or removal of these materials. Further information on the management of hazardous materials is provided in Chapter 23 (Health, safety and hazards).

With the application of the proposed measures, the risk of dust would be substantially minimised and well managed. The measures are expected to be effective in reducing dust to levels such that dust would not affect aviation safety. Any impacts that the community, nearby receptors and sensitive environments experience would be temporary.

12.4.3 Exhaust emissions

The main source of emissions would be from the combustion of diesel fuel and petrol from heavy vehicles, mobile excavation machinery, and stationary combustion equipment as well as from the handling and/or on-site storage of fuel and other chemicals. The volume of emissions from construction vehicles and machinery would depend on the type of fuel used, the power output and condition of the engine, and duration of operation.

Exhaust emissions would involve periodically localised emissions of carbon monoxide, particular matter (PM_{10} and $PM_{2.5}$), oxides of nitrogen (NO_x), sulfur dioxide, volatile organic compounds, and PAHs associated with the combustion of diesel fuel and petrol.

Exhaust emissions generated during construction would not significantly contribute to emissions in the area, given the existing levels of transport uses. Emissions from construction vehicles and plant would be dispersed along the alignment of the project site and intermittent in nature depending on particular construction activities.

12.4.4 Potential odour impacts from the former Tempe landfill

The project would involve works at the former Tempe landfill with the potential to generate odour. Three sources of odorous emissions were identified and assessed:

- Exposed waste on excavation faces and emplacement areas
- Covered waste areas
- Disturbance and handling of waste (ie from plant and equipment performing waste movement operations).

Specific odour emission rates for each potential odour source were identified using an in-house database of odour emission rates from various putrescible and non-putrescible landfills in NSW. The adopted odour emission rates, as odour units per square metre per second ($OU/m^2/s$), are shown in Table 12.4.

Table 12.4 Adopted odour emission rates

Source	Specific odour emission rate (OU/m2/s)
Exposed waste	1
Covered waste	0.12
Waste disturbance and handling	26

Predicted odour impacts were modelled in accordance with the Approved Methods for two construction scenarios:

- Scenario 1 (worst case) considered the entire area of the proposed excavation emitting odour at the same time
- Scenario 2 (realistic case) considered only a portion of the proposed excavation area (equivalent to about 30 per cent of the total) emitting odour at any one time.

The predicted 99th percentile odour emission concentrations are summarised in Table 12.5. The values bolded red indicate exceedances of the two odour unit criterion.

Table 12.5 Predicted odour concentrations and sensitivity analysis (99th percentile)

Receiver	Receiver type	Scenario 1 (worst case)	Scenario 2 (realistic case)
R01 Tempe Recreation Reserve	Recreational	**2.8**	1.5
R02 2 Station Street, Tempe	Residential	1.5	0.8
R03 South Street, Tempe	Residential	**2.3**	1.4
R04 5 Wentworth Street, Tempe	Residential	1.7	0.9
R05 5 South Street, Tempe	Residential	**2.6**	1.4
R06 2 South Street, Tempe	Vacant lot	**3.3**	1.9
R07 Brissett Rollers	Commercial	**3.1**	1.5
R08 IKEA	Commercial	**4.1**	2.0
R09 Salvos Stores, St Peters	Commercial	**3.7**	1.9
R10 3 Bellevue Street, Tempe	Residential	1.4	0.8
R11 Maritime Container Services	Industrial	1.8	1.0
R12 Boral Recycling	Industrial	0.8	0.5
R13 Sydney Airport	Commercial	**2.4**	1.1
R14 Atlas Air Inc building	Commercial	**3.2**	1.6
R15 Qantas Freight Terminal	Commercial	**2.2**	1.1
R16 C & L Sales & Services	Commercial	1.8	1.0
R17 Tempe Lands	Recreational	**3.5**	**2.1**

The results of the assessment indicate that:

- Exceedances of the odour unit assessment criterion are predicted for scenario 1 (worst case), mainly attributed to the large area of exposed waste assumed in this scenario
- Only one potential exceedance of the odour assessment criterion is predicted for scenario 2 (realistic case). This was at receptor R17 (Tempe Lands).

Based on the desktop analysis, it was concluded that:

- Odour emissions could be managed to within the adopted criterion levels by controlling the amount of exposed waste, including related waste handling and movement activities, to within 30 per cent of the total waste excavation and filling areas
- Any odours would be localised and temporary, following the covering of the waste.

Regardless of these conclusions, a number of mitigation measures are proposed to reduce the potential for odour impacts. The approach to managing the potential for odour impacts is described in section 12.7.

12.4.5 Landfill gas

The breakdown of putrescible waste and organic matter in a landfill generates methane, carbon dioxide and other trace gases (landfill gas) that may pose hazards to site safety, human health and the surrounding environment. While methane and carbon dioxide are odourless, other components of landfill gas, such as hydrogen sulfide and ammonia can be odorous, affecting local amenity. Methane may be explosive if concentrations reach five to 15 per cent by volume in air. Carbon dioxide can be an asphyxiant if sufficient volumes collect in a confined space.

As the project would involve removing sections of the existing cap at the former Tempe landfill, there would be an initial release of any trapped gases resulting in increased odour potential. Following this, specific works that intersect with the waste (such as excavation and piling) may also release any pockets of trapped gas for short periods. Based on previous measurements taken during geotechnical investigations at the site, while methane can be present initially in high concentrations, these rapidly decrease once venting occurs (over a period of hours or days).

Due to the age of the landfill, it is expected that the majority of putrescible waste has degraded. However, there would be ongoing low production of landfill gas from other sources. Works within the site would be undertaken with the assumption that high levels of methane and landfill gas would be present, and appropriate management measures would be put in place. These would include, at a minimum, relevant occupational work, health and safety precautions, measurements of methane concentrations using a gas meter, and restrictions on hot works.

The Sydney Airport northern lands car park area is currently managed in accordance with an environmental management plan, which documents the procedures to be followed during any future works in this area. Construction would be carried out in accordance with this plan. Further information, including relevant mitigation measures, are provided in section 12.7 and Chapter 13 (Contamination and soils). Implementation of the proposed measures are expected to effectively manage potential landfill gas impacts during construction.

12.4.6 Summary of impacts on Sydney Airport (Commonwealth) land

Dust

Figure 12.5 shows the locations of sensitive receptors on Sydney Airport land and within 350 metres of the project site. These receptors are either commercial or industrial.

As noted in section 12.4.2, there is a medium risk (earthworks, construction, track out) and high risk (demolition) of dust impacts on nearby receptors. Uncontrolled dust generation also has the potential to create visibility issues for aviation operations.

Management and mitigation measures from the Construction Air Quality Management Plan (see section 12.7) would be implemented to minimise dust and mitigate the effects of construction on local air quality. With the application of the proposed measures, the risk of dust would be substantially minimised and well managed. The measures are expected to be effective in reducing dust to levels such that dust would not affect aviation safety.

Odour

Five of the 17 receptors included in the odour modelling are located on Sydney Airport land (receptors R12, R13, R14, R15 and R16). The results of the odour modelling (Table 12.5) show that:

- No exceedance of the odour criterion is predicted for scenario 2 (realistic case) at any receptors located on Sydney Airport land
- Exceedances of the criterion are predicted at some receptors on Sydney Airport land for scenario 1 (worst case). These exceedances are mainly attributed to the large area of exposed waste assumed in this scenario.

The proposed approach to managing odour (see section 12.7) would minimise the potential for odour impacts on Sydney Airport land as a result of works at the former Tempe landfill.

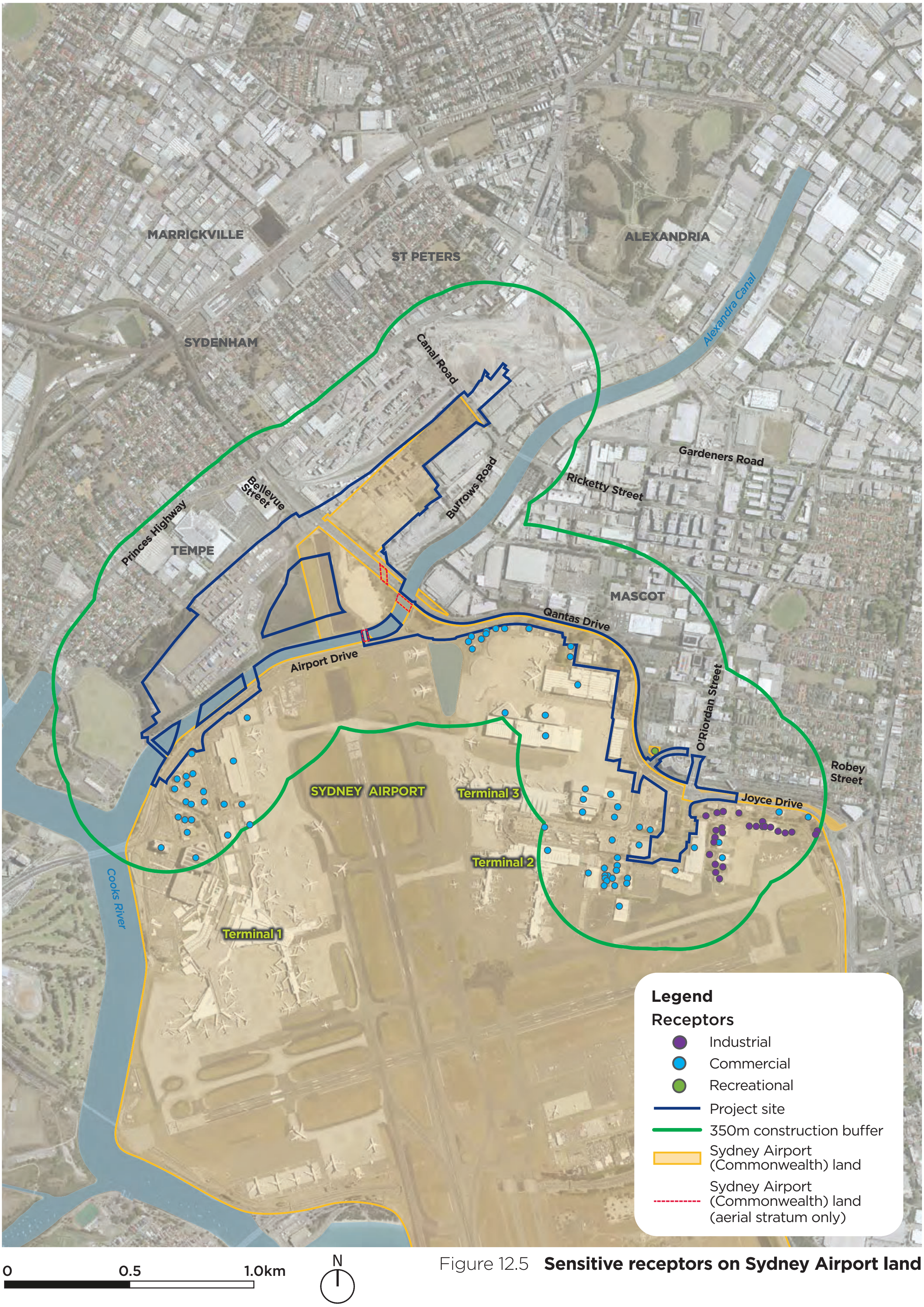


Figure 12.5 **Sensitive receptors on Sydney Airport land**

Exhaust emissions

Exhaust emissions generated during construction would not significantly contribute to emissions on Sydney Airport land, given the existing levels of vehicle use in the study area.

Landfill gas

Works in the Sydney Airport northern lands car park area would be carried out in accordance with the procedures in the existing environmental management plan for this area. Implementation of these procedures is expected to effectively manage potential landfill gas impacts on Sydney Airport land during construction.

12.5 Assessment of operation impacts

12.5.1 Potential emissions

The emissions model estimated emissions for more than 2,000 road links and multiple pollutants for each traffic scenario. A description of each traffic scenario is provided in Table 9.1 (see Chapter 9 (Traffic, transport and access)).

The estimated total emissions for all roads (including tunnels) in the study area are provided in Table 12.6. This shows that in both 2026 and 2036, when comparing the 'with the project' and cumulative scenarios and the 'without the project' scenarios:

- Emissions of CO increased slightly
- Emissions of all other pollutants decreased slightly or stayed broadly the same.

The predicted absolute and percentage changes in emissions are shown in Table 12.7 and Table 12.8, respectively. The results indicate that the overall changes in emissions associated with the project in a given future year (2026 or 2036) would be much smaller than the underlying reductions in emissions from the traffic on the network between 2016 and the scenario year due to improvements in emission-control technology.

For the 'base year' and the 'without the project' scenarios, it can be seen from the results provided in Table 12.8 that between 2016 and 2026, the total emissions of CO, NO_x and THC from traffic on the road network are predicted to decrease by between 45 and 55 per cent. Between 2016 and 2036, the reductions were between 50 and 65 per cent. For PM_{10} and $PM_{2.5}$, the underlying reductions were smaller, at between around 10 and 20 per cent. This is mainly because there is currently no anticipated regulation of non-exhaust particles (such as from tyre and brake wear, road surface wear and resuspension of road dust), which form a substantial fraction of the total.

Table 12.6 Total traffic emissions in the study area

Scenario	Total daily vehicle kilometres travelled (millions)	Total emissions (tonnes/year)				
		CO	NO_x	PM_{10}	$PM_{2.5}$	THC
Base year (2016)	6.3	4,329	2,391	129	90	474
2026 without the project	6.8	2,086	1,338	112	71	218
2026 with the project	6.9	2,093	1,320	111	70	213
2026 cumulative scenario	7.0	2,110	1,326	112	70	213
2036 without the project	7.3	1,596	1,245	118	72	163
2036 with the project	7.5	1,607	1,227	117	72	160
2036 cumulative scenario	7.6	1,636	1,233	118	72	158

Table 12.7 Absolute changes in total traffic emissions in the study area

Scenario comparison	Change in total emissions (tonnes/year)				
	CO	NO_x	PM_{10}	$PM_{2.5}$	THC
Underlying changes in emissions with time					
2026 without the project vs the base year (2016)	-2,244	-1,053	-17	-19	-256
2026 with the project vs the base year (2016)	-2,734	-1,146	-11	-18	-311
Changes due to the project in a given year					
2026 with the project vs without the project	+7.5	-18.2	-0.9	-0.6	-5.1
2026 cumulative scenario vs without the project	+24.5	-12.0	-0.5	-0.3	-5.6
2036 with the project vs without the project	+11.7	-18.7	-0.7	-0.4	-3.0
2036 cumulative scenario vs without the project	+40.0	-12.0	-0.2	-0.1	-5.7

Table 12.8 Percentage changes in total traffic emissions in the study area

Scenario comparison	Change in total emissions (%)				
	CO	NO_x	PM_{10}	$PM_{2.5}$	THC
Underlying changes in emissions with time					
2026 without the project vs the base year (2016)	-51.8%	-44.0%	-12.9%	-21.4%	-53.9%
2026 with the project vs the base year (2016)	-63.1%	-47.9%	-8.4%	-19.5%	-65.6%
Changes due to the project in a given year					
2026 with the project vs without the project	+0.4%	-1.4%	-0.8%	-0.8%	-2.3%
2026 cumulative scenario vs without the project	+1.2%	-0.9%	-0.4%	-0.4%	-2.6%
2036 with the project vs without the project	+0.7%	-1.5%	-0.6%	-0.6%	-1.8%
2036 cumulative scenario vs without the project	+2.5%	-1.0%	-0.2%	-0.1%	-5.7%

12.5.2 Local impacts

A summary of the air quality modelling results is provided below. The overall results for each traffic scenario for all pollutant sources, including concentrations and contour plots, are provided in Technical Working Paper 4 (Air Quality). Overall, the results of the operational air quality modelling showed that:

- The predicted total concentrations of all modelled pollutants at receptors were usually dominated by the existing background contribution, although for NO_2, a significant contribution was predicted to be generated from the modelled road traffic
- For several air quality metrics (notably annual mean $PM_{2.5}$ and 24-hour PM_{10} and $PM_{2.5}$), exceedances of the criteria were predicted to occur both with and without the project. This was because of high background concentrations. In other words, the background levels already exceed the relevant criteria without the project
- Where increases in pollutant concentrations at receptors were predicted, these were mostly small. Only a very small proportion of receptors were predicted to have larger increases and these were near proposed new sections of road.

The modelled spatial changes in air quality as a result of the project are quite complex, reflecting the complex changes in traffic on the network. Key outcomes are predicted to include:

- Marked increases in pollutant concentrations on the new roads associated with the project (Terminal 1 connection, St Peters interchange connection, and the Qantas Drive upgrade and extension)
- Increases in pollutant concentrations on several existing roads (Qantas Drive, Joyce Drive, General Holmes Drive, and Airport Drive near Terminal 1) due to increased traffic
- Decreases in pollutant concentrations along several existing roads (M5 East, Southern Cross Drive, Botany Road, and Canal Road) due to reductions in traffic of between 8 per cent and 28 per cent on these roads
- For the cumulative scenarios (in 2026 and 2036) there were some additional air quality changes associated with the future introduction of the proposed F6 Extension project, including:
  - Further reductions in concentration along Southern Cross Drive and the M5 East
  - A reduction in concentrations along The Grand Parade
  - An increase in concentration along President Avenue.
- For selected odorous pollutants, the change in the maximum 1-hour concentration was an order of magnitude below the corresponding odour assessment criteria in the NSW Approved Methods and should not be perceptible by the community.

A summary of the key findings for specific pollutants is provided below.

Carbon monoxide (maximum 1-hour)

For all receptors and scenarios, the predicted maximum 1-hour CO concentration was well below the assessment criterion of 30 $\mu g/m^3$, as well as the lowest international air quality standard identified in the literature (22 $\mu g/m^3$).

There was an increase in CO at between 40 and 51 per cent of residential, workplace and recreational receptors, although even the largest increases were small compared with the criteria.

Carbon monoxide (maximum rolling 8-hour)

At all receptors the predicted maximum rolling 8-hour CO concentration was well below the NSW impact assessment criterion of 10 $\mu g/m^3$. There are no lower criteria used internationally, as determined from the literature review.

Nitrogen dioxide (annual mean)

At all receptors, the predicted NO_2 concentration was well below the assessment criterion of 62 $\mu g/m^3$. At all receptors the NO_2 concentration was also predicted to be below the EU limit value of 40 $\mu g/m^3$.

The maximum contribution of road traffic in any scenario and at any receptor was 13.4 $\mu g/m^3$.

An increase in the annual mean NO_2 concentration was predicted at between 24 and 43 per cent of receptors, depending on the scenario. While the largest increases in annual NO_2 were around 4 to 5 $\mu g/m^3$, the increase was greater than 1 $\mu g/m^3$ for no more than around one per cent of receptors.

Figure 12.6 shows the change in annual mean NO_2 concentration in 2036 with the project compared to without the project. The green shading represents a decrease in concentration and the purple shading an increase in concentration. Any changes in NO_2 of less than 1 $\mu g/m^3$ are not shown.

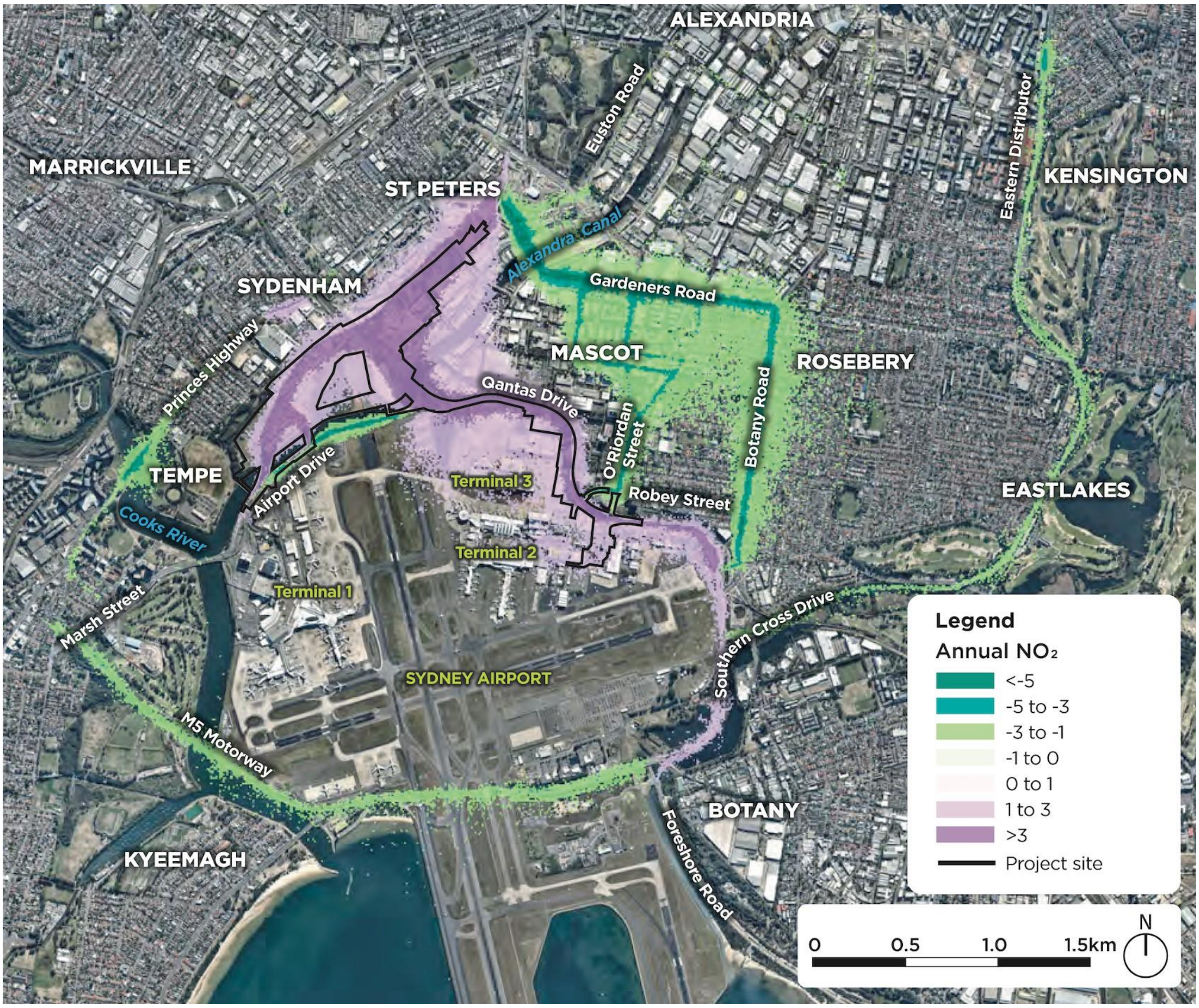


Figure 12.6 Contour plot of change in annual mean NO_2 concentration in 2036

Nitrogen dioxide (maximum 1-hour)

There was only one receptor (out of 12,145) with an exceedance of the NSW 1-hour NO_2 criterion of 246 µg/m^3, and this was not a sensitive location (a car park within Sydney Airport).

An increase in the maximum 1-hour NO_2 concentration was predicted at between 33 and 47 per cent of receptors depending on the scenario. At the majority of receptors, the change was relatively small in all scenarios: for around three to five per cent of all receptors, there was an increase in concentration of less than 5 µg/m^3. At the Sydney Airport receptor mentioned above, there was an increase in the maximum 1- hour NO_2 concentration of 31 µg/m^3 which resulted in an exceedance of the air quality criterion.

The contour plot for the change in the maximum 1-hour NO_2 concentration for 2036 with the project compared to without the project is shown in Figure 12.7.

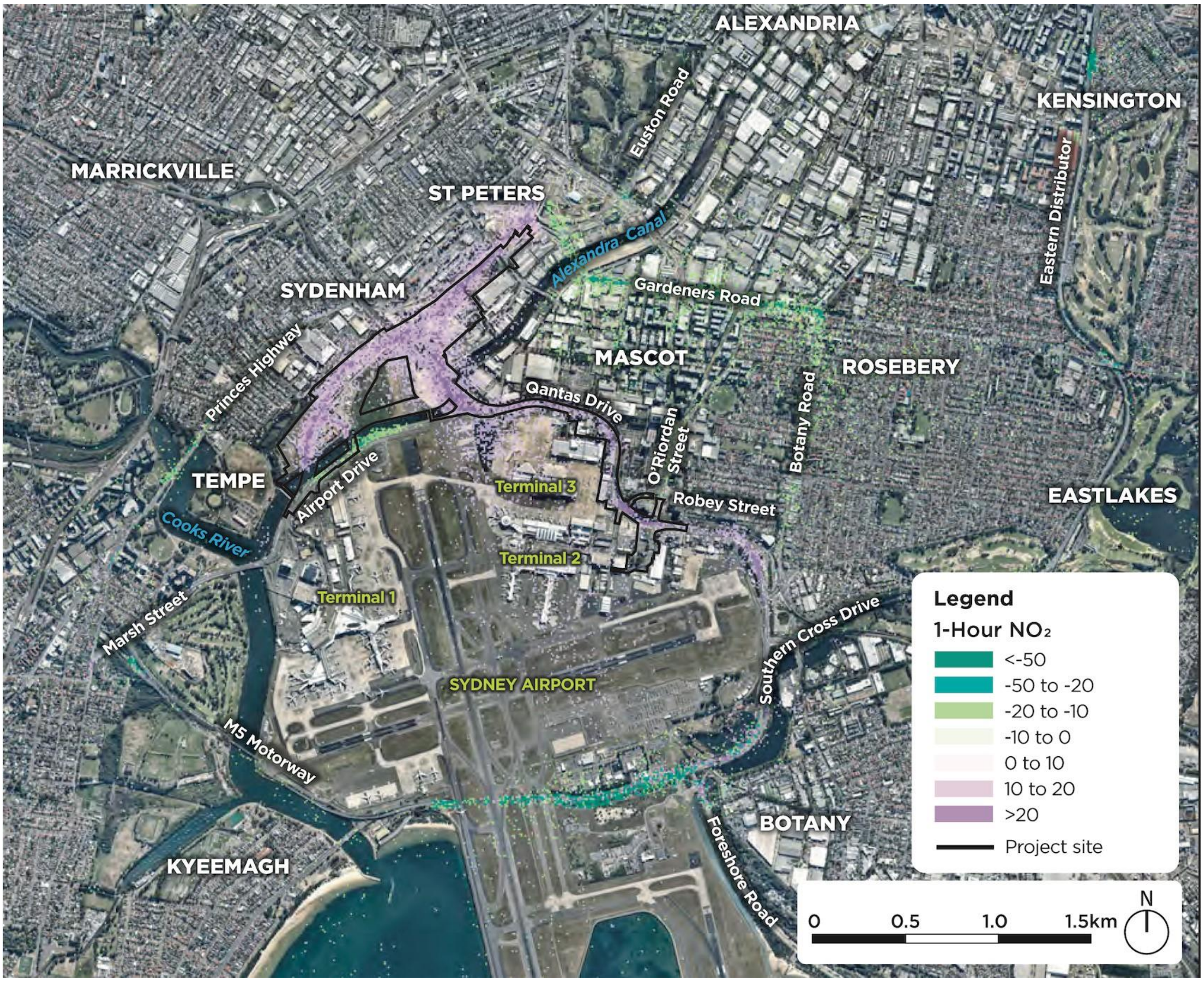


Figure 12.7 Contour plot of change in maximum 1-hour NO_2 concentration in 2036

PM_{10} (annual mean)

The concentration at the vast majority of receptors was predicted to be below 23 µg/m^3, with only two receptors predicted to have a concentration just above the assessment criterion of 25 µg/m^3 in any scenario.

The maximum road traffic contribution in any scenario was 6.9 µg/m^3.

There was an increase in concentration at between 35 and 42 per cent of the receptors, depending on the scenario. At the majority of receptors, the change was relatively small.

The contour plot for the change in the annual mean PM_{10} concentration for 2036 with the project compared to without the project is shown in Figure 12.8.

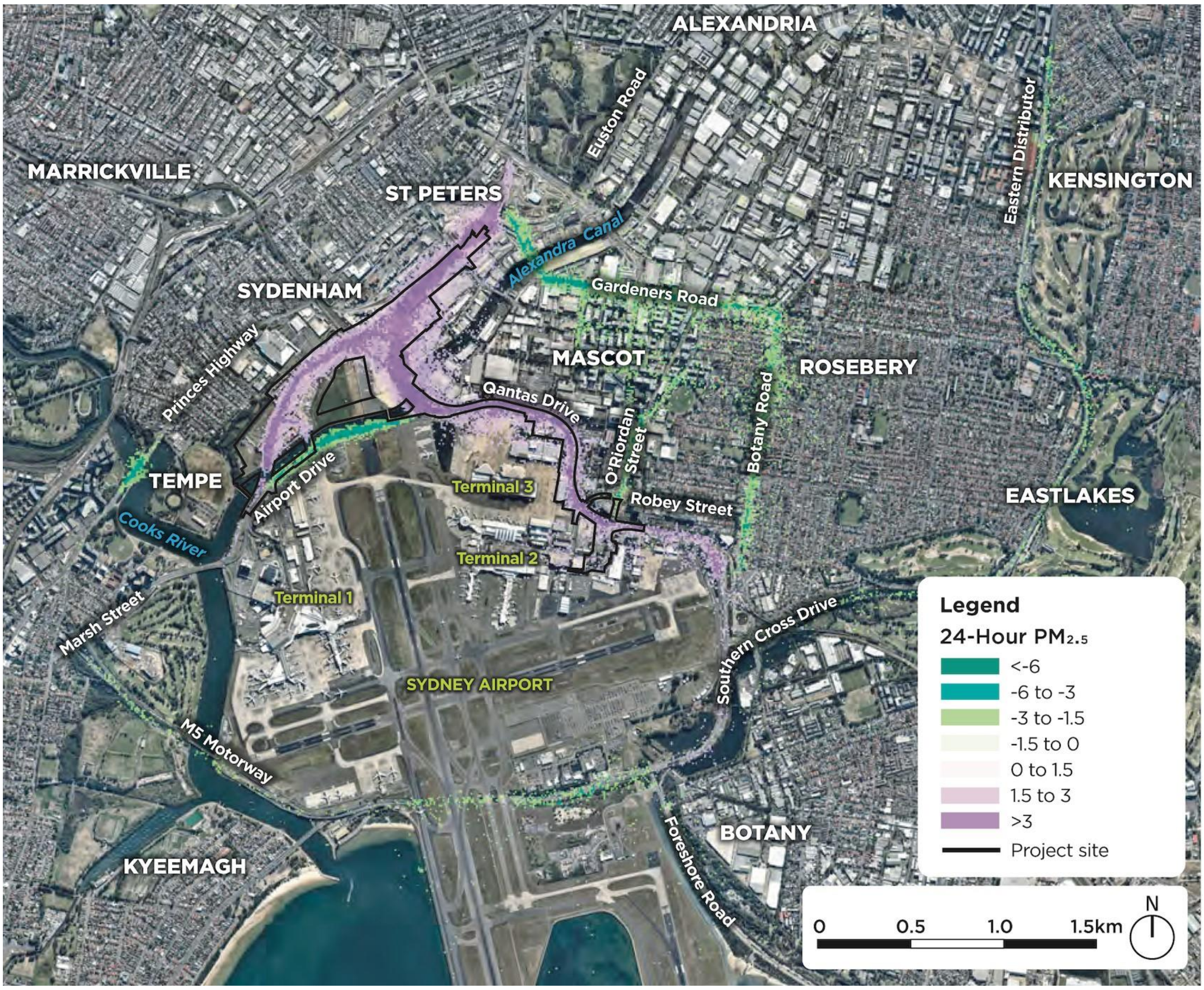


Figure 12.8 Contour plot of change in annual mean PM_{10} concentration in 2036

PM$_{10}$ (maximum 24-hour)

The results for maximum 24-hour PM$_{10}$ were highly dependent on the assumption for the background concentration. Because the background concentration was quite high (56.4 µg/m^3), the total concentration was above the assessment criterion of 50 µg/m^3 at all receptors.

There was an increase in concentration at between 33 and 46 per cent of receptors, depending on the scenario. Where there was an increase, this was greater than 0.5 µg/m^3 (one per cent of the criterion) at seven to ten per cent of receptors, depending on the scenario.

The contour plot of the change in maximum 24-hour PM$_{10}$ for 2036 with the project compared to without the project is shown in Figure 12.9.

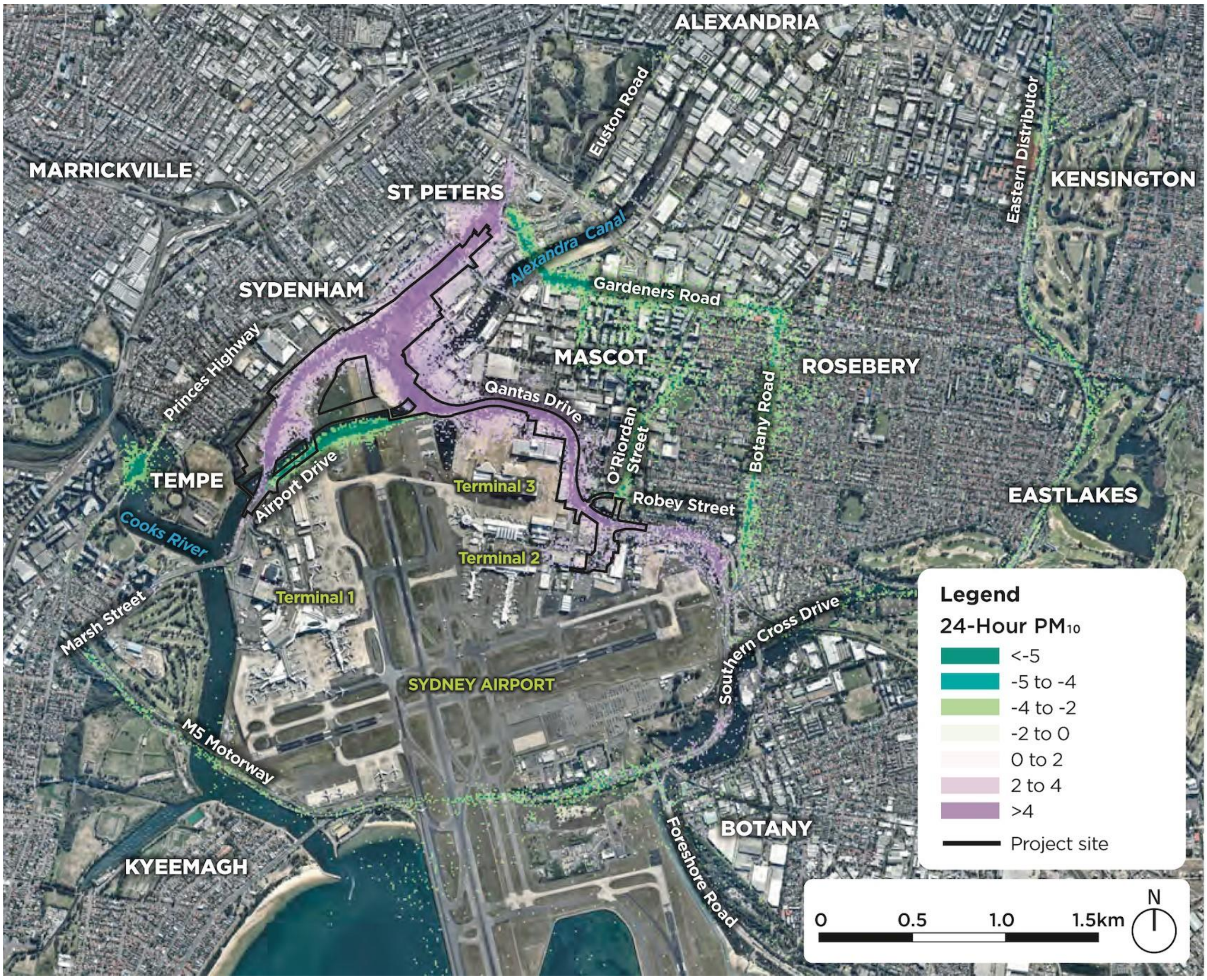


Figure 12.9 Contour plot of change in maximum 24-hour PM$_{10}$ concentration in 2036

$PM_{2.5}$ (annual mean)

The predictions for annual mean $PM_{2.5}$ were highly dependent on the assumptions on background values and based on a mapped background which already exceeded the NSW criterion of 8 µg/m^3 at all receptors. Clearly, there would also be exceedances of the Air NEPM long-term target of 7 µg/m^3. Internationally, there are no standards lower than 8 µg/m^3 for annual mean $PM_{2.5}$.

The highest predicted concentration at any receptor in any scenario was 13.6 µg/m^3. The road traffic contribution was 7.1 µg/m^3.

There was an increase in concentration at between 37 per cent and 44 per cent of receptors, depending on the scenario. Where there was an increase, this was greater than 0.1 µg/m^3 at around two to four per cent of receptors.

No receptor had an increase in annual mean $PM_{2.5}$ that was above the acceptable threshold of 1.8 µg/m^3.

The contour plot of the change in annual mean $PM_{2.5}$ in 2036 with the project compared to without the project is shown in Figure 12.10.

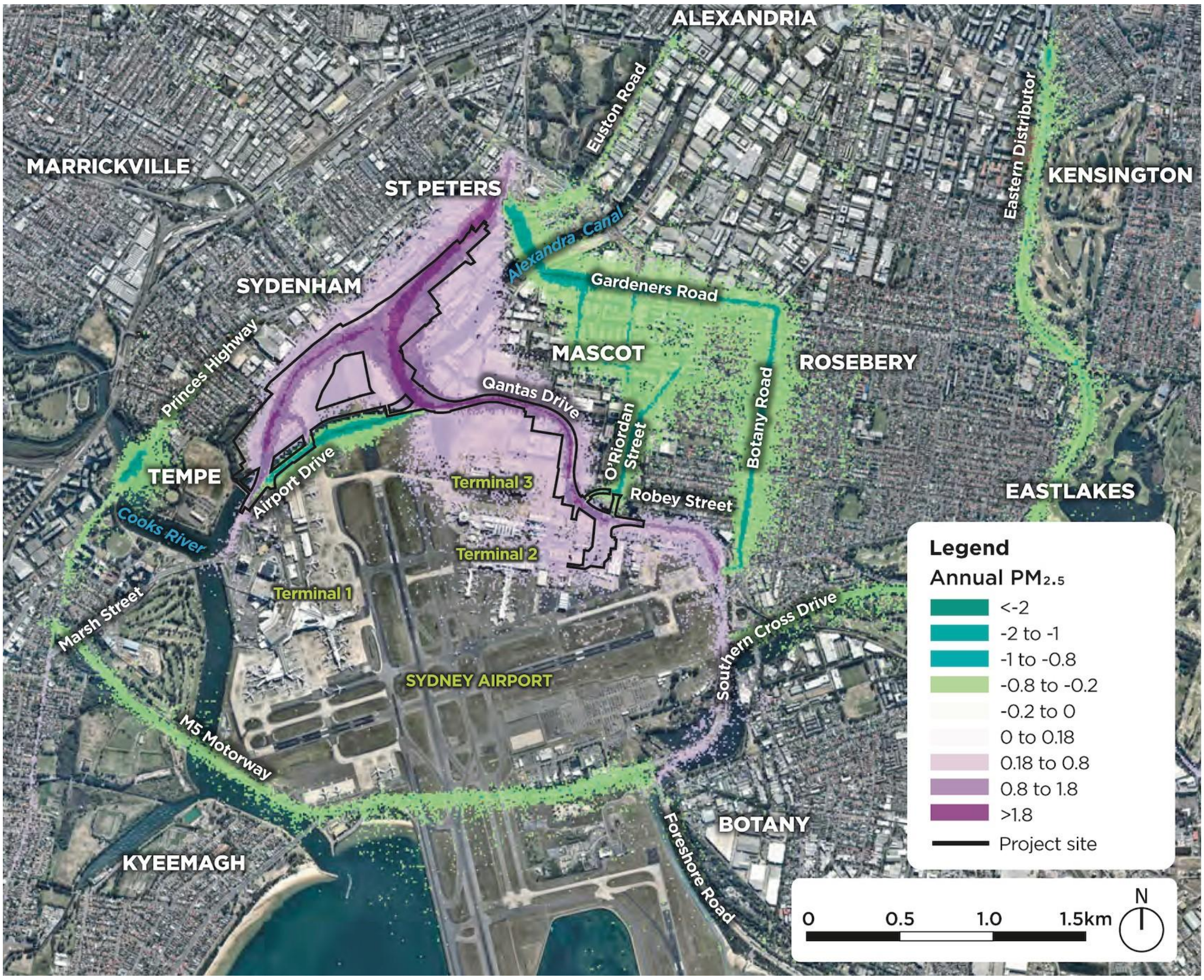


Figure 12.10 Contour plot of change in annual mean $PM_{2.5}$ concentration in 2036

$PM_{2.5}$ (maximum 24-hour)

Given the high background concentration for 24-hour $PM_{2.5}$ (40.9 µg/m^3) in all scenarios, the total concentration at all receptors was above the assessment criterion of 25 µg/m^3.

The largest predicted increase in concentration at any receptor as a result of the project in any scenario was 3.8 µg/m^3. For most of the receptors the change in concentration was small.

The contour plot of the change in maximum 24-hour $PM_{2.5}$ in 2036 with the project compared to without the project is shown in Figure 12.11.

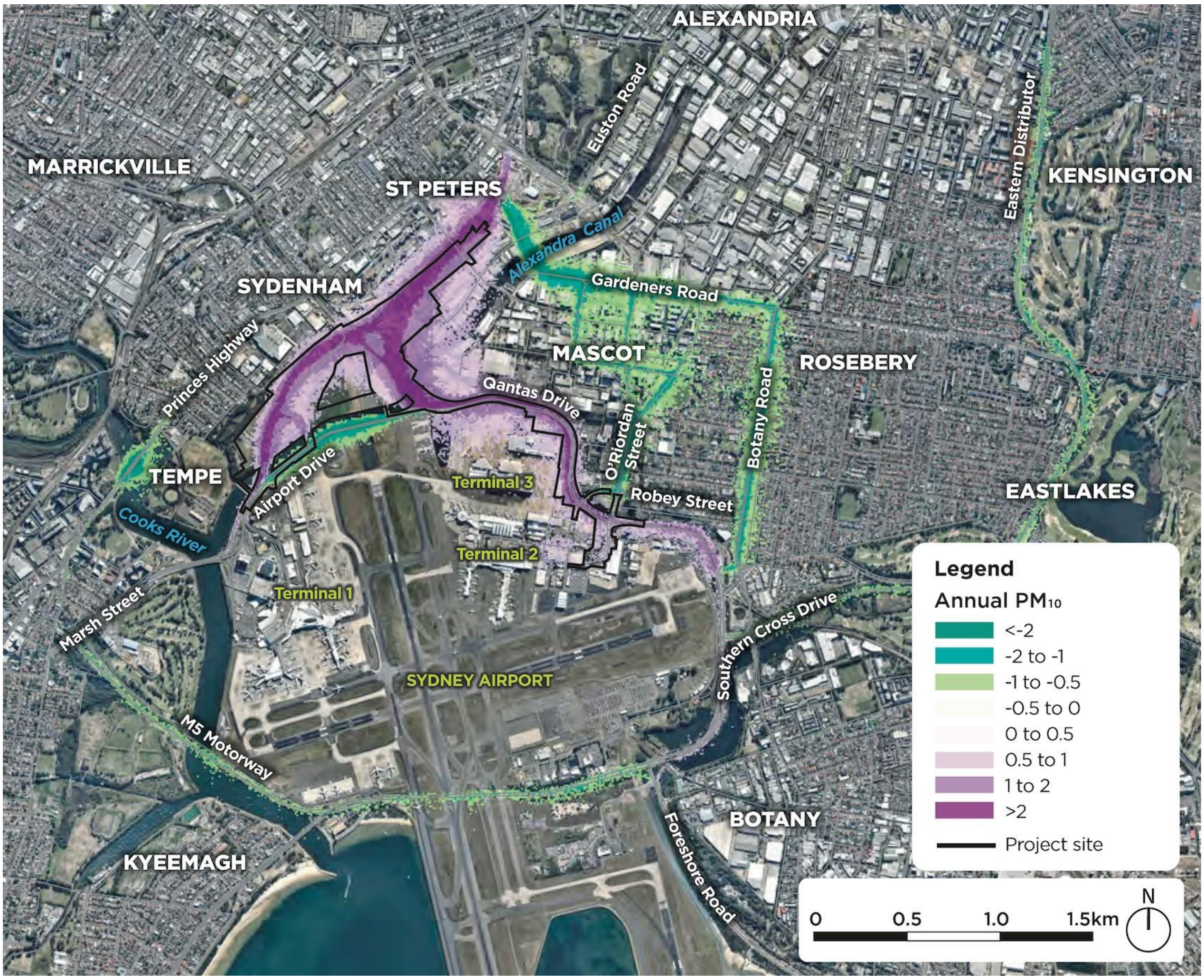


Figure 12.11 Contour plot of change in maximum 24-hour $PM_{2.5}$ concentration in 2036

Air toxics

The changes in the maximum 1-hour concentrations were compared with the relevant assessment criteria. For each compound, where there was an increase in the concentration, this was well below the corresponding assessment criteria.

Odour

The change in the maximum one hour THC concentration as a result of the project was calculated for each of the residential, workplace and recreational receptors. The largest change in the maximum 1-hour THC concentration across all receptors was then determined, and this was converted into an equivalent change for three of the odorous pollutants identified in the Approved Methods (toluene, xylenes and acetaldehyde). These pollutants were taken to be representative of other odorous pollutants from motor vehicles.

As shown in Table 12.9, the predicted change in the maximum 1-hour concentration of each of these odorous pollutants was found to be an order of magnitude below the corresponding odour assessment criteria in the Approved Methods.

Table 12.9 Comparison of changes in odorous pollutant concentrations with criteria in Approved Methods (residential, workplace and recreational receptors)

Scenario	Largest increase in maximum 1-hour THC concentration relative to the without the project scenario (µg/m3)	Largest increase in maximum 1-hour concentration		
		Toluene (µg/m3)	Xylenes (µg/m3)	Acetaldehyde (µg/m3)
Odour criterion (µg/m³)		***360***	***190***	***42***
2026 without the project	56.1	4.1	3.4	0.9
2026 with the project cumulative scenario	50.5	3.7	3.0	0.8
2036 without the project	39.1	2.4	1.9	0.8
2036 with the project cumulative scenario	35.5	2.1	1.8	0.7

In terms of potential odour from works at the former Tempe landfill, once construction works are completed, the working areas would be capped preventing future odour being released through the surface. Therefore, no ongoing operational odour emissions are anticipated.

12.5.3 Landfill gas

The addition of piles and/or services and drainage trenches through the landfill cap and waste may cause the formation of new preferential pathways for gas to escape and flow. However, the low estimated landfill gas production rates of zero to 0.2 litres per hour suggest that an interception mechanism, similar to that currently in place, would be sufficient to limit gas concentrations to less than one per cent methane (by volume) or 1.5 per cent carbon dioxide (by volume), ensuring there would be no adverse impacts from on and offsite migration.

Roads and Maritime would install a gas collection and venting mechanism beneath the capping layer of the road infrastructure and proposed mounds in accordance with the requirements of the *Environmental Guidelines: Solid waste landfills* (EPA, 2016a), to allow landfill gas to be collected and passively vented and minimise the potential for accumulation. The gas collection system would also include appropriate seals around any cap perforations, such as bridge piles or other support structures. This would minimise the presence of preferential pathways along services and drainage trenches and from the infrastructure generally.

In addition, the new landfill capping layer is expected to reduce the potential for landfill gas emissions, and the increased topsoil/vegetation layer across the project site would promote oxidation of landfill gas before emission to the atmosphere.

The existing environmental management plans for the Sydney Airport northern lands carpark area (adjacent to the former Tempe landfill) requires ongoing inspections in the centre of the area to monitor erosion of the cap and the presence of landfill gas. It also documents the requirements for maintaining the gas venting system.

Implementation of the proposed gas collection and venting system along with continued implementation of existing environmental management plans is expected to effectively manage potential landfill gas impacts during operation.

12.5.4 Regional impacts

The changes in the total emissions resulting from the project are described in section 12.5.1. These changes can be viewed as a proxy for the project's regional air quality emissions. Based on this, the potential for regional air quality impacts are likely to be negligible.

The regional air quality impacts of a project can also be considered in terms of its capacity to influence ozone production. EPA has recently developed the Tiered Procedure for Estimating Ground Level Ozone Impacts from Stationary Sources (ENVIRON, 2011). Although this procedure does not relate specifically to road projects, it was applied to the air quality assessment to give an indication of the likely significance of the project's effect on ozone concentrations in the region. The analysis found that the project is predicted to result in a small reduction in ozone concentrations.

Overall, it can be concluded that the regional impacts of the project would be negligible and undetectable in ambient air quality measurements at background locations.

12.5.5 Summary of impacts on Sydney Airport (Commonwealth) land

A total of 162 residential, workplace and recreational receptors are located on Sydney Airport land. However, none of the receptors represent particularly sensitive locations from an air quality perspective.

As described in section 12.5.2, for each pollutant and metric, increases in concentrations are predicted at some receptors and decreases at others, depending on their proximity to new sections of road and changes in the traffic network.

Since most of the proposed main network changes would occur near Sydney Airport land, the increases there would be among the largest determined for the study area. Nevertheless, the predicted increases are within acceptable ranges. The most marked predicted changes in concentration included:

- Increases at the north of the airport, around Terminals 2/3 and to the west of Terminal 1
- Reductions near the existing Airport Drive to the north of Terminal 1.

With the likely advances in vehicle emissions technology that would occur in the future, the potential impacts on Sydney Airport land as a result of changes in traffic emissions due to the project are not considered to be significant.

Continued implementation of the existing environmental management plan together with the proposed installation of the gas collection and venting mechanism beneath the road infrastructure and proposed emplacement mounds, are expected to effectively manage potential ongoing landfill gas impacts on Sydney Airport land.

Consistency with the Sydney Airport Master Plan

Sydney Airport Master Plan 2039 (SACL, 2019a) (the Master Plan) has a number of operational and environment objectives. With respect to air quality, one of the objectives is to continue to improve environmental performance at the airport to protect environmentally significant areas.

A key theme of the airport's Master Plan and Environment Strategy is the commitment to sustainability. All major airports have an effect on the air quality environment due to the nature of their operations, and minimising these impacts is fundamental to operating sustainably.

The assessment of the construction impacts of the project on air quality is consistent with this objective and also the theme of sustainability, in that risks have been assessed and mitigation measures are recommended which take into account human health and amenity, and environmentally significant and sensitive areas. Any impacts would likely be temporary.

Modelling indicates the project would result in predicted increases in the concentrations of air pollutants in at least some areas of Sydney Airport. However, any increases in concentrations are likely to be smaller than future predicted emissions reductions between 2016 and 2036 due to advances in vehicle emissions technology.

12.6 Cumulative impacts

A cumulative assessment was undertaken which considered the cumulative risk of dust impacts from the Botany Rail Duplication project in terms of dust soiling, human health and ecological criteria. The assessment indicated that, without mitigation, identified receivers close to the works areas would be at high risk of experiencing cumulative dust impacts. Mitigation measures have been developed (see section 12.7) to minimise the risk of these impacts, as well as the other construction impacts from the project. Chapter 23 (Health, safety and hazards) considers potential impacts to human health).

There are a number of other major infrastructure projects in close proximity to the project site, including the New M5 and M4-M5 Link. The New M5, which includes works at St Peters interchange including the former Alexandria landfill site, is scheduled to be completed prior to the commencement of the Sydney Gateway road project. The M4-M5 Link is farther away, however would be under construction at the same time as the Sydney Gateway road project for a period of about two years. While the potential for cumulative impacts with the M4-M5 Link are not considered to be high, largely because of the separation distance between the two projects, the measures provided in section 12.7 would address this risk.

With regards to cumulative operational air quality impacts, the operational assessment, summarised in section 12.5.2, considered future road developments in the area, such as the F6 Extension (Stage 1 and subsequent stages), the New M5, the M4-M5 Link and Western Harbour Tunnel and Beaches Link. The latter two projects were considered in the 2036 scenario. Existing major developments, such as at Port Botany and Sydney Airport, were also considered in the operational assessment as part of the review and inclusion of background monitoring results. Therefore, the potential for cumulative air quality impacts during operation has been considered as part of the operational air quality impact assessment, with the exception of potential cumulative impacts from operation of the Botany Rail Duplication (considered below).

The summary of results (see section 12.5.2) notes that, for the cumulative scenarios (2026 and 2036), the operational air quality modelling predicted some additional air quality changes associated with the future introduction of the proposed F6 Extension project, including for $PM_{2.5}$:

- Further reductions in concentration along Southern Cross Drive and the M5 East
- A reduction in concentrations along The Grand Parade
- An increase in concentration along President Avenue.

In relation to the cumulative effects from operation of the Botany Rail Duplication, the predominant pollutant of concern would be $PM_{2.5}$ from the diesel locomotive engines. The level of cumulative impact would depend on the contribution of $PM_{2.5}$ from diesel locomotive engines to background air quality compared to the contribution from other existing sources (particularly vehicle traffic). A review of the annual and maximum 24-hour average concentrations of $PM_{2.5}$ indicated that the most significant component is the background levels of this pollutant, with only a relatively minor contribution from vehicle traffic. It is therefore expected that any additional $PM_{2.5}$ from diesel locomotives would only result in minor increases of an already minor contributor to total $PM_{2.5}$ concentrations.

In addition, the Strategic Motorway Planning Model does not account for any reductions in freight traffic that may result following completion of the Botany Rail Duplication. Given that the main pollutant of concern from these freight vehicles is also $PM_{2.5}$, it is possible that the additional freight transport options provided by the increased rail capacity would result in fewer heavy vehicles using the road corridor. This could result in a reduction in impacts following implementation of the Sydney Gateway road project.

12.7 Management of impacts

12.7.1 Approach

Approach to mitigation and management

The assessment identified that the main potential for air quality impacts would be during construction, when there would be the potential for dust and odour impacts if works are not effectively managed.

In terms of the potential for operation impacts, the project has been designed, as far as practicable, to optimise the throughput and operation of vehicles on the local road network. This includes, for example, optimisation of signalised intersections, minimisation of road gradients, and application of speed limits appropriate to the road geometry. Such approaches would generally reduce fuel consumption and overall emissions on a per vehicle basis.

Approach to managing the key potential impacts identified

Potential air quality impacts during construction, including dust and emissions from construction plant and landfill gas, would be managed in accordance with a project-specific Construction Air Quality Management Plan, which would be implemented as part of the CEMP. The plan would define the processes, responsibilities and management measures that would be implemented to minimise potential impacts on air quality. Further information on the CEMP, including requirements for the Construction Air Quality Management Plan, is provided in Chapter 27 (Approach to environmental management and mitigation).

Detailed design and construction planning would seek to minimise odour impacts at the former Tempe landfill by:

- Minimising the need to expose waste, and/or the area exposed at any one time
- Where there is the potential to generate odour, managing this in accordance with an odour management strategy (see below).

The potential for odour emissions and impacts during construction would depend on the strategy adopted by the contractor for excavation within the former Tempe landfill and the management of excavated materials. The odour management strategy would guide pre-construction odour investigations and identify work methods and management measures to ensure that:

- Significant odour issues are avoided
- Any odour issues are rapidly identified and effectively resolved.

The odour management strategy would involve:

- Odour emission sampling to verify the likely odour emission rates from all potential odour sources
- Updating the odour modelling based on the above information, to confirm the odour impact predictions and to refine the measures needing to be implemented to avoid exceedances of the criterion
- Confirming the proposed work methods and mitigation measures that aim to limit odour at sensitive receptors to no more than the 2 OU criterion
- Confirming the approach and action plan if significant odour issues occur, as well as other complementary procedures and actions in response to odour complaints.

Odour would be monitored by undertaking routine (twice daily) odour surveys. If offensive odour is observed at off-site receptors, odour eliminator sprays (or deodorisers) could be used to provide short-term mitigation. Other measures may also be considered based on the outcomes of the odour management strategy.

The odour management strategy would complement the Construction Air Quality Management Plan.

Approach to managing other impacts

Other mitigation measures are provided in section 12.7.2. Mitigation measures to manage impacts from landfill gas are provided in Chapter 13 (Contamination and soils).

Expected effectiveness

Ambient weather conditions such as wind speed and direction, soil moisture and rainfall or dew would substantially influence the day to day potential for dust generation and also the dispersion of odour during construction. Accordingly, construction personnel would need to routinely observe weather conditions to ensure appropriate mitigation measures are implemented or proposed to be in place when conditions change. The proposed measures for dust control are routinely employed as ‘good practice’ on construction sites in NSW and are therefore expected to be effective in controlling dust generation.

The desktop odour modelling and actions proposed in the odour management strategy would set a solid foundation for obtaining site-specific emissions information and updating the impact predictions, prior to construction commencing. Routine daily odour monitoring would also be conducted to identify potential odour issues and contingency measures would be available to address potential issues, should they occur. If these management measures are adopted and carried out effectively, minimal potential for impacts would be expected.

12.7.2 List of mitigation measures

Measures that will be implemented to address potential air quality impacts are listed in Table 12.10.

Table 12.10 Air quality mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Managing air quality impacts during construction	AQ1	A Construction Air Quality Management Plan will be prepared as part of the CEMP and implemented during construction. The plan will detail processes, responsibilities and measures to manage air quality, odour and landfill gas and minimise the potential for impacts during construction. The plan will include an air quality, odour and landfill gas monitoring program, and will detail the measures that will be implemented to compare the actual performance of construction against the predicted performance. Monitoring will be undertaken for the duration of construction.	Pre-construction, construction
Avoiding odour impacts	AQ2	Odour impacts at the former Tempe landfill will be minimised as far as possible by: ▪ Construction planning to minimise the need to expose waste, and/or the area exposed at any one time ▪ Where there is the potential to generate odour, this will be managed in accordance with the odour management strategy (measure AQ3). Further modelling will be carried out to demonstrate that the proposed excavation methodology for the former Tempe landfill can comply with the 2 OU criterion.	Pre-construction, construction
Monitoring and controlling odour at the former Tempe landfill	AQ3	An odour management strategy will be developed prior to construction and implemented for the duration of works involving ground disturbance at the former Tempe landfill. The strategy will include: ▪ Proposed work methods and mitigation measures that aim to limit odour at sensitive receptors to no more than the 2 OU criterion ▪ Routine observation of weather conditions ▪ Regular odour surveys at receptor locations by appropriately qualified professionals (see AQ4) ▪ Measures to minimise the generation of odour at the end of each work day/shift	Pre-construction, construction

Impact/issue	Ref	Mitigation measure	Timing
		▪ Mechanisms for investigating odour complaints, including conduct of additional odour surveys ▪ Contingency and rectification measures (eg use of deodorisers) should significant odour issues occur at sensitive receivers in the vicinity of the project site.	
	AQ4	Odour surveys will be undertaken at downwind receptors for the duration of works involving ground disturbance at the former Tempe landfill in accordance with *Determination of odorants in ambient air by field inspection* (VDI 3940, 1993). The odour surveys will be undertaken: ▪ Daily, for one hour when works commence, and prior to works completing ▪ If wind conditions drop below three metres per second ▪ If an odour complaint is received. If significant odour issues are observed in the vicinity of sensitive receptors, the contingency and rectification measures defined by the odour management strategy will be implemented (see AQ3).	Construction
Impacts on air quality as a result of demolition	AQ5	Demolition activities, including removal of hazardous building materials, will be planned and carried out in a manner that minimises the potential for dust generation.	Construction
Cumulative dust impacts arising from concurrent construction of the Gateway road project and the Botany Rail Duplication project	AQ6	The detailed construction program will be developed in consultation with the contractors constructing the Botany Rail Duplication project. Consultation will be maintained over the duration of both projects to plan activities in a manner that reduces the potential for air quality-related impacts. Where practicable, activities with a high potential to generate dust will be programmed so that they do not occur at the same time.	Pre-construction, construction

12.7.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 12.7.2).

With the application of effective management measures, the residual adverse impacts on air quality during construction activities are considered to be temporary and of an acceptable nature.

Although the project is not expected to result in unacceptable pollutant concentrations at surrounding receptors during operation, concentrations were predicted to increase at some receptors. However, where increases were predicted, these were mostly minor and only a small proportion of receptors were predicted to have larger increase, and these were near proposed new road sections. Therefore, residual impacts as a result of operation of the project are considered to be low and of an acceptable nature.

Chapter 13

Contamination

This chapter provides a summary of the contamination and soils assessment. It describes existing contamination and soils within the project site, identifies potential impacts, considers whether the site is suitable for the proposed development, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 5 (Contamination and Soils) and Technical Working Paper 16 (Former Tempe Landfill Assessment). Further information about potential groundwater and water quality impacts as a result of contamination is provided Chapters 15 (Groundwater) and 16 (Surface water).

The SEARs relevant to contamination and soils are listed below. There are no MDP requirements specifically relevant to contamination and soils, however there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)).

Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
12	**Contamination**	
12.1	The Proponent must assess the potential for contamination and any impacts associated with the management of contaminated soils and water resources including, but not limited to:	
	(a) a detailed assessment of the extent and nature of any contamination of the soil, groundwater and soil vapour including from activities on Tempe Tip and PFAS;	Section 13.2
	(b) an assessment of potential risks to human health and the environmental receptors in the vicinity of the site;	Sections 13.3 and 13.4
	(c) a description and appraisal of any mitigation and monitoring measures; and	Section 13.6
	(d) consideration of whether the site is suitable for the proposed development.	Section 13.4.3
12.2	Any assessment of contamination must be in accordance with relevant guidelines produced or approved under the *Contaminated Land Management Act 1997*.	Section 13.1
12.3	All reports prepared for the assessment of contamination must be prepared, or reviewed and approved, by a consultant certified under either the Environment Institute of Australia and New Zealand's Certified Environmental Practitioner (Site Contamination) scheme (CEnvP(SC)) or the Soil Science Australia Certified Professional Soil Scientist Contaminated Site Assessment and Management (CPSS CSAM) scheme.	Technical Working Paper 5 (Contamination and Soils) was reviewed and approved by a consultant certified under the Environment Institute of Australia and New Zealand's Certified Environmental Practitioner (Site Contamination) scheme (CEnvP(SC)).

Reference	Requirement	Where addressed
12.4	The Proponent must assess whether the land is likely to be contaminated and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with current guidelines.	Section 13.3 Section 13.6.1
13	**Soils**	
13.1	The Proponent must verify if the proposal is on land marked as Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map or within 500 m of adjacent Class 2, 3 or 4 land that is below 5 m Australian Height Datum (AHD) and where the proposal is likely to lower the water table in this adjacent land below 1 m AHD.	Section 13.2.2
13.2	The Proponent must assess the impact of the proposal on acid sulfate soils (including the impacts of acidic runoff offsite) in accordance with the current guidelines.	Sections 13.3.3 and 13.4.4
13.3	The Proponent must assess whether salinity is likely to be an issue and if so, determine the presence, extent and severity of soil salinity within the proposal area.	Sections 13.2.2, 13.3.3 and 13.4.4
13.4	The Proponent must assess the impacts of the proposal on soil salinity and how it may affect groundwater resources.	Sections 13.3.3 and 13.4.4, and Chapter 15 (Groundwater)
13.5	The Proponent must assess the impacts on soil and land resources (including erosion risk or hazard). Particular attention must be given to soil erosion and sediment transport consistent with the practices and principles in the current guidelines.	Sections 13.2.2, 13.3.3 and 13.4.4 and Chapter 16 (Surface water)

13. Contamination and soils

13.1 Assessment approach

Construction work can expose contaminated soils and groundwater in areas where previously contaminating activities or land uses have been undertaken. Exposing contaminated soils and/or groundwater can mobilise contaminants, potentially leading to environmental, health and safety risks.

There is also the potential for construction and operation of new infrastructure to expose and disturb soils or contaminate soils, surface water and groundwater if these activities are not managed appropriately. The disturbance of soil, if improperly managed, can lead to soil erosion, increase soil salinity levels, and/or cause oxidation/acid generation, all of which could affect receiving environments.

It is important that such risks are identified and planned for during project development so that they can be avoided, minimised and effectively managed through appropriate design and construction planning.

A contamination and soils assessment has been carried out for both the construction and operational stages of the project in general accordance with the framework for the assessment of site contamination outlined in the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (as amended). The assessment was reviewed and approved by an experienced practitioner certified under the Environment Institute of Australia and New Zealand's Certified Environmental Practitioner (Site Contamination) scheme (CEnvP(SC)).

An overview of the approach to the contamination and soils assessment is provided below, including the legislative and policy context and a summary of the assessment methodology.

13.1.1 Legislative and policy context to the assessment

The assessment was undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A to B) and with reference to the following:

- Relevant legislation and planning instruments, including the EP&A Act, the Airports Act and associated regulations, *Contaminated Land Management Act 1997* (NSW) (CLM Act), *State Environmental Planning Policy No 55 - Remediation of Land* (SEPP 55), and the EPBC Act
- *National Environment Protection (Assessment of Site Contamination) Measure 1999* (as amended)
- *PFAS National Environmental Management Plan* (Heads of EPAs Australia and New Zealand (HEPA), 2018) (the PFAS NEMP)
- *Australian Guidelines for Water Quality Monitoring and Reporting* (ANZECC/ARMCANZ, 2000) (the ANZECC guidelines)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Governments, 2018)
- *Managing asbestos in or on soil* (WorkCover NSW, 2014)
- *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases* (NSW EPA, 2012)
- *Acid Sulfate Soils Assessment Guidelines* (Acid Sulfate Soils Management Advisory Committee (ASSMAC), 1998)
- *Managing Urban Stormwater: Soils and construction* - Volume 1 (Landcom, 2004), Volume 2B Waste landfills (DECC, 2008a) and Volume 2D, Main Road Construction (DECC, 2008b) (collectively referred to as the Blue Book)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

13.1.2 Methodology

Study area

The study area for the contamination assessment is the project site, as described in Chapter 2 (Location and setting). Based on a preliminary review of the contamination history across the project site, five assessment areas within the project site were defined for the contamination assessment (referred to as project areas by the assessment):

- Assessment area 1 – Former Tempe landfill
- Assessment area 2 – Sydney Airport northern lands car park
- Assessment area 3 – Land north of the rail corridor
- Assessment area 4 – Sydney Airport land along Alexandra Canal and Qantas Drive
- Assessment area 5 – Alexandra Canal.

These areas were identified as having the potential to require special management (potentially including remediation) before or during construction and/or operation. The following additional areas were also considered by the contamination assessment; however, a detailed assessment was not undertaken for these areas for the reasons detailed below:

- Rail corridor – extends from Alexandra Canal in the south to the Ikea site in the north. This area will be investigated further during detailed design.
- St Peters interchange tie-in – this portion of the project site extends beyond Canal Road to the north-east and has been assessed as part of the contamination investigations undertaken for the New M5.

These areas are shown in Figure 13.1. Desktop searches for the contamination assessment also extended a further 500 metres around the project site.

Key tasks

The assessment methodology generally followed the framework for the assessment of site contamination outlined in the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (as amended) (the NEPM). The assessment involved:

- Reviewing the following databases to identify areas of known and potential contamination:
  - NSW EPA register of contaminated sites and list of notified sites, under sections 58 and 60 of the CLM Act, for sites located within 500 metres of the project site
  - NSW EPA's environment protection licence records under section 308 of the POEO Act
  - WaterNSW database for registered groundwater bores
- Reviewing publicly available data and web-based information searches, background information relevant to the study area, survey data, and topography including:
  - Historical aerial photographs from the NSW Government Land and Property Information website
  - Australian Soil Resource Information System (maintained by the Commonwealth Scientific and Industrial Research Organisation (CSIRO))
  - *Geology of the Sydney 1:100,000 Sheet 9130* (Herbert, 1983)
  - *Soil Landscapes of the Sydney 1:100,000 Sheet map* (9130) (Chapman and Murphy, 1989)
  - NSW Soil and Land Information System
  - NSW Government acid sulfate soils risk mapping
  - Maps published by the Geological Survey of NSW, former Department of Conservation and Land Management, and Australian Soils Resource Information System

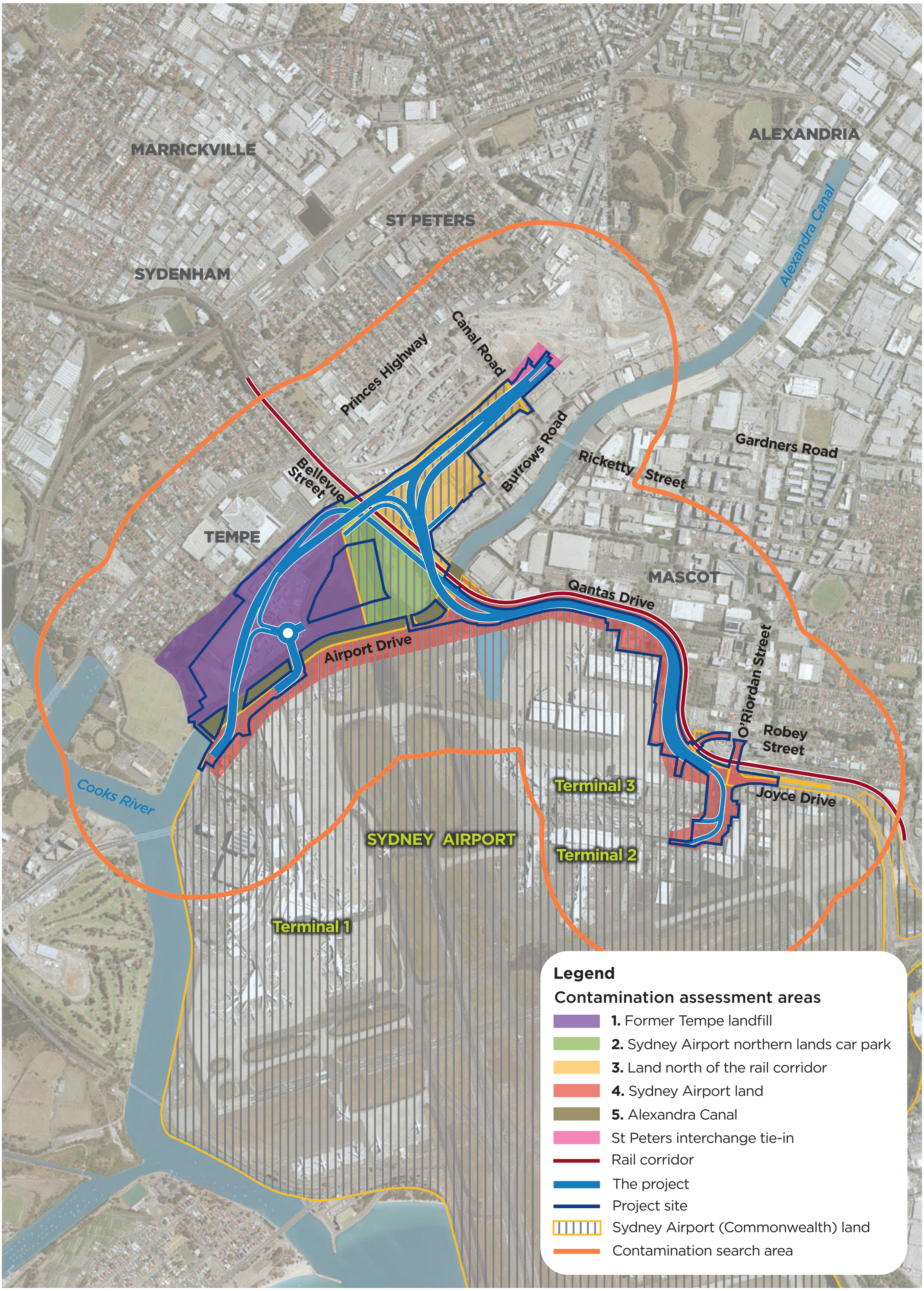
- Reviewing previous contamination assessments applicable to the project site, including those provided by Sydney Airport Corporation
- A site visit in December 2018 to compare site conditions to the conditions documented in historical reports and identify potential sources of contamination in the project site
- Reviewing intrusive investigations undertaken by Roads and Maritime between November 2018 and February 2019. These investigations included soil sampling at 66 locations and installation of 34 groundwater monitoring wells and 20 landfill gas monitoring wells throughout the project site. Sampling locations are shown in Appendix F of Technical Working Paper 5 (Contamination and Soils)
- Compiling a conceptual site model for the assessment areas to identify potential contamination sources, receptors and exposure pathways
- Identifying the potential to disturb acid sulfate soils and areas of salinity
- Assessing potential construction and operation impacts that may result from contaminated land or groundwater, including a preliminary qualitative risk assessment to identify the severity of impacts
- Assessing the potential impacts on soils
- Identifying mitigation measures to reduce or minimise identified impacts.

13.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Contamination and soils risks with an assessed level of medium or above, identified by the environmental risk assessment, included:

- Management and disposal of leachate from the former Tempe landfill where the removal of the capping layer results in the infiltration of rainwater and the production of additional leachate that may not be managed by the existing leachate system
- Disturbance of the capping layer, leachate and gas management systems at the former Tempe landfill due to sub-surface works being undertaken in this area
- Disturbance/mobilisation of landfilled materials and contaminants at the former Tempe landfill where sub-surface works such as excavation have the potential to extend deeper than the existing capping layer
- Disturbance/mobilisation of contaminated sediments in Alexandra Canal as a result of construction in the canal or the operation of new stormwater outlets
- Interaction with potentially contaminated soils and groundwater as a result of sub-surface disturbance during construction and operation, including disturbance and potential migration/mobilisation of contaminants (such as per-and poly-fluoroalkyl substances (PFAS))
- Release of potentially contaminated groundwater where construction activities such as piling and trenching intercept groundwater and dewatering is required
- Dewatering, management and disposal or discharge of contaminated groundwater and/or managing the disposal of contaminated soils encountered during construction in areas where existing contamination is present
- Contamination of soils and groundwater due to spills or leaks of fuels, oils or other hazardous substances during construction and operation
- Direct contact and/or inhalation of contaminated soil and/or groundwater by site workers where construction and operational activities result in the exposure of existing contamination.

In some instances the design has been modified to avoid the risks noted above. This is described further in Chapter 6 (Project alternatives and options). Where the risks cannot be avoided through project design or construction planning the contamination and soils assessment included consideration of these potential risks.



0 0.5 1.0km N

Figure 13.1 **Contamination assessment areas**

13.2 Existing environment

13.2.1 Topography and geology

The project site is relatively flat and low-lying, with gentle undulations. The topography generally slopes gently upwards from zero metres Australian Height Datum in the south, west and north-west of the project site, to elevations of 30 to 40 metres Australian Height Datum in the north-east, east and south-east. Areas of higher elevations are also present across the former Tempe landfill.

A band of Ashfield Shale underlies a series of low crests running north-east to south-west, parallel to the western part of the project site. Ashfield shale comprises black to dark grey shale and laminate. Minor occurrences of Hawkesbury Sandstone are also mapped to the west of the Cooks River. These geological units are overlain by Quaternary sediments, which infilled drowned river valleys that were incised into the bedrock. These sediments, referred to locally as the Botany Sands, are composed of predominantly unconsolidated to semi-unconsolidated permeable sands interspersed with lenses and layers of peat, peaty sands, silts and clays (low permeability).

Reclamation and stabilisation of Sydney Airport land altered the original southern drainage channel networks of Alexandra Canal and Cooks River, which were diverted around the airport. Other influences on landform include drainage and reclamation of the original swamps, estuaries and wetlands that surrounded Botany Bay, landfill activities, and extensive cut/fill works.

Most of the project site is mapped as ‘disturbed terrain’, which extends across Sydney Airport land, the lower reaches of the Cooks River, Alexandra Canal, Mascot, and into Tempe and St Peters. Disturbed terrain is described as areas extensively disturbed by human activity, including complete disturbance, removal or burial of original soils.

Introduced fill, including dredged estuarine sand and mud, demolition rubble, industrial and household waste, is also found within the project site.

13.2.2 Soils

Soil types

Soil landscapes within the project site predominantly consist of disturbed terrain, with the exception of the north-western extent of the project site, which is underlain by the residual Blacktown soil landscape and the aeolian Tuggerah soil landscape. The key characteristics of these soil landscapes are listed in Table 13.1.

Table 13.1 Soil landscapes

Soil landscape	Characteristics	Erosion/mass movement potential
Disturbed terrain	Original soil materials have been removed, greatly disturbed or buried, and landfill, including soil, rock, building and waste materials, may have been added.	The erosion potential of this soil landscape depends on the nature of the disturbed soil or fill. Could result in mass movement hazard, soil impermeability and poor drainage. Source of sedimentation and groundwater contamination.
Blacktown (residual landscape)	Shallow to moderately deep (less than one metre deep) red and brown podzolic soils. Occurs on gently undulating rises on Wianamatta Group shales and Hawkesbury shale.	Soils are moderately reactive, highly plastic with poor drainage. No appreciable erosion occurs in this unit. The land surface above this soil landscape within the project site is generally paved.
Tuggerah (Aeolian landscape)	Deep (greater than two metres) podzols on dunes and podzol/humus intergrades on swales. Occurs on gently rolling coastal dune fields.	Limitations include extreme wind erosion hazard, non-cohesive and highly permeable soil, very low soil fertility, localised flooding, and permanently high water tables.

Soil salinity

Salinity has the potential to damage foundations of infrastructure, make soils unsuitable for re-use as fill, and may affect landscaping. Saline soil and water has the potential to damage concrete and metal structures, including bridge piers and foundations.

Most of the project site is classified as having low salinity potential. The following areas (shown on Figure 13.2) are classified as having high salinity potential:

- An area in the Sydney Airport northern lands car park (assessment area 2), immediately north of Alexandra Canal
- An area north of the rail corridor (assessment area 3), to the west of the St Peters interchange.

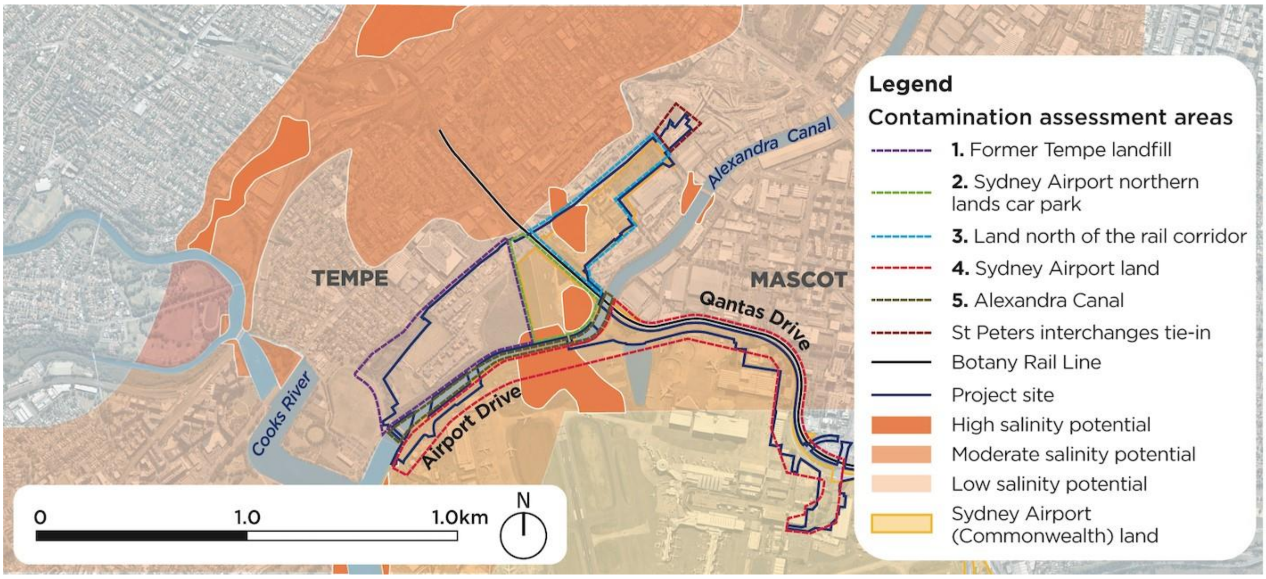


Figure 13.2 Salinity potential

Acid sulfate soils

Acid sulfate soils and potential acid sulfate soils are naturally occurring soils containing iron sulfides. On exposure to air, iron sulfides oxidise and create sulfuric acid. This increase in acidity can result in the mobilisation of aluminium, iron and manganese from the soils.

The CSIRO Australian Soil Resource Information System indicates that there is a low probability of acid sulfate soils within most of the project site, except for Alexandra Canal and low lying areas surrounding the canal, which are mapped as potentially containing acid sulfate soils.

Table 13.2 lists acid sulfate risk classifications for land within and in the vicinity of the project site. The risk classifications are based on the NSW Government acid sulfate soil risk mapping. Acid sulfate soil risk mapping is shown on Figure 13.3.

Table 13.2 Acid sulfate soil classifications

Location	Acid sulfate soil class	Work that would potentially expose acid sulfate soils
Alexandra Canal	1	Any work below natural ground
Former Tempe landfill (assessment area 1), Sydney Airport northern lands car park (assessment area 2), land north of the rail corridor (assessment area 3) and Sydney Airport land (assessment area 4)	2	Work beyond the natural ground surface and work by which the water table is likely to be lowered
St Peters interchange north of Canal Road	3	Work beyond one metre below natural ground surface and work by which the water table is likely to be lowered one metre below natural ground surface
Joyce Drive, east of the intersection with O'Riordan Street	4	Work more than two metres below the natural ground surface and work by which the water table is likely to be lowered by more than two metres below natural ground surface.

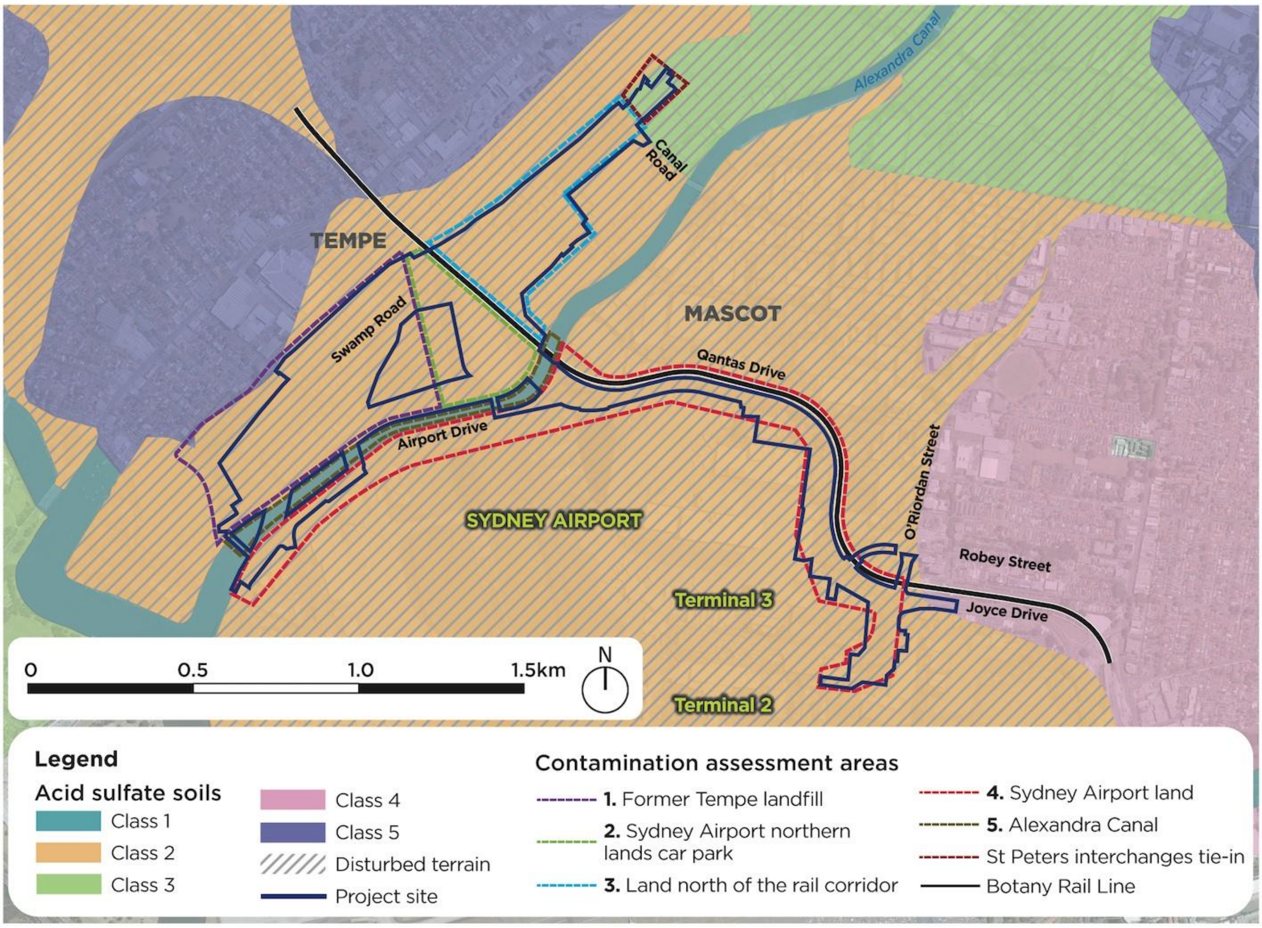


Figure 13.3 Acid sulfate soils risk mapping

13.2.3 Surface water

The project site is located in the Botany Bay catchment area, which includes two river catchments – the Cooks River catchment and the Georges River catchment.

Surface water features near and within the project site include Alexandra Canal, Tempe Wetlands, Mill Stream and Botany Bay to the south-east. Constructed ponds, which are known as the northern ponds, are located on Sydney Airport land and discharge to Alexandra Canal. Most of the project site drains to Alexandra Canal with a small portion of Sydney Airport land draining to Mill Stream.

Further information on surface water features and hydrology is provided in Chapter 16 (Surface water).

13.2.4 Hydrogeology

There are two main groundwater systems beneath the site – a deeper groundwater system associated with the Triassic aged, fractured/porous Hawkesbury Sandstone, and a shallow, highly permeable system within the Quaternary aged marine sands, referred to as the Botany Sands aquifer. The project is likely to intersect the Botany Sands aquifer.

The Botany Sands aquifer extends north and east from Botany Bay to Surry Hills and Centennial Park. The flow directions within the aquifer are generally controlled by topography. Groundwater flows south and south-west from the recharge areas located at higher elevations north-east of the Botany Basin, towards rivers and other tributaries, and into Botany Bay.

The Botany Sands aquifer has a relatively shallow water table and is readily recharged by rainfall. The level of groundwater under Sydney Airport is an average of three metres below the ground surface. However, the level can often be less than one to two metres below the ground surface, with the level varying in relation to recharge from rainfall and evaporation. The Botany Sands aquifer is highly vulnerable to contamination due to the permeability of the sands and shallow depth of the aquifer. Historical industrial land uses in the area have included chemical manufacturing, fuel storage, tanneries, metal electroplaters, service stations, landfills, dry cleaners and wool scorers. These industries have resulted in the potential and known occurrence of a wide range of pollutants in groundwater.

Due to the extent of known contamination, and to ensure that public health is not put at risk, the NSW Government has placed controls on the extraction and use of groundwater in some areas. The project site is located in the Botany Groundwater Management Area 2 (see Figure 13.4). In this area, domestic bore water use is prohibited and the extraction of groundwater for industrial and irrigation purposes is restricted unless water is proven to be suitable for use.

Further information on groundwater is provided in Chapter 15 (Groundwater).

13.2.5 Areas of contamination concern

This section provides an overview of the areas of contamination concern located in each of the assessment areas considered by the contamination assessment, identified as an outcome of the desktop review of existing information and data. It includes contaminated sites located within 500 metres of the project site (shown on Figure 13.4) that have been notified under section 60 of the CLM Act or otherwise reported to the NSW EPA. It also describes other areas of concern with respect to contamination (also shown on Figure 13.4). There are no public contaminated site registers for Commonwealth-owned land, including Sydney Airport land.

Key previous and existing land uses are described for each area. Further information on land use and properties in the project site is provided in Chapter 19 (Land use and property).

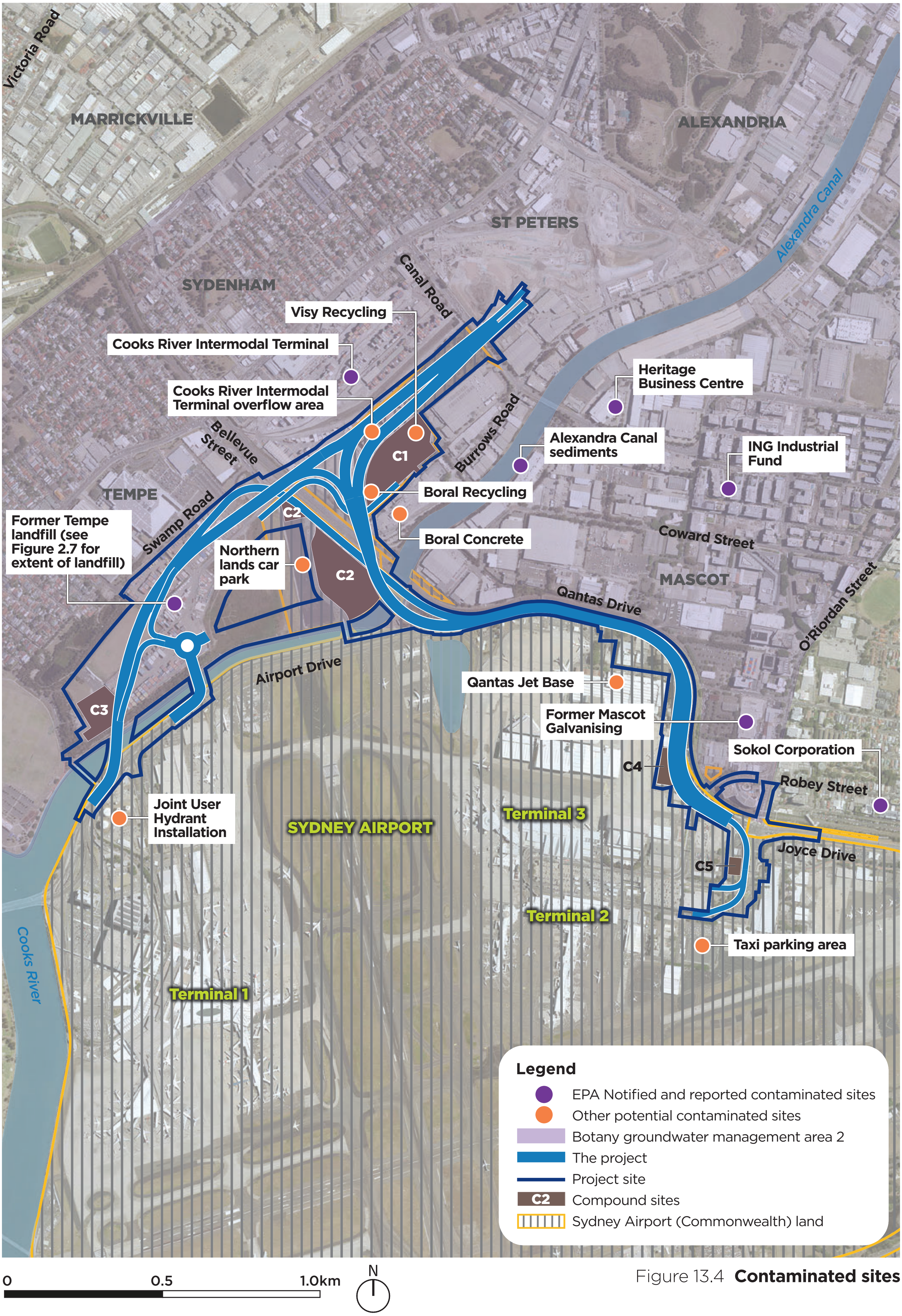


Figure 13.4 **Contaminated sites**

Former Tempe landfill (assessment area 1)

Land use

This area incorporates a portion of the former Tempe landfill, which was used as a council operated landfill between 1910 and the mid-1970s. During this period the landfill received a wide range of waste, including general domestic waste, liquid waste, industrial waste and hazardous waste (referred to as stage 1 fill). Part of the site was used as a scrapyard once landfill operations ceased.

In 2000, Marrickville Council was issued an environment protection licence (number 6665) for filling activities, which included acceptance of green waste, minor quantities of putrescible waste, demolition waste from road works and building maintenance, and council clean-up waste (referred to as stage 2 fill). This environment protection licence was surrendered in 2004, subject to surrender conditions amended in 2006. These conditions included regular monitoring of existing gas monitoring wells and of gas accumulation in commercial buildings, certain residential buildings, and utility trenches.

Current uses of this area include recreation/open space (uses within the Tempe Lands) and industrial (Tyne Container Services).

Desktop search results

A search of the NSW EPA's contaminated land record and of the NSW EPA's record of notices identified the former Tempe landfill (notified/reported to the NSW EPA as the former Tempe Tip) as a site that is currently regulated under the CLM Act and declared as a remediation site. In July 2000, the NSW EPA declared the former Tempe landfill a remediation site under section 21 of the CLM Act as a result of leachate migrating off-site towards Alexandra Canal. The leachate was found to be mainly affected by metals and ammonia. The remediation order issued to the former Marrickville Council required that a remediation action plan (RAP) be prepared to address the contaminant migration into Alexandra Canal.

Marrickville Council subsequently entered into a voluntary remediation proposal, which was approved by the NSW EPA in 2014. The voluntary remediation proposal requires that the water quality of Alexandra Canal is not adversely impacted by leachate originating from the former landfill site. It also included requirements to install infrastructure at the former landfill site to mitigate environmental risk.

A bentonite cut-off barrier wall was constructed in 2004 along the southern, eastern and western boundaries of the landfill to prevent leachate migrating into Alexandra Canal. A leachate collection and treatment system was also installed to treat leachate before discharge to wastewater via a trade waste agreement with Sydney Water.

Between 2004 and 2006, the surface of the former landfill was regraded and capped to minimise water infiltration and provide enhanced protection to people and the environment. The composition and thickness of the cap varies across the site. It generally comprises inert waste (concrete, sandstone, etc) and virgin excavated natural material overlain by either bitumen/asphalt or topsoil and turf/vegetation.

Between 2005 and 2009, landfill gas monitoring was carried out in accordance with conditions required under the environment protection licence surrender notice. The monitoring results indicated that off-site landfill gas migration was occurring through the north-western site boundary. A passive interception and venting trench was installed along the impacted boundary to address this issue. The trench extends into Ikea's site.

An environmental management plan (EMP) was developed for the Tempe Lands in 2006 to implement controls on future development and provide for maintenance works to manage residual contamination.

A Site Audit Statement was prepared in 2009 that documents the completeness of the voluntary remediation agreement and certifies the suitability of the area for various land uses, subject to the implementation of the EMP.

Potential contamination

Table 13.3 provides an overview of potential contamination sources and contaminants of concern within this area, including results of previous and recent site investigations.

Table 13.3 Overview of potential contamination within the former Tempe landfill (assessment area 1)

Potential source of contamination	Contaminants of potential concern[1]	Outcomes of site investigations
▪ Landfilling of the site during operation as a landfill ▪ Current container storage activity in a portion of the site ▪ Historic weed and insect control on vacant areas	▪ Total recoverable hydrocarbons (TRH) ▪ Polycyclic aromatic hydrocarbons (PAHs) ▪ Asbestos containing materials ▪ Heavy metals ▪ Phenols ▪ Polychlorinated biphenyls (PCBs) ▪ PFAS ▪ Pesticides (organochlorine and organophosphorus pesticides) ▪ Volatile organic compounds ▪ Semi volatile organic compounds ▪ Nutrients (in groundwater) ▪ Landfill gas (carbon monoxide, carbon dioxide, hydrogen sulfide and methane)	**Soil** ▪ Elevated concentrations of contaminants were encountered across the site at varying depths ▪ Hotspots of TRH, PAHs and heavy metals in fill materials were found to exceed relevant criteria ▪ Low levels of PFAS compounds were detected in most soil samples tested. All PFAS concentrations were below the PFAS NEMP health criteria for recreational users and commercial workers ▪ Potential asbestos containing materials were identified **Groundwater** ▪ Concentrations of ammonia and heavy metals exceeded assessment criteria ▪ Low levels of hydrocarbons and PFAS were reported **Other** ▪ Landfill gas concentrations recorded across the assessment area ▪ The maximum gas screening value recorded within the site falls into 'characteristic gas situation 2' low risk conditions (NSW EPA, 2012) ▪ High concentrations of methane and carbon dioxide were detected

Note: 1. Contaminants of potential concern are based on previous and current activities undertaken in the assessment area.

Sydney Airport northern lands car park (assessment area 2)

Land use

This area has been used for commercial/industrial uses since 1930. A bulk fuel storage depot operated at the site from 1930 until between 1950 and 1970.

Currently, the area is mainly used for parking by Sydney Airport staff. A small strip of vegetation is located between Alexandra Canal and the car park. The car park is fully sealed with asphalt.

Desktop search results

No sites listed on NSW EPA's contaminated land record or NSW EPA's record of notices are located within this area.

The area is impacted by its former use for commercial/industrial activities as well as the historical migration of landfill gas from the adjoining former Tempe landfill. Sydney Airport has undertaken staged investigation and remediation of the site, to render the site suitable for its use as a car park.

Remediation works were undertaken in the western portion of the assessment area in 2015. These works involved removing contaminated soil, followed by installing a gas venting system and capping layer. The capping layer comprises the sealed surface, underlain by clean fill and a geotextile marker layer.

Remediation works were undertaken in the centre of the assessment area in 2016. These works involved capping to address soil contamination in fill material, including the presence of asbestos containing materials. The capping layer consists of a geotextile marker layer overlain with clean fill to a maximum of 0.8 metres deep.

Remediation works within the eastern section of the assessment area are still pending.

The assessment area is managed by Sydney Airport Corporation in accordance with a long-term EMP prepared in January 2017, which documents the procedures to be followed during any future works in this area. The EMP requires ongoing inspections in the centre of the area to monitor erosion of the cap and the presence of landfill gas. For the western portion of the assessment area, this EMP has been superseded by another EMP that documents the requirements for maintaining the gas venting system.

Potential contamination

Table 13.4 provides an overview of potential contamination sources and contaminants of concern within this area, including results of previous and recent site investigations.

Table 13.4 Overview of potential contamination within the Sydney Airport northern lands car park (assessment area 2)

Potential source of contamination	Contaminants of potential concern[1]	Outcomes of site investigations
▪ Historic bulk fuel storage ▪ Historic general commercial/industrial activity ▪ Historic uncontrolled site filling ▪ Potential firefighting activity (firefighting foam) ▪ Adjacent landfill activities (former Tempe landfill)	▪ TRH ▪ PAHs ▪ Heavy metals ▪ Asbestos ▪ Phenols ▪ Nutrients (including ammonia) ▪ Landfill gas ▪ PFAS	**Soil** ▪ Asbestos identified within fill material across the area (bonded asbestos containing materials and asbestos fines/fibrous asbestos) ▪ Hotspots of TRH, PAHs and lead in fill material exceeded criteria in Schedule 2 of the Airports (Environment Protection) Regulations 1997 **Groundwater** ▪ Ammonia, phosphate and heavy metals exceeded assessment criteria ▪ PFAS detected in groundwater. Concentrations reported in one monitoring well location exceeded NEMP ecological (95 per cent protection) criteria **Other** ▪ Landfill gas including methane concentrations recorded ▪ The maximum gas screening value recorded falls into ‘characteristic gas situation 3’ moderate risk conditions (NSW EPA, 2012)

Note: 1. Contaminants of potential concern are based on previous and current activities undertaken in the assessment area.

Land north of the rail corridor (assessment area 3)

Land use

This area has had an extensive industrial history and has been filled with uncontrolled fill. Buildings adjacent to the south of the area were built as wool stores and contained asbestos containing material and potentially other hazardous building materials. The buildings were damaged by a large gas explosion in 1990.

This assessment area is currently occupied by commercial/industrial tenants including Cooks River Intermodal Terminal, Boral Recycling and Visy Paper. The leased Cooks River Intermodal Terminal overflow area within the centre of the assessment area is occupied by stored shipping containers and driveways with large unsealed areas. A vacant, vegetated area located immediately east of Canal Road appears to have been artificially raised using fill.

Desktop search results

A search of the NSW EPA's contaminated land record and record of notices identified the 'Cooks River Rail Terminal' (the Cooks River Intermodal Terminal) as a contaminated site notified to the NSW EPA. This listing refers to the land used to operate the Cooks River Intermodal Terminal, a portion of which is located at the northern edge of this assessment area. This site has a documented history of industrial use since 1947.

A search of the NSW EPA's record of facilities licensed under the POEO Act identified the Boral Recycling and Visy Recycling sites within the project site as holding current environment protection licences, despite being located on Sydney Airport land.

The search also identified the Heritage Business Centre within 500 metres of this area (see Figure 13.4). These sites do not require regulation under the CLM Act, therefore it is assumed that the EPA has not identified significant contamination migrating off-site at levels that could pose a risk to human health or the environment.

Potential contamination

Previous investigations within Lot 2 in DP802342 (the southern portion of assessment area 3) reported elevated concentrations of PAHs and heavy fraction petroleum hydrocarbons. Potential free tar and fragments of asbestos containing materials were also observed.

Table 13.5 provides an overview of potential contamination sources and contaminants of concern within this area, including results of previous and recent site investigations.

Table 13.5 Overview of potential contamination within land north of the rail corridor (assessment area 3)

Potential sources of contamination	Contaminants of potential concern[1]	Outcomes of site investigations
▪ Historic general commercial/industrial activity ▪ Historic uncontrolled site filling ▪ Asbestos containing materials in soil from previous buildings ▪ PCBs in soil ▪ Current freight storage activity.	▪ TRH ▪ PAHs ▪ Heavy metals ▪ Asbestos ▪ Phenols ▪ PCBs ▪ PFAS ▪ Pesticides	**Soil** ▪ Hotspots of TRH, PAHs, benzene, toluene, ethylbenzene and xylenes (BTEX), heavy metals and asbestos detected in fill above assessment criteria ▪ PCBs identified in one location ▪ PFAS concentrations reported above the NEPM ecological criteria (discrete areas only) ▪ Seepage of tar-like material was observed in one location in the south-west portion of the area **Groundwater** ▪ Ammonia, phosphate, heavy metals and PFAS concentrations in groundwater exceeded assessment criteria. On-site and off-site sources may have contributed to groundwater contamination ▪ A previous well had TRH above groundwater criteria but was removed in 2012.

Note: 1. Contaminants of potential concern are based on previous and current activities undertaken in the assessment area.

Sydney Airport land along Alexandra Canal and Qantas Drive (assessment area 4)

Land use

This area has historically been used as an aerodrome since 1919. The assessment area is currently used for Sydney Airport operations and road transport (Airport Drive, Qantas Drive and Joyce Drive). The Jet Base and Qantas Flight Training Centre is located within the north-eastern corner of the assessment area (adjacent to Qantas Drive). The base includes a number of buildings and structures that would be removed as part of the project (see Chapter 8 (Construction)).

The northern ponds are located west of the Jet Base. The ponds, which provide flood mitigation and a spill control function for the airport, discharges to Alexandra Canal.

Joint User Hydrant Installation (JUHI) (a Sydney Airport tenant) operates a bulk fuel storage terminal adjacent to Airport Drive on Sydney Airport land.

Desktop search results

Two sites listed on NSW EPA's contaminated land record are located within 500 metres of this area (ING Industrial Fund and Former Mascot Galvanising – see Figure 13.4). Contamination on the Former Mascot Galvanising site is currently regulated under the CLM Act and this site is also listed on NSW EPA's record of notices.

Potential contamination

There are a number of known contaminated groundwater plumes located in land within Qantas's lease areas within Sydney Airport, including the Jet Base. Site investigations identified a number of contaminants in the soil and/or groundwater, including hydrocarbons, PAHs, PFAS and heavy metals.

The JUHI site is impacted by hydrocarbons that are managed under a RAP. Remediation activities have included removing liquid hydrocarbons where possible and regular groundwater monitoring of the hydrocarbon plume.

Table 13.6 provides an overview of potential contamination sources and contaminants of concern within this area, including results of previous and recent site investigations.

Table 13.6 Overview of potential contamination within Sydney Airport land (assessment area 4)

Potential sources of contamination	Contaminants of potential concern[1]	Outcomes of site investigations
▪ Historic uncontrolled site filling ▪ Historic general and Sydney Airport commercial/industrial activity ▪ Fuel storage and firefighting training ▪ Jet Base ▪ Taxi parking area light non-aqueous phase liquid plume (down-hydraulic gradient)	▪ TRH ▪ PAHs ▪ Heavy metals ▪ Asbestos ▪ Phenols ▪ PCBs ▪ Volatile halogenated compounds ▪ PFAS	**Soil** ▪ No significant soil contamination identified ▪ PAHs hotspot directly beneath project site ▪ TRH, BTEX, PAHs, heavy metals and asbestos detected in fill material within adjacent airport areas **Groundwater** ▪ Concentrations of heavy metals directly beneath project site exceeded the assessment criteria. Groundwater contamination likely attributed to background concentrations or off-site sources ▪ TRH, chlorinated solvents, PAHs, ammonia, sulphide and heavy metals found in down-hydraulic gradient airport areas exceeded groundwater criteria (as per Schedule 2 of the Airports (Environment Protection) Regulations 1997) ▪ Light non-aqueous phase liquid was recorded in six of the monitoring wells gauged, at thicknesses ranging between 0.1 m and more than 0.5 m, in down-hydraulic gradient locations ▪ PFAS exceeded NEPM criteria within the project site

Note: 1. Contaminants of potential concern are based on previous and current activities undertaken in the assessment area.

Alexandra Canal (assessment area 5)

Desktop search results

A search of the NSW EPA's contaminated land record and of the NSW EPA's record of notices identified that Alexandra Canal is listed on both databases and has been declared a remediation site as a result of contamination of bed sediments from historical industrial activities in the local area.

Due to the type and levels of contaminants, the NSW EPA determined that the bed sediments have the potential to present a significant risk of harm to human health and the environment if disturbed. The NSW EPA consequently issued Sydney Water with a remediation order (number 23004) under the CLM Act to regulate sediment disturbance.

Potential contamination

Contaminants of concern that have previously been identified in Alexandra Canal sediments include:

- pH
- Petroleum hydrocarbons
- PAHs
- PCBs
- Pesticides
- Asbestos
- Metals
- Speciated nitrogen
- Organotin compounds
- PFAS.

Investigations undertaken for the assessment identified:

- Concentrations of metals, TPH, PAHs, PCBs and pesticides in sediment exceeding the ecological criteria
- Asbestos detected in 13 of the sediment samples collected
- PFAS compounds detected, however concentrations were below the NEMP criteria
- Organotin compounds detected – organotin waste materials are subject to a chemical control order under Part 3, Division 5 of the *Environmentally Hazardous Chemicals Act 1985* (NSW).

Surface water quality investigations undertaken for the project (see Chapter 16 (Surface water)) identified:

- Samples obtained from Alexandra Canal frequently exceeded ANZECC guidelines default trigger values for total nitrogen, total phosphorus, aluminium, iron, manganese, mercury, zinc and ammonia
- PFAS compounds, including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), were detected in samples obtained from Alexandra Canal
- PFAS was detected in samples taken from up-stream sampling points
- Concentrations of PFAS were below the nominated criteria.

13.2.6 Summary of contaminated areas and existing soils on Sydney Airport (Commonwealth) land

Contaminated areas

The following assessment areas considered by the assessment are located on Sydney Airport land:

- Sydney Airport northern lands car park (assessment area 2)
- Land north of the rail corridor, with the exception of the northern and southern extents (assessment area 3)
- Sydney Airport land along Alexandra Canal and Qantas Drive (assessment area 4).

Soil and groundwater impacted with contaminants above health and/or environmental criteria is present in these areas. Detectable concentrations of PFAS in soil and groundwater, including concentrations above the NEMP criteria, have been reported across all of these areas.

Additional contamination issues identified include:

- Landfill gas recorded in Sydney Airport northern lands car park
- Fill material, including asbestos containing materials and other contaminants, across the Sydney Airport northern lands car park has been subject to ongoing remediation
- Light non-aqueous phase liquid identified in groundwater beneath the Jet Base, down-gradient of the project site.

Soils

Soils on Sydney Airport land are mapped as ‘disturbed terrain’. Reclamation and stabilisation in the area has altered the original topography of the site and drainage patterns.

Areas mapped as having high salinity potential are shown on Figure 13.2 and include the following areas on Sydney Airport land:

- In Sydney Airport northern lands car park (assessment area 2), immediately north of Alexandra Canal
- In land north of the rail corridor (assessment area 3), to the west of the St Peters interchange.

13.3 Assessment of construction impacts

13.3.1 Potential to encounter contamination

There is potential for contamination to be encountered across the project site. If inadequately managed, disturbance of contaminated areas has the potential to:

- Mobilise contaminants, affecting nearby soils, surface water and groundwater
- Increase the migration of contaminants into surrounding areas via leaching, overland flow and/or subsurface flow (water and/or vapour) or dust, with the potential to impact on receiving environments, such as Alexandra Canal, and the surrounding community
- Increase the risk of exposure to contaminants (direct contact and/or inhalation) by site workers, visitors and the local community.

The risk of disturbing or encountering contaminated material during construction varies depending on the extent and type of contamination and the work undertaken. A preliminary contamination risk evaluation (considering the potential for risks without implementation of appropriate controls or remediation) was undertaken to understand the potential risk of the identified areas of contamination concern. The risk evaluation was undertaken by assessing identified areas of contamination concern based on the likelihood of:

- Encountering contamination
- The exposure pathway for human and/or ecological receptors (demonstrated by the conceptual models provided by Figure 13.5 to Figure 13.8, which show the ways that contamination may be encountered).

The following risk categories were assigned:

- Low – impact can be managed by implementing standard construction management practices in accordance with relevant guidelines
- Medium – contamination specific management plans and controls are required
- High – engineered controls and/or environmental/health monitoring are required.

Table 13.7 summarises the findings of the preliminary contamination risk evaluation, providing impacts that would occur during works across all assessment areas, and additional impacts that are specific to assessment areas. It is noted that the following areas are not considered to have additional impacts beyond those mentioned for all areas:

- Land north of the rail corridor (assessment area 3)
- Rail corridor
- St Peters interchange tie-in.

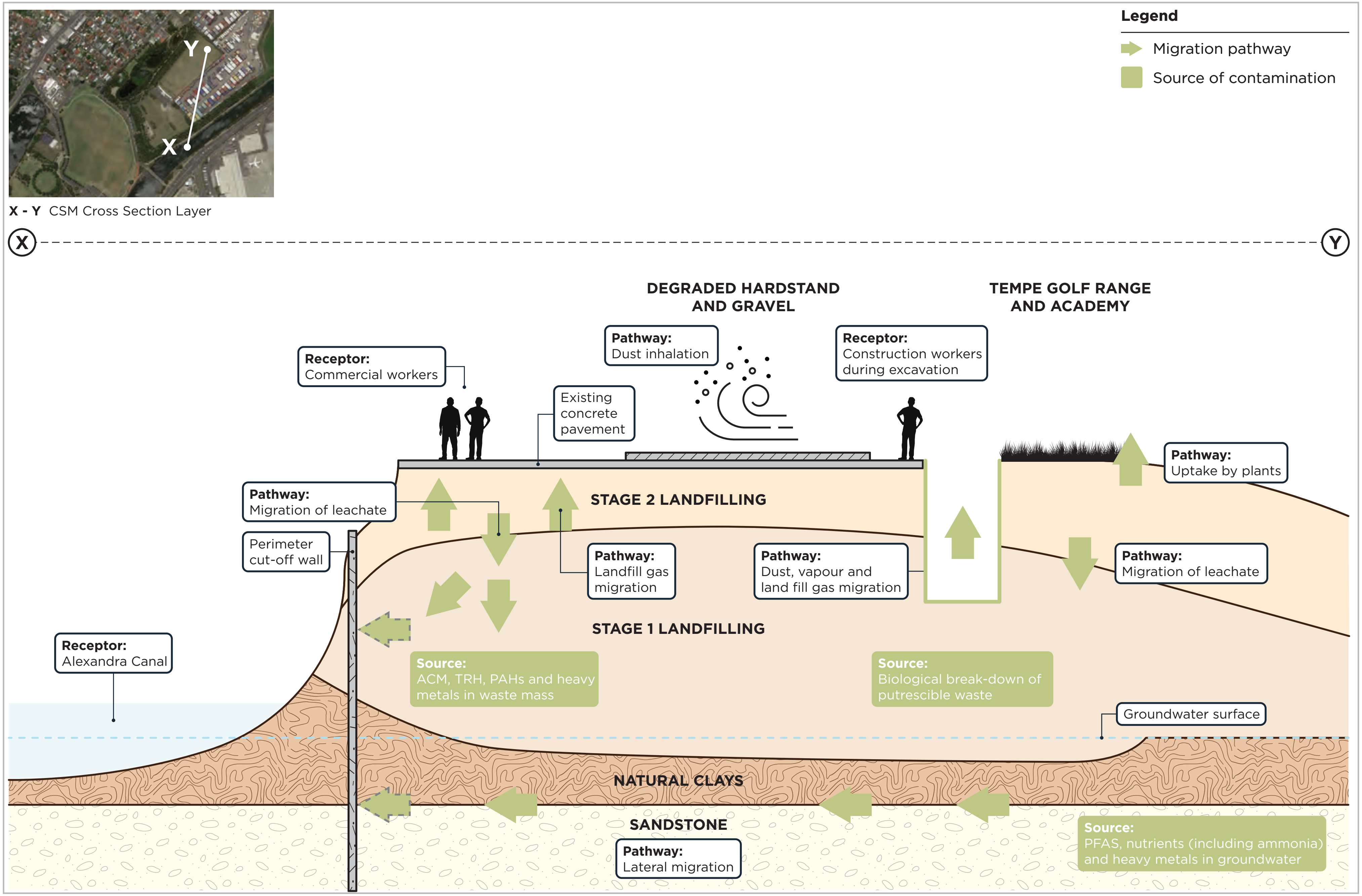


Figure 13.5 **Conceptual site model – former Tempe landfill**

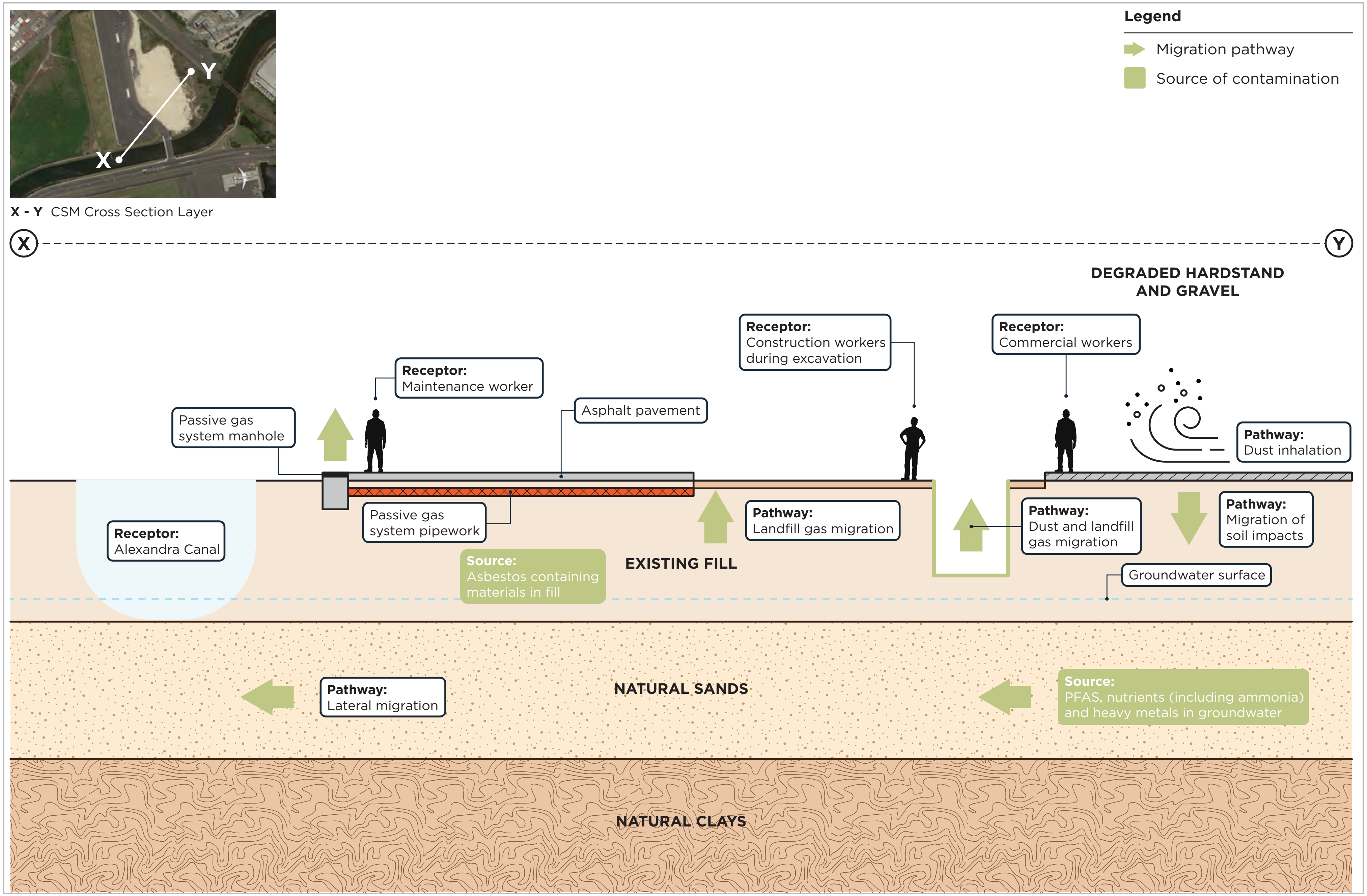


Figure 13.6 **Conceptual site model – Sydney Airport northern lands car park**

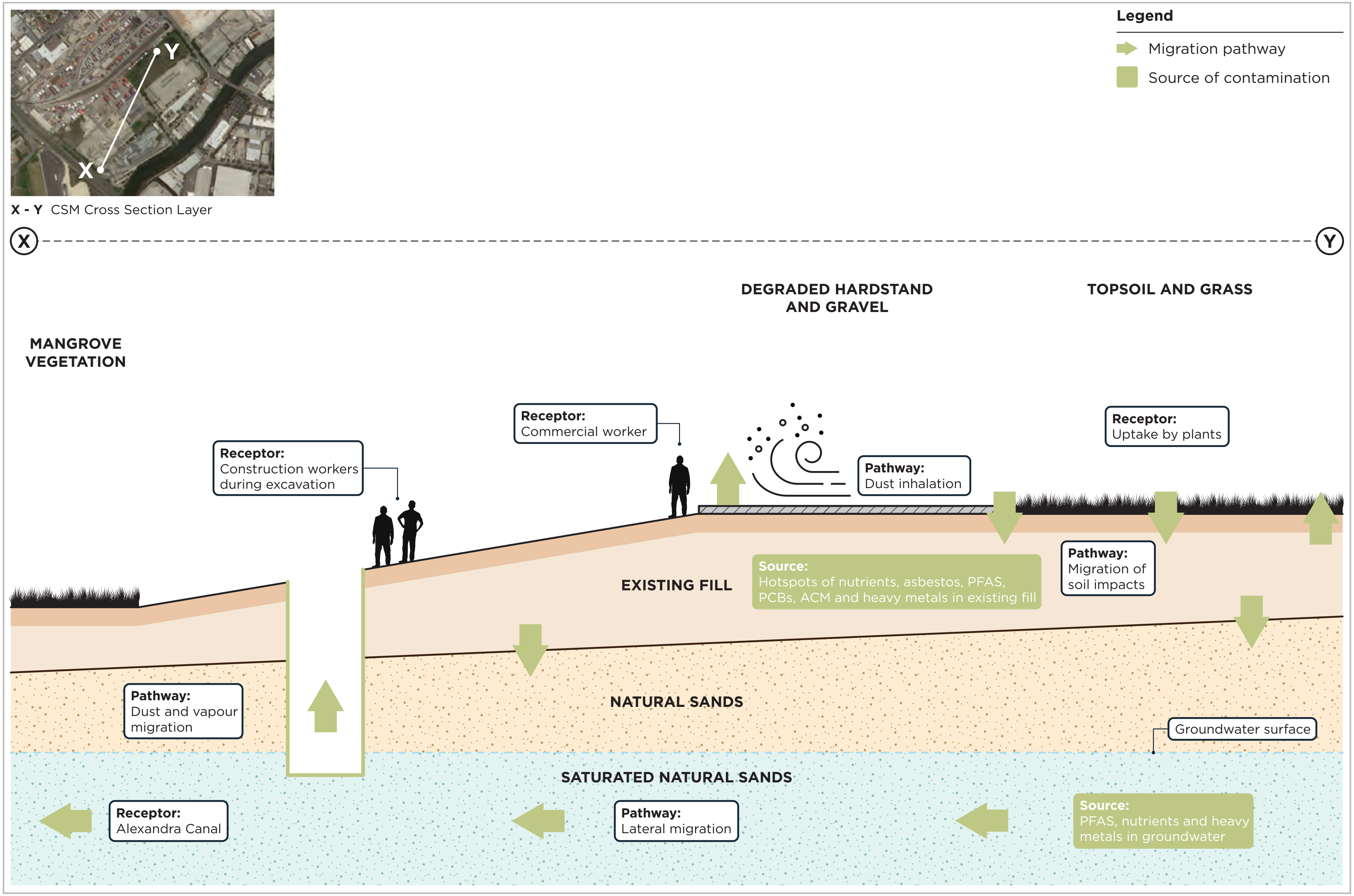


Figure 13.7 **Conceptual site model – Land north of the rail corridor**

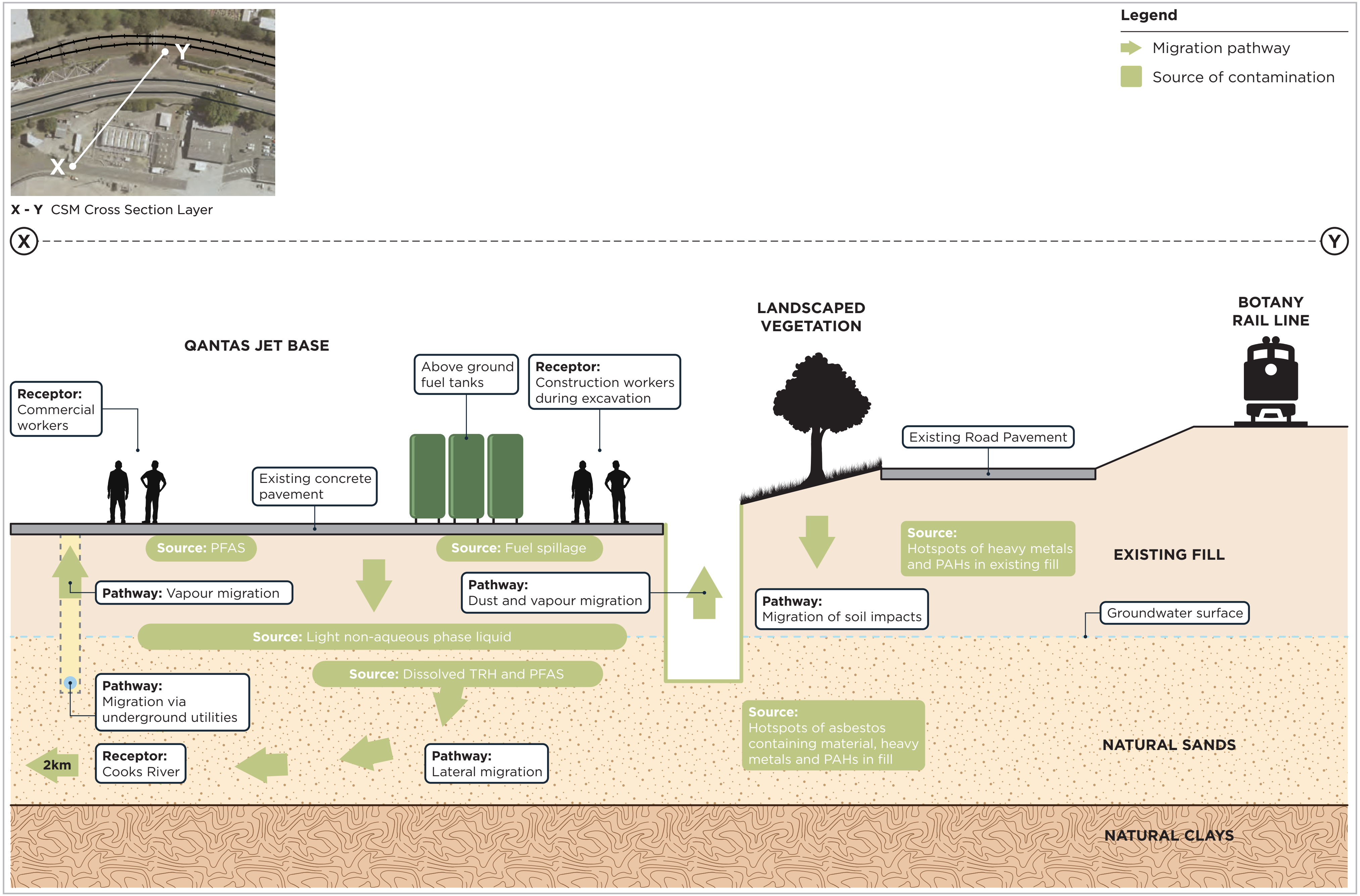


Figure 13.8 **Conceptual site model – Sydney Airport land**

Table 13.7 Preliminary contamination risk evaluation (without implementation of controls or remediation)

Assessment area	Construction activity	Potential impact	Risk rating	Mitigation required
All areas	Excavation and ground disturbance activities that would be undertaken across the project site, including but not limited to: ▪ Vegetation removal ▪ Construction compound establishment ▪ Vehicle movements on unsealed surfaces ▪ Installing drainage systems and utilities ▪ Excavation for retaining walls and embankments ▪ Piling for bridge piers ▪ Temporary spoil stockpiling ▪ Cut for final pavement levels.	Due to the presence of shallow contaminated groundwater, extraction of groundwater during excavation could result in contamination of the receiving surface water environment if any extracted groundwater is not treated adequately prior to discharge to surface water or stormwater.	High	Treatment and monitoring of groundwater would be undertaken prior to discharge. A dewatering management strategy would be developed to confirm the appropriate management approaches to minimise any impacts associated with dewatering (see Chapter 15 (Groundwater)).
		There is the potential for construction workers to either ingest or have contact with contaminated groundwater during excavation activities.	Low	Potential impacts would be mitigated by implementing standard construction safety measures, including the use of personal protective equipment.
		Due to the presence of contaminated soil, the disturbance of soils could result in erosion and contaminated and sediment laden run-off discharging to surface water or stormwater.	Medium	A Construction Soil and Water Management Plan would be prepared (in accordance with the Blue Book) and implemented as part of the CEMP to manage potential impacts associated with erosion and runoff (see section 13.6).
		The disturbance of contaminated soil could result in site workers and the community being exposed to dust containing contaminants, including airborne asbestos fibres, which exceed occupational health levels for inhalation.	Medium	A Construction Air Quality Management Plan would be prepared and implemented to mitigate potential dust and airborne fibres (see Chapter 12 (Air quality)). This would include a requirement for monitoring in accordance with work health and safety requirements.
		The movement of equipment, vehicles and personnel from unsealed areas containing soil contamination to 'clean' areas, either within the project site (eg compounds, areas without exposed soil contamination) or outside the project site could result in cross contamination. This could affect workers, via direct contact/ingestion, or the increased potential for contaminated sediment laden run-off.	Low	This would be managed by implementing standard environmental management measures as detailed in the Construction Soil and Water Management Plan, including street sweeping of tracked sediment and the provision of vehicle wash down areas.

Assessment area	Construction activity	Potential impact	Risk rating	Mitigation required
Former Tempe landfill (assessment area 1)	Excavation and ground disturbance activities across the assessment area including but not limited to: ▪ Excavation which would remove parts of the capping layer ▪ Excavation through the construction waste fill layer ▪ Emplacement of excavated material into emplacement mounds. ▪ Movement of plant and equipment ▪ Construction compound establishment and operation ▪ Piling for bridge piers near Alexandra Canal ▪ Installing drainage systems and utilities.	There is the potential for increased rainfall infiltration when the landfill cap is removed during excavation. This could result in additional leachate volumes, which may exceed current leachate management system capacity.	Medium	The EMP requires that approval is sought from a site auditor where there is a proposed change in land use from those outlined in the EMP or where removal of capping is significant. A RAP would be prepared to define how the landfill cap would be reinstated during construction (see section 13.6).
		The exposure of landfill material during excavation and construction of the emplacement mounds could result in increased potential for contaminated sediment laden run-off discharging to surface water or stormwater, particularly during rainfall events	Medium	A Construction Soil and Water Management Plan would be prepared and implemented as part of the CEMP to manage potential impacts associated with erosion and runoff (see section 13.6).
		Odours and landfill gas could be generated during works at the former landfill site, which could result in health and amenity impacts on workers and the surrounding community.	Medium	A Construction Air Quality Management Plan would be prepared and implemented to mitigate potential landfill gas and odour issues during construction (see Chapter 12).
		The weight from the emplacement mounds and other construction materials (including plant, equipment and construction compounds) has the potential to result in stability and settlement issues such as the movement or collapse of landfill material which could also result in the creation of fissures which release landfill gas and/or odour.	High	A settlement and slope stability analysis would be undertaken to ensure that the mounds and other construction material do not impact landfill stability. There may be a need to provide engineering controls where the placement of compounds, plant and/or equipment has the potential to impact stability (see section 13.6).
		Ground disturbance activities have the potential to damage the existing gas collection systems along the north-western boundary.	Low	The presence of the gas collection systems would be identified on site plans and avoided as far as possible (see section 13.6).
		Ground disturbance activities could damage the leachate collection system (eg sumps and pipes) and change established leachate flow paths. Piling to support piers for the Terminal 1 connection bridge and the freight terminal bridge would be installed close to the existing bentonite cut-off wall. As the wall forms part of the leachate containment system, any potential impact to its	High	Detailed design would seek to avoid interactions with the bentonite cut-off wall. The vertical and horizontal location of the wall near the proposed bridge support structures would be established during detailed design, and a suitable buffer area established. Any works close to the wall would consider the existing leachate collection system (including

Assessment area	Construction activity	Potential impact	Risk rating	Mitigation required
		integrity could result in leachate entering Alexandra Canal. Piling would be undertaken very close to where the bentonite cut-off wall is located (the exact location/depth of the wall is still to be confirmed).		sumps and pumping equipment) and the stability of the canal bank. The RAP for this area will describe measures to protect the landfill management infrastructure during construction, or reinstate the infrastructure such that it continues to operate effectively after construction is finished (see section 13.6).
		Disturbance of the landfill cap and establishment of enclosed or confined places above the former landfill, including trenches for utilities and drainage, could result in the accumulation of gases creating an explosive atmosphere. This could also result in the depletion of oxygen levels inside compound buildings and trenches.	High	The cap would be reinstated and other controls would be provided to mitigate this risk, including ongoing monitoring during works (see section 13.6). Reinstatement of the cap would be outlined in the RAP for this area (see section 13.6). Measures to mitigate impacts associated with the accumulation of landfill gas would be included in the Construction Air Quality Management Plan (see Chapter 12).
Sydney Airport northern lands car park (assessment area 2)	Excavation and ground disturbance activities that would be undertaken across the project site, including but not limited to: ▪ Installation of drainage and utilities ▪ Temporary spoil stockpiling ▪ Cut for final pavement levels ▪ Piling for the Qantas Drive and terminal link bridges ▪ Construction compound establishment and operation	Nuisance odours and landfill gas could be generated during disturbance of the existing cap, which could affect worker and community health and amenity.	Medium	A Construction Air Quality Management Plan would be prepared and implemented to mitigate potential landfill gas and odour issues during construction (see Chapter 12).
		Ground disturbance activities have the potential to damage the existing gas collection system.	High	The gas venting system would be protected and/or relocated prior to works commencing. This would be undertaken in accordance with the EMP that applies to the area (see section 13.6).
		Disturbance of the cap and establishment of enclosed or confined places, including trenches for utilities and drainage, could result in the accumulation of gases creating an explosive atmosphere. This could also result in the depletion of oxygen levels inside compound buildings and trenches.	High	The cap would be reinstated and other controls would be provided to mitigate this risk, including ongoing monitoring during works. The cap would be reinstated in accordance with the EMP that applies to this area. Measures to mitigate impacts associated with the accumulation of landfill gas would be included in the Construction Air Quality Management Plan (see Chapter 12).

Assessment area	Construction activity	Potential impact	Risk rating	Mitigation required
Sydney Airport land (assessment area 4)	Drainage and utilities works	The presence of groundwater with light non-aqueous phase liquid and volatile contaminants reported in wells down-gradient of the project site could mean that there is the potential for volatile soils and groundwater to exist beneath this assessment area. This could result in the accumulation of volatile contaminants (from soil and/or groundwater) in confined space work areas.	Medium	Limited soil and groundwater assessment has been undertaken in this area. Further assessment would be undertaken to discount this potential risk (see section 13.6).
Alexandra Canal (assessment area 5)	Construction of stormwater outlets	Coffer dams would be used to construct stormwater outlets in Alexandra Canal and minimise sediment disturbance and mobilisation. The installing and removing the coffer dams, however, could disturb and mobilise contaminated sediments within the bed of the canal, which could affect water quality and aquatic ecosystems.	High	To limit the mobilisation of contaminated sediments, physical controls (such as silt curtains) would be put in place when installing and removing the coffer dams. This is discussed further in the section below the table.

Potential disturbance of contaminated sediments in Alexandra Canal

The project has been designed to minimise the disturbance of the Alexandra Canal bed sediments. Structural supports and foundations associated with the bridge crossings have been located outside of the canal walls.

The proposed stormwater system would connect into Alexandra Canal. The outlets would be constructed by first constructing coffer dams around the outlet locations. The water inside the coffer dam would then be removed so that the stormwater outlets could then be constructed without further sediment disturbance.

Installing and removing the coffer dams has the potential to disturb sediments within the bed of the canal and cause localised sediment plumes. Due to the contaminated nature of the sediments mobilisation of contaminated sediments would have the potential to affect water quality within the canal. However, these effects would be mitigated by using silt curtains, which would be installed around the coffer dams during installation and removal.

In accordance with the requirements of the remediation order for Alexandra Canal, and due to the presence of contaminated sediments, a management plan would be prepared for all works proposed within the canal (see section 13.6).

Potential water quality impacts associated with disturbing contaminated sediments within Alexandra Canal are discussed further in Chapter 16 (Surface water).

13.3.2 Potential to generate site contamination

If inadequately managed, construction activities have the potential to result in the contamination of soil due to:

- Accidental spills and leaks of fuel, oils, and other potentially contaminating substances, from plant and equipment or mishandling of dangerous goods stored on site
- Inadequate handling of contaminated materials and excavated waste
- Mobilisation of contaminants during demolition of structures, including buildings and services, which contain potentially contaminating substances such as asbestos and leaded paint.

The potential contamination of surface soils due to the above activities could affect groundwater through leaching, and/or surface water due to mobilisation of contaminated run-off. Additionally, there is the potential for the mobilisation of contaminated surface water during works on the stormwater pipe that connects the northern ponds, which could affect water quality in Alexandra Canal.

These potential impacts would be mitigated by implementing the mitigation measures provided in section 13.6. Hazardous materials surveys would be undertaken prior to the stripping and demolition of any buildings and structures. Hazardous materials would be removed and disposed of in accordance with relevant legislation, codes of practice, and Australian Standards. Mitigation measures are provided in Chapter 23 (Health, safety and hazards) to minimise the potential impacts of transport and handling dangerous goods and hazardous materials.

To avoid potential cross-contamination of soils, the reuse of materials for fill or other purposes would be subject to testing in accordance with the relevant guidelines prior to their use. Where materials are deemed unsuitable for reuse, or where there is a surplus of reusable material (eg fill), this would be managed in accordance with the management hierarchy and measures provided in Chapter 24 (Waste management).

13.3.3 Soil impacts

Soil erosion and sediment transport

Construction would temporarily expose the natural ground surface and sub-surface through the removal of vegetation, general excavation and soil disturbance, and the removal of hardstand surfaces including roads and footpaths.

Excavation and ground disturbance activities would expose and disturb soils, which if not managed adequately, could result in:

- Erosion of exposed soil and stockpiled materials
- Exposure of soil containing sulfidic material to oxygen, resulting in the production and mobilisation of sulfuric acid
- Increases in salinity levels in soil
- Potential for localised changes to landform such as earth embankments and cut or fill areas which could impact local hydrology
- Dust generation resulting in air quality impacts
- Mobilisation of contaminated sediments and contamination of surface water runoff, with resultant potential for environmental and human health impacts.

The potential for dust impacts is considered in Chapter 12 (Air quality). The potential for soil erosion impacts would be minimised by implementing a Construction Soil and Water Management Plan that would be prepared in accordance with the Blue Book, as described in section 13.6.

Acid sulfate soils

The exposure of acid sulfate soils to oxygen during disturbance can lead to the generation of sulfuric acid. The subsequent acidic leachate can then lead to mobilisation of heavy metals such as aluminium and iron into water bodies. Drainage from acid sulfate soils may affect water quality and can impact aquatic organisms.

Acid sulfate soils may be encountered during piling for bridge piers, excavation for stormwater drainage, utility works and outfall connections to Alexandra Canal. Additionally, dewatering for road construction could result in localised drawdown of the groundwater table which could temporarily expose potential acid sulfate soils to air.

Further investigations would be undertaken within areas of medium and high acid sulfate soil potential during detailed design. Due to the disturbed nature of the project site, all excavated soil for the project would be subject to the provisions of an acid sulfate soil management plan developed in accordance with the *Acid Sulfate Soils Assessment Guidelines* (ASSMAC, 1998). Once acid sulfate soils have been treated, depending on the results of testing, they could either be reused on site, or disposed of at an appropriate facility.

Salinity

The project would involve excavation and piling within areas of high salinity potential for the construction of the Terminal 1 connection, St Peters interchange connection, Qantas Drive upgrade and for the terminal links. High salinity soil can reduce or preclude vegetation growth and produce aggressive soil conditions, which may be detrimental to concrete and steel. Impacts may also occur as a result of the erosion and off-site transport of saline sediments, resulting in impacts on the receiving environment. However, given that receiving waters within the study area are saline, the potential for impacts to water quality due to off-site migration of saline sediments is considered to be negligible.

The potential for any impacts due to the presence of saline soils is considered to be low. Any potential impacts would be temporary and managed by implementing standard erosion and sediment control measures. Soils associated with areas of high salinity potential would be considered during detailed design and mitigation measures developed and implemented as appropriate to minimise impacts associated with salinity.

13.3.4 Summary of impacts on Sydney Airport (Commonwealth) land

Contamination

Construction has the potential to disturb known areas of contamination located on Sydney Airport land in the following areas:

- Sydney Airport northern lands car park (assessment area 2)
- Land north of the rail corridor (assessment area 3)
- Sydney Airport land along Alexandra Canal and Qantas Drive (assessment area 4).

In summary, construction would have the potential for the following impacts on Sydney Airport land:

- Damage the existing remediation system (cap and landfill gas collection system) within the Sydney Airport northern lands car park
- Mobilise contaminants from existing contaminated areas, impacting nearby soils, surface water and groundwater
- Increase the migration of contaminants into surrounding areas via leaching, overland flow and/or subsurface flow or dust
- Increase the risk of exposure to contaminants (direct contact and/or inhalation) by site workers, visitors and the local community.

Other potential impacts would be managed by implementing the measures provided in section 13.6.

Soils

Potential impacts to soils on Sydney Airport land would include:

- Exposure of acid sulfate soils on land mapped as class 2 and 3 risk during excavations more than 1.5 metres deep, piling for piers and bridge abutments, and trenches for service upgrade/relocation
- Disturbance of soils in areas mapped as having high salinity potential resulting in the potential erosion and off-site transport of saline soils.

These impacts are expected to be manageable with the application of the measures described in section 13.6.

Following implementation of the mitigation measures for contamination and soils, the potential impacts on Commonwealth land are not considered to be significant.

13.3.5 Need for remediation

Construction has the potential to impact the contaminant management infrastructure and systems that are currently in place in the following assessment areas:

- Former Tempe landfill (assessment area 1) – the landfill cap, cut-off wall and leachate management system
- Sydney Airport northern lands car park (assessment area 2) – the remediation cap and passive gas venting system.

Where the project has the potential to damage and/or remove these existing systems or impact on their effectiveness, the controls and protocols outlined in the existing EMPs would need to be implemented. The EMP may require a RAP to be prepared where potential disturbance is deemed to be significant and approved by a site auditor (for works on land subject to the EP&A Act) or by Sydney Airport Corporation and endorsed by the Airport Environment Officer (for works on Sydney Airport land).

The RAP(s) would describe how the existing systems would be managed during construction, or how these systems would be reinstated, such that they continue to operate effectively after construction is finished.

Given the presence of soil contamination across the project site, the RAP(s) would also need to consider clean-up and/or remediation strategies to be implemented to ensure the project site is suitable for the proposed development (ie operation of road infrastructure). This includes ensuring that the existing contamination within the project site does not pose an ongoing risk to maintenance workers and/or the environment. In accordance with the hierarchy of preferred remediation strategies in the *Contaminated Land Management Guidelines for the NSW Site Auditor Scheme* (NSW EPA, 2017b) these strategies could include (in order of preference):

- On-site treatment of soil to destroy the contaminant or reduce the associated hazard to an acceptable level
- Off-site treatment of the soil to destroy the contaminant or reduce the associated hazard to an acceptable level, after which the soil is returned to site
- Consolidation and isolation of the contaminated soil on site by containment with a properly designed barrier
- Removal of contaminated material to an approved site or facility, followed by replacement with clean fill (as required).

Given the presence of asbestos in soil in the former Tempe landfill, Sydney Airport northern lands car park and land north of the rail corridor, for which there are no appropriate on or off-site treatment methods, the preferred remediation strategy would be consolidation and isolation on site using an appropriately constructed barrier to prevent exposure. This may include using the final road pavement and installation of additional capping, where required.

Where remediation is required, it would be undertaken in general accordance with the following:

- The RAP(s) would be prepared during detailed design by a suitably qualified environmental consultant, as defined in Schedule B9 of the NEPM
- For remediation of land subject to the EP&A Act - the RAP(s) would be approved by a site auditor accredited under the site auditor scheme under the CLM Act
- For remediation of Sydney Airport land – the RAP(s) would be approved by Sydney Airport Corporation and endorsed by the Airport Environment Officer. If Sydney Airport Corporation and/or the Airport Environment Officer consider that a site assessor is required, the site assessor would be nominated by the Secretary (as defined by Regulation 6.10 of the Airports (Environment Protection) Regulations 1997) and would endorse the RAP(s)
- The implementation of the RAP(s) would be validated by a suitably qualified environmental consultant, who would document the validation in a validation report that would be reviewed by a site auditor (for land subject to the EP&A Act) or reviewed by Sydney Airport Corporation and the Airport Environment Officer (for Sydney Airport land)
- The requirements for ongoing monitoring and maintenance of the reinstated systems as well as any new structures constructed to manage existing contamination would be documented in an EMP (or multiple EMPs) that would be prepared for the project site
- Following preparation and approval of the EMP(s) the site auditor would prepare a Site Audit Statement confirming the suitability of the project site for the proposed development (for land subject to the EP&A Act) or the Sydney Airport Environment Officer would confirm the objectives of remediation have been met (for Sydney Airport land).

While there is contaminated groundwater across the project site, this has been assessed to be an existing issue that would not be worsened by the project, provided the mitigation measures in section 13.6 are implemented. This would not preclude use of the site for the project. Therefore, remediation of groundwater is not considered necessary. Further information about groundwater is provided in Chapter 15 (Groundwater).

13.4 Assessment of operation impacts

13.4.1 Potential to encounter contamination

Day-to-day operation of the project would not expose site users (including road users, users of future open space and airport staff in Sydney Airport land), to potentially contaminated soil (or groundwater) if remediation is undertaken as described in section 13.3.5. Additionally, it is expected that remediation and encapsulation of the project site would take into consideration any potential maintenance activities, such that where sub-surface maintenance works are required these would not extend beyond the capping and marker layer.

There is the potential for landfill gas in the former Tempe landfill and Sydney Airport northern lands car park to accumulate in confined spaces (such as utilities) that would need to be accessed by maintenance workers. Additionally, the presence of piles for the bridges and other sub-surface infrastructure could result in the creation of new preferential pathways for the landfill gas to escape. The RAP(s) prepared for these assessment areas would need to consider this potential risk. This would include providing new gas collection and venting systems within the former Tempe landfill and Sydney Airport northern lands car park and/or reinstating the existing remediation systems in these areas. Where remediation does not remove the potential for existing exposure pathways to be realised the EMP(s) would identify the risk and associated mitigation measures for future maintenance activities.

There is the potential for landfill settlement to occur in the former Tempe landfill following placement of the proposed emplacement mound(s) and completion of the road work due to the additional weight of this infrastructure. Settlement could cause fissures or breaches in the capping layer, which could increase infiltration of surface water. Fissures could also cause preferential pathways for landfill gas emissions. Settlement and slope stability analysis would be undertaken to inform the design of the emplacement mounds and capping layer.

The emplacement mound(s) could also change surface water flows across the former landfill, which could result in scouring and erosion of the capping layer. The design of the capping layer would need to be integrated with the design of surface water drainage to mitigate potential impacts on the integrity of the landfill.

Modelling undertaken as part of the surface water assessment determined that there is the potential for sediments close to three new stormwater outlets within Alexandra Canal to be temporarily mobilised during a one per cent annual exceedance probability flood event. However, it is likely that contaminated bed sediments would be mobilised during a flood of this same magnitude. Energy dissipaters would be installed at these three locations to minimise sediment mobilisation. This is discussed further in Chapter 16 (Surface water). The design and construction of the stormwater outlets would be undertaken in accordance with the requirements of the remediation order, and in consultation with Sydney Water.

13.4.2 Potential to generate contamination

Operation has the potential to contaminate soil and groundwater from leaks and spills of fuel, oils and other hazardous materials during maintenance activities. However, the potential is considered to be low, given the likely scale and duration of maintenance activities.

This potential impact would be minimised by implementing procedures to handle dangerous goods and hazardous materials and manage spills similar to those used for other Roads and Maritime road infrastructure.

13.4.3 Suitability of the site for the development

A summary of the works that would be required within each contamination assessment area to ensure the project site's suitability for the proposed development (ie operation of road infrastructure), is provided in Table 13.8.

Further information regarding the remediation requirements for the project site and the general remediation process that would be followed to ensure site suitability is provided in section 13.3.5.

Table 13.8 Suitability of site for development with reference to assessment areas

Assessment area	RAP required/site suitability
Former Tempe landfill (assessment area 1)	The EMP for this area requires that approval is sought from a site auditor where there is a proposed change in land use from those outlined in the EMP or where removal of capping is significant. A RAP is required to document the reinstatement of the existing remediation systems, where impacted, the design and implementation of the emplacement mounds, and the final road pavement and additional capping design. Current known contamination status does not impede suitability of the site for the proposed development.
Sydney Airport northern lands (assessment area 2)	Where the project has the potential to damage and/or remove existing systems or impact on their effectiveness, the controls and protocols outlined in the existing EMP would need to be implemented. The EMP may require a RAP to be prepared where potential disturbance is deemed to be significant and approved by a site auditor (for works on land subject to the EP&A Act) or approved by Sydney Airports Corporation end endorsed by the Airport Environment Officer (for works on Sydney Airport land). A new EMP is required, or the existing EMP revised, to document long term maintenance and monitoring requirements in the assessment area. Current known contamination status does not impede suitability of the site for the proposed development (subject to remediation and management under the existing EMP).
Land north of the rail corridor (assessment area 3)	Additional soil sampling is required to inform construction due to limited soil characterisation across the area. A RAP is required to document the design and implementation of the final road pavement and additional capping. An EMP is required to document long term maintenance and monitoring requirements in the assessment area. Current known contamination status does not impede suitability of the site for the proposed development (subject to remediation and management under a RAP and EMP).
Sydney Airport land (assessment area 4)	Additional assessment and groundwater monitoring is required adjacent to the airport boundary, to delineate the extent of groundwater impacts associated with the Jet Base, and assess the potential for down-gradient groundwater contamination to be disturbed during construction dewatering. A RAP is required to document the design and implementation of the final road pavement and additional capping. An EMP is required to document long term maintenance and monitoring requirements in the assessment area. Current known contamination status does not impede suitability of the site for the proposed development (subject to remediation and management under a RAP and EMP). The project would not impede remediation of existing groundwater contamination beneath the Jet Base.
Alexandra Canal (assessment area 5)	In accordance with the requirements of the remediation order for Alexandra Canal a strategy is required to document how the disturbance and migration of contaminated sediments would be minimised during construction.
Rail corridor	No changes of land use proposed.
St Peters interchange tie-in	The conditions of approval for the New M5 project requires preparation of a soil contamination report, and where remediation is required, the report must be accompanied by a site audit statement prepared by an accredited site auditor. The completion of the above would need to be verified prior to construction commencing.

13.4.4 Soil impacts

Soil erosion and sediment transport

There is potential for recently disturbed soils to be susceptible to erosion, particularly during initial periods of landscaping and re-establishment of vegetation. This may occur in areas where planting is proposed, including adjacent to disturbed areas, along embankments and in the reinstatement of temporary ancillary facilities where topsoil is settling and vegetation is establishing. Temporary soil stabilisation may be required immediately following construction to prevent potential erosion, topsoil loss or soil migration. This is particularly likely to be required following severe storms. A rehabilitation strategy would be prepared to guide the approach to rehabilitation of disturbed areas, and would include requirements for ongoing monitoring following the establishment of these areas, as described in section 13.6.2.

Operation is not likely to result in any significant impacts on soils, topography or geology. The risk of soil erosion during operation would be minimal, as all areas impacted during construction would be sealed or rehabilitated and landscaped to prevent soil erosion from occurring. Maintenance activities involving ground disturbance would be undertaken in accordance with Roads and Maritime’s standard operating procedures.

Operation is not expected to result in geomorphological impacts.

Soil salinity

Operation is not expected to impact the salinity levels of the project site. Maintenance activities would be unlikely to involve ground disturbance activities of sufficient magnitude to increase water infiltration resulting in erosion and off-site transport of saline sediments, particularly with the implementation of standard erosion and sediment control measures.

Salinity and potential effects on the durability of infrastructure will be considered further during detailed design.

Acid sulfate soils

Operation would not impact on acid sulfate soils. Maintenance activities would be unlikely to involve ground disturbance activities of sufficient depth to encounter acid sulfate soils.

13.4.5 Summary of impacts on Sydney Airport (Commonwealth) land

Operation would result in negligible potential impacts on Sydney Airport land based on the following:

- Ongoing maintenance and monitoring of the reinstated remediation system in Sydney Airport northern lands car park and the capping layer and final road pavement in Sydney Airport land would be undertaken in accordance with the EMP(s)
- Maintenance activities that involve ground disturbance would be undertaken in accordance with Roads and Maritime’s standard operating procedures, which would limit the potential for impacts associated with soil erosion and sedimentation.

Consistency with the Sydney Airport Master Plan

The *Sydney Airport Master Plan 2039* (the Master Plan) identifies soil and land management as a key environmental issue. It recognises that due to a long history of aviation and related uses at the airport (including fuel storage and firefighting training) the airport site contains a number of areas that are subject to soil and groundwater contamination. Existing contamination issues are currently managed by implementing a contaminated sites strategy, underground storage tank strategy, and through tenant and contractor management.

By implementing the Master Plan and associated *Sydney Airport Environment Strategy 2019-2024* (the Environment Strategy), Sydney Airport Corporation plans to manage and reduce potential impacts from contaminated land and groundwater by:

- Preventing pollution from airport activities
- Preventing soil and groundwater contamination
- Managing known and suspected contaminated sites.

The five year plan for soil and land management in the Environmental Strategy includes a range of actions, of which the following are of most relevance to the project:

- Buildings and infrastructure will be planned and designed to minimise disturbance and potential impacts on soil and contaminated land where possible
- Ensure each site has a comprehensive conceptual site model
- Continue to ensure that fill material is reused and managed where appropriate in accordance with the PFAS NEMP and the Airports (Environment Protection) Regulations 1997 or disposed of in line with applicable waste classification guidelines under the NSW *Protection of the Environment Operations Act 1997*
- Where required, assess potential soil quality and contaminated land impacts and identify appropriate management measures for both the construction and operational phase of developments
- Undertake training of tenants, contractors and project managers in relation to the identification and management of soil and land contamination.

The project is consistent with these measures. In particularly, the project has been designed to avoid and/or minimise the disturbance of soils and therefore minimises the likelihood of disturbance of contaminated soils. A rigorous impact assessment process has been undertaken to ensure contamination and soils impacts are appropriately assessed and impacts minimised where practicable. Measures have been developed to ensure that soil quality and contaminated land impacts are considered during detailed design, construction planning and in the operational phase.

The key performance indicator relevant to contamination and soils for the actions outlined above is that there is a reduction (through management/remediation) of the number of contaminated sites. The project is not expected to reduce the number of contaminated sites, however it would where possible seek to minimise contamination in impacted areas and manage contamination in a way to ensure that the number of contaminated sites does not increase as a result of the project.

13.5 Cumulative impacts

Cumulative contamination and soil impacts may result from the disturbance of soils, including contaminated soil, and discharge of contaminated groundwater from other projects occurring simultaneously close to the project. This could result in the erosion and transport of soils and contaminated sediments into surface water bodies.

The EISs prepared for M4-M5 Link and New M5 included assessment of contamination and provided management measures. These projects are not expected to generate significant new contamination during construction. However, they are all likely to encounter and disturb existing contamination from past land uses that would require investigation, management and/or remediation.

The potential for cumulative impacts due to erosion and sedimentation would be managed by implementing standard erosion and sedimentation control measures. As such, it is not expected that the project would have a substantial cumulative impact on erosion and sedimentation.

Provided that projects constructed concurrently with the project are completed in accordance with the conditions of approval and any environment protection licence conditions, cumulative contamination and soils impacts are expected to be minimal.

13.6 Management of impacts

13.6.1 Approach

Approach to mitigation and management

The impact assessment has been undertaken based on the results of desktop research as well as the readily available results of intrusive site investigations. Further information on contaminants present, their concentration in soil and groundwater, and their coverage across the project site is being collected. These additional sampling results will be used to inform further actions and decisions in relation to the need for remediation of areas.

The assessment identified that if the existing contamination issues across the project site are not adequately managed during construction (including reinstating existing remediation systems), the project would have the potential to impact the receiving environment and sensitive receivers. Construction would also have the potential to expose and disturb soils which could also impact the receiving environment.

Approach to managing the key potential impacts identified

Where required, RAP(s) would be developed outlining the remediation strategies to be implemented during construction to ensure the existing site contamination does not pose an ongoing risk to maintenance workers, the community and/or the environment.

Where there are existing remediation systems in place (at the former Tempe landfill and Sydney Airport's northern lands car park), the controls and protocols outlined in the existing EMP would be implemented. The EMP may require a RAP to be prepared, which would describe how these systems would be managed during construction, or how these systems would be reinstated such that they continue to operate effectively after construction is finished. The RAP(s) would also include detailed information regarding construction of any new structures required to manage existing contamination (eg the emplacement mounds in the former Tempe landfill) so that these new structures do not pose an ongoing contamination risk.

Any maintenance activities during operation would be undertaken in accordance with the EMP(s).

A plan of management would be developed and implemented to manage work within Alexandra Canal that has the potential to disturb sediments. The management plan would address the requirements of the remediation order for the Alexandra Canal bed sediments, to prevent disturbance and dispersion of potentially contaminated sediments.

The plan would be prepared in consultation with Sydney Water and the NSW EPA.

Approach to managing other impacts

Other potential soil and contamination impacts during construction would be managed in accordance with the CEMP. The CEMP would include a Soil and Water Management Plan, which would define the processes, responsibilities and erosion and sediment control measures that would be implemented during construction (in accordance with the Blue Book). Further information on the CEMP, including requirements for the Soil and Water Management Plan, are provided in Chapter 27 (Approach to environmental management and mitigation).

Soil impacts during operation are not predicted to be significant, and therefore no specific mitigation and management measures are proposed.

Expected effectiveness

The project has minimised contamination and soil impacts as far as practicable. As described in Chapter 6, design and construction planning has included a focus on avoiding or minimising potential contamination and soil impacts. Despite this, the potential to encounter contaminated soil and groundwater during construction cannot be eliminated or avoided completely. To ensure that the potential for existing contamination impacts are minimised, any RAP(s) and EMP(s) developed as part of the project would be reviewed and approved by a site auditor or site assessor in accordance with the CLM Act or Airports (Environment Protection) Regulations 1997.

Accredited site auditors are engaged to independently review contaminated land consultant reports to ensure the methods and interpretation of data are consistent with NSW EPA guidance. Site auditors and assessors provide increased certainty to planning authorities of the nature and extent of contamination and the suitability of a site for a specific use.

For impacts associated with soil, the erosion and sediment control measures to be implemented would be in accordance with the requirements of the Blue Book. The measures contained in the Blue Book are based on field experience and have been previously demonstrated to be effective. In general, the implementation of measures in accordance with the Blue Book would either result in a reduced potential for the impact to be realised through either the use of engineered controls (eg sediment fences, covers on stockpiles etc) or avoidance (eg not undertaking works during wet weather and minimising areas of exposed soils). Therefore, there is no reason the proposed mitigation measures should not be effective, if implemented in accordance with the Blue Book.

Audits and reporting of the effectiveness of environmental management measures employed during construction would be carried out to demonstrate compliance with management plans and other relevant approvals and would be outlined in detail in the CEMP prepared for the project.

13.6.2 List of mitigation measures

Measures that will be implemented to address potential contamination and soils impacts are listed in Table 13.9.

Measures to manage landfill gas, dust and odour impacts are provided in Chapter 12 (Air quality). Measures to manage surface water quality, potential groundwater contamination and waste, are provided in Chapters 15 (Groundwater), 16 (Surface water) and 24 (Waste management).

Table 13.9 Contamination and soils mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Investigation of data gaps and potential for unidentified asbestos containing materials	CS1	Additional soil and groundwater investigations will be undertaken to inform detailed design, construction planning, and preparation of remediation action plan(s) (RAP(s)). The investigations will include: ▪ Further characterising the existing contamination status of the project site, including the potential for unidentified asbestos containing materials ▪ Groundwater investigations for all assessment areas and any indirectly affected areas. ▪ Soil and groundwater testing to address data gaps for land north of the rail corridor and Sydney Airport land.	Detailed design
High salinity potential	CS2	Soil salinity will be considered in the design of subsurface structures.	Detailed design
Management of contaminated sites	CS3	Where the project has the potential to affect the remediation systems in the former Tempe landfill and Sydney Airport northern lands car park, the controls and protocols outlined in the existing EMP will be implemented such that the systems continue to operate effectively during operation. A RAP (or multiple RAPs) will be prepared (as required) to describe the remediation strategy to be implemented to ensure that existing contamination does not pose a future risk to human health or the environment during operation. The RAP(s) will be prepared by a suitably qualified and experienced consultant, as defined in Schedule B9 of the *National Environment Protection (Assessment of Site Contamination) Measure 1999*.	Detailed design

Impact/issue	Ref	Mitigation measure	Timing
		The RAP(s) will be prepared and implemented in accordance with the following requirements: ▪ The voluntary remediation proposal, EMP and any RAPs in place for the former Tempe landfill ▪ The requirements of the existing Sydney Airport RAP and EMP (if applicable) ▪ *National Environment Protection (Assessment of Site Contamination) Measure 1999* ▪ Airports (Environment Protection) Regulations 1997 (for Sydney Airport land) ▪ *Environmental Guidelines: Solid waste landfills* (NSW EPA, 2016a) (for reinstatement of the capping layer and/or design of the new capping layer and final road pavement at the former Tempe landfill). The RAP(s) will be: ▪ Prepared in consultation with the Airport Environmental Officer and NSW EPA (as relevant) ▪ For works on land subject to the EP&A Act – approved by an independent site auditor accredited under the site auditor scheme under the CLM Act ▪ For works on Sydney Airport land – approved by Sydney Airport Corporation and endorsed by the Airport Environment Officer. If Sydney Airport Corporation and/or the Airport Environment Officer consider a site assessor is required, the site assessor will be nominated by the Secretary (as defined by Regulation 6.10 of the Airports (Environment Protection) Regulations 1997) and will endorse the RAP(s).	
Demolition of structures containing hazardous materials	CS4	Hazardous materials surveys will be undertaken to inform construction planning, including demolition activities and utility adjustments.	Pre-construction
Potential impacts of soil disturbance	CS5	A Construction Soil and Water Management Plan will be prepared as part of the CEMP and implemented during construction. The plan will detail processes, responsibilities and measures to manage potential soil and water quality impacts during construction, including potential impacts associated with the presence of existing contamination, stockpile management, saline soils and acid sulfate soils. The Construction Soil and Water Management Plan will be prepared in accordance with relevant guidelines and standards, including *Managing Urban Stormwater – Soils and Construction*, Volume 1 (Landcom, 2004) Volume 2B Waste landfills (DECC, 2008a) and Volume 2D (DECC, 2008b) (the Blue Book).	Pre-construction, construction
Acid sulfate soils	CS6	An Acid Sulfate Soils Management Plan will be prepared as part of the Construction Soil and Water Management Plan in accordance with the *Acid Sulfate Soils Assessment Guidelines* (ASSMAC, 1998). The plan will define the process and measures to manage actual and potential acid sulfate soil and sediment disturbed during construction. The plan will include a summary of available acid sulfate soil information relevant to the project site and identify any further soil/water analysis required as a precursor to implementing the management plan. Acid sulfate soils will be disposed off-site (where required) in accordance with the *Waste Classification Guidelines - Part 1 and Part 4: Acid sulfate soils* (NSW EPA, 2014a).	Pre-construction, construction

Impact/issue	Ref	Mitigation measure	Timing
Impacts on sediments in Alexandra Canal during construction	CS7	A plan of management will be developed in accordance with the remediation order and implemented to manage work within Alexandra Canal and minimise the disturbance and migration of contaminated sediments. The plan will identify specific methodologies to minimise disturbance and dispersion of potentially contaminated sediments. The plan will be prepared in consultation with Sydney Water Corporation and submitted for the NSW EPA's approval in accordance with the remediation order requirements.	Pre-construction, construction
Impacts on the former Tempe landfill	CS8	An assessment will be undertaken of the potential hazards associated with landfill gas during construction and operation. The assessment will consider the potential for ingress and build-up of gases that may pose a risk to safety. Where the need for measures to manage landfill gases post-construction is identified, such measures will be described in the RAP(s) (measure CS3). Measures could include the design and installation of a landfill gas management system to provide a preferential flow path for landfill gas below the road infrastructure and emplacement mounds.	Detailed design
	CS9	A settlement and slope stability analysis will be undertaken to ensure that the emplacement mounds are designed to suitable engineering standards such that the long-term stability of the capping layer is maintained. The design and construction of the emplacement mounds will be described in the RAP(s) (measure CS3) and will be in accordance with *Environmental Guidelines: Solid waste landfills* (NSW EPA, 2016a). The design will be prepared in consultation with the NSW EPA.	Detailed design
	CS10	The location of all existing landfill management infrastructure, including the bentonite wall, leachate collection system and passive gas collection system, will be confirmed and (if required) the design will be further refined to avoid impacts on this infrastructure. Measures will be developed, and included in the RAP (if required) to protect the landfill management infrastructure during construction, or reinstate the infrastructure such that it continues to operate effectively after construction is finished.	Detailed design
	CS11	The potential for settlement will be considered as part of the siting and layout of construction compounds and work areas in the former Tempe landfill. Where required, ground treatment (eg foundation layers or sheet piling) will be provided to minimise this risk.	Pre-construction, construction
	CS12	Landfill material will be appropriately handled and stockpiled, to ensure minimal impact to the surrounding community, on-site workers and the environment. Landfill waste will be managed in accordance with the requirements of *Environmental Guidelines: Solid waste landfills* (NSW EPA, 2016a). Excavated landfill waste to be disposed of will be classified in accordance with the *Waste Classification Guidelines*, Part 1: Classifying waste (NSW EPA, 2014a) before being disposed of at an appropriately licensed waste facility.	Construction
Landfill gas intrusion	CS13	Protocols to address and manage landfill gases within the construction footprint in the former Tempe landfill and Sydney Airport northern lands car park will be developed and implemented during construction. The protocols will consider confined and/or enclosed spaces and appropriate controls as required (eg. forced ventilation), and will include appropriate occupational monitoring.	Pre-construction, construction
	CS14	Hot works within the former Tempe landfill and Sydney Airport northern lands car park will be restricted where there is a potential for fire or explosion. Monitoring for potentially flammable gases will occur during all hot works.	Construction

Impact/issue	Ref	Mitigation measure	Timing
Works within Sydney Airport land	CS15	Any material imported and used within Sydney Airport land will be tested prior to use to ensure it does not exceed the acceptable limits in the PFAS National Environmental Management Plan (HEPA, 2018) and Schedule 3 of the Airports (Environment Protection) Regulations 1997.	Construction
Stockpile management and handling	CS16	Storage and containment systems for the stockpiling of contaminated material during construction will be designed to be impervious to the materials stored, resistant to fire (where required), covered to prevent contact with rainfall, and managed and maintained to prevent any release of liquids and contaminated run-off to stormwater drains, waters and land.	Pre-construction, construction
Management of previously unidentified contaminated material	CS17	The discovery of previously unidentified contaminated material will be managed in accordance with an unexpected contaminated finds procedure, as outlined in the *Guideline for the Management of Contamination* (Roads and Maritime, 2013b) and detailed in the CEMP. Awareness training will be provided for all on-site staff to assist in the identification of potentially contaminated material as per the unexpected contaminated finds procedure. In the event that unexpected indicators of contamination are encountered during construction (such as odours or visually contaminated materials), work in the area will cease, and the finds will be managed in accordance with the unexpected contaminated finds procedure.	Construction
PFAS impacted soil and groundwater	CS18	PFAS contaminated materials will be managed in accordance with the risk-based framework presented in the *PFAS National Environmental Management Plan* (HEPA, 2018). If soil and/or water containing PFAS is proposed for reuse, the proposed reuse must not result in an unacceptable or increased risk to human health and/or the environment. A health and environmental risk assessment and consultation with the NSW EPA (and the Airport Environment Officer where the works are on Sydney Airport land) will be required before any reuse of PFAS contaminated soil and/or water.	Construction
Remediation/ management of existing contamination	CS19	Validation of remediation will be undertaken during construction and a validation report prepared by a suitably qualified environmental consultant as defined in Schedule B9 of the *National Environment Protection (Assessment of Site Contamination) Measure 1999* to confirm the requirements of the RAP(s) have been met. For works on land subject to the EP&A Act, the validation report will be reviewed by a site auditor accredited in accordance with the site auditor scheme under the CLM Act. For works on Sydney Airport land, Sydney Airport Corporation and the Airport Environmental Officer will review the report.	Construction
	CS20	The requirements for ongoing monitoring and maintenance of any installed or reinstated remediation systems will be documented in EMP(s) prepared for the respective areas. The EMP(s) will be prepared and implemented in accordance with the following requirements: ▪ The voluntary remediation proposal, EMP and any RAPs in place for the former Tempe landfill, including requirements for ongoing gas monitoring ▪ The requirements of the Sydney Airport RAP and EMP (if applicable) ▪ *National Environment Protection (Assessment of Site Contamination) Measure 1999* ▪ *Environmental Guidelines: Solid waste landfills* (NSW EPA, 2016a) (for reinstatement of the capping layer and/or design of the new capping layer and final road pavement at the former Tempe landfill).	Operation

Impact/issue	Ref	Mitigation measure	Timing
		The EMP(s) will be: ▪ Prepared in consultation with the Airport Environmental Officer and NSW EPA (as relevant) ▪ For works on land subject to the EP&A Act – approved by an independent site auditor accredited under the site auditor scheme under the CLM Act ▪ For works on Sydney Airport land – approved by Sydney Airport Corporation and endorsed by the Airport Environment Officer. Following implementation and validation of the RAP(s) (if required by the existing EMP), and approval of the EMP(s), the site auditor will prepare a Site Audit Statement confirming the suitability of the project site for the proposed development (for works on land subject to the EP&A Act). For works on Sydney Airport land, the Airport Environmental Officer will confirm the objectives of the remediation have been met.	
Erosion impacts post construction	CS21	A rehabilitation strategy will be prepared to guide the approach to rehabilitation of disturbed areas following the completion of construction.	Pre-construction, construction
Contamination during operation	CS22	Spills and leaks of vehicles or maintenance plant and equipment will be managed in accordance with Roads and Maritime's standard operating procedures.	Operation
	CS23	Ongoing management measures will be implemented for any areas where contamination remains following construction, and has the potential to cause an ongoing risk to maintenance works, the community and/or the receiving environment. These management measures will be documented in the EMP(s).	Operation

13.6.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 13.6.2).

As described in section 13.2.5 there is existing contamination throughout the project site. The project also has the potential to cause additional issues through the proposed management of existing contamination (eg the emplacement mounds) and where there are existing remediation systems present. However, through implementation and validation of the RAP(s) and ongoing implementation of the EMP(s), where required, any residual risks associated with the presence of existing contamination are expected to be minimal.

Chapter 14

Flooding

This chapter describes the existing hydrological environment and potential for flooding, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 6 (Flooding).

The SEARs relevant to flooding are listed below. There are no MDP requirements specifically relevant to flooding, however there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)). Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
9	**Flooding**	
9.1	The EIS must include maps illustrating the following features relevant to flooding as described in the *NSW Floodplain Development Manual* (2005): (a) flood prone land; (b) flood planning areas and any areas below the flood planning level; (c) hydraulic categorisation (floodways and flood storage areas); and (d) flood hazard.	Section 14.2.2, Figure 14.2 to Figure 14.6
9.2	The Proponent must assess and (model) the impacts on flood behaviour during construction and operation for a full range of flood events (including a minimum of the 5% Annual Exceedance Probability (AEP), 1% AEP) up to the probable maximum flood (taking into account sea level rise and storm intensity due to climate change) including:	
	(a) any detrimental increases in the potential flood affectation of other properties, assets and infrastructure;	Section 14.3.1
	(b) consistency (or inconsistency) with applicable Council floodplain risk management plans/studies;	Section 14.3.2
	(c) compatibility with the flood hazard of the land;	Section 14.3.3
	(d) compatibility with the hydraulic functions of flow conveyance in floodways and storage areas of the land;	Section 14.3.4
	(e) adverse effects to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the proposal;	Section 14.3.5
	(f) redirection of flow, flow velocity and scour potential (including erosion, siltation, and bank stability of water courses from removal of riparian vegetation);	Section 14.3.6
	(g) impacts the development may have upon existing community emergency management arrangements for the full range of food risks. These matters must be discussed with the State Emergency Services and Council; and	Section 14.3.7
	(h) any impacts the development may have on the social and economic costs to the community as a consequence of flooding.	Section 14.3.8
9.3	The assessment should take into consideration any flood studies undertaken by local government councils and State government agencies.	Section 14.1.2

14. Flooding

14.1 Assessment approach

When new road and bridge infrastructure is built, it is important to ensure that it will not be adversely affected by flooding. It is also just as important to ensure that the infrastructure does not contribute to flooding impacts in the catchment area. This is achieved by undertaking detailed flood modelling to ensure that potential flooding issues are identified and managed through project design.

The assessment of potential impacts of the project on existing flood regimes has been undertaken with consideration of the *Floodplain Development Manual* (DIPNR, 2005). The key objectives of this policy are to identify potential flood hazards and risks, reduce the impact of flooding and flood liability on owners and occupiers of flood prone property, and reduce public and private losses resulting from floods.

The assessment was carried out to inform the project design and the impact assessment identified the potential impacts of existing flooding conditions on the project, as well as potential flood impacts from project implementation. Potential impacts during project construction and operation were considered.

An overview of the approach to the assessment is provided below, including the legislative and policy context and a summary of the assessment methodology.

14.1.1 Legislative and policy context to the assessment

The assessment has been undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations
- The flood related planning controls contained in local planning instruments relevant to the study area – the *Marrickville Local Environmental Plan 2011, Botany Bay Local Environmental Plan 2013, Rockdale Local Environmental Plan 2011* and the *Sydney Local Environmental Plan 2012*
- *Managing Urban Stormwater – Soils and Construction Volume 1, 4th Edition* (Landcom, 2004), *Volume 2B Waste Landfills* (DECC, 2008a) and *Volume 2D, Main Road Construction* (DECC, 2008b) (collectively referred to as the 'Blue Book' in this document)
- *Australian Rainfall and Runoff; A Guide to Flood Estimation* (Geoscience Australia, 2019)
- *Cooks River Flood Study* (PB-MWH Joint Venture, 2009)
- *Coastal Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Flood Risk Assessments* (DECCW, 2010b)
- *Floodplain Development Manual* (DIPNR, 2005)
- *Hydrology Model Development Report – Cooks River Flood Modelling* (Aurecon Jacobs Joint Venture, 2016)
- *Mascot, Roseberry and Eastlakes Floodplain Risk Management Study and Plan* (RH DHV, 2017)
- *Marrickville Local Flood Plan* (SES, 2015)
- *Floodplain Risk Management Guideline: Practical Considerations of Climate Change* (DECC, 2007)
- NSW government planning directions and guidelines, including the *Guideline on Development Controls on Low Flood Risk Areas* and *Direction 4.3 – Flood Prone Land*
- *Sea Level Rise Policy Statement* (DECCW, 2009)
- *Sydney Airport Flood Study* (AECOM, 2018)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

14.1.2 Methodology

Study area

The study area for the flooding assessment includes the project site (as described in Chapter 2 (Location and setting)) and the Alexandra Canal, Tempe Wetlands and Mill Stream catchments. Alexandra Canal and Tempe Wetlands form part of the larger Cooks River catchment, while both the Cooks River and Mill Stream drain to Botany Bay. The catchments are described in section 14.2.1.

Key tasks

The project involves providing new infrastructure in an area subject to existing flooding. As a result, a flooding assessment was undertaken as an input to the design. The flooding assessment involved:

- Reviewing available data and existing flood studies within the identified catchments including:
  - *The Cooks River Flood Study* (PB-MWH Joint Venture, 2009), the *Sydney Airport Flood Study* (AECOM, 2018) and the *Hydrology Model Development Report - Cooks River Flood Modelling* (Aurecon Jacobs Joint Venture, 2016)
  - Existing and future flooding conditions
  - Existing drainage infrastructure
- Developing a set of hydrologic and hydraulic models (referred to as ‘flood models’) of the catchments located within the study area (see below)
- Refining the project design to minimise flooding impacts where possible
- Assessing potential flooding impacts and risks associated with the project, which involved:
  - Comparing potential flood impacts against the base case scenario to identify the extent of impacts
  - Considering catchment flooding conditions using the above models, as well as ocean flooding in the areas of the Cooks River and Alexandra Canal (due to tidal influences)
  - Identifying the potential for impacts on flooding during construction
  - Identifying the potential for impacts on flooding of neighbouring properties and assets due to changes to ground levels and the introduction of new structures
- Developing measures to minimise potential changes to the flood regime as a result of the project.

The flood models used were originally developed as part of the flooding investigations undertaken for the New M5 EIS. A RAFTS model of the Cooks River catchment and a DRAINS model of the Alexandra Canal catchment were used to generate design discharge inputs to the hydraulic models, while flooding patterns in the vicinity of the project site were defined using the Lower Cooks River TUFLOW two dimensional hydraulic modelling software. The models were developed and updated as needed for application to the project. Further information on the models used, their development and validation, is provided in Annexure A of Technical Working Paper 6 (Flooding).

The frequency of flood events is generally referred to in terms of their Annual Exceedance Probability (AEP). For example, for a five per cent AEP flood, there is a five per cent probability (or a one in 20 chance) that there would be floods of a greater magnitude each year. For a one per cent AEP flood, there is a one per cent probability (or a one in 100 chance) that there would be floods of greater magnitude each year.

To assess the potential impacts associated with the project, a full range of flooding events from the 0.2 per cent to the 50 per cent AEP event were modelled for the:

- Existing case (what would occur without the project)
- Developed case (what would occur with the project).

The probable maximum flood (PMF) event was also modelled for the existing and developed case. The PMF is considered to be the worst-case flood event for an area. The PMF represents extreme flooding conditions. Land susceptible to flooding during a PMF event is known as flood prone land.

The impact of climate change was incorporated into the flood modelling processes by considering the *Floodplain Risk Management Guideline: Practical Considerations of Climate Change* (DECC, 2007) and *Sea Level Rise Policy Statement* (DECCW, 2009). Specifically, this involved increasing the one per cent AEP design rainfall intensity by between 10 and 30 per cent and an increase in sea level consistent with a predicted increase of between 0.4 and 0.9 metres by 2050. The outcomes are described in section 14.4.1. Further information on relevant policies and model scenarios is provided in chapters 2 and 3 of Technical Working Paper 6.

14.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Flooding risks with an overall assessed risk rating of medium or above, identified by the environmental risk assessment, included:

- Obstruction or modification of existing drainage infrastructure that results in changes to overland flows, and associated impacts on adjacent land uses and public safety
- Impacts on existing flood evacuation routes and flood planning areas during construction and operation
- Changes to flooding regimes, including potential for increased property inundation, increased flood duration or changes to flood hazards.

The flooding assessment included consideration of these potential risks.

14.2 Existing environment

14.2.1 Catchments and key waterbodies

The project site is mainly located within the lower reaches of the Cooks River catchment, a sub-catchment of the larger Botany Bay catchment. A small portion of the project site, near the intersection of Sir Reginald Ansett Drive and Keith Smith Drive, discharges to Mill Stream via the Sydney Airport stormwater system. Mill Stream drains to Botany Bay, which is part of the Georges River catchment.

Both the Cooks River and Georges River catchments have been extensively developed meaning that the rainfall-runoff response of the catchments has been altered from a natural state. This has resulted in changes to the quantity and speed of runoff within the catchments.

Key watercourses and waterbodies in the study area are described in Table 14.1 and shown on Figure 14.1. Further information regarding the catchments and key waterbodies is provided in Chapter 16 (Surface water).

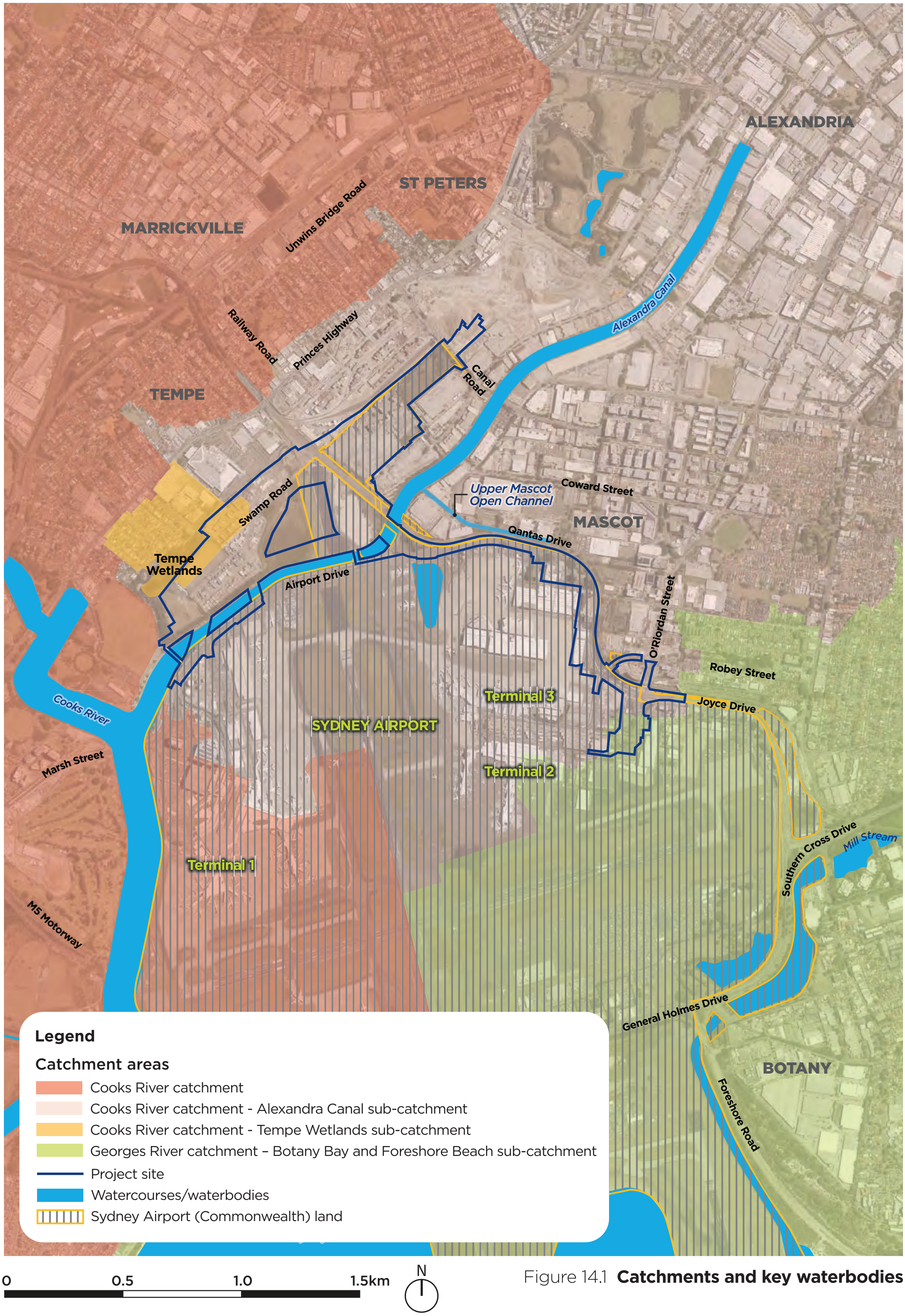


Figure 14.1 **Catchments and key waterbodies**

Table 14.1 Key watercourses and waterbodies within the study area

Waterbody	Description
Alexandra Canal	The majority of the project site is located within the Alexandra Canal catchment, which is a sub-catchment of the Cooks River catchment. Alexandra Canal is one of the main tributaries of the Cooks River and the main watercourse in the vicinity of the project site. The canal is a four kilometre long constructed watercourse that discharges to the Cooks River to the south-west of the project site near the Tempe Recreation Reserve. The canal is owned and operated by Sydney Water Corporation. The tidal influence from the Cooks River extends to the head of the canal.
Tempe Wetlands	The Tempe Wetlands forms part of the Cooks River catchment. It is an artificial wetland, located to the west of Alexandra Canal and adjacent to South Street in Tempe. The wetlands, which are about 2.8 hectares in area, provide temporary detention of flood waters. The project site crosses the Tempe Wetlands catchment to the east of the wetlands.
Mill Stream	A small portion of the project site is located within the Mill Stream catchment, which is a sub-catchment to the Georges River catchment. In the project site, the Mill Stream catchment covers an area of about 2.7 hectares and consists of sealed roads, commercial and re-vegetated land. Engine Pond and Mill Pond are located to the south-east of the project site and are fed by Mill Stream, which has its source in the Lachlan Swamps and further upstream in Eastlakes.

14.2.2 Existing flooding and drainage conditions

As noted above, the Cooks River and Georges River catchments are both highly urbanised and dominated by impervious surfaces. This means that these systems experience very low flows during dry periods and very high flows after storms, causing erosion and flooding in some areas. Key flooding information relevant to the project site is summarised below.

Alexandra Canal

Flooding along Alexandra Canal is mainly confined to the channel itself for floods up to the five per cent AEP event. However, during a one per cent AEP event, flooding tops the canal banks upstream of the Botany Rail Line, causing inundation of adjacent commercial and industrial development of depths exceeding one metre at several locations. This can result in hazardous flooding conditions to persons and property. Flooding also occurs downstream of the Botany Rail Line during the one per cent AEP event, discharging over Airport Drive and inundating Sydney Airport land at a depth typically less than 0.1 metre.

During a 10 per cent AEP event, inundation of a low point along Qantas Drive, located about 300 metres to the east of Alexandra Canal, can occur to a maximum depth of one metre. This can increase to 1.2 metres during a one per cent AEP event and 2.1 metres during a PMF event. Higher ground to the north and south of this low point make it susceptible to significant depths of inundation that would be hazardous to road users.

During a 10 per cent AEP event, inundation of a low point along Airport Drive discharges in an easterly direction into a trapped depression within Sydney Airport, where depths of inundation can occur to a maximum depth of 0.7 metres. This can increase to 1.1 metres during a one per cent AEP event and 1.5 metres during a PMF event.

A significant portion of the project site, which is located on Sydney Airport land between the Botany Rail Line and Canal Road, is affected by overland flow that discharges from the Cooks River Intermodal Terminal and the Botany Rail Line.

Tempe Wetlands

At the existing drainage system located on the Princes Highway, flooding travels overland along Station Street, Hart Street, Wentworth Street and Fanning Street in an easterly direction before discharging into Tempe Wetlands. During a one per cent AEP flood event, the depth of inundation along these streets can be up to 0.3 metres.

Mill Stream

Flooding that exceeds the capacity of the local drainage system at the southern end of Ninth Street in Sydney Airport can pond at its intersection with Shiers Avenue. During a one per cent AEP flood event, flooding can occur to a maximum depth of 0.4 metres. Depths of ponding in a PMF event can exceed 0.8 metres, which is sufficient to result in hazardous flooding conditions to persons or property.

The extent and depth of existing flooding for the one per cent AEP event and the PMF are shown on Figure 14.2 and Figure 14.3, respectively. Figure 14.3 shows Alexandra Canal, Tempe Wetlands, an area between the Cooks River Intermodal Terminal and north of the Botany Rail Line, and parts of Sydney Airport south of Airport Drive as being flood prone areas. Additionally, existing low points along sections of Airport Drive (about 900 metres long) and Qantas Drive (about 200 metres long) north of the Robey Street intersection are shown to be subject to substantial existing inundation.

Flood planning areas

A flood planning level is defined as a combination of flood levels derived from historical flood events or floods of specific AEPs (DIPNR, 2005). The flood planning level is defined in the *Rockdale Local Environmental Plan 2011* and the *Marrickville Development Control Plan 2011* as land located below the one per cent AEP flood level plus 0.5 metres. A flood planning area is the area of land below the flood planning level subject to flood planning controls.

Figure 14.4 shows the areas identified as being below the flood planning level within the project site. The figure indicates that the site is highly constrained in all directions by existing flooding conditions, including areas of flood prone land shown in Figure 14.3.

Hydraulic categorisation of areas

There are three categories of floodplain defined by the *Floodplain Development Manual* (DIPNR, 2005) as follows:

- Floodways – areas of a floodplain where a significant discharge of water occurs during floods, often aligned with obvious natural channels. These are areas that, even if only partially blocked, would cause a significant increase in flood levels and/or a significant redistribution of flood flow, which in turn may adversely affect other areas.
- Flood storage areas – areas of a floodplain that are important for the temporary storage of floodwaters during the passage of flood
- Flood fringe – areas of land affected by flooding, after floodway and flood storage areas have been defined. Development in flood fringe areas would not have any significant effect on the pattern of flood flows and/or flood levels.

Figure 14.5 shows the preliminary hydraulic categorisation of the study area based on a one per cent AEP event. As shown in the figure, Alexandra Canal and the Cooks River are the main floodways within the study area. The Tempe Wetlands and an area of land between the Cooks River Intermodal Terminal and the Botany Rail Line comprise flood storage areas. A large part of Sydney Airport south of Airport Drive is identified as a flood fringe area.

Flood hazard areas

Floods create hazardous conditions to which humans are particularly vulnerable. Fast-flowing shallow water or slow-flowing deep water can unbalance people, sweep away vehicles and undermine buildings or other structures. The flood hazard within an area is determined from a combination of the depth and velocity of floodwaters. Figure 14.6 shows the provisional low and high flood hazard conditions within the study area, as outlined in the Floodplain Development Manual.

As shown in the figure, high flood hazard areas are located in Alexandra Canal, Cooks River, Tempe Wetlands and Sydney Airport northern ponds. Low hazard areas are located between the Cooks River Intermodal Terminal and north of the Botany Rail Line, parts of Sydney Airport land south of Airport Drive, and along sections of Airport Drive and Qantas Drive.

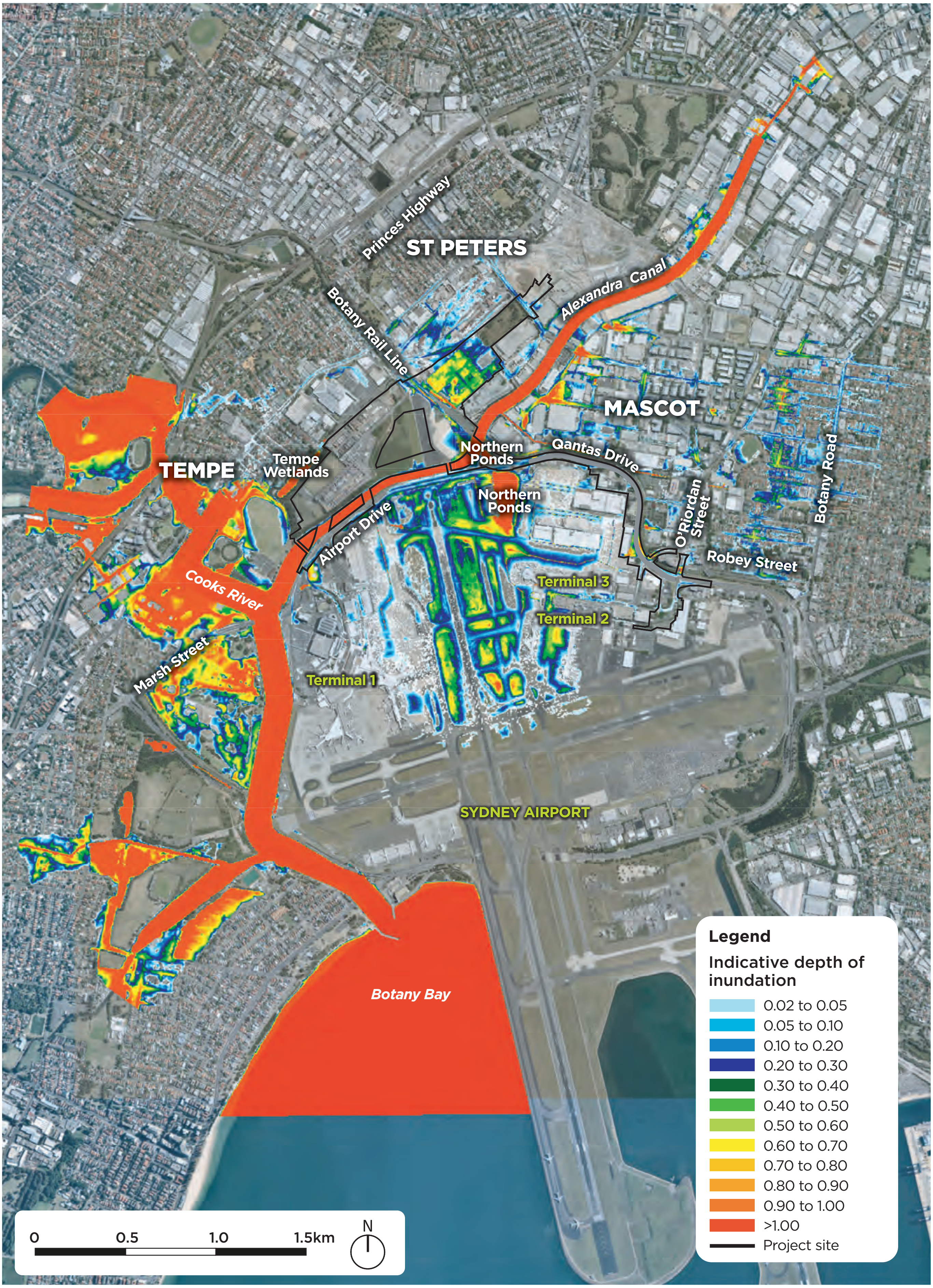


Figure 14.2 **Existing flood depth and extent – one per cent AEP event**

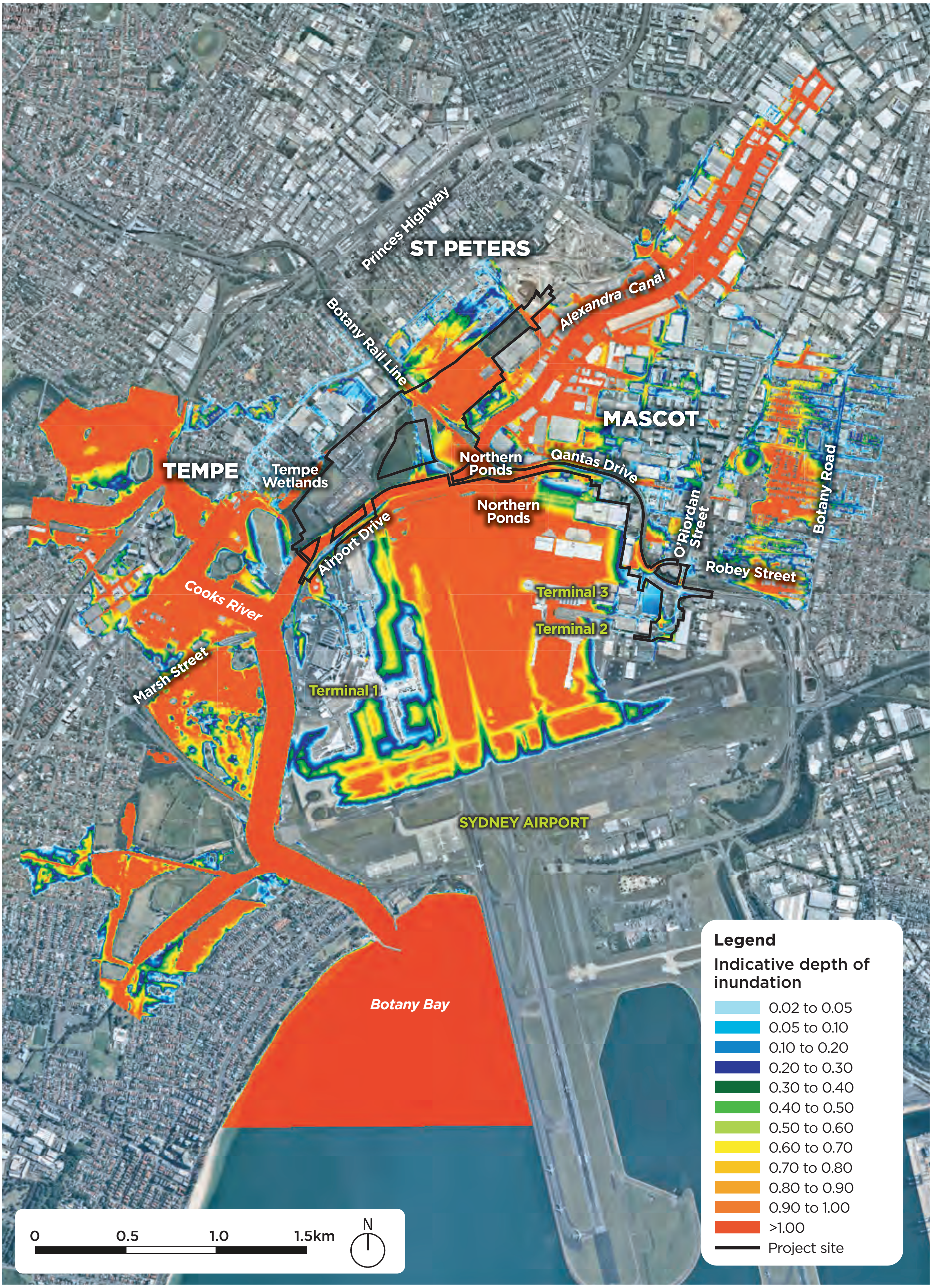


Figure 14.3 **Existing flood depth and extent – probable maximum flood event**

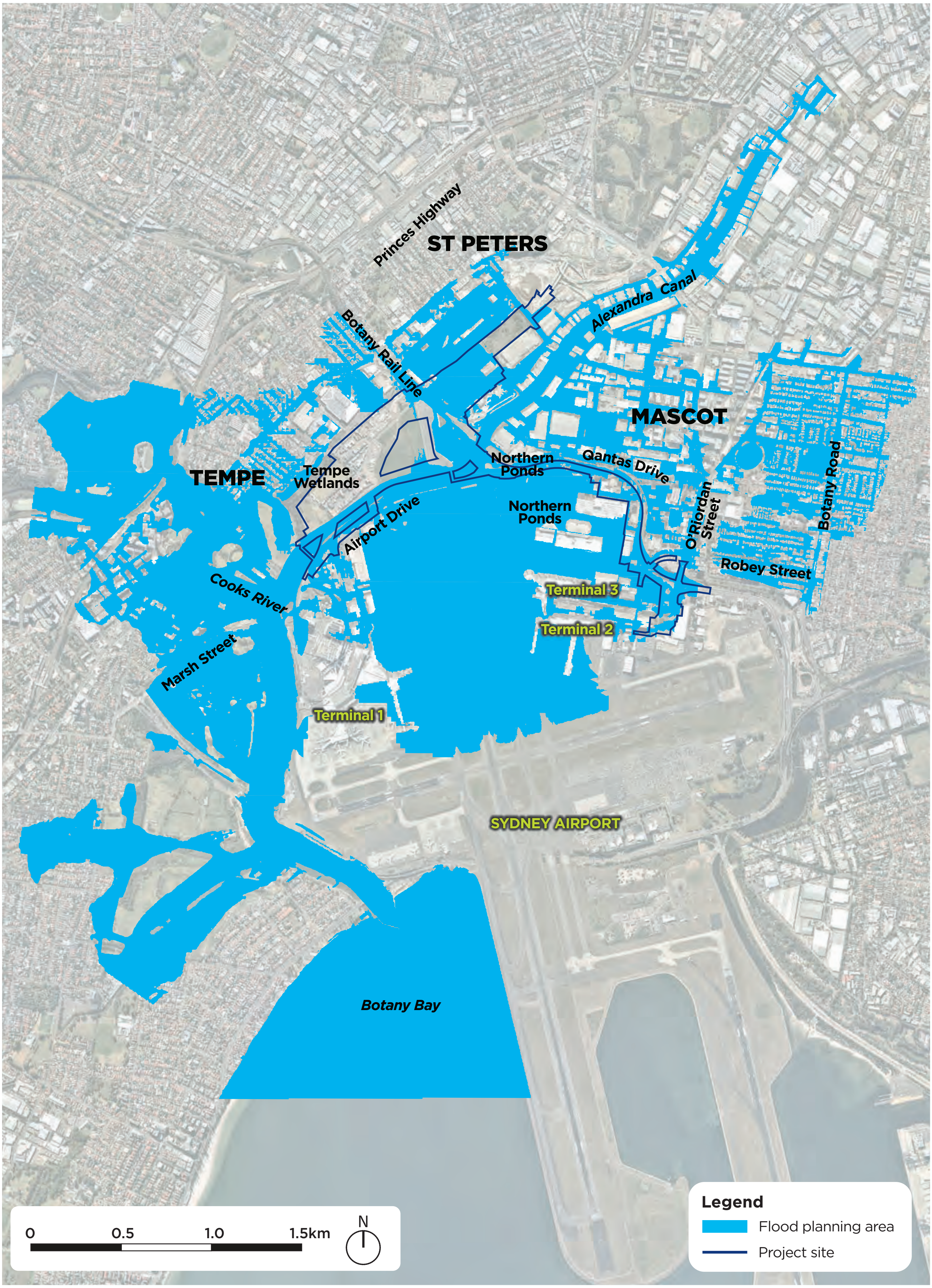


Figure 14.4 **Flood planning level for a one per cent AEP event plus 0.5 metres**

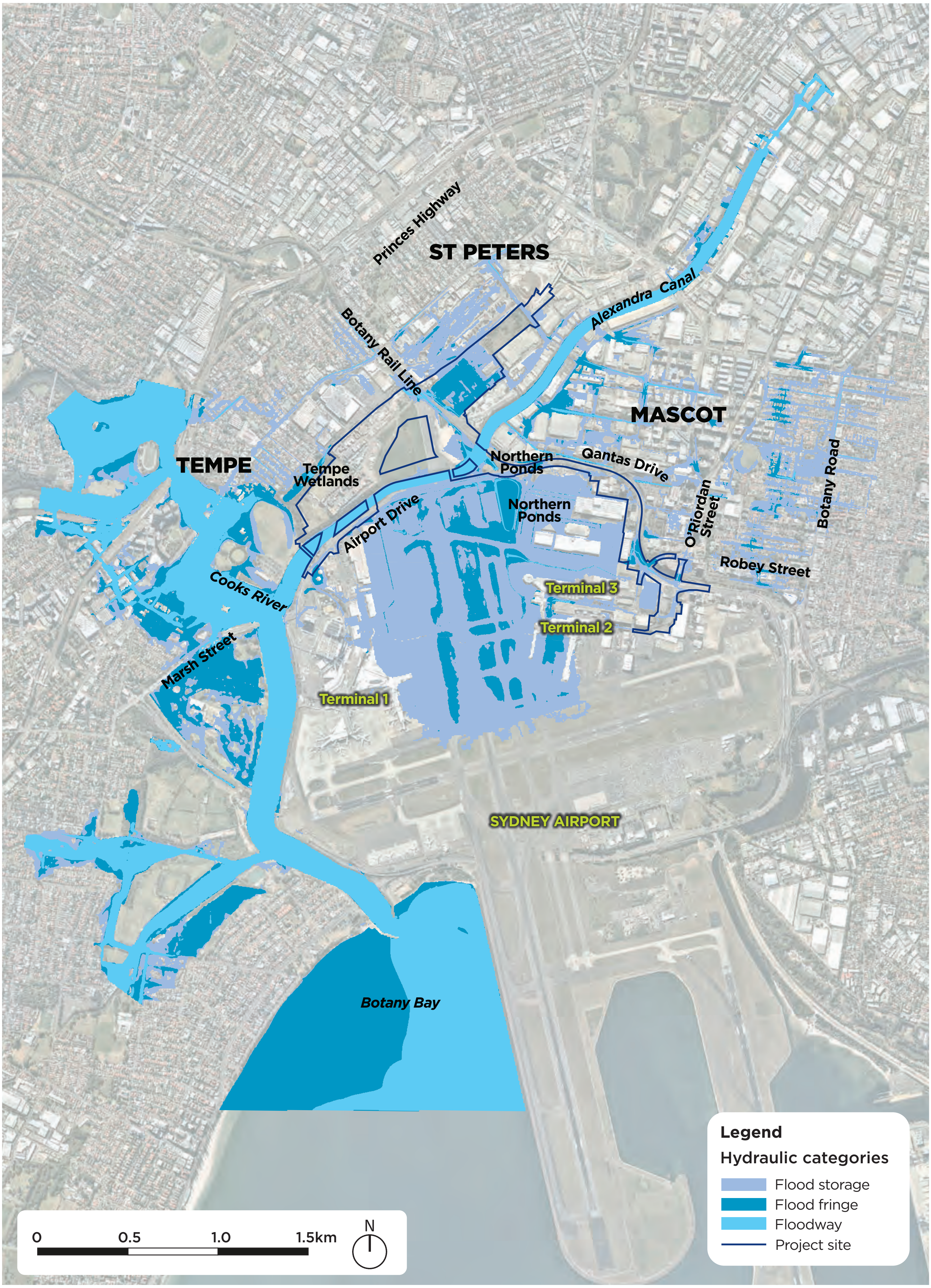


Figure 14.5 **Preliminary hydraulic categorisation of areas during a one per cent AEP event**

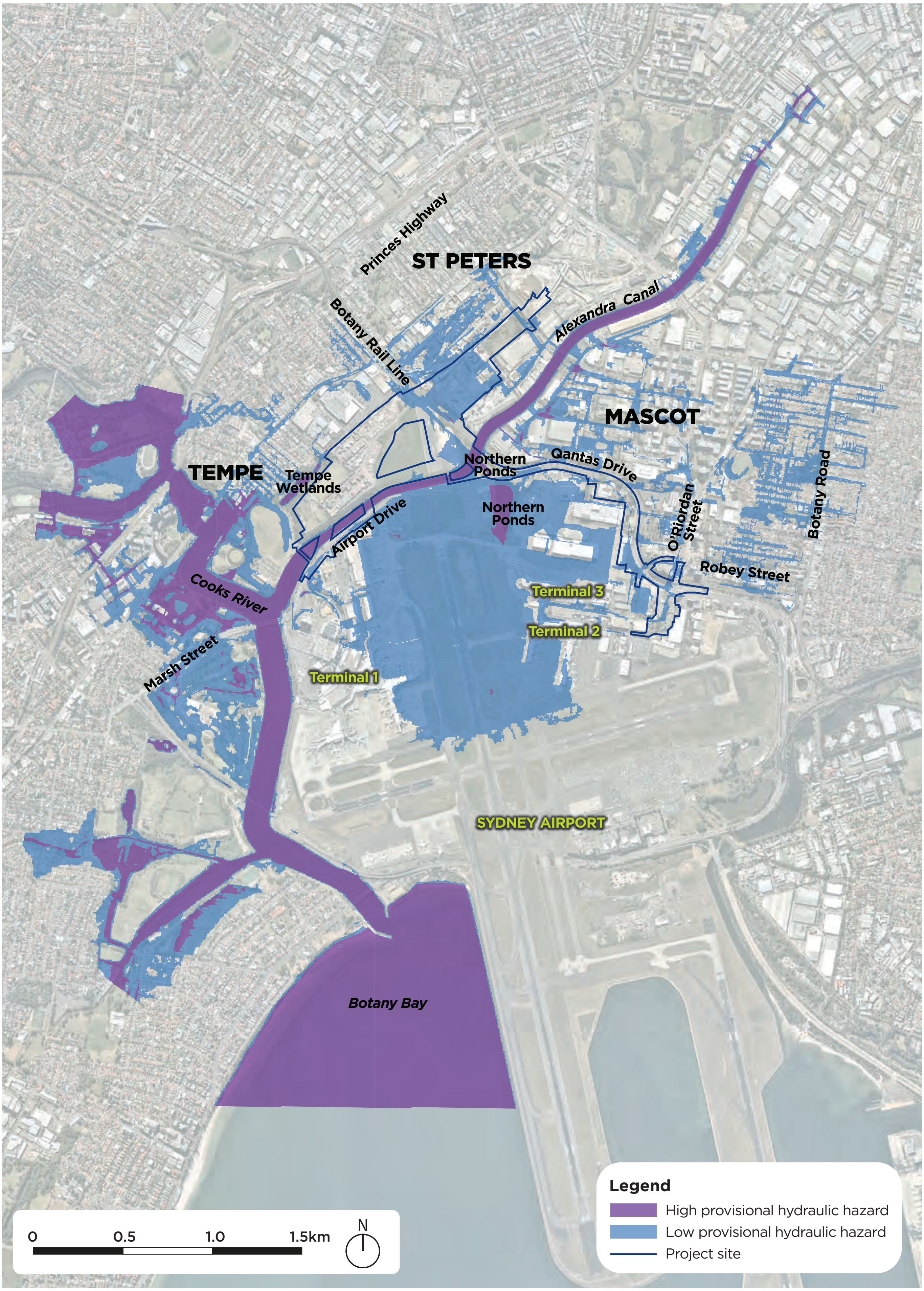


Figure 14.6 **Preliminary flood hazard areas during a one per cent AEP event**

14.2.3 Summary of the flooding characteristics of Sydney Airport (Commonwealth) land

The project site is mainly located within the lower reaches of the Cooks River catchment. Alexandra Canal, Tempe Wetlands and Mill Stream are the key waterbodies in the project site. A small portion of the project site, near the intersection of Sir Reginald Ansett Drive and Keith Smith Drive, drains to Mill Stream via the Sydney Airport stormwater system.

Sydney Airport land is affected by overland flow that discharges from the Cooks River Intermodal Terminal and the Botany Rail Line. A large part of Sydney Airport south of Airport Drive is identified as a flood fringe area. High flood hazard areas are located in the Sydney Airport northern ponds and low hazard areas are located in parts of Sydney Airport land south of Airport Drive, and along sections of Airport Drive and Qantas Drive.

14.3 Assessment of construction impacts

Construction compounds and activities have the potential to change overland flow patterns and exacerbate flooding by affecting areas of flood conveyance and storage, potentially changing levels of inundation upstream. The potential increase in water level upstream of structures, which can obstruct flow, is known as afflux.

14.3.1 Changes in flood affectation of property, assets and infrastructure

The key findings of the assessment for a one per cent AEP design event are summarised below and in Table 14.2. Figure 14.7 shows the potential change in flood inundation as a result of construction.

The assessment identified that while construction activities would involve works within existing flood affected areas, the greatest potential for adverse impacts on flood behaviour would be associated with works for the St Peters interchange connection and along Qantas Drive. This is due to a combination of existing flood behaviour in these locations as well as the proposed works occupying areas of flood storage and intercepting existing surface water flows. The modelling indicates that construction would result in an increase in flood inundation of up to 0.05 metres (50 millimetres) above existing flood inundation levels (between 0.3 to 0.8 metres depending on location). These increases in flood levels are minor.

While the findings of the assessment provide an indication of the potential impacts of construction on flood behaviour, further investigation is needed during detailed design and construction planning. This should adopt a merits-based approach, taking into account the relatively short duration of the works (about 3.5 years) in relation to the likelihood of a large infrequent storm event occurring.

Table 14.2 Summary of changes to peak flood levels during the one per cent AEP event

Work area/compound	Changes in peak flood levels and depths
St Peters interchange connection work area	
St Peters interchange connection compound WestConnex interface compound Other areas	Peak flood levels would increase by a maximum of 0.03 metres along Alexandra Canal north of the Botany Rail Line, leading to a minor increase in the depth of inundation at a number of commercial and industrial properties located along the canal's eastern and western banks and the Beaconsfield West Substation. Subject to further hydraulic assessment during detailed design, floor level surveys may be required to confirm whether construction would increase above-floor inundation and flood damages in affected properties.
Eastern bridges work area	
Eastern bridges compound Other areas	There would be an increase in the depth of inundation along the southern side of the Botany Rail Line by a maximum of 0.05 metres (above the existing depth of inundation of 0.4 metres).

Work area/compound	Changes in peak flood levels and depths
Western bridges work area	
Western bridge compound Freight terminal bridge compound Other areas	Construction is expected to have a negligible impact on existing flood behaviour in the immediate vicinity of this location.
Qantas Drive work area	
Qantas Drive compound Qantas Drive bridge compound Other areas	Peak flood levels would increase by a maximum of 0.02 metres along Alexandra Canal south of the Botany Rail Line. This is a minor change and the impacts would be mainly confined to the canal with the exception of: ▪ An area along Airport Drive where the depth of inundation would increase by 0.02 metres (above the existing depth of inundation of 0.3 metres) ▪ An area along the western bank of the canal on Sydney Airport land where the depth of inundation would increase by 0.02 metres (above the existing depth of inundation of 0.4 metres) ▪ An area within Sydney Airport land to the south of Airport Drive where the depth of inundation would increase by 0.01 metres (above the existing depth of inundation of 0.5 metres).
Terminals 2/3 access work area	
Ninth Avenue compound	There would be a negligible impact on existing flood behaviour in the immediate vicinity of this location.
Airport Drive work area	
Terminal 1 connection bridge compound Other areas	There would be a minor increase in the depth of inundation within an area of Sydney Airport land to the south of Airport Drive where the depth of inundation would increase by a maximum of 0.01 metres (above the existing depth of inundation of 0.8 metres).

14.3.2 Consistency with council floodplain risk management plans

The policies, guidelines and flood planning documents used to guide the approach and methodology for the assessment are listed in section 14.1. This includes the *Mascot, Rosebery and Eastlakes Floodplain Risk Management Study & Plan* (RH DHV, 2017), which includes part of the Alexandra Canal catchment to the north of Qantas Drive. This study defines the hydraulic and hazard categorisation of the floodplain and sets out general, non-structural and location-specific structural measures that need to be undertaken to manage the flood risk associated with future development. The measures include:

- Developing emergency response measures and improved flood awareness
- Providing detention basins
- Upgrading stormwater drainage infrastructure.

Construction of the project would not prevent or compromise these measures. The project is therefore considered to be consistent with the *Mascot, Rosebery and Eastlakes Floodplain Risk Management Study & Plan*.

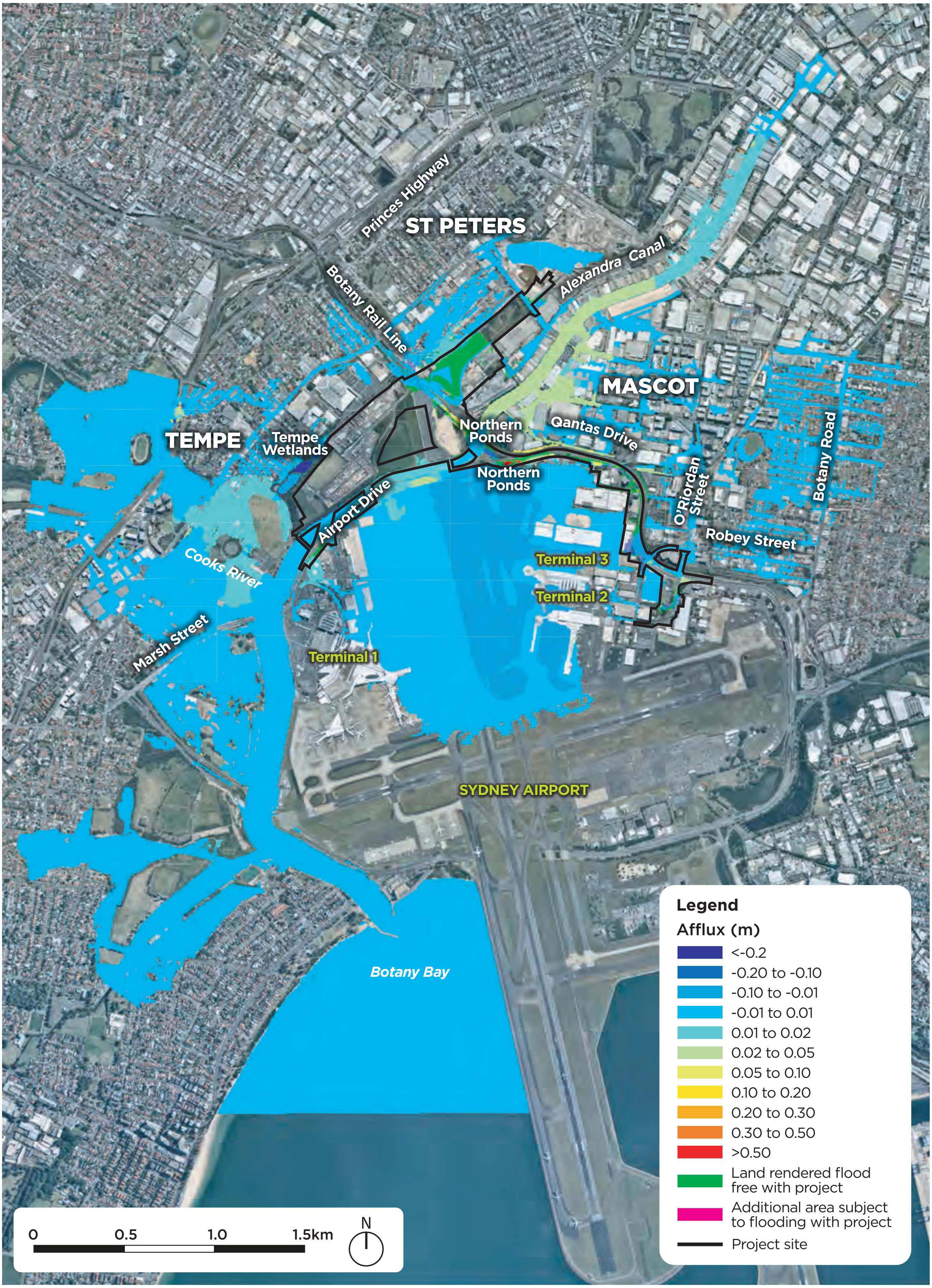


Figure 14.7 **Change in inundation as a result of construction during the one per cent AEP event**

14.3.3 Compatibility with the flood hazard of the land

Some construction activities, work sites, and compounds would be located in areas where there is an existing flood hazard. However, due to the generally small sizes of compounds and work sites relative to the size of the floodplain, there would be minimal impacts on flood hazard. The layout of construction compounds and work sites would be developed with consideration of overland flow paths and would avoid flood-liable land, where practicable. All five construction compound areas, described in Chapter 8 (Construction), include land located outside areas of high hazard during a one per cent AEP event, which would be suitable for site facilities. The location of compounds and work sites would be reviewed during construction planning to avoid high hazard areas.

As construction is not expected to have a significant impact on the preliminary hazard categorisation of the floodplain the project is therefore considered to be compatible with the flood hazard of the land.

14.3.4 Compatibility with the hydraulic functions of the land

Obstruction of flow paths and floodways due to the presence of construction works and equipment has the potential to redistribute flood flows, impact downstream properties, and/or mobilise construction equipment or debris. This may result in downstream safety or water quality impacts.

No construction compounds would be located within identified floodways.

Part of compound C1 north of the Botany Rail Line overlaps with an area identified as flood storage, however the area is small in relation to the total flood storage area identified on Figure 14.5. Smaller areas of compounds C2 and C4 are also located in areas identified as flood storage.

Where compounds are located within or partially within flood-liable land, a detailed review of the proposed location and layout, including siting of buildings and plant, would be undertaken by the appointed construction contractor(s). However, given their relatively small size relative to the overall floodplain area, minimal impacts are expected. Construction of the project is therefore considered to be compatible with the existing hydraulic functions of the land.

14.3.5 Effects on beneficial inundation of the floodplain

Due to the urbanised nature of the floodplain, there are no areas where beneficial inundation currently occurs that would be affected by the project.

14.3.6 Redirection of flow, changes to flow velocity and scour potential

There is the potential for temporary drainage works to impact overland flow paths. This could divert or concentrate flows, potentially resulting in scouring of downstream areas, particularly where soil has been exposed during construction.

Soil and water management measures would be implemented in accordance with the Blue Book to minimise potential impacts resulting from runoff and flooding during construction.

All temporary works associated with construction of the bridges crossing Alexandra Canal would be located outside the canal to avoid potential impacts on flow conveyance in the canal, changes to velocity and the potential for scour. However, there is the potential for localised increases in scour potential as a result of the construction of new and upgraded drainage outlets within the canal. This is considered in Chapter 16 (Surface water).

Based on the construction activities and compounds assessed, no appreciable changes in flow velocities (or scour potential) would occur.

14.3.7 Impacts on existing emergency management arrangements

A number of roads within and surrounding the project site are subject to flooding under existing conditions (described in section 14.2.2). The *Marrickville Local Flood Plan* (SES, 2015) provides a plan for emergency response to flooding within the former Marrickville local government area (now part of the Inner West local government area), including within the catchments of the Cooks River, Alexandra Canal and Mill Stream. The plan sets out preparedness measures, the process for carrying out response operations and coordination of immediate recovery measures from flooding.

With the implementation of mitigation measures provided in section 14.6, no impacts on existing emergency management arrangements are expected during construction. Inner West Council was consulted during the assessment regarding the results. A letter was also sent to NSW State Emergency Services outlining the key findings. Ongoing liaison would be undertaken with relevant stakeholders during detailed design and the construction period.

14.3.8 Social and economic costs

Although there would be temporary changes during construction, including establishment of site compounds and various construction works, as outlined in section 14.3.1, there is not expected to be a material change in flooding behaviour compared with existing conditions. Given the relatively short duration of construction and the small likelihood of a major rainfall event occurring within this period, no social or economic costs to the community are expected as a result of potential flooding impacts.

14.3.9 Summary of impacts on Sydney Airport (Commonwealth) land

Potential impacts on flood behaviour during construction on Sydney Airport land are described in Table 14.3 and would include a minor increase in inundation levels of between 0.01 and 0.05 metres during a one per cent AEP event.

Table 14.3 Summary of changes to peak flood levels during a one per cent AEP event – Sydney Airport land

Work area/compound	Potential impact of construction on flood behaviour on Sydney Airport land
St Peters interchange connection and Qantas Drive work area	
St Peters interchange connection compound Qantas Drive compound Qantas Drive bridge compound Other areas	Peak flood levels would increase in the following areas: ▪ An area along Airport Drive where the depth of inundation would increase by 0.02 metres (above the existing depth of 0.3 metres) ▪ An area along the western bank of Alexandra Canal where the depth of inundation would increase by 0.02 metres (above the existing depth of 0.4 metres) ▪ An area to the south of Airport Drive where the depth of inundation would increase by 0.01 metres (above the existing depth of 0.5 metres). The above impacts are considered to be minor in terms of the relative increase in the depth of inundation.
Eastern bridges work area	
Eastern bridges compound Other areas	Peak flood levels would increase the depth of inundation along the southern side of the Botany Rail Line by a maximum of 0.05 metres (above the existing depth of inundation of 0.4 metres).
Terminals 2/3 work area	
Ninth Avenue compound Other areas	Construction is expected to have a negligible impact on existing flood behaviour in the immediate vicinity of this work area.

14.4 Assessment of operation impacts

14.4.1 Changes in flood affectation of property, assets and infrastructure

The key findings of the assessment of the potential impacts during a one per cent AEP design event, incorporating the proposed drainage upgrades and flood mitigation basin, are summarised below and in Table 14.4. Figure 14.8 and Figure 14.9 show the predicated changes in flood inundation during a one per cent AEP event and PMF event, respectively.

The assessment determined that once constructed, the project would have only a minor impact on flood behaviour for floods up to a PMF (see Figure 14.9), with the exception of the following impacts within Sydney Airport land:

- One per cent AEP flood levels in an area of Sydney Airport to the existing low point on Qantas Drive would increase by a maximum of 0.03 metres over an area that includes several plant and commercial buildings and other infrastructure
- During a PMF, the depth of inundation in an area immediately adjacent to the southern approach ramp of the Terminal 1 connection bridge would increase by a maximum of 0.32 metres, with impacts extending east to the freight terminal bridge. Under pre-project conditions, the depth of inundation in the affected area is typically between 0.4 and 1.5 metres.

Where the assessment has identified the potential for an increase in existing flood levels, further assessment is proposed, as described in section 14.6. The project would not have a significant impact on the future development potential of land located outside the project site.

Table 14.4 Summary of changes to peak flood levels during operation one per cent AEP and PMF – entire project

Catchment	Changes in peak flood levels and depths
Alexandra Canal	
St Peters interchange connection Terminal 1 connection Qantas Drive upgrade and extension Terminals 2/3 access Terminal links Northern lands access Active transport facilities	Flooding in Alexandra Canal: ▪ During a one per cent AEP event, there would be a localised increase in peak flood levels in Alexandra Canal in the vicinity of the Botany Rail Line by a maximum of 0.04 metres. These impacts are confined to the canal and would not affect adjoining properties. Along other areas of the canal, the increase in peak flood levels would be negligible (ie 0.01 metres or less). ▪ There would either be no change or a slight reduction in PMF levels along the Alexandra Canal to the south of the Botany Rail Line, while PMF levels north of the rail line would increase by up to 0.06 metres. There would be no significant increase in the extent of inundation during a PMF event. Flood behaviour in the vicinity of Qantas Drive including Sydney Airport land to the south-east: ▪ Peak one per cent AEP flood levels in an area of Sydney Airport land adjacent to Qantas Drive would increase by a maximum of 0.03 metres over an area that includes several buildings and other structures. Similar increases in peak flood levels would also occur during the two per cent, five per cent and 10 per cent AEP events. ▪ A negligible increase in the depth of inundation (by 0.01 metres) in the car park located within Sydney Airport land to the west of Lancastrian Road. ▪ The upgrade of the drainage system along Qantas Drive between Lancastrian Road and Robey Street would generally result in a reduction in overland flow and therefore the depth of inundation in the area of Sydney Airport land immediately to the west. Flood behaviour in the vicinity of Airport Drive including the portion of Sydney Airport land to the south-west: ▪ During a one per cent AEP, the depth of inundation at the trapped depression to the north of Arrivals Court would increase by 0.03 metres above existing depth of 0.6 metres, and there would be a minor increase in the extent of inundation.

Catchment	Changes in peak flood levels and depths
	▪ There would be a slight reduction in peak flood levels within the northern pond closest to Alexandra Canal. ▪ During a PMF, the depth of inundation in an area of Sydney Airport immediately adjacent to the southern approach ramp of the Terminal 1 connection bridge would increase by a maximum of 0.32 metres, with impacts extending east to the freight terminal bridge. The existing depth of inundation is typically between 0.4 and 1.5 metres. ▪ There would be a slight reduction in peak flood levels within the northern pond closest to Alexandra Canal during a two per cent and one per cent AEP event. There would be no change in peak flood levels within the pond during flood events between the 50 per cent and five per cent AEPs. PMF levels would increase by a maximum of 0.04 metres. Flood behaviour along the western bank of Alexandra Canal between the Botany Rail Line and Canal Road: ▪ There would be a minor change in the depth of inundation within the Cooks River Intermodal Terminal for all events up to 0.25 per cent AEP. During a PMF, depths of inundation in the Cooks River Intermodal Terminal would increase by a maximum of 0.08 metres (on existing depths of between 0.6 and 1.2 metres). ▪ During a one per cent AEP event there would be an increase in the depth of inundation along the northern side of the Botany Rail Line by a maximum of 0.02 metres (on an existing depth of 0.4 metres).
Tempe Wetlands	
Terminal 1 connection	There would be a slight reduction in peak flood levels in the Tempe Wetlands for all events up to the PMF.
Mill Stream	
Terminals 2/3 access	For all events up to one per cent AEP, there would be minor changes in the depth of inundation in the vicinity of the Terminals 2/3 access. During a PMF, the depth of inundation in areas to the north and south of the Terminals 2/3 access would be increased by a maximum of 0.6 metres but typically 0.03 metres or less. Impacts would be confined to an area of road and the carpark within Terminals 2/3. There would be no impacts to critical infrastructure or a significant increase in flood hazard.

The assessment of flow velocities and duration of inundation found that within the Alexandra Creek catchment area, changes in velocities are estimated to be generally less than 0.1 to 0.2 metres per second. This is anticipated at all locations during the one per cent AEP event as a result of the project. This is considered a minor impact to the existing flood hazard. There would also be relatively minor changes in the duration of inundation.

There is the potential for an increase in scour potential in Alexandra Canal as a result of the proposed upgrade of the drainage system and an increase in peak flows discharging into the canal. Appropriate methods of scour protection at identified locations would be identified during detailed design.

Given the small scale of works within the Mill Stream catchment, the project would result in a negligible to minor increase in peak flow velocities and the duration of inundation in this area.

Effects of climate change

The effects of climate change and project impacts on existing flood behaviour was assessed during a 0.5 per cent (lower climate change scenario) and a 0.2 per cent (upper climate change scenario) AEP event. These events were adopted as substitutes for assessing the sensitivity to an increase in rainfall intensity of the one per cent AEP event due to climate change.

Based on the climate change assessment guidelines listed in section 14.1, the assessment indicated that results would be similar to the one per cent AEP scenario and there would be relatively minor increases in flood impacts under both the lower and upper climate change scenarios.

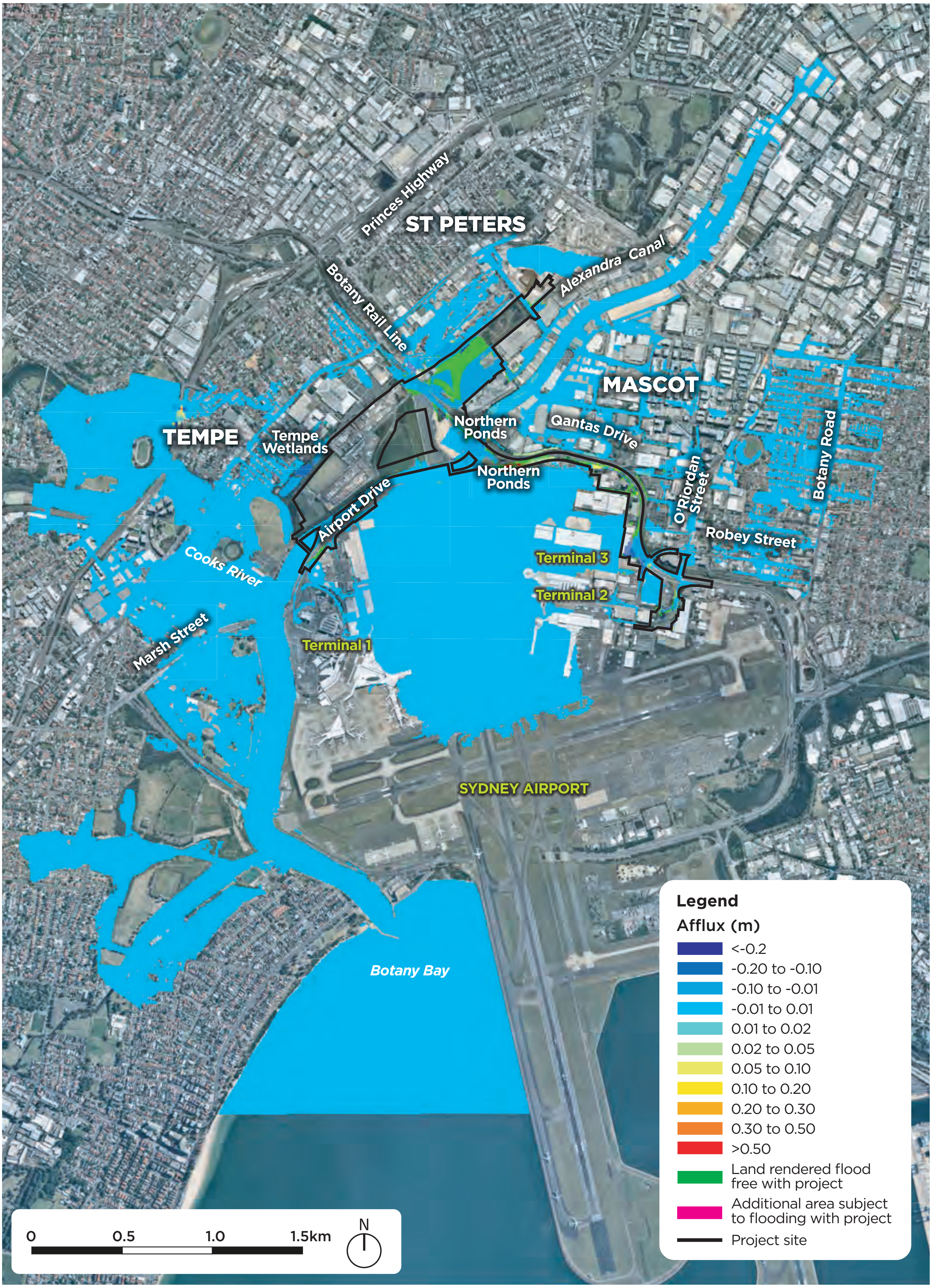


Figure 14.8 **Change in inundation due to the project during a one per cent AEP flood event**

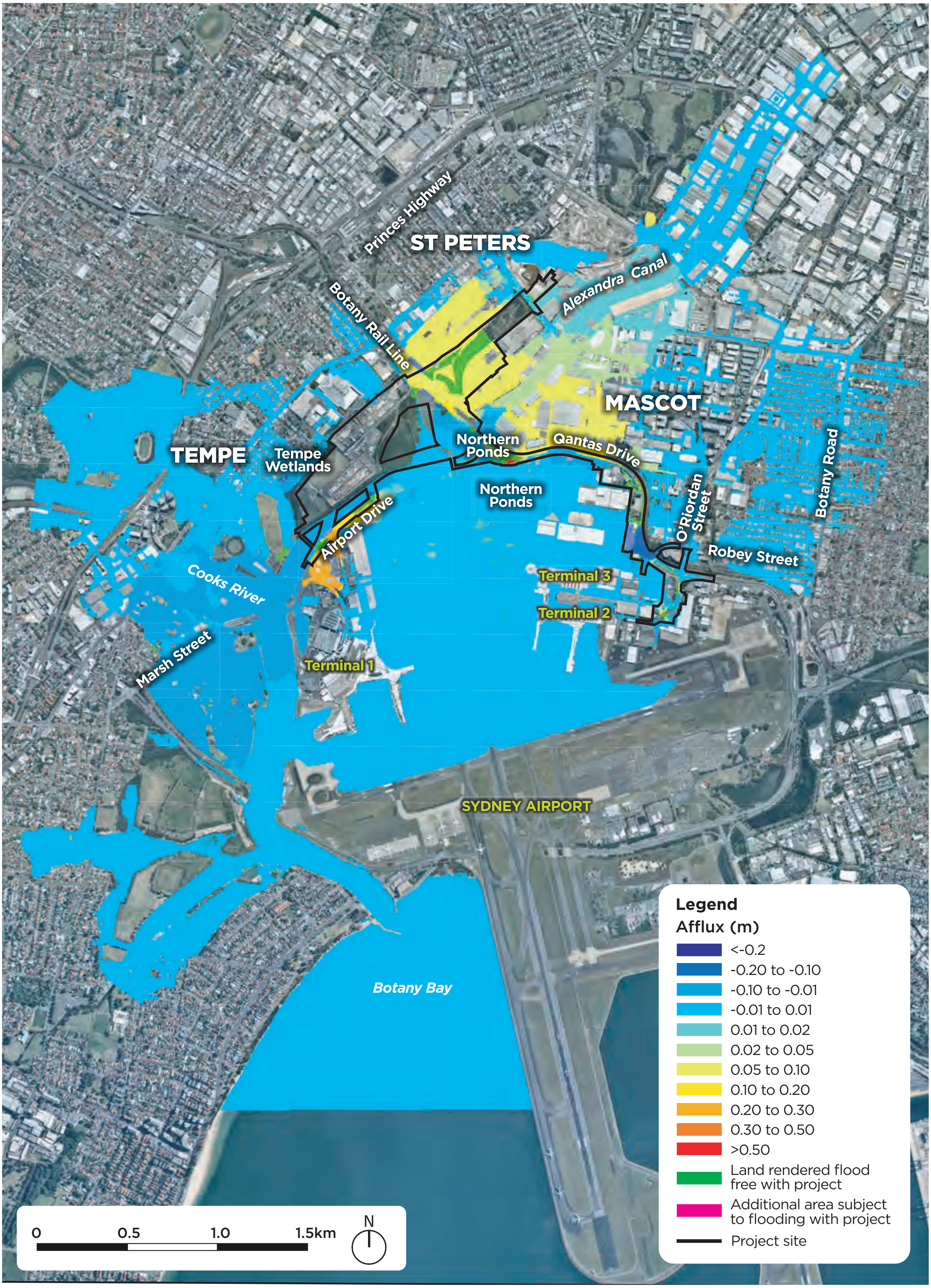


Figure 14.9 **Change in inundation due to the project during a probable maximum flood**

Active transport link bridge

The proposed active transport link includes a new bridge across Alexandra Canal to the west of the Botany Rail Line. The proposed link would depart from the western side of the canal to the east of the Nigel Love Bridge, crossing under the proposed Qantas Drive bridge, landing on the eastern side of the canal to the north of the outlet from Sydney Airport's northern ponds. The proposed link is located in a critical area of the canal where overbank flooding and discharges from the northern ponds occurs during events less frequent than the one per cent AEP.

The bridge would be designed to be 0.5 metres above the one per cent AEP flood level in the canal with the intent to also be above the PMF if possible. A key constraint is the minimum clearance required to the underside of the Qantas Drive extension bridge and the overall height of the bridge structure.

The landing points and approach ramps of the bridge would need to be carefully designed to minimise any influence on overbank flows, with particular regard to discharges from Sydney Airport's northern ponds. Modelling to confirm the extent of any potential changes to predicted flood impacts would be provided at a later project stage.

14.4.2 Consistency with council floodplain risk management plans

As described in section 14.3.1, the project would generally result in minor changes in existing flood extent and depth. Therefore, the project is considered to be compatible with the local floodplain risk management plans described in section 14.3.2. Where the assessment identifies the potential for an increase in existing flood levels and extent (see Table 14.2 and Table 14.4), further assessment is proposed in conjunction with design refinement (see section 14.6). This would take into consideration the consistency with council floodplain risk management plans, where relevant.

14.4.3 Compatibility with the flood hazard of the land

The flood modelling indicates that the project would not materially change the existing flooding behaviour or the depth and velocities of floodwaters. As such, the project is considered compatible with the flood hazard of the land.

14.4.4 Compatibility with the hydraulic functions of the land

The project would result in changes to the flood behaviour of local surface water systems in specific locations. However, the implementation of proposed drainage or mitigation measures would result in no significant changes to the major floodways or floodplain storage areas. The project is considered compatible with the existing hydraulic functions of the land.

14.4.5 Effects on beneficial inundation of the floodplain

Due to the urbanised nature of the floodplain, there are no areas where beneficial inundation currently occurs that would be affected by the project.

14.4.6 Redirection of flow, changes to velocity and scour potential

As described in section 14.4.1, changes in peak flow velocities due to the project are estimated to be generally less than 0.2 metres per second within the Alexandra Canal catchment, while minor changes in flow velocities are predicted within the Tempe Wetlands.

The changes in peak flow velocities in Alexandra Canal during a one per cent AEP event would have the potential to cause bed erosion and bank instability. As the increase is minor, the potential impact is considered to be minor. There is also the potential for localised increases in scour potential due to the predicted increase in peak flows discharging into the canal from new and upgraded drainage outlets. Chapter 16 (Surface water) describes the potential impact of the project on scour potential in Alexandra Canal and provides mitigation measures to reduce the mobilisation of bed sediments in the canal.

Given the nature of proposed works within the Mill Stream sub-catchment, the project would not impact on peak flows and velocities in Mill Stream.

14.4.7 Impacts on existing emergency management arrangements

The project would have a relatively minor impact on flood behaviour for all events up to the PMF. As a result, there are not expected to be any impacts on existing emergency management arrangements across the majority of the project site.

Within Sydney Airport to the north of Arrivals Circuit, there is the potential for the project to result in localised flood level increases during the PMF of up to 0.32 metres. However, the proposed freight terminal bridge would provide an emergency access from the impacted area to land that is located above the PMF flood level. As a result, no adverse impacts of the project on existing emergency management arrangements are expected.

Consultation has been conducted with Inner West Council during the development of the technical study regarding the results. A letter was also sent to the NSW State Emergency Services outlining the key findings. Ongoing liaison would be undertaken with relevant stakeholders during detailed design.

14.4.8 Social and economic costs

Section 14.4.1 indicates that the project has the potential to result in minor increases in flood inundation based on the concept design. However, the characteristics of the study area are such that even minor increases in flooding could result in impacts on adjacent properties.

During detailed design, a floor level survey would be undertaken for properties where there is a potential for increases in peak flood levels for events up to one per cent AEP. This would confirm the extent to which the project may increase above-floor inundation and flood damage, and therefore the scope of mitigation that may be required. At this preliminary stage, the number of buildings within Sydney Airport that may be affected is estimated to be around five or six. A key objective of detailed design would be to reduce this potential impact as far as reasonably practicable.

14.4.9 Summary of impacts on Sydney Airport (Commonwealth) land

Potential impacts on flood behaviour during operation on Sydney Airport land are summarised in Table 14.5.

The preliminary assessment has demonstrated that the project is unlikely to increase the extent, duration or magnitude of flooding such that there would be a significant impact on Sydney Airport land. The potential adverse impacts of flooding during operation would be minimised by implementing the mitigation measures provided in section 14.6.

Table 14.5 Summary of project impacts on flood behaviour – Sydney Airport land

Flood characteristic	Summary of impact on Sydney Airport land
Peak flood levels and depths	▪ Peak one per cent AEP flood levels in an area adjacent to the existing low point in Qantas Drive that includes several buildings and other structures, located about 300 metres to the east of Alexandra Canal, would increase by a maximum of 0.03 metres over an area. ▪ For all events up to one per cent AEP, there would be minor changes in the depth of inundation in the vicinity of the Terminal 1 and freight terminal connections. ▪ During a PMF, the depth of inundation in an area adjacent to the southern approach ramp of the Terminal 1 connection bridge would increase by a maximum of 0.32 metres, with impacts extending east to the freight terminal bridge. The existing depth of inundation in the affected area is typically between 0.4 and 1.5 metres. ▪ For all events up to one per cent AEP, there would be a slight reduction in the depth of inundation in an area to the south-east of the St Peters interchange connection. During a PMF, the depth of inundation would increase by a maximum of 0.08 metres (on existing depths of more than one metre). ▪ For all events up to one per cent AEP, there would be minor changes in the depth of inundation in the vicinity of the Terminals 2/3 access. During a PMF, the depth of inundation in areas to the north and south of the Terminals 2/3 access would increase by a maximum of 0.06 metres (but typically 0.03 metres or less). Impacts would be confined to areas of road and car park within Terminals 2/3.
Peak flows and velocities	▪ In areas to the south of the existing low points on Qantas Drive, peak one per cent AEP flow velocities would increase by between 0.1 and 0.2 metres per second above existing velocities of 0.5 metres per second. Potential impacts would be confined to an existing access road and car park where the scour potential would be low. The change in velocity would have a minor impact on the existing flood hazard. ▪ Changes in peak one per cent AEP flow velocities in the vicinity of the Terminals 2/3 connection would be confined to the new section of road where peak flow velocities would be less than one metre per second.
Extent and duration of inundation	▪ During a one per cent AEP event, there would be a reduction in the extent of inundation within an area to the south of Qantas Drive between Lancastrian Road and Robey Street. Across the remainder of the Alexandra Canal catchment, there would be relatively minor changes in the extent of inundation for all events up to the PMF. ▪ There would be minor changes in the duration of inundation within the grassed areas in the vicinity of the runways and taxiways during a 20 per cent AEP event.

Consistency with the Sydney Airport Master Plan

Sections 12.1 and 14.6.5 of the *Sydney Airport Master Plan 2039* (SACL, 2019a) (the Master Plan) refer to the requirement for flood modelling of new developments, and the achievement of minimum flood immunity criteria or other mitigation approaches, to ensure on and off-site impacts are minimised. These sections also require that the effects of climate change on the performance of the stormwater drainage network are considered and the feasibility of implementing infrastructure works to mitigate issues are assessed.

The assessment described in sections 14.3 and 14.4 outlines the results of flood modelling and identifies that overall, the project would have only a minor impact on the functionality of the existing stormwater drainage systems and flood behaviour in Sydney Airport for floods up to the PMF.

The following residual flood impacts have been identified on existing infrastructure within Sydney Airport:

- Peak one per cent AEP flood levels in an area of Sydney Airport adjacent to the existing low point on Qantas Drive would be increased by a maximum of 0.03 metres over an area that includes several buildings and other structures. Similar increases in peak flood levels would also occur during storms with AEPs of two per cent, five per cent and 10 per cent.
- During a PMF, the depth of inundation in an area immediately adjacent to the southern approach ramp of the Terminal 1 connection bridge would increase by a maximum of 0.32 metres, with impacts extending east to the freight terminal bridge. The existing depth of inundation in the affected area is typically between 0.4 and 1.5 metres

The proposed works at Airport Drive and Qantas Drive would, as a minimum, maintain the level of flood immunity of the existing sections of road while in other locations, the flood immunity would be substantially improved.

An assessment of the impact that climate change could have on the project was completed. This showed relatively minor increases in flood impacts as a result of the project under both the lower and upper bound climate change assessment scenarios. A coordinated approach with Sydney Airport would be adopted to manage the impact of climate change on flooding for the new and upgraded sections of road.

14.5 Cumulative impacts

This section presents an assessment of the potential impacts on flood behaviour in combination with the following major projects approved or currently under construction in the vicinity of the project site:

- Botany Rail Duplication
- New M5
- M4-M5 Link.

The cumulative assessment focussed on impacts during operation, given the relatively short-term nature of exposure to potential flood impacts during construction, together with the general requirement to manage adverse impacts to within acceptable levels on existing development.

Botany Rail Duplication

The proposed Botany Rail Duplication project may impact on the rate of flow discharging to the drainage system across Qantas Drive and through Sydney Airport to the north of Seventh Street.

The Botany Rail Duplication project would also involve works in the Alexandra Canal floodplain. This, in combination with the project, has the potential for cumulative impacts on flood behaviour.

Given the minor nature of flood impacts associated with the Sydney Gateway road project in this area, it is expected that the potential cumulative impacts with the Botany Rail Duplication project would also be minor in nature. If required, these could be managed through appropriate measures to control an increase in the rate of runoff from the future project.

New M5

Flood modelling undertaken during detailed design for the New M5 project, shows that it would have a negligible impact on peak one per cent AEP flood levels along the full length of Alexandra Canal. It would also result in localised increases in peak one per cent AEP flood levels by a maximum of 0.05 metres in the overbank areas of the canal adjacent to the bridge crossings.

The change in peak one per cent AEP flood levels in these areas during operation of the Sydney Gateway road project would be negligible along the section of Alexandra Canal upstream of a location about 50 metres north of the Botany Rail Line. As a result, cumulative impacts with the New M5 project on flood behaviour are considered to be negligible.

M4-M5 Link

There would be no cumulative impacts on flood behaviour as the M4-M5 Link is located in different catchments which are remote from the project.

14.6 Management of impacts

14.6.1 Approach

Approach to mitigation and management

The assessment of flooding impacts has been conducted with reference to the methodology outlined in the Floodplain Development Manual and the other guidance documents outlined in section 14.1. This includes a preliminary assessment to identify the impacts the project would have on existing flood behaviour and to develop a range of potential measures aimed at mitigating its impact on the environment.

The project has been designed, as far as practicable, to minimise the impact of flooding on adjacent property and assets while also providing an appropriate flood immunity for the project. Where reasonable and feasible, the identified flooding impacts would be further reduced during detailed design.

Approach to managing the key potential impacts identified

Potential flooding impacts during construction and operation would be managed in accordance with a flood mitigation strategy. The flood mitigation strategy would build on the preliminary flood assessment and would be based on further design development and flood modelling undertaken during the detailed design stage. It would also include:

- Identifying flood risks to the project, including consideration of local drainage characteristics and the potential impacts of climate change and a partial blockage of watercourse structures on flood behaviour
- Identifying potential flood impacts on the existing environment and future development potential of land, including a floor level survey to confirm whether there would be above-floor inundation to affected residential, commercial or industrial buildings
- Identifying design changes and other mitigation measures to manage the risk of flooding and to not worsen existing flooding characteristics during construction and operation
- Preparing a flood emergency management plan defining measures to be implemented during construction to prepare for a flood, as well as procedures that will be implemented during a flood.

The flood mitigation strategy would be prepared in consultation with Sydney Airport Corporation, Sydney Water, ARTC, NSW State Emergency Services and relevant councils.

Approach to managing other impacts

Potential flooding impacts during construction would also be managed in accordance with the Construction Soils and Water Management Plan, which would be developed as part of the CEMP (see Chapter 27 (Approach to environmental management and mitigation)).

The Construction Soils and Water Management Plan would describe the erosion and sediment control measures to be developed and implemented during construction to minimise sediment disturbance, mobilisation and runoff. Soil and water management measures would be developed and implemented in accordance with the Blue Book.

Project-specific management measures have been developed with the aim of minimising or mitigating, where practicable, the impacts described in sections 14.3 and 14.4. These are provided in section 14.6.2.

Expected effectiveness

Roads and Maritime has experience in managing potential flooding impacts as a result of road developments of similar scale and scope to this project. In particular, these issues are also currently being addressed as part of the F6 Extension and New M5 projects.

The potential impacts on flooding as a result of the project have been modelled. The proposed management strategy is expected to be effective at mitigating the potential flooding impacts. Where potential flooding impacts were identified, the design of the project would be further refined to minimise these impacts, where possible. Preparing and implementing a Flood Mitigation Strategy would ensure that the appropriate flood standards are set, and that the impacts of the project, including contribution from climate change, are effectively managed.

Construction of the project may result in minor and temporary impacts that would be managed through the implementation of standard construction techniques and protection measures.

Auditing and reporting on the effectiveness of environmental management measures employed during construction is generally carried out to show compliance with management plans and other relevant approvals, and would be outlined in detail in the CEMP.

14.6.2 List of mitigation measures

Measures that will be implemented to address potential impacts on flooding are listed in Table 14.6.

Table 14.6 Flooding mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Management of the potential for flooding impacts during construction	HF1	A flood mitigation strategy will be prepared and relevant measures will be implemented as part of the design and during construction. The strategy will include undertaking additional flood modelling taking into account detailed design and proposed construction planning and methodologies.	Detailed design, construction
Impacts on flood behaviour from construction	HF2	Hydrologic and hydraulic assessments will be carried out for all temporary and permanent project components (including ancillary facilities) that have the potential to affect flood levels in the vicinity of the project. The results of the assessment will inform the preparation of the flood mitigation strategy (measure HF1) as well as the design of temporary construction facilities and design development.	Detailed design/ pre- construction
Impacts on property	HF3	Where flood levels in the one per cent AEP event are predicted to increase at any residential, commercial and/or industrial buildings as a result of construction or operation of the project, a floor level survey will be carried out. If the survey indicates existing buildings would experience above floor inundation during a one per cent AEP event, further refinements will be made (as required) to the design of temporary and permanent project components to minimise the potential for impacts.	Detailed design
Impacts on drainage systems	HF4	Further modelling will be undertaken based on the detailed design to determine the ability of the receiving drainage systems to effectively convey drainage discharges from the project once operational. The modelling will be undertaken in consultation with Sydney Airport Corporation and relevant council(s). It will include, but not be limited to: ▪ Confirming the location, size and capacity of all receiving drainage systems affected by operation ▪ Assessing the potential impacts of drainage discharges from the project drainage systems on the receiving drainage systems ▪ Identifying all feasible and reasonable mitigation measures to be implemented where drainage from the project is predicted to adversely impact on the receiving drainage systems.	Detailed design

Impact/issue	Ref	Mitigation measure	Timing
Potential impacts of climate change on flooding	HF5	The potential impacts of climate change on flooding behaviour will be considered during further modelling, in accordance with the procedures set out in *Floodplain Risk Management Guideline: Practical Considerations of Climate Change* (DECC, 2007) and *Australian Rainfall and Runoff* (Geoscience Australia, 2019). An approach to integrating the identified effects into the design and operation of the infrastructure will be determined and implemented.	Detailed design
Potential flood impacts on ancillary construction facilities	HF6	As a minimum, site facilities will be located outside high flood hazard areas based on a one per cent AEP flood. For site facilities located within the floodplain, the flood mitigation strategy will identify how risks to personal safety and damage to construction facilities and equipment will be managed.	Construction
Adaptive management of infrastructure	HF7	Roads and Maritime and Sydney Airport Corporation will review measures to maintain or improve over time the flood immunity of the infrastructure resulting from the effects of climate change.	Operation

14.6.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 14.6.2).

A summary of the potential residual impacts and management approach is provided in Table 14.7.

Table 14.7 Residual impacts – flooding

Potential residual impact	Management approach
Residual construction impacts of the project could include temporary increases in flood levels in rare to extreme flood events.	Measures to manage residual flood impacts during construction will include: ▪ Staging construction to limit the extent and duration of temporary works on the floodplain ▪ Ensuring construction equipment and materials are removed from floodplain areas at the completion of each work activity or should a weather warning be issued of impending flood producing rain ▪ Providing temporary flood protection to properties identified as being at risk of adverse flood impacts during any stage of construction of the project ▪ Developing flood emergency response procedures to remove temporary works during periods of heavy rainfall.
The assessment identified the following minor residual impacts on existing infrastructure within Sydney Airport: ▪ Peak flood levels in an area of Sydney Airport adjacent to Qantas Drive would increase by a maximum of 0.03 metres over an area that includes several buildings and other structures ▪ During a PMF, the depth of inundation in an area immediately adjacent to the southern approach to the Terminal 1 connection bridge would increase by a maximum of 0.32 metres, with impacts extending east to the Freight terminal bridge.	Detailed design will be undertaken with the aim of minimising flood impacts. A flood mitigation strategy will be developed, which will include modelling of the final design and construction approach. The strategy will provide for a merits-based approach to any identified impacts. Consultation with relevant stakeholders would be undertaken as required. A floor level survey will be undertaken to confirm the effect on identified structures and assist in the identification of appropriate mitigation measures.

Potential residual impact	Management approach
Residual operational impacts of the project could include increases in flood levels in rare to extreme flood events of greater than the one per cent AEP event. This could include impacts to surrounding properties, including increased flood depth, potential flood damages during a flood event, and emergency access during times of flooding.	Further consultation with relevant stakeholders and consideration of these potential impacts during the detailed design stage would reduce any residual impacts to an acceptable level.

Chapter 15

Groundwater

This chapter describes the existing groundwater environment, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 7 (Groundwater). Potential groundwater impacts are also considered in Chapter 13 (Contamination and soils) (in terms of the potential for contamination impacts) and in Chapter 16 (Surface water) (in terms of the potential to affect surface water quality once it is removed from the ground).

The SEARs relevant to groundwater, which fall under the headings of 'water – hydrology' and 'water – quality', are listed below. There are no MDP requirements specifically relevant to groundwater, however there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)). Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed[1]
Key issue SEARs		
10	**Water - Hydrology**	
10.1	The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the proposal, including rivers, streams, estuaries and wetlands as described in the BAM.	Section 15.2 and Figure 15.2 (groundwater resources) Section 16.2 and Figure 16.1 (surface water resources) Key resources described in the BAM are also considered in Chapter 22 (Biodiversity)
10.2	The Proponent must prepare a detailed water balance for ground and surface water including the proposed intake from all water supply options and discharge locations (including figures showing these locations), volume, frequency, duration and proposed water conservation and reuse measures for both the construction and operation of the proposal.	Sections 15.3.3 and 15.4.3 (groundwater) Sections 16.3.1 and 16.4.1 (surface water)
10.3	The Proponent must assess (and model if appropriate) the impact of the construction and operation of the proposal and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including:	
	(a) natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge;	Sections 15.3 and 15.4 (groundwater) Sections 16.3.1, 16.3.2 16.4.1 and 16.4.2 (surface water) Chapter 22 (biodiversity)
	(b) impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement	Sections 15.3.1 and 15.4.1 (groundwater)
	(c) changes to environmental water availability and flows, both regulated/licensed and unregulated/rules-based sources;	Sections 15.3.3 and 15.4.3 (groundwater) Not relevant for surface water

Reference	Requirement	Where addressed[1]
	(f) water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction and operation.	Sections 15.3.3 and 15.4.3 (groundwater) No surface water take proposed
10.4	The Proponent must identify any requirements for baseline monitoring of hydrological attributes.	Section 15.6 (groundwater) No monitoring of hydrological attributes is considered necessary. Baseline water quality monitoring is recommended in section 16.6.1 (surface water).
10.5	The assessment must include details of proposed surface and groundwater monitoring.	Section 15.6 (groundwater) Section 16.6.1 (surface water)
11.	**Water – Quality**	
11.1	The Proponent must: (a) Describe the background conditions for any surface and groundwater resources likely to be affected by the proposal including leachate from Tempe Tip	Section 15.2 (groundwater) Section 16.2.3 (surface water)
	(c) identify and estimate the quality and quantity of all pollutants that may be introduced into the water cycle by source and discharge point and describe the nature and degree of impact that any discharge(s) may have on the receiving environment, including consideration of all pollutants (including contaminated groundwater) that pose a risk of non-trivial harm to human health and the environment	Sections 15.3.1, 15.3.2, 15.4.1 and 15.4.2 (groundwater) Sections 16.3.1, 16.3.2 16.4.1 and 16.4.2 (surface water)
	(d) assess the impacts of leachate generation from proposal related activities on the Tempe Tip site and proposed measures for managing potential impacts during construction and operation	Sections 15.3.3, 15.4.3 and 15.6 (groundwater) Sections 16.3.2 and 16.4.2 (surface water)
	(j) demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented	Section 15.6 (groundwater) Section 16.6 (surface water)
	(l) identify proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality.	Section 15.6 (groundwater) Section 16.6.1 (surface water)
11.2	The assessment should consider the results of any current water quality studies, as available, for the catchment areas traversed by the proposal.	Section 15.1.2 (groundwater) Sections 16.1.2, 16.1.4 and 16.2.3 (surface water)

15. Groundwater

15.1 Assessment approach

Groundwater is naturally occurring water contained within rocks and sediments below the ground surface. Construction activities that involve excavation have the potential to encounter groundwater, depending on the depth of both the groundwater and excavation required. Interacting with and removing groundwater during construction is regulated by a number of pieces of legislation aimed at avoiding environmental impacts, including a reduction in the availability and quality of water for users and for ecosystems that depend on it. Understanding the existing characteristics of groundwater is therefore a key part of determining the potential for impacts from infrastructure development and developing appropriate strategies to manage potential impacts.

The groundwater assessment included consideration of the construction and operation activities that may impact groundwater within the project site and adjacent areas. For the purposes of the assessment, groundwater which comes into contact with waste material within the former Tempe landfill is considered to be leachate. Such leachate is collected via the landfill leachate system before it is treated and disposed of.

An overview of the approach to the assessment is provided below, including the legislative and policy context and a summary of the assessment methodology.

15.1.1 Legislative and policy context to the assessment

The assessment has been undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations, POEO Act, *Contaminated Land Management Act 1997* (NSW), *Water Act 1912* (NSW), *Water Management Act 2000* (NSW) and Water Management Regulation 2018
- *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*
- *NSW Aquifer Interference Policy* (Department of Primary Industries, 2012a)
- *NSW State Groundwater Policy Framework Document* (Department of Land and Water Conservation, 1997)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Governments (ANZG), 2018)
- *Australian Drinking Water Guidelines* (National Health and Medical Research Council, 2018)
- *Guidelines for Managing Risks in Recreational Water* (National Health and Medical Research Council, 2008)
- *National Water Quality Management Strategy* (Australian and New Zealand Environment and Conservation Council, 2000)
- *Botany Bay and Catchment Water Quality Improvement Plan* (Sydney Metropolitan Catchment Management Authority, 2011)
- *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales* (NSW EPA, 2004)
- *Risk assessment guidelines for groundwater dependent ecosystems* (Department of Primary Industries, 2012b)
- *Australian groundwater modelling guidelines* (National Water Commission, 2012)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

15.1.2 Methodology

Study area

The assessment included a review of existing groundwater bores within a one kilometre radius of the project site.

Computer modelling (see below for further detail) was used to establish the radius of groundwater drawdown resulting from dewatering of the construction activities. As a result, the study area for the assessment included all sensitive receptors within the area of drawdown around proposed excavations that could be impacted by the project (see Figure 15.4).

Key tasks

The assessment generally involved:

- Reviewing relevant proprietary databases detailing the existing groundwater, geological and hydrogeological environments, including:
  - Hydrogeology of the Botany Basin (Hatley, 2004)
  - Bureau of Meteorology online database
  - WaterNSW online database for registered groundwater bores
- Existing hydrology/flooding, surface water quality, leachate monitoring (for the former Tempe landfill only) and groundwater monitoring data provided by Roads and Maritime, Sydney Airport Corporation and publicly available data
- Reviewing similar assessments for other projects within or close to the study area
- Characterising the current hydrogeological and groundwater conditions in the study area
- Undertaking field investigations, including drilling, permeability testing, monitoring well installation, and water level and quality monitoring
- Developing an analytical computer groundwater model
- Undertaking calculations to predict groundwater inflows and drawdown as a result of the project
- Assessing potential groundwater-related impacts, including a preliminary settlement estimate for adjacent development
- Identifying mitigation measures.

Further information on key activities is provided below.

Field investigations

Baseline groundwater data within the study area was obtained from previous studies and from monitoring undertaken for the project. Groundwater monitoring undertaken for the project since December 2018 included:

- Screening of 27 groundwater wells within or around the former Tempe landfill, 47 wells in the Botany Sands aquifer, and eight wells in bedrock aquifers (primarily Hawkesbury Sandstone) – the location of these monitoring wells is shown on Figure 15.1 and the details of sampling completed at each well is provided in Appendix A of Technical Working Paper 7 (Groundwater)
- Manually monitoring 74 wells for groundwater levels and 73 wells for groundwater quality
- Installing data loggers in 14 wells to monitor groundwater levels
- Hydraulic testing in 16 wells.

Impact assessment

The construction and operation impact assessment focussed on changes to the following groundwater conditions as outlined by the *NSW Aquifer Interference Policy*:

- Groundwater drawdown – including a comparison of the depth of excavation that could require dewatering against interpreted groundwater levels, with consideration of natural variations in groundwater levels
- Groundwater recharge – including a comparison of the change in sealed areas relative to unsealed areas during construction and operation to assess the impacts on recharge
- The potential for beneficial reuse of the groundwater source – including consideration of the suitability of extracted groundwater for beneficial reuse to ensure that the receiving environment is not affected by any discharges.

The assessment assumed that each excavation would be undertaken separately. To allow for overlapping excavations, worst-case construction conditions were considered. This assumed that excavations would be larger and remain open for a longer duration than actually expected. The potential impacts of constructing the following project features, where excavation would be required, were considered:

- Utilities and services installation, augmentation and protection
- Stormwater drainage infrastructure including pipes, channels and the proposed flood mitigation basin (locations and depths shown on Figure 15.3)
- Retaining walls (locations shown on Figure 15.3)
- Bridges, bridge ramps and underpasses (locations shown on Figure 15.3)
- Road cuttings.

Groundwater modelling

An analytical modelling approach was undertaken to inform the impact assessment. This approach was selected for the following reasons:

- The project would mainly interact with shallow unconsolidated aquifers
- Potential drawdown impacts would be temporary, localised and associated with construction
- The aquifer with the potential to be impacted is considered to be a single unit and is well understood as a result of previous assessments.

The inflow rate and radius of influence for individual construction areas were calculated to inform the proposed approach to managing potential groundwater impacts. The radius of influence is the maximum distance from the centre of the excavation where groundwater drawdown can be detected. Radius of influence calculations were completed to assess the potential impacts of the project against the *NSW Aquifer Interference Policy* criteria. Receptors inside the radius of influence were considered to be potentially affected.

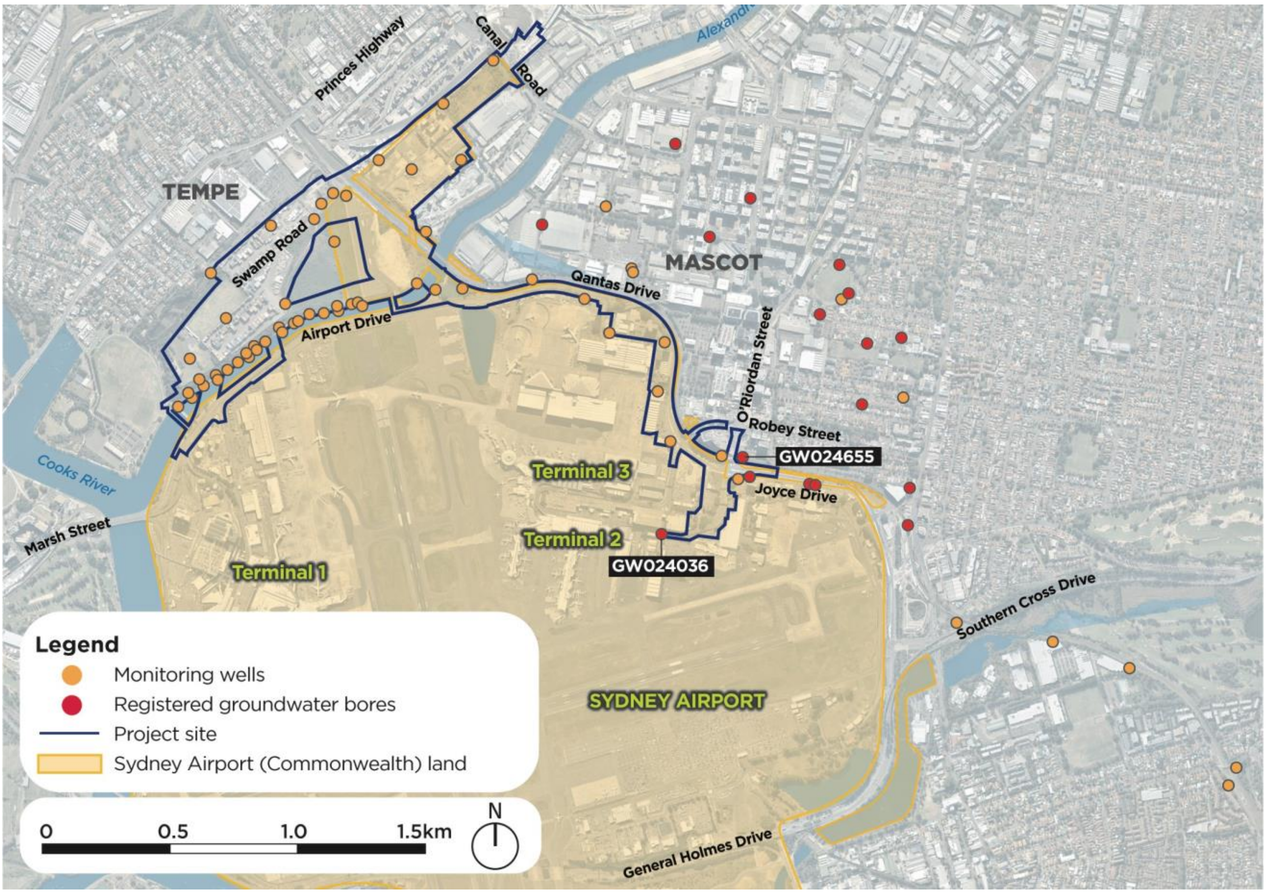


Figure 15.1 Location of monitoring wells and registered groundwater bores

Assessment criteria

Potential groundwater impacts were assessed with reference to the minimal impact considerations for highly productive groundwater sources for coastal sand water sources in the *NSW Aquifer Interference Policy*. A highly productive (high yields and total dissolved solids less than 1,500 milligrams per litre (mg/L)) system was selected based on the conceptual understanding of hydrogeological conditions within the study area. The criteria include:

- Water table – Less than or equal to 10 per cent cumulative variation in the water table at a distance of 40 metres from any high priority groundwater dependant ecosystem or high priority culturally significant site. A criteria of 0.05 metres was set to protect groundwater dependant ecosystems.
- Water table – A maximum two metre water table decline at any water supply location such as a bore (impacts are considered as the total impact of all works associated with the project)
- Water pressure – A pressure head decline of not more than two metres at any water supply location such as a bore (impacts are considered as the total impact of all works associated with the project)
- Water quality – Any change in groundwater quality should not lower the beneficial use category of the groundwater source beyond a distance of 40 metres from the activity.

It is noted that the *NSW Aquifer Interference Policy* assessment criteria were also applied to the assessment of the potential impacts of those parts of the project within Sydney Airport land, as there are no groundwater guidelines or criteria specific to Commonwealth land.

15.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Groundwater risks with an overall assessed risk rating of medium or above, identified by the environmental risk assessment, included:

- Dewatering of excavations may cause drawdown of the groundwater table, impacting sub-surface flows and potentially affecting the stability of nearby structures
- Dewatering of excavations causing drawdown could result in migration of existing contaminated groundwater plumes
- These potential risks and impacts were considered as part of the groundwater assessment.

15.2 Existing environment

15.2.1 Groundwater setting and characteristics

Hydrogeology and aquifers

Groundwater is located within the following hydrogeological units in the study area:

- Hawkesbury Sandstone – A semi-confined dual porosity (fractured and secondary porosity) regional aquifer extending across the Sydney Basin. Groundwater flow is predominantly through the open and connected fractures and bedding plane of the rock mass. Reduced water quality within the upper portion of the sandstone unit may be due to the natural leakage of saline groundwater from the Wianamatta Group (Ashfield Shale).
- Ashfield Shale – A low-yielding aquifer. Like the Hawkesbury Sandstone, its permeability is controlled by fracture intensity, persistence and joint aperture. Groundwater within this unit is highly saline.
- Quaternary Sediments – The Botany Sands is an unconfined, high permeability aquifer. In coastal sand aquifers, including the Botany Sands aquifer, groundwater is contained in the pore spaces in the unconsolidated sand sediments. The level of connection between surface water and groundwater is significant. The estimated travel time between groundwater and surface watercourses is days to months.
- Fill – Two main types of fill materials are located in the study area – landfill material at the former Tempe landfill, and fill associated with reclaimed land in the vicinity of and including Sydney Airport land. The reclaimed material is generally reworked local estuarine deposits and is similar in composition to the underlying natural materials. There are also intermittent areas of fill across the project site associated with development/infrastructure.

The project site is likely to intersect the shallow, unconsolidated Botany Sands aquifer.

Hydraulic conductivity

Hydraulic conductivity is a fundamental aquifer property that assists in understanding the local drawdown that may be imposed on the local hydrogeological regime. Hydraulic conductivity is measured in metres per day and is a calculation of how quickly groundwater flows through a porous medium (soil matrix or rock mass) under natural conditions. The higher the value of hydraulic conductivity, the greater the movement of groundwater expected.

Hydraulic conductivity data from previous investigations and those undertaken for the assessment within the Botany Sands aquifer and unconsolidated fill (a total of 31 test points) are summarised in Table 15.1.

Table 15.1 Hydraulic conductivity for wells within the Botany Sands aquifer

Value	Conductivity (metres per day)
Average	10.03
Minimum	0.09
Maximum	52
Median	1.86

Groundwater recharge

Recharge to the Botany Sands aquifer is mainly via direct rainfall infiltration, with recharge from infiltration ranging from six per cent over estuarine sediments and 37 per cent over sands. The main area of recharge is located to the north-east of the project site at Centennial Parklands. Other green areas, such as the golf courses and the Botany Wetlands to the east of the project site, are also key recharge areas. The project site is mapped as an impervious surface, as developments such as roads, Sydney Airport and other structures and paving reduce the amount of surface infiltration. Therefore, it is expected that the project site would have lower groundwater recharge from rainfall infiltration compared with that of pervious spaces (open spaces such as Tempe Recreation Reserve) overlying the same aquifer. Leakage from water supply and drainage networks generally compensate for decreased direct recharge in urban areas.

Groundwater depth and flow

Monitoring results for 10 bores within the project site identified:

- Shallow groundwater depths, ranging between one and four metres below ground level in the north and north-west of the project site
- The depth of groundwater within the uncontrolled fill in the former Tempe landfill is recorded at an average of 12 metres below ground surface.

Flow directions within the Botany Sands aquifer are generally controlled by topography. From the recharge areas located at higher elevations east and north-east of the Botany Basin, groundwater flows south and south-west towards rivers and other tributaries and into Botany Bay. Based on available well monitoring data, groundwater is located at about 35 metres Australian height datum near Centennial Parklands, with elevations gently declining south to Botany Bay. Regional groundwater flow directions for the Botany Bay catchment are shown on Figure 15.2.

15.2.2 Groundwater quality

The quality of groundwater within and surrounding the project site has historically been poor due to contamination by surrounding industry and other contaminating activities. Investigations carried out for the project have identified that groundwater within and surrounding the project site exceeds the relevant criteria for a number of contaminants. Baseline monitoring undertaken for the assessment identified exceedances of the following criteria:

- Human health (recreational) criteria for arsenic, chromium, total phosphorus, manganese, naphthalene, total recoverable hydrocarbon, iron, ammonia, chloride, sodium, total dissolved solids and pH, lead and PFAS
- Airports (Environment Protection) Regulations 1997 fresh and marine water (exceedances for freshwater and marine unless stated) criteria for aluminium, arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, iron and total petroleum hydrocarbons (freshwater only)
- Ecological criteria from the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018):
  - Freshwater criteria for aluminium, nickel, zinc, copper, boron, cadmium, manganese
  - Marine criteria for cobalt, copper, lead, zinc

  – Freshwater and marine criteria for naphthalene, ammonia and PFOS.

As a result of the historical contamination, restrictions on groundwater extraction from the Botany Sands aquifer were implemented by the NSW Government in 2006 for a number of suburbs, including Mascot, Tempe and St Peters. Within these areas, groundwater extraction is prohibited for domestic use, and use for industrial and irrigation purposes is restricted, subject to testing and treatment (if required). Extracted groundwater may be used for remediation, temporary construction dewatering, testing or monitoring purposes.

Further information on contamination is provided in Chapter 13 (Contamination and soils).

15.2.3 Groundwater users

A total of 23 registered groundwater wells, used for household, recreational, irrigation, commercial/industrial, dewatering or unknown purposes, are located within a one kilometre radius of the project site. The majority of the wells are shallow (less than 20 metres deep) and are expected to be within the Botany Sands aquifer and alluvial sediments. The locations of registered groundwater wells are shown on Figure 15.1.

15.2.4 Water balance

Botany Sands aquifer

The average daily rainfall recharge of the Botany Sands aquifer to the north and east of Cooks River (where the project site is located) is estimated to be about 53,950 cubic metres per day. About 19,135 cubic metres per day of this is estimated to be used by water access licences (mainly in the northern areas of Botany Sands aquifer) and about 34,815 cubic metres per day is estimated to discharge from the aquifer to surface waters.

About 4,874 cubic metres per day of the groundwater discharged to surface water passes beneath the project site to Alexandra Canal. The groundwater discharge to Alexandra Canal from beneath the eastern areas of the project site is about 3,825 cubic metres per day. As the project site represents less than one per cent of the Botany Sands aquifer, the existing recharge within the project site would be less than one per cent of the total rainfall recharge in the Botany Sands aquifer (ie less than 540 cubic metres per day). The total rainfall recharge rates within the project site are considered to be lower than 540 cubic metres per day (based on average recharge by area) as the project site includes more sealed areas compared with the overall area of the Botany Sands aquifer.

Former Tempe landfill

The water balance provided in Technical Working Paper 16 (Former Tempe Landfill Assessment) indicates that daily discharges of leachate range from between 40 cubic metres per day and 108 cubic metres per day. Daily extraction rates in the order of 60 to 100 cubic metres per day generally allow leachate levels to be maintained at or about the elevation of the bentonite cut-off wall, preventing the flow of leachate to Alexandra Canal.

15.2.5 Groundwater dependent ecosystems

There are no groundwater dependent ecosystems located within the project site. The nearest groundwater dependent ecosystems are:

- The Botany Wetlands and Lachlan Swamps, located about two kilometres south-east of the project site
- Vegetation along Wolli Creek, located about one kilometre west of the project site.

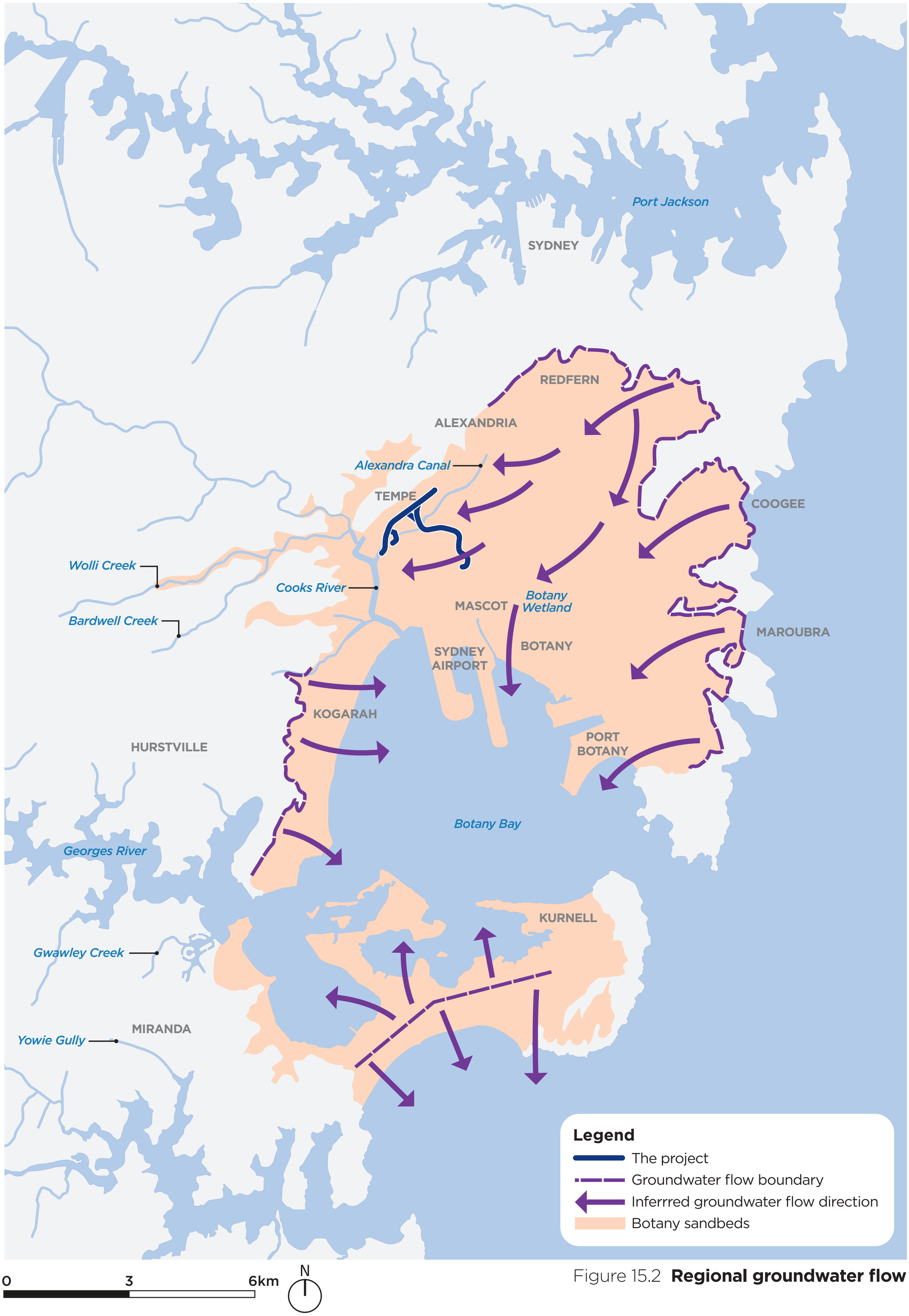


Figure 15.2 **Regional groundwater flow**

15.2.6 Summary of groundwater characteristics on Sydney Airport (Commonwealth) land

Sydney Airport land within the project site is located above the Botany Sands aquifer, with flows of groundwater from north to south below Sydney Airport land towards Botany Bay. Groundwater within this aquifer is contaminated with a number of these sources located on Sydney Airport land including the Sydney Airport Jet Base and taxi staging area east of Terminal 1.

The groundwater resource within Sydney Airport land is similar to the study area as a whole.

One existing groundwater bore is located on Sydney Airport land within the project site (GW24036).

15.3 Assessment of construction impacts

Excavation during construction has the potential to intersect groundwater. The locations of construction works with the potential to intersect groundwater are shown on Figure 15.3.

15.3.1 Aquifer interference

Area of groundwater influence

The radii of influence for groundwater drawdown for the identified excavation areas are shown on Figure 15.4. The results assume that no measures are implemented to limit the inflow of groundwater into excavations.

Given the relatively short duration and progressive nature of excavation for activities such as utilities adjustments, stormwater drainage installation and retaining wall construction, the radius of groundwater drawdown resulting from dewatering is estimated to be less than 100 metres from these activities. Due to the similarity between the radius of groundwater drawdown influence for stormwater lines and utilities, the radius of groundwater drawdown influence for utilities has not been presented on Figure 15.4.

Constructing the cutting associated with the eastbound terminal link and excavating the flood mitigation basin are expected to result in a much larger radius of influence. This is a result of the larger excavation depths for these elements and the need for continuous dewatering to maintain the groundwater levels below the base of the excavations and minimise inflows. The radii of influence for construction of the flood mitigation basin are estimated to be about 570 metres under worst-case conditions (established to account for groundwater level response to long term climatic conditions and rainfall) and 470 metres under likely conditions (established through the monitoring of existing wells on site), while construction of the eastbound terminal link would result in a radius of influence of 500 metres under the worst-case conditions.

Water table changes

There are no groundwater dependent ecosystems located within the radii of influence for groundwater drawdown resulting from dewatering. The closest groundwater dependent ecosystem is located around one kilometre west of the site. The maximum distance that the radius of influence extends from the eastern boundary of the site is about 80 metres.

Two registered groundwater wells lie within the radii of influence. Well GW024036 is an irrigation well on Sydney Airport land within the project site. As new road infrastructure is proposed directly above this well, it would be removed during construction. Well GW024655, located in a former Caltex property, is on the edge of the radius of influence of the nearest area of excavation.

The radii of influence also intersect Alexandra Canal in a number of areas. This is considered to be the only surface water ecosystem potentially affected by drawdown. The canal is tidally influenced and has a constant water supply. As a result, it is unlikely to be adversely impacted by groundwater drawdown or small groundwater discharge reductions associated with excavation.

Water pressure

The Botany Sands aquifer is an unconfined aquifer. As a result, no pressure changes could occur that would affect the elevation of the water table.

15.3.2 Groundwater quality

Acid sulfate soils

The radii of drawdown influence intersects areas mapped as Class 2 and Class 3 acid sulfate soils (see Chapter 13 (Contamination and soils)). The exposure of acid sulfate soils to oxygen has the potential to generate sulfuric acid and lower the pH of groundwater. If not managed appropriately, this could result in the corrosion of sub-surface infrastructure, and impacts on surface water quality and riparian ecology.

As a result of the natural variation in groundwater levels however, particularly close to Alexandra Canal which is subject to tidal influence, it is likely that some areas mapped as potential acid sulfate soils have already been exposed to oxygen, with resulting oxidisation of sediments.

While groundwater would be captured during groundwater dewatering, any oxidised sediments would potentially continue to generate low pH groundwater that could discharge to surface water environments. This would significantly lower the beneficial use potential (environmental values) of these waterways on a short-term basis. Further information on acid sulfate soils and how they would be managed during construction is provided in Chapter 13.

Contaminated sites

Soils within and in the vicinity of the project site feature a range of contaminants depending on the location and historical land uses in the study area. As a result, there is potential to intersect contaminated groundwater during excavation, which if not managed appropriately, could contaminate receiving environments.

There is also potential for contaminated groundwater to migrate towards excavations due to groundwater drawdown as a result of works outlined in Figure 15.3. The following contaminated sites (described in Chapter 13) are located within the radii of influence of proposed excavations:

- Former Tempe landfill
- Alexandra Canal bed sediments
- Boral recycling and concrete, St Peters
- Taxi staging area located south of Keith Smith Avenue
- Joint user hydrant installation site on Sydney Airport land
- Cooks River Intermodal Terminal
- Sydney Airport Jet Base.

Groundwater dewatering is unlikely to result in significant changes to the dimensions and behaviour of the contamination plumes associated with these sites. This is because excavation times would be relatively short and the capture zones (the distance that particles would travel to enter the excavation) are small. If excavations intersect these plumes, any extracted groundwater would be managed in accordance with the management measures defined by the dewatering management strategy (see section 15.6) to minimise the potential for impacts.

In addition, no sensitive receptors (such as groundwater dependant ecosystems and water supply wells) are located between the identified contaminated sites and proposed excavations such that potential water quality impacts could occur. As such, no adverse impacts on groundwater receptors are expected.

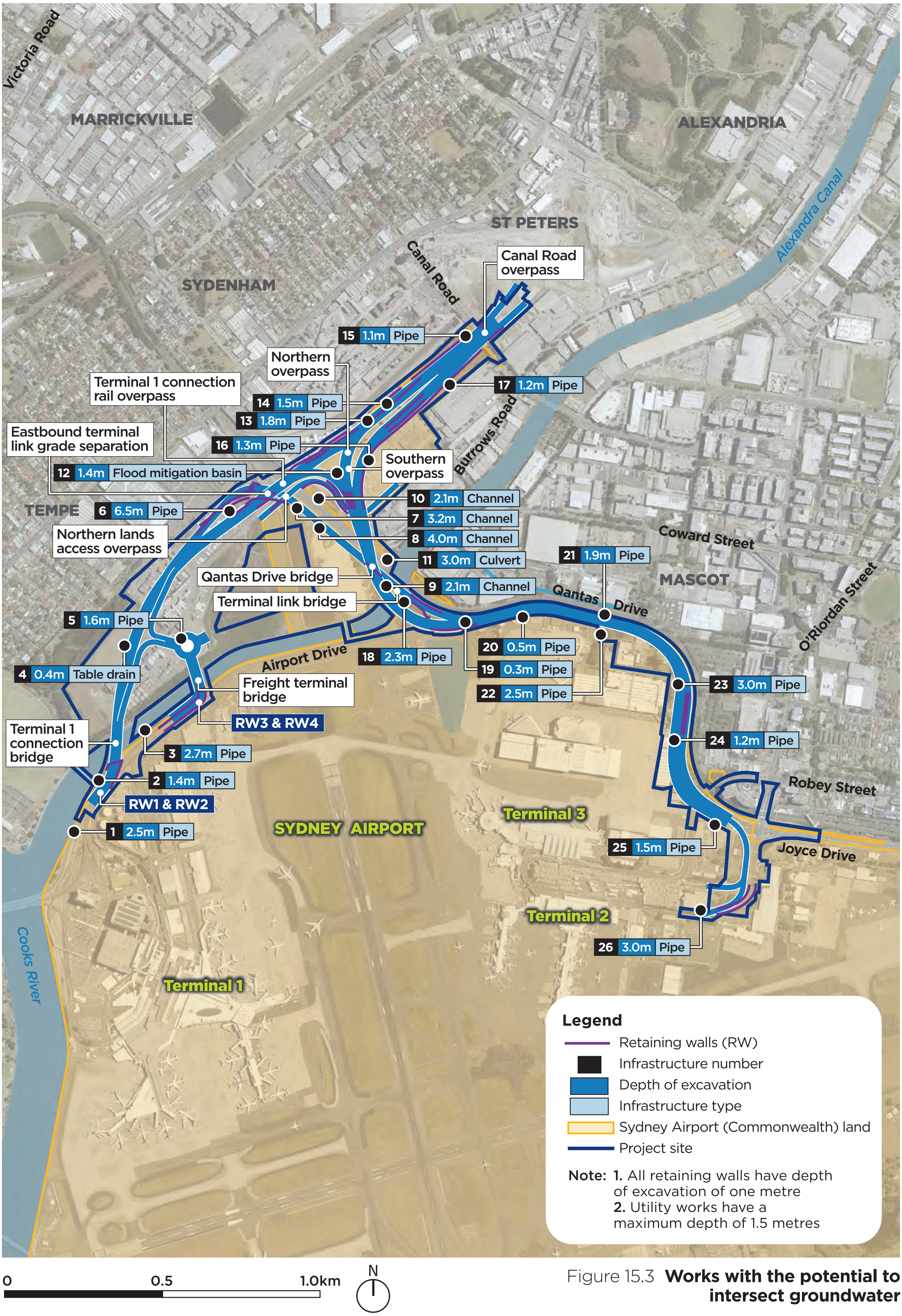


Figure 15.3 **Works with the potential to intersect groundwater**

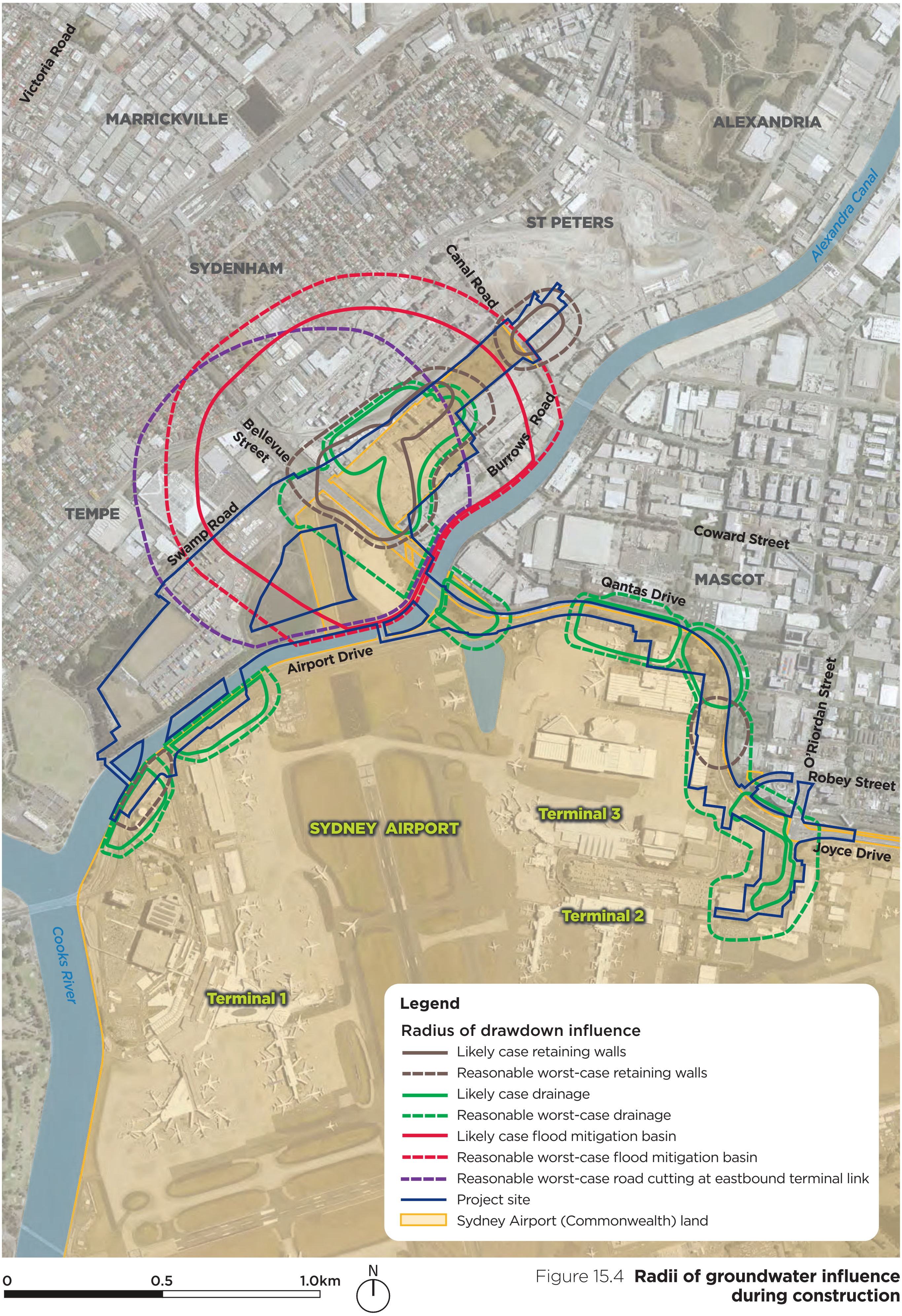


Figure 15.4 **Radii of groundwater influence during construction**

Excavation dewatering

Dewatering excavations would result in groundwater being brought to the surface. Extracted groundwater could be managed by a number of methods, including reinjection, infiltration, reuse during construction, discharge to stormwater or waterbodies, disposal to the wastewater system, and collection for off-site disposal at a waste facility. The most appropriate method would depend on a variety of factors, including the volume and quality of the groundwater, and the extraction location.

One method for managing extracted groundwater would be to discharge it to the stormwater drainage network or nearby surface waters (including discharge to land that then potentially flows to nearby watercourses). This could affect surface water quality if the groundwater being discharged is not of suitable quality.

Roads and Maritime has established the baseline characteristics of key watercourses within the study area (see section 16.2) through an ongoing surface and groundwater monitoring program. Roads and Maritime has also developed project-specific discharge criteria for extracted surface and groundwater (see Chapter 16) to minimise the potential for impacts on surface water quality.

If dewatering activities are not appropriately managed, discharges of groundwater have the potential to impact surrounding receiving environments (including surface water quality). A dewatering management strategy would be developed to minimise the need to dewater and confirm the appropriate management of extracted groundwater (see section 15.6).

Implementation of these measures would minimise the potential for impacts on surface water quality and ensure that extracted groundwater would be treated to a level that, at a minimum, matches the existing water quality characteristics of key surface waterbodies and their dependent ecosystems.

Other potential groundwater quality issues

Other potential risks to groundwater quality during construction include contamination by:

- Hydrocarbons from accidental fuel and chemical spills
- Contaminants contained in turbid runoff from impervious surfaces.

Surface water from site runoff may infiltrate and impact the underlying groundwater. As the infiltration process is generally effective in filtering polluting particles and sediment, the risk of contamination of groundwater from any pollutants found in particulate form in surface water runoff, such as heavy metals, is generally low.

Soluble pollutants, such as pH altering solutes, salts and nitrates, as well as soluble hydrocarbons, can infiltrate soils and contaminate groundwater. Under certain pH conditions, metals may also become soluble and could infiltrate groundwater.

The potential groundwater impacts as a result of such incidents would be managed by implementing best practice construction management measures defined in Chapters 13 (Contamination and soils), 16 (Surface water) and 23 (Health, safety and hazards).

Summary

An assessment of the project against the minimal impact criteria in the *NSW Aquifer Interference Policy* is provided in Table 15.2. The outcome of the assessment is that the project is expected to have only a minimal impact on groundwater within the study area.

Table 15.2 Assessment against the minimal impact criteria of the NSW Aquifer Interference Policy

Criteria	Response summary
Water table – less than or equal to 10% cumulative variation in the water table at a distance of 40 m from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the schedule of the relevant water sharing plan	There are no high priority groundwater dependent ecosystems located within the radii of influence of the project. The radii of influence intersect Alexandra Canal, which is the only surface water ecosystem potentially affected by drawdown. The canal is tidally influenced and has a constant water supply. As a result, no decline in the water table is expected.
Water table – a maximum 2 m water table decline cumulatively at any water supply work	Two registered groundwater wells have been identified within the radii of influence. Well GW024655 is located on the edge of the expected radius of influence and is therefore not expected that a drawdown of more than 2 m would occur. Well GW024036 is located within the footprint of the project site and it is estimated that the drawdown would be about 2.4 m. The well would however be destroyed during construction. Make good provisions would be implemented for this well if required.
Water pressure – a cumulative pressure head decline of not more than a 2 m decline at any water supply work	Not relevant for the Botany Sands aquifer.
Water quality – any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond a distance of 40 m from the activity	Roads and Maritime has established baseline surface water quality conditions in key surface waterbodies within the study area. By setting discharge criteria for extracted groundwater that are protective of the receiving environments, there would be no lowering of the beneficial use category of these surface waterbodies.

15.3.3 Water balance

Water required for construction would not be sourced from groundwater. Potential water sources would include recycled construction water or mains water.

Groundwater recharge of the Botany Sands aquifer

Stripping of existing sealed roads and other hard stand surfaces to enable construction of new sections of road may result in a temporary increase in groundwater recharge. The increase in average recharge, assuming that the existing surface is entirely sealed and the entire construction footprint (excluding the former Tempe landfill) would be stripped at once, is expected to be about 47 cubic metres per day. This is a small amount (less than one per cent) relative to the overall water balance estimated for the project, of about 3,825 cubic metres per day. This increase in recharge would have a negligible impact on the overall groundwater elevation (less than one millimetre) across the site.

Individual rainfall events would result in larger rainfall infiltration rates recharging the aquifer system and subsequent groundwater response. However, this is expected to be small relative to the overall groundwater response occurring in the wider aquifer due to the same rainfall event.

Leachate generation within the former Tempe landfill

A leachate generation assessment was undertaken as part of Technical Working Paper 16 (Former Tempe Landfill Assessment). The assessment concluded that removing sections of the capping layer at the former Tempe landfill would increase the rainfall infiltration rate, resulting in an increase in leachate generation.

Compared to existing leachate extraction rates of between 60 and 100 cubic metres per day, the leachate generation rate (once sections of the capping layer have been removed) is expected to increase to:

- About 200 cubic metres per day under average rainfall year conditions
- About 450 cubic metres per day under 90th percentile wet weather conditions (if they occur) at the start of construction.

- Without appropriate adjustment to the volume of leachate being treated and discharged, leachate might overtop the bentonite cut-off wall installed around the former Tempe landfill and migrate into Alexandra Canal.

A leachate management strategy (see section 15.6) would be developed to consider the management of leachate during construction and to ensure the former Tempe landfill continues to meet the objectives of the site's voluntary remediation proposal.

Groundwater dewatering volumes and inflow rates

The maximum volume of groundwater that would be dewatered from the project site is estimated to be between about 1,144 cubic metres per day (likely groundwater level conditions) and 4,970 cubic metres per day (worst-case groundwater level conditions). The actual volume of groundwater extracted would depend on the number of excavations, the excavation depths compared to groundwater levels, and the length of time that excavations are open.

Table 15.3 outlines the likely and worst-case inflow rates for construction of the main project features predicted to intersect groundwater as a result of excavation. Further information on inflow rates is provided in Table 5-1 of Technical Working Paper 7 (Groundwater).

Based on the three and a half year construction period, it is estimated that the total volume of water to be extracted would be between about 262,000 cubic metres and 1,433,000 cubic metres. Actual groundwater extraction rates and the total volume of water extracted would depend on the final construction methodology, which would be developed by the construction contractor(s). The management of this water would be determined as part of the dewatering management strategy (see section 15.6) and would ensure impacts on the environment are minimised.

Table 15.3 Summary of estimated inflow rates during construction

Project feature	Likely case inflow rates (m^3/day)	Worst-case inflow rates (m^3/day)
Retaining walls	9 to 224	151 to 740
Stormwater outlet/lines	3 to 410	400 to 1,620
Stormwater channels	184 to 550	1,262 to 2,135
Flood mitigation basin	579	1,725
Utilities	58 to 170	50 to 1,025
Eastbound terminal link	-	510

15.3.4 Preliminary settlement estimate

The area of groundwater drawdown (see Figure 15.4) is located below a number of developed areas around Qantas Drive, Airport Drive and north-west of the Sydney Airport northern lands. Lowering the groundwater table in these locations may change the groundwater pressure, which could result in ground movement in the short term and settlement in the long term. A preliminary settlement assessment indicated that the groundwater table may be affected (lowered) at a number of locations as a result of dewatering of excavations, which could affect structures at these locations.

Table 15.4 provides a summary of preliminary settlement estimates as a result of groundwater drawdown. Settlement risks were found to be very slight (cracks of between 0.1 and one millimetre) or slight (cracks of between one and five millimetres).

The results of the settlement assessment would be reviewed during detailed design following confirmation of the preferred construction approach. The aim of the review would be to ensure settlement is avoided, or where predicted, would remain within an acceptable range, to minimise impacts on surrounding land uses and structures.

Table 15.4 Preliminary settlement estimate due to groundwater drawdown

Infrastructure (see Figure 15.3)	Item description	Identified nearby asset	Calculated surface settlement at the asset (mm)	Estimated level of severity
RW1 & RW2	Retaining wall	Joint User Hydrant Installation	25	Slight
RW1 & RW2	Retaining wall	High pressure gas main	30	Slight
RW3 & RW4	Retaining wall	Airport infrastructure	30	Slight
3	Stormwater outlet/line	High pressure gas main	35	Slight
7	Stormwater channel	Car park	10	Slight
8	Stormwater channel	Car park	5	Very slight
9	Stormwater channel	Botany Rail Line	10	Slight
10	Stormwater channel	Botany Rail Line	25	Slight
11	Stormwater channel	Botany Rail Line	20	Slight
11	Stormwater channel	Tank within Boral site	20	Slight
12	Sedimentation basin	Botany Rail Line	20	Slight
18	Stormwater outlet/line	Botany Rail Line	30	Slight
18	Stormwater outlet/line	Building	5	Very slight
22	Stormwater outlet/line	Airport infrastructure	30	Slight

15.3.5 Summary of impacts on Sydney Airport (Commonwealth) land

In summary, construction would have the potential for the following groundwater impacts on Sydney Airport land:

Impact to water supply wells

Water supply well GW024036 would be decommissioned as part of the project.

Settlement of built structures

Settlement risks ranging from very slight to slight have been identified at the Joint User Hydrant Installation near Terminal 1 and along Airport Drive and Qantas Drive. The settlement assessment would be reviewed during detailed design following confirmation of the preferred construction approach, with the aim of minimising the potential for impacts on surrounding land uses and structures.

Impacts on groundwater pH

The radii of groundwater drawdown would intersect areas within Sydney Airport land mapped as class 2 and 3 acid sulfate soils. Any drawdown may potentially generate low pH groundwater, which could corrode sub-surface infrastructure and impact surface water and riparian ecology at any discharge points on Sydney Airport land. As only a small amount of works are proposed within the Mill Stream catchment, no water quality impacts are expected.

Migration of contaminant plumes

Dewatering large volumes of groundwater may mobilise contaminant plumes, such as those under the Sydney Airport Jet Base and taxi staging area south of Keith Smith Avenue. The groundwater capture zones for excavations would be small (in the order of 10 metres) and would therefore not significantly affect the shape and behaviour of existing contaminant plumes. Such impacts would be minimised where possible by minimising impacts on groundwater during detailed design and construction planning.

Discharge of contaminated groundwater to surface water bodies within Sydney Airport land

Water quality impacts would not be expected as:

- Only a small amount of works are proposed within the Mill Stream catchment
- Any discharges would need to meet the project-specific criteria (see Technical Working Paper 8 (Surface Water)) that have been developed in accordance with the Airports (Environment Protection) Regulations 1997).

Potential impacts are not considered to be significant with effective implementation of the mitigation measures provided in section 15.6.2.

15.4 Assessment of operation impacts

15.4.1 Aquifer interference

Water required during operation would not be sourced from groundwater. As a result there would be no risk of drawdown. In relation to the minimal impact criteria of the *NSW Aquifer Interference Policy*:

- Groundwater pressure or water table changes in water supply wells would not exceed two metres. As such, impacts associated with groundwater drawdown would be negligible.
- Water table changes would be less than 10 per cent of the cumulative variation in the water table 40 metres from any groundwater dependent ecosystem (noting that there are no such ecosystems in the vicinity of the project site). As such, impacts associated with groundwater drawdown are also considered to be negligible.
- As there would be no groundwater drawdown during operation, no impacts on acid sulfate soils are expected. Groundwater flow patterns would be the same as the existing situation, as there would be no ongoing groundwater dewatering or more than a negligible change to rainfall recharge. As a result, there would be no lowering of the beneficial use category of the groundwater source beyond 40 metres of the activity.

There may be isolated occasions where groundwater dewatering is required for maintenance activities. However, the details of such activities are not known. Separate approvals would be sought for any future works requiring dewatering as required.

15.4.2 General operational activities

There is the potential for groundwater quality to be impacted as a result of spills or leaks of fuels and/or oils from vehicle accidents and/or maintenance equipment.

The project's stormwater runoff and drainage infrastructure, including the flood mitigation basin, would be designed to minimise infiltration of contaminants to groundwater by directing rainfall and runoff from roads/pavements to the proposed infrastructure. This infrastructure would not be connected to the groundwater system. Further information on the management of accidental spills is provided in Chapter 23 (Health, safety and hazards).

15.4.3 Water balance

Any water required during operation would be sourced from non-groundwater sources.

The project site already includes impervious surfaces and other features that reduce infiltration. The project would result in only a minor increase in impervious surfaces. As a result, minimal reduction in groundwater recharge is expected.

Following excavation within the former Tempe landfill the project would include increasing the thickness of the existing capping layer which is expected to generally lower the generation of leachate compared to existing conditions.

As the potential changes in flows would be very small, any changes to the overall water balance would be negligible.

15.4.4 Summary of impacts on Sydney Airport (Commonwealth) land

Operation would result in negligible potential impacts on Sydney Airport land:

- Impacts on surface water features, water supply wells, acid sulfate soils and settlement of sediments – as groundwater would not be used to operate the project, impacts associated with groundwater drawdown are considered to be negligible
- Impacts on groundwater quality – as there would be no ongoing dewatering or significant changes to recharge, negligible changes in groundwater elevations are expected
- Water balance – minimal reduction in recharge is expected, as the project site already includes impervious surfaces and other features that generally reduce infiltration.

The impacts that have been identified would not reduce the quantity, quality or availability of groundwater at identified receptors and are unlikely to be significant.

Consistency with the Sydney Airport Master Plan

The *Sydney Airport Master Plan 2039* (SACL, 2019a) identifies water quality and water use as a key environmental issue. This includes preventing groundwater contamination and managing existing contamination (mainly contamination of the Botany Sands aquifer). The five year plan for water quality and water use in the *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b) (the Environment Strategy) includes a range of actions to address issues associated with water-related impacts, however it does not include actions specific to groundwater.

Sydney Airport Corporation plans to manage potential impacts on groundwater by implementing the contaminated sites strategy, which includes a groundwater monitoring program to provide early detection of any leaks.

The project is consistent with the objectives of the Environment Strategy, in that the project would prevent soil and groundwater contamination from occurring on Sydney Airport land. It would also seek to manage existing known contaminated groundwater within the Botany Sands aquifer in line with relevant objectives.

15.5 Cumulative impacts

15.5.1 Construction

Potential impacts on groundwater resulting from the project would be limited to the construction phase. Other major infrastructure projects with the potential for cumulative impacts include the New M5, M4-M5 Link, Botany Rail Duplication and Airport North Precinct road works. The Botany Rail Duplication would not use construction techniques that involve groundwater dewatering and therefore no cumulative impacts are predicted.

Both the New M5 and M4-M5 Link are subsurface roads which will result in substantial groundwater drawdown zones, particularly during operation. The closest project is the mainline tunnels for the New M5, which is under construction about 300 metres to the north and west of the project site. Groundwater drawdown from the New M5 tunnels could intersect leachate within the former Tempe landfill and parts of the Sydney Gateway project site. Constructing the Sydney Gateway road project is not expected to exacerbate these impacts as the predicted groundwater impacts would be minor and short-term. Conversely, other projects may result in greater potential exposure of acid sulfate soils and long term settlement of unconsolidated sediments.

The Airport North Precinct Upgrade works may result in similar effects in combination with the Sydney Gateway road project. The potential for cumulative impacts would be assessed further during detailed design when the scheduling and construction methodology for each project is available. Any cumulative impacts associated with construction would be temporary.

15.5.2 Operation

As described in section 15.3 the potential for impacts on groundwater during operation is considered low, therefore no cumulative groundwater impacts with other projects are expected.

15.6 Management of impacts

15.6.1 Approach

Approach to mitigation and management

The assessment identified that, if groundwater is not adequately managed during construction (including appropriate handling, storage, treatment and discharge of potentially contaminated groundwater and any changes to the water table), the project would have the potential to impact the receiving environment and sensitive receptors. Construction would also have the potential to increase leachate generated during excavation at the former Tempe landfill. To minimise the potential for these impacts, detailed design and construction planning would emphasise (in order of priority):

- Avoiding the need to extract groundwater, including adjusting the design (where practicable) to avoid the groundwater table
- Minimising inflow volumes into excavations by selecting appropriate construction methods
- Managing extracted groundwater in accordance with the outcomes of the dewatering and leachate management strategies, described below.

Approach to managing the key potential impacts identified

A dewatering management strategy would be developed to ensure groundwater is appropriately managed when intersected during various construction activities. The strategy would include:

- Reviewing existing groundwater conditions to provide adequate background information
- Identifying proposed management options, including discharge to surface water, infiltration, reinjection, disposal to the wastewater network and disposal at a waste facility
- Assessing the feasibility of each proposed option, considering site-specific constraints, details of when each option is appropriate and any associated environmental impacts
- Developing procedures to limit exposure of receptors (eg personal protective equipment requirements for construction workers)
- Identifying requirements of affected landowners and relevant regulatory authorities in relation to each management option
- Confirming the measures to be implemented to manage groundwater during dewatering activities.

A leachate management strategy would be developed to manage leachate at the former Tempe landfill prior to construction and ensure that the objectives of the site’s voluntary remediation agreement continue to be met. The strategy would include:

- Identifying specific methodologies and measures for leachate management including the collection, transfer, storage, treatment and disposal of leachate
- Developing a framework for monitoring leachate levels and quality, including frequency, notification and reporting requirements

- Identifying management measures to be implemented to minimise the risk of overtopping of the bentonite wall, including but not limited to pumping from leachate sumps
- Identifying changes to the existing leachate management plan or the need for a new plan.

These strategies would complement the Construction Soil and Water Management Plan (see below).

Approach to managing other impacts

In accordance with mitigation measure CS5 (see section 13.6), a Construction Soil and Water Management Plan would be prepared as part of the CEMP and implemented during construction. The plan would detail processes, responsibilities and measures to manage potential soil and water quality impacts (including potential impacts on groundwater) during construction. Further information, including an outline of the plan, is provided in Chapter 27 (Approach to environmental management and mitigation). Other measures are provided in section 15.6.2.

During operation, impacts on groundwater would be negligible with groundwater conditions expected to return to the existing conditions soon after construction is completed. As a result, no specific mitigation measures are required.

Expected effectiveness

Roads and Maritime is experienced in the management of groundwater impacts associated with major road projects, particularly as a result of recent experience with tunnelling projects. The proposed measures are considered appropriate to manage the potential impacts and ensure the works are undertaken in accordance with all relevant guidelines which have been used for a wide range of project types.

Implementing a groundwater monitoring program would confirm the effectiveness of mitigation measures. The results would provide information to drive further development of additional or optimised measures to ensure that any subsequent impacts are appropriately managed.

Roads and Maritime also has recent, site-specific experience undertaking works within the Botany Sands aquifer, during the Airport East Precinct Upgrade project to the east of Qantas Drive. Managing groundwater for this project has provided Roads and Maritime with site-specific knowledge of how to manage groundwater impacts within the Botany Sands aquifer.

15.6.2 List of mitigation measures

Measures that will be implemented to address potential impacts on groundwater are listed in Table 15.5.

Table 15.5 Groundwater mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Avoiding impacts on groundwater	GW1	Detailed design and construction planning will seek to minimise impacts on groundwater by: ▪ Avoiding the need to extract groundwater ▪ Minimising groundwater inflows and volumes into excavations.	Detailed design
Settlement of unconsolidated sediments	GW2	Modelling of settlement induced by groundwater drawdown will be undertaken in accordance with relevant guidelines, based on detailed geotechnical information obtained from the site investigations and the proposed construction approach. Should modelling identify any settlement issues, measures to reduce settlement will be confirmed.	Detailed design
Impacts on existing groundwater well	GW3	A survey of GW024036 will be undertaken to confirm the use of this bore. If this bore is in use, alternative water sources will be considered to ensure ongoing water supply as required.	Detailed design

Impact/issue	Ref	Mitigation measure	Timing
Dewatering of excavation	GW4	A dewatering management strategy will be developed to confirm the approach to managing dewatering of excavations during construction. The strategy will: ▪ Outline measures to minimise groundwater inflow ▪ Describe likely groundwater quality based on sampling data ▪ Estimate potential groundwater inflow rates and volumes for proposed excavations ▪ Identify proposed methods for managing extracted water, which could include reuse, infiltration, reinjection, discharge to stormwater, disposal to the wastewater system, and collection for off-site disposal ▪ Include a feasibility assessment of each proposed management option for extracted groundwater ▪ Identify any groundwater treatment requirements and methods for any of the proposed management options ▪ Describe any applicable monitoring requirements.	Pre-construction
Managing leachate within the former Tempe landfill	GW5	A leachate management strategy will be developed to manage leachate at the former Tempe landfill during construction and ensure that the objectives of the site's voluntary remediation agreement continue to be met. The strategy will: ▪ Identify predicted changes in leachate volumes due to the project, based on the detailed construction methodology ▪ Identify any required changes to the existing leachate management system due to predicted changes in leachate volume and concentration and any other changes due to the project ▪ Describe a framework for monitoring leachate levels and quality to ensure that no leachate migrates into Alexandra Canal during construction. The strategy will be developed in consultation with relevant stakeholders, including Inner West Council, Sydney Water and the NSW EPA.	Pre-construction
Monitoring of construction impacts	GW6	The existing groundwater monitoring program will continue during construction, and will be supplemented as required, to: ▪ Confirm groundwater quality to inform the selection management options for extracted groundwater, including treatment requirements for discharge ▪ Monitor potential migration contaminants due to groundwater extraction (if it is a credible risk) ▪ Confirm if acidification of groundwater is occurring due to exposure of acid sulfate soils ▪ Confirm local groundwater levels to inform estimation of potential inflows and dewatering rates ▪ Monitor drawdown levels and radii of influence to allow comparison against predictions ▪ Confirm any changes to groundwater levels due to the cumulative impacts of other projects.	Construction

15.6.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 15.6.2).

Residual impacts on groundwater are not expected to be present following the implementation of mitigation measures outlined in section 15.6.2 and through the development of the design. Monitoring of groundwater during construction would identify if there are any residual impacts following implementation of the measures proposed. Should monitoring identify residual impacts, further measures would be developed to ensure that impacts on groundwater are minimised

Chapter 16

Surface water

This chapter describes the existing surface water environment, including hydrological conditions and water quality, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 8 (Surface Water).

The SEARs relevant to hydrology and surface water quality are listed below. There are no MDP requirements specifically relevant to surface water, however there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)).

Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
10	**Water – hydrology**	
10.1	The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the proposal, including rivers, streams, estuaries and wetlands as described in the BAM.	Section 16.2 and Figure 16.1 Key resources described in the BAM are also considered in Chapter 22 (Biodiversity)
10.2	The Proponent must prepare a detailed water balance for ground and surface water including the proposed intake from all water supply options and discharge locations (including figures showing these locations), volume, frequency, duration and proposed water conservation and reuse measures for both the construction and operation of the proposal.	Sections 16.3.1 (construction) and 16.4.1 (operation)
10.3	The Proponent must assess (and model if appropriate) the impact of the construction and operation of the proposal and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including:	
	(a) natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge;	Sections 16.3.1, 16.3.2 (for construction impacts) and 16.4.1 and 16.4.2 (for operation impacts) Impacts on aquatic ecology are considered in Chapter 22
	(c) changes to environmental water availability and flows, both regulated/licensed and unregulated/rules-based sources	Not relevant to this project
	(d) direct or indirect increases in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses;	Sections 16.3.1, 16.3.2 and 16.4.1, 16.4.2 Impacts on riparian vegetation are also considered in Chapter 22
	(e) minimising the effects of proposed stormwater and wastewater management during construction and operation on natural hydrological attributes (such as volumes, flow rates) and on the conveyance capacity of the existing stormwater systems where discharges are proposed through such systems; and	Sections 16.3.1 and 16.4.1

Reference	Requirement	Where addressed
	(f) water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction and operation.	No water take (direct or passive) of surface water is proposed. Expected groundwater take is identified in section 15.4.3
10.4	The Proponent must identify any requirements for baseline monitoring of hydrological attributes.	No monitoring of hydrological attributes (Alexandra Canal or Mill Stream) are considered necessary. Baseline water quality monitoring is recommended in section 16.6.1
10.5	The assessment must include details of proposed surface and groundwater monitoring	Section 16.6.1
11	**Water - quality**	
11.1	(a) Describe the background conditions for any surface and groundwater resources likely to be affected by the proposal including leachate from Tempe Tip;	Section 16.2.3 (surface water). Groundwater conditions and leachate from the former Tempe landfill are considered in Chapter 15 (Groundwater) and Technical Working Paper 16 – Landfill Assessment respectively
	(b) state the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the proposal, including the indicators and associated trigger values or criteria for the identified environmental values;	Section 16.1.4 and Table 16.1 Appendix B, Technical Working Paper 8 – Surface Water
	(c) identify and estimate the quality and quantity of all pollutants that may be introduced into the water cycle by source and discharge point and describe the nature and degree of impact that any discharge(s) may have on the receiving environment, including consideration of all pollutants (including contaminated groundwater) that pose a risk of non-trivial harm to human health and the environment;	Sections 16.3.1, 16.3.2 16.4.1 and 16.4.2
	(d) assess the impacts of leachate generation from proposal related activities on the Tempe Tip site and proposed measures for managing potential impacts during construction and operation;	Sections 16.3.2 and 16.4.2
	(e) describe the proposed measures for treating and disposing of construction and operational wastewater flows;	Sections 16.1.4, 16.3.1 and 16.4.1
	(f) identify the rainfall event that the water quality protection measures will be designed to cope with;	Section 7.10.8
	(g) assess the significance of any identified impacts including consideration of the relevant ambient water quality outcomes;	Sections 16.3 and 16.4
	(h) demonstrate how construction and operation of the proposal will, to the extent that the proposal can influence, ensure that: — where the NSW WQOs for receiving waters are currently being met they will continue to be protected; and — where the NSW WQOs are not currently being met, activities will work toward their achievement over time;	Sections 16.3.2 and 16.4.2
	(i) justify, if required, why the WQOs cannot be maintained or achieved over time;	Sections 16.3.2 and 16.4.2
	(j) demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented	Section 16.6

Reference	Requirement	Where addressed
	(k) identify sensitive receiving environments (which y include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments; and	Sections 16.2.3 (identification of sensitive receiving environments) and 16.6 (strategy to minimise impacts)
	(l) identify proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality	Section 16.6.1 Existing groundwater quality is discussed in Chapter 15 (Groundwater)
11.2	The assessment should consider the results of any current water quality studies, as available, for the catchment areas traversed by the proposal.	Sections 16.1.2, 16.1.4 and 16.2.3

16. Surface water

16.1 Assessment approach

Constructing and operating roads can mobilise pollutants (such as sediment or chemicals), with the potential to affect water quality and/or flows in surrounding watercourses. Understanding the existing characteristics of watercourses and identifying potential impacts associated with construction and operation is an important component of an environmental impact assessment. Identifying potential water quality risks during the project planning phase assists in the development of appropriate management strategies to ensure that potential impacts are appropriately managed.

As the project has the potential to disturb soil and areas of contamination (see Chapter 13 (Contamination and soils)) and affect significant watercourses and waterbodies (including Alexandra Canal), a surface water assessment has been undertaken by experienced specialists. An overview of the approach to the assessment is provided below, including the legislative and policy context and a summary of the assessment methodology.

16.1.1 Legislative and policy context to the assessment

The assessment was undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations, POEO Act, and the *Water Management Act 2000* (NSW)
- *National Water Quality Management Strategy* (Department of Agriculture and Water Resources, 2018)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Governments, 2018)
- *Australian Guidelines for Water Quality Monitoring and Reporting* (ANZECC/ARMCANZ, 2000)
- *NSW Water Quality and River Flow Objectives* (DECCW, 2006)
- *Managing Urban Stormwater – Soils and Construction* (Landcom, 2004), Volume 2B Waste landfills (DECC 2008a) and Volume 2D Main Road Construction (DECC, 2008b) (collectively referred to as the 'Blue Book' in this chapter)
- *PFAS National Environmental Management Plan* (HEPA, 2018)
- *NSW MUSIC Modelling Guidelines* (BMT WBM, 2015)
- *Botany Bay and Catchment Water Quality Improvement Plan* (Sydney Metropolitan Catchment Management Authority, 2011)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

16.1.2 Methodology

Study area

The study area for the surface water assessment included the catchment areas within the project site and receiving watercourses, described in section 16.2.

Key tasks

The surface water assessment involved:

- Reviewing existing environmental conditions and water quality data in the study area including (but not limited to):
  - Data from assessments undertaken for other major projects in the study area (the New M5 and M4-M5 Link projects)
  - Baseline water quality monitoring data collected between December 2017 and March 2019
- Identifying assessment criteria for the project based on:
  - Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ, 2000) (the ANZECC guidelines) which are the same as those adopted by the new Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Governments, 2018) (the Water Quality Guidelines)
  - NSW Water Quality and River Flow Objectives (DECCW, 2006) for catchments affected by the project
  - Schedule 2 (Water pollution accepted limits) of the Airports (Environment Protection) Regulations 1997 (for watercourses within Sydney Airport land)
- Identifying activities that could affect surface water hydrology and quality during construction and operation
- Assessing potential impacts during construction based on a qualitative desktop assessment
- Assessing potential impacts on hydrology and water quality during operation, including:
  - Identifying existing and future predicted pollutant loads using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) modelling software
  - Assessing future predicted pollutant loads against pollutant load reduction targets in the Botany Bay and Catchment Water Quality Improvement Plan 2011 (Sydney Metropolitan Catchment Management Authority, 2011)
  - Assessing potential changes to surface water flow by calculating the runoff for the existing and future scenarios using the MUSIC modelling software
  - Assessing potential geomorphological impacts, such as changes in bed and bank stability, based on the findings of flood modelling (see Chapter 14 (Flooding))
- Recommending mitigation and management measures, including water quality monitoring for identified impacts.

16.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Risks to surface water hydrology and quality with an assessed risk rating of medium or above, identified by the environmental risk assessment, included:

- Sedimentation of receiving watercourses and waterbodies as a result of increases in velocity of flows, soil disturbance and transport off site
- Impacts on water quality as a result of interaction with potentially contaminated soils and groundwater during construction
- Impacts on water quality in Alexandra Canal as a result of the disturbance of contaminated sediments during construction or scour at discharge outlets during operation
- Impacts on water quality as a result of disturbance of actual or potential acid sulfate soils and/or acid drainage during construction

- Impairment or modification of existing drainage infrastructure resulting in changes to overland flows and drainage pathways during construction or operation
- Impacts on water quality during operation as a result of runoff from road pavement surfaces containing contaminants from vehicle movements (oils, grease, heavy metals etc).

These potential risks and impacts were considered as part of the surface water assessment. Potential risks associated with soils are considered in Chapter 13 (Contamination and soils) and potential risks associated with groundwater are considered in Chapter 15 (Groundwater).

16.1.4 Assessment criteria

Construction water quality

Environmental values associated with water quality

The *NSW Water Quality Objectives* provide the agreed environmental values and long-term goals for NSW's surface waters. The objectives are consistent with the national framework for assessing water quality set out in the Water Quality Guidelines (previously the ANZECC guidelines). The water quality objectives provide environmental values for NSW waters and the Water Quality Guidelines provide the technical guidance to assess the water quality needed to protect those values.

The Airports (Environment Protection) Regulations 1997 also provide accepted limits of pollutants in fresh and marine waters in relation to watercourses on land subject to the Airports Act. These have also been taken into consideration when selecting criteria (known as trigger values for water quality) for the assessment.

Establishing ambient water quality in receiving waters

The Water Quality Guidelines and the Airports (Environment Protection) Regulations 1997 (as relevant) recommend default trigger values associated with the identified environmental values for various physical, biological and chemical pollutants that may be present in water. Trigger values are the criteria used for concentrations that, if exceeded, would indicate a potential environmental problem, and so 'trigger' the need for a management response. It is noted that in 2018, the ANZECC guidelines were superseded by the Water Quality Guidelines. The default trigger values for various pollutants in the Water Quality Guidelines are the same as those in the ANZECC guidelines. The trigger values and levels of protection referred to in this chapter are sourced from the ANZECC guidelines.

Water quality data for the receiving waters in the study area indicate that the values for many toxicants regularly exceed the default trigger values specified in the ANZECC guidelines. The data was investigated to define ambient water quality in the receiving watercourses.

Defining ambient water quality for the project generally involved:

- Identifying trigger values (as per the ANZECC guidelines and the Airports (Environment Protection) Regulations 1997) for long-term goals based on relevant environmental values – known as long-term (or default) trigger values
- Comparing the results of baseline monitoring of existing water quality against the default trigger values (see section 16.2.3 for a description of existing water quality for watercourses in the study area)
- Identifying ambient water quality values based on baseline water quality monitoring data – while these values are different to the long-term (default) trigger values, they can indicate whether existing water quality would be affected during, and shortly after, construction, particularly where water quality monitoring results indicate that contaminants currently exceed the default trigger values
- Any discharges for water during construction would be temporary and would be unlikely to inhibit achieving the desired long-term environmental values for the receiving watercourses. Establishing criteria for water to be discharged during construction, based on the ambient water quality values as described above with consideration of ANZECC default trigger values, would ensure that discharges do not affect the receiving watercourse in the short-term.

Relevant environmental values

As the project is located within the sub-catchments of the Cooks River and Georges River (Alexandra Canal and Mill Stream respectively), the relevant environmental values for these catchments, outlined in the *NSW Water Quality Objectives*, are to maintain and improve water quality in order to support aquatic ecosystems. The long-term goal is to return the sub-catchments to a condition where the watercourses are suitable for primary contact activities and aquatic food. The watercourses are, however, highly degraded, and primary contact activities and aquatic food are either not recommended or prohibited. Potential impacts associated with the project would be temporary and unlikely to affect achieving the longer term goals. For the purposes of managing the potential short-term impacts of the project, the primary environmental value is considered to be aquatic ecosystems.

The default trigger values associated with these environmental values depends on the level of protection to be achieved. The ANZECC guidelines recognise that different levels of protection may be appropriate for different waterbodies, corresponding to the condition of the ecosystem and whether the values are already being achieved. In a highly disturbed watercourse, a reduced level of protection may be an appropriate short-term goal with the aim of restoring it to a higher condition.

Establishing appropriate discharge criteria

Some water may need to be discharged during construction. The quality of the water discharged would influence whether there are any impacts on water quality and aquatic ecosystems in the receiving waters.

A detailed list of the indicators and associated default trigger values for all the environmental values associated with the Cooks River and Georges River catchments is provided in Appendix A of Technical Working Paper 8 (Surface Water). These default trigger values are recommended for the evaluation of water quality conditions in the existing environment against long-term water quality goals.

The ambient water quality values would be adopted as the reference state for potential water quality impacts during construction, and in the period after construction until such time as the project site is adequately stabilised, are provided in Appendix B of Technical Working Paper 8 (Surface Water) and are based on water quality monitoring results to date (see section 16.2.3).

Discharge criteria that are protective of ambient water quality values would be set during construction, as follows:

- For physical and chemical stressors – use the least stringent of:
  - The 80th percentile value from the baseline monitoring data; or
  - The default trigger value for aquatic ecosystems in marine waters.
- For non-bioaccumulative pollutants – use the least stringent of:
  - The 80th percentile value from the monitoring data; or
  - The 80 per cent level of protection for species in marine waters.
- For bioaccumulative pollutants – use the least stringent of:
  - The 80th percentile value from the monitoring data; or
  - The 95 per cent level of protection for species in marine waters.

Discharge criteria for construction water (extracted groundwater and contaminated runoff) that is developed using this method would be unlikely to noticeably impact water quality. As discharges of construction water would be temporary, discharges of water that comply with criteria developed in this manner would be unlikely to affect achievement of the long-term water quality goals for the watercourses.

Operation water quality

In the absence of water quality criteria specific to the operation of a roadway, the surface water pollutant reduction targets for development in the *Botany Bay and Catchment Water Quality Improvement Plan 2011* were adopted for the operational impact assessment (see Table 16.1).

Table 16.1 Pollutant reduction targets for Botany Bay catchment

Stormwater pollutant	Pollutant reduction target (%)
Gross pollutants	90
Total suspended solids	85
Total phosphorus	60
Total nitrogen	45

In addition, the management of water quality on Sydney Airport land would need to be consistent with the *Sydney Airport Environmental Strategy 2019–2024*. The key performance indicator adopted in the strategy relevant to surface water quality is that water quality monitoring results for stormwater from the airport should remain the same or improve.

16.2 Existing environment

The existing surface water features that comprise the hydrological regime for the study area are described in the following sections and are shown on Figure 16.1.

16.2.1 Catchments and watercourses

The project site is mainly located within the Cooks River catchment, which is a sub-catchment of the larger Botany Bay catchment. The Botany Bay catchment covers about 1,565 square kilometres and contains several sub-catchments. A small portion of the project site, near the intersection of Sir Reginald Ansett Drive and Keith Smith Drive, drains to the lower estuarine reach of Mill Stream. Mill Stream drains to Botany Bay, which is part of the Georges River catchment.

Both the Cooks River and the Georges River catchments are highly urbanised, meaning the rainfall-runoff response of the catchments has been altered from a natural state. This has resulted in changes to the quantity and speed of runoff within the catchment.

The catchment boundaries and key watercourses within and near the project site are shown on Figure 16.1.

Cooks River catchment

The Cooks River catchment, located in the inner to middle south-western suburbs of Sydney, has an area of about 100 square kilometres. The majority of the catchment is highly developed. The Cooks River is about 23 kilometres long and flows from Chullora in the west to Botany Bay in the east. The river discharges into the north of Botany Bay, near Sydney Airport. The river is tidally influenced as far as South Enfield. In addition to Alexandra Canal, the major tributaries of the river include:

- Coxs Creek
- Cup and Saucer Creek
- Wolli Creek
- Muddy Creek
- Bardwell Creek
- Sheas Creek
- Freshwater Creek.

Parts of the Cooks River remain in a natural state, while other sections were lined with concrete from the 1940s onwards. Sydney Water has undertaken progressive channel naturalisation works at three locations to restore the river closer to its natural state. Between 2008 and 2012, the former Sydney Metropolitan Catchment Management Authority undertook, in consultation with local councils, a number of wetland remediation projects along the Cooks River.

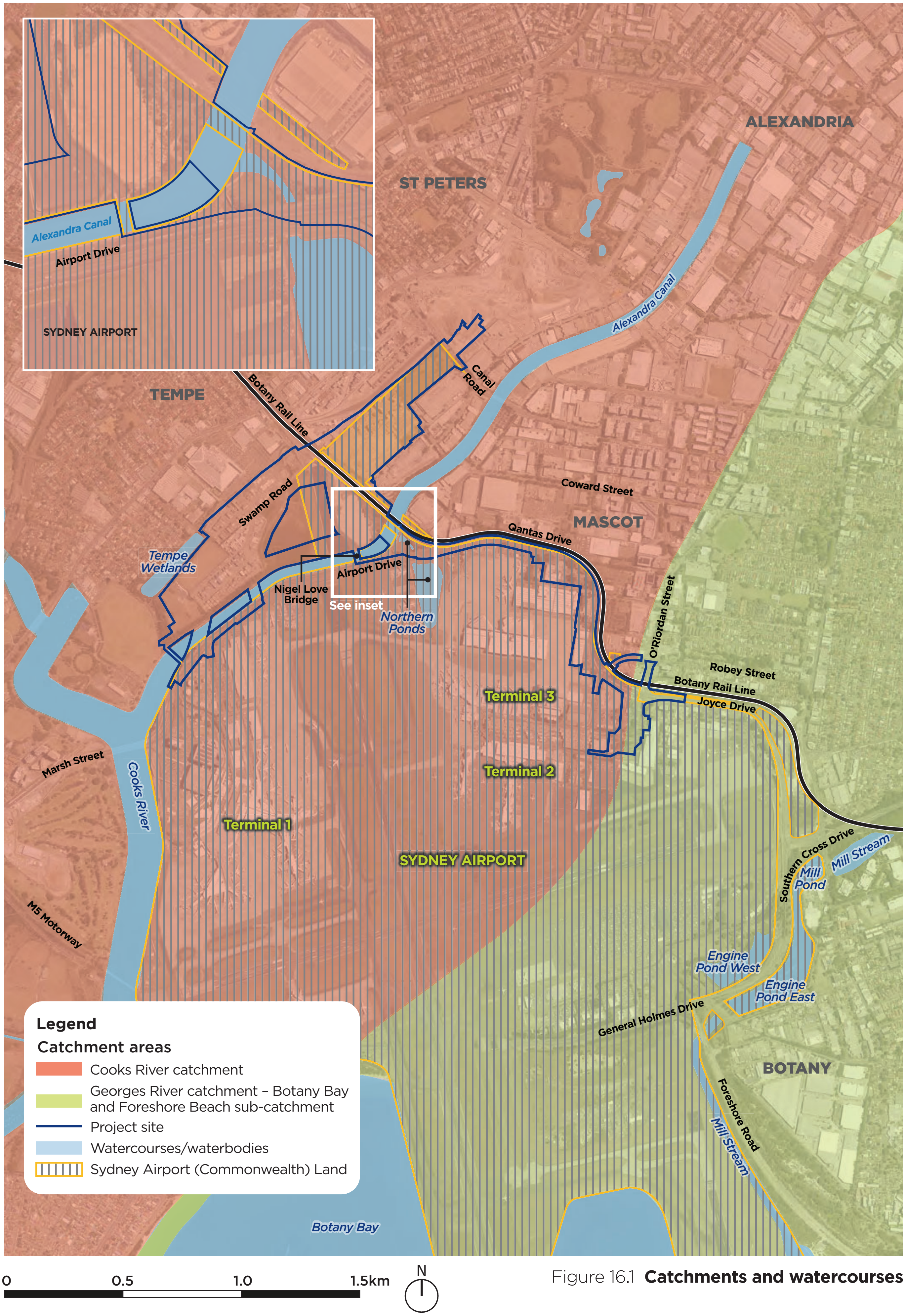


Figure 16.1 **Catchments and watercourses**

Alexandra Canal sub-catchment

The Alexandra Canal catchment is a sub-catchment of the Cooks River catchment and has an area of about 23 square kilometres. It was artificially constructed through dredging and channelisation of the former Sheas Creek, noted above as a major tributary of the Cooks River.

Alexandra Canal is the main watercourse within and in the vicinity of the project site. The canal is a four kilometre long constructed watercourse that discharges to the Cooks River to the south-west of the project site near Tempe Recreation Reserve. Within the project site, its banks are artificial, engineered structures constructed of concrete or sandstone.

A constructed pond, known as the northern ponds, is located on Sydney Airport land and discharges to Alexandra Canal. The pond provides flood mitigation and a spill control function.

Alexandra Canal has historically been contaminated due to the surrounding industrial land use, extensive land reclamation and industries discharging water directly to the canal. Currently contaminants entering via stormwater come from heavy industry, urban areas and road networks.

Older sediments are known to be highly contaminated, and have been overlain by more recent, less contaminated sediments. In 2004, the NSW EPA issued a remediation order (No 23004) under the CLM Act. The order requires any works or activities that would disturb canal sediments occur in accordance with a management plan approved by the NSW EPA.

The former Tempe landfill, which is crossed by the project site, is located in the Alexandra Canal sub-catchment. In 2001, the NSW EPA issued a remediation order (order 23003) to Marrickville Council under Section 23 of the CLM Act due to leachate migrating off site towards Alexandra Canal. Marrickville Council subsequently entered into a voluntary remediation proposal with the NSW EPA. The voluntary remediation proposal is still in place and requires that '... the water quality of Alexandra Canal is not adversely impacted by leachate originating from the site.'

As a result of the remediation order, a barrier wall was constructed in 2004 along the southern, eastern and western boundaries of the former landfill to prevent leachate migrating into Alexandra Canal. Leachate levels within the landfill are maintained by pumping to a leachate treatment plant where it is treated before discharge into Sydney Water's wastewater system.

Further information about contamination within Alexandra Canal is provided in Chapter 13 (Contamination and soils).

Tempe Wetlands

Tempe Wetlands is a local wetland located adjacent to the project site at the Tempe Lands. This wetland is an artificially constructed wetland surrounded by planted vegetation.

Georges River catchment

The Georges River catchment is located in the southern and western suburbs of Sydney and covers an area of about 960 square kilometres. With a population of over one million people, it is one of the most highly urbanised catchments in Australia. Georges River is about 96 kilometres long, and flows from Appin in the south in a northerly direction to Chipping Norton, then in an easterly direction to Botany Bay. The river discharges into the south of Botany Bay, between Sans Souci and Kurnell.

Mill Stream sub-catchment

The Mill Stream sub-catchment has an area of about 36 square kilometres and extends from Centennial Park in the north-east to its outlet into Botany Bay in the south. The upper reach of the catchment is located within the Randwick City Council local government area, while the lower reach is located within the Bayside Council local government area.

Engine Pond and Mill Pond are located south-east of the project site in the lower reaches of the Mill Stream sub-catchment. Mill Pond, Engine Pond and the Mill Stream are collectively known as the Sydney Airport Wetlands and are considered environmentally significant areas by the *Sydney Airport Master Plan 2039*

(SACL, 2019a) (the Master Plan) and *Sydney Airport Environment Strategy 2019–2024* (SACL, 2019b) (the Environment Strategy).

The natural landform of the Mill Stream sub-catchment comprises rounded sand dunes and expanses of gentle slopes with local depressions and exposed water tables. The lower reach of Mill Stream, into which part of the eastern end of the project site drains (see section 16.2.2), is a concrete-lined estuarine channel.

16.2.2 Hydrology

North of Alexandra Canal, the project site generally drains in a south-westerly direction towards the canal.

On the southern side of the canal, the project site also drains to Alexandra Canal, except for a small portion in the south-eastern corner which drains towards Mill Stream.

Flow control in the canal is provided by water levels in the Cooks River and by its tidal-influence which extends to within the project site. Due to these limits, the canal is generally considered to act as a sediment trap with flushing only occurring during large floods.

16.2.3 Water quality

Water quality baseline

Sampling results

Project-specific water quality monitoring was undertaken over a 15 month period during 2018 and 2019. Water samples, which were collected from 11 locations in Alexandra Canal, Mill Stream and Cooks River, were analysed to establish baseline water quality conditions in the study area. These results were supplemented by water quality data obtained from the New M5 Environmental Impact Statement (AECOM, 2015).

A review of this data indicated that both the Alexandra Canal and Mill Stream sub-catchments are in poor condition. The analysis indicates that:

- Samples obtained from the Cooks River and Alexandra Canal frequently exceeded ANZECC guidelines default trigger values for total nitrogen, total phosphorus, aluminium, iron, manganese, mercury, zinc and ammonia
- Samples obtained from Mill Stream frequently exceeded ANZECC guidelines default trigger values for total nitrogen, total phosphorus, aluminium, copper, iron, lead, manganese, mercury, zinc, total suspended solids, turbidity and ammonia, as well as the limits of acceptable contamination specified in Schedule 2 of the Airports (Environment Protection) Regulations 1997.

In relation to PFAS, the results indicate that:

- PFAS compounds, including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), were detected in almost all samples obtained from the Cooks River, Alexandra Canal and Mill Stream
- Concentrations of PFAS were below the 95 per cent level of protection criteria for marine species from the *PFAS National Environmental Management Plan* (HEPA, 2018).

Water quality sampling locations are shown on Figure 16.2. The water quality sampling results were compared to the default trigger values in Table 16.3. Existing exceedances of the default trigger values are shown in red bold font. In Mill Stream, the sampling locations shown on Figure 16.2 were in the freshwater reach of the stream. However, discharge of construction water would most likely occur within the lower estuarine reach as this is where the project would connect with the stormwater system from Sydney Airport's Terminals 2/3 precinct. Given this, water quality sampling has recently commenced within the estuarine reach, and the results from this sampling would be used to establish discharge criteria for Mill Stream.

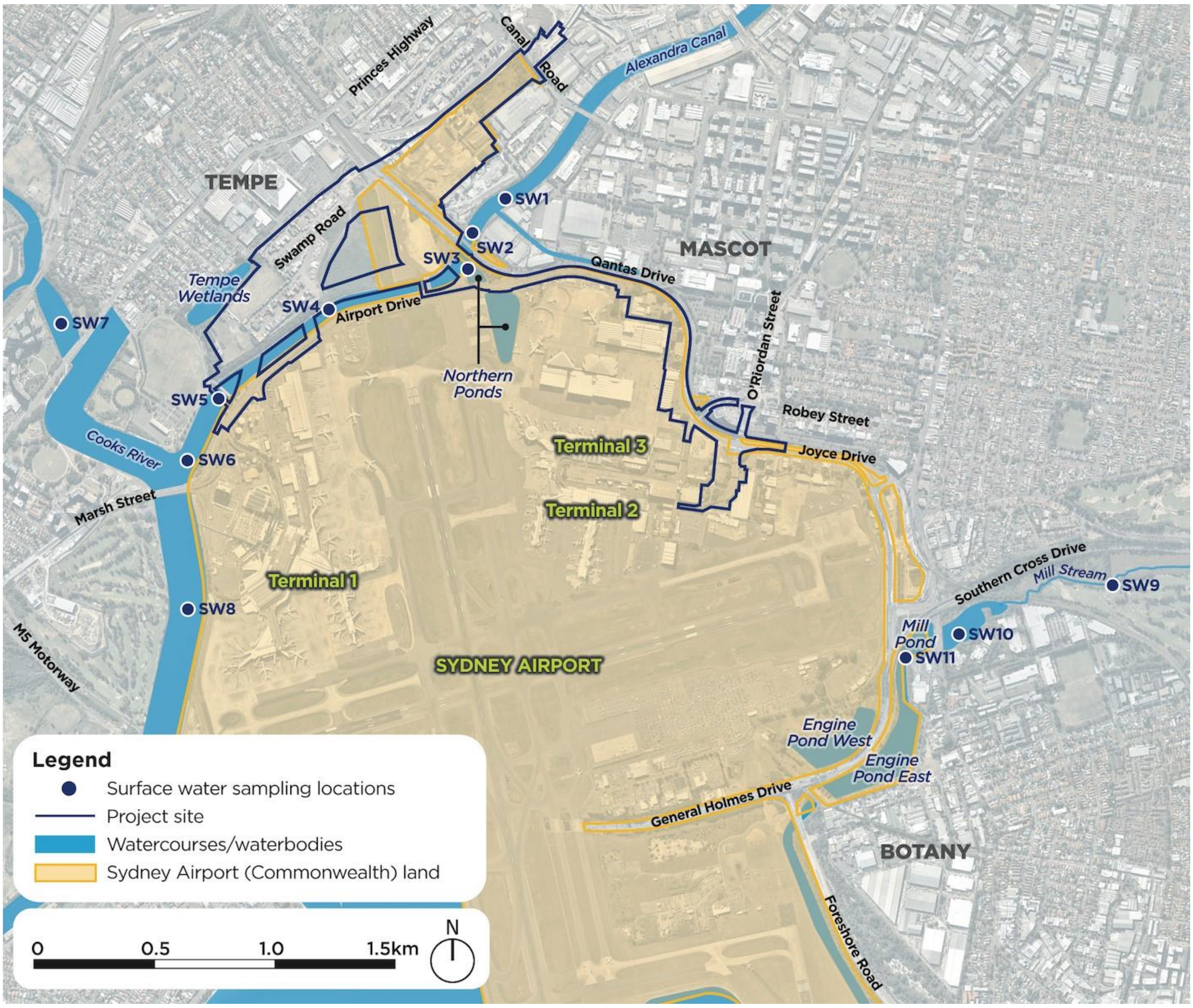


Figure 16.2 Surface water sampling locations

Modelling results

As described in section 16.1.2, modelling was undertaken to estimate existing pollutant loads in the Alexandra Canal and Mill Stream sub-catchments. Estimated annual pollutant loads in the Alexandra Canal and Mill Stream sub-catchments are provided in Table 16.2.

Table 16.2 Existing annual pollutant loads

Sub-catchment	Total suspended solids (kg/yr)	Total phosphorous (kg/yr)	Total nitrogen (kg/yr)
Alexandra Canal	315,000	509	3,777
Mill Stream	4,870	7.84	58.2

Table 16.3 Comparison of baseline water quality and default trigger values

Parameter	Unit	Default trigger value[1]	Alexandra Canal (80th percentile values)								Mill Stream (80th percentile values)		
			SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11
Aluminium (filtered)	µg/L	10	**34.2**	**40.8**	**30.8**	**37.4**	**27.2**	**27.4**	**24.8**	**29.4**	**25.4**	**42**	**189**
Arsenic (filtered)	µg/L	30	1.94	1.94	1.84	2	2.04	2.1	1.96	2	1.3	2.86	1.6
Chromium (filtered)	µg/L	20	0.5	0.54	0.54	0.5	0.5	0.5	0.5	0.5	0.3	0.4	0.8
Copper (filtered)	µg/L	5	2.8	2.4	2.4	2	2	1.4	2	2	2.76	2.12	3.16
Iron (filtered)	µg/L	10	**70**	**58.6**	**54.8**	**55.2**	**74**	**48.8**	**83.8**	**43.8**	**302.4**	**268.4**	**353.4**
Lead (filtered)	µg/L	4.4	0.96	0.98	0.88	0.8	0.56	0.62	0.8	0.94	0.6	1.38	1.16
Manganese (filtered)	µg/L	10	**32.56**	**32.26**	**30.12**	**28.3**	**24.06**	**20.26**	**31.72**	**21.64**	**65.68**	**20.04**	**29.58**
Mercury (filtered)	µg/L	0.4	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.02	**0.41**	0.01	0.01
Nickel (filtered)	µg/L	100	1.04	1.24	1	1.14	0.9	1	0.9	0.94	0.66	0.5	0.8
Zinc (filtered)	µg/L	5	**47.2**	**48.8**	**46.4**	**30.8**	**25.4**	**21.8**	**24.6**	**26.2**	**22.4**	**9.6**	**34.8**
pH (lab)	pH units	7-8.5	7.82	7.84	7.85	7.93	7.98	8	7.94	8.05	7.31	7.93	7.36
Total suspended solids	mg/L	10	**16.6**	**13.8**	**20.4**	**16.6**	**14.8**	**15.2**	**13**	10	**126.8**	**54**	**46**
Turbidity	NTU	10	**13.26**	**11.04**	**12.26**	**13.22**	**13.2**	**11.48**	8.26	7.26	**53.32**	**27.84**	**18.32**
Ammonia (as N)	mg/L	0.01	**0.23**	**0.23**	**0.21**	**0.18**	**0.14**	**0.15**	**0.16**	**0.12**	**0.22**	**0.04**	**0.25**
Nitrate (as N)	mg/L	10	0.3	0.31	0.28	0.27	0.23	0.24	0.19	0.19	0.53	0.16	0.7
Nitrite (as N)	mg/L	0.1	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02
Total nitrogen (as N)	mg/L	0.3	**1.21**	**1.23**	**1.1**	**1.07**	**0.98**	**0.9**	**1.13**	**0.93**	**0.93**	**1.47**	**1.4**
Total phosphorus	mg/L	0.03	**0.08**	**0.07**	**0.07**	**0.07**	**0.06**	**0.07**	**0.08**	**0.07**	**0.04**	**0.06**	**0.06**

Parameter	Unit	Default trigger value[1]	Alexandra Canal (80th percentile values)								Mill Stream (80th percentile values)		
			SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11
PFOA	µg/L	220	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
PFOS	µg/L	0.13	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.05	0.07

Notes:
1. 80th percentile is the level or value below which 80% of results are expected to occur. Alternatively, it is the level likely to be exceeded 20% of the time.
2. Default trigger values documented in the ANZECC guidelines are shown in Appendix A of Technical Working Paper 8 (Surface Water).
3. **Red** bold text indicates exceedances of the default trigger values.
4. SWX refers to surface water monitoring locations shown on Figure 16.2.
5. Default trigger values represent the environmental values in the following order of precedence: aquatic ecosystems, secondary contact recreation, primary contact recreation and aquatic foods.
6. Sample locations SW9, SW10 and SW11 are located within Mill Stream's freshwater reach.

Sensitive receiving environments

A sensitive receiving environment is one that has a high conservation value, or supports human uses of water that are particularly sensitive to degraded water quality. For the study area, sensitive receiving environments are considered to include:

- Threatened ecological communities associated with aquatic ecosystems
- Known and potential habitats for threatened fish
- Key fish habitats
- Recreational swimming areas.

The project has the potential to affect a number of sensitive receiving environments including the Cooks River, Mill Stream and Botany Bay.

Botany Bay is used for a range of beneficial purposes, such as recreation and fishing. The Cooks River and Botany Bay are both defined as key fish habitats under the *Fisheries Management Act 1994* (NSW). The biodiversity assessment (see Technical Working Paper 1 (Biodiversity Development Assessment Report)) confirmed that Tempe Wetlands and Alexandra Canal do not provide habitat for threatened species and no threatened aquatic or migratory species were recorded during biodiversity field surveys (see Chapter 22 (Biodiversity) for further information).

16.2.4 Overview of existing hydrology and water quality on Sydney Airport (Commonwealth) land

The northern ponds, which discharge to Alexandra Canal, are located on either side of Airport Drive.

Mill Stream is identified as an environmentally significant area by the Master Plan and Environment Strategy. A small portion of the project site drains in a southerly direction to Mill Stream (see section 16.2.2). Both Alexandra Canal and Mill Stream may potentially receive discharges from the project, either directly from surface runoff or discharge or through the drainage network.

Existing data indicates that both the Alexandra Canal and Mill Stream sub-catchments are in poor condition. Baseline water quality data indicated that the default trigger levels for contaminants were frequently exceeded.

The trigger values provided in Schedule 2 of the Airports (Environment Protection) Regulations 1997 apply to watercourses on Sydney Airport land. The eastern portion of the airport site, between Alexandra Canal and Joyce Drive, drains through the airport's drainage systems. However, the ultimate destination of this water is Alexandra Canal. As a result, the ANZECC guidelines have been adopted for the purposes of establishing site-specific trigger discharge criteria for this waterway.

As part of Mill Stream is located on Sydney Airport land, the trigger values from both the ANZECC guidelines and Schedule 2 of the Airports (Environment Protection) Regulations 1997 were adopted for Mill Stream for the purposes of establishing site-specific discharge criteria for this waterway.

16.3 Assessment of construction impacts

16.3.1 Hydrology

Water balance

A water balance can be used to ascertain any changes in water flow into and out of a domain or ecosystem. Changes in the water balance may indicate a potential impact on reliant organisms or ecosystems.

The water balance considered potential changes in water and wastewater flows between existing conditions and conditions during construction. The analysis focussed on the Alexandra Canal system, which is the main watercourse within the project site with the potential to receive surface water discharges during construction.

Potential changes to the water balance affecting Alexandra Canal could result from:

- Discharges of extracted groundwater
- Changes to surface runoff from the former Tempe landfill
- Runoff from disturbed areas of the project site.

Each of these and the potential changes as a result of construction is considered below. While some minor changes to the Alexandra Canal system water balance could be expected, the changes are not expected to have an effect on the environment or supporting ecosystems.

Extracted groundwater

Groundwater is likely to be intercepted from a range of construction activities involving excavation within the project site. Modelling indicates that there could be up to 400,000 cubic metres of groundwater extracted per annum with peak extraction rates estimated between 1,100 to 5,000 cubic metres per day (worst case), depending on the required depths of excavations and groundwater levels at the time. These estimates may change as a result of the proposed construction methods to be used by the appointed construction contractors.

One method for managing the estimated volume of extracted groundwater would be to discharge to Alexandra Canal. Assuming the maximum estimated discharge of 5,000 cubic metres per day to Alexandra Canal at low tide, based on a 1.6 kilometre long reach of Alexandra Canal that could be affected, this represents about seven per cent of the volume of water in this reach. This impact would be lower during average and high tide conditions. Discharges would only occur during excavations deep enough to intercept groundwater and where removal of the groundwater is necessary for construction.

As described in Chapter 15 (Groundwater), groundwater in the study area already flows towards Alexandra Canal as well as to Botany Bay. Therefore, the impact of extracted groundwater being discharged to the canal is expected to be minimal, with the only change being the rate at which groundwater would infiltrate into the canal when compared with the existing (slower) infiltration rate through the soil.

Any discharges of groundwater to Alexandra Canal would be undertaken in accordance with discharge requirements agreed with Sydney Water and the NSW EPA and based on the agreed discharge criteria and subsequent monitoring outlined in this document.

Further information is provided in Chapter 15 (Groundwater).

Runoff and leachate from the former Tempe landfill

Within the former Tempe landfill, leachate generation is estimated to increase to between 200 and 450 cubic metres per day (depending on rainfall assumptions) due to the temporary removal of sections of the landfill cap required to facilitate construction. Leachate is currently managed within the landfill site by a collection system. It is discharged to the wastewater system in accordance with a trade waste agreement with Sydney Water.

The additional leachate expected to be generated during construction would be collected and disposed of in the same manner through additional pumping (as required). Any change to surface water runoff at this location would be minimal in relation to the water balance and due to the fact that work at this location would only occur for a portion of the overall construction period.

Runoff from disturbed areas

Runoff from disturbed areas would be managed in accordance with the requirements of the Blue Book and directed to discharge locations following any necessary treatment. The project site is generally flat and low-lying with gentle undulations. As a result, it is unlikely that substantial changes to existing drainage catchments or runoff rates would occur as a result of construction. The need for any sediment basins would be considered by the construction contractor, taking into consideration the limited available site area, presence of contaminated sites, and potential to attract additional groundwater requiring management.

Construction water

Water would be required on site for various activities, including dust control, soil compaction and vegetation establishment. It is estimated that around 87 megalitres of water would be required during construction. Preference would be given to the use of recycled water from the project site over potable water sources where appropriate, to facilitate broader water conservation and reuse objectives.

Watercourses and geomorphology

Potential impacts on landscape health, including the bed or banks of natural watercourses, may result from:

- Direct construction activity adjacent to or within watercourses, including constructing bridge crossings and drainage outlets
- The removal of riparian vegetation
- Temporary increases in runoff and water discharges
- Sediment deposition in receiving watercourses.

There is little to no potential for changes to watercourse bed or banks as a result of hydrological changes from the project, due to the highly engineered nature (concrete or sandstone walls) of Alexandra Canal within the project site, and the lower reach of Mill Stream.

Construction would include works adjacent to the banks of Alexandra Canal, including constructing the proposed bridges. While the construction methods would be confirmed following appointment of the construction contractors, the bridges have been designed with the intention that no permanent structures associated with the bridges would be required in the canal.

Works within Alexandra Canal include constructing new stormwater outlets and upgrade of existing stormwater outlets (see section 7.10.6). Temporary coffer dams would be required. These could temporarily disturb sediments during their installation and removal (see section 8.2.3). These effects would be mitigated by the use of silt curtains installed around the coffer dams during installation and removal. Works on the banks of the canal would be undertaken in accordance with the *Guidelines for controlled activities on waterfront land* (DPI, 2012b).

Coffer dams may alter flow velocities in the immediate vicinity of the dams, which may cause localised scouring of sediments. Due to its size and connection with the Cooks River however, the overall movement of water from Alexandra Canal to the Cooks River is slow and is predominantly associated with daily tidal changes. Generally, the canal acts as a sediment trap with little flushing occurring except during large flooding events. Therefore, any sediment disturbance associated with the installation or removal of coffer dams is likely to be localised. Similarly, for the short period over which coffer dams are installed, it is not expected water movements would result in changes to the sediment distribution within the overall canal or the bed geomorphology. Any changes would be most likely to occur during large flood events when sediments within the canal would already be mobile.

As indicated in the above sections, potential changes to the water balance and the duration of any changes would be limited to the construction phase and individual activities. Discharges of extracted groundwater to Alexandra Canal during the worst case scenario would represent about seven per cent of the total volume of water in this reach of the canal. As such, potential discharges would likely have minimal impact on levels and velocities in the canal, and would be unlikely to affect the geomorphology of the canal bed. The impact would be lower during average or high tide conditions.

General construction activity, including vegetation removal and ground disturbance, has the potential to increase sediment loads in affected watercourses. Soil and water management measures would be implemented in accordance with the Blue Book to minimise erosion from the project site and sedimentation in the receiving waters. Erosion and sediment loads would also reduce as construction is completed and as the disturbed areas are stabilised. As a result, it is not expected that the geomorphology of the canal bed or any natural processes would be affected. No construction works are proposed to be undertaken within or near Mill Stream.

Potential impacts on the hydrological attributes of Alexandra Canal are expected to be short-term and manageable with the application of appropriate mitigation measures provided in section 16.6.

The design has undertaken a review of the capacity of the existing stormwater management system and has proposed upgrades to maintain the efficacy of the stormwater network and where possible, reduce flooding. Mitigation measure HF1 requires the development of a flood mitigation strategy for the construction phase, including confirming the ability of the proposed stormwater systems to accept discharges of construction water if proposed.

16.3.2 Water quality

Discharge criteria

Potentially contaminated groundwater would be intercepted and extracted during construction (described in Chapter 15 (Groundwater)). There is also the potential for construction in contaminated areas within the project site (described in Chapter 13 (Contamination and Soils)) to result in contaminated runoff that would require collection and discharge, although the potential for this would be low with the implementation of standard erosion and sedimentation control measures. The discharge of these waters to Alexandra Canal or Mill Stream would not cause environmental degradation or pollution if it is of suitable quality, relative to existing water conditions.

Preliminary discharge criteria for these site discharges, selected based on the methodology described in section 16.1.4, are provided in Table B2 of Appendix B of Technical Working Paper 8 (Surface Water), and are based on water quality monitoring to date. The criteria adopted for construction would be based on all available water quality monitoring data at the time construction commences, and would also be selected based on the methodology described in section 16.1.4.

The discharge criteria are considered justified on the basis that the construction discharges would be temporary, limited to the construction phase, unlikely to noticeably impact ambient water quality outcomes in the short term, and also unlikely to affect achievement of the long-term water quality goals for the watercourses.

Potential sources of water quality impacts

Construction activities may present a risk to water quality in Alexandra Canal and/or Mill Stream if mitigation and management measures are not effectively implemented throughout the construction period. Potential sources of water quality impacts would include:

- Soil transported off site during rainfall events and from discharge of sediment-laden water
- Disturbance of sediments in the bed and banks of Alexandra Canal during construction of drainage outlets
- Exposure of actual or potential acid sulfate soils, which may generate acidic runoff
- Spills or leaks from construction machinery (including chemicals, oils, grease, and petroleum hydrocarbons) and gross pollutants such as litter
- Leachate and runoff from contaminated sites (including the former Tempe landfill as described in Chapter 13 (Contamination and soils))
- Contaminated groundwater discharged into receiving watercourses (including PFAS, heavy metals and ammonia).

Management of contaminated runoff

As described in Chapter 13 (Contamination and soils), excavation would be required in potentially contaminated soil. Surface water runoff may also come into contact with contaminated materials within the project site.

The potential for contamination of surface waters would be managed in accordance with Blue Book procedures and where possible, by isolating runoff from contaminated land from other surface water runoff. If discharge to surface waters is proposed, the contaminated runoff would need to be treated to meet relevant environmental protection licence conditions or site-specific discharge criteria. Other methods of management for contaminated runoff may include infiltration or off-site disposal. With the implementation of appropriate mitigation measures, the risk of significant water quality impacts due to contaminated runoff would be low.

Management of contaminated groundwater

Groundwater at the site would be intercepted by excavation activities and is known to be contaminated by the following substances, exceeding the proposed surface discharge criteria for Alexandra Canal:

- Metals, particularly aluminium, lead, manganese, mercury and zinc
- Ammonia
- Bicarbonate
- Nitrogen and phosphorus
- pH
- Total suspended solids
- PFOS.

Treatment of extracted groundwater would be required before it can be discharged to watercourses (as one possible management approach), with the treatment process designed to meet the site-specific discharge criteria for the receiving watercourse as outlined in section 16.1.4. Following treatment, and provided that the site-specific discharge criteria are met, the risk of significant water quality impacts from discharge of extracted groundwater would be low.

The proposed surface water management measures provided in section 16.6 aim to minimise impacts on receiving watercourses during construction due to discharge of extracted groundwater. In the context of the overall catchment, and with the implementation of the proposed management measures, any potential short-term impacts are unlikely to impact on ambient water quality within the receiving watercourses. Therefore, the project is likely to have a negligible influence on whether the *NSW Water Quality and River Flow Objectives* are protected (if currently met) or achieved (if currently not met) during construction.

Upgrade of stormwater outlets

Constructing the drainage outlets in Alexandra Canal would involve work below the water surface. This has the potential to disturb contaminated sediments within the canal and affect water quality. The proposed management approaches, including establishing temporary coffer dams within areas protected by silt curtains, would minimise the potential for sediment transport. The use of silt curtains while coffer dams are installed and removed would contain any mobilised sediments within the near vicinity of the work area. Due to the tidal nature of Alexandra Canal and its connection with the Cooks River, mobilised sediments would re-settle close to the location of disturbance, rather than be transported downstream and into other receiving watercourses.

A plan of management would be prepared for works within the canal to define how disturbance and migration of contaminated sediments would be minimised. The plan would be approved by the NSW EPA in accordance with the remediation order (number 23004) for Alexandra Canal. All works in the canal would be undertaken in accordance with the requirements of the plan (see Chapter 13 (Contamination and soils)).

Alexandra Canal does not contain habitat for threatened aquatic species and is not used for primary or secondary contact recreational activities. Therefore, the risk of significant impacts on aquatic species associated with sediment and contaminant disturbance would be minimal.

Table 16.4 summarises the construction activities that have the potential to impact water quality along with the key mitigation and management approach and level of impact expected. With the implementation of appropriate mitigation measures described in section 16.6, potential impacts on water quality would be minimised.

Table 16.4 Potential water quality impacts during construction

Activity with the potential to impact water quality	Potential water quality impact	Likelihood of impact and/or mitigation approach
Earthworks, including vegetation clearing, stripping of top soil and stockpiling	Increased turbidity, lowered dissolved oxygen levels and increased nutrients Potential for increased contaminants in watercourses if soil is contaminated	Low All construction activities would be undertaken in accordance with Construction Soil and Water Management Plan (which would incorporate the requirements of the Blue Book) to limit the potential for off-site soil transport (see section 16.6).
Activities that require groundwater dewatering such as construction of retaining walls, drainage infrastructure and utilities	Increased pollutant discharges to watercourses	Low Impacts would be avoided by setting discharge criteria at levels which are consistent with existing water quality conditions and adhere to identified protection levels for the agreed environmental values.
	Mobilisation of contaminant plumes	Low Given the short duration of excavation and that the groundwater capture zones are small, there is limited potential for movement of contaminated plumes. This potential impact is considered in Chapter 15 (Groundwater).
	Exposure of acid sulfate soils and subsequent acidification of watercourses	Low Further testing and investigations would be conducted within areas of medium and high acid sulfate soil potential during detailed design, and all excavated soils would be subject to the provisions of an acid sulfate soil management plan (see Chapter 13 (Contamination and soils)).
Ground disturbance works at the former Tempe landfill	Increased contaminants, particularly ammonia, released to receiving waterbodies	Low Leachate within the landfill is managed by a perimeter (bentonite) wall and collection system that prevents overflow into Alexandra Canal. Any damage to the existing leachate management systems could result in leachate overflowing into the canal. Leachate levels within the landfill, including any changes resulting from construction works and the quality of discharges would be monitored and managed in accordance with license conditions (see Chapter 13 (Contamination and soils)). Therefore, no water quality impacts are anticipated.
Construction of drainage outlets in Alexandra Canal	Increased turbidity Potential for increased mobilisation of contaminated sediments	Low Coffer dams and silt curtains would to be used to reduce sediment transport. A plan of management would be prepared and implemented to minimise the disturbance and transport of contaminated sediments (see Chapter 13 (Contamination and soils)).

Activity with the potential to impact water quality	Potential water quality impact	Likelihood of impact and/or mitigation approach
Bridge construction	Increased turbidity, lowered dissolved oxygen levels and increased nutrients Potential for increased sediment transport	Low The bridge crossings have been designed with the intention that no physical works would impact the canal walls or be conducted within the canal. Therefore, no impacts are expected.
Enlargement of the northern pond	Bed and bank disturbance, increased turbidity and sedimentation	Low The pond primarily functions as a flood detention device with gates blocking the backflow of waters from Alexandra Canal. Any sediment disturbance as a result of vegetation removal or excavation of the banks would be entirely contained to the pond. Measures would be implemented to ensure the potential for the gates to open during construction is minimised (see section 16.6).
General	Increased gross pollutants (eg litter) Increased pollutants and contaminants in watercourses as a result of contingency events eg spills and leaks	Low Control of gross pollutants and actions to be taken during contingency events would be managed in accordance with standard measures in the CEMP.

16.3.3 Summary of impacts on Sydney Airport (Commonwealth) land

Potential impacts on hydrology and surface water quality on Sydney Airport (Commonwealth) land are discussed in sections 16.3.3 and 16.4.3. The potential impacts include:

- Increased sedimentation and turbidity
- Runoff from contaminated sites and changes to bank conditions of the northern pond where additional storage volume would be created.

The vegetation at the northern pond is exotic and not likely to provide habitat for common species. The water quality is generally low and, as a result, it is unlikely to have high aquatic biodiversity values. Works at the pond would not impact on flow conveyance or scour potential.

A small section of the project site drains to Mill Stream. Discharging of extracted groundwater to Mill Stream is not anticipated during construction. However, in the event discharges are required, consultation with Sydney Airport Corporation and the Department of Infrastructure, Transport, Cities and Regional Development would be undertaken to ensure there are no adverse impacts prior to discharge occurring.

Impacts are expected to be manageable with the application of the proposed construction mitigation measures described in section 16.6. Following implementation of the mitigation measures, the potential impacts on Sydney Airport land are not considered to be significant.

16.4 Assessment of operation impacts

16.4.1 Hydrology

Water balance

The water balance assessment considers changes in flow conditions between existing and future (operating) conditions of the project. An increase in flow generally reflects an increase in impervious area, which could result in increased pollutant loads, increased erosion and sedimentation potential and/or changes to the bed conditions of the watercourses.

The project would result in an increase in impervious areas within the Alexandra Canal sub-catchment of about six hectares due to existing pervious land becoming road surface (from about 21 hectares to 27 hectares). In the Mill Stream catchment, the project would result in an increase in impervious area of about 0.13 hectares (from about 1.03 hectares to 1.16 hectares).

The resulting changes in flows in these watercourses are shown in Table 16.5.

Table 16.5 Existing versus operational flow from impervious surface area in the project site

Sub-catchment	Existing conditions flow (ML/yr)	Operation conditions flow (ML/yr)	Percentage change in flow (%)
Alexandra Canal	249	266	6
Mill Stream	8.9	9.8	10

Table 16.6 shows the percentage change in flow in the wider catchment areas. When the wider catchment areas are considered, the changes to stormwater flow during operation are considered to be negligible.

Table 16.6 Percentage change in flow for larger catchments

Greater catchment	Existing conditions flow (ML/yr)	Operation conditions flow (ML/yr)	Percentage change in flow (%)
Alexandra Canal	1,740	1,750	1
Mill Stream	24.5	25.4	4

Detailed design would include additional modelling to confirm the ability of the receiving drainage systems to effectively convey stormwater discharges.

The project is not expected to consume potable water or generate wastewater during operation. There would be no water take or discharge from operation, other than stormwater runoff.

Impacts on watercourse stability and flows

As indicated above, the project would result in a minor increase in flows as a result of the increase in impervious surfaces. These minor increases would not alter flow velocities significantly or result in impacts on landscape health. Changes in flow velocities are discussed in Chapter 14 (Flooding) and are summarised below:

- During the one per cent annual exceedance probability event, increases in flow velocity within Alexandra Canal would be generally less than 0.2 metres per second
- There would be a minor reduction in flow and velocities in the Tempe Wetlands
- The project would have a negligible impact on peak flows and velocities in Mill Stream.

Appropriate scour protection measures would be incorporated into the design of the upgraded drainage outlets to minimise potential for scouring within Alexandra Canal.

16.4.2 Water quality

Potential sources of impacts

During operation, there is potential for surface water quality to be impacted by the following processes and activities:

- Scour and mobilisation of contaminated sediments at proposed new drainage outlet locations and increased flow to existing locations (Alexandra Canal) impacting on water quality
- Landfill leachate volume exceeding the capacity of the leachate management system and entering watercourses impacting on water quality

- Erosion of recently disturbed areas resulting in the sedimentation of watercourses
- Increase in sediment and pollutant loads in stormwater due to the increase in road surface and vehicular traffic, and associated pavement and tyre wear
- Spills or leaks of fuels and/or oils from vehicle accidents and/or operational facility and equipment.

Potential impacts on surface water quality are described in more detail below.

Predicted stormwater quality and quantity

Water quality

As described in section 16.4.1, the project would increase impervious areas (such as road pavement) that would be exposed to direct rainfall and would therefore increase runoff volume and associated pollutant mobilisation. Runoff from road pavement would typically contain pollutants such as sediments, nutrients, oils and greases, petrochemicals and heavy metals, which could potentially impact on water quality when discharged into receiving watercourses.

The increase in impervious surface area means there is potential for higher pollutant loads to be discharged to the receiving environments of Alexandra Canal and Mill Stream. A number of water quality treatment measures, such as gross pollutant traps, and hydrodynamic separators, are proposed to manage runoff from the project and the associated water quality impacts. Modelling was carried out to assess the performance of the proposed water quality treatment measures against the targets specified in the *Botany Bay and Catchment Water Quality Improvement Plan*. A summary of the modelling results is provided in Table 16.7.

Table 16.7 Modelling results for operational water quality

Pollutant	Operational load (without treatment) (kg/yr)	Operation load with treatment (kg/yr)	Pollutant reduction (kg/yr)	Pollutant load reduction achieved (%)	Reduction target[1] (%)
Alexandra Canal					
Total suspended solids	94,400	46,400	48,000	50.8	85
Total phosphorus	158	112	46	29.1	60
Total nitrogen	638	504	134	21.0	45
Mill Stream					
Total suspended solids	2200	578	1622	73.7	85
Total phosphorus	3.5	2.0	1.6	45.7	60
Total nitrogen	26.4	15.9	10.5	39.8	45

Note: 1. Targets from the *Botany Bay and Catchment Water Quality Improvement Plan*

The modelling results indicate that, although the proposed treatment devices would minimise impacts on water quality during operation, the adopted pollutant reduction targets would not be achieved. For Alexandra Canal, the modelling results indicate the following percentage change in pollutant load:

- A minor reduction for total nitrogen
- A negligible increase for total suspended solids
- A minor increase for total phosphorus.

This indicates a small impact during operation.

The water quality treatment measures proposed would reduce the rate of pollutants entering Mill Stream during operation to below the existing rates. Therefore, although the pollutant reduction targets are not met, the project would result in an overall improvement in water quality in Mill Stream.

The performance of the treatment devices and the type and design of specific stormwater treatment measures across the project would be further refined as part of detailed design with the aim of achieving pollutant reduction targets. Modelling would be updated during detailed design to assess likely system performance. Given the space constraints and the treatment options available however, it is unlikely that the pollution reduction targets would be met.

Soil mobilisation in Alexandra Canal

The proposed new drainage outlets in Alexandra Canal could increase the potential for sediment mobilisation during operation. Modelling performed has indicated that sediments are likely to be mobilised locally at three of the nine outlet locations. Scour protection measures would be provided at the outlets to minimise the mobilisation of contaminated sediments at the base of the canal.

The specific scour protection measures required would be identified during detailed design in consultation with relevant stakeholders, including Sydney Water.

No bridge piers or bridge abutments are proposed in Alexandra Canal. A number of abutments at Terminal Link Bridge, Qantas Drive Bridge and Freight Terminal Bridge are proposed within slow flow velocity zones of floodplains. The likelihood of abutment scour is low and would be further considered during the detailed design stage.

Operation of the project is not expected to result in geomorphological impacts or impacts to landscape health.

Impacts of leachate generation

The assessment undertaken for the former Tempe landfill (refer to Technical Paper 16 (Landfill Assessment)) indicated that the volume of leachate is expected to decrease following the completion of the project and replacement of the landfill capping layer.

Spills and leaks

Motor vehicle operations, maintenance plant and equipment leakages or a vehicle crash may cause spills of oils, lubricants, hydraulic fluids and chemicals. Spills and leakages have the potential to pollute downstream watercourses, as a result of being conveyed to watercourses via the stormwater network. The impact would be minimised by implementing procedures to handle dangerous goods and hazardous materials and manage spills similar to those used for other Roads and Maritime operations. Further discussion on accidental spills is provided in Chapter 13 (Contamination and soils) and Chapter 23 (Health, safety and hazards).

Achieving the water quality objectives

As described above, the proposed treatment devices would result in a minor reduction in total nitrogen, a negligible to minor increase in total suspended solids and total phosphorous within Alexandra Canal and a reduction in pollutants entering Mill Stream during operation. Although the proposed treatment devices would reduce impacts on water quality during operation, the pollution reduction targets would not be achieved for catchments in the study area.

This is largely a result of the urbanised nature of the catchment and the pollutant loads at the project site being generated from across the wider catchment.

There are no sensitive receivers within Alexandra Canal, and the very small predicted impact is not expected to cause any adverse effects. Therefore, the identified increases in pollutant loads are considered to be acceptable and would not interfere with any other pollution reduction initiatives elsewhere in the catchment.

The water quality treatment measures proposed would reduce pollutant loads during operation in the Mill Stream catchment to below the existing levels. So, although the pollutant reduction targets would not be met, an overall improvement in the ambient water quality outcomes for Alexandra Canal and Mill Stream is nonetheless expected.

16.4.3 Summary of impacts on Sydney Airport (Commonwealth) land

Watercourses and waterbodies on Sydney Airport land include the northern ponds and a portion of Mill Stream. These watercourses may receive discharges from the project, either directly from drainage discharges or through the stormwater network.

A small section of the proposed road drainage system would drain to the northern ponds. Since it is not feasible to provide water quality treatment for this small section of the road, there would be a minor impact to water quality from this section. The water quality of the stormwater discharged from Sydney Airport land is unlikely to be impacted by the project.

Modelling of pollutant loadings in Mill Stream during operation indicated that there would be an improvement in water quality in Mill Stream compared to existing conditions.

With implementation of the mitigation measures provided in section 16.6, there is not expected to be any significant impacts on Sydney Airport land associated with surface water quality and hydrology.

Consistency with the Sydney Airport Master Plan

The *Sydney Airport Master Plan 2039* (SACL, 2019a) (the Master Plan) identifies water quality and water use as a key environmental issue. It recognises that activities at Sydney Airport have the potential to impact water quality in surrounding watercourses, and notes the mechanisms that are in place at the airport to manage water quality.

By implementing the Master Plan and the *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b) (the Environment Strategy), Sydney Airport Corporation plans to manage and reduce potential impacts on the water quality of surrounding watercourses by implementing (amongst other things):

- Use of passive filtrations systems such as swales to absorb pollutants and decrease runoff volumes
- Inclusion of water quality treatment measures
- Spill and emergency response procedures.

The Environment Strategy includes water quality and water use objectives for the next five years. The relevant objectives for the project are:

- Minimising the impact of airport operations and construction on water quality in water bodies on or adjacent to the airport
- Maintaining and improving the water quality and associated biodiversity values of the Sydney Airport Wetlands.

Additionally, a number of items in the five year action plan are relevant, including:

- Incorporate design features in new developments to reduce contaminant loads in stormwater and to align with catchment water quality objectives
- Continue to implement the initiatives contained in the Sydney Airport Stormwater Quality Management Plan, including continuation of regular stormwater quality sampling.

A detailed technical assessment (see Technical Working Paper 8 (Surface Water)) has been undertaken for the impact assessment to demonstrate that the project has considered, for both construction and operation, the importance of water quality. The project includes water treatment devices such as gross pollutant traps and hydrodynamic hydrocarbon and suspended solid separators. Consideration of additional water sensitive urban design features would be undertaken during detailed design, subject to feasibility and space constraints. These and other measures are proposed to ensure protection of the watercourses around Sydney Airport, and associated biodiversity and other values.

Baseline water quality monitoring has been conducted over a period of 15 months and has informed the adoption of site-specific discharge criteria for Mill Stream, should this discharge be required. Setting discharge criteria based on surface water baseline monitoring would ensure existing environmental and other values associated with the watercourses are protected.

The project would not impact on sensitive areas at Sydney Airport, including Sydney Airport Wetlands or the Botany Bay marine environment, and is not in conflict with any of the identified biodiversity actions identified in the Environment Strategy. The key performance indicator relevant to surface water quality for the actions and initiatives in the Master Plan is that water quality monitoring results for stormwater from Sydney Airport stay the same or improve. As described in section 16.4.1, modelling undertaken for the project indicates that during operation, this key performance indicator would be achieved within Mill Stream.

16.5 Cumulative impacts

Cumulative impacts on water quality are generally related to the movement of soil and water across project boundaries. The project would be constructed at the same time as other major projects underway and/or planned in the surrounding area. In particular, construction would interact with the Botany Rail Duplication and M4–M5 Link projects.

16.5.1 Construction

The Botany Rail Duplication has the potential to impact Mill Stream, as it would involve constructing an additional rail bridge (including vegetation clearing, installation of piers and abutments) over Mill Stream. In addition, a large portion of the flow from the Botany Rail Duplication site would discharge to Mill Stream. A very small portion of the Gateway project site is located within the Mill Stream catchment. The EIS for the Botany Rail Duplication indicates that no significant water quality impacts on Mill Stream are predicted. Therefore, with the implementation of appropriate management and mitigation measures, the potential for the Sydney Gateway road project to materially increase cumulative impacts associated with the Botany Rail Duplication is expected to be negligible.

The M4–M5 Link project site is located about 300 to 500 metres from the Sydney Gateway road project site within the Cooks River catchment. The majority of the works are underground, although given the distance, it is unlikely that the discharge of any collected groundwater or surface water discharges would be cumulative with those to Alexandra Canal from the Sydney Gateway road project.

All of the State significant infrastructure projects in planning or under construction generally include measures to ensure that effective soils and surface water management procedures are implemented to prevent adverse impacts on receiving watercourses. Therefore, with the implementation of measures in section 16.6, and if mitigation measures are applied consistently and effectively across projects, minimal cumulative surface water impacts are anticipated.

16.5.2 Operation

During operation, other major projects constructed within the Cooks River and Georges River catchments may impact flow and water quality in the receiving watercourses within the study area. Increases in impervious areas from infrastructure (as well as development projects) may contribute to the increased volumes, rates and pollutant runoff in the area.

Drainage from the Botany Rail Line would flow into the Sydney Airport drainage network and through the northern ponds into Alexandra Canal as well as Mill Stream. However, no change in water quality is expected. Cumulative impacts associated with the project and the Botany Rail Duplication are therefore likely to be negligible.

Sections of the New M5 and small sections of the M4–M5 Link would be constructed in the Georges River and Cooks River catchments to the north and west of the project site. The New M5 EIS concluded that the treatment devices included in the design would result in fewer pollutants entering Alexandra Canal and

Cooks River. Similarly, the EIS concluded that the M4–M5 Link would reduce stormwater pollutant loading to receiving watercourses and have a neutral or beneficial effect.

Therefore, with the implementation of proposed measures in section 16.6, and if mitigation measures are applied effectively to major projects, minimal cumulative surface water impacts are anticipated.

16.6 Management of impacts

16.6.1 Approach

Approach to mitigation and management

The assessment identified that if construction is not adequately managed, including managing the potential for erosion and sedimentation, and managing groundwater during dewatering, it would have the potential to impact water quality in receiving watercourses. Given the known contamination in areas of the site, runoff will need to be adequately managed, including monitoring for specific pollutants, prior to discharge or disposal.

Constructing the drainage outlets in Alexandra Canal also has the potential to disturb contaminated sediments within the canal and affect water quality.

There is limited potential for operation impacts, with the exception of drainage discharges from the stormwater outlets into Alexandra Canal. A preliminary analysis has identified which of these should be subject to controls to avoid further scouring. These would be refined and confirmed during detailed design.

Approach to managing the key potential impacts identified

In accordance with mitigation measure CS5 (see section 13.6), a Construction Soil and Water Management Plan would be prepared as part of the CEMP and implemented during construction. The plan would detail processes, responsibilities and measures to manage potential soil and water quality impacts during construction. The plan would be prepared in accordance with relevant guidelines and standards, including *Managing Urban Stormwater – Soils and Construction*, Volume 1 (Landcom, 2004) Volume 2B Waste landfills (DECC, 2008a) and Volume 2D (DECC, 2008b) (collectively referred to as the 'Blue Book'). The development of mitigation measures in the plan would be guided by the Blue Book to determine the magnitude of rainfall events to which the capacity of the construction mitigation measures should be designed. Further information, including an outline of the plan, is provided in Chapter 27 (Approach to environmental management and mitigation).

Discharge criteria for any extracted groundwater or contaminated runoff would be established by considering long-term default trigger values and baseline water quality data and would be selected based on the following:

- For physical and chemical stressors – use the least stringent of:
  - The 80th percentile value from the baseline monitoring data; or
  - The default trigger value for aquatic ecosystems in marine waters.
- For non-bioaccumulative pollutants – use the least stringent of:
  - The 80th percentile value from the monitoring data; or
  - The 80 per cent level of protection for species in marine waters.
- For bioaccumulative pollutants, including PFAS – use the least stringent of:
  - The 80th percentile value from the monitoring data; or
  - The 95 per cent level of protection for species in marine waters.

Treatment would occur prior to discharge to stormwater or watercourses, as required, to meet the established criteria. For extracted groundwater, data from relevant groundwater wells would be used to determine treatment requirements. If the discharge criteria cannot be met, other management and disposal options would be adopted.

Scour protection measures would be provided at the drainage outlets at Alexandra Canal to minimise potential impacts on the canal, such as mobilisation of contaminated sediments. The necessary measures would be confirmed during detailed design in consultation with relevant stakeholders, including Sydney Water. Additionally, a plan of management would be developed and implemented to manage work within Alexandra Canal that has the potential to disturb sediments. The plan would include strategies such as using silt curtains during installation and removal of the coffer dams, and would be approved by the NSW EPA in accordance with the remediation order (number 23004) for Alexandra Canal. This is described further in Chapter 13 (Contamination and soils).

The effectiveness of the mitigation measures would be monitored by developing and implementing a surface water monitoring program.

Surface water monitoring program

Water quality baseline monitoring would continue to be undertaken and would be refined to include the location of possible discharges in Mill Stream. Any additional indicators or other parameters would also be added to the current suite to ensure full coverage of the indicators recommended.

A program to monitor potential surface water quality impacts would be developed and would include:

- Measurement of water quality parameters at each location for pH, electrical conductivity, temperature, dissolved oxygen, reduction-oxidation potential and turbidity. Flow direction will also be noted.
- Laboratory analysis of all water samples for:
  - Physical properties – pH, total dissolved solids, total suspended solids, turbidity, major anions, cations and alkalinity
  - Nutrients - nitrate, nitrite, total nitrogen, ammonia and total phosphorus
  - Contaminants of concern – per- and polyfluoroalkyl substances, total recoverable hydrocarbons, volatile organic compounds, polycyclic aromatic hydrocarbons, total phenols, organochlorine pesticides, organophosphorus pesticides, total and dissolved heavy metals (lead, zinc, copper, cadmium, chromium, nickel, iron, manganese, mercury, arsenic and aluminium) and tributyltin.

Sampling would be undertaken monthly, during a range of wet and dry conditions (where possible), at the locations shown on Figure 16.2. As a minimum, continued monitoring at locations SW2 and SW6 on Alexandra Canal and SW8 on the Cooks River is proposed, with SW2 and SW6 used to monitor potential water quality impacts due to the project (see Figure 16.2). A new monitoring station would be required on the lower estuarine reach of Mill Stream if groundwater discharge to that watercourse is proposed.

A full list of proposed values for water quality monitoring during construction is tabulated in Appendix B2 of Technical Working Paper 8 (Surface Water). This includes values for physical and chemical stressors, non-bioaccumulative toxicants and bioaccumulative toxicants.

Impact monitoring will continue for a minimum of 12 months following the completion of construction, or until affected watercourses are certified by a suitably qualified and experienced independent specialist as being rehabilitated to an acceptable condition (or as otherwise required by any project conditions of approval).

Approach to managing other impacts

Implementing other relevant measures provided in Chapters 13 and 15 (Groundwater), including the acid sulfate soils management plan, the dewatering management strategy and the leachate management strategy, would also assist in minimising the potential for water quality impacts during construction.

Expected effectiveness

The implementation of erosion and sediment control measures to manage water quality and hydrology impacts would be in accordance with the requirements of the Blue Book. The measures contained in the Blue Book are based on field experience, tailored to particular project types and have been extensively used and demonstrated to be effective. In general, the implementation of measures in accordance with the Blue Book will either result in a reduced potential for the impact to be realised or the impact will be avoided (eg not undertaking works during wet weather and minimising areas of disturbance). Therefore, there is no reason the proposed mitigation measures should not be effective, if implemented in accordance with the Blue Book requirements.

The approach to managing water quality within receiving watercourses has been developed with reference to the water quality management framework defined in the Water Quality Guidelines. This includes the approach to managing discharges of extracted groundwater and contaminated runoff to surface watercourses or other management and disposal methods which may be preferred by the appointed contractors. These guidelines provide a leading practice framework for managing water quality, therefore any mitigation measures developed through consideration of this framework would also be expected to be effective.

Monitoring and auditing would be undertaken during construction to ensure that the CEMP relevant sub-plans, and the monitoring program are being implemented.

16.6.2 List of mitigation measures

Measures that will be implemented to address potential impacts on surface water are listed in Table 16.8.

Table 16.8 Surface water mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Sedimentation and scour protection at Alexandra Canal	SW1	The potential for scour at bridge abutments will be considered for flow events up to and including the one per cent annual exceedance probability event. Scour protection will be included in the detailed design as required.	Detailed design
	SW2	Discharge outlets will be designed with appropriate energy dissipation and scour protection measures to minimise the potential for scour. Scour protection will be developed in consultation with relevant stakeholders, including Sydney Water.	Detailed design
	SW3	All works within or adjacent to Alexandra Canal will be managed in accordance with *Guidelines for Controlled Activities on Waterfront Land – Riparian corridors* (Department of Industry, 2018).	Construction
Water sensitive urban design	SW4	Appropriate treatment measures, including water sensitive urban design, will be considered in the detailed design with the aim of improving water quality within Alexandra Canal and/or achieving the targets outlined in the *Botany Bay and Catchment Water Quality Improvement Plan* (Sydney Metropolitan Catchment Management Authority, 2011).	Detailed design
	SW5	Surface water drains and associated infrastructure will be designed to prevent scour of soil, erosion and associated sedimentation impacts.	Detailed design
Monitoring water quality	SW6	A water quality monitoring program will be developed and implemented as part of the Construction Soil and Water Management Plan to monitor potential surface water quality impacts. The program will define: ▪ Monitoring parameters ▪ Monitoring locations ▪ Frequency and duration of monitoring.	Construction

Impact/issue	Ref	Mitigation measure	Timing
		The monitoring program will include ongoing baseline monitoring to determine the water quality of potential receiving waters prior to commencement of construction. Proposed discharge will be updated as required prior to construction based on the baseline data at the time. Water quality monitoring will continue for a minimum of 12 months following the completion of construction, or until affected watercourses are certified by a suitably qualified and experienced independent expert as being rehabilitated to an acceptable condition (or as otherwise required by any project conditions of approval).	
Discharge to stormwater network	SW7	The performance of treatment systems required to treat construction water before discharge will be verified in relation to the established discharge criteria.	Construction
Release of sediment-laden water during works in northern ponds	SW8	Construction planning will ensure that operation of the sluice gate at the northern ponds outlet to Alexandra Canal is not affected by the works.	Construction

16.6.3 Managing residual impacts

Residual impacts are considered to be the impacts of the project that may remain in the medium to long term, after implementation of the design approaches described in Chapters 7 (Project description) and 8 (Construction) and the measures to mitigate and manage the identified potential impacts described in this chapter.

A summary of the potential residual soil and surface water impacts is provided in Table 16.9.

Table 16.9 Residual impacts – surface water

Potential residual impact	Management approach
The implementation of erosion control measures and devices during construction may result in potential impacts on overland flow paths and rates.	Impacts on overland flow paths are considered to be manageable, as all measures will be installed in accordance with the Blue Book.
Operation has the potential to result in an increase in water quality pollutants in Alexandra Canal	The project should aim to develop and implement treatment solutions to minimise impacts on overall water quality in the receiving waters during the detailed design phase.

Chapter 17

Non-Aboriginal heritage

This chapter provides a summary of the non-Aboriginal heritage assessment. It describes existing non-Aboriginal heritage, identifies potential impacts, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 9 (Statement of Heritage Impact).

The SEARs relevant to non-Aboriginal heritage are listed below. There are no MDP requirements specifically relevant to non-Aboriginal heritage; however, there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)). Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
7	**Heritage**	
7.1	The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts and visual impacts) to the heritage significance of:	
	(a) environmental heritage, as defined under the Heritage Act 1977;	This chapter
	(d) items listed on State, National and World Heritage lists;	Sections 17.3 and 17.4
	(e) heritage items and conservation areas identified in local and regional planning environmental instruments applicable to the proposal area.	Sections 17.3 and 17.4
7.2	Where impacts to State or locally significant heritage items are identified, the assessment must:	
	(a) include a significance assessment, a statement of heritage impact for all heritage items including the Alexandra Canal, Cooks River Container Terminal and Mascot underbridges (O'Riordan and Robey Streets) (including significance assessment) and a historical archaeological assessment;	Sections 17.3 and 17.4
	(b) assess the consistency of the proposal against conservation policies of any relevant conservation management plan, including the Conservation Management Plan for Alexandra Canal (NSW Department of Commerce, 2004);	Appendix B of Technical Working Paper 9
	(c) consider impacts to the item of significance caused by, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, visual amenity, landscape and vistas, curtilage, subsidence, architectural noise treatment, drainage infrastructure, contamination remediation and site compounds (as relevant);	Sections 17.3 and 17.4
	(d) outline measures to avoid and minimise those impacts during construction and operation in accordance with the current guidelines; and	Section 17.6

Reference	Requirement	Where addressed
	(e) be undertaken by a suitably qualified heritage consultant(s) and/or historical archaeologist (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria).	The assessment was undertaken by qualified heritage consultants (see section 1.6 of Technical Working Paper 9).

17. Non-Aboriginal heritage

17.1 Assessment approach

Heritage impact assessment for major infrastructure projects in NSW is carried out by skilled and experienced heritage consultants and archaeologists in accordance with relevant legislation, guidelines and policies. Where there is the potential to impact items of local or State heritage significance, a statement of heritage impact is prepared using a standard assessment approach and guidelines produced by the NSW Heritage Office. A statement of heritage impact needs to address:

- The heritage significance of items with the potential to be impacted by a project
- The significance of the potential impacts
- Why more sympathetic solutions are not viable
- The measures to mitigate negative impacts.

Any heritage impact assessment also needs to consider whether there is the potential for significant impact on items listed on the World Heritage List, National Heritage List or Commonwealth Heritage List. Where the potential for significant impact is identified a referral is then submitted to the Commonwealth Minister for Environment in accordance with the EPBC Act.

An overview of the approach to the assessment is provided below, including the legislative and policy context and a summary of the assessment methodology.

17.1.1 Legislative and policy context to the assessment

Relevant legislation, policies and guidelines

The assessment was undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, *Heritage Act 1977* (NSW) (the Heritage Act), EPBC Act, and the Airports Act and associated regulations
- *Assessing Heritage Significance* (Heritage Office, 2001)
- *Statements of Heritage Impact* (Heritage Office, 2002)
- *Historical Archaeology Code of Practice* (Heritage Office, 2006a)
- *Assessing Significance for Historical Archaeological Sites and Relics* (NSW Heritage Division, 2009)
- *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance* (Australia ICOMOS, 2013) (the Burra Charter)
- *Significant impact guidelines 1.2 – Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies* (DSEWPC, 2013)
- *Working Together Managing Commonwealth Heritage Places, A guide for Commonwealth Agencies* (Commonwealth of Australia, 2019)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b)
- *Sydney Airport Heritage Management Plan* (SACL, 2009).

17.1.2 Methodology

Study area

The study area for the assessment was defined as the project site (described in Chapter 2 (Location and setting)). The assessment also included consideration of a 150 metre wide buffer from the project site in relation to the potential for indirect impacts on heritage items as a result of works undertaken within the project site. The study area and buffer is shown on Figure 17.1.

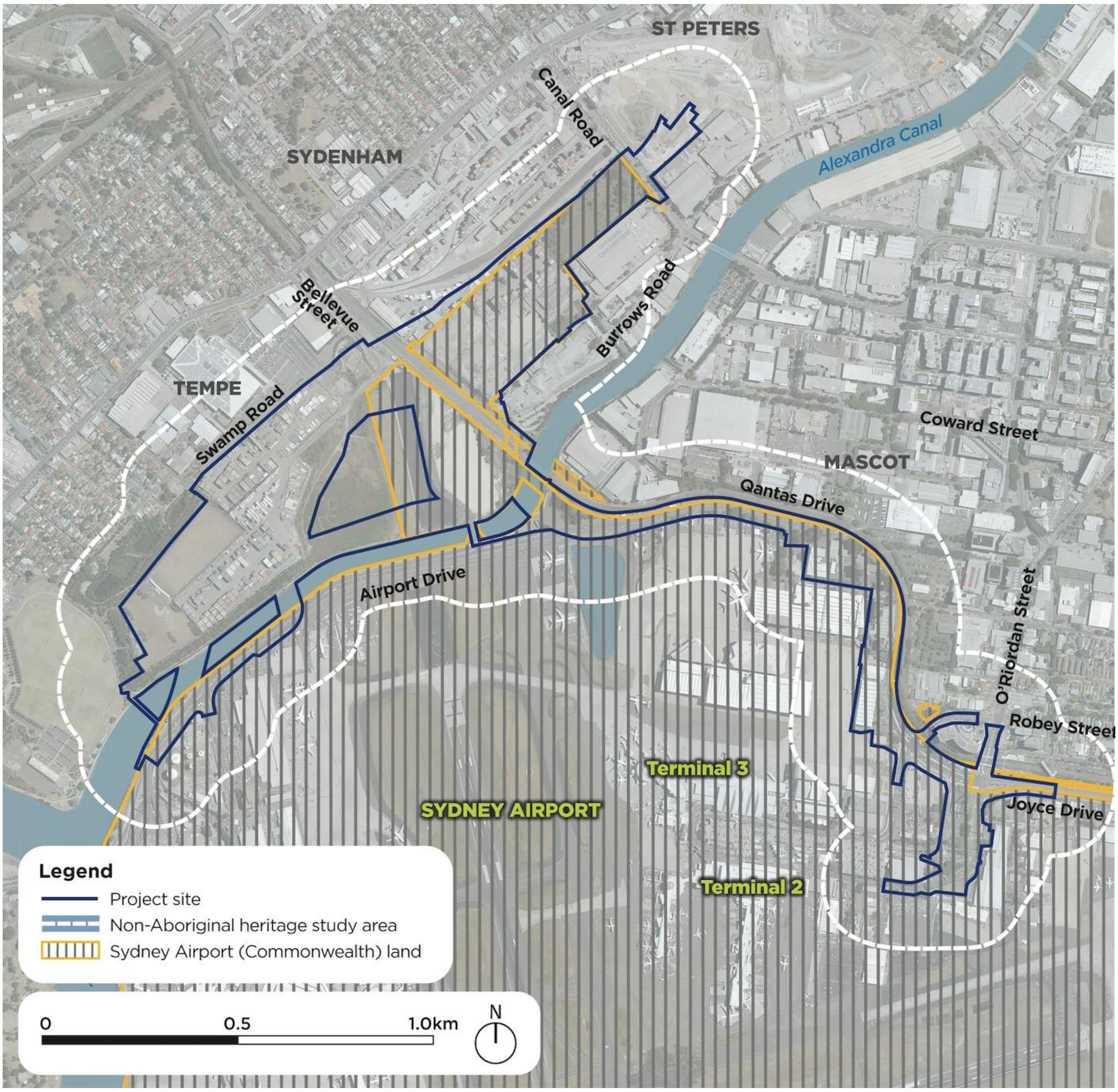


Figure 17.1 Non-Aboriginal heritage study area

Key tasks

The assessment involved:

- Background research on the historical context of the project site and heritage listed items, including reviewing previous assessments and relevant conservation/heritage management plans, and searching statutory and other heritage lists (described below)

- Site inspections undertaken in December 2018 and February 2019 to identify listed and potential heritage items and areas of archaeological potential
- Assessing the significance of heritage with the potential to be impacted by the project
- Assessing the significance of the potential impacts on listed and potential heritage items and areas of archaeological significance with consideration of the guidelines and requirements listed in section 17.1.1
- Identifying measures to manage and mitigate the identified impacts
- Preparing a statement of heritage impact to describe the results of the assessment.

Potential impacts on non-Aboriginal heritage were assessed based on impacts to the significance of a heritage item as a result of:

- Direct (physical) impacts – caused by removing or altering the item or fabric of heritage significance, or excavating in areas of archaeological potential within the project site
- Potential direct impacts – caused by vibration or by removing adjoining structures within or outside the project site
- Visual impacts – caused by changes to the setting or curtilage of heritage items, places, historic streetscapes and views within or outside the project site.

The main potential for direct and potential direct impacts would occur during construction. These potential impacts are considered in section 17.3.1 and 17.3.2.

Visual impacts are generally associated with operational infrastructure and the permanent changes to landscape and setting that would occur during operation. These potential impacts are considered in section 17.4.

The following heritage lists and databases were searched in April 2019:

- World Heritage List
- Australian heritage lists (under the EPBC Act):
  - National Heritage List
  - Commonwealth Heritage List
- Register of the National Estate (it is noted that this is an archival list and is not a statutory heritage register)
- NSW heritage lists (under the Heritage Act):
  - NSW State Heritage Register
  - Section 170 NSW Government agency heritage and conservation registers
- Local heritage lists (under local environmental plans (LEPs)):
  - Botany Bay Local Environmental Plan 2013 (the Botany Bay LEP)
  - Marrickville Local Environmental Plan 2011 (the Marrickville LEP)
  - Sydney Local Environmental Plan 2012 (the Sydney LEP).

A detailed description of the assessment methodology is provided in section 3 of Technical Working Paper 9 (Statement of Heritage Impact).

17.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Risks to non-

Aboriginal heritage with an assessed overall rating of medium or above, identified by the environmental risk assessment, included:

- Direct physical impacts on items listed on the State Heritage Register (Alexandra Canal) and other heritage items associated with construction of new road infrastructure
- Impacts on the heritage significance of Alexandra Canal as a result of the change to its landscape and visual context associated with the presence of new bridges over the canal
- Impacts on items of heritage significance at Sydney Airport.

The non-Aboriginal heritage assessment included consideration of these potential risks.

17.2 Existing environment

A summary of the non-Aboriginal historical context and existing non-Aboriginal heritage features of the study area is provided in this section. Aboriginal heritage is addressed in Chapter 18 (Aboriginal heritage).

17.2.1 Historical context

The study area has a long history of settlement and development, with significant historical features and activities including agriculture, modification of the Cooks River and Shea's Creek, dredging and reclamation, Sydney's drinking water supply, development of Sydney Airport and other transport infrastructure, and residential and industrial development.

During the early years of settlement, land in and surrounding Tempe, St Peters, Botany and Mascot comprised of thick scrub and forest, marshy wetlands and sand banks. These were dissected by streams and creeks associated with Shea's Creek and the Cooks River.

The first land grant occurred in 1796. Market gardens were first established around Botany and Mascot in the 1830s and became common in the 1870s. The majority of market gardens were established between the Alexandra Canal and O'Riordan Street, which acted as a boundary between residential subdivisions to the east and agricultural activity to the west. Figure 17.2 shows a plan of the study area (with the project site shown in red) prior to construction of Alexandra Canal.

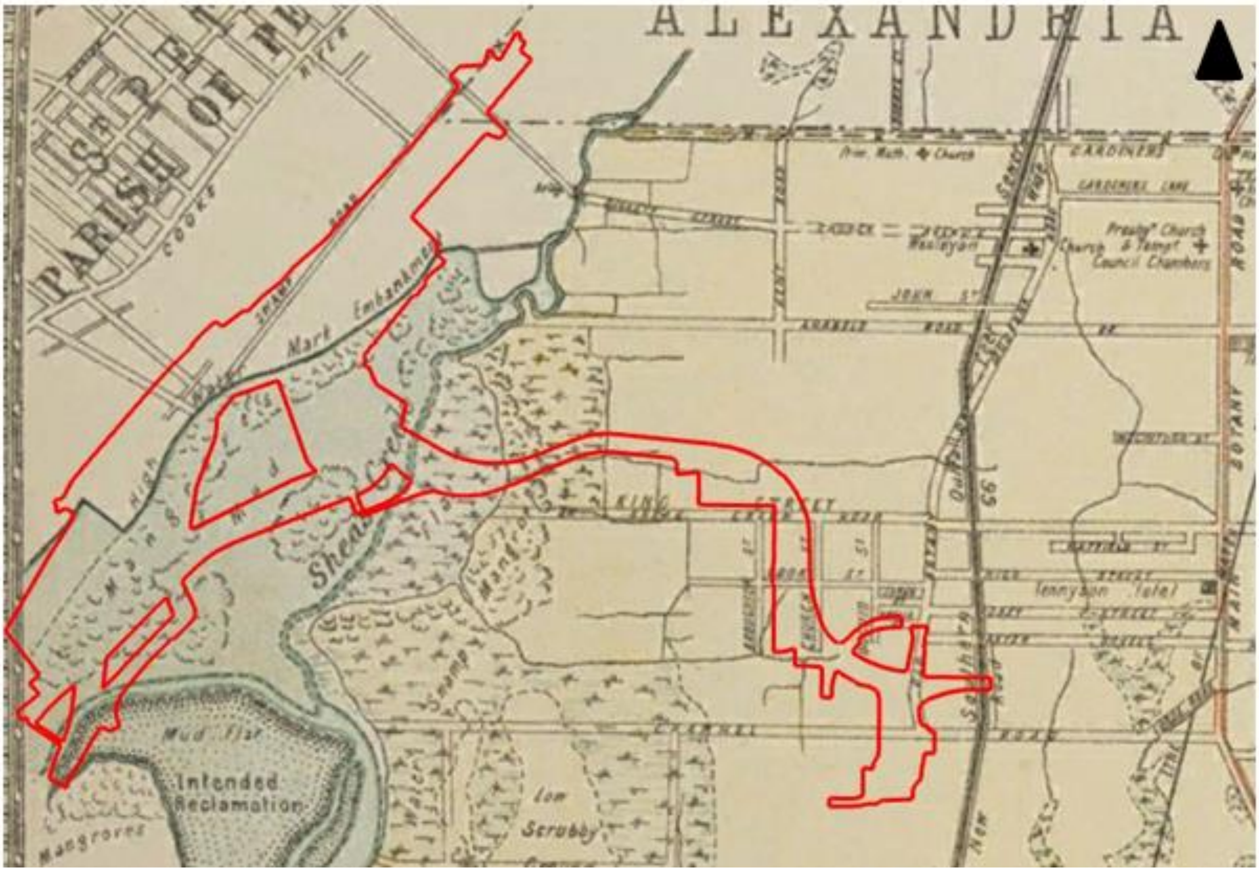


Figure 17.2 Historical plan of the study area from between 1880 and 1899

The mid-19th century saw significant changes to land use in and around the study area, with industrial development concentrated along parts of Alexandra Canal and Cooks River.

By the 1880s, residential subdivision was occurring in the Tempe and St Peters areas. This included the Lauriston Park Estate, near the existing location of Sydney Airport.

The Botany Rail Line, which was designed to carry goods from Sydney's western industrial sites to tanneries at Botany and to shipping at Port Botany, was completed in 1925.

Areas to the west of Alexandra Canal in Tempe were used as a gravel quarry from 1920. By 1970, land associated with the quarry was used by the then Marrickville Council to dispose of waste materials (mainly building waste). The use of this site as a landfill (the former Tempe landfill) was gradually phased out from the 1990s.

Significant developments in the study area are described below.

Alexandra Canal

Major construction works for the canal began in 1891. This involved formalising Shea's Creek and land along the mouth of the Cooks River to create a channel to ship goods up and down the canal. The original plan was to join the Cooks River with the Parramatta River. However, the depression of the 1890s halted works and construction of the canal stopped near Huntley Street in Alexandria.

The canal's tendency to collect silt deposits made the movement of large vessels difficult. As a result, the canal was never used for its intended purpose. It eventually became a waste and stormwater outlet for surrounding development.

The original wall of the canal was constructed from sandstone blocks, placed at an angle with rubble at the base of the walls to provide support. In the early 1960s, during the expansion of Sydney Airport, parts of the canal were filled and a section was realigned. The new sections of the canal were mostly constructed of different materials, including concrete blocks. The *Alexandra Canal Conservation Management* (NSW Heritage Office 2004) has mapped the heritage significance of the canal wall, which varies based on the type of materials used in its construction and therefore has different management requirements based on the fabric being impacted.

Sydney (Kingsford Smith) Airport

The most significant development to occur in Mascot was the establishment of Sydney Airport. Originally an amateur private operation established on land occupied by Ascot Racecourse in 1911, it opened as an aerodrome in 1919. The airport expanded several times during the 20th century. Its development was associated with the re-alignment of Cooks River, the Botany Rail Line, Alexandra Canal and surrounding roads, as well as several major land reclamations.

Regular commercial services between Sydney, Melbourne and Adelaide began in 1924. Post-war increases in the demand for passenger flights resulted in the expansion of Sydney Airport in the 1950s and 1960s. Since this time, the airport has been subject to a range of developments and expansions. The main north–south runway was extended over reclaimed land in Botany Bay in 1968 and again in 1972. The third runway was opened in 1994.

Today, the airport includes various landscapes, structures, features and elements that contribute to its significance.

Historical photographs showing the (then) Mascot Aerodrome and surrounding development are shown on Figure 17.3 and Figure 17.4 (the project site is shown in red in Figure 17.4).

Figure 17.3 Aerial view of Mascot Aerodrome from 1928 (circled) and the adjoining Botany Rail Line

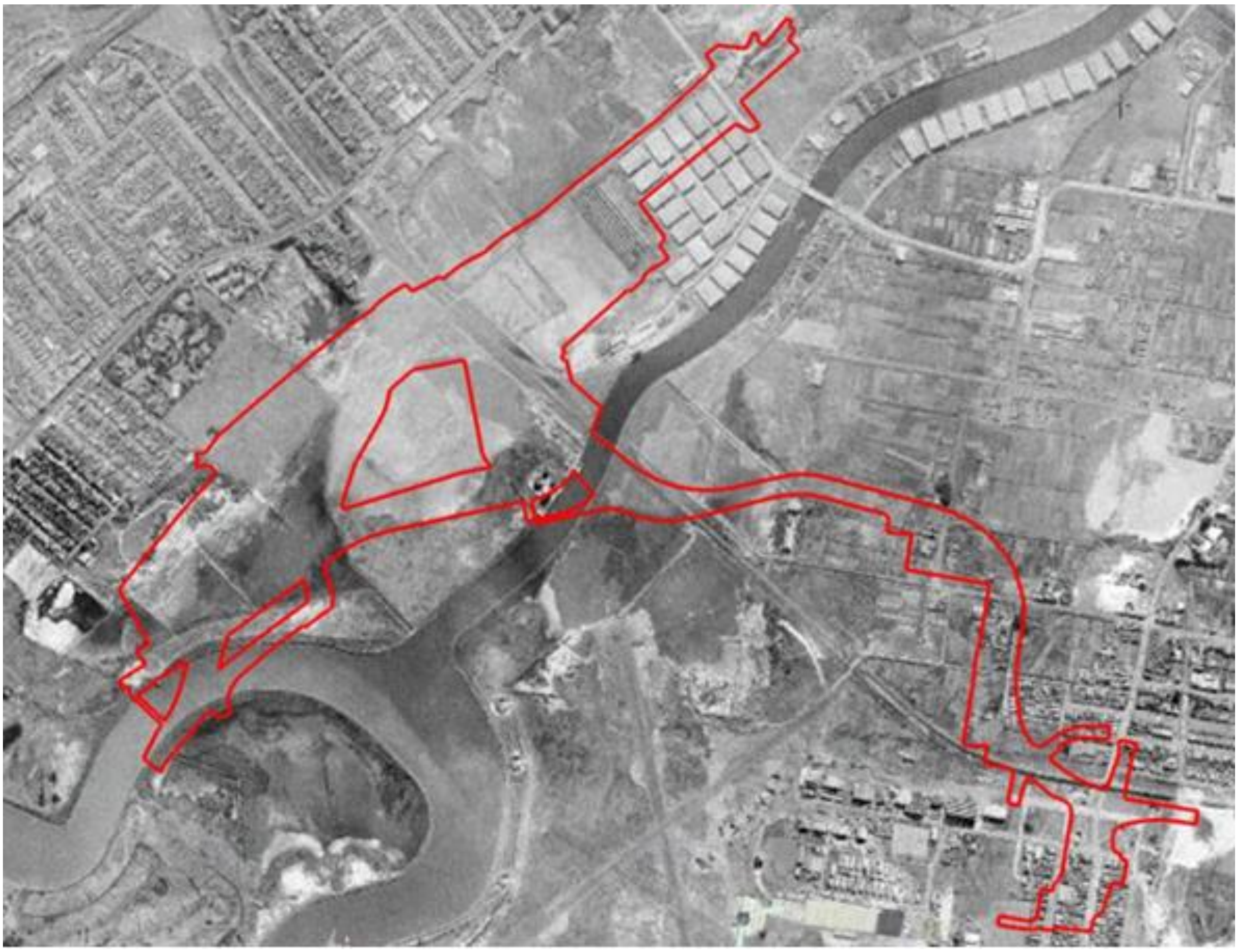


Figure 17.4 Aerial view of the study area from 1943

17.2.2 Heritage listed items

Heritage listed items within the study area and buffer are summarised in Table 17.1 and shown on Figure 17.5. A full list and detailed descriptions of items is provided in section 3 and 6 of Technical Working Paper 9 (Statement of Heritage Impact). In relation to the project site:

State Heritage Register

- One item listed on the State Heritage Register is located within the project site - Alexandra Canal

Local environmental plans and section 170 registers

- Six items listed on LEPs and/or section 170 registers are located within the project site:
  - Alexandra Canal
  - Sydney (Kingsford Smith) Airport Group
  - Mascot (O'Riordan Street) Underbridge
  - Mascot (Sheas Creek) Underbridge
  - Mascot (Robey Street) Underbridge
  - Cooks River Container Terminal (and associated items)

Other heritage lists and databases

- No listed heritage conservation areas are located in the study area
- No items on the World or National Heritage Lists are located in the study area
- The Australian Heritage Database records the Sydney (Kingsford Smith) Airport Group as an 'indicative place' on the Commonwealth Heritage List.

Table 17.1 includes a summary of the significance of heritage items within the study area and buffer, and their location with respect to the project site. Further information on these items and their significance is provided in section 6 of Technical Working Paper 9 (Statement of Heritage Impact).

Table 17.1 Heritage listed Items within the study area

Item	Listing	Approx. distance from project site	Summary of item and heritage significance
Items listed on the State Heritage Register			
Alexandra Canal	State Heritage Register Sydney Water section 170 register Marrickville LEP Botany Bay LEP *('Alexandra Canal (including sandstone embankment'))* Sydney LEP *('Alexandra Canal (between Cooks River and Huntley Street) including interior')* Register of the National Estate (interim) (non-statutory list)	Partly within the project site	A summary of the history and characteristics of this item is provided in section 17.2.1. The canal is of high historic, aesthetic and technical/research significance. It is one of only two navigable canals built in NSW. It is characterised by its controlled route, defined edges, and sandstone embankment walls. Historically, the canal is a rare example of 19th century navigational canal construction in Australia.
Other listed items			
Sydney (Kingsford Smith) Airport Group	Botany Bay LEP Indicative Place (Commonwealth Heritage List) Register of the National Estate (interim) (non-statutory list)	Partly within the project site	A summary of the history and characteristics of this item is provided in section 17.2.1. The airport group is a complex cultural landscape with local significance. It demonstrates strong historical, historic association, social, aesthetic and technological significance. It includes both the values associated with the contemporary airport and the heritage values associated with the layers of use of the area.
Mascot (O'Riordan Street) Underbridge	Transport for NSW (Railcorp) section 170 register	Within the project site (over O'Riordan Street)	The Mascot (O'Riordan Street) Underbridge is a two span, single track, reinforced concrete girder railway bridge, which carries the Botany Rail Line over O'Riordan Street. This item is of local significance as part of the original infrastructure of the Botany Rail Line.

Item	Listing	Approx. distance from project site	Summary of item and heritage significance
Mascot (Robey Street) Underbridge	Transport for NSW (Railcorp) section 170 register	Within the project site (over Robey Street)	The Mascot (Robey Street) Underbridge is a single span, double track steel railway bridge, which carries the Botany Rail Line over Robey Street. This item is of local significance as the first welded steel railway bridge on the NSW rail network.
Mascot (Shea's Ck) Underbridge	Transport for NSW (Railcorp) section 170 register	Partly within the project site (over Alexandra Canal)	The Sheas Creek Underbridge is a five-span double track railway bridge, which carries the Botany Rail Line over Alexandra Canal. It was opened in 1925. This item is of local significance as part of the original infrastructure for the Botany Rail Line.
Cooks River Container Terminal	NSW Port section 170 register Marrickville LEP	Partly within the project site, located off Cooks Road, St Peters	Originally known as the Cooks River Goods Yard, the terminal was developed in 1946 when the original goods yards in Sydney reached maximum capacity. The terminal site includes tracks, buildings and roadways, as well as features considered to be of individual significance. This item is of local historic significance as an integral part of the Sydney goods rail system. Continually used as a freight site since its inception, it was one of the first railway goods yards to be converted to accommodate containerisation.
Cooks River Container Terminal: Electric Overhead Travelling Crane	NSW Ports section 170 register	20 metres from the project site	The crane travelled on elevated runways supported on vertical steel columns. This item is of little significance but contributes to an understanding of freight handling systems at Cooks River Terminal prior to containerisation.
Cooks River Container Terminal: Lay Down Points Lever	NSW Ports section 170 register	130 metres from the project site	The item comprises an intact lay down points lever associated with track equipment for the former Cooks River goods yard. This item is a relatively rare points lever, which is specific to special locations such as ports and goods yards.
Cooks River Container Terminal: Precast Concrete Hut 1	NSW Ports section 170 register	120 metres from the project site	This single panelled precast concrete hut is of moderate local significance. It is representative of intact Department of NSW Railways signal relay huts from around 1950.

Item	Listing	Approx. distance from project site	Summary of item and heritage significance
Morton Bay fig tree	Marrickville LEP	110 metres from the project site on South Street, Tempe	This item is a prominent feature of the landscape and was probably planted shortly after subdivision of this part of Tempe in the late 19th century/early 20th century.
House - Daktari	Botany Bay LEP	100 metres from the project site on High Street, Mascot	This item of local historic and aesthetic heritage significance is a substantially intact example of a traditional 19th century double-fronted weatherboard cottage.

17.2.3 Other items of heritage significance

The assessment identified the Botany Rail Line as an item of potential heritage significance. Parts of the rail line are located in the project site (shown on Figure 17.5).

The assessment notes that the rail line is considered to be of local heritage significance. The statement of significance notes that ‘The Botany Rail Line has historic, associative, social, aesthetic, technical and representative significance at a local level due to its relationship with surrounding industrial development (past and present), the Metropolitan Goods Line network and the use of freight transport in NSW’.

17.2.4 Archaeological sites and potential

The potential for a site to contain historical archaeology was assessed by identifying former land uses and associated features, and evaluating whether subsequent actions (either natural or human) may have impacted evidence for these former land uses. The significance of potential archaeological remains was then assessed.

The majority of the project site was considered to have nil to low archaeological potential and/or significance. The highest levels of archaeological potential and/or significance were identified at the following locations (shown on Figure 17.6):

- Alexandra Canal – short sections of the western bank and an adjacent area have moderate to high potential for remains of State significance from between 1870 and 1990, including evidence of landscape modification such as levies, drainage lines or redeposited soils and evidence of quarrying activities
- St Peters – an area to the north of the rail corridor has moderate potential for remains of local significance from between 1919 and 1990, including evidence of rail infrastructure, market gardens and brickwork buildings
- Sydney Airport and Mascot – an area to the east of Alexandra Canal has moderate potential for remains of local significance from between 1919 and 1990, including evidence of rail infrastructure, market gardens and residential development.

There are no listed archaeological sites within the study area.

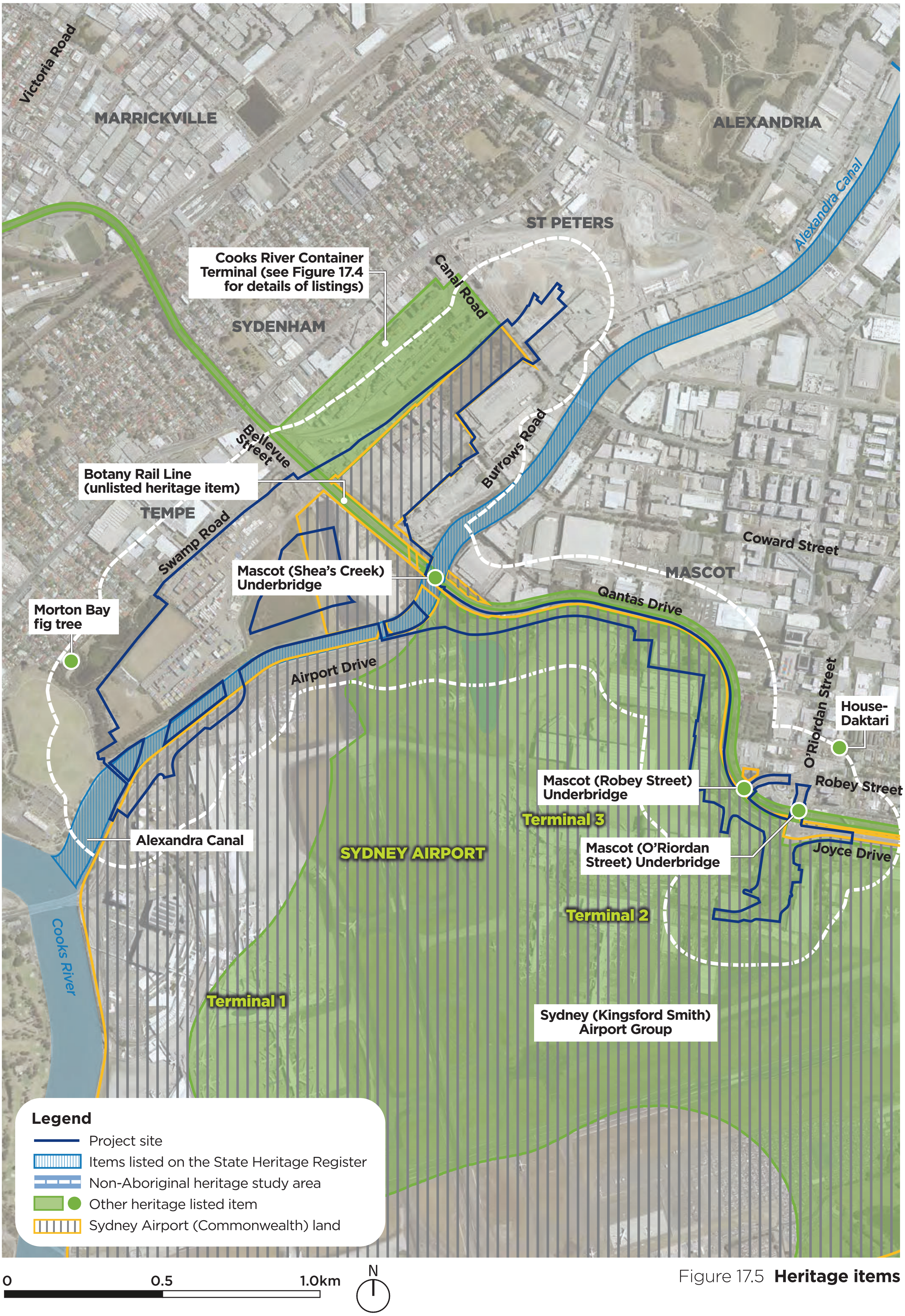


Figure 17.5 **Heritage items**

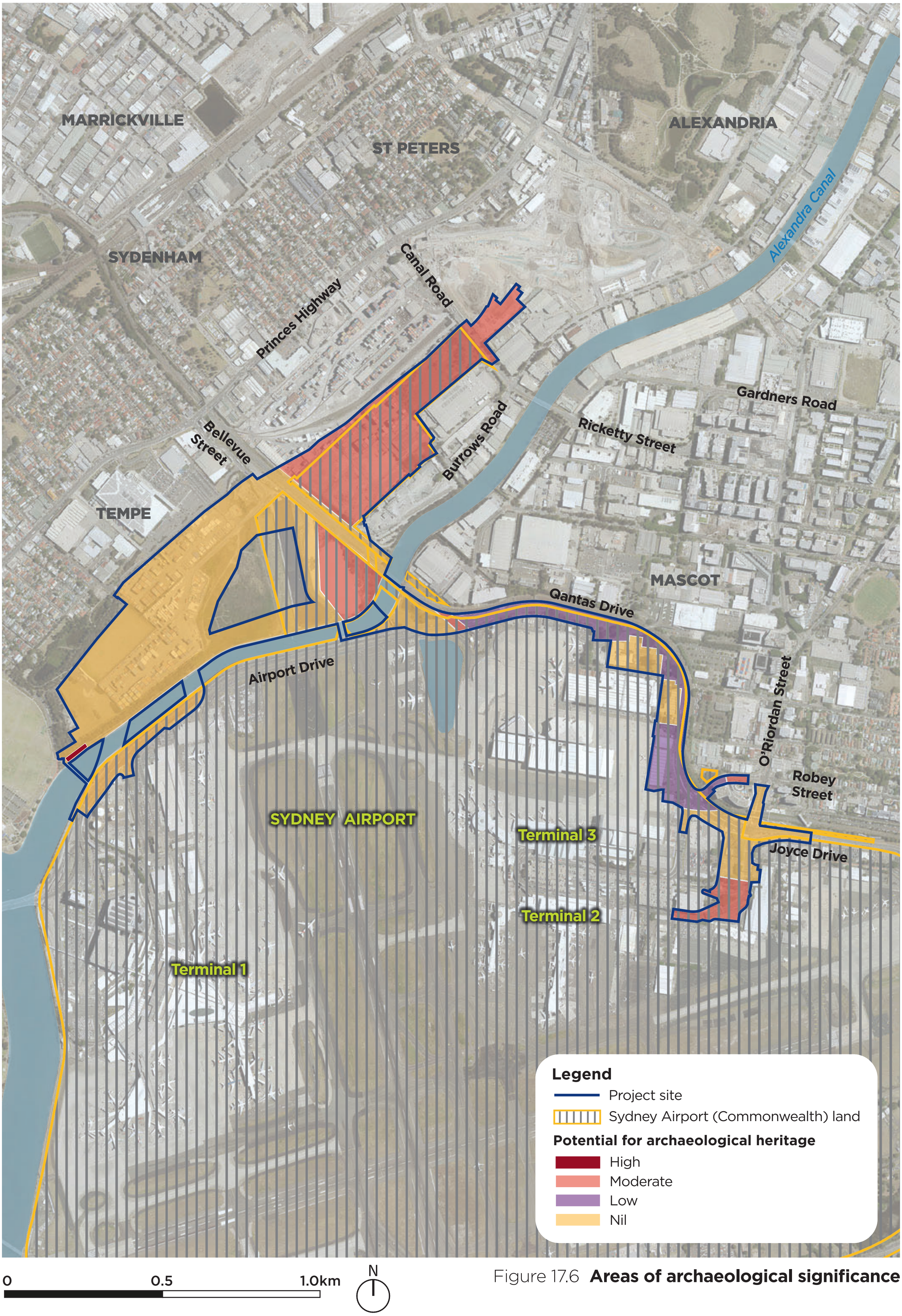


Figure 17.6 **Areas of archaeological significance**

17.2.5 Non-Aboriginal heritage on Sydney Airport (Commonwealth) land

Items and areas of heritage and archaeological significance within the project site that are located on Sydney Airport land, are summarised below.

Heritage listed items - Sydney (Kingsford Smith) Airport Group

The Sydney (Kingsford Smith) Airport Group is listed as a local heritage item by the Botany Bay LEP.

The Australian Heritage Database records the Sydney (Kingsford Smith) Airport Group as an 'indicative place' for listing on the Commonwealth Heritage List. This means that data associated with the item has been provided to, or obtained by, the Australian Government and entered into the Australian Heritage Database, but that the statutory obligations that apply to a formal listing do not apply. However, the potential impacts on this item have been considered as if it was formally listed.

Australian Government agencies that own or lease a Commonwealth heritage place are required to manage the place in accordance with Commonwealth heritage management principles (Commonwealth of Australia 2019). Under section 341S(1) of the EPBC Act, an agency with control or ownership of a Commonwealth heritage place is responsible for preparing a heritage management plan to protect and manage the heritage values of that place. In line with this requirement, the Sydney Airport Heritage Management Plan assesses the significance of individual elements within the Sydney (Kingsford Smith) Airport Group and provides a plan for managing heritage. This includes some of the buildings and elements located along the project site near Qantas Drive. The heritage management plan states that these buildings, which were developed between 1956 and 1972, have neutral or little heritage significance. The location of these buildings is shown on Figure 17.7.

Sydney (Kingsford Smith) Airport Group is also listed on the non-statutory Register of the National Estate (interim). Further information is provided in section 17.2.2.

Archaeological sites and potential

An area within the project site to the east of Alexandra Canal (shown on Figure 17.6) has a moderate potential for archaeological remains of local significance dating from between 1919 and 1990, including evidence of rail infrastructure, market gardens and residential development.

Figure 17.7 Direct impacts on the Sydney (Kingsford Smith) Airport Group

17.3 Assessment of construction impacts

17.3.1 Direct (physical) Impacts

The main potential for direct impacts on items of heritage significance would be to Alexandra Canal, the Sydney (Kingsford Smith) Airport Group and the Cooks River Intermodal Terminal.

The proposed bridges over Alexandra Canal have been designed to avoid direct impacts on the canal and its walls. However, nine drainage outlets in the canal wall would still be required, with three of these affecting the original sandstone fabric that has the highest significance (sandstone and remnant stone). Options have been investigated to avoid these impacts, as described in section 6.5, with the key principles being the need to drain stormwater efficiently, without substantially affecting surrounding areas or disturbing contaminated bed sediments within Alexandra Canal. Other options considered would include longer drainage lines and discharging into adjacent catchments, which would have resulted in other impacts, including the need to impact major infrastructure such as the Botany Rail Line.

Impacts on the Sydney (Kingsford Smith) Airport Group and the Cooks River Intermodal Terminal have been avoided as far as possible. The project would impact the northern edge of the Sydney (Kingsford Smith) Airport Group site along the southern side of Qantas Drive (an area of about 5.1 hectares). This area contains buildings that are described in Sydney Airport's Heritage Management Plan as having neutral or little heritage significance. Some of these buildings would be removed, and Qantas Drive would be widened at this location. The location of these potential impacts is shown on Figure 17.7. These impacts are unavoidable, as the location of the Botany Rail Line directly to the north of Qantas Drive constrains the direction in which the existing road corridor can be widened in this location.

The project would impact the south-eastern corner of the Cooks River Intermodal Terminal site. This area of land (about 0.9 hectares) would be acquired, and a small section of roadway (part of the St Peters interchange connection) would be constructed in this location. There would be no impacts on the individual elements associated with the heritage listing (which are also subject to individual listings). The location of these potential impacts is shown on Figure 17.8. These impacts are unavoidable, as the need to meet existing road standards coupled with the fixed connection points for the project means that the road alignment could not be completely contained within existing undeveloped Sydney Airport land on the western side of Alexandra Canal.

The majority of subsurface excavations required to construct the project would take place within areas considered to have nil or low potential for archaeological remains. However, subsurface excavation could potentially impact local and/or State significant archaeological remains associated with Alexandra Canal and the Sydney (Kingsford Smith) Airport Group. Additionally, there are some areas within and around Alexandra Canal, St Peters and Sydney Airport and Mascot that are considered to have moderate to high archaeological potential (described in section 17.2.4 and shown in Figure 17.6), which the project could have the potential to impact through direct ground disturbance.

A summary of the results of the assessment of the potential for direct impacts on heritage items and associated archaeological remains, and the assessed significance of these impacts, is provided in Table 17.2. Measures to manage and mitigate the impacts identified are provided in section 17.6.

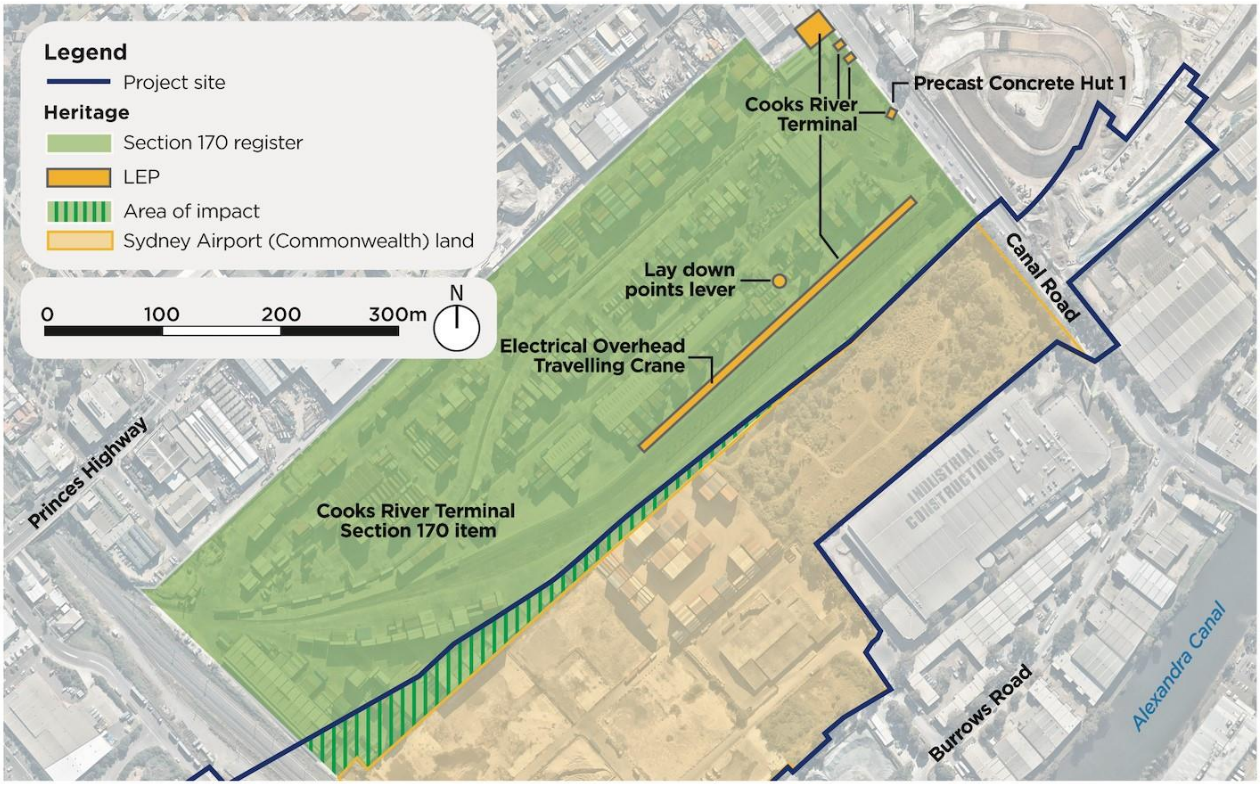


Figure 17.8 Direct impacts on the Cooks River Intermodal Terminal

Table 17.2 Summary of affects to heritage significance as a result of direct (physical) impacts

Item	Proposed works	Impacts on heritage fabric	Impacts on potential archaeological remains
Items listed on the State Heritage Register			
Alexandra Canal	Construction of: ▪ Four new bridges over the canal ▪ Nine drainage outlets within the canal walls	Construction of the bridges would not directly impact the canal or its curtilage (which extends three metres from the banks of the canal). Construction of the drainage outlets would impact the canal walls. The impact to this element has been assessed as: ▪ Minor when it relates to non-original fabric (concrete) – construction of eight of the drainage outlets would impact this fabric ▪ Major when it relates to original sandstone fabric – construction of three of the drainage outlets would impact this fabric.	The overall impact to potential archaeological remains associated with this item has been assessed as moderate. Subsurface excavations have the potential to impact local and State significant archaeological remains associated with the canal.
Other items			
Sydney (Kingsford Smith) Airport Group	Construction of the Qantas Drive upgrade and extension. Eleven existing buildings and associated landscaping elements, which are considered to have heritage value by the Sydney Airport Heritage Management Plan, would be removed. Eight of these buildings are assessed as having little heritage value and three are assessed as having neutral heritage value.	The overall impact has been assessed as moderate as removing buildings rated as having little heritage value is inconsistent with the Sydney Airport Heritage Management Plan, and would remove evidence of Sydney Airport's post-war history and architecture.	The overall impact to potential archaeological remains has been assessed as minor to moderate. Subsurface excavations have the potential to impact local and State significant remains associated with market gardens and historical residential development.
Mascot (O'Riordan Street) Underbridge	None	The project would not directly impact this item as no works to this item are proposed.	Impacts on potential archaeological remains associated with the item has been assessed as minor to negligible.
Mascot (Robey Street) Underbridge	None	The project would not directly impact this item as no works to this item are proposed.	Impacts on potential archaeological remains associated with the item has been assessed as negligible.

Item	Proposed works	Impacts on heritage fabric	Impacts on potential archaeological remains
Mascot (Shea's Ck) Underbridge	Construction of a new bridge (the Terminal Link bridge) close to this item (five metres from the item at the nearest point).	The project would not directly impact this item as no works to this item are proposed.	Impacts on potential archaeological remains associated with the item has been assessed as negligible.
Cooks River Container Terminal and associated items	Construction of the western alignment of the St Peters interchange connection would affect part of the south-eastern corner of the site. Buildings and structures in this location would be removed.	The overall impact has been assessed as minor as: ▪ The project would permanently alter the curtilage of the item ▪ The structures proposed for removal are not considered to have heritage significance ▪ The project would not directly impact individually listed items within the curtilage of the Cooks River Container Terminal.	The overall impact to potential archaeological remains has been assessed as minor. Only a small portion of the item's curtilage would be impacted, limiting impacts on potential archaeological remains.
Morton Bay fig tree	None	The project would not directly impact this item as no works to this item are proposed.	Impacts on potential archaeological remains associated with the item has been assessed as negligible.
Botany Rail Line	Construction of three overpasses over the existing rail corridor	The overall impact has been assessed as minor as: ▪ The project has the potential to impact a brick culvert/water management structure, which is considered to have moderate heritage value ▪ There would be minor impacts on land within the corridor and no direct impacts on the rail line itself.	The overall impact to potential archaeological remains has been assessed as minor. Only a small area of land associated with the rail corridor would be impacted, limiting impacts on potential archaeological remains.
House - Daktari	None	The project would not directly impact this item as the works would be undertaken about 10 metres north-east of the items curtilage.	Impacts on potential archaeological remains associated with the item has been assessed as negligible.

17.3.2 Other impacts

The potential for vibration impacts during construction was assessed by Technical Working Paper 3 (Noise and Vibration), and the results are summarised in Chapter 11 (Noise and vibration). Sections of Alexandra Canal, Cooks River Container Terminal, Mascot (O'Riordan Street) Underbridge, Mascot (Sheas Creek) Underbridge, and the Mascot (Robey Street) Underbridge have been identified as being within the cosmetic damage minimum working distances. As a result, there is the potential for vibration impacts, depending on how the works are managed in the vicinity of these items. Where heritage items are considered potentially sensitive to vibration impacts, more stringent requirements would be applied and monitoring undertaken to ensure that the potential for vibration impacts is low.

No other potential direct or significant visual impacts during construction were identified by the non-Aboriginal heritage assessment.

17.3.3 Summary of impacts on Sydney Airport (Commonwealth) land

The project would directly impact elements of the Sydney (Kingsford Smith) Airport Group. The widening of Qantas Drive near Sydney Airport would affect land near the northern boundary of the Sydney (Kingsford Smith) Airport Group. This would require the buildings in this location to be removed, as shown on Figure 17.7. Eight of these buildings are assessed as having some heritage value (rated as 'little') by the Sydney Airport Heritage Management Plan. Although the Sydney (Kingsford Smith) Airport Group is not subject to a statutory listing on the Commonwealth or National heritage lists, the potential impacts on this item have been assessed as if it was formally listed.

The *Significant impact guidelines 1.2* (DSEWPC, 2013) provides a guide to assessing whether impacts on Commonwealth heritage values are likely to be significant. The potential impacts on the Sydney (Kingsford Smith) Airport Group were also assessed in accordance with the Sydney Airport Heritage Management Plan.

The assessment concluded that direct impacts on the Sydney (Kingsford Smith) Airport Group would have the potential for moderate impacts on the significance of this item, as:

- Removing these buildings is inconsistent with the Sydney Airport Heritage Management Plan
- Evidence of Sydney Airport's post-war history and architecture represented by these structures would be removed.

Excavation at this location also has the potential to affect any archaeological remains that may be present. The assessment concluded that the impact to potential archaeological remains at this location would be minor to moderate. Subsurface excavations have the potential to impact remains associated with market gardens, historical residential development (the Lauriston Park Estate) and Byrne's land grant, which may have been subject to early colonial occupation.

Measures have been provided in section 17.6 to mitigate and manage the impacts identified.

17.4 Assessment of operation impacts

17.4.1 Impacts of the project as a whole

The main potential for impacts on non-Aboriginal heritage during operation would be as a result of visual impacts associated with the project, and how these impacts may affect the significance of heritage items. Potential visual impacts can occur as a result of changes to the landscape and/or the presence of new infrastructure in the vicinity of an item.

The main potential for effects to heritage significance as a result of visual impacts would be to Alexandra Canal and the Sydney (Kingsford Smith) Airport Group. The project includes four new bridges over the canal, which would affect the character of the canal and surrounding landscape. These impacts are unavoidable. As described in section 6.3, the proposed corridor and alignment for the project, which includes a number of crossings of the canal, was selected as an outcome of an extensive options selection process that considered interfaces with surrounding projects and infrastructure. The additional crossings are required to enable the project to respond to the needs described in Chapter 5 (Strategic context and project need).

The findings of the assessment of the potential effects to heritage significance as a result of the visual impacts of the project during operation are summarised in Table 17.3.

Operational impacts such as increased noise, vibration or air quality are not considered likely to affect heritage. The potential for vibration impacts during operation was assessed by Technical Working Paper 3 (Noise and Vibration), and the results are summarised in Chapter 10 (Noise and vibration). No impacts on heritage listed items were identified.

Table 17.3 Summary of the effects to heritage significance as a result of visual impacts

Item	Summary of assessment results
Items listed on the State Heritage Register	
Alexandra Canal	The overall impact to this item is assessed as major as: ▪ The addition of four new bridges over Alexandra Canal would result in permanent modifications to the existing landscape, obstruct view lines towards and along the canal, and alter its 'open sky' character of the canal ▪ The new bridges would increase the number of crossings from three crossings (including one existing crossing and two to be constructed as part of the New M5) to seven crossings ▪ The new drainage outlets would alter the existing appearance of the canal walls, removing a portion of the fabric in nine locations, one of these locations consist of original sandstone fabric that is considered to have the highest significance.
Other items	
Sydney (Kingsford Smith) Airport Group	The overall impact to this item is assessed as moderate as: ▪ The buildings that would be removed visually contribute to Sydney Airport's post-war development history ▪ The new road infrastructure together with the removal of these items and associated landscape elements (including mature trees) would alter the existing appearance of Sydney Airport when viewed from Qantas Drive ▪ The buildings are not considered elements of moderate or high significance.
Mascot (O'Riordan Street) Underbridge	The overall impact to this item is assessed as negligible as it would not be impacted by the project.
Mascot (Robey Street) Underbridge	The overall impact to this item is assessed as negligible as it would not be impacted by the project.
Mascot (Shea's Ck) Underbridge	The overall visual impact to this item is assessed as moderate as a new bridge would be located in close proximity to this item, altering the existing landscape and views to and from the item.
Cooks River Container Terminal and associated items	The overall impact to this item is assessed as minor to moderate as: ▪ The new road infrastructure would be visible from the individual items associated with the item's listing and would modify the item's immediate and surrounding landscape ▪ The majority of its significant landscape features would be retained.
Morton Bay fig tree	The overall impact to this item is assessed as negligible as views to and from the item would not be impacted.
House-Daktari	The overall impact to this item is assessed as negligible as views to and from the item would not be impacted.

Item	Summary of assessment results
Botany Rail Line	The overall impact to this item is assessed as moderate as the project would alter the item's existing and historic landscape due to the presence of three bridges and overpasses that would be constructed over the rail corridor, and the new road corridor that would be constructed adjacent to the rail corridor's western boundary.

17.4.2 Overall level of impact on heritage items and archaeology

A summary of the overall impacts of the project on the identified items, taking into account the potential impacts of both construction and operation, is provided in Table 17.4. The assessment concluded that the overall impact on archaeology would be moderate.

Table 17.4 Overall level of impact

Item	Overall impact rating
Alexandra Canal	Major
Mascot (O'Riordan Street) Underbridge	Negligible
Mascot (Robey Street) Underbridge	Negligible
Mascot (Shea's Ck) Underbridge	Minor
Sydney (Kingsford Smith) Airport Group	Moderate
Cooks River Container Terminal and associated items	Minor
Morton Bay Fig Tree	Negligible
House - Daktari	Negligible
Botany Rail Line	Minor to moderate

17.4.3 Summary of impacts on Sydney Airport (Commonwealth) land

The project would change the visual appearance of the northern edge of the Sydney (Kingsford Smith) Airport Group as a result of the widened section of Qantas Drive and the removal of existing buildings and associated landscape elements (including mature trees). This would change the visual character in this area.

The assessment concluded that these impacts would have the potential for moderate impacts on the significance of the Sydney (Kingsford Smith) Airport Group.

Consistency with the Sydney Airport Master Plan

The *Sydney Airport Master Plan 2039* (SACL, 2019a) (the Master Plan) recognises the heritage values associated with Sydney Airport. The Master Plan states that 'These heritage values are associated with the airport as a whole and are embodied in the location, form and function of its individual elements. This includes the arrangement of streets, buildings and runways, and the ways in which these attributes reflect the airport's history of change and growth.' The Master Plan recognises the role of the Sydney Airport Heritage Management Plan in managing heritage at Sydney Airport.

The Master Plan notes that three heritage items have been identified as 'environmentally significant areas' under the Airports Act, and are also recognised as significant in the Heritage Management Plan:

- The location and form of Keith Smith Avenue
- The location and function of the main north–south and east–west runways
- Sydney Airport Wetlands (incorporating Engine Ponds East and West, Mill Pond and Mill Stream).

The project would not impact these items.

The Master Plan also notes that the Sydney Airport Heritage Management Plan identifies a number of other items of heritage significance. These include buildings in the Sydney Airport Jet Base, some of which are located in the project site. The impacts on these items have been assessed by the non-Aboriginal heritage assessment, and the results of the assessment are summarised above and in section 17.3.

The Master Plan recognises that proposed developments at the airport (as detailed in the Master Plan), particularly within the airport's North East Sector (the north-eastern area of the airport site to the south of Qantas Drive and Joyce Drive) '… will have significant impacts on a number of heritage significant structures including buildings and hangars within the Jet Base …'

The plan notes that Sydney Airport Corporation will pursue opportunities for the airport's history and significance to be interpreted as part of new development. Key relevant initiatives under the Master Plan include:

- Integrate heritage interpretation devices into new and existing Sydney Airport facilities, through delivery of an interpretation strategy
- Ensure that heritage items of recognised significance are recorded to an appropriate archival standard.

The measures provided in section 17.6 to mitigate and manage the impacts identified by the non-Aboriginal heritage assessment are consistent with the initiatives in the Master Plan. The potential impacts on the Jet Base as a result of the project are consistent with the types of impacts the Master Plan envisages would be likely as a result of development in this area. These impacts have been assessed in accordance with the Sydney Airport Heritage Management Plan.

17.5 Cumulative impacts

Cumulative heritage impacts represent the incremental loss of, or modifications to, a historical or environmental resource over time. The main nearby projects with the potential to directly or indirectly impact non-Aboriginal heritage are the proposed Botany Rail Duplication and the New M5 (which is under construction).

In the immediate vicinity of the project site, the Botany Rail Duplication would result in:

- Removal of two locally listed heritage items (the Mascot (O'Riordan Street) Underbridge and the Mascot (Robey Street) Underbridge)
- Modifications to one locally listed item (the Mascot (Botany Road) Underbridge)
- Alterations to the Botany Rail Line, which is identified as a potential heritage item
- Potential impacts on State and locally significant archaeology, including Alexandra Canal.

In the immediate vicinity of the project site, the impacts of the New M5 will include:

- Visual impacts on Alexandra Canal from two new bridges over the canal and additional drainage outlets
- Modifications to the St Peters Brickpit Geological Site (listed on the non-statutory Register of the National Estate).

The assessment concluded that the most significant potential cumulative impact would be as a result of the number of bridges over Alexandra Canal. This is mainly a result of the impacts on the canal's existing character, which has remained relatively 'open' since its establishment in the late 19th century. The addition of six new bridges (the combined impacts of the proposed Sydney Gateway road project and the approved New M5 would permanently alter these characteristics.

17.6 Management of impacts

17.6.1 Approach

Approach to mitigation and management

- The assessment identified that the project would have the potential for moderate to major impacts on the heritage significance of:
- Alexandra Canal
- Sydney (Kingsford Smith) Airport Group
- Areas with the potential for archaeological remains of moderate to high significance.

The project would also have the potential for minor to moderate impacts on the Botany Rail Line.

Approach to managing the key potential impacts identified

A key approach to minimising the potential for heritage impacts, and in particular cumulative impacts with other projects, would be designing the project in accordance with the urban design and landscape plan to be prepared for the project. The plan would include strategies and design principles to ensure that the design of project features and ancillary infrastructure is sympathetic to the existing landscape heritage significance of the study area. The design of the project, in particular the bridges over Alexandra Canal and heritage interpretation, would also seek to enhance the heritage significance of Alexandra Canal, which provides a link to the area's European and industrial heritage. Further information on the approach to urban design is provided in section 7.12.

Measures are provided in section 17.6.2 to ensure that the bridges over Alexandra Canal, and the drainage outlets in the canal walls, are designed to take into account the heritage significance of the canal and its landscape, and to integrate with the bridges and outlets that will be constructed as part of the New M5. This includes avoiding areas of significant fabric, or reusing this material within the canal where avoidance is not possible. Whilst these measures would reduce the impact to the canal, the assessment concluded the project would have a major impact to this item.

The approach to managing impacts at Sydney (Kingsford Smith) Airport Group would involve establishing protection barriers around heritage items and landscape elements to be retained to prevent accidental impacts during construction. Due to the requirement for the removal of buildings within the airport and construction of additional infrastructure, the project would have a moderate impact on this item. The approach for managing these impacts would include incorporating heritage interpretation into the design to recognise its historical significance.

For areas where potential impacts on archaeology have been identified, a Historical Archaeological Assessment and Research Design and Excavation Methodology would be prepared following approval to define the approach to archaeological assessment. Archaeological research designs provide an outline of the research framework for archaeological work on site and the methodologies to be used to realise the research potential of a site.

With respect to the potential for vibration impacts, as described in Chapter 10 (Noise and vibration), the Construction Noise and Vibration Management Plan would outline the measures to manage construction vibration impacts for the project. Where vibration levels are predicted to exceed the screening criteria, the plan would provide for a more detailed assessment of the structure (including its heritage values) and vibration monitoring, to ensure vibration levels remain below appropriate limits for that structure. Further information on the management of potential vibration impacts during construction, including relevant mitigation measures, is provided in Chapter 10 (Noise and vibration).

Approach to managing other impacts

The potential for impacts during construction would be managed in accordance with a project-specific Heritage Management Plan, which would be implemented as part of the CEMP. The plan would detail processes and responsibilities to minimise potential impacts on heritage during construction. It would be prepared in accordance with relevant guidelines, standards, and the Alexandra Canal Conservation Management Plan and Sydney Airport Heritage Management Plan. It would be prepared in consultation with the agencies responsible for the heritage items that would be affected by the project. Further information on the CEMP, including requirements for the Heritage Management Plan, is provided in Chapter 27 (Approach to environmental management and mitigation).

Other mitigation measures are listed in section 17.6.2.

Expected effectiveness

Avoidance is considered to be the most effective strategy for preventing impacts. Through development of the project design and construction planning, a number of impacts on non-Aboriginal heritage have been avoided or reduced. However, not all impacts on heritage can be avoided entirely as this would result in additional impacts on other areas Therefore, further measures to mitigate impacts are required.

The measures provided in section 17.6.2 have been identified as an outcome of the non-Aboriginal heritage assessment and considering best practice approaches to managing potential impacts as defined by relevant heritage guidelines. The non-Aboriginal heritage assessment was prepared by a specialist heritage consultant.

The project aims to create a uniform and visually captivating landscape that would improve the overall nature of land on both sides of Alexandra Canal. If carried out sympathetically, and with consideration given to incorporating the area’s history into the bridge and landscape designs, this will have a positive impact on the study area.

17.6.2 List of mitigation measures

Measures that will be implemented to address potential impacts on non-Aboriginal heritage are listed in Table 17.5.

Table 17.5 Non-Aboriginal heritage mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Avoiding impacts on heritage	NAH1	The design will avoid impacts on non-Aboriginal heritage items, significant heritage fabric, locally and State significant archaeological remains and landscapes (including mature trees) as far as reasonably practicable. This includes significant fabric associated with Alexandra Canal and the Sydney (Kingsford Smith) Airport Group.	Detailed design
Minimising impacts on heritage	NAH2	The design will be prepared in accordance with the urban design and landscape plan for the project, and will minimise the potential for visual impacts on heritage items by incorporating sympathetic fabric, colour and form in the design.	Detailed design
Design of the bridges over Alexandra Canal	NAH3	The bridges over Alexandra Canal will be designed to: ▪ Be sympathetic to the heritage sensitivity and industrial landscape of the canal ▪ Minimise physical impacts on the canal ▪ Incorporate a high quality architectural design using suitable material and forms ▪ Integrate with the bridges for the New M5 ▪ Retain the open character of the canal as far as possible ▪ Have regard to the Alexandra Canal Conservation Management Plan.	Detailed design

Impact/issue	Ref	Mitigation measure	Timing
		An appropriately qualified and experienced heritage architect or engineer will provide independent review of the designs, and the Heritage Council of NSW and Sydney Water will be consulted.	
Design of the drainage outlets at Alexandra Canal	NAH4	The drainage outlets at Alexandra Canal will be designed to: ▪ Minimise impacts on significant original fabric and highly visible areas ▪ Be sympathetic to the industrial landscape of the canal and its existing fabric ▪ Use suitable material and forms ▪ Have regard to the Alexandra Canal Conservation Management Plan. An appropriately qualified and experienced heritage architect or engineer will provide independent review of the design, and the Heritage Council of NSW and Sydney Water will be consulted.	Detailed design
Reuse of significant fabric at Alexandra Canal	NAH5	Where significant fabric is to be removed, consideration will be given to reusing the fabric for interpretation or repair and maintenance of other sections of the canal, in consultation with Sydney Water.	Detailed design
Heritage interpretation	NAH6	Appropriate heritage interpretation will be incorporated into the design in accordance with the *NSW Heritage Manual* (NSW Heritage Office and Department of Urban Affairs and Planning, 1996), *Interpreting Heritage Places and Items: Guidelines* (NSW Heritage Office, 2005), and the NSW Heritage Council's Heritage Interpretation Policy. This will focus on recognising the historical significance of the following items: ▪ Alexandra Canal ▪ Sydney (Kingsford Smith) Airport Group ▪ Cooks River Container Terminal ▪ Mascot (Shea's Ck) Underbridge ▪ Botany Rail Line.	Detailed design
Managing heritage impacts during construction	NAH7	A Heritage Management Plan will be prepared prior to construction and implemented as part of the CEMP. It will include measures to manage non-Aboriginal heritage and minimise the potential for impacts during construction. The plan will take into account relevant conservation and heritage management policies in the Alexandra Canal Conservation Management Plan and the Sydney Airport Heritage Management Plan.	Pre-construction, construction
Impacts on archaeology	NAH8	A Historical Archaeological Research Design and Excavation Methodology will be prepared for, and implemented at, the following locations within the project site: ▪ Intact sections of Alexandra Canal along the western bank of the canal on either side of the existing pedestrian and rail bridges ▪ Vacant land at 30 Canal Road (Lot 4 DP 555771 and Lot 3 DP 825649) ▪ Land located north of Canal Road that is currently used for the construction (stockpiling) of the New M5 (Lot A DP 391775, Lot B DP 394647 and Lot 2 DP1168612) ▪ Sydney Airport land considered to contain low or moderate archaeological potential ▪ Land along Qantas Drive considered to contain low or moderate archaeological potential	Pre-construction, construction

Impact/issue	Ref	Mitigation measure	Timing
		■ Sydney Airport land located east of Sydney Airport northern lands car park and west of Botany Rail Line (Lot 1 DP 826101) ■ Land to the west of Boral's St Peters facility and east of the Botany Rail Line. The Historical Archaeological Assessment and Research Design and Excavation Methodology will identify the specific features of archaeological significance that could be present at these locations, provide a scope for further investigations to confirm and specify appropriate archaeological management for any remains identified.	
Archival recording	NAH9	Photographic archival recording will be carried out for affected sections of the following items: ■ Alexandra Canal ■ Sydney (Kingsford Smith) Airport Group ■ Cooks River Container Terminal ■ Mascot (Shea's Ck) Underbridge ■ Botany Rail Line. Photographic archival recording will be carried out prior to works commencing in the vicinity of the item, and in accordance with *How to Prepare Archival Records of Heritage Items* (Heritage Office, 1998) and *Photographic Recording of Heritage Items Using Film or Digital Capture* (Heritage Office, 2006b). Once complete, a report will be prepared detailing the history and significance of the item, relevant findings from the archival recording and an overview of the project. This document would subsequently be held by the appropriate local council(s), local library, local historical society and the owner of the asset.	Pre-construction
Avoiding impacts during construction	NAH10	Heritage items and landscaping located outside the project site and associated with the following items will be marked on site plans contained within the CEMP as areas to be avoided during construction, where works are proposed within 10 metres of: ■ Alexandra Canal (significant fabric and gazetted curtilage as detailed in the conservation management plan for Alexandra Canal) ■ Sydney (Kingsford Smith) Airport Group – fabric of high significance (as identified in the Sydney Airport Heritage Management Plan), trees and plantings ■ Cooks River Container Terminal – fabric of high significance, trees and plantings ■ Mascot (Shea's Ck) Underbridge – fabric associated with the bridge. Protective barriers will be established prior to works at these locations.	Construction
Potential vibration impacts on heritage items	NAH11	Potential vibration impacts on features of heritage significance will be managed in accordance with the Construction Noise and Vibration Management Plan (measure NV1) and noise and vibration mitigation measure NV12.	Construction
Unexpected finds	NAH12	Any items of potential heritage conservation significance or human remains discovered during construction will be managed in accordance with the *Standard Management Procedure Unexpected Heritage Items* (Roads and Maritime, 2015e).	Construction

17.6.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 17.6.2).

Residual impacts on non-Aboriginal heritage would include impacts on Alexandra Canal as a result of the installation of three drainage outlets in significant fabric and the visual impacts of the new bridges over the canal. There would also be a moderate impact to the Sydney (Kingsford Smith) Airport Group from the removal of buildings. With the implementation of mitigation measures, residual impacts on all other non-Aboriginal heritage items would be neutral to minor.

Despite the residual impacts described above, these items would continue to retain heritage values. Heritage interpretation would assist in promoting the historical significance of the items. Opportunities to further reduce impacts on these items, including further avoidance of impacts, will be investigated during detailed design. The project also aims to create a uniform and visually captivating landscape that would improve the overall nature of land on both sides of Alexandra Canal. If carried out sympathetically and with consideration given to incorporating the area’s history into its bridge and landscape designs, this will have a positive impact on the study area and enhance the significance of the Alexandra Canal.

Chapter 18

Aboriginal heritage

This chapter provides a summary of the Aboriginal heritage assessment. It describes existing Aboriginal heritage, identifies potential impacts, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 10 (Aboriginal Cultural Heritage Assessment Report).

The SEARs relevant to Aboriginal heritage are listed below. There are no MDP requirements specifically relevant to Aboriginal heritage; however, there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)). Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
7	**Heritage**	
7.1	The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts and visual impacts) to the heritage significance of:	
	(a) Aboriginal places, objects and cultural heritage values, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines;	This chapter
	(b) Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan;	Section 18.2.2
7.3	Where archaeological investigations of Aboriginal objects are proposed these must be conducted by a suitably qualified archaeologist, in accordance with section 1.6 of the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010).	Section 18.6.1
7.4	Where impacts to Aboriginal objects and/or places are proposed, consultation must be undertaken with Aboriginal people in accordance with the current guidelines.	Sections 18.1.2 and 18.6.2.

18. Aboriginal heritage

18.1 Assessment approach

Aboriginal heritage assessment is an important component of infrastructure planning and assessment. It is undertaken in consultation with representatives of Aboriginal stakeholders and is respectful of the cultural knowledge they hold. The assessment of potential impacts on Aboriginal heritage considers cultural knowledge, and the results of background research and field investigations. This includes an assessment of the potential for Aboriginal heritage items to be located at depth where the surface ground is disturbed.

An overview of the approach to the Aboriginal heritage assessment is provided in this section, including the legislative and policy context and a summary of the assessment methodology.

18.1.1 Legislative and policy context to the assessment

The assessment was undertaken in accordance with the SEARs and MDP requirements (provided in Appendix A to B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations, the *National Parks and Wildlife Act 1974* (NSW), the EPBC Act, the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth) and the *Native Title Act 1993* (Cth)
- *Procedure for Aboriginal cultural heritage consultation and investigation* (Roads and Maritime, 2011b)
- *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH, 2011)
- *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW, 2010c)
- *Significant impact guidelines 1.2 - Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies* (DSEWPC, 2013)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

18.1.2 Methodology

Study area

The study area for the assessment is the project site, as described in Chapter 2 (Location and setting). Background research, including database searches, was based on a wider search area of 14 by 14 kilometres centred on the project site.

Key tasks

The assessment involved:

- Background research on the Aboriginal archaeological and historical context of the project site and registered Aboriginal sites, including reviewing a previous Aboriginal heritage assessment undertaken between 2016 and 2018, and searching the Aboriginal Heritage Information Management System (AHIMS) database in December 2018
- Site inspections of identified areas of archaeological potential in July 2018
- Consultation with the Aboriginal community in accordance with the *Procedure for Aboriginal cultural heritage consultation and investigation* (Roads and Maritime, 2011) and the *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW, 2010c)

- Assessing the Aboriginal heritage significance of the project site and areas of archaeological potential
- Assessing the potential impacts of the project
- Identifying measures to minimise impacts on Aboriginal heritage.

Aboriginal consultation

Aboriginal consultation was undertaken as an input to the assessment in accordance with the consultation guidelines listed in section 18.1.1. The purpose of consultation was to provide the Aboriginal community with an opportunity to input to the assessment and the Aboriginal Cultural Heritage Assessment Report. Aboriginal consultation included:

- Identifying, notifying and registering relevant Aboriginal parties by:
  - Contacting relevant organisations to identify Aboriginal parties with cultural interest/knowledge in the study area
  - Placing advertisements in newspapers, including the Koori Mail and local newspapers
  - Sending letters to Aboriginal parties to invite them to register their interest in the project – a total of 12 individuals representing 10 groups registered their interest
- Presenting information about the project and assessment at an Aboriginal focus group meeting held in December 2018
- Sending the draft Aboriginal Cultural Heritage Assessment Report to registered Aboriginal parties for review.

Further information on the assessment methodology, including the consultation activities, is provided in sections 3 and 4 of Technical Working Paper 10 (Aboriginal Cultural Heritage Assessment Report).

18.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*.

The potential to impact identified areas of archaeological potential as result of ground disturbance during construction was the only risk identified by the environmental risk assessment that had an assessed overall risk rating of medium or above. The Aboriginal cultural heritage assessment included consideration of this potential risk.

18.2 Existing environment

18.2.1 Aboriginal historical and landscape context

Prior to European settlement, land in the study area was occupied by the Gadigal people. It is considered likely that the project site was occupied by the Wangal clan, whose territory extended between the Parramatta and Cooks rivers. In the study area, wetlands associated with the original alignment of Shea's Creek, the Cooks River and Gumbramorra Swamp were a source of reliable fresh water and food for Aboriginal people. Outcrops of Hawkesbury Sandstone around the Cooks River and surrounding environment would have provided shelter and materials.

Since early European settlement the study area has been subject to significant disturbance and development. However, deeper estuarine and fluvial soils remain intact in some areas, including surrounding some parts of Alexandra Canal. Within these deeper soils, shell material has been encountered at depths of up to five metres below ground level.

Alexandra Canal has been identified as having Aboriginal heritage values. The Sydney Water Section 170 heritage register listing for the canal notes that 'the discovery of the butchered Dugong, Aboriginal axes and the remains of an ancient forest in this area that were uncovered during construction have revealed both a species and a food source of Aboriginal occupation in the Botany basin and a scientific understanding to the changing sea levels along the area.'

18.2.2 Recorded Aboriginal sites and places

There are no listed Aboriginal sites recorded on the AHIMS database within the project site. The closest listed site is the Shea's Creek Dugong (AHIMS ID 45-6-0751), which is recorded to have been located about 250 metres from the project site. The AHIMS record indicates that this site has been destroyed.

No Aboriginal sites or places listed under the EPBC Act were identified in the project site.

The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth) provides for the protection for intangible Aboriginal heritage within Australia, including places, objects and folklore that that 'are of particular significance to Aboriginals in accordance with Aboriginal tradition. No intangible Aboriginal heritage was identified in the project site.

There are no Aboriginal places declared under section 84 of the *National Parks and Wildlife Act 1974* (NSW), or Aboriginal places of heritage significance defined by the *Standard Instrument – Principal Local Environmental Plan*, located within or near the project site.

There are no native title claims relevant to the project site.

18.2.3 Archaeological survey results, potential and significance

Whilst the study area is likely to have been occupied by Aboriginal people, the likelihood of surviving evidence remaining is influenced by a range of factors, including the durability of material and amount of disturbance to the land. The large-scale removal and modification of the underlying geology and associated soils, during construction of Sydney Airport, Alexandra Canal, the Botany Rail Line and the surrounding urban environment, is likely to have significantly impacted or removed the original landforms and associated archaeological potential.

Two areas with archaeological potential were identified during the archaeological field surveys. These are referred to as Investigation Area 1 and Investigation Area 2. These areas are located close to Alexandra Canal, adjacent to the rail corridor on either side of the canal, and mainly within Sydney Airport land. Although evidence of surface disturbance was identified at these locations, geological data indicates that deeper soils (at a depth of about five metres below ground level) are undisturbed. These deeper soils have the potential to contain Aboriginal archaeological deposits due to the age of these soils. As such, Investigation Area 1 and Investigation Area 2 are considered to have archaeological potential.

The locations of Investigation Area 1 and Investigation Area 2 are shown on Figure 18.1. Photographs showing the areas are provided at Figure 18.2 and Figure 18.3.

Based on the results of the survey and review of existing conditions, the assessment of the archaeological significance of the project site concluded that:

- The majority of the project site has nil to low archaeological potential and does not have scientific significance
- Investigation Area 1 and Investigation Area 2 have moderate archaeological potential and moderate to high scientific significance as a result of the potential presence of undisturbed material beneath the ground surface
- Any archaeological remains would be rare and have the potential to add to knowledge of the Aboriginal heritage values of the study area.

Figure 18.1 **Areas of Aboriginal archaeological potential**

Figure 18.2 Investigation Area 1

Figure 18.3 Investigation Area 2

18.2.4 Aboriginal heritage within Sydney Airport (Commonwealth) land

The majority of the project site within Sydney Airport land has been cleared and developed, and the former natural landforms and associated archaeological potential have been removed. Accordingly, the majority of the project site on Sydney Airport land is assessed as having nil to low archaeological potential and scientific significance.

However, the two areas of archaeological potential that have been identified, Investigation Area 1 and Investigation Area 2, are mainly located on Sydney Airport land (as shown on Figure 18.1). Parts of these areas have moderate archaeological potential and moderate to high scientific significance.

18.3 Assessment of construction impacts

18.3.1 Impacts on recorded Aboriginal sites and places

There would be no impacts on recorded Aboriginal sites or places as none were identified within the project site.

18.3.2 Impacts on areas with Aboriginal archaeological potential

Works associated with the project would disturb the ground within Investigation Areas 1 and 2. These works include constructing the piers associated for the Qantas Drive bridge (on both sides of Alexandra Canal) and the culvert connecting to the northern side of Alexandra Canal. Constructing this infrastructure would involve works at depths that could disturb the underlying sandy and clay estuarine deposits, which are considered to be archaeologically sensitive and potentially contain archaeological material. These works would directly and partially impact these areas of archaeological potential, resulting in a partial loss of the potential Aboriginal heritage values of these areas.

To mitigate these potential impacts, salvage excavation would be undertaken prior to construction as described in section 18.6.1.

18.3.3 Summary of impacts on Sydney Airport (Commonwealth) land

Construction would partially impact the potential archaeological values of the identified investigation areas. The *Significant impact guidelines 1.2* (DSEWPC, 2013) provide a guide to assessing whether impacts on heritage values are likely to be significant. The assessment concluded that:

- The project would result in a partial and localised impact to areas of potential Aboriginal heritage value on Sydney Airport (Commonwealth) land
- These potential impacts are not considered to be significant.

The approach to managing and mitigating the potential impacts are described in section 18.6.

Consistency with the Sydney Airport Master Plan 2039

The *Sydney Airport Master Plan 2039* (SACL, 2019a) (the Master Plan) recognises the Aboriginal heritage values of the land within and surrounding the Sydney Airport site. The Master Plan acknowledges the special significance that land in the area holds for Aboriginal people.

The plan notes that Sydney Airport Corporation will ensure potential impacts on heritage values associated with the airport are managed and reduced. Key relevant initiatives under the Master Plan include:

- Conserve the significant places of the airport, in line with the Heritage Management Plan
- Integrate heritage interpretation devices into new and existing Sydney Airport facilities, through delivery of an interpretation strategy
- Ensure that heritage items of recognised significance are recorded to an appropriate archival standard
- Establish an archive of historical records of the history of Sydney Airport and the site

The measures provided in section 18.6, which include developing an Aboriginal heritage interpretation strategy and including appropriate Aboriginal heritage interpretation in the design, are consistent with the Master Plan.

18.4 Assessment of operational impacts

Impacts on Aboriginal heritage would be limited to the construction stage of the project. No additional impacts on the areas of archaeological potential are predicted during operation.

18.5 Cumulative impacts

The main nearby projects with the potential to impact Aboriginal heritage are the Botany Rail Duplication and the New M5. The Botany Rail Duplication is not expected to impact any listed Aboriginal sites, places or areas of archaeological potential. No items or places of Aboriginal heritage significance in the vicinity of the project site have the potential to be impacted by the New M5 project.

While these projects would not impact Aboriginal heritage, Aboriginal archaeological remains are a rare and diminishing resource in urban areas. Impacts on any items of Aboriginal heritage significance present within the two areas of archaeological potential would have a cumulative impact on the regional archaeological landscape, although only a discrete area would be impacted by the project. Other locations along Alexandra Canal, which may contain buried soil landscapes, would not be impacted by the project. This means that a representative sample of these landscapes would be remain in the locality.

18.6 Management of impacts

18.6.1 Approach

Approach to mitigation and management

Approach to managing the key potential impacts identified

The assessment identified that impacts on the two areas of Aboriginal archaeological potential are unavoidable. It has not been confirmed whether any items of significance are located in these areas.

Salvage excavation would be undertaken prior to construction within those parts of Investigation Area 1 and Investigation Area 2 where deep sediments would be directly impacted by the project. The layers of archaeological interest are likely to be well below the water table in highly permeable soils. As such, carrying out hand held test excavations in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECCW, 2010d) would not be feasible as inflow volumes would be too great. There is also the risk that the sandy soils would collapse as the excavation progresses to the depths required. As described in Chapters 13 (Contamination and soils) and 15 (Groundwater), the groundwater is contaminated. While mitigation measures are proposed in Chapters 13 and 15 to manage groundwater, there is no way to prevent the inflow of contaminated groundwater into excavations. As a result, and to reduce the total number and duration of excavations, it is proposed that investigations to identify and remove any Aboriginal heritage material in the two areas of archaeological potential would proceed directly to salvage excavation.

The proposed methodology (detailed in Technical Working Paper 10 (Aboriginal Cultural Heritage Assessment Report)) provides for staged salvage excavation to be undertaken by qualified archaeologists with the participation of Aboriginal stakeholders. The aim of this excavation is to identify any Aboriginal heritage objects present in deeper estuarine deposits and, if any are found, to remove the objects from the area of potential impact.

Consultation with the Aboriginal community was undertaken to confirm the proposed salvage methodology and the process for the temporary and long-term care and management of any Aboriginal objects retrieved.

A staged salvage excavation is proposed to minimise impacts on the environment, including the generation of contaminated waste and the duration of time that any such waste is exposed. The excavation program would be undertaken in three stages:

- Stage 1 – Use of 14 push tubes in locations where excavation is proposed (see Figure 14.1 of Technical Working Paper 10)
- Stage 2 – This stage would be triggered if two adjacent locations investigated in stage 1 show the presence of estuarine deposits. Push tubes would then be used at 2.5 metre intervals between the confirmed locations of deposits
- Stage 3 – If significant archaeological objects are identified during stage 2, additional push tubes would be used around the stage 2 locations.

All material would be inspected to confirm the presence of any hazardous materials. Once material is cleared for investigation, the push tubes would be opened and recorded. The manner in which the material obtained is processed would depend on the nature of the material identified:

- Estuarine deposits would be hand sieved and samples taken where appropriate
- For shell middens, bulk samples would be taken and sieved if a low density of shell is present.

Post-excavation analysis and reporting would be undertaken in accordance with the methodology provided in Technical Working Paper 10.

An Aboriginal heritage interpretation strategy would be developed in consultation with registered Aboriginal parties and other relevant stakeholders. Regardless of whether any Aboriginal heritage objects are identified during salvage excavation, opportunities for Aboriginal heritage interpretation (identified by the interpretation strategy), would be integrated into the urban design and landscape plan. This plan would be developed during detailed design as described in section 7.12.

Other measures

The potential for impacts during construction would be managed in accordance with a project-specific Aboriginal Heritage Management Plan, which would be implemented as part of the CEMP. The plan would detail processes and responsibilities to minimise potential impacts on Aboriginal heritage during construction. It would be prepared in accordance with relevant guidelines, standards and Technical Working Paper 10 (Aboriginal Cultural Heritage Assessment Report). The plan would also include the unexpected finds procedure and the proposed salvage methodology. Further information on the CEMP, including requirements for the Heritage Management Plan, is provided in Chapter 27 (Approach to environmental management and mitigation).

Other mitigation measures are listed in section 18.6.2.

Expected effectiveness

The proposed salvage methodology has been developed based on best management practice, relevant standards and guidelines, and specialist knowledge. The strategy has been developed by suitably qualified archaeologists and in consultation with Aboriginal stakeholders. The strategy aims to remove any Aboriginal heritage items from within the project site while minimising impacts on currently unknown items. It has also considered the context of the project site and environmental conditions and constraints within the project site.

The Aboriginal cultural heritage assessment report (including the proposed mitigation measures) was prepared by a specialist Aboriginal heritage consultant in consultation with Aboriginal stakeholders. A suitably qualified archaeologist would be responsible for delivering the salvage excavation. Consultation would continue throughout the salvage excavation to ensure the effectiveness of those activities.

The potential loss of intrinsic Aboriginal cultural value linked to these impacted sites cannot be offset; however, any salvaged material will increase understanding, strengthen interpretation, and improve ongoing and future management of Aboriginal heritage in the area. The proposed approach to management is considered to be effective in reducing the potential impacts of the project on Aboriginal heritage as far as practicable, and providing for the appropriate management of Aboriginal heritage in the event that it is encountered.

18.6.2 List of mitigation measures

Measures that will be implemented to address potential impacts on Aboriginal heritage are listed in Table 18.1.

Table 18.1 Aboriginal heritage mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Archaeological investigation areas impacted by the project	AH1	Detailed design and construction planning will avoid direct impacts on Investigation Area 1 and Investigation Area 2 where practicable.	Detailed design
	AH2	Archaeological salvage excavation will be undertaken prior to construction within those parts of Investigation Area 1 and Investigation Area 2 where deep sediments would be directly impacted by the project. Archaeological salvage excavation (including post-excavation analysis and reporting) will be completed prior to any activities that may result in harm to Aboriginal objects in these areas.	Pre-construction

Impact/issue	Ref	Mitigation measure	Timing
Aboriginal heritage interpretation	AH3	An Aboriginal heritage interpretation strategy will be developed in consultation with registered Aboriginal parties and other relevant stakeholders. The interpretation strategy will have regard to *Sydney Airport Master Plan 2039* and the Sydney Airport Heritage Management Plan. Appropriate Aboriginal heritage interpretation will be incorporated into the project design in accordance with the interpretation strategy.	Detailed design
Managing heritage impacts during construction	AH4	An Aboriginal Heritage Management Plan will be prepared prior to construction and implemented as part of the CEMP. The plan will include measures to manage Aboriginal heritage and minimise the potential for impacts during construction. It will include the proposed salvage methodology, unexpected find procedure (see measure AH6) and process for additional consultation with Aboriginal stakeholders.	Pre-construction, construction
Aboriginal consultation	AH5	Aboriginal stakeholder consultation will continue to be undertaken in accordance with the *Procedure for Aboriginal cultural heritage consultation and investigation* (Roads and Maritime, 2011b) and *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW, 2010c).	Pre-construction, construction
Unexpected finds	AH6	If suspected Aboriginal heritage items or human remains are uncovered during construction they will be managed in accordance with the *Standard Management Procedure: Unexpected Heritage Items* (Roads and Maritime Services, 2015e).	Construction

18.6.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 18.6.2).

No residual impacts on Aboriginal heritage are predicted.

Chapter 19

Land use and property

This chapter provides an assessment of the potential impacts on land use and property. It describes existing land uses and properties in the project site, assesses the impacts of construction and operation, and provides mitigation measures to manage the impacts identified.

The SEARs and MDP requirements relevant to land use and property are listed below. In addition, there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)). Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
6	**Socio-economic, land use and property**	
6.2	The Proponent must assess the social and economic impacts from construction and operation on potentially affected properties, infrastructure, utility services, businesses (including impacts to freight management associated with the reduction of container storage, and consequent impacts to the broader industry), recreational users and land and water users.	This chapter assesses the potential impacts on land use and property. Potential social and economic (including business) impacts are considered in Chapter 20 (Socio-economic impacts).
Major development plan requirements		
91(4)	In specifying a particular objective or proposal covered by paragraph (1)(a), (c) or (ga), a major development plan, or a draft of a major development plan, must address: (a) the extent (if any) of consistency with planning schemes in force under a law of the State in which the airport is located; and (b) if the major development plan is not consistent with those planning schemes – the justification for the inconsistencies.	Section 19.4.4

19. Land use and property

19.1 Assessment approach

Developing a new road changes the existing use of the land on which it is located. It can also permanently affect any properties located on this land as well as adjacent land uses. Assessing potential impacts on land use and property broadly involves considering existing and potential future land uses in the study area, and determining how these land uses may change, both temporarily during construction and permanently during operation.

An overview of the approach to the land use and property assessment is provided in this section, including the legislative and policy context and assessment methodology.

19.1.1 Legislative and policy context to the assessment

The assessment has been undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations
- *Significant impact guidelines 1.2 – Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies* (DSEWPC, 2013)
- *Botany Bay Local Environmental Plan 2013, Marrickville Local Environmental Plan 2011, Sydney Local Environmental Plan 2012* and the *Rockdale Local Environmental Plan 2011*
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019–2024* (SACL, 2019b)
- Land use strategies that apply to the study area (see sections 5.1 and 19.2.2).

19.1.2 Methodology

Study area

The study area is defined as the project site (as described in Chapter 2) and land surrounding the project site. Generally the study area consists of properties within the project site and land within about 500 metres of the project site.

Key tasks

The assessment involved:

- Confirming land use and planning controls (land use zones) in the study area, involving a review of:
  - Land use zoning maps under the relevant local environmental plan (LEP) – the *Botany Bay Local Environmental Plan 2013* (Botany Bay LEP), *Marrickville Local Environmental Plan 2011* (Marrickville LEP), *Sydney Local Environmental Plan 2012* (Sydney LEP) and the *Rockdale Local Environmental Plan 2011* (Rockdale LEP), which apply to different areas of the project site
  - Land use zoning maps and future development plans under the *Sydney Airport Master Plan 2039* (SACL, 2019a) (the Master Plan)
  - Aerial imagery
- Undertaking a site visit to confirm land uses within and around the project site

- Reviewing key strategic plans and development applications relevant to the study area to identify future priorities, including land uses and developments. This included searching development application registers, the NSW major project tracking system, and the Joint Regional Planning Panels development and planning register for the period 2105 to 2019
- Identifying properties located within the project site
- Assessing the potential impacts of construction and operation, including temporary and permanent land use changes, impacts on properties, and potential impacts on utilities
- Identifying measures to avoid, minimise and manage the potential impacts identified.

Chapter 20 (Socio-economic impacts) considers the potential social, community, economic and business impacts of the project, including those that may occur as a result of the impacts identified in this chapter.

19.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Land use and property risks with an overall assessed risk rating of medium or above, identified by the environmental risk assessment, included:

- Temporary changes to land use, including recreation/open space uses within Tempe Lands, as a result of the establishment of construction work areas and associated ancillary facilities
- Impacts on properties as a result of the project's temporary and/or permanent land requirements
- Permanent impacts on the availability of land for recreation uses (particularly at Tempe Lands) and other uses, including the availability of industrial zoned land.

This chapter considers these potential risks.

19.2 Existing environment

19.2.1 Existing land use, property and zoning

Land use and property

The study area includes a varied and relatively dense mix of land uses. Sydney Airport is by far the dominant land use. However, a range of other land uses are located within and in the vicinity of the project site. The following sections describe these uses.

Land uses within and surrounding the project site, and the land use zoning according to the relevant LEP, are shown on Figure 19.1 to Figure 19.5. Properties within the project site are shown on these figures and are listed in Table 19.2.

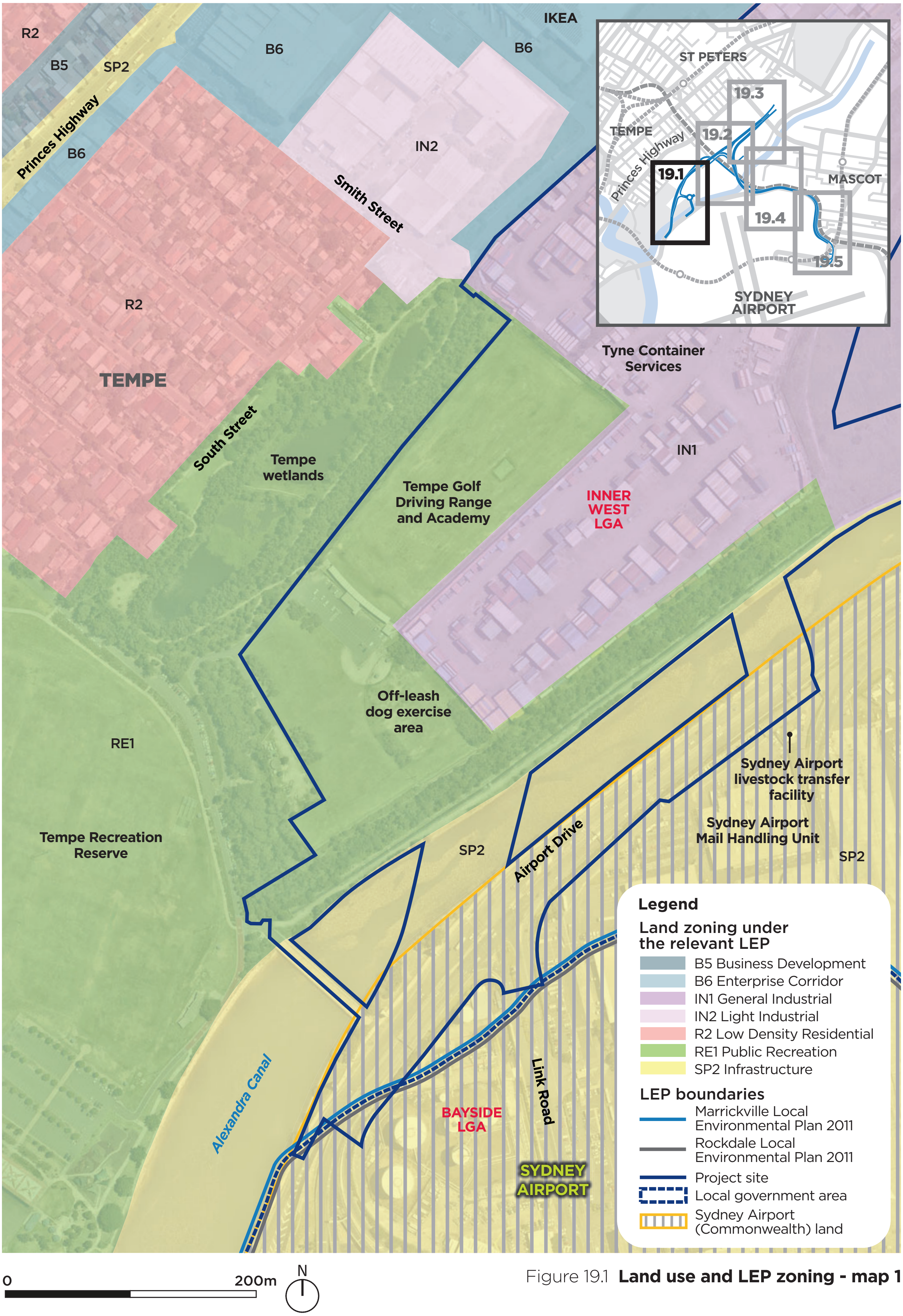


Figure 19.1 **Land use and LEP zoning - map 1**

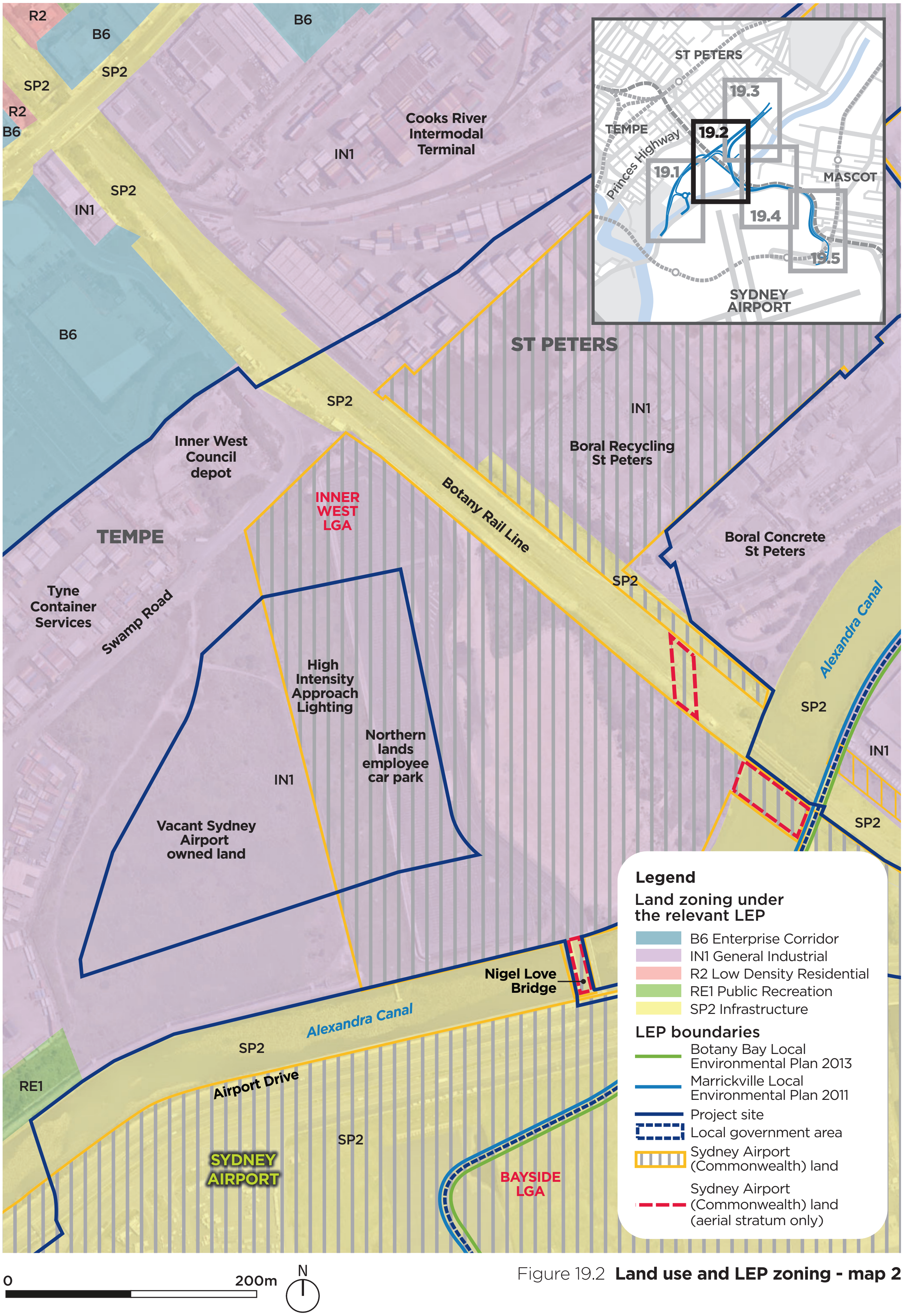


Figure 19.2 **Land use and LEP zoning - map 2**

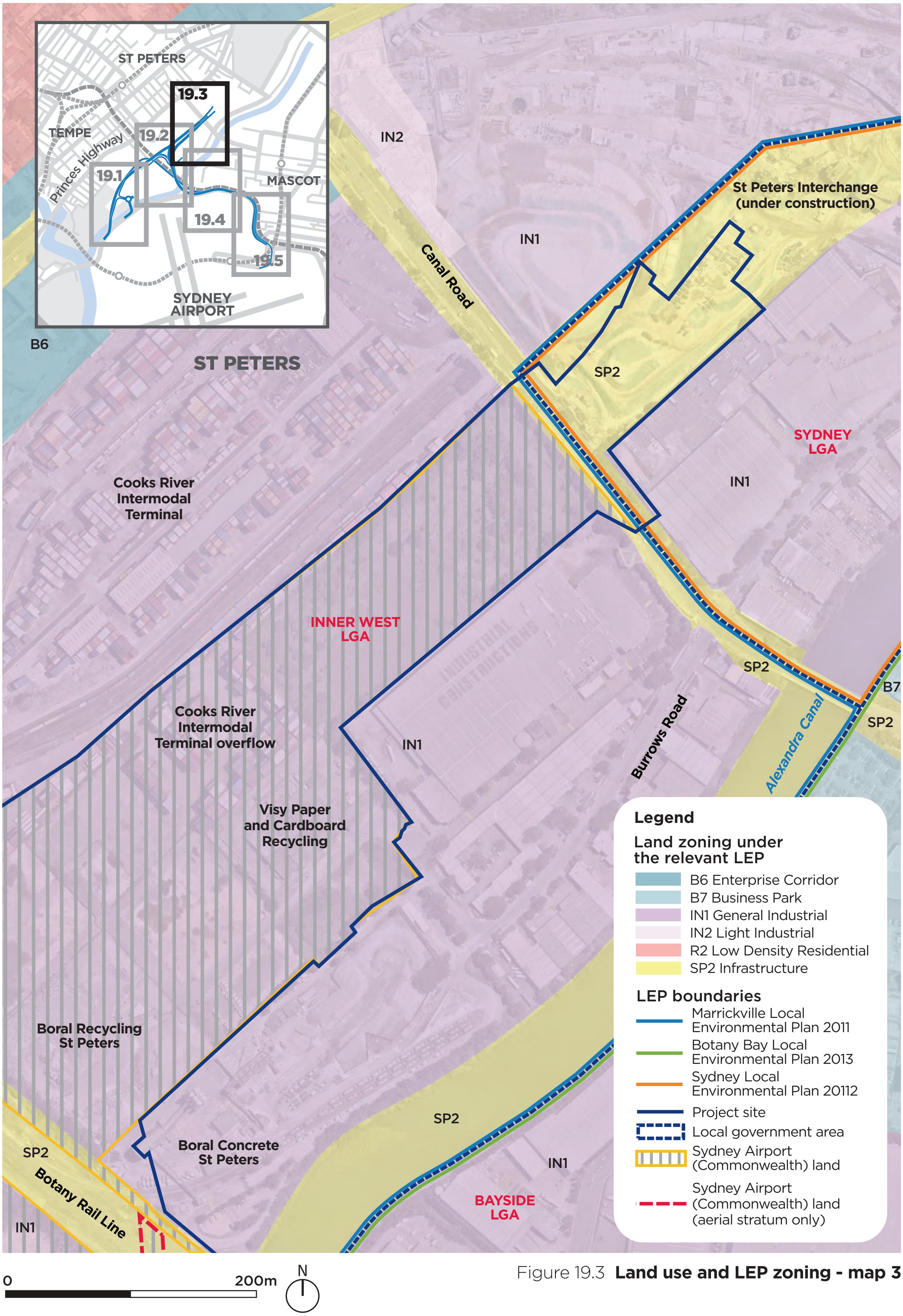


Figure 19.3 **Land use and LEP zoning - map 3**

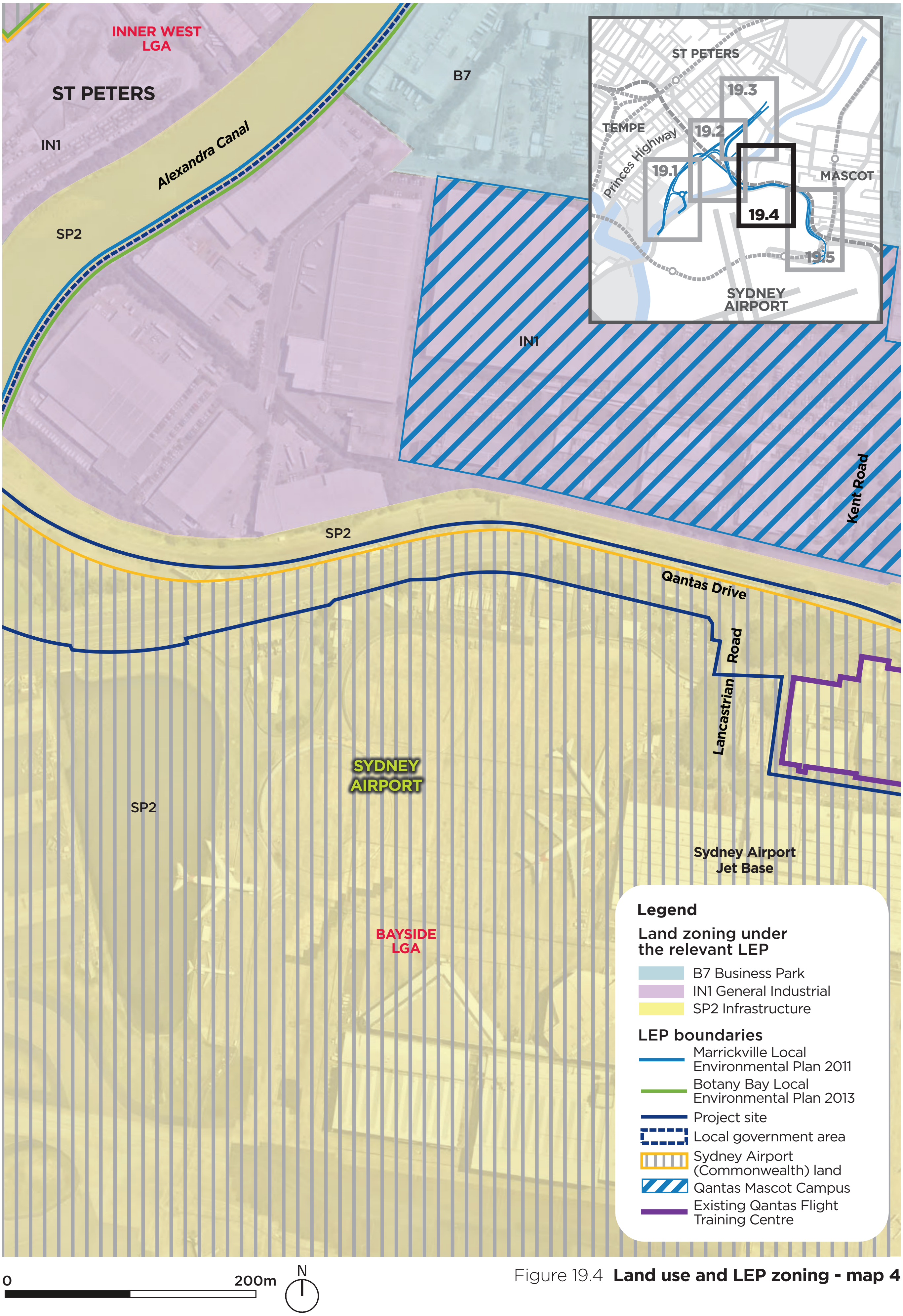


Figure 19.4 **Land use and LEP zoning - map 4**

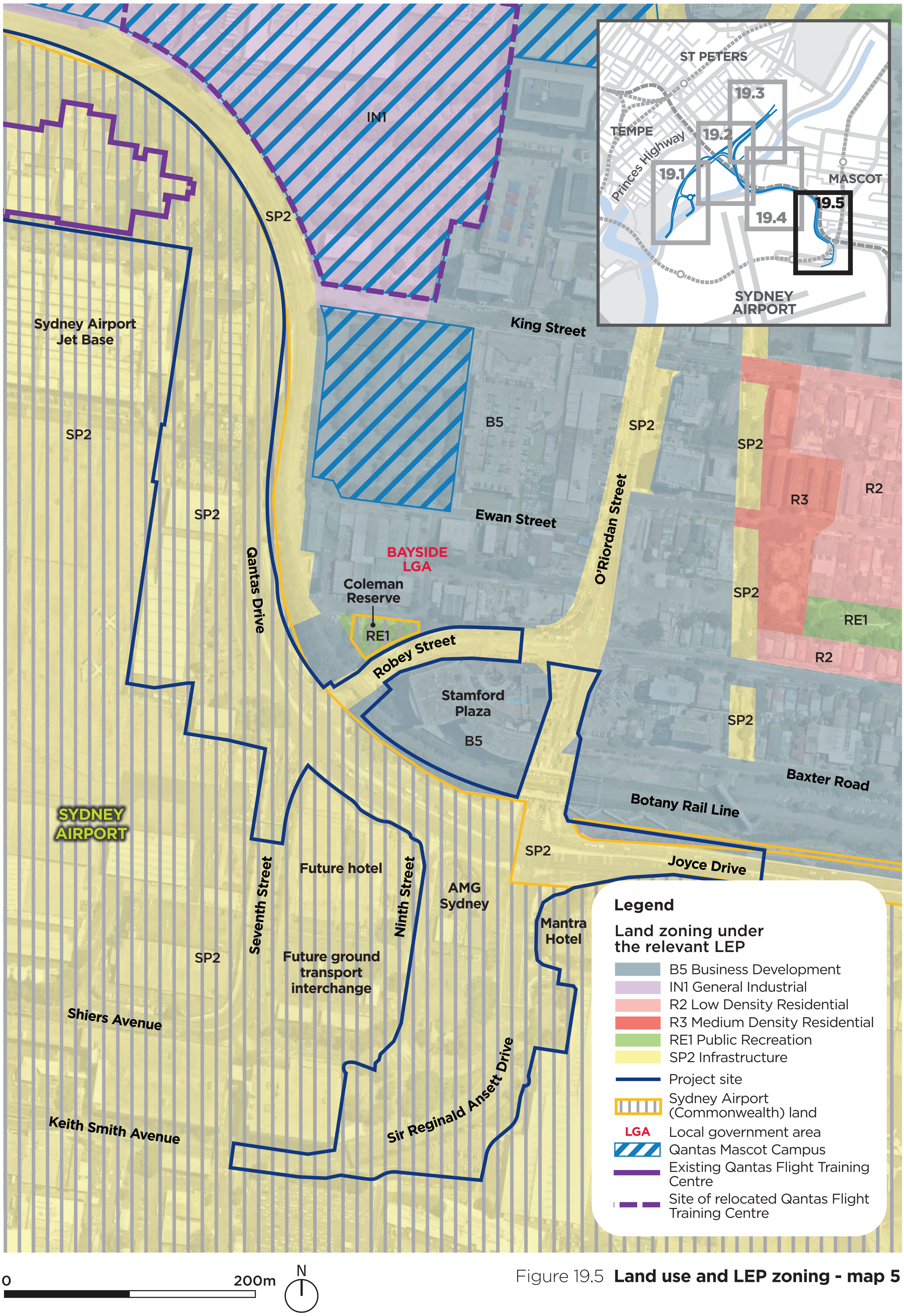


Figure 19.5 **Land use and LEP zoning - map 5**

Sydney Airport

Sydney Airport is the dominant land use in the study area, located on land south of Airport Drive and Qantas Drive. The majority of land within Sydney Airport is occupied by the runways, associated taxiways and terminals. Other land includes uses that support the operation of the airport. An area of Sydney Airport land, known as the northern lands, is located at the north-western end of the project site.

The Master Plan's land use plan divides Sydney Airport land not occupied by the runways into five sectors, which are shown on Figure 19.6. The project site is located within or adjacent to the North West, North East and Northern Lands sectors.

The North West Sector is mainly occupied by Terminal 1 and freight related land uses, including the freight terminal, Sydney Airport mail handling unit and livestock transfer facility (see Figure 19.1). It also includes external and internal access roads, including Airport Drive.

The southern part of the North East Sector is mainly occupied by Terminals 2/3, and the northern part (adjacent to Qantas Drive) is occupied by the Sydney Airport Jet Base (see Figure 19.7), which is currently used by Qantas under lease. The lease area includes the Qantas Flight Training Centre and Qantas Drive. The eastern part of the North East Sector also includes a number of business including AMG Sydney, numerous hotels (outlined below) and fast food outlets (eg Krispy Kreme, McDonalds and KFC).

Land uses within the Northern Lands Sector include the high intensity approach lighting for the main north–south runway, a staff car park (see Figure 19.8) and land sub-leased for industrial purposes to the north of the Botany Rail Line (described below).

Further information on Sydney Airport and its facilities is provided in Chapter 11 (Airport operations).

Transport infrastructure

In addition to Sydney Airport, key transport infrastructure in the study area includes:

- Arterial and local roads
- Botany Rail Line
- Sydney Trains T8 Airport and South Line
- Alexandra Canal cycleway.

Further information on transport infrastructure in the study area is provided in Chapters 2 (Location and setting) and 9 (Traffic, transport and access).

These areas are generally zoned SP2 Infrastructure.

Residential land uses

Residential land uses in the vicinity of the project site are generally located in four main areas:

- East of O'Riordan Street in Mascot – including mainly low density dwellings, with the nearest of these located about 40 metres from the project site in Baxter Road north of the Botany Rail Line
- Mascot – including medium density residential apartment buildings generally located north of Coward Street, about 700 metres north of the eastern end of the project site
- Tempe – including low density residential dwellings to the south-west of the project site, generally bounded by Station, South and Smith streets and the Princes Highway, with the nearest of these located about 75 metres north-west of the project site
- Tempe/St Peters – consisting of low and medium density residential dwellings located to the west of the Princes Highway.

These areas are generally zoned R2 Low Density Residential or R3 Medium Density Residential.

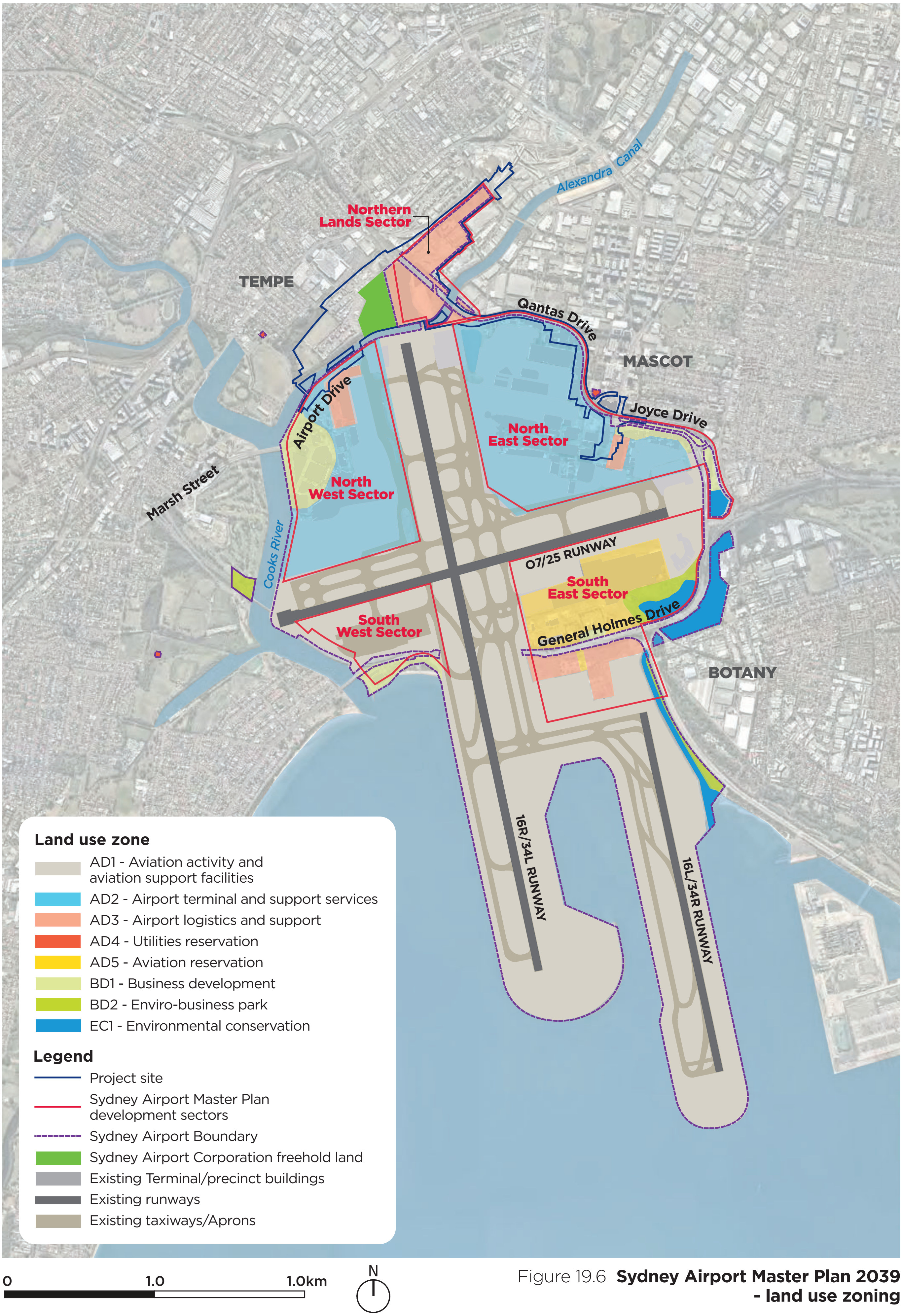


Figure 19.6 **Sydney Airport Master Plan 2039 - land use zoning**

Industrial

Industrial land uses within or near the project site are generally located in three main areas:

- Mascot – north of the project site to the west of O'Riordan Street/Bourke Street/Kent Road, including aviation support land uses and the Qantas Mascot Campus
- Tempe/St Peters – between Canal Road, the Princes Highway and Alexandra Canal, including the following main uses/properties within/close to the project site:
  - Concrete production – Boral Concrete St Peters
  - Freight container services – Cooks River Intermodal Terminal (see Figure 19.9), Tyne Container Services (located on the former Tempe landfill)
  - Council facilities – Inner West Council Depot
- Sydney Airport land – industrial land uses are currently located on land sub-leased from Sydney Airport Corporation, in the northern lands:
  - Recycling facilities – Boral Recycling and Visy Recycling
  - Freight container services – the Cooks River Intermodal Terminal overflow area (see Figure 19.9).

These areas are generally zoned IN1 General Industrial. Further information on businesses in the study area is provided in section 20.2. It is noted that Visy are currently proposing to relocate their operations from the existing site in the northern lands to a site in Alexandria.

Commercial

Commercial land uses within or near the project site include:

- Retail uses located along the Princes Highway, including Ikea
- Mascot – generally located to the north of the Botany Rail Line and within or near the Mascot town centre (on Botany Road) and Mascot Station (on Bourke Street)
- AMG Sydney (including service facility) at the intersection of Qantas Drive and Sir Reginald Ansett Drive
- Hotels:
  - Stamford Plaza, at the intersection of Qantas Drive and O'Riordan Street (see Figure 19.10)
  - Ibis Budget Sydney Airport and Mantra, at the intersection of Joyce Drive and Sir Reginald Ansett Drive
  - Citadines Connect and Quest, at the intersection of O'Riordan Street and Baxter Road
- Advertising structures – located along Joyce Drive, Qantas Drive, Airport Drive and Sir Reginald Ansett Drive (see Figure 19.11). These structures are mainly located on Sydney Airport land. Some structures are located on land owned by RailCorp adjacent to the Botany Rail Line.

These areas are generally zoned B5 Business Development and B6 Enterprise Corridor. Further information on businesses in the study area is provided in section 20.2.

Recreation/open space

Tempe Recreation Reserve is located at the south-western end of the project site. The reserve includes playing fields, a playground and the Robyn Webster Sports Centre. The project site crosses the Tempe Lands, which is an open space and recreation area located adjacent to the Tempe Recreation Reserve on part of the former Tempe landfill site. The Tempe Lands includes:

- Tempe Golf Range and Academy
- Tempe Wetlands

- Off-leash dog exercise area (see Figure 19.12)
- Area of passive open space.

Further information on the above facilities, and other community infrastructure in the study area, is provided in section 20.2.

Water infrastructure

Alexandra Canal is located within and near the project site. Further information on the canal is provided in section 14.2.

Other water infrastructure in the study area includes the desalinated water delivery pipeline and a network of potable, wastewater and stormwater infrastructure.

Further information on utilities is provided in section 8.7.

Figure 19.7 Jet Base and Qantas Flight Training Centre (viewed from Qantas Drive)

Figure 19.8 High intensity approach lighting

Figure 19.9 Cooks River Intermodal Terminal

Figure 19.10 Stamford Plaza hotel (viewed from Qantas Drive at Ninth Street)

Figure 19.11 Advertising structures adjacent to Qantas Drive near Lancastrian Road

Figure 19.12 Recreation land uses at Tempe Lands (off-leash dog exercise area)

Land use zoning

Land use zoning under the relevant LEP is shown on Figure 19.1 to Figure 19.5.

The project site is mainly located on land subject to the Marrickville LEP (generally west of Alexandra Canal and south of Canal Road) and the Botany Bay LEP (generally east of Alexandra Canal). Small areas of the project site are located on land subject to the Sydney LEP (north of Canal Road) and the Rockdale LEP (at the western extent of the project near Terminal 1) (see Figure 19.1 to Figure 19.5).

Land within the project site is zoned under the relevant LEP as follows:

- The majority of the project site is zoned IN1 General Industrial or SP2 Infrastructure (with various nominated infrastructure types)
- A small area of land north of Qantas Drive at the Robey and O'Riordan street intersection is zoned B5 Business Development
- Sydney Airport is zoned SP2 Infrastructure
- Tempe Lands and the Tempe Recreation Reserve are zoned RE1 Public Recreation.

The Master Plan includes a land use plan to guide development at Sydney Airport. The land use plan divides the Sydney Airport site into eight zones, and provides objectives and permissible land uses for each zone. Land within the project site is zoned by the Master Plan as follows:

- AD2 (Airport Terminal and Support Services)
- AD3 (Airport Logistics and Support)
- BD1 (Business Development).

Land use zoning under the Master Plan is shown on Figure 19.6.

19.2.2 Future land uses and development

Strategic planning

The main strategies and plans that are directly relevant to future land use and development in the study area are considered in Table 19.1, with a summary of the key directions and policies that may influence future development. Most of these apply to the Mascot area.

Further information on the strategic context for the project as a whole, including those strategies and policies relevant to the need for the project, is provided in Chapter 5 (Strategic context and project need).

Table 19.1 Strategic planning in the study area

Strategy/plan	Key directions relevant to changes in land use in the study area
A Metropolis of Three Cities – the Greater Sydney Region Plan (Greater Sydney Commission, 2018a)	▪ Green Square–Mascot is identified as a strategic centre and commercial office precinct, and as part of Sydney's eastern economic corridor
Eastern City District Plan (Greater Sydney Commission, 2018b)	▪ Green Square–Mascot is identified as a significant centre for the Eastern City District and a supporting centre for the nearby Harbour CBD, Port Botany and Sydney Airport. The plan recognises that the area is undergoing major urban renewal from a predominantly industrial area to one with increased residential use ▪ The plan provides a target for an additional 20,000 jobs in Green Square–Mascot, with supporting key actions including strengthening the economic role of the centre and planning for the provision of social infrastructure
Botany Bay Planning Strategy 2031 (City of Botany Bay, 2009)	▪ A target of an additional 710 dwellings in the vicinity of Mascot Station ▪ Supporting the development of new off-site employment locations near Sydney Airport to accommodate the growth in demand for airport related activity ▪ Developing the Mascot Station precinct as a major retail and commercial centre ▪ Developing the O'Riordan Street precinct as a major city/airport gateway
Mascot Station Town Centre Precinct Masterplan (City of Botany Bay Council, 2012)	▪ Provides a guide to planning in the vicinity of Mascot Station, including residential/mixed use development in previous industrial zoned areas
Sydney Airport Master Plan 2039 (SACL, 2019a)	▪ Establishes the strategic direction for development at Sydney Airport and provides for the development of additional uses at the airport site ▪ Further information is provided in section 19.2.3

Future developments surrounding the project site

Sydney Airport

The Master Plan's Airport Development Plan describes future developments proposed by Sydney Airport Corporation within or close to the project site. The locations of these are shown on Figure 19.13.

Within the Northern Lands Sector, land within and adjacent to the project site is identified for future freight and logistics land uses. The following future land uses have been identified:

- New freight facilities located north and south of the Botany Rail Line (see Figure 19.13)

- Potential for flight catering facilities should there be a demand for such facilities (location not identified)
- Potential for airside aviation support services, including freight, catering, ground support equipment storage and maintenance, truck staging and vehicle storage (location not identified).

Within the North West Sector, land adjacent to the project site is identified for future freight and logistics uses, with consolidation of the Terminal 1 freight facilities in the location of the existing freight terminal, as shown on Figure 19.13.

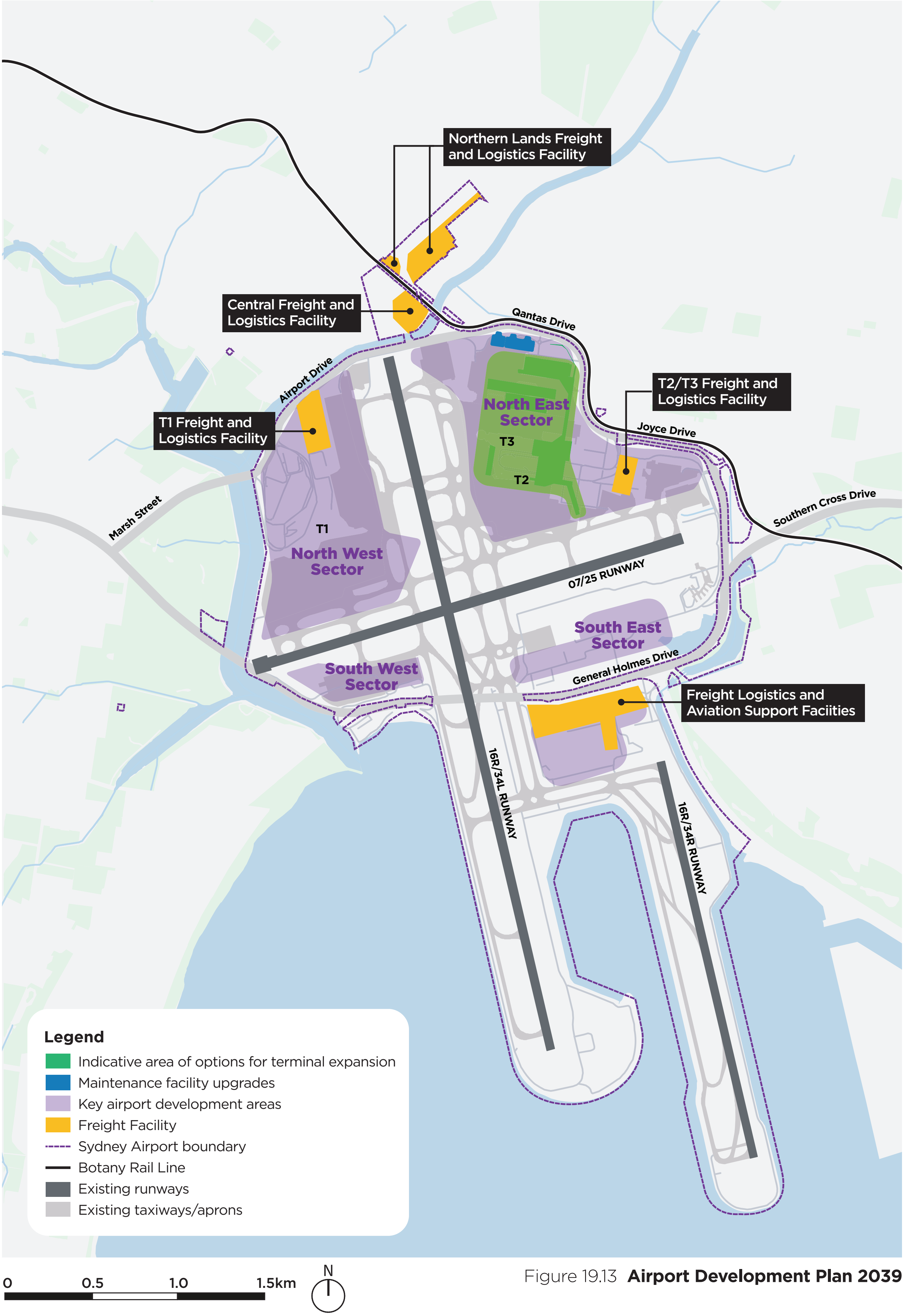


Figure 19.13 **Airport Development Plan 2039**

Within the North East Sector, land within and adjacent to the project site is identified for the following uses:

- Expansion of Terminals 2/3 to the north of Terminal 3 (see Figure 19.13 for indicative expansion area)
- Consolidation of Terminals 2/3 freight and logistics facility (see Figure 19.13)
- Aviation support facilities (including maintenance facilities) south of Qantas Drive (see Figure 19.13)
- Commercial development.

The timing of these potential developments is currently not known.

In addition, the *Sydney Airport T2/T3 Ground Access Solutions and Hotel MDP* (SACL, 2015), which was approved in March 2015, provides for a number of developments within the Terminals 2/3 precinct at the eastern end of the project site, including:

- Ground access and road works
- A ground transport interchange, including a ground level bus facility and new multi-storey parking for about 4,000 vehicles
- Expansion of the P3 car park and redevelopment of the P1 East car park to provide additional parking for 1,500 vehicles and facilitate development of a pedestrian corridor
- A new hotel on Qantas Drive between Seventh and Ninth streets.

The ground access works are largely completed, with other developments yet to commence.

Other areas

Other major developments with the potential to affect land use in the study area include:

- A new Qantas Flight Training Centre at 297 King Street in Mascot (located about 35 metres east of the project site on the northern side of the rail corridor), to provide for relocation of the facilities currently located at the Jet Base on Qantas Drive, with construction estimated to commence in late 2019 and be completed in about 23 months
- A mixed use commercial development consisting of retail and office space at 1–5 Chalmers Crescent in Mascot, about 130 metres north of the project site
- A commercial development consisting of four commercial towers at 7–21 Chalmers Street in Mascot, about 130 metres north of the project site
- A hotel at 2–8 Sarah Street in Mascot adjacent to the project site in Robey Street (under construction)
- A hotel at 5–11 Ewan Street in Mascot, about 160 metres north of the project site.

19.2.3 Summary of the land use and property environment on Sydney Airport (Commonwealth) land

Existing land uses, properties and zoning

Existing land uses, properties and zoning (under the Master Plan) within/close to the project site include:

- North West Sector:
  - Terminal 1
  - Freight related land uses, including the freight terminal, mail handling unit and livestock transfer facility
  - Roadways, including Airport Drive
  - Zoned mainly AD2 Airport Terminal and Support Services, with smaller areas zoned BD1 Business Development and AD3 Airport logistics and support

- North East Sector:
  - Terminals 2/3
  - Sydney Airport Jet Base (currently occupied by Qantas)
  - Roadways, including Qantas Drive
  - Commercial uses (AMG) and hotels located on Sydney Airport land
  - Zoned mainly AD2 Airport Terminal and Support Services, with smaller areas zoned AD3 Airport Logistics and Support and BD1 Business Development
- Northern Lands Sector:
  - High intensity approach lighting for the main north–south runway
  - Staff car park
  - Industrial activities (Boral Recycling, Visy Recycling and the Cooks River Intermodal Terminal overflow) located on Sydney Airport land
  - Zoned AD3 Airport Logistics and Support.

The land uses are shown on Figure 19.1 to Figure 19.5. Zoning under the Master Plan is shown on Figure 19.6. Further information is provided in section 19.2.1.

Future development planning

The Airport Development Plan forms part of the Sydney Airport Master Plan. It provides the plan to accommodate growth at Sydney Airport, including plans for improvements to Sydney Airport's airfield, aviation facilities, terminals and infrastructure to support the forecast increase in passenger numbers and aircraft movements to 2039.

The Airport Development Plan also outlines the commercial property opportunities that exist in the landside (non-operational) areas of the airport, to complement aviation operations and provide opportunities for the local economy. The plan provides for future developments within or close to the project site as described in section 19.2.2 and shown on Figure 19.13.

19.3 Assessment of construction impacts

19.3.1 Land requirements

The project would require the use of land both temporarily and permanently. While the permanent land requirements would be long-term and related to the operation, these impacts would commence during construction and are discussed below.

Permanent land requirements

The project's operational footprint consists of the land that would be permanently required for the project's functional and operational infrastructure (described in Chapter 7 (Project description)). The operational footprint is shown on Figure 7.3 to Figure 7.7. The anticipated land requirements within this footprint are listed in Table 19.2 and shown on Figure 19.14.

In total, it is anticipated that around 36.2 hectares of land would be permanently required. The permanent land requirements are anticipated to include:

- 20.6 hectares of Commonwealth-owned land
- 14.1 hectares of land owned by the NSW or local government (Inner West Council)
- 1.5 hectares of privately owned land.

No residential land would be required.

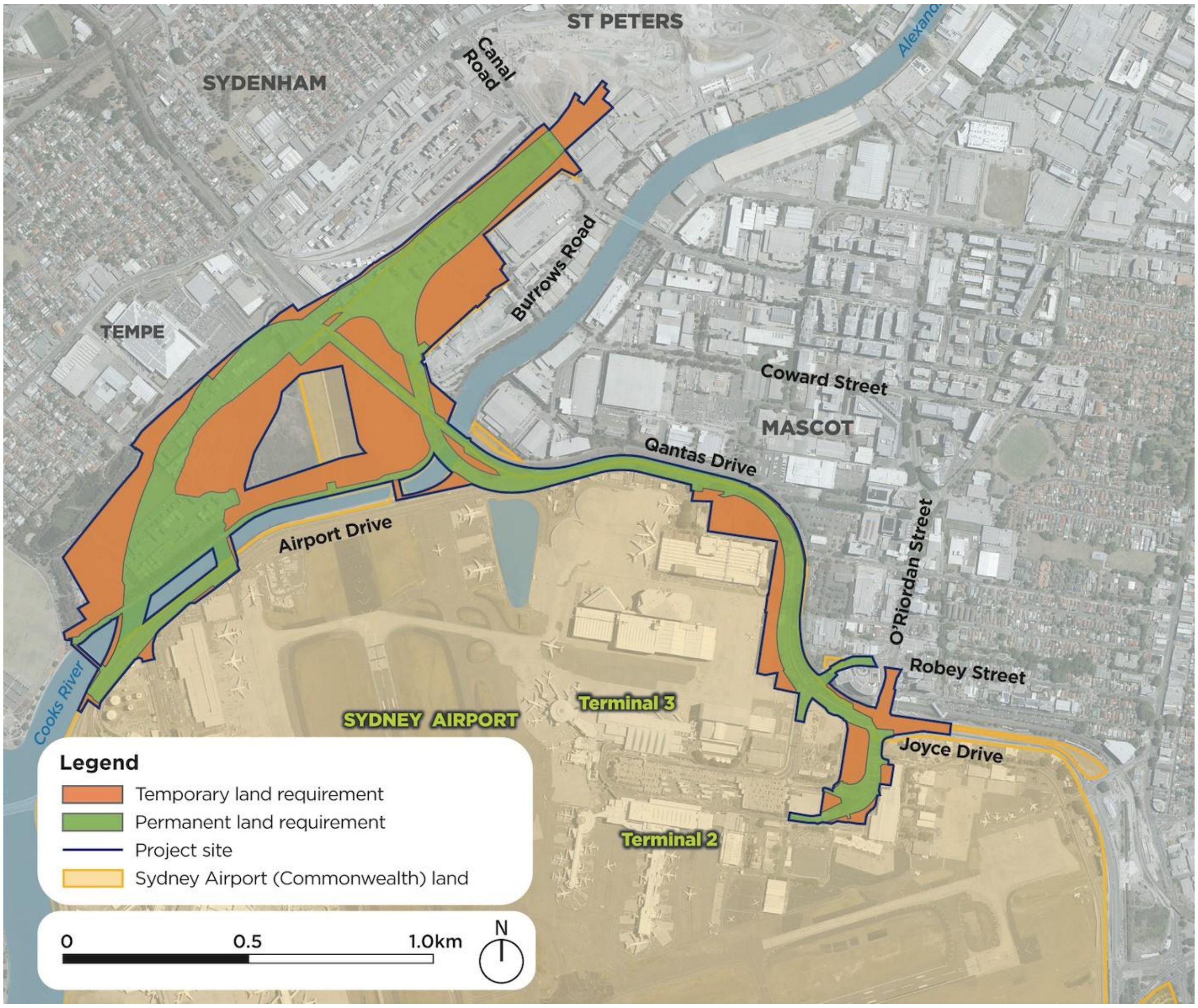


Figure 19.14 Project land requirements

Acquisition or lease arrangements

Roads and Maritime has commenced discussions with affected private property owners concerning the purchase, lease or license of land that would be required as part of the permanent operational footprint. Roads and Maritime has also commenced discussions in regard to land owned by other NSW government agencies and Inner West Council about acquisition or lease arrangements. Easements would also potentially be required, particularly for elevated sections of the project above the Botany Rail Line and Alexandra Canal.

Acquisitions and leases on privately-owned land, or land owned by the NSW or local government, would be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW), the *Land Acquisition Information Guide* (NSW Government, 2014), and the land acquisition reforms announced by the NSW Government in 2016, which can be viewed online at *https://www.finance.nsw.gov.au/land-property/land-acquisition-reform-2016.*

Commonwealth-owned land required for the project would be leased by the NSW Government under a long-term lease agreement, subject to complying with any requirements of relevant Australian Government agencies. For Sydney Airport land, Sydney Airport Corporation, as leaseholder, would notify tenants that their sub-lease agreements would be concluded. The conclusion of leases would be undertaken in accordance with the contract terms with Sydney Airport Corporation and the tenant, and Sydney Airport Corporation would provide support to manage the return of lands and handover to Roads and Maritime.

Table 19.2 Anticipated land requirements

Location	Land use	Main properties affected	Ownership	Estimate of area required (% of total property comprising identified lot/DPs)[1, 3]		
				Temporary[2]	Permanent	Total
Private land						
25 Burrows Road, St Peters	Industrial	Boral Concrete	Private	<0.1 hectares (0.9 per cent)	0.1 hectares (2.3 per cent)	0.1 hectares (3.2 per cent)
Swamp Road, Tempe	Vacant	None	Sydney Airport Corporation	3.6 hectares (50.4 per cent)	0.5 hectares (6.2 per cent)	4.1 hectares (56.6 per cent)
Robey Street, Mascot	Transport	Botany Rail Line	Private	<0.1 hectares (1.6 per cent)	-	<0.1 hectares (1.6 per cent)
241 and 241A O'Riordan Street, Mascot	Commercial	Stamford Hotel	Private	0.1 hectares (1.2 per cent)	-	0.1 hectares (1.2 per cent)
Talbot Street and 20 Canal Road, St Peters	Industrial	Cooks River Intermodal Terminal	Private	0.5 hectares (2.5 per cent)	0.9 hectares (6.5 per cent)	1.4 hectares (7.2 per cent)
Private land total				**4.2 hectares**	**1.5 hectares**	**5.7 hectares**
Commonwealth-owned land						
Sydney Airport, Mascot	Transport Water infrastructure	Jet Base Qantas Drive and Sir Reginald Ansett Drive Northern ponds Advertising structures Mail handling unit and livestock transfer facilities Parking areas (including those used by DHL)	Commonwealth of Australia	5.8 hectares (0.9 per cent)	11 hectares (1.7 per cent)	16.8 hectares (2.6 per cent)
30 Canal Road, St Peters	Vacant	None	Commonwealth of Australia	0.9 hectares (28.2 per cent)	2.3 hectares (71.8 per cent)	3.2 hectares (100 per cent)

Location	Land use	Main properties affected	Ownership	Estimate of area required (% of total property comprising identified lot/DPs)[1, 3]		
				Temporary[2]	Permanent	Total
6-10 Burrows Road, St Peters	Industrial	Boral Recycling Visy Recycling Cooks River Intermodal Terminal overflow	Commonwealth of Australia	3.9 hectares (44.2 per cent)	4.9 hectares (55.7 per cent)	8.8 hectares (100 per cent)
Swamp Road, St Peters	Transport	Sydney Airport – northern lands car park and vacant land	Commonwealth of Australia	5 hectares (61.8 per cent)	1.8 hectares (22.4 per cent)	6.8 hectares (84.2 per cent)
Swamp Road, St Peters	Transport	Sydney Airport - high intensity approach lighting	Commonwealth of Australia	0.4 hectares (42.6 per cent)	0.3 hectares (27.3 per cent)	0.7 hectares (69.9 per cent)
Swamp Road, St Peters Bellevue Street, St Peters	Transport	Botany Rail Line	Commonwealth of Australia	0.5 hectares (54.2 per cent)	0.3 hectares (22.4 per cent)	0.8 hectares (76.7 per cent)
1008C Botany Road, Mascot	Transport	Joyce Drive	Commonwealth of Australia	0.2 hectares (2 per cent)	-	0.2 hectares (2 per cent)
Commonwealth-owned (Sydney Airport land) total				**16.7 hectares**	**20.6 hectares**	**37.3 hectares**
Land owned by the NSW or local government						
1–3 Swamp Road, Tempe	Industrial	Council depot	Inner West Council	0.2 hectares (16.8 per cent)	0.8 hectares (83.2 per cent)	1 hectare (100 per cent)
2 Swamp Road, Tempe 5–15 Swamp Road, Tempe	Industrial	Tyne Container Services	Inner West Council	4 hectares (36.7 per cent)	6.9 hectares (63.3 per cent)	10.9 hectares (100 per cent)
South Street, Tempe	Public recreation	Tempe Lands – off-leash dog exercise area and surrounding open space	Inner West Council	2.6 hectares (31.7 per cent)	1.9 hectares (22.9 per cent)	4.5 hectares (54.6 per cent)
	Public recreation	Tempe Golf Range and Academy	Inner West Council	1.9 hectares (67.8 per cent)	0.9 hectares (32.2 per cent)	2.8 hectares (100 per cent)
Holbeach Avenue, Tempe	Public recreation	Tempe Recreation Reserve	NSW Government	<0.1 hectares (0.3 per cent)	<0.1 hectares (0.3 per cent)	<0.1 hectares (0.6 per cent)
Alexandra Canal, Mascot/St Peters/Tempe	Watercourse	Alexandra Canal	Sydney Water[4]	0.4 hectares (1 per cent)	2.1 hectares (8.9 per cent)	2.6 hectares (10.9 per cent)

Location	Land use	Main properties affected	Ownership	Estimate of area required (% of total property comprising identified lot/DPs)[1, 3]		
				Temporary[2]	Permanent	Total
5 and 5A Canal Road, St Peters	Transport	St Peters interchange (under construction)	Roads and Maritime	0.7 hectares (6.7 per cent)	<0.1 hectares (<0.1 per cent)	0.7 hectares (6.7 per cent)
9 Canal Road, St Peters	Transport	St Peters interchange (under construction)	Roads and Maritime	0.6 hectares (0.4 per cent)	-	0.6 hectares (0.4 per cent)
Various	Transport	Botany Rail Line Qantas Drive Advertising structures	RailCorp[5]	1.5 hectares (19.7 per cent)	1.5 hectares (21 per cent)	3 hectares (43.9 per cent)
Other publicly owned land total				**11.9 hectares**	**14.1 hectares**	**26.1 hectares**

Notes:
1. Lot and DP number of land at each location are outlined in Tables 7.2 and 8.5
2. Temporary land requirements are only required during construction and would be in addition to the permanent land requirements
3. The estimate of land required is based on a concept design that is subject to refinement during detailed design, and the final area required may vary from that shown
4. Sydney Airport Corporation also has aerial rights above lots 11 and 12 of DP 1050464
5. Sydney Airport Corporation also has aerial rights above lot 1 of DP 1054373

Temporary land requirements

In addition to the indicative permanent land requirements (for land required as part of the operational footprint), some land would be required during construction only. These areas, which are listed in Table 19.2 and shown on Figure 19.14, would be required for construction compounds, to provide access to construction work areas, and to facilitate the manoeuvring of construction plant and machinery.

In total, around 69.1 hectares of land would be required for construction, of which around 32.8 hectares would only be required temporarily. The temporary land requirements are anticipated to include:

- 16.7 hectares of Commonwealth-owned land
- 11.9 hectares of land owned by the NSW or local government (Inner West Council)
- 4.2 hectares of privately owned land.

No residential land would be required for construction.

Sydney Airport land required for construction only would be leased by Roads and Maritime for the duration of construction. Sydney Airport land not required beyond construction would be available for future development in accordance with the Master Plan (see section 19.2.3).

Other land required during construction only would be via a lease or a memorandum of understanding with the relevant government agency or private landholder. Land that is subject to a temporary lease would be restored to at least its former condition (or as agreed with landowners) following completion of construction.

19.3.2 Land use impacts

Direct impacts on land use during construction would result from the permanent and temporary land requirements described in section 19.3.1 and the short-term presence of construction equipment, plant, vehicles, compounds and work sites within the construction footprint. During construction, the use of this land would change from those uses described in section 19.2.1 to a construction site. Public access to this land (where it is currently available) would be restricted.

19.3.3 Property impacts

Property impacts associated with the project’s land requirements

The main property impacts would be associated with the project’s temporary and permanent land requirements, which has the potential to:

- Partially affect a property where part of a site is required, requiring adjustments to or relocation of facilities to other parts of the site
- Fully affect a property if the entire site on which a property is located is required.

The properties that would be directly impacted during construction are summarised in Table 19.3. The socio-economic (including business) impacts of these changes are considered in Chapter 20 (Socio-economic impacts).

Table 19.3 Property impacts – construction

Property	Level of potential affect	Estimate of area affected[1] (hectares)	Impacts
Boral Concrete St Peters	Partial	0.1	A small portion of Boral's site is required to construct the project. This area is located at the north-western corner of the site and comprises less than 3.2 per cent of the overall site. The area is currently occupied by vehicle wash facilities. The loss of this small area on the edge of the site is unlikely to affect the overall operation of this property. The need to relocate any facilities from the impacted area would be discussed with the landowner.
Boral Recycling Visy Recycling Cooks River Intermodal Terminal overflow area	Full	8.8	The two recycling facilities, located off Burrows Road in St Peters, operate on land leased from Sydney Airport Corporation that is required to construct the project. Cessation of these leases would be undertaken by Sydney Airport Corporation as the Airport Lessee Company. The properties would need to cease operations at this site and all facilities/structures would need to be removed. It is noted that Visy are proposing to relocate their operations from this site to a site in Alexandria. The project is given as the justification for the need to relocate their operations, which is the subject of a current development application. The operators of the Cooks River Intermodal Terminal lease an area of land from Sydney Airport Corporation that is required for the project, located adjacent to the terminal site. This land is located along the southern boundary of the terminal site and is used as an additional container storage area. To make the land available for the project, this lease has not been renewed.
Cooks River Intermodal Terminal	Partial	1.4	A small portion (about 7.2 per cent) of the Cooks River Intermodal Terminal site is currently required to construct the project. However, the design is currently being refined with the aim of minimising the potential impacts on this property. The area is currently occupied by containers and storage buildings. The relocation of structures in this area would be discussed with the landowner and operator.
Tyne Container Services	Full	10.9	This property operates on land leased from Inner West Council that is required to construct the project. The cessation of the lease over this land would be required and would be undertaken by Inner West Council as the landowner. The property would need to cease operations at this site and all facilities/structures would need to be removed.
Inner West Council depot	Full	1	This property is located on land owned by Inner West Council that is required to construct the project. The depot is mainly used to store equipment and materials. The depot would need to cease operations at this site and the structures located on this site would need to be removed.
Tempe Lands (including Tempe Golf Range and Academy and the off-leash dog exercise area)	Partial	7.3	An area of about 7.3 hectares within the Tempe Lands (owned by Inner West Council and located on the former Tempe landfill) would be required to construct the project. Of this area, about five hectares is used for recreation purposes (including the Tempe Golf Range and Academy and the off-leash dog exercise area). The Tempe Golf Range and Academy currently operates under a commercial lease with Inner West Council. Cessation of this lease would be required. The business would need to cease operations at this site and all facilities/structures would need to be removed. The existing off-leash dog exercise area and surrounding areas of open space would also be affected. Impacts on opportunities for off-leash dog exercise during construction would be minimised by providing a temporary area as close as possible to the existing facility (see section 8.4.2).

Property	Level of potential affect	Estimate of area affected[1] (hectares)	Impacts
Tempe Recreation Reserve	Partial	<0.1	The project would impact a small area (about 0.5 per cent) of the reserve due to the requirement to connect the active transport link to existing paths within the reserve. As the area affected is located on the edge of the reserve, the overall use of the reserve would not be impacted.
Sydney Airport Corporation northern lands car park and adjacent vacant land	Partial	6.8	An area at the northern end of the existing car park (located on Sydney Airport land) would be required for construction compound C2. Part of this area would also be required to construct the northern lands access. This would result in a small reduction in the number of car spaces available. Further information on potential impacts on parking is provided in Chapter 9 (Traffic, transport and access). The use of the car park would be able to continue throughout construction, albeit at a reduced capacity.
Sydney Airport Corporation car park south of AMG	Full	0.3	The existing car park would be required for construction compound C5. This would result in a loss of parking at this location. Further information on potential impacts on parking is provided in Chapter 9 (Traffic, transport and access).
Sydney Airport Corporation car parks leased to DHL	Full	0.2	Construction would temporarily affect two parking areas near Terminals 2/3 that are accessed off Ross Smith Avenue and Sir Reginald Ansett Drive respectively. These parking areas, which have a combined capacity of 80 spaces, are used by the adjacent DHL business. This would affect the number of parking spaces used by DHL employees/customers. Further information on potential parking impacts is provided in Chapter 9 (Traffic, transport and access).
High intensity approach lighting for the main north–south runway	Partial	0.7	An area of land currently occupied by the high intensity approach lights would be required to construct the project. Sydney Airport Corporation would adjust these lights prior to the project commencing.
Vacant Sydney Airport owned land	Partial	4.1	This area of land, located to the south of Swamp Road, is owned by Sydney Airport Corporation. During construction, the use of some of this land would change from vacant land to a construction site.
Sydney Airport mail handling unit	Partial	0.07	An area of about 0.07 hectares within this facility would be required during construction. This area is currently used for parking associated with the facility. Use of this area would affect about 40 parking spaces. Potential impacts on parking are considered in Chapter 9 (Traffic, transport and access).
Sydney Airport livestock transfer facility	Partial	0.05	An area of about 0.05 hectares within this facility would be required during construction. This area forms part of a larger area used to manoeuvre, park, load and unload trucks associated with the facility's operation. In addition, an entry gate at the north-eastern end of the facility would be affected. This would require vehicles to use an alternate gate or reverse out of the facility.
Alexandra Canal cycleway	Full	n/a	To minimise potential safety impacts during construction and as a result of the proposed closure of Airport Drive, the existing cycleway along Airport Drive would be closed before construction. A temporary active transport link would be provided on the western side of Alexandra Canal to maintain connectivity for pedestrians and cyclists while the permanent link is being constructed (see section 8.6.4). The potential impacts of these changes are considered in Chapter 9 (Traffic, transport and access).

Property	Level of potential affect	Estimate of area affected[1] (hectares)	Impacts
Sydney Airport Jet Base (currently occupied by Qantas including the Qantas Flight Training Centre)	Partial	4.5	Widening Qantas Drive to the south (between Ninth Street and Lancastrian Road, Mascot) would affect land currently occupied by the Jet Base. East of Lancastrian Road, this land is occupied by the Qantas Flight Training Centre (see Figure 19.4 and Figure 19.5). South of the flight training centre, the land is occupied by a number of the Jet Base's support buildings and structures (including workshops, substation, fuel facilities and chemical storage). These facilities and structures (described in Table 8.1) would be removed during construction. The majority of these buildings (excluding the training facility) are currently vacant. With respect to the flight training centre, the project would directly affect the northern edge of the site, including two of the three buildings. While small in relative area, important facilities that cannot be relocated within the existing site would be affected. As a result, Qantas is proposing to relocate the training centre to a new site located within Qantas' 'Mascot Campus' on the northern side of the Botany Rail Line (see section 19.2.2). This relocation, which is being managed by Qantas, is subject to a separate approval process. The project includes removing the flight training centre's structures and buildings once the centre has relocated. Impacts on other facilities at the Jet Base would vary. Some buildings/structures would be completely impacted, while others would be partially impacted. All uses within these support buildings/structures would need to relocate to other areas, either within the broader Jet Base site or to other locations on Sydney Airport land. The relocation of these facilities would be undertaken by Qantas and/or Sydney Airport Corporation subject to a separate approval process. These facilities could relocate to areas designated for aviation support uses by the Master Plan. These areas are shown as a new maintenance area in the North East Sector or aviation support facilities within the South East Sector (see Figure 19.13). During construction, the size of the Jet Base would reduce from the existing 30 hectares to about 25.5 hectares. The project would not affect any key maintenance facilities within the Jet Base. The reduction in size is not expected to impact operation of the Jet Base, particularly considering the majority of the buildings that would be removed are currently vacant. The proposed relocation of aviation support services within the Jet Base is consistent with the Master Plan. Removing these structures would allow future development in these areas in accordance with the Master Plan (see Table 19.5).
Commercial properties on O'Riordan Street	Partial	0.1	Widening Qantas Drive west of the O'Riordan Street intersection would impact a small area across two lots that form part of the Stamford Hotel property. These areas are currently vacant and are separate to the main property (ie the hotel), which is located on the northern side of the rail corridor. As a result, there would be minimal impacts on the overall property and the operation of the hotel.

Property	Level of potential affect	Estimate of area affected[1] (hectares)	Impacts
Advertising structures	Structures located within the project site would be fully affected		A total of 27 advertising structures are located along Airport Drive, Qantas Drive and Sir Reginald Ansett Drive on land leased from RailCorp and Sydney Airport Corporation. The majority of these structures are located on land required for the Qantas Drive upgrade and widening, the Terminals 2/3 access, and the Terminal 1 connection. Six structures would be removed as they are located on the section of Airport Drive that would be closed as part of the project. Of these structures, 18 are located on Sydney Airport land and nine are located on land subject to the EP&A Act. The location of the affected structures is shown on Figure 19.15. The approach to mitigating the impacts on these structures would be confirmed during detailed design. This would include minimising the need to remove structures where possible. Acquisition of structures not located on Sydney Airport land would be in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW).
Botany Rail Line	Partial	3.9	The project would include constructing three bridges/overpasses over the Botany Rail Line. Impacts on the rail corridor would generally be limited to airspace above the corridor, with the exception of a few locations for proposed bridge piers. Impacts on the operation of the Botany Rail Line would be minimal, with works undertaken during rail closedown periods when trains are not operating along the corridor.
Alexandra Canal	Partial	3	Impacts on this property would generally be limited to the airspace above the canal as a result of the construction of the four proposed bridges over the canal. The only physical works proposed within the canal are drainage outlets. The project is not expected to impact use of the canal.

Note: 1. The estimated area of impact includes the estimated total land requirements (both temporary and permanent land requirements, which overlap in most instances) as these impacts would occur during construction.

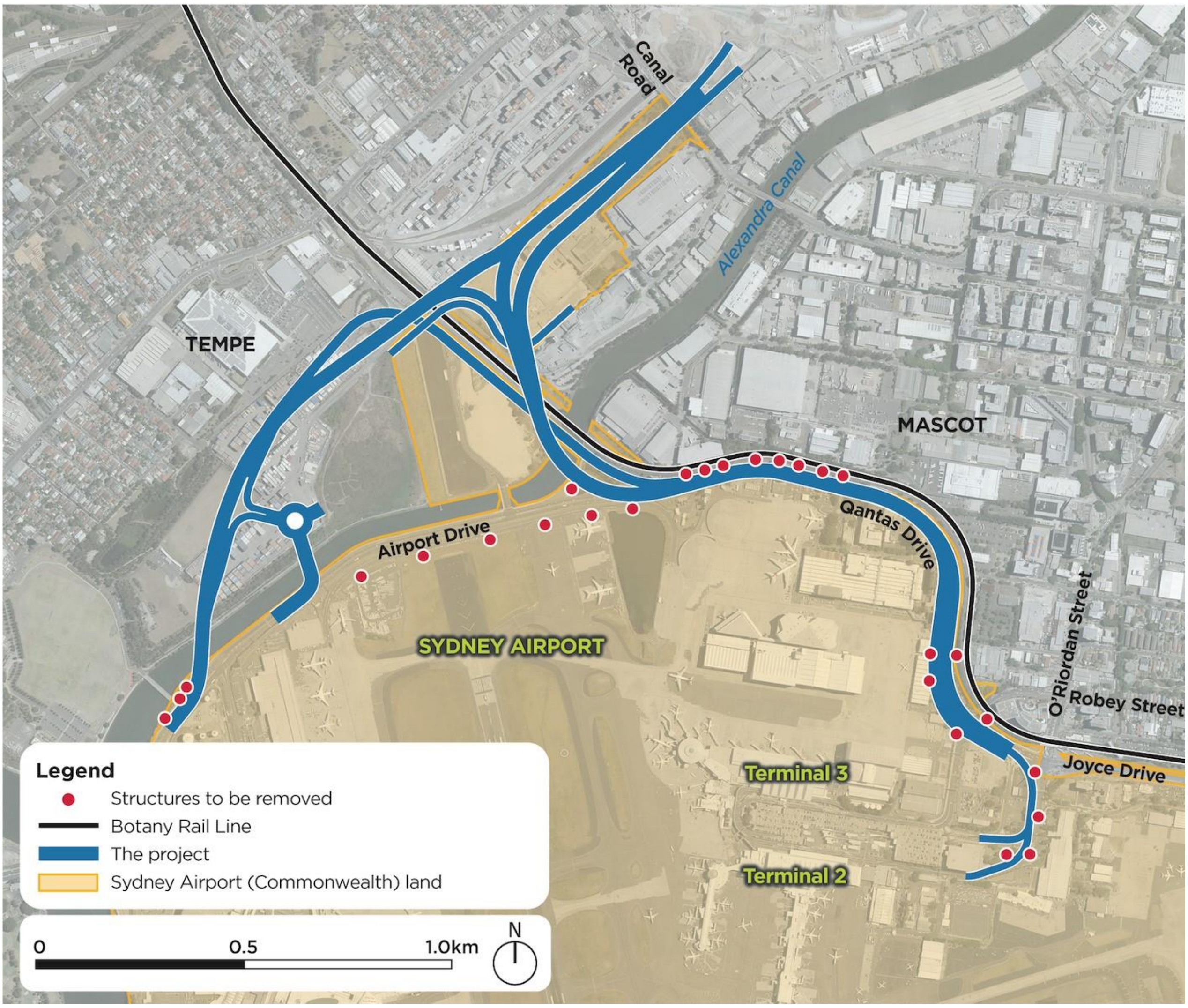


Figure 19.15 Impacts on advertising structures

Utility impacts

Utilities, such as water supply, stormwater drainage, wastewater, electricity, gas, fuel and telecommunications, are located across the project site. These and other utilities would need to be protected, adjusted or augmented where they conflict with the final design and in accordance with the requirements of the relevant asset owner.

Section 8.7 provides an overview of the key utilities that have been identified to date and the proposed treatment during construction. These utilities are owned and operated by a range of public and private organisations. As outlined in section 8.7, impacts on utilities are generally contained to three areas where a high density of utilities are located (see Figure 8.21):

- Airport Drive and Qantas Drive
- Sir Reginald Ansett Drive and Shiers Avenue
- Canal Road.

Utilities along Airport Drive, Qantas Drive, Sir Reginald Ansett Drive and Shiers Avenue also include utilities servicing Sydney Airport.

The adjustments required would be confirmed during detailed design in consultation with utility owners. Adjustments are generally expected to be contained within existing or new road corridors. There is the possibility that adjustments could extend beyond the project footprint. The location of some underground utilities within the road reserve may potentially restrict the amount of roadside planting in some locations.

Interruptions to utilities would be minimised as far as possible. Where interruptions are required, consultation with affected landowners and utility owners would be undertaken, and advance notice provided, to minimise any unavoidable impacts.

Any utility adjustments on Sydney Airport land would be undertaken in consultation with Sydney Airport Corporation and in accordance with the Utilities Development Plan contained within the Master Plan.

19.3.4 Summary of impacts on Sydney Airport (Commonwealth) land

Land requirements

The project's permanent land requirements are estimated to include about 20.6 hectares of Commonwealth-owned (Sydney Airport) land. In addition, about 16.7 hectares of Sydney Airport land (excluding freehold land owned by Sydney Airport Corporation) would be required during construction only.

The proposed acquisition/lease arrangements are described in section 19.3.1.

Sydney Airport land required for construction would be leased by Roads and Maritime for the duration of construction. Following construction, this land would be available for future development in accordance with the Master Plan (see section 19.2.3).

Land use impacts

During construction, the use of Sydney Airport land within the project site would change from the uses described in section 19.2.1 to a construction site. Public access to this land would be restricted; however, the majority of this land is currently not accessible to the public. Land use impacts on Sydney Airport land are not considered to be significant, with impacts generally affecting uses not directly associated with the operation of the airport.

Property impacts

The main property impacts would be where land is required as part of the project's land requirements (described in section 19.3.1). The project would affect the following properties located on Sydney Airport land during construction:

- Sydney Airport Jet Base
- Livestock transfer facility
- Mail handling unit
- Northern lands car park
- High intensity approach lighting
- The area leased by Boral Recycling, Visy Recycling and for the Cooks River Intermodal Terminal overflow area.

Three car parking areas located near Terminals 2/3 would also be affected during construction. A number of advertising structures located on Sydney Airport land would be affected.

The potential impacts on these properties are described in section 19.3.3.

During construction, access to Sydney Airport land would be maintained at all times as far as possible. Where access has the potential to be affected, consultation would be undertaken with the owners/operators of the property to confirm alternative access arrangements or specific requirements (such as periods when access must be maintained). Further information on potential access impacts is provided in section 9.3.

The project would result in some impacts on utilities located on Sydney Airport land. Any utility adjustments on Sydney Airport land would be undertaken in consultation with Sydney Airport Corporation and in accordance with the Utilities Development Plan contained within the Master Plan.

19.4 Assessment of operation impacts

19.4.1 Land use impacts

Impacts on existing land uses

Much of the project site is already used for transport (road) infrastructure, including Qantas Drive, Airport Drive and Sir Reginald Ansett Drive, and internal access roads at Terminals 1 and 2/3. In these areas, the overall transport land use would remain with the infrastructure upgraded.

In other areas, the project would result in a change in land use from the existing uses described in section 19.2.1 to road infrastructure. Much of the project site would involve the continued use of land that is currently used for transport infrastructure purposes as a road, or the use of Sydney Airport land that is currently vacant. The main land use impacts would be on land that is currently used for industrial and recreation/open space purposes.

Table 19.4 outlines the potential impacts of the project on the availability of land zoned for particular uses under the relevant LEP and the Master Plan. Once the project is operational, about 18.5 hectares of land that is currently zoned for industrial purposes would be used for transport (road), of which about 10 hectares is Sydney Airport land. This land is zoned as AD3 (Airport Logistics and Support) by the Master Plan and is therefore not expected to be used for industrial purposes in the long-term (excluding potential airport related uses which could be considered industrial). In addition, once the project is operational, about 2.7 hectares of land currently used for recreation/open space purposes would be used for transport (road).

Subject to future planning, the project's residual land (see section 19.4.3) would provide opportunities to offset impacts on existing land uses.

Further information about changes to land use at the individual property level is provided in section 19.4.2. Potential amenity impacts are considered in Chapter 20 (Socio-economic impacts).

Table 19.4 Impacts on availability of land zoned for particular uses

Zone	Impacts on availability of land zoned for the particular use
Local environmental plans	
IN1 General Industrial	The project would affect about 18.5 hectares of land zoned IN1 by the relevant local environmental plan, with a permanent change in land use from industrial to transport infrastructure. Of this land, about 10 hectares is located on Sydney Airport land and is subject to the Master Plan and the Airports Act (not a local environmental plan/the EP&A Act). Under the Master Plan, this land is zoned for airport related land uses. The Master Plan allows industrial land uses to occur in this zone. The project would affect about 8.5 hectares of industrial zoned land that is not subject to the Master Plan. The loss of this land for industrial purposes would reduce the overall availability of industrial land in the study area. Due to the inner city location of the study area the availability of land zoned for industrial land uses is limited.

Zone	Impacts on availability of land zoned for the particular use
SP2 Infrastructure *(with the nominated infrastructure type including Airport, Air Transport Facilities, Stormwater Management Systems, Railway and Classified Road)*	The project would not affect the amount of SP2 zoned land in the study area. The project would potentially result in an increase in land zoned SP2, should parts of the project located on other zones (eg IN1) be rezoned to SP2 to match the use of the land for the purpose of a road. Any rezoning would be undertaken as part of a separate process.
RE1 Public Recreation	The project would affect about 2.7 hectares of land zoned RE1, with a permanent change in land use to transport infrastructure.
B5 Business Development	The project would affect about 0.05 hectares of land zoned B5, with a permanent change in land use to transport infrastructure.
Sydney Airport Master Plan 2039	
AD2 - Airport Terminal and Support Services	The project would affect about 10 hectares of land zoned AD2. This land is currently mainly used for road transport purposes as it is occupied by Airport Drive, Qantas Drive and Sir Reginald Ansett Drive. This land use would continue with the project. The project would result about two hectares of land zoned AD2 which is not used for road transport along the southern side of Qantas Drive (currently Sydney Airport Jet Base). This area is located on the edge of the zones adjacent to the existing roadway. The realignment of Airport Drive would allow land currently occupied by Airport Drive to be returned to Sydney Airport for uses permitted within this zone, effectively increasing the amount of land in this zone available for development. This area is about 2.8 hectares in space, therefore effectively resulting in an overall increase AD2 land available for development (ie not used for roadway).
AD3 - Airport Logistics and Support	The project would affect about 11 hectares of land zoned AD3. This would occur mainly within the Northern Lands Sector. The impacts on the AD3 zone would potentially reduce the amount of land available for the development of airport logistics and support facilities. However, the Master Plan notes that the project would potentially affect land zoned AD3 in this area and would improve access to these areas.
BD1 - Business Development	The project would affect a small area (about 0.02 hectares) of land zoned BD1 along Airport Drive. This would be a minor impact, as the land is already used as a roadway.
AD1 - Aviation Activity and Aviation Support Facilities	The project would not directly affect land uses in this zone. The realignment of Airport Drive would allow land currently occupied by Airport Drive to be returned to Sydney Airport for uses permitted within this zone, effectively increasing the amount of land in this zone available for development.

Impacts on future land uses

The Airport Development Plan, which forms part of the Master Plan, provides for the future development of Sydney Airport land. The Airport Development Plan and the proposed future uses under the plan of land within the project site are described in section 19.2.2. The consistency of the project's operational features with the proposed future uses is considered in Table 19.5. The locations of the future land uses (where known) are shown on Figure 19.13.

Table 19.5 Impacts on future land uses proposed by the Airport Development Plan

Location	Potential future use of Sydney Airport land within the project site (under the Airport Development Plan)	Potential impacts
Northern Lands Sector – north of Botany Rail Line	Freight uses, including a freight and logistics facility Flight catering facilities (no specific location) Airside aviation support services, including freight, catering, ground support equipment storage and maintenance, truck staging and vehicle storage	As noted in Table 19.4, the project would reduce the amount of land available for these uses in this area. However, this impact is recognised by the Master Plan, which notes that the project would improve access to this area. The Airport Development Plan identifies an area for new freight facilities (shown on Figure 19.13) that would be impacted by the project. The majority of this area consists of land that would be available following its proposed use for construction compound C1. The land shown between the main area of the future facility and Canal Road would be largely unaffected. However, the project would affect the western area proposed for part of this freight facility. Overall, the amount of land remaining is expected to be sufficient for the future proposed use.
Northern Lands Sector – south of Botany Rail Line	Freight uses including Central Freight and Logistic Facility	The project would affect an area identified for future freight uses, including a central freight and logistic facility (see Figure 19.13). The project would result in a slight reduction in the land available for these uses by about 1.5 hectares. This is not considered to affect the ability of this land to be used for these purposes.
North West Sector – Airport Drive near Terminal 1	Not applicable	Works in this area would mainly affect Airport Drive. Where the project encroaches on adjacent Sydney Airport land (ie the mail handling unit), this encroachment is minimal and there would be no impacts on existing or future land uses under the Master Plan.
North West Sector – along Qantas Drive	Future terminal expansion north of Terminals 2/3 within the Sydney Airport Jet Base site Commercial developments within the North East Sector (no specific location) Aviation support facilities (including maintenance facilities) south of Qantas Drive Hotel development Terminals 2/3 access viaduct between Seventh and Ninth streets, Mascot (within Terminals 2/3 precinct)	The Master Plan includes reference to the future relocation of aviation support services (including the Jet Base) that are currently located along Qantas Drive. The proposed removal of buildings in this area (as part of the project) would allow future development in these areas in accordance with the Master Plan, including future terminal expansion. However, the presence of a section of the new roadway would reduce the amount of land available for future development. The impacted area would consist of a narrow area located adjacent to Qantas Drive.
North West Sector – south of Qantas Drive/Joyce Drive (Terminals 2/3 area)	Ground transport interchange located between Seventh and Ninth streets, Mascot (within Terminals 2/3 precinct)	The project would provide direct access to the interchange, which would be consistent with the Master Plan.

19.4.2 Property impacts

During operation, property impacts would be associated with the permanent land requirements of the project. This has the potential to:

- Reduce the amount of land available at a particular property
- Affect the development potential of the site.

Properties with the potential to be permanently impacted by the project are listed in Table 19.6, together with a summary of the potential permanent impacts. Potential business impacts are considered in Chapter 20 (Socio-economic impacts).

Table 19.6 Property impacts – operation

Property	Permanent impacts
Boral Concrete St Peters	Following construction, about 0.1 hectares (2.3 per cent) of the property would continue to be required as part of the project's operational footprint. This may include some areas where only airspace is required. This is unlikely to affect the overall use and development potential of the site.
Sydney Airport land at Burrows Road, St Peters (currently leased to Boral Recycling, Visy Recycling and for the Cooks River Intermodal Terminal overflow area)	Following construction, about 4.9 hectares (55.7 per cent) of the overall site (which is Commonwealth-owned land leased to Sydney Airport) would continue to be required as part of the project's operational footprint. The remaining land (around 3.9 hectares) would be available for other uses, in accordance with the Sydney Airport Master Plan (see Table 19.5).
Cooks River Intermodal Terminal	Following construction, around 0.9 hectares (about 6.5 per cent of the property) may continue to be required as part of the project's operational footprint. Although this is unlikely to affect the overall use of the site, the reduction in land area, together with the loss of the leased overflow area (described in Table 19.3), has the potential to affect the amount of land available for empty container storage. This potential impact is considered in section 20.3.4. It is noted that the design is currently being refined with the aim of minimising the potential impacts on this property.
Site currently leased by Tyne Container Services	As described in Table 19.3, the property currently located on this site would need to cease operating at this location prior to construction. Following construction, about 6.9 hectares (63.3 per cent) of the overall site would continue to be required as part of the project's operational footprint. The remaining land (about four hectares) would be available for others uses. The future use of this land would be guided by the master plan that is being prepared by Inner West Council (see sections 7.12 and 19.4.3).
Site currently used for the Inner West Council depot	As described in Table 19.3, the property currently located on this site would need to cease operating at this location prior to construction. Following construction, the site would continue to be required as part of the project's operational footprint.
Tempe Lands	Following construction, about 2.8 hectares (25 per cent) of the overall site would continue to be required as part of the project's operational footprint. Areas used during construction that are not required for operation (about 4.5 hectares) would be available for recreation uses. The future use of this land, including provision of a new off-leash dog exercise area, would be guided by the master plan that is being prepared by Inner West Council (see sections 7.12 and 19.4.3).
Tempe Recreation Reserve	Following construction, about 0.03 hectares would continue to be required for the active transport link. This would not affect the use of reserve as a whole.
Sydney Airport northern lands car park and adjacent vacant land	Following construction, about 1.8 hectares (22.4 per cent) of the overall site (which is Commonwealth-owned land leased to Sydney Airport) would continue to be required as part of the project's operational footprint. The remaining land (around five hectares) would be available for parking and other uses in accordance with the Master Plan (see Table 19.5).

Property	Permanent impacts
Vacant land owned by Sydney Airport Corporation	Following construction, about 0.5 hectares (6.2 per cent) of the overall site would continue to be required as part of the project's operational footprint. Areas used during construction that are not required for operation (about 3.6 hectares) would be available for other uses in accordance with the zoning of the land, IN1 General Industrial. The project would improve access to this land via the northern lands access and stub road on the freight terminal access roundabout. This would benefit any future land uses and improve the development potential for the land.
Alexandra Canal cycleway	As described in section 7.9 and Table 19.3, the existing cycleway along Airport Drive would be closed before construction and a new active transport link would be provided along the western side of Alexandra Canal. The land along Airport Drive that is currently used for the cycleway would be returned to Sydney Airport for use as airside areas in accordance with the Master Plan. The new active transport link would ensure that a cycleway would be maintained along Alexandra Canal in the long-term. The potential impacts on active transport are considered in section 9.4.7.
Sydney Airport Jet Base	Following construction, about 1.3 hectares of the overall site would continue to be required as part of the project's operational footprint. Areas used during construction that are not required for operation (about 3.2 hectares) would be available for other uses in accordance with the Master Plan (see Table 19.5). It is not expected that this reduction in site area would affect the overall operation of the Jet Base, as the majority of existing structures are currently vacant and the Qantas Flight Training Centre is relocating as described in Table 19.3. In addition, no impacts on the overall development potential or future uses of this land (as described in Table 19.5) are expected.

19.4.3 Residual land

Following construction, it is expected that some of the land required to construct the project in Tempe (including land within Tempe Lands and other areas on the former Tempe landfill previously occupied by Tyne Container Services) would be made available for other uses. It is estimated that the residual land would comprise a total of about 10 hectares on part of the following lots:

- Lot 25 DP 1227132
- Lots 303, 304 and 305 of DP 1136081.

Potential future uses could include open space/recreation, or other future uses in accordance with the priorities of local and regional strategic planning and Inner West Council. The land would be treated (ie remediated) where required to ensure that it is safe to use for future use.

Council is developing a master plan to identify how this land could be used, which will consider Council's recreational needs analysis prepared in 2018. The future use of this land would be subject to a separate assessment and approval process.

Roads and Maritime is continuing to consult with Inner West Council on the draft master plan, including providing feedback from the community regarding the preferred future use of this land. Feedback received from the community has included requests for:

- A new off-leash dog area
- Recreational facilities, including floodlit futsal fields and changing rooms
- Passive open space and walking paths
- Barbeque facilities, seating and shaded areas
- Children's playground
- Car parking.

Roads and Maritime would continue to consult with Council about compensation for the purposes of offsetting the loss of public open space and recreational facilities at Tempe Lands, and to ensure consistency with the project's final urban design and landscape plan (see section 7.12).

19.4.4 Summary of impacts on Sydney Airport (Commonwealth) land

Impacts on existing land use

Where the project site is located on Sydney Airport land, it would involve the use of land that is currently used for transport infrastructure purposes as a road, or the use of Sydney Airport land that is currently vacant. The main change to land use would be to land that is currently used for industrial purposes, which would be used for transport (road) infrastructure. As outlined in Table 19.4, this would result in a reduction in industrial land zoned under the LEP. As any future development would be in accordance with the Master Plan, this development would be for airport related uses including development that could be considered industrial in nature.

Impacts on land use are considered to be consistent with the Master Plan, which guides land use on Sydney Airport land.

Consistency with local planning schemes

Section 91(4) of the Airports Act requires a major development plan to address the extent of consistency of the major airport development with the planning schemes in force under a law of the State in which the airport is located. Table 19.7 outlines the consistency of the project, where it is located on Sydney Airport land, with the relevant local environmental plan, in terms of the land use zones within which it is located.

Table 19.7 Consistency of project with local planning schemes

Zone	Objectives	Consistency with zone objectives	Consistency with permissible uses
Marrickville Local Environmental Plan 2011			
IN1 General Industrial	▪ To provide a wide range of industrial and warehouse land uses. ▪ To encourage employment opportunities. ▪ To minimise any adverse effect of industry on other land uses. ▪ To support and protect industrial land for industrial uses. ▪ To protect industrial land in proximity to Sydney Airport and Port Botany. ▪ To enable a purpose built dwelling house to be used in certain circumstances as a dwelling house.	The project would include providing access to areas of industrial zoned land located on Sydney Airport land. It is considered to be a complementary land use. The project would not conflict with, or prevent the efficient operation of land in this zone.	The project is a permissible use in this zone.
SP2 Infrastructure (Air Transport Facilities))	▪ To provide for infrastructure and related uses. ▪ To prevent development that is not compatible with or that may detract from the provision of infrastructure. ▪ To protect and provide for land used for community purposes.	The project is considered to be consistent with the objectives of this zone. The project is being proposed to improve connectivity to Sydney Airport terminals and support the efficient distribution of freight to and from Sydney Airport (see Chapter 5 (Strategic context and project need)). The project would not conflict with or prevent the efficient operation of land in this zone.	The project is a permissible use in this zone.
SP2 Infrastructure (Railway) and (Stormwater	▪ To provide for infrastructure and related uses. ▪ To prevent development that is not compatible with or that may detract from the provision of infrastructure.	The project involves the provision of infrastructure in land zoned for infrastructure uses. It would not conflict with or prevent the efficient	The project is a permissible use in this zone.

Zone	Objectives	Consistency with zone objectives	Consistency with permissible uses
Management System)	▪ To protect and provide for land used for community purposes.	operation of land in this zone, and is considered to be consistent with the objectives of this zone.	
Botany Bay Local Environmental Plan 2013* and *Rockdale Local Environmental Plan 2011			
SP2 Infrastructure (Airport)	▪ To provide for infrastructure and related uses. ▪ To prevent development that is not compatible with or that may detract from the provision of infrastructure.	As noted above, the project would not conflict with or prevent the efficient operation of land in this zone and is considered to be consistent with the objectives of this zone.	The project is a permissible use in this zone.

Property impacts

During operation, property impacts would be associated with the permanent land requirements of the project (see section 19.3.1). The project's permanent land requirements would affect the following properties associated with Sydney Airport's operations that are located on Sydney Airport land:

- Jet Base
- Northern lands car park and adjacent vacant land
- High intensity approach lighting
- The area currently leased by Boral Recycling, Visy Recycling and for the Cooks River Intermodal Terminal overflow area.

The project would also affect Sydney Airport land at Burrows Road, St Peters.

The potential impacts on these properties are described in section 19.4.2.

Consistency with the Sydney Airport Master Plan

Land use and future planning

On Sydney Airport land, the project would involve a change from how the land is currently used – from (generally) Sydney Airport support/related facilities to road. However, the land would still be used for transport purposes.

The Master Plan provides that roads are a permissible land use in the land use zones within which the project site is located. The Master Plan identifies Sydney Gateway as a potential project within Sydney Airport land. Table 19.8 outlines the consistency of the project against the zone objectives for impacted zones under the plan. Impacts on the availability of land zoned for particular purposes are considered in Table 19.4. Impacts on specific land uses identified in the Master Plan are considered in Table 19.5. Based on the above, the project is considered to be consistent with the land use plan in the Master Plan.

The consistency of the project with the planning objectives for Sydney Airport, as defined by the Master Plan, is considered in section 3.6.4.

Table 19.8 Consistency with zone objectives under the Sydney Airport Master Plan

Zone	Objectives	Consistency and permissibility
AD2 – Airport Terminal and Support Services	1. Protect the long-term viability and operational efficiency of Sydney Airport for its primary aviation function. 2. Facilitate development of contemporary passenger terminals and related facilities for the handling, transfer and processing of passengers that are capable of meeting the standards expected by international, domestic and regional travellers, as well as supporting the needs of Sydney Airport's workforce. 3. Provide for aviation activities and support facilities. 4. Facilitate compatible and ancillary functions within the zone provided that development does not render the land permanently unfit for aviation activities. 5. Encourage employment opportunities. 6. Ensure heritage items are appropriately considered and managed.	The project is considered to be consistent with the objectives of the zone, as it would provide a direct connection between the Sydney motorway network and Sydney Airport. This would ensure the long-term viability and operational efficiency of Sydney Airport by ensuring the effective movement of passengers to and from the terminals to the surrounding road network. As outlined in Table 19.4 and Table 19.5, the project would not reduce the amount of land available for aviation activities and support facilities as the majority of land zoned for this purpose that would be impacted is existing roadway occupied by Airport Drive, Qantas Drive and Sir Reginald Ansett Drive. The project is a permissible land use within this zone.
AD3 – Airport Logistics and Support	1. Protect the long-term viability and operational efficiency of Sydney Airport for its primary aviation function. 2. Facilitate the development of freight services and airport logistics (and ancillary office space) 3. Facilitate compatible and ancillary functions within the zone provided that development does not render the land permanently unfit for aviation activities. 4. Ensure development is compatible, where practicable, with surrounding land uses in this area. 5. Ensure heritage items are appropriately considered and managed.	The project is considered to be consistent with the objectives of this zone as it would provide a direct connection between the Sydney motorway network and Sydney Airport. This would ensure the long-term viability and operational efficiency of the Sydney Airport by ensuring the effective movement of passengers to and from the terminals to the surrounding road network. As outlined in Table 19.4 and Table 19.5, the project would result in a reduction in land available for the development of freight services and airport logistics. The project is expected to improve access to any future freight and logistics areas from the Sydney motorway network. The project is considered to be consistent with surrounding land uses, due to the largely industrial nature of surrounding land and because the project would be undertaken either within existing transport corridors or in close proximity to future road corridors (ie St Peters interchange). The project is a permissible land use within this zone.

Zone	Objectives	Consistency and permissibility
BD1 – Business development	1. Enable a mix of business, retail and industrial uses in locations that are close to and that support the functioning of the Airport. 2. Integrate suitable and compatible land uses in accessible locations so as to maximise public transport patronage and encourage active transport. 3. Encourage employment opportunities and promote businesses along main roads. 4. Enable a limited range of other land uses that will provide facilities and services to meet the day-to-day needs of the local workforce. 5. Ensure heritage items are appropriately considered and managed. 6. Maximise, where possible, the use of existing access and egress points to the on-airport road network.	Land currently subject to this zoning within the project site is located on Airport Drive. The use of this land for development that meets these objectives is therefore currently limited. The project is considered to be consistent with the objectives of this zone as it would provide a direct connection between the Sydney motorway network and Sydney Airport land. It would improve access to Sydney Airport land, and is not inconsistent with the future use of the land for purposes permitted in the BD1 zone. The project is a permissible land use within this zone.

The need for the project is recognised by the Master Plan, which was developed with reference to the project potentially being part of the external road network (subject to approval). The Master Plan notes that the five year ground transport plan (which forms part of the Master Plan) has been developed to complement the project.

The Master Plan also notes that the project would increase opportunities for freight related development in Sydney Airport's northern lands as a result of improved access to Sydney's motorway network.

The Master Plan identifies that new links to the northern lands would be required. These new connections are being provided as part of the project in the form of the freight terminal link and northern lands access.

The project is consistent with future planning for ground transport as described by the Master Plan, and meets Sydney Airport's development, growth and infrastructure needs as defined in these plans. As described in section 5.1.4, Sydney Airport Corporation has proposed and carried out a number of road and access improvements within Sydney Airport land, including planning for the proposed ground transport interchange. The project would complement and enhance the future operation and efficiency of these improvements, working together to improve access to and from Sydney Airport's terminal and freight facilities.

19.5 Cumulative impacts

Cumulative land use impacts would be associated with the loss of a particular land use as a result of the project together with that caused by other projects occurring in the study area.

Nearby projects, including the Botany Rail Duplication project, the New M5 and M4-M5 Link, are either located in existing transport corridors or consist mainly of below ground works with limited surface works. This results in limited additional potential impacts for most land use types, with the exception of open space and industrial land uses.

The New M5 project would result in temporary direct impacts on some areas at Sydney Park. However, this impact would be limited to the construction period. The New M5 would also result in the generation of new areas of open space on the former Alexandra landfill site.

The New M5 also included acquisition of some industrial properties. The associated impacts of the Sydney Gateway road project would further reduce the amount of industrial land in the study area.

Subject to future planning, the project's residual land (see section 19.4.3) would provide opportunities to offset cumulative impacts on existing land uses.

19.6 Management of impacts

19.6.1 Approach

Approach to mitigation and management

The assessment identified that land use and property impacts would be associated with the acquisition or leasing of land required for the construction and operation.

Approach to managing the key potential impacts identified

The key approaches to managing the impacts identified would involve:

- Minimising the final operational footprint as far as possible
- Managing the acquisition process in accordance with relevant legislative requirements and recent reforms
- Making residual land available for future uses.

As described in section 7.12, residual land within the Tempe Lands and adjacent industrial land, which would be used to construct the project but is not required for operational infrastructure, would be considered for future use, including open space/recreation uses. Inner West Council is developing a master plan to identify how this land would be used. Roads and Maritime is continuing to consult with Inner West Council on the draft master plan and would input to this process as appropriate. This would assist in offsetting impacts on existing land uses.

Approach to managing other impacts

Other measures to further minimise impacts on land use and property are provided in section 19.6.2. Impacts on property access would be managed in accordance with the measures provided in section 9.6.

Expected effectiveness

Roads and Maritime has extensive experience in consulting with affected landowners and managing potential impacts on property as a result of road developments of a similar scale and scope to this project. Accordingly, these measures are expected to be effective.

19.6.2 List of mitigation measures

Measures that will be implemented to address potential impacts on land use and property are listed in Table 19.9.

Table 19.9 Land use and property mitigation measures

Impact/issue	Ref	Measure	Timing
Impacts on property and land use	LU1	The design will continue to be refined to minimise land requirements and potential impacts on existing land uses and properties as far as possible. Consultation with landholders will be ongoing to identify opportunities to minimise impacts on onsite operations where practicable.	Detailed design

Impact/issue	Ref	Measure	Timing
Impacts on advertising structures	LU2	The approach to mitigating impacts on advertising structures (including adjusting, relocating or providing new structures at locations along project infrastructure) will be confirmed during detailed design.	Detailed design
Use of residual land	LU3	Roads and Maritime will continue to consult with Inner West Council regarding the future use of residual land in the Tempe Lands and adjoining area. This will include opportunities for open space and recreation uses, and provision for a new off-leash dog exercise area and council depot. Roads and Maritime will support and assist Inner West Council with the master planning process for these areas as appropriate, and will ensure that the urban design and landscape plan for the project is consistent with the outcomes of this process.	Detailed design
Impacts on utilities	LU4	The location of all utilities, services and other infrastructure will be identified prior to construction to determine requirements for access to, diversion, protection and/or support. This will include (as required), undertaking utilities investigations, including intrusive investigations, and consultation and agreement with service providers.	Detailed design
Impacts on privately-owned land or land owned by the NSW or local government	LU5	Acquisition will be undertaken in accordance with: ▪ The *Land Acquisition (Just Terms Compensation) Act 1991* (NSW) ▪ *Determination of compensation following the acquisition of a business* (NSW Government, undated).	Pre-construction
Impacts on Commonwealth-owned land subject to a lease with Sydney Airport Corporation	LU6	Sydney Airport, as the leaseholder of the land, will notify tenants that their sub-lease agreements will be concluded. Termination of leases will be undertaken in accordance with the contract terms with Sydney Airport Corporation and the tenant. Sydney Airport will provide support to manage the return of lands and handover to Roads and Maritime.	Pre-construction
Impacts on Qantas Flight Training Centre	LU7	Consultation with Qantas will occur throughout construction planning and construction to minimise impacts on the Qantas Flight Training Centre until the relocation process is complete.	Pre-construction, construction
Future management of residual land	LU8	The ongoing management of residual land, and Roads and Maritime's role in this process, will be confirmed in consultation with Inner West Council.	Operation

19.6.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 19.6.2).

The project would impact existing recreation/open space land. It would also impact industrial zoned land. Planning for the future use of the project's residual land (as described in section 7.12) would provide opportunities to minimise this potential residual impact.

Chapter 20

Socio-economic impacts

This chapter describes the existing socio-economic (including business) environment, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 11 (Socio-economic Impact Assessment) and Technical Working Paper 12 (Business Impact Assessment).

The relevant SEARs and MDP requirements are listed below. Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
6.	**Socio-economic, land use and property**	
6.1	The Proponent must assess social and economic impacts in accordance with the current guidelines.	Section 20.3 and 20.4
6.2	The Proponent must assess the social and economic impacts from construction and operation on potentially affected properties, infrastructure, utility services, businesses (including impacts to freight management associated with the reduction of container storage, and consequent impacts to the broader industry), recreational users and land and water users.	This chapter (sections 20.3 and 20.4) assesses the potential socio-economic impacts of the project. Section 20.3.4 considers potential impacts on the freight industry focussing on potential impacts on the availability of land for empty container storage. Potential property, land use and utility impacts are considered in Chapter 19 (Land use and property).
6.3	The assessment must address as relevant, how environmental changes in the locality may affect people's: (a) way of life; (b) community; (c) access to and use of infrastructure, services and facilities (including recreational facilities and open space); (d) culture; (e) health and wellbeing; (f) surroundings; and (g) relevant statutory rights including personal and property rights.	Sections 20.3 and 20.4 For the purpose of this assessment, culture is defined as community values and way of life. No personal property rights would be affected by this project. Potential impacts on land use and properties are considered in Chapter 19 (Land use and property), including information about relevant statutory rights. Health and wellbeing from a socio-economic perspective are considered in this chapter. Further information about potential health impacts is provided in Chapter 23 (Health, safety and hazards).
	It must also consider how different groups may be disproportionately affected and communities severed by the proposal.	Sections 20.3 and 20.4

Reference	Requirement	Where addressed
Major development plan requirements *(in accordance with Section 91 of the Airports Act)*		
91(1)(ga)	The likely effect of the proposed developments that are set out in the major development plan, or the draft of the major development plan, on: (iii) the local and regional economy and community, including an analysis of how the proposed developments fit within the local planning schemes for commercial and retail development in the adjacent area	This chapter considers the effect on the local and regional economy and community. An analysis of the consistency with local planning schemes is provided in Chapter 19 (Land use and property).

20. Socio-economic impacts

20.1 Assessment approach

Constructing and operating a major a new road link creates access and economic benefits for the wider community and economy. It may also cause amenity impacts and disturbance to local communities and businesses, particularly during construction. A key element of planning and developing the project has been developing an understanding of the potential impacts in order to optimise outcomes for the community.

Where a project has the potential to impact the community and surrounding businesses, a socio-economic assessment is undertaken to assess the potential for adverse impacts, and recommend mitigation and management measures to minimise impacts that cannot be avoided.

The socio-economic assessment for the project has been undertaken by social sustainability and business impact specialists experienced in infrastructure development. The purpose of this assessment is to inform project development and ensure that the overall project design is appropriate for its context, optimises community and social outcomes, and avoids or minimises adverse impacts as far as reasonable and feasible. Due to the number of significant businesses in the vicinity of the project site, a business impact assessment was also undertaken.

An overview of the approach to these assessments is provided below, including the legislative and policy context and a summary of assessment methodologies.

20.1.1 Legislative and policy context to the assessment

The assessment has been undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations
- *Environmental Impact Assessment Practice Note: Socio-economic assessment* (Roads and Maritime Services, 2013c)
- *Social Impact Assessment Guidelines for State significant mining, petroleum production, and extractive industry development* (NSW Department of Planning and Environment, 2017)
- *International Principles for Social Impact Assessment* (Vanclay F., 2003)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

20.1.2 Methodology

Study area

Socio-economic impact assessment

The socio-economic impact assessment study area is shown on Figure 20.1. It includes the project site, as described in Chapter 2 (Location and setting), and surrounding suburbs that could be directly affected by the project (Mascot, Tempe and St Peters).

The regional study area was also considered in relation to the potential for indirect impacts. The regional study area includes part/all of the Sydney, Inner West, Bayside and Randwick local government areas.

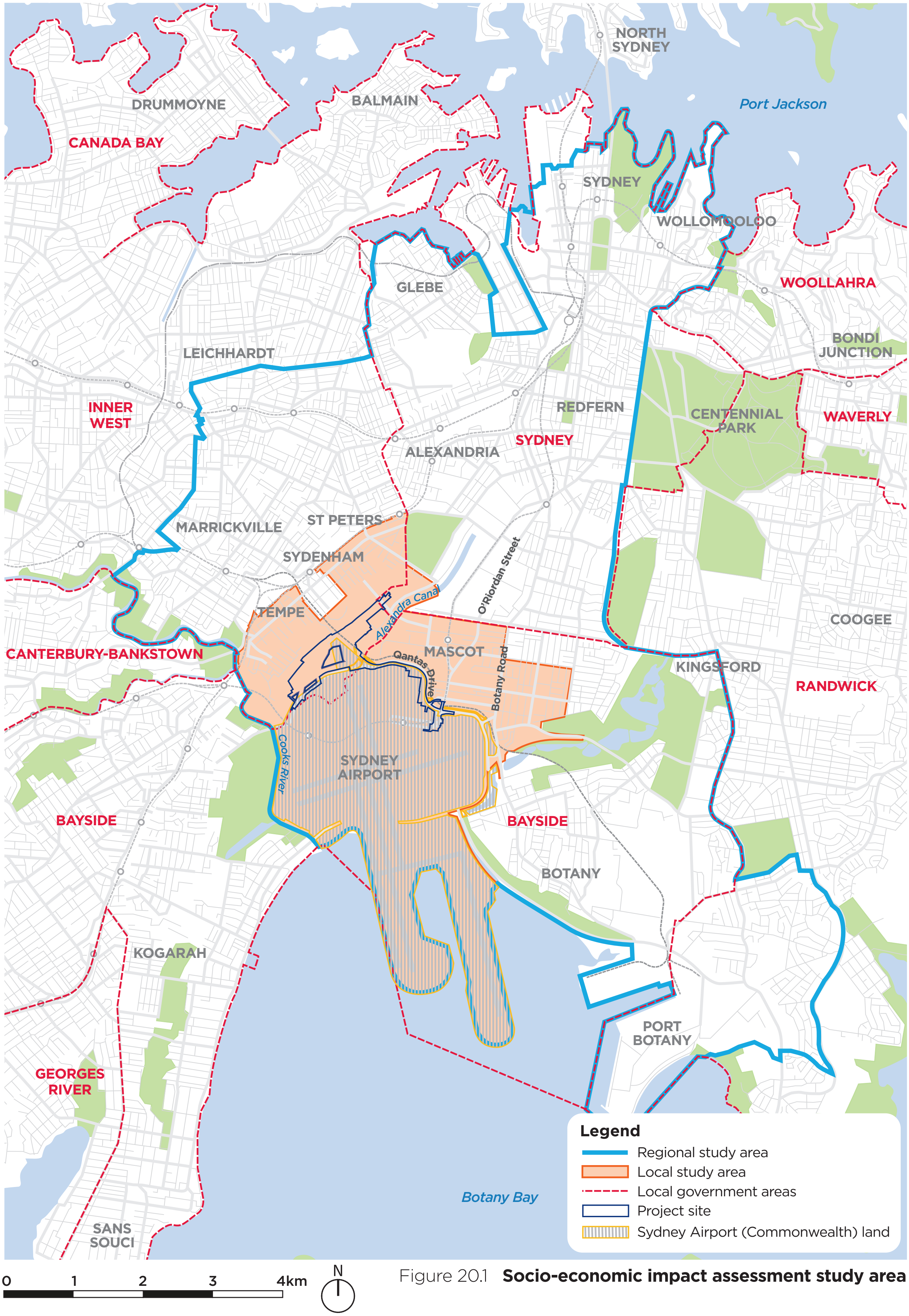


Figure 20.1 **Socio-economic impact assessment study area**

Business impact assessment

The Australian Bureau of Statistics (ABS) geographic boundaries (referred to as Statistical Area Level 2) were used to define the business impact assessment study area. The Statistical Area Level 2 is the smallest area for the release of ABS statistics. The study area for the business impact assessment (see Figure 20.2) is defined by the extents of the statistical areas that overlap with or contain businesses within a one kilometre radius of the project site.

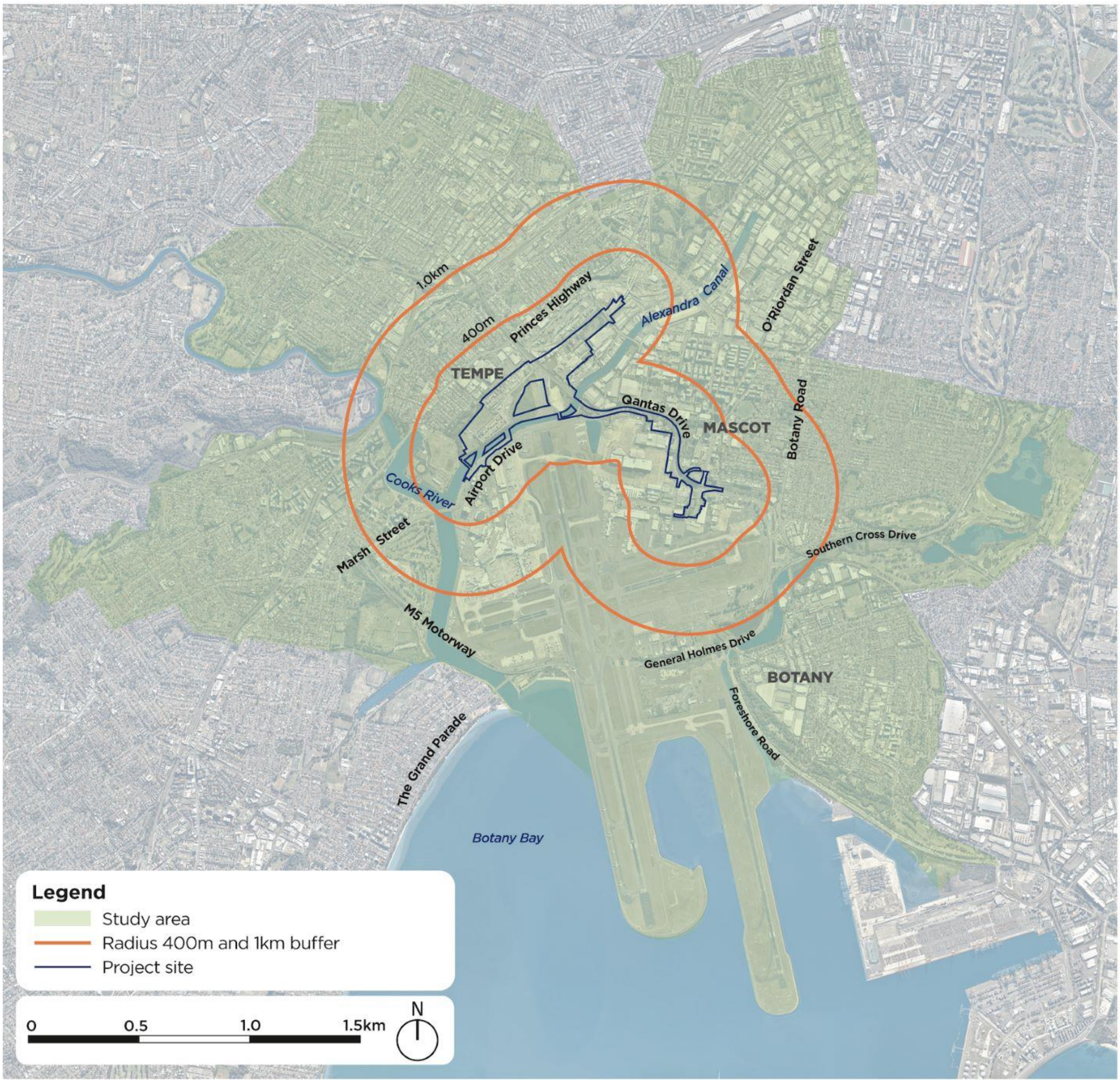


Figure 20.2 Business impact assessment study area

Key tasks

Socio-economic impact assessment

The socio-economic impact assessment involved:

- Confirming the study area for the purposes of the assessment
- Reviewing background information and data relevant to the study area, including:
  - ABS Census 2016 (ABS, 2016)

  - NSW population and household projections (Department of Planning and Environment, 2016)
  - Local council community plans, strategies, studies and other available information
  - Relevant consultation outcomes from other recent major projects in the study area
- Describing the existing socio-economic environment of the study area, including developing a demographic profile for communities with the potential to be affected by the project
- Visiting the study area to assist with understanding the social characteristics of the communities
- Identifying and mapping community infrastructure and facilities within 500 metres of the project site
- Reviewing other technical papers prepared for the impact assessment to understand the nature, scale and significance of potential impacts, and identify associated socio-economic impacts
- Taking into account issues raised by the community and relevant stakeholders during consultation (see Chapter 4 (Consultation))
- Assessing the potential socio-economic impacts during construction and operation, including the likely significance of these impacts (as described below)
- Identifying measures to mitigate the potential impacts.

Business impact assessment

The business impact assessment formed an important input to the overall socio-economic assessment. It involved:

- Defining the study area and local business precincts
- Reviewing strategic planning and policy documents to determine the existing and future proposed characteristics of the study area
- Preparing a profile of the existing business environment including zoning, amenity and business types
- Calculating the number of businesses, employment levels and economic contribution of industries in the study area
- Consulting with businesses and undertaking a business survey (as described below) to develop an understanding of business characteristics, values and sensitivities, and how they could be impacted by the project
- Assessing the potential direct and indirect business impacts during construction and operation, including the likely significance of these impacts (as described below)
- Identifying measures to manage potential impacts.

Consultation

Consultation with the community and key stakeholders has been conducted prior to, and during, the impact assessment process, as described in Chapter 4 (Consultation). Consultation with residents, businesses and the community is planned to continue throughout the planning, construction and operation stages of the project. The outcomes of consultation were used to inform the socio-economic impact assessment.

Business surveys

A survey was undertaken of those businesses anticipated to experience direct or indirect impacts from the project (generally located within a one kilometre radius of the project site). A total of 115 surveys were completed between November 2018 and March 2019. The aim of the survey was to identify key business characteristics, issues and concerns regarding the project. The survey included a range of questions relating to awareness of the project, existing access and delivery requirements, and issues associated with construction and operation. The results of the survey informed the business impact assessment.

Significance of impacts

The potential significance of identified impacts was determined based on the sensitivity of the receptor and the magnitude of the project. For negative impacts, sensitivity refers to the qualities of the receptor, which influence its vulnerability to change and capacity to adapt. Magnitude refers to the scale of the proposed changes as a result of the project.

The level of significance of the potential impacts was assessed by combining the level of sensitivity and magnitude of impacts (see Figure 20.3). This assessment took into account the mitigation measures provided in section 20.6 and those identified in other relevant chapters of this document.

SENSITIVITY \ MAGNITUDE	High	Moderate	Low	Negligible
High	High impact	High to Moderate	Moderate	Negligible
Moderate	High to Moderate	Moderate impact	Moderate to Low	Negligible
Low	Moderate	Moderate to Low	Low	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

Figure 20.3 Impact significance rating matrix

20.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Socio-economic risks with an assessed level of medium or above, identified by the environmental risk assessment, included:

- Impacts on some businesses as a result of the land requirements for the project (acquisition and lease cessation)
- Impacts on community infrastructure as a result of the project's temporary and permanent land requirements
- Community and business amenity impacts during construction and operation, including as a result of changes to traffic, noise, air quality and the visual environment
- Temporary impacts on community values and lifestyle for local residents, workers and visitors, due to changes to travel patterns
- Temporary access restrictions or changes resulting from construction sites and activities, which may affect how people access community infrastructure, and how they use the existing road infrastructure
- Impacts on amenity and the use of nearby community facilities and areas within the Tempe Lands and Tempe Recreation Reserve because of the presence of project infrastructure.

These potential risks and impacts were considered by the socio-economic and business impact assessments.

20.2 Existing environment

20.2.1 Overview of local study area

The local socio-economic study area is highly urbanised with a combined population of 21,473 people in 2016 (ABS, 2016).

Mascot, which is located in the Bayside local government area, is one of Sydney's fastest growing suburbs with a population of 14,772 in 2016. Growth is expected to continue, with a 22.64 per cent increase in the population projected between 2016 and 2036 (NSW Department of Planning and Environment, 2016). The demographic profile of Mascot is changing, as more high-density dwellings are built, attracting new residents to the suburb. With the growth of residential areas, there has also been a transition from heavy industry to lighter industrial and warehousing areas, and an increase in business and commercial spaces. A large area within Mascot is dedicated to Sydney Airport and airport-related businesses and operations, including airline services, freight and trade businesses, and passenger services such as car parks and hotels.

Tempe is located in the Inner West local government area and is a relatively small suburb compared to others in the local government area, with a population of 3,556 people in 2016. The population of the Inner West local government area population is expected to increase by 21 per cent between 2016 and 2036 (NSW Department of Planning and Environment, 2016). Tempe was once a hub of tram and rail infrastructure and other industry, with pockets of residential uses. In recent years, the suburb has transformed to become a semi-industrial and commercial area, with pockets of residential uses. Tempe has been identified as an area for future residential growth (Inner West Council, 2018a), with new transport infrastructure connecting the area to the Sydney central business district, and a new creative precinct commissioned in the neighbouring suburb of Sydenham.

St Peters is located partly within the Inner West local government area and the City of Sydney. The residential area in St Peters is within the Inner West local government area. The suburb is characterised by semi-industrial, commercial and residential areas. In 2016, the population of St Peters was 3,145. The suburb has undergone change in recent years, with construction of the M4-M5 Link and the New M5 requiring acquisition of residential properties. Once the projects are operational, it is anticipated that the suburb would experience a change in amenity due to changes in connectivity and road traffic.

20.2.2 Demographic profile

The main demographic characteristics of the study area, including comparisons with the characteristics of the local government and Greater Sydney statistical areas as a whole (where relevant), are provided below.

- Age profile:
  - Mascot and St Peters had a younger median age (32 and 34 years respectively) compared to the local government areas ((35 years in the Bayside local government area and 36 years in the Inner West local government area) and Greater Sydney (36 years)). Tempe had an older median age (38 years) compared to the Inner West local government area and Greater Sydney.
- Cultural diversity:
  - Mascot had a higher proportion of people who were born in countries where English is not the main language (46.3 per cent) than the Bayside local government area (41.1 per cent) and Greater Sydney (29.3 per cent).
  - Mascot had a similar proportion of people who speak a language other than English compared to the Bayside local government area, and a greater proportion of people compared to Greater Sydney (35.8 per cent). The top languages spoken in Mascot other than English included Mandarin, Indonesian, Cantonese and Greek.

  - Tempe had a higher proportion of people identified as Aboriginal or Torres Strait Islander (2.1 per cent) than the Inner West local government area (1.1 per cent) and Greater Sydney (1.5 per cent).
  - Tempe had a higher proportion of people who speak a language other than English (61.1 per cent) compared to the Inner West local government area (28.4 per cent) and Greater Sydney overall. The top languages spoken in Tempe included Macedonian, Vietnamese and Cantonese.
  - St Peters had a lower proportion of the population who speak a language other than English (24.4 per cent) compared to the Inner West local government area and Greater Sydney overall. The most commonly spoken languages in St Peters included Cantonese, Vietnamese, Macedonian, Mandarin and Greek.
- Employment:
  - Mascot had a lower unemployment rate (5.2 per cent) than both the Bayside local government area and Greater Sydney (six per cent). Tempe had a similar rate of unemployment (4.6 per cent) compared to the Inner West local government area (4.8 per cent) but a lower rate than Greater Sydney. St Peters had a lower rate of unemployment (3.9 per cent) than the Inner West local government area and Greater Sydney.
- Need for assistance:
  - Mascot had a lower level of need for assistance with core daily activities (3.4 per cent) compared to the Bayside local government area (5.3 per cent) and Greater Sydney (4.9 per cent).
  - Tempe had a higher proportion of people who require assistance (5.5 per cent) than the Inner West local government area (4.5 per cent) and Greater Sydney (4.9 per cent).
  - St Peters had a lower proportion of people who require assistance (2.9 per cent) than the Inner West local government area (4.5 per cent) and Greater Sydney (4.9 per cent).
- Journey to work:
  - Mascot had a higher proportion of people who travel to work by public transport (32.7 per cent by train and 7.7 per cent by bus) compared to the Bayside local government area (27.1 and 5.8 per cent respectively) and Greater Sydney (16.3 and 6.1 per cent respectively), reflecting a lower level of car reliance.
  - Tempe had a higher proportion of people who drive to work (42.9 per cent) compared to the Inner West local government area (38.9 per cent), although this was lower than Greater Sydney (52.8 per cent).
  - St Peters had a higher proportion of people who travel to work by train (40.5 per cent) compared to the Inner West local government area (26.8 per cent) and Greater Sydney (16.3 per cent).
  - Tempe had a lower proportion of people who walk to work (4.3 per cent) compared to the Inner West local government area (5.6 per cent) and a similar proportion to Greater Sydney (four per cent).
  - Tempe had a similar proportion of people who cycle to work (2.8 per cent) compared to the Inner West local government area (2.8 per cent), which is higher than Greater Sydney (0.7 per cent).
  - St Peters had higher proportions of people who cycle and walk to work (3.5 and 5.9 per cent respectively) compared to the Inner West local government area (2.8 and 5.6 per cent respectively) and Greater Sydney (0.7 and four per cent respectively).
  - St Peters had a lower proportion of people who drive to work (35.6 per cent) compared to the Inner West local government area (38.9 per cent) and Greater Sydney (52.8 per cent).
  - Mascot had higher proportions of people who walk or cycle to work (7.4 and 1.1 per cent respectively) than the Bayside local government area (3.7 and 0.7 per cent respectively) and Greater Sydney (four and 0.7 per cent respectively).

- Socio-economic disadvantage:
  - In Mascot, the ABS's Index of Relative Socio-Economic Disadvantage ranked Mascot at decile nine, which means the suburb has a low rate of socio-economic disadvantage.
  - Tempe was ranked at decile 8, which means the suburb has a low rate of socio-economic disadvantage.
  - St Peters was ranked at decile 10, which means the suburb has a very low level of socio-economic disadvantage.

20.2.3 Community infrastructure and facilities

Community infrastructure and facilities include services and facilities identified as having social value to the community. Community infrastructure and facilities within 500 metres of the project site are listed in Table 20.1 and shown on Figure 20.4.

Table 20.1 Community infrastructure and facilities

Facility type	Facility name	Suburb
Community centre/library	Komuniteti Shqiptar Ne Sydney	Mascot
	Mascot Library	Mascot
Recreation facility	Robyn Webster Sports Centre	Tempe
	Tempe Golf Range and Academy	Tempe
	Tempe Jets – Basic X Music Business Hub	Tempe
	Sydney Model Autosports	Tempe
	Australian Academy of Parkour, Exercise and Self Defence	Tempe
Open space	Coleman Reserve	Mascot
	High Street Reserve	Mascot
	John Curtin Reserve	Mascot
	Tempe Recreation Reserve	Tempe
	Tempe Lands	Tempe
	Kendrick Park	Tempe
	Lori Short Reserve	Tempe
Child care	Aero Kids Early Learning Centre	Mascot
	The Joey Club – Sydney	Mascot
	SDN Children's Services	Mascot
	Guardian Early Learning Centre	Tempe
	Betty Spears Child Care Centre	Tempe
	Helping Hands	St Peters
School	Mascot Public School	Mascot
	St Peters Public School and St Peters Community Preschool	St Peters
Place of worship	Citygate Fellowship Church	Mascot
	St Peter and St Paul Catholic Church	Tempe
	Uniting Church in Tempe	Tempe
	True Buddhist Temple	Tempe

Facility type	Facility name	Suburb
	Al Hijrah Mosque	Tempe
	St Peters Anglican Church	St Peters
Medical	Mascot Medical and Dental Centre	Mascot
	Just Better Care Inner West	St Peters

20.2.4 Community values

Community values refer to tangible and intangible characteristics and aspects of a community, such as amenity and character, lifestyle, access, connectivity, community cohesion and community health and safety.

Values held by communities in the study area were identified a review of consultation outcomes and local government strategic and community planning documents. Community values for the local study area are discussed together as values that are likely to be similar.

It is noted that the Bayside local government area was formed in September 2016 following the amalgamation of the former Rockdale and Botany Bay local government areas. In the absence of a specific community plan for the Bayside local government area, the community values of the Mascot community were identified based on a review of the *Botany Bay Planning Strategy 2031* (City of Botany Bay, 2009), *Bayside 2030: Community Strategic Plan 2018-2030* (Bayside Council, 2018) (Bayside 2030), *2017–2021 Disability Inclusion Action Plan* (Bayside Council, 2017a), *Bayside Crime Prevention Strategy* (Bayside Council, 2017b), and a review of consultation outcomes.

Values of the Tempe and St Peters communities were identified based on a review of *Our Inner West 2036: A Community Strategic Plan for the Inner West Community* (Inner West Council, 2018a) (Our Inner West 2036) and the *Recreation Needs Study – A Healthier Inner West* (Inner West Council, 2018b) and a review of consultation outcomes from recent projects in the study area.

Local amenity and character

All three suburbs include former industrial areas and industrial precincts that are still operating. This unique amenity, character and diversity is valued by the community (Inner West Council, 2018a; Bayside Council, 2018).

According to the *Botany Bay Planning Strategy 2031*, communities living in Mascot value the heritage character, good quality urban design and the amenity of local residential areas. The strategy recognises the potential challenge presented to residential amenity by future expansion of airport and port activities, and a resulting increase in truck and rail freight.

Consultation with Bayside communities to inform Bayside 2030 highlighted that communities aspire to have places focused on people and reflect what is meaningful to local communities, such as incorporating public open space.

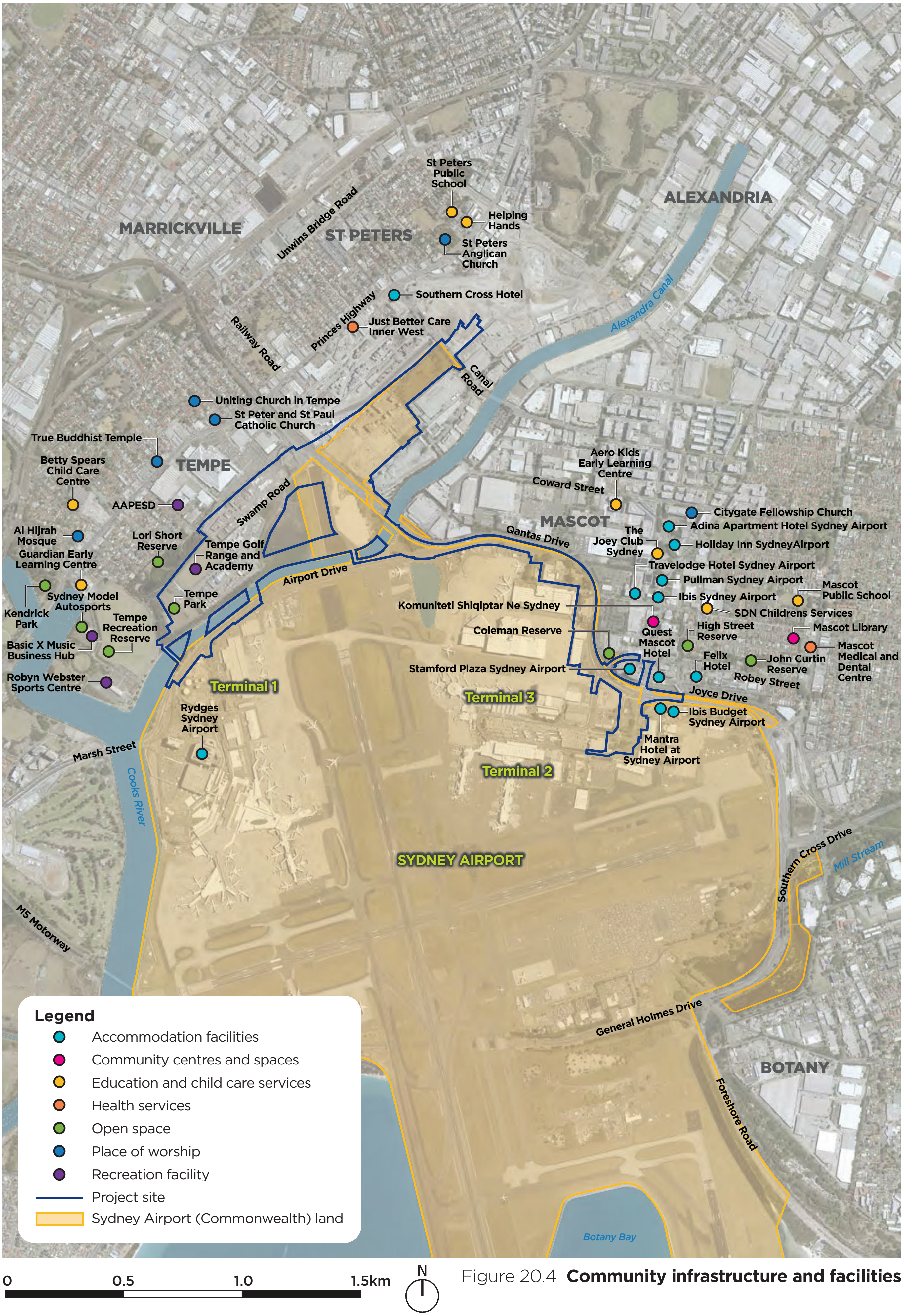


Figure 20.4 **Community infrastructure and facilities**

According to Our Inner West 2036, Inner West residents value the amenity and character of their communities, as well as the diversity of each suburb's unique character. Preserving this character and the heritage of each area is important to local communities. Residents also value the green and natural spaces throughout the local government area and want to ensure they are protected. They also aspire for urban environments that are green, cool and rich with biodiversity (Inner West Council, 2018a and Roads and Maritime, 2015d). Consultation with people living in Tempe indicated the high level of importance residents place on wetlands and open space in the Tempe Lands and Tempe Recreation Reserve.

Community consultation has indicated that residents are concerned about noise, air pollution and visual impacts during construction and operation.

Access and connectivity

According to the *Botany Bay Planning Strategy 2031*, local connectivity within some suburbs in the Bayside local government area (including Mascot) is a challenge due to the lack of transport options and isolation. Outcomes from community consultation undertake for Bayside 2030 indicated that communities are seeking improved connectivity, places that are accessible and create a sense of belonging, and integrated transport. The community aspires to have more walking paths, cycleways and transport corridors to support local connectivity.

During community consultation for the project and others in the study area, Mascot residents raised issues associated with local traffic and access and the importance of connectivity through the suburb, particularly pedestrian and public transport connectivity given the high levels of traffic.

According to Inner West community satisfaction results (Inner West Council, 2018a and Micromex, 2018), residents identified that the top priority areas for the council to focus on in the next 10 years are:

- Managing development, adequate planning and over development
- Traffic management and congestion
- Availability of, access to, and improvement of public transport.

Collectively, these priority areas contribute to the overall connectivity within the local government area's suburbs and with other areas of Sydney. These priority areas are also reflected in Our Inner West 2036, which states that the community desires accessible services, efficient and convenient movement around the local government area, improved transport networks, and reduced traffic congestion through new public transport and road infrastructure.

Consultation with the community identified that access and connectivity is a priority for vehicle users and active transport users. Concerns were raised about the lack of footpaths in residential areas of Tempe. In addition, residents commented that workers and visitors to Sydney Airport should be encouraged to park at the airport rather than on local residential streets in Tempe.

The suburbs of Tempe and St Peters do not have their own town centre, making access and connectivity with neighbouring suburbs essential to access services and promote community cohesion (Roads and Maritime, 2015d). Access and connectivity is a challenge faced by all three suburbs in the local study area, primarily due to dedicated land uses (such as industrial uses) that interrupt residential corridor connectivity. In response to community feedback, people in the Bayside and Inner West local government areas have identified access and connectivity as an area for improvement in the future.

A description of the existing transport and traffic environment in the study area is provided in Chapter 9 (Traffic, transport and access) and Technical Working Paper 1 (Traffic, Transport and Access).

20.2.5 Regional economy

Sydney Airport, Port Botany and their associated industries are the second largest employment area in Greater Sydney. The Sydney central business district is the largest employment area in Greater Sydney (Ernst & Young, 2011). The economic centres of Sydney Airport and Port Botany are regionally significant because of the job opportunities they provide as well as their involvement in regional economic trade.

Sydney Airport

Sydney Airport associated businesses are significant sources of employment for skilled workers across Greater Sydney, with around 32,700 jobs at the airport itself (SACL, 2019a). Major industries of employment at Sydney Airport are outlined in Table 20.2.

Table 20.2 Major areas of employment in Sydney Airport

Area	Employment proportion (%)
Transport and storage	63
Construction	8
Retail, cafes and accommodation	9
Government services	7
Property and business services	5
Maintenance, cleaning and engineering services	2

Source: *Economic contribution of Sydney Airport* (Deloitte Access Economics, 2018)

Deloitte Access Economics reported that in 2017, Sydney Airport generated $6.2 billion in value added and employed 30,900 full time employees (Deloitte Access Economics, 2018).

Australia's tourism industry is heavily reliant on Sydney Airport. In 2018, the airport supported 159,900 full-time equivalent tourism jobs in Australia (Deloitte Access Economics, 2018).

Port Botany

Port Botany is a major trade centre for NSW and is integral to the economy of Sydney and broader NSW. The port is a major source of employment, supporting 21,000 jobs. It supplies goods to businesses in metropolitan Sydney and Greater Sydney, which also supports employment. Over 4,000 people are employed at the port, which operates 24 hours per day, seven days a week.

The area surrounding Port Botany and Sydney Airport hosts industries that work to enable and service the regional freight movements from the port. Two container freight facilities, Tyne Container Services and the Cooks River Intermodal Terminal, are within and adjacent to the project site. The management of empty containers is fundamental to the overall logistics process serving Port Botany and Sydney Airport container trade. Access to container storage facilities is critical to the function of the port and other freight trade.

Connectivity and access to Sydney Airport and Port Botany

Connectivity to Sydney Airport is provided by road, public transport (trains and buses) and active transport. People travelling to and from the airport rely on these connections to continue to other destinations, such as travelling to work or meeting family and friends.

Connectivity for local workers and freight movements to Port Botany is primarily provided by road. The Botany Rail Line, which is located within and adjacent to the project site, provides access for freight containers via rail.

The existing traffic, transport and access environment is described in Chapter 9 (Traffic, transport and access).

20.2.6 Local business characteristics

Eight local business precincts were defined based on the extent of business, industrial or special purpose land use zonings and the characteristics of businesses in these areas. Business precincts within the study area are shown on Figure 20.5 and described in Table 20.3.

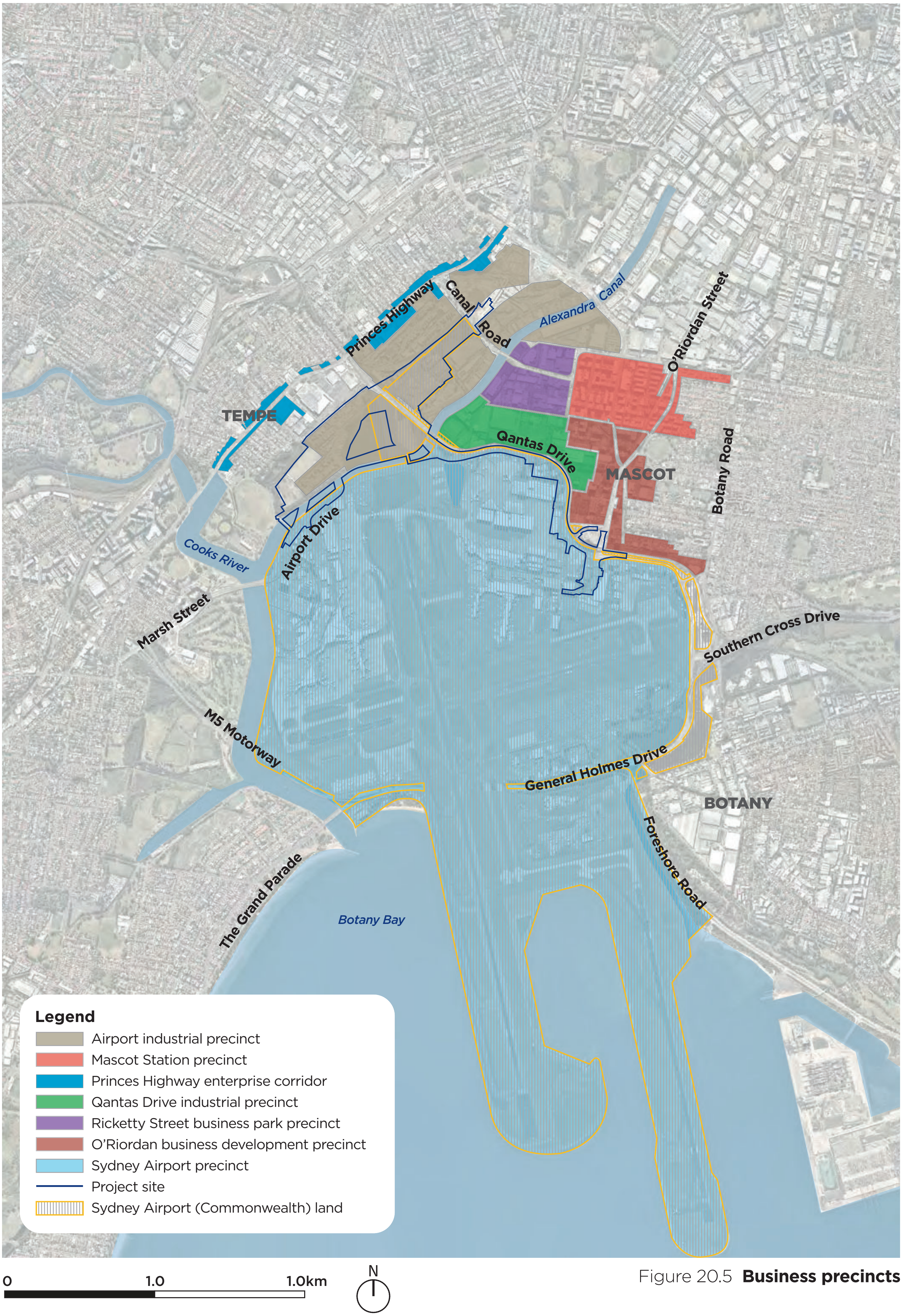


Figure 20.5 **Business precincts**

Table 20.3 Local business characteristics in the study area

Business precinct	Description
Sydney Airport	Sydney Airport is Australia's busiest airport, servicing domestic and international passenger airline activities and associated support activities, including catering, baggage handling, maintenance and refuelling. Sydney Airport also incorporates businesses associated with: ▪ Retail (such as a car dealership, newsagencies, clothing and duty-free stores) ▪ Hospitality (including accommodation and on-site food and beverage options) ▪ Ground transport, including terminal shuttle buses and taxi services ▪ Security and other government services, including Australian Border Force, Australian Quarantine and Inspection Services, Australian Federal Police and security contractors ▪ Dedicated freight and logistics business ▪ Other corporate/office-based businesses. Businesses on Sydney Airport land cater to domestic and international markets. Air freight is a vital economic activity at Sydney Airport, with about half of Australia's international air freight passing through the airport. The retail and hospitality businesses have a relatively captured market. Ground transport services are particularly sensitive to delays in travel time, road alterations and congestion. Office and accommodation businesses are generally more sensitive to changes in amenity.
O'Riordan Street business precinct	The O'Riordan Street business precinct has a large number of hotels, car rental services and airline corporate headquarters. Businesses in this area demonstrate strong synergies with Sydney Airport. Hotels would most likely be sensitive to alterations in amenity and reduced connectivity with the airport. Businesses in the precinct generally cater to the local government area and wider region.
Ricketty Street business park	The Ricketty Street business park precinct includes urban services (such as automotive repairs, storage, postal services etc), suppliers, distribution/warehousing centres, wholesale trade and manufacturing. Businesses in this area service the local government area and wider region and depend on access and connectivity. Businesses are unlikely to depend on passing trade and business exposure as their customer base extends beyond the local catchment. It is expected that the majority of businesses would have a low sensitivity to amenity impacts. The hospitality uses in the precinct predominantly service local workers and are unlikely to depend on passing trade.
Mascot Station precinct	This precinct is located around Mascot Station and provides commercial and retail services to support the local community. Buildings in the area generally contain ground floor shopfront premises with housing above. Some hotels are also located in the area. Businesses in the area would support a predominantly local catchment, including residents and workers. Businesses in this area are likely to depend on passing trade, business visibility and good amenity.
Qantas Drive industrial precinct	The Qantas Drive industrial precinct is closely linked to airport and freight activity, with a high presence of distribution centres, logistic and freight services. Businesses would generally service a regional, interstate and potentially international client base. Most businesses would be highly dependent on access and connectivity, have a lower dependency on passing trade, and rely on efficient access to arterial roads. The businesses would have lower sensitivities to changes in amenity.
Sydney Airport industrial precinct	The Sydney Airport industrial precinct includes mixed industrial uses such as container storage, urban support services, wholesalers, manufacturing, specialist suppliers and services. Businesses in the precinct generally cater to the local government area and wider region. The container service/freight businesses would cater to both a domestic and international market. Empty container parks aid in the servicing of containerised trade. Businesses would depend on access, connectivity and efficient access to arterial roads.

Business precinct	Description
Princes Highway enterprise corridor	The Princes Highway enterprise corridor extends around 2.5 kilometres along the Princes Highway from the Cooks River in the south, to around Albert Street in the north. Businesses in this area mainly consist of bulky goods/large format retailers (such as Ikea), fast food restaurants, manufacturing wholesalers, hotels, transport and warehousing and some urban services. The majority of businesses front the Princes Highway with passing trade, and accessibility for customers, workers, and services to and from the highway, are particularly importance to these businesses. Businesses serve the local government area and wider region.

20.2.7 Summary of the socio-economic characteristics of Sydney Airport (Commonwealth) land

A description of the existing environment and demographic profile of the local study area, including Sydney Airport land, is provided in section 20.2. A description of the overall economic importance of Sydney Airport is provided in Chapter 5 and section 20.2.5.

Two of the business precincts identified in section 20.2.6 are located on Sydney Airport land – the Sydney Airport precinct and the airport industrial precinct. Businesses located on Sydney Airport land within, or partly within, the project site include Visy Recycling, Boral Recycling, an overflow area associated with the Cooks River Intermodal Terminal, the Sydney Airport livestock transfer facility (managed by Swissport), the mail handling unit (managed by Qantas Freight) and the Jet Base (currently occupied by Qantas and including the Qantas Flight Training Centre).

The majority of employees at Sydney Airport are employed in transport and storage (63 per cent), including airlines, taxis and transport support services (Deloitte Access Economics, 2018). Other major industries of employment are retail, cafes and accommodation (nine per cent), construction (eight per cent) and government services (seven per cent).

20.3 Assessment of construction impacts

The main potential for socio-economic impacts during construction would occur as a result of:

- Land requirements (eg acquisition and leasing)
- Changes to access arrangements and connectivity
- Amenity impacts as a result of construction work
- Employment generation and other economic benefits, including increased trade.

Potential impacts and benefits are summarised below.

20.3.1 Land requirements

The project would require the permanent acquisition and leasing of properties, including the temporary use of land for construction purposes. The project's temporary and permanent land requirements, and the property impacts of these requirements, are described in Chapter 19 (Land use and property).

Roads and Maritime has sought to minimise the requirement for permanent land acquisition. The project would not require the acquisition of residential properties. As described in section 19.3.1, where acquisitions are required on privately-owned land or land owned by the NSW or local government, they would be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW) and the land acquisition reforms announced by the NSW Government in 2016. As a result, land requirements would not infringe on people's personal rights.

For Sydney Airport land, Sydney Airport Corporation, as leaseholder, would notify tenants that their sub-lease agreements would be concluded. The termination of leases would be undertaken in accordance with the contract terms with Sydney Airport Corporation and the tenant, and Sydney Airport Corporation would provide support to manage the return of lands and handover to Roads and Maritime.

The potential socio-economic impacts of the project's land requirements are considered in the following sections.

Business impacts as a result of the project's land requirements

The project's land requirements, and the resulting property impacts, would directly affect the following businesses:

- Maritime Container Services (as operators of Cooks River Intermodal Terminal)
- Boral Concrete St Peters
- Boral Recycling St Peters
- Visy Recycling
- Tyne Container Services
- Tempe Golf Range and Academy
- Qantas Flight Training Centre
- Swissport (as operators of Sydney Airport's livestock transfer facility)
- Qantas Freight (as operators of Sydney Airport's mail handling unit near Terminal 1).

Some of these businesses would be able to continue to operation in their existing location. Others (mainly those subject to lease arrangements that would need to be terminated as a result of the project's land requirements) would not be able to continue to operate in their existing location. The termination of leases and/or relocation of businesses may have the following effects:

- Disruption to business operations
- Loss of revenue and productivity
- Stress and anxiety relating to locating and leasing or purchasing a new site
- Difficulty finding alternative properties, particularly for those businesses with specific requirements
- Relocation and re-establishment costs
- Employee training costs for new employees
- Trade catchment alterations.

A summary of the potential business impacts as a result of the project's land requirements is provided in Table 20.4. These potential impacts would occur prior to or during construction, as this is when the land would be required. Table 20.4 also provides the level of significance of these impacts according to the significance assessment undertaken as described in 20.1.2.

Table 20.4 Business impacts as a result of the project's land requirements

Business	Summary of impacts	Sensitivity	Magnitude of potential impacts	Assessed significance of impacts
Maritime Container Services (as operators of the Cooks River Intermodal Terminal)	The Cooks River Intermodal Terminal provides a range of functions. It uses road and rail to transfer containers to and from Port Botany and regional NSW, and provides the largest empty container storage facility in the state. As well as the terminal site, the facility operators also lease an area on the adjoining site for empty container storage. A small section of the Cooks River Intermodal Terminal site is currently required for the project. However, the design is currently being refined with the aim of minimising the potential impacts on this property. In addition, the lease of the overflow area on the adjoining Sydney Airport land would need to cease. The business would be able to continue operations on the intermodal terminal site with a reduction in the overall container storage capacity. This would have the potential to impact business revenue and the ability for the broader empty container storage industry to meet demand. There would also be a potential impact on longer-term operation and expansion plans. Construction would also result in temporary impacts on the operation of the rail siding within the terminal. The business would be highly sensitive to the changes due to the impacts on the long-term expansion plans and operating capacity at a time when demand in the broader industry is high (see section 20.3.4).	High	Moderate	High to moderate
Boral Concrete St Peters	Boral Concrete is the largest concrete batching plant supplier in Sydney. The concrete plant is located on land owned by Boral Resources. A small area on the edge of the Boral Concrete site would be required. The business would be able to continue to operate on the site. Boral has received approval for a development application to upgrade and expand the concrete batching plant. The area that the development application applies to includes part of the area required for the project. It would need to be modified to reflect the project's land requirements. Boral Concrete also uses an area within the adjoining site (land leased from Sydney Airport Corporation for the Boral Recycling business) to park concrete trucks. This area would not be available during construction. Alternative arrangements for parking these trucks within Sydney Airport land are currently being confirmed.	Low	Moderate	Moderate to low
Boral Recycling	Boral Recycling, which is located on Sydney Airport land leased from Sydney Airport Corporation, is a construction materials handling facility. The land leased for this business would be required for the project and the business would need to cease operation and relocate (if an appropriate site is available). This may affect employment. There are other recycling facilities in the area that may benefit from an increase in demand for services.	Moderate	Moderate	Moderate

Business	Summary of impacts	Sensitivity	Magnitude of potential impacts	Assessed significance of impacts
Visy Recycling	Visy Recycling, which is located on Sydney Airport land leased from Sydney Airport Corporation, is a waste transfer facility. The land leased for this business would be required for the project and the business would need to relocate or close. It is noted that Visy Recycling is proposing to relocate its operations from the existing site in St Peters to a site in Alexandria. The project is given as the justification for the need to relocate the business, which is the subject of a current development application. Relocation would have the potential to result in relocation and re-establishment costs for the business.	Moderate	Moderate	Moderate
Tyne Container Services	Tyne Container Services, which is located on land leased from Inner West Council, provides a range of container services, including container storage, supply, modification and repair. The land leased for this business would be required for the project and the business would need to relocate (if an appropriate site is available) or close. Relocation of the business would have the potential for: ▪ Relocation and re-establishment costs ▪ Effects on existing employees ▪ Loss of business revenue during the relocation period. If unable to relocate and the business decides to close, this would have the potential to affect the container freight industry at a time when land for empty container storage is at a critical supply level (see section 20.3.4).	High	Moderate (if business is able to relocate to a nearby location) High (if the business closes)	High
Tempe Golf Range and Academy	Tempe Golf Range and Academy, which is located on land leased from Inner West Council, provides a golf driving range, golf instruction and a golf shop on site. Land leased for this business would be required for the project and the business operation on this site would need to close. It is understood that the business is planning to relocate outside the study area. Relocation of the business would have the potential for: ▪ Relocation and re-establishment costs ▪ Impacts on customers needing to travel to an alternative golf driving range ▪ Effects on existing employees ▪ Benefits to other golf ranges in the surrounding areas from any increase in demand.	Low	Moderate	Moderate to low

Business	Summary of impacts	Sensitivity	Magnitude of potential impacts	Assessed significance of impacts
Qantas Flight Training Centre	The Flight Training Centre, which is located on the Sydney Airport Jet Base, includes sensitive flight simulators which are used by pilots and flight crews for periodic testing by simulating both aircraft and emergency procedural environments. The land requirements for the project would affect the Qantas Flight Training Centre, which would need to relocate. The facility may continue to operate in its current location during the early phases of construction. Relocation of the facility, which is subject to a separate planning and approval process, would result in potential impacts on training scheduling and an inconvenience to business operations.	High	Moderate	High to moderate
Swissport (livestock transfer facility)	The livestock transfer facility, which is located on Sydney Airport land near Terminal 1, is used for the transport and quarantine of animals. Construction would affect part of the area used to park and queue delivery trucks at the facility. In addition, an entry gate at the north-eastern end of the facility would be affected. This would require vehicles to use an alternate gate or reverse out of the facility. The business would be able to continue to operate with changes to vehicle movement patterns.	Low	Low	Low
Qantas Freight (mail handling unit)	Construction would temporarily impact 40 parking spaces along the northern boundary of the mail handling unit facility, located on Sydney Airport land near Terminal 1. The business would be able to continue to operate with changes to car parking arrangements for employees and customers. Changes to car parking would be managed by Sydney Airport Corporation as part of an upcoming lease renewal of this area.	Low	Low	Low
DHL	Construction would temporarily impact two car parking areas near Terminals 2/3 that are accessed off Ross Smith Avenue and Sir Reginald Ansett Drive respectively. The car parking areas, which have a combined capacity of 80 spaces, are used by the adjacent DHL business. Only one of these car parks would be occupied by construction works at any one time. The business would be able to continue to operate with changes to car parking arrangements for employees and customers. Further information on the potential impacts of the project on parking during construction are provided in section 9.3.7.	Low	Low	Low

Business	Summary of impacts	Sensitivity	Magnitude of potential impacts	Assessed significance of impacts
Advertising signs	Advertising signs are a prominent feature in the study area. A total of 30 advertising signs would be impacted by the project (see Table 19.3). Twenty-seven advertising signs would need to be permanently removed to facilitate construction. Views to three signs along Qantas Drive eastbound would be obstructed by the Terminals 2/3 access viaduct. Both the landowners and the companies that own and operate the signs would experience a loss in revenue due to removal of the signs, which could affect contract opportunities for businesses that lease and manage the signs and contractors or employees that maintain and change the signs. Companies that advertise on the signs would experience a reduction in exposure at this location. The final approach to mitigating the impacts on these structures would be confirmed during detailed design. Impacts to billboards on privately-owned land, or land owned by the NSW or local government, would be compensated in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW).	High	Moderate	High to moderate

Community infrastructure impacts as a result of the project's land requirements

Construction would affect Tempe Lands, with land that is currently occupied by two facilities in Tempe Lands required during construction (see Chapter 19 (Land use and property)). The potential community infrastructure impacts of these land requirements are described below.

Tempe Golf Range and Academy

As well as operating as a business, this property also provides recreation opportunities for the community. The potential impacts on this business are summarised in Table 20.4. Relocating the golf range outside the local area could have the potential for the following community impacts:

- Increased distances and travel times for some users
- Disruption of established networks and the risk of social isolation for some vulnerable members (such as older people who may rely more on social networks and have less capacity to adapt to changes).

Users of the golf driving range could access Barton Park Driving Range, which is located about four kilometres from the Tempe Golf Range and Academy. This could result in increased competition for the use of Barton Park Driving Range, affecting existing members due to the increased demand.

Users of the Tempe Golf Range and Academy who walk or cycle to the facility may be required to travel further or change travel modes to access Barton Park Driving Range or other similar facilities. This could potentially deter some users and their active recreation opportunities. Users who drive or use public transport to access the facility may also be required to travel further. However, it is expected they would adapt to the change more easily.

Most users of the facility would be expected to have a low sensitivity to its relocation, as they are likely to have minimal vulnerabilities and a high ability to absorb or adapt to change. The magnitude of the impact would be moderate as it would only affect the users of that facility. The level of significance would therefore be moderate to low. Vulnerable users may have a moderate to high sensitivity, therefore the significance would be moderate to high-moderate.

Off-leash dog exercise area in Tempe Lands

The project would affect the existing off-leash dog exercise area. During construction, a temporary off-leash dog exercise area would be provided as close as possible to the existing area. The exact location of the temporary area would be confirmed in consultation with Inner West Council.

Depending on the location of the temporary area and its proximity to construction work areas, some users may prefer to use other off-leash dog exercise areas, such as at in Wolli Creek or Sydenham (around 1.4 kilometres and three kilometres away respectively). Alternatively, some users may prefer to use the southern part of Tempe Recreation Reserve and Kendrick Park to exercise their dogs (on-leash).

During construction, access would be maintained to the temporary off-leash dog exercise area and temporary parking spaces provided. During construction, the condition of the temporary off-leash dog exercise area would be regularly monitored and maintained.

Most users of the off-leash dog exercise area are expected to have a low to moderate level of sensitivity, and would be expected to have some ability to adapt to the change. The magnitude of the impact would be low as it would only affect users of the facility, therefore the level of significance would be low to moderate.

20.3.2 Access and connectivity

As discussed in Chapter 9 (Traffic, transport and access), construction would have the potential for:

- Changes to traffic conditions and access arrangements resulting in increased travel time
- Changed access or increased travel time to community places and facilities
- Changes to pedestrian and cyclist networks

- Loss of parking spaces
- Impacts on public transport, including the removal of bus stops.

These impacts would inconvenience residents, visitors, customers, businesses, and service providers travelling through the study area, as well as travellers and workers accessing Sydney Airport during the construction period. The potential social impacts of these changes are considered below.

Social impacts

Travel times

Changes to traffic conditions and access arrangements could affect residents, workers and general community members travelling through the study area, in particular Mascot, and travellers accessing Sydney Airport. The changes could also affect workers from other areas commuting to and from the airport and Port Botany by road. For people travelling to the airport, this could lead to delays to their journeys or missing flights. Additional time spent travelling could also reduce the amount of time people spend with families, undertaking leisure and social activities, and cause delays in getting to work or other commitments.

Most people travelling through the study area are expected to have a moderate level of sensitivity, as they may have a number of vulnerabilities associated with increased travel time and some ability to absorb or adapt to changes. Some people (such as flight passengers) may have a high level of sensitivity, as increased travel times could affect their onward journey. The magnitude would be moderate as the impacts would affect most people travelling through the local study area and the changes would be experienced throughout the construction period. The level of significance would be moderate for most people travelling through the study area, and high-moderate to moderate for flight passengers and airport workers.

Active transport

Changes to pedestrian and cyclist networks near the project could increase travel times. This could reduce the amount of time that people spend with families, undertaking leisure and social activities, and cause delays in getting to work or other commitments. These impacts would be minimised through the provision of alternative cycle routes during construction, including a temporary active transport link on the western side of Alexandra Canal (see Chapter 8 (Construction)).

Active transport was identified as a key issue during consultation. The temporary active transport route may result in a small increase in travel distance and time for some commuter cyclists travelling to Sydney Airport. However, this is unlikely to deter most cyclists from using the route.

Cyclists may have a low to moderate level of sensitivity to these changes, associated with the small, inclined section of the temporary route. The magnitude would be low, as only a small section of the overall route would be more difficult. The level of significance would be low to moderate-low.

Most pedestrians are expected to have no vulnerability to changes to pedestrian networks and would be able to absorb or adapt to changes. The magnitude would be low and the level of significance would be negligible. There is potential for vulnerable community members (such as older people or people with a need for assistance) to be more sensitive to changes to pedestrian and shared paths as changes can be confusing and difficult to navigate, and may temporarily deter some people from using these paths even with diversions and signage. Vulnerable pedestrians may have a moderate sensitivity, therefore the significance would be moderate-low.

The removal of the pedestrian crossing on Airport Drive at Link Road may result in an increase in travel distance and time for freight terminal workers who may live in Tempe and walk to work. The increased time may deter workers from using this route. The magnitude of this change would be moderate for those affected. They would be expected to have low vulnerability and a high ability to adapt to these changes, therefore the level of significance would be moderate-low. More vulnerable workers may have a moderate level of sensitivity; therefore, the significance would be moderate.

Parking availability

Impacts on on-street parking as a result of construction would be limited as parking for the majority of construction workers would be provided in construction compounds to avoid the need for workers to park in nearby streets. Workers would also be encouraged to travel by public transport and car pool.

Consultation with the community identified concerns about the existing use of parking along residential streets in Tempe and Mascot by non-residents, which may include some airport workers and passengers. Further reductions in parking along local streets, if it was to occur, could cause further inconvenience and annoyance to these residents.

Public transport

Two bus stops on Qantas Drive at the Lancastrian Road intersection would be permanently removed. These stops are used by bus routes 400 and 420 and are not heavily used. The bus services would continue to operate during construction, and would be subject to the same delays, detours and diversions as general traffic.

Most bus passengers are expected to have a moderate level of sensitivity, as they may have a number of vulnerabilities associated with increased travel time, and some ability to absorb or adapt to changes. The changes would affect bus passengers throughout the construction period, therefore the magnitude would be moderate. Vulnerable bus passengers would have a moderate to high sensitivity. The level of significance for bus passengers would be moderate, and high-moderate to moderate for vulnerable bus passengers.

Community infrastructure and facilities impacts

Changes to traffic and transport conditions near the project site could affect the time and route taken to travel to community facilities. These changes may cause nuisance, reduce some people’s ability to enjoy their usual social activities, and affect the values of local residents and their sense of enjoyment of their local area.

The potential use of parking spaces in Tempe Recreation Reserve and surrounding local streets for workers during construction could reduce the availability of parking for reserve users. This could temporarily inconvenience sporting groups and reduce access for passive users, which could affect active lifestyles and social interactions. The level of sensitivity is moderate to low. The magnitude would be low and the level of significance would be moderate-low to low.

Although pedestrian access would be maintained along Smith Street and South Street, construction traffic may temporarily deter some community members from walking or cycling to Tempe Recreation Reserve. This could potentially affect active lifestyles and social interactions for some users. The temporary loss of access for vulnerable residents (such as older people and people who need assistance) could lead to social isolation. Most people who walk to the facilities are expected to have low to moderate levels of sensitivity given the high value the local community places on these facilities. The magnitude of the impact would be low and the level of significance would be low to moderate-low. Vulnerable users are likely to have moderate to high levels of sensitivity and a moderate to moderate-low level of significance.

Business impacts

The study area contains a high number of businesses sensitive to changes in access and connectivity as they rely on servicing, deliveries and distribution. Potential impacts on businesses as a result of changes to access and connectivity during construction include:

- Temporary inconvenience for employees, customers, distributors and servicing and delivery providers due to extended travel distances and times
- Increased competition for on-street parking due to additional construction workers in the area
- Changes in employee and customer access affecting business productivity and personal time
- Reduced arrival reliability affecting airline passengers, staff and the freight and distribution businesses

- Reduced time for people to spend at shops and restaurants in the airport
- Heightened anxiety and stress experienced by workers, service providers and customers
- Potential financial and emotional burden on passengers if they miss flights
- Loss of passing trade for retail and hospitality businesses
- Changes to parking arrangements.

Although construction could result in temporary changes to access arrangements, properties containing businesses would remain accessible. Changes in access arrangements could temporarily inconvenience employees, customers and contractors and potentially deter customers from travelling to the area.

Many businesses in and around Sydney Airport, along with airlines, are likely to have a high sensitivity as they would be vulnerable to changes in travel times. The magnitude of these changes would be moderate, therefore the level of significance would be high to moderate.

Increased travel times may affect employees and customers of businesses at Sydney Airport. This could reduce the time available to spend with families, undertaking leisure and social activities, and cause delays in commuting to and from work. Most employees are likely to have a low to moderate level of sensitivity to increased travel times as they would be expected to have some vulnerabilities and some ability to adapt to changes in travel times. The magnitude would be moderate as the impacts would affect most travellers through the local study area. The level of significance would therefore be moderate to moderate-low. Potential access and connectivity impacts would be temporary and minimised as far as possible with the implementation of the measures provided in Chapter 9 (Traffic, transport and access). A stakeholder engagement and community consultation strategy would also be implemented (as described in Chapter 4 (Consultation) to communicate changes to relevant stakeholders.

20.3.3 Amenity

'Amenity' refers to the pleasant or normally satisfactory aspects of a location that contribute to its overall character and enjoyment by residents or visitors. Construction may result in the following impacts, which could affect amenity:

- Increase in noise and vibration levels as a result of construction plant and equipment
- Increase in dust generated during construction
- Changes in the visual outlook near compounds and construction work areas.

These potential impacts and relevant mitigation measures are considered in Chapters 9 (Traffic, transport and access), 10 (Noise and vibration), 12 (Air quality) and 21 (Landscape character and visual amenity). Amenity impacts would be temporary, and managed by the mitigation measures outlined in these chapters.

The potential for amenity impacts is considered below.

Social amenity impacts

Noise and vibration

Potential noise and vibration changes during construction could reduce amenity for residents and hotel guests in areas close to construction. This may cause nuisance, interrupt daily activities and affect people’s enjoyment and pride in their local area. Potential noise and vibration impacts could lead to some people spending less time outdoors in backyards or on balconies engaging in recreational activities or relaxing, or closing windows while indoors. Noise at night-time may lead to disturbance in sleep patterns.

While most residents may be sensitive to daytime noise and vibration impacts, they would be likely to adapt to and absorb the change. The magnitude of the impacts would be low and the level of significance would be low.

During consultation, concern was raised about the potential for construction related noise to impact the operation and enjoyment of hotels. This could potentially lead to some people spending less time outdoors or engaging in recreational activities or relaxing. It may also disturb or interfere with day-to-day activities. Hotel guests are considered to be less sensitive to noise and vibration impacts, due to the expected high performance facades and glazing, as well as the temporary nature of the guests' exposure to these impacts. Hotel guests would have a negligible level of sensitivity due to the temporary nature of their use of the facility. The magnitude would be low as the impacts would affect only some hotels, therefore the level of significance would be negligible.

During night work, there is potential for sleep disturbance at residential areas in the eastern part of Tempe, residential areas in Mascot, and hotels near the airport, as well as some residential properties in Sydenham. Most residents are likely to have a moderate level of sensitivity to night-time noise. The magnitude of the impacts would be low and the level of significance would be moderate-low. Hotel guests would have a low level of sensitivity to night-time noise due to the temporary nature of their use of the facility, therefore the significance would be low for these users.

There is potential for social impacts from increased noise and vibration to be greater on vulnerable groups who may be more sensitive to noise amenity changes and have less capacity to adapt to changes. The demographic profile identified high proportions of families with children and people with a need for assistance living in Tempe. Vulnerable residents would have a moderate to high level of sensitivity due to potential for multiple vulnerabilities and little capacity to adapt to change. The magnitude of the impact would be low for these residents. The level significance would therefore be moderate to moderate-low for vulnerable groups.

Visual amenity

Construction would result in temporary impacts on visual amenity in Tempe Lands and along Airport and Qantas Drive. Although this would result in changes to the overall visual amenity of the area, residents in Tempe near the project site would not have direct views of construction activities, and would be unlikely to experience a visual impact from their residences.

Changes to the visual surroundings of the area may impact local residents' sense of pride in their local area. Local residents are considered to have a moderate level of sensitivity to this change due to the value they place on the amenity and character of the area. The magnitude of the impact would be negligible and mainly visible to local residents while moving about the suburb rather than from their place of residence. The level of significance would be low.

Changes to views of Alexandra Canal may impact local heritage interest groups or members of the wider community who value Sydney's heritage. Sensitivity to these changes would be moderate for those interested in Sydney's heritage. The magnitude of change is likely to be low and the social impact from visual changes to Alexandra Canal is expected to be of low significance.

Construction activities on Qantas Drive and the northern lands would be visible from some windows at hotels adjacent to the project site. Hotel guests would have a negligible level of sensitivity due to the temporary nature of their use of the facility. The magnitude of the change would also be low as it would affect some hotels. Therefore, this is not anticipated to result in social impacts on hotel guests.

Air quality

Any increases in dust may lead to some residents altering their way of life, such as leaving windows of houses or vehicles shut, or spending limited time in backyards or on balconies. People may also need to spend more time cleaning due to settling dust. This may lead to temporary nuisance to these residents. People who may be more sensitive to dust include older people, children and people with medical conditions such as asthma.

Most residents would likely have a negligible to low sensitivity to dust, as they are likely to have minimal or no vulnerabilities and be able to adapt to change. The magnitude of the impacts would affect some residents in the local study area. The level of significance would be negligible to low. Vulnerable residents may have moderate to high levels of sensitivity, therefore the level of significance for these residents would be moderate to low.

Community infrastructure amenity impacts

Amenity impacts may affect the enjoyment of community facilities close to the project site, particularly for outdoor areas such as Tempe Lands, Tempe Recreation Reserve, Tempe Wetlands and Coleman Reserve. Changes in amenity may temporarily affect the use and enjoyment of outdoor areas and may deter some users from using areas close to construction activities.

Overall, most users of Tempe Recreation Reserve, Tempe Wetlands, the temporary off-leash dog area, the Cooks River and Coleman Reserve are likely to have negligible or low levels of sensitivity as they are likely to have minimal vulnerabilities and a high ability to absorb or adapt to amenity changes, particularly given the existing proximity to the airport. The magnitude of the impact would be low due to the number of users with the potential to be affected. The level of significance would therefore be negligible to low.

As outlined in Chapter 10 (Noise and vibration), noise increases are considered minimal at other community facilities in proximity to the project, including Guardian Early Learning Centre, Betty Spears Child Care Centre and Aero Kids Early Learning Centre, St Peters Anglican Church, and St Peter and St Paul Catholic Church. Any increases would potentially disturb learning and play activities at childcare centres, particularly where they are occurring outdoors and any services or other activities undertaken at the places of worship. Such impacts are considered minimal as predicted increases are based on the worst case construction scenarios and the implementation of mitigation measures provided in Chapter 10 would reduce potential impacts.

Most users of churches are expected to have negligible to low levels of sensitivity as they are likely to have minimal vulnerabilities and a high ability to absorb or adapt to amenity changes. The magnitude would be low due to the number of users affected. The level of significance would be negligible to low. However, most users of child care centres are likely to have moderate to high sensitivity to amenity impacts; therefore, the level of significance would be moderate to moderate-low.

Business amenity impacts

Changes in amenity can affect the enjoyment and desirability of the business environment, influencing how customers choose businesses in the study area.

As discussed in Chapter 10 (Noise and vibration), businesses close to the project site would experience an increase in external noise levels during construction. This could impact on worker productivity, employee health and wellbeing affecting business revenue. Vibration impacts may also cause increased stress and anxiety for employees and customers.

Construction may result in noise increases at the Mantra Hotel, the planned hotel on Ninth Street, Stamford Plaza, Ibis Budget Sydney Airport, Citadines Connect Sydney Airport, Quest Mascot and Travelodge. These businesses may experience reduced customer experience and satisfaction, resulting in a reduction in repeat or new customers.

The Qantas Flight Training Centre has several areas that are potentially sensitive to noise impacts, including the flight simulator facilities. Although Qantas is proposing to relocate the training centre to a new site (see Table 19.3), it may continue to operate in its existing location during the initial phases of construction. In a worst-case scenario, construction work would be immediately outside the facility, generating moderate to high noise exceedances.

Overall, most businesses in the study area have a low sensitivity to noise and the magnitude of change from the existing environment would be negligible. Construction noise would be noticeable, albeit intermittent and temporary, in locations immediately adjacent to the proposed construction compounds in the Sydney Airport (north eastern section), O’Riordan Street business precinct and Qantas Drive industrial precincts. The magnitude of impact would be low. Businesses in these precincts are mostly industrial and commercial, with low noise sensitivity, and would be able adapt to the change. A small number of receivers, including some of the hotels and the Qantas Flight Training Centre, have a moderate sensitivity to noise, with some ability to adapt to the change. The level of significance would be moderate-low.

Construction of the grade-separated road connection that forms part of the Terminals 2/3 access would reduce the exposure of businesses on the corner of Sir Reginald Ansett Drive and Qantas Drive. This includes the AMG car dealership and service centre and the proposed airport hotel. This would impact these businesses due to the reduced visibility. Construction of the Terminals 2/3 access would also obstruct views to three advertising signs on Qantas Drive (eastbound). The change would have a consequence on advertising sales and business revenue.

In most instances, businesses in the study area would be unaffected by visual changes and would have a negligible sensitivity. However, a small number of businesses would be moderately sensitive. The magnitude of change experienced in most areas would be negligible; however, a small number of businesses would experience a moderate magnitude of change. The overall level of significance would be negligible, but would be moderate for individual businesses, such as AMG and owners of advertising signs.

Construction dust can result in increased operating costs, reduced hygiene or increased respiratory issues for employees or customers. Vehicle related businesses, including vehicle hire services, car dealerships and car washes, would also be sensitive to dust. There are several food handling and catering businesses close to the construction footprint in the Qantas Drive industrial precinct and in Sydney Airport along Ross Smith Avenue, which would have higher sensitivity to dust.

With the implementation of mitigation measures in section 12.7, air quality impacts would result in a low magnitude of change. In most instances, businesses in the study area would be unaffected by air quality changes and would have a negligible sensitivity. However, some businesses would have moderate sensitivity. The overall level of significance would be low.

The implementation of mitigation measures provided in other relevant chapters in Part B would assist in reducing the potential for amenity impacts on businesses.

20.3.4 Economic impacts and benefits

During construction, the project would provide some benefits to businesses, including increased demand for services or expenditure at businesses within the study area.

Expenditure and employment

Construction would directly benefit the economy by injecting economic stimulus into the local, regional and state economies. The economic benefits of construction would include:

- Increased expenditure at local and regional businesses through purchases by construction workers
- Direct employment associated with on-site construction activities
- Direct expenditure associated with on-site construction activities
- Indirect employment and expenditure through the provision of goods and services required for construction.

Over 12 per cent of businesses in the study area supply construction services or materials and products used in construction, such as Boral Concrete. These businesses may benefit from the increase in demand.

As noted in Chapter 8 (Construction), the construction workforce requirements would vary over the construction period in response to the activities underway and the number of active work areas. The workforce is expected to peak at about 1,000 workers for a period of about 13 months, indicatively from the fourth quarter of 2021. Either side of this peak, workforce numbers are expected to reduce by about a third. A smaller start-up/close-out workforce (fewer than 400 workers) would be on site for the initial and final months of the program. Final construction workforce requirements would be confirmed by the construction contractor(s). In addition to the above, it is estimated that the project would generate around 3,000 indirect jobs per year over the construction period.

Construction workers would generate additional sources of retail expenditure for nearby businesses. This would be spent predominantly on convenience-related items such as lunches, coffees, snacks, shopping etc. It is estimated that workers would spend an average of $2,400 per worker per year in the study area and retailers could capture about $1.79 million in additional expenditure annually. This additional expenditure could total an additional $6.27 million over the construction period. Locations that may benefit from the increase in worker expenditure include:

- Mascot town centre, which is the largest retail centre close to the project site
- Takeaway food retailers along Ross Smith Drive and Princes Highway
- Hotels in the vicinity of Sydney Airport if workers are required to stay overnight
- Restaurants and cafes in the study area.

Overall, construction would produce medium to long-term job opportunities, skill development and economic benefit to the area.

Impacts on employment levels at Sydney Airport

Sydney Airport indirectly supports about 57,400 full-time equivalent jobs via economic contributions, with around 32,700 jobs at the airport itself (Deloitte Access Economics, 2018; SACL, 2019a). While construction has the potential to affect access and connectivity for employees using the road system to access the airport (see section 20.3.2), it is unlikely to affect employment levels at Sydney Airport.

Flow-on economic benefits related to construction

Using ABS multiplier tables and a construction cost estimate of $1.65 billion, the economic multipliers indicate that construction would generate around $2.2 billion of activity in production-induced effects and around $1.5 billion in consumption-induced effects. Overall, it is estimated that construction would have long-term economic benefit to the region, generating about $5.3 billion in total economic activity.

Broader effects on the freight management/container storage industry as a result of project impacts

As described in Chapter 19 (Land use and property) and section 20.3.1, the project would require land currently occupied by Tyne Container Services. This would mean that the business would no longer be able to operate at this site. The project would also require cessation of the lease over the area that is currently leased from Sydney Airport Corporation for overflow container storage by the Cooks River Intermodal Terminal. It may also affect a small area of land on the Cooks River Intermodal Terminal site.

The above areas provide empty container storage and services. The role and functions of empty container parks in the freight industry are discussed in Appendix D of Technical Working Paper 12 (Business Impact Assessment). A summary of the potential effects on this industry of the project’s land requirements is provided below.

Eleven empty container parks operate in Sydney with a cumulative capacity of about 58,000 twenty-foot equivalent unit containers across an overall total storage area of 55 hectares. This includes the Tyne Container Services site and the Cooks River Intermodal Terminal. The Tyne Container Services site has an area of about 10 hectares, and the Cooks River Intermodal Terminal site has an area of about 12 hectares, representing about 40 per cent of the overall area of empty container parks in Sydney. This capacity has remained largely unchanged since 2015.

In recent years, the supply of empty containers requiring temporary storage prior to export/import has increased. The empty container park sector has reached a situation where the available capacity has been exhausted. Since 2017, trade imbalances and the drought have caused a substantial build-up of empty containers in Sydney. Empty container parks are reported to be at about 85 to 95 per cent of capacity, with an overflow of empty containers required at more than 20 transport depots.

This capacity issue would be worsened by the impacts on the Tyne Container Services site and the Cooks River Intermodal Terminal (mainly as a result of the cessation of the lease from Sydney Airport Corporation of the overflow storage area). As a result of the project’s land requirements there would be an estimated capacity loss of up to about 12,000 twenty-foot equivalent units (an average storage volume of 9,000 twenty-foot equivalent units) on the basis that:

- Efficiency improvements are not realised in the container supply chain
- Relocation of the existing storage is not possible.

The expected increase in empty container storage capacity at the new/expanded intermodal terminal developments at Moorebank, Enfield and St Marys, and expansion of the direct delivery of empty containers to Port Botany, may assist in offsetting the loss of capacity as a result of the project. This would depend on the ramp-up of operations at intermodal terminals between 2019 and 2021 before this land is required for the project. In addition, further expansion in the capacity of intermodal terminals and empty container parks after 2023 would be necessary to support the predicted growth in Port Botany’s throughput.

There is a preference for empty container storage parks to be near Port Botany to reduce travel time and associated costs. Road transport presently accounts for around 85 per cent of the containers moved to and from Port Botany, with the balance carried by rail to and from metropolitan and regional intermodal terminals. The project has the potential to affect traffic and access during construction, which could create further time and cost inefficiencies for the empty container transport industry. Without a suitable nearby alternative for Tyne Container Services, local importers, exporters and shipping companies may face additional costs associated with accessing intermodal terminals. As a result, container turnover times may increase.

The industry is highly sensitive to changes in capacity. Assuming the worst-case scenario, the magnitude of impacts of the project would be moderate and the level of significance would be high to moderate. This scenario would include:

- Additional container storage is not available prior to closure of Tyne Container Services and the effects on container storage capacity at Cooks River Intermodal Terminal
- Efficiency improvements are not realised in the container supply chain.

In July 2019, Transport for NSW commissioned a study to identify broader issues associated with the management of empty containers, including impacts on the supply chain, availability of storage space and potential initiatives to improve container management. This study will investigate empty container management issues, impacts of container storage availability on the supply chain and immediate, short and longer-term initiatives to address these issues.

Transport for NSW is currently in the process of finalising the study and, once complete, it will engage stakeholders on recommended outcomes and actions. The draft study’s emerging recommendations point towards a greater need for data sharing and transparency and the identification of opportunities to improve the efficiency of current empty container supply chain operations. This may include the need for industry and government to work collaboratively to solve these issues.

Roads and Maritime would continue to work closely with Transport for NSW in relation to management of empty containers, including the timing and implementation of any actions resulting from the project.

Employment land supply and economic productivity

The project’s land requirements would reduce the supply of industrial and business zoned land (employment land) in the study area (see Chapter 19 (Land use and property)). Land in this area that is suitable for industrial uses is scarce and in high demand. The project would result in a loss of over 10 hectares of industrial zoned land. This would have the potential to affect the long-term economic productivity of the area and associated employment opportunities.

A reduction in the supply of employment land can increase demand for remaining land, affecting rents and potentially displacing less viable businesses. Due to the near city location of the study area and the limited availability of new employment land, the area is considered to be highly sensitive to changes in the supply of employment land. The magnitude of change is considered to be moderate, with the level of significance of these impacts considered to be high to moderate.

Impacts on utilities are likely to be temporary and would be managed in consultation with relevant utility service providers and the affected utility user in accordance with the mitigation measures provided in Chapter 19 (Land use and property).

20.3.5 Summary of impacts on Sydney Airport (Commonwealth) land

Considering the number of people employed at Sydney Airport and the number of passengers that travel to and from the airport, the airport and associated businesses are sensitive to changes in access and connectivity. Sydney Airport is located in a predominantly industrial/commercial area with a range of significant transport infrastructure, including the airport itself. As a result, most businesses on Sydney Airport land would not be sensitive to changes in amenity, with the exception of hotels, retail facilities and the Qantas Flight Training Centre.

Potential impacts on Sydney Airport land during construction are discussed in sections 20.3.1 to 20.3.4. In summary, the main impacts include:

- Socio-economic impacts as a result of the project's land requirements, including:
  - Relocation of the Qantas Flight Training Centre with potential impacts on training schedules and inconvenience to business operations
  - Relocation/closure of Boral Recycling and Visy Recycling, and alterations to land available for the Cooks River Intermodal Terminal overflow operations, with the potential for impacts on the business and employees
  - Impacts to the Sydney Airport mail handling unit, DHL and livestock transfer facility, including effects on parking and access
  - Removal of 18 advertising signs from Sydney Airport land, resulting in reduced exposure and potential loss of revenue for advertising companies/owners
- Changes to access and traffic, with the potential for:
  - Delays for airline passengers, crew and employees, potentially affecting business efficiency and revenue
  - More time needed for travel, affecting time available for leisure and social activities
  - Reduced efficiency of freight and product transfer
  - Amenity impacts (increases in noise, vibration and dust) at hotels and businesses on Sydney Airport land, with the potential to affect businesses, employees and customers
  - Reduced exposure for advertising signs and businesses.

The assessment of significance undertaken with consideration of the people and community guidance criteria defined by the *Significant impact guidelines 1.2 – Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies* (DSEWPC, 2013) (Significant Impact Guidelines 1.2) concluded that construction would not result in significant socio-economic impacts overall.

Local economy

Potential benefits on the local economy are described in section 20.3.4. Retailers on Sydney Airport land would benefit from the expenditure of the construction workforce, including those along Ross Smith Drive that offer takeaway food services, car park operators, car wash operators and hotels.

20.4 Assessment of operation impacts

The main potential for socio-economic impacts and benefits during operation would occur as a result of:

- The project's permanent land requirements
- Improved connectivity and travel times
- Community amenity benefits and impacts
- Economic impacts and benefits.

Potential impacts and benefits are summarised below.

20.4.1 Land requirements

Business impacts as a result of the project's land requirements

The majority of business impacts as a result of the project's land requirement would occur during construction and are discussed in Table 20.4. Some of the land would only be required during construction. This land would be returned to the land owner and would be available for the business on the site once construction is complete. Table 20.5 outlines the changes to business impacts as a result of changes to land requirements for operation, with all other impacts as per Table 20.4.

Table 20.5 Business impacts as a result of the project's land requirements during operation

Business	Summary of impacts
Maritime Container Services (as operators of the Cooks River Intermodal Terminal)	Up to about 0.9 hectares of land may continue to be required as part of the project's operational footprint. The potential business impacts of this land requirement are described in Table 20.4.
Boral Concrete	About 0.1 hectares (2.3 per cent) of the property would continue to be required as part of the project's operational footprint. The potential business impacts of this land requirement are described in Table 20.4.
Sydney Airport Jet Base	About 1.3 hectares of the overall site would continue to be required as part of the project's operational footprint. Areas used during construction that are not required for operation (about 3.2 hectares) would be available for other uses in accordance with the Master Plan.

Community infrastructure impacts as a result of the project's land requirements

The project would result in the permanent loss of around one hectare of land within Tempe Lands. This area includes land currently occupied by the Tempe Golf Range and Academy and the off-leash dog exercise area. However, upon completion of the project, up to 10 hectares of residual land would be available for use in this area. This would consist of land temporarily required during construction, including about four hectares currently occupied by recreational facilities within Tempe Lands, and land currently occupied by Tyne Container Services. Potential future uses could include open/space recreation or other future uses in accordance with the priorities of local and regional strategic planning and Inner West Council.

Inner West Council is developing a master plan to identify how this land could be used, which will consider the results of a recreational needs analysis prepared in 2018. The future use of this land would be subject to a separate assessment and approval process.

Roads and Maritime is continuing to consult with Inner West Council on the draft master plan, including providing feedback received from the community in relation to their preferences for the future use of this land. During consultation for the project, Roads and Maritime has received feedback from the local community and Council on future uses and amenities at Tempe Lands. This has included requests for:

- A new off-leash dog area

- Recreational facilities, including floodlit futsal fields and changing rooms
- Passive open space and walking paths
- Barbeque facilities, seating and shaded areas
- Children's playground
- Car parking.

Roads and Maritime would continue to consult with Council about compensation for the purposes of offsetting the loss of public open space and recreational facilities at Tempe Lands, and in relation to consistency between the project's urban design and landscape plan and Council's master plan for the future use of Tempe Lands and adjoining areas.

20.4.2 Access and connectivity

As discussed in Chapter 9 (Traffic, transport and access), the project would:

- Provide a new high capacity, direct and continuous connection between the Sydney motorway network and Sydney Airport's terminals
- Reduce daily traffic flows on Botany Road (through Mascot town centre) and O'Riordan Street by between 25 to 30 per cent
- Reduce daily traffic flows on the Princes Highway by about eight per cent in 2036
- Reduce delays at intersections within the study area, including in Mascot and the intersection of Bourke Street and Coward Street, which accommodate high pedestrian crossing activity
- Make it easier to access Terminals 2/3 and providing better separation for Sydney Airport and through traffic.

Social impacts

The project would improve traffic flow and travel times for road users, including local residents, commuters and general community members, and travellers accessing Sydney Airport and nearby community infrastructure.

Reducing traffic along Botany Road through Mascot and on the Princes Highway has the potential to reduce barriers for travel across these roads. This would benefit pedestrians and people with mobility difficulties, with the potential for increased opportunities for community participation and greater cohesion for communities.

The project would benefit regional and Greater Sydney communities by providing faster and more efficient travel to Sydney Airport, Mascot and Port Botany and along the employment corridor between the Sydney central business district and these locations. Reduced travel times would allow people to spend more time on leisure and social activities.

Substantially improved bus travel times along key corridors would benefit several routes servicing the airport and surrounding areas. However, the removal of the bus stops at Lancastrian Road (on Qantas Drive) would change access arrangements for a small number of employees at the Jet Base who use bus routes 400 and 420. The business survey indicated that about three per cent of local employees travel by bus to work in the study area. A proportion of these would have high sensitivity to changes in the bus network. The nearest bus stops are at Terminals 2/3 about 750 metres away.

Business impacts

The project is expected to provide long-term benefits for businesses in the local area and Greater Sydney, including:

- Enhanced road network capacity and connectivity improving the efficiency of freight and commercial vehicle movements between major economic regions of Sydney, increasing trade catchments and business productivity, and reducing overhead costs

- Improved road network travel speeds, which would improve travel times for existing employees and customers, potentially attracting new employees and customers
- Additional employment opportunities and economic benefits if businesses attracted to the enhanced connections relocate to the area
- Improved connectivity to Sydney Airport and Port Botany for businesses across Greater Sydney, expanding economic supply chains and attracting new investment
- Unlocking the capacity for Sydney Airport and surrounding industrial land to expand operations and increase employment and economic output
- Redistribution of traffic (including heavy vehicles) from local to arterial roads, improving the amenity and safety of the business environment and enhancing access and connectivity
- Improvements in the reliability, connectivity and safety of the active transport and public transport network.

Reduced local traffic in Mascot along Botany Road (though the town centre), and along local roads in Mascot more generally, may improve amenity, creating the potential to attract new businesses, more customers, and improve performance. Retail and customer service businesses are most likely to benefit from this change. Conversely, a reduction in the volume of traffic on local streets may reduce business exposure and passing trade. Based on the business survey, businesses in this area are considered to have a higher dependency on passing trade from local residents and workers. The improvements to amenity of Mascot would have the potential to counter the effects of any reduction in vehicle passing trade.

The increased traffic on Qantas Drive may increase passing trade for takeaway food and car services along Ross Smith Avenue in the Sydney Airport precinct's north-east sector. It could also enhance the exposure of businesses fronting Joyce Drive and Qantas Drive, including the hotels in this area.

Improved travel times would benefit employees and customers travelling by car and bus. Commuting via the road network is the dominant journey to work method for residents in the study area. Connections to the freight and passenger terminals at Sydney Airport would be more direct and efficient. This could reduce stress and anxiety for people travelling to the airport and provide more time at the airport. Travel time efficiencies could also be achieved for servicing and deliveries at businesses in the Sydney Airport precinct, which could improve business productivity and reduce overhead costs.

20.4.3 Amenity

Social amenity impacts

Operation has the potential to generate some amenity changes, including increases to noise in some areas, and changes to visual amenity and air quality.

Noise and vibration

As discussed in Chapter 10 (Noise and vibration), the project has the potential to increase noise levels at some residential properties due to the presence of new road infrastructure and the removal of structures (such as buildings and shipping containers), which currently provide shielding to ground noise.

The assessment identified that residents are likely to be sensitive to noise. Residents in the eastern part of Tempe are considered to have a higher level of sensitivity to noise due to the level of concerns raised during the consultation process. The magnitude of impacts was considered to be low, as only some areas would have the potential to be affected. The overall level of significance of these impacts was considered to be low for Mascot residents and moderate-low for residents in the eastern part of Tempe. Hotel guests would have a negligible level of sensitivity due to the temporary nature of their occupancy. The magnitude would be low, as noise would only affect some facilities. Overall, the level of significance would be negligible. Vulnerable residents would have a moderate to high level of sensitivity, therefore the level of significance would be moderate to moderate-low.

The mitigation measures described in Chapter 10 would be implemented to minimise the potential for operational noise impacts.

Visual amenity

Residents, road users, community facilities users, pedestrians and cyclists are likely to experience changes in the visual amenity due to the presence of new road infrastructure. Visual amenity impacts would occur where permanent facilities are located. The presence of new road infrastructure would alter the character of Tempe Lands. As discussed in section 20.2.4, residents in the eastern part of Tempe value green and natural spaces, and may have low sensitivity to these visual changes. The magnitude of the change is considered to be low, due to the existing amenity and character of the area. The significance of the impact would be low.

The new elevated road infrastructure and loss of vegetation near Terminal 2/3 would alter views, which would permanently change the visual environment for people using Qantas Drive, potentially affecting what local residents value about their local area. Given most people would only be exposed to these visual changes while travelling along the road, it is unlikely to impact people's day-to-day activities or values. Most community members may have low sensitivity to these visual changes as they would be expected to have a high ability to adapt. The magnitude may be low to moderate as there would be long-term changes, but may only affect some community members. The significance would therefore be low to moderate-low.

Changes to the visual form of the heritage listed Alexandra Canal, including the introduction of new bridges and the new, shared path adjacent to the canal, would be of interest to heritage groups and other members of the community. People who value the significance of Alexandra Canal may have moderate sensitivity to these visual changes. The magnitude of the change is considered to be low due to the existing amenity and character of the area. The significance of the impact would be moderate-low. Mitigation measures in Chapter 17 (Non-Aboriginal heritage) would be implemented to minimise impacts on the heritage significance of the canal.

Mitigation measures in Chapter 21 (Landscape character and visual amenity) would be implemented to minimise impacts on visual amenity.

Air quality

The project would improve air quality on the M5 Motorway, Southern Cross Drive, Botany Road and Canal Road due to reduced traffic volumes. These roads traverse industrial, commercial, residential and open space areas, including Mascot town centre, and are used by local residents, commuters, pedestrians, cyclists, and workers at local businesses. Air quality changes are not expected to be noticeable to most people. Some people may perceive an improvement to air quality, which could lead to more people choosing to walk and cycle along these roads, increasing active travel.

The air quality assessment (see Chapter 12 (Air quality)) predicted minor increases in pollutants at some locations. The magnitude of this impact is considered negligible and is unlikely to change people's day-to-day activities. Some vulnerable community members may be more sensitive to air quality changes, such as older people, children, and people with medical conditions such as asthma.

Most people are expected to have a low to moderate sensitivity to air quality changes. Vulnerable residents may have moderate to high levels of sensitivity, however the magnitude of the impact is expected to be negligible therefore the level of significance for residents would be negligible.

Mitigation measures in Chapter 12 (Air quality) would be implemented to minimise impacts on air quality.

Community infrastructure amenity impacts

Users of the Tempe Recreation Reserve, Tempe Wetlands, the Cooks River, Coleman Reserve and Tempe Lands would potentially experience increased levels of noise and a change in the visual environment. The overall function of open space areas is not expected to be affected by the project.

Overall, most users of these facilities are likely to have low to moderate levels of sensitivity. Given the existing proximity to Sydney Airport and the associated noise, air quality and visual environment. The magnitude is considered to be low. The level of significance would therefore be moderate-low to low.

There is the potential for impacts on the amenity of Coleman Reserve (as a result of noise impacts and changes to the visual catchment), which would affect amenity for users of the reserve, including pedestrians and workers who use the reserve during breaks. These users are expected to have negligible to low sensitivity. The magnitude would be low, therefore the significance would be low to moderate-low.

Business amenity impacts

Increased noise and visual alterations during operation would mainly affect businesses (including hotels) around the Qantas Drive, O'Riordan Street and Sir Reginald Ansett Drive intersection. Changes in amenity can affect the enjoyment and desirability of the business environment, influencing how many customers choose businesses. The business survey identified that the majority (55 per cent) of respondents stated that operation of the project would result in neutral impacts on amenity. Twenty-eight per cent stated the impacts would be positive, two per cent stated that impacts would be negative, and 14 per cent stated that they were unsure/not applicable.

Operational noise impacts are predicted to increase at businesses near O'Riordan Street in Mascot, due to the removal of several airport buildings adjacent to Qantas Drive, which were previously shielding businesses from on-ground aircraft noise. An increase in noise levels, particularly at night time, is predicted near the Joyce Drive and O'Riordan Street intersection, and on Baxter Road in Mascot. Hotels on Sydney Airport land may also experience increased noise levels. Hotels that do not have high performance facades have the potential to be sensitive to high noise levels, as they rely on providing a positive customer experience.

Overall, most businesses in the study area have low sensitivity to noise and the magnitude of change from the existing environment would be negligible. A small number of receivers, including some hotels and the Qantas Flight Training Facility, have moderate sensitivity to noise. The magnitude of change from the existing environment would be low, as noise increases would be confined to receptors in a limited geographic area. The level of significance would be low.

The increase in traffic volumes predicted along Qantas Drive and the new project alignment, compared to the current volumes, would increase exposure for existing signs.

Three advertising signs along Qantas Drive (eastbound) would be indirectly impacted. Views to the signs would be obscured by the grade-separated road connection to Terminals 2/3, resulting in reduced rent return and exposure. The proposed elevated viaduct could also reduce exposure to passing traffic for AMG. As a retail premises, the business would be moderately sensitive to reductions in business visibility. The magnitude of change would be moderate and the level of significance moderate.

The project would create the opportunity to deliver an entry statement design feature that would enhance the arrival and departure experience for visitors arriving to Sydney via Sydney Airport. The project would also provide the opportunity for advertising structures to be included in the design, which could support advertising signage in the future.

Overall, the amenity impacts described above are unlikely to affect the long-term function and viability of businesses. The overall benefits of the project, in conjunction with other major transport projects, would provide long-term benefits to businesses across Greater Sydney.

20.4.4 Economic impacts and benefits

The project would lead to improved travel times to Sydney Airport terminals, and the Mascot and Port Botany precincts. It would provide greater network capacity and resilience for more efficient distribution of freight to and from the airport and port, and logistic centres in Western Sydney. It is also expected to reduce congestion and heavy vehicle movements through the local road network.

Based on the above, the project is expected to result in economic benefits to Greater Sydney communities. Faster travel times and less congestion on the local road network would benefit workers who currently travel by road to and from the airport and port, including those employed in airport and port-related industries, surrounding employment areas, as well as passengers travelling via the airport for business purposes. This is expected to enhance overall productivity, while also benefiting individual workers.

The project would lead to improved efficiency of Sydney's economic supply chain and movement of goods to businesses in Greater Sydney. This could indirectly benefit business owners and employees through increased productivity and reduce freight costs, which could increase income generation. This could also support the development of businesses and industry on land west of Alexandra Canal, including freight, catering, storage and maintenance, truck staging and vehicle storage. It would also provide the opportunity for expanded airport operations, including additional commercial development and freight airline movements. This would indirectly benefit the economy through increased business and tourism expenditure.

As discussed in section 20.3.4, the project would impact on areas available for empty container storage with the potential to have a broader consequence on the sustainability of the industry. However, this impact would be alleviated if proposed/expanded intermodal terminals are operational before construction of the project.

Local and regional operational economic effects

The *Sydney Airport Master Plan 2039* (the Master Plan) notes that with the project, Sydney Airport's northern lands could be developed for airside aviation support activities, including freight, catering, storage and maintenance, truck staging and vehicle storage. Increased road capacity would also provide an opportunity to expand airport operations, including additional commercial development and growth in passenger and freight airline movements in line with the Master Plan. This would indirectly support the economy by increasing employment opportunities, increased business and tourism expenditure.

The project has the potential to contribute to lower costs associated with transport and access to Sydney Airport, Port Botany and businesses in the study area, with associated opportunities for expansion of businesses local and regionally. Such expansion could increase job opportunities and provide economic benefits associated with increased trade and employment.

Other potential long-term benefits for the local and regional economies include:

- Broadening trade catchments
- Enhancing freight network efficiency
- Enhancing employment connectivity.

These are described below.

Altered trade catchments

Improvements in travel times would have the potential to expand catchment areas for some businesses, as customers further afield would be able to bypass inner city pinch points and access these businesses. This can benefit business and the economy by:

- Increasing efficiency and appeal of businesses to customers
- Increasing distribution capability and delivery times for businesses
- Reducing transport costs and improved reliability for businesses, employees and customers
- Linking regional importers, exporters and services to the trade gateways of Sydney Airport and Port Botany via enhanced connections to the Sydney motorway network.

The benefits would be long-term and positive.

Freight and efficiency costs

The freight industry is an important part of the NSW economy as an enabler of economic activity. Numerous industries depend on efficient transport to service operational requirements. In 2019, the transport, postal and warehousing industry contributed $22.6 billion to the national economy, representing 5.1 per cent of the total value generated by all industries (ABS, 2019).

Air freight handled by Sydney Airport is predicted to increase by about 58 per cent – from 643,000 tonnes in 2017 to around one million tonnes in 2039 (SACL, 2019a). The amount of container freight handled by Port Botany is predicted to significantly increase – from 14.4 million tonnes in 2016 to 25.5 million tonnes in

2036 (77 per cent increase) (Transport for NSW, 2018a). Transporting this freight to and from the airport will place additional demands on the road network in the study area.

As noted in section 20.4.2 and described further in Chapter 9 (Traffic, transport and access), the project would improve access, connectivity and travel times. Benefits of travel time improvements include:

- Reduction in operating costs (eg wear and tear associated with extended periods of slow movement)
- Reliability benefits (eg reduction in variance in travel time allowing for efficient scheduling)
- Direct travel time savings (eg reduction in real or opportunity costs associated with transit times).

As a result, the project would have the potential to

- Increase the efficiency and reliability of freight movements on the local and regional road network
- increase capacity for product distribution
- Reduce overhead costs for businesses
- Enhance transport and logistics scheduling and productivity.

Employment connectivity

Over 500,000 of Sydney's jobs are located in the Eastern Economic Corridor, which extends from Macquarie Park in the north via the Sydney central business district, to Port Botany and Sydney Airport (Greater Sydney Commission, 2018). The study area accommodates about a fifth of these jobs (ABS, 2016). Businesses surveyed identified that congestion is a significant factor in attracting and retaining employees. Congestion may also affect access to employment opportunities for some residents in the study area.

With the expected job growth across the eastern economic corridor, businesses within the study area would face further competition for skilled workers.

The project would address this issue by reducing travel times on key routes. These long-term improvements would assist in connecting Sydney Airport and local businesses with potential employees, while also increasing the employment catchments of local and regional residents affected by congestion.

For commuters, the project would contribute to a more reliable road network, with the potential for reductions in commuting time and lower vehicle operating costs. This would benefit Greater Sydney, particularly residents and businesses in Western Sydney who would have enhanced, direct motorway access to the study area and Sydney Airport.

20.4.5 Summary of impacts on Sydney Airport (Commonwealth) land

The project would provide socio-economic benefits to Sydney Airport, mainly related to improved connectivity and faster travel times. This could result in increased economic productivity and employment opportunity at Sydney Airport. The project would also provide opportunities for a new 'Gateway' entry statement to welcome domestic and international visitors.

General community members, workers and travellers commuting to and from Sydney Airport would experience increased connectivity and faster travel times. Reduced travel times could increase the time people spend with families or undertaking social activities.

Potential impacts on Sydney Airport land are discussed in sections 20.4.1 to 20.4.4. Key potential impacts include amenity impacts (increased noise, changes to air quality and visual amenity) at Coleman Reserve and businesses on Sydney Airport land, including hotels and AMG.

Changes to the visual environment as a result of the new elevated road infrastructure near Terminals 2/3 would alter views along the road corridor. Visual impacts are unlikely to affect most business owners, customers and employees. However, changes to visibility may affect some businesses such as AMG.

The assessment of significance undertaken with consideration of the people and community guidance criteria in the Significant Impact Guidelines 1.2 concluded that the project would not result in significant socio-economic impacts.

Employment levels

The project would facilitate the delivery of key planning directions in the Master Plan by delivering additional road capacity to Sydney Airport. It would have the potential to service and facilitate growth of airline services, aviation support facilities, freight and commercial services on airport land in accordance with the plan.

The Master Plan indicates that an additional 3,500 full time equivalent jobs could be created at Sydney Airport between 2019 and 2024. This project would assist in meeting the access and connectivity demands that this growth would generate.

Local and regional economy

The project would provide direct access to the Sydney motorway network for businesses on Sydney Airport land. This has the potential to benefit the local and regional economy by:

- Facilitating the achievement of key planning directions in the Master Plan
- Broadening trade catchments
- Enhancing the efficiency of the freight network
- Enhancing employment connectivity
- Enhancing customer connectivity
- Attracting new business investment.

The project would provide enhanced road connections to Sydney Airport, contributing to the future economic productivity and efficiency of the airport itself, as well as that of businesses on Sydney Airport land.

Consistency with the Sydney Airport Master Plan

The Master Plan forecasts significant commercial development and employment increases on Sydney Airport land, requiring enhanced ground transport connectivity, with the project supporting this growth by improving access (as described in Chapter 9 (Traffic, transport and access)).

The project is consistent with relevant social and economic directions of the Master Plan, as it aligns with its vision and objectives (see section 3.6), is identified as a key project, and is likely to deliver the benefits forecast. The project would improve connectivity and travel times to Sydney Airport, which would contribute to regional economic growth. Improved access to Sydney Airport would also benefit employees and visitors.

20.5 Cumulative impacts

20.5.1 Construction

Constructing the project concurrently with the Botany Rail Line Duplication and other projects, including the Airport North Precinct Upgrade, F6 Extension, M4-M5 Link and New M5, Sydney Airport Terminals 2/3 Ground Access Solutions and Hotel, would have the potential for the following cumulative socio-economic impacts:

- Further impacts on amenity from additional construction noise for some residents, business owners, employees, customers and guests of hotels close to the project sites where they are located in close proximity

- Access and connectivity impacts, which could cause annoyance and reduce time people can spend on leisure or other important activities
- Potential for construction fatigue where people experience impacts over an extended period of time from multiple projects. This can lead to annoyance, inconvenience, diminished sense of pride, reduced capacity to participate in work and community activities, affect personal relationships, and reduce social interactions. Further information on the potential for construction fatigue is provided in section 23.3.1
- Business owners may have greater difficulty attracting and retaining employees and customers, which could lead to stress and worry.

Cumulative benefits associated with constructing the project concurrently with other projects include job and income generation opportunities.

20.5.2 Operation

Once operational, the Sydney Gateway road project and Botany Rail Line Duplication, as well as the other major transport projects, are predicted to deliver cumulative benefits.

As discussed in Chapter 9 (Traffic and transport), the cumulative road network would carry more traffic and record a higher than average trip speed for vehicles. The inclusion of the F6 Extension and Western Harbour Tunnel would reduce the daily traffic volumes predicted on the A1, M1 Motorway and Southern Cross Drive. Additional traffic reductions within the study area are also predicted in both directions in Mascot along O'Riordan Street, the Princes Highway and on Botany Road.

The delivery of all major transport projects would provide cumulative benefits, including:

- Supporting Sydney's long-term economic and employment growth, through improved transport connectivity to key employment areas across the city
- Alleviating congestion and contributing to improved connectivity, speeds, reliability and safety of the broader road network, which is of particular importance to the contribution and efficiencies of the freight industry
- Generating economic effects and benefits to businesses through reduced operational expenses and opportunity for increased revenues from expanded trade catchments
- Improved business viability and centre regeneration opportunity as a result of new connections
- Improved connections across the network, enhancing accessibility for customers and employees and creating greater opportunity for business synergies
- Attraction of new business investment, enhancing agglomeration effects for existing businesses and local economic productivity
- Amplified productivity resulting from freight efficiency, benefiting businesses and employees
- Improved travel times on local roads, reduction in perceived barriers, and improved amenity in Mascot town centre
- Local and regional connectivity for commuter and recreational cyclists associated with the new active transport link.

While the project would generally be beneficial, it would increase the volume of vehicles travelling on some roads, including Qantas Drive. The increase in vehicles at the main motorway access locations would have the potential to affect the amenity of the local environment, associated with an increase in traffic noise and reduction in air quality. This is unlikely to have a noticeable impact.

In addition, the reduction of traffic on surface roads would improve the road network and allow for enhanced bus services. Cumulative time savings (with other approved projects) would be about 50 per cent during morning and evening peaks, representing significant time savings that may increase the attractiveness of bus services for local workers, further reducing costs associated with transit.

20.6 Management of impacts

20.6.1 Approach

Approach to mitigation and management

Approach to managing the key potential impacts identified

Comprehensive and appropriate communication and consultation with the community and other key stakeholders will play a key role in managing the potential for socio-economic impacts during construction and operation. Effective communication and engagement are fundamental to reducing risk and minimising potential impacts. Identifying, engaging and effectively communicating with stakeholders is critical to the successful delivery of the project. As described in Chapter 4 (Consultation), the approach to consultation aims to:

- Build relationships with key stakeholders
- Establish a broad understanding of the need for the project
- Provide clear, concise and targeted information which is readily accessible to all stakeholder groups
- Establish channels for feedback and dialogue
- Understand community and stakeholder issues
- Inform project development, construction planning and environmental assessment
- Create opportunities to raise awareness of the project.

Roads and Maritime and Sydney Airport Corporation would continue to engage with stakeholders and the community in the lead up to, and during, construction. A communications strategy would be developed for the construction phase to ensure that:

- The community and stakeholders have a high level of awareness and forewarning of all processes and activities
- Accurate and accessible information is made available
- A timely response is given to issues and concerns raised by the community
- Feedback from the community is encouraged
- Opportunities for input are provided.

In relation to the potential for socio-economic impacts, the strategy would include:

- Communication with potentially affected residents, other community members, businesses and other key stakeholders to provide information about the project, and the likely nature, extent and duration of amenity and access changes during construction
- Protocols to identify and engage with vulnerable persons that might be affected by construction, including families with children, people with need for assistance, older people, people with disability, people with mobility difficulties or medical conditions, and culturally and linguistically diverse people
- Protocols for communicating information about potential access changes and delays in and around Sydney Airport and other relevant project information.

Further information about consultation during project delivery is provided in Chapter 4.

Business management plans would be prepared and implemented for businesses that would be affected by the project. The plans would be developed on a case by case basis and would detail specific measures, developed in consultation with the business operator. These would include:

- Protocols to identify, in consultation with each affected business, specific feasible and reasonable measures to maintain vehicular and pedestrian access during business hours, and visibility of the business to potential customers during construction, including alternative arrangements for times when access and visibility cannot be maintained

- Measures to support affected businesses during the acquisition process.

Measures to manage the land acquisition process are provided in section 19.6.

Approach to managing other impacts

Implementing other relevant measures provided in Chapters 9 (Traffic, transport and access), 10 (Noise and vibration), 12 (Air quality) and 21 (Landscape character and visual amenity), would minimise the potential for socio-economic (amenity) impacts. These include the Construction Traffic and Access Management Plan, Construction Noise and Vibration Management Plan, the Operational Noise and Vibration Review, consultation with hotels to confirm façade performance, Construction Air Quality Management Plan, odour management strategy, and the urban design and landscaping plan.

Other measures are provided in Table 20.6.

Expected effectiveness

Roads and Maritime and Sydney Airport Corporation have experience managing potential socio-economic impacts during construction. The measures provided in section 20.6.2 are based on previous projects in urban environments and are designed to mitigate construction related impacts.

Community and stakeholder involvement has been and would continue to be tailored to each phase of the project. This would enable appropriate consideration and balancing of community and stakeholder issues to achieve best for project outcomes. A key approach to consultation would be to provide two-way communication channels to enable timely intervention aimed at resolving issues raised by the community and stakeholders.

Implementation of a comprehensive approach to consultation, communication and environmental management during construction, together with a rigorous monitoring program, would assist in minimising the potential for socio-economic impacts.

20.6.2 List of mitigation measures

Measures that will be implemented to address potential socio-economic impacts are listed in Table 20.6.

Table 20.6 Socio-economic mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Potential social and community impacts during construction	SE1	A communications strategy will be prepared to detail the process of communicating and engaging with the community and stakeholders in the lead up to, and during, construction. It will ensure that: ▪ The community and stakeholders have a high level of awareness and forewarning of all processes and activities ▪ Accurate and accessible information is made available ▪ A timely response is given to issues and concerns raised by the community ▪ Feedback from the community is encouraged ▪ Opportunities for input are provided. In relation to the potential for socio-economic impacts, the strategy will include: ▪ Communication with potentially affected residents, other community members, businesses and other key stakeholders to provide information about the project, and the likely nature, extent and duration of amenity and access changes during construction ▪ Protocols to identify and engage with vulnerable persons that might be affected by construction	Pre-construction, construction

Impact/issue	Ref	Mitigation measure	Timing
		▪ Protocols for communicating information about potential access delays in and around Sydney Airport and other relevant project information.	
Potential impacts on businesses	SE2	Business management plans will be prepared and implemented for businesses affected by the project. The plans will be developed on a case by case basis and will detail specific measures, developed in consultation with the business operator. These will include: ▪ Protocols to identify, in consultation with each affected business, feasible and reasonable measures to maintain vehicular and pedestrian access during business hours, and visibility of the business to potential customers during construction, including alternative arrangements for times when access and visibility cannot be maintained ▪ Measures to respond to identified impacts as far as possible.	Pre-construction, construction
Permanent land requirements at Tempe Lands	SE3	Roads and Maritime will continue to consult with Inner West Council to ensure: ▪ Impacts on open space and recreational facilities in Tempe Lands will be offset ▪ Consistency between the project's urban design and landscape plan and Council's master plan for Tempe Lands.	Detailed design
Safety of active transport links	SE4	Temporary and operational active transport links will be designed to ensure the safety of the users in accordance with crime prevention through environmental design principles.	Detailed design
Impacts on the off-leash dog exercise area	SE5	A temporary off-leash dog exercise area will be provided. Access to this area will be maintained throughout construction, and temporary parking spaces will be provided. The location of the off-leash dog exercise area and the number of temporary parking spaces will be confirmed in consultation with Council. The condition of the temporary off-leash dog exercise area will be regularly monitored and maintained.	Construction
Impacts on community facilities and infrastructure	SE6	Access to community facilities and infrastructure will be maintained during construction. Where alternative access arrangements need to be made, these will be developed in consultation with relevant service providers and communicated to users. Any changes to access arrangements will be managed in accordance with the Construction Traffic and Access Management Plan.	Construction

20.6.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section and 20.6.2).

Residual socio-economic impacts would include:

- Minor impacts on some businesses, community facilities, employees and community members as a result of the project's land requirements
- Minor impacts on community members as a result of changes in noise and visual amenity
- Impacts on the exposure of AMG as a result of the new elevated viaduct

- Impacts on areas available for empty container storage with the potential to have a broader consequence on the industry – this impact would be alleviated if intermodal terminals are operational before construction
- Reduction in the amount of advertising space in the vicinity of the project site due to the removal of advertising structures. Detailed design would, where possible, seek to minimise impacts on these structures.

Chapter 21

Landscape character and visual amenity

This chapter provides a summary of the results of the landscape character and visual amenity assessment. It describes the existing landscape and visual environment, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 13 (Urban Design, Landscape Character and Visual Impacts).

The SEARs relevant to the landscape and visual amenity assessment are listed below. There are no MDP requirements specifically relevant to landscape and visual amenity, however there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)). Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively

Reference	Requirement	Where addressed
Key issue SEARs		
4	**Placemaking and urban design**	
4.3	The Proponent must: (a) estimate the number of trees to be cleared by the project (a tree is defined by Australian Standard (AS) 4970 Protection of trees on development sites) that will not be covered by a biodiversity offset strategy;	Section 21.3.3
	(b) for those trees to be cleared, describe how the project will achieve a net increase in tree canopy within or adjacent to the construction footprint.	Section 21.3.3
5	**Visual amenity**	
5.1	The Proponent must assess the visual impact of the project and any ancillary infrastructure on: (a) views and vistas;	Sections 21.3 and 21.4.2
	(b) streetscapes, key sites and buildings (including existing landscape works, green space and tree canopy);	Sections 21.3, 21.4.1 and 21.4.2
	(c) heritage items including Aboriginal places and environmental heritage;	Section 17.4.1
	(d) the local community.	Sections 21.3, 21.4.1 and 21.4.2
5.2	The Proponent must provide visual representations of the project from key receiver locations to illustrate the project and its visual impacts and how the project has responded to the visual impact through urban design and landscape works.	Sections 21.4.2 and 21.6.1

21. Landscape character and visual amenity

21.1 Assessment approach

Cities and environments change over time as new land uses, buildings, infrastructure and services are introduced. Urban design is the discipline of designing landscape, infrastructure and spaces so that cities are shaped and improved as they grow and infrastructure needs expand. A key element of planning and developing the project has been the involvement of urban design professionals to help shape project design to minimise impacts and optimise outcomes for the community.

As the project has the potential to impact the community, surrounding land and road users, there is a formal process to assess the potential for landscape and visual impacts and recommend mitigation and management measures to minimise impacts that cannot be avoided. The urban design and visual impact assessment has been undertaken by accredited urban design specialists experienced in infrastructure development. By commencing the landscape character and visual impact assessment early in the project development process and working closely with project road and civil designers, impacts can be identified early and resolved through appropriate design to optimise project outcomes. This ensures that overall project design is appropriate for its context, optimises community and social outcomes and avoids or minimises adverse impacts as far as reasonable and feasible.

An overview of the approach to the assessment is provided below, including the legislative and policy context and a summary of the assessment methodology.

Further information on the approach to urban design and place making for the project is provided in Chapter 7 (Project description).

21.1.1 Legislative and policy context to the assessment

The assessment has been undertaken in accordance with the SEARs and MDP required (provided in Appendices A to B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations
- *Guideline for landscape character and visual impact assessment* (Roads and Maritime, 2018d)
- *Beyond the pavement: urban design policy, procedures and design principles* (Roads and Maritime, 2014)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

21.1.2 Methodology

Study area

The study area is defined by landscape character zones (see section 21.2.2). These generally extend to Kogarah Golf Course to the south-west, the Princes Highway to the west, St Peters interchange to the north, Joyce Drive to the east and Sydney Airport to the south.

Key tasks

The assessment involved:

- Reviewing the concept design and relevant literature
- Analysing aerial photographs and topographic maps, and undertaking site visits, to understand the existing landscape and visual context of the study area
- Undertaking a contextual analysis to understand both the constraints and opportunities for the project

- Identifying landscape character zones and their sensitivity to change
- Identifying representative viewpoints and sensitive receptors and their sensitivity to change
- Undertaking a tree survey to identify the number of existing trees with the potential to be affected by the project
- Describing the key visual features of construction and operation
- Assessing the potential landscape character and visual impacts during construction and operation based on the potential sensitivity and the magnitude of impacts
- Determining the potential significance of impacts through a combined assessment of sensitivity and magnitude
- Recommending mitigation and management measures.

Landscape character impact assessment

In the urban context, landscape refers to the overall character and function of a place. It includes all elements within the public realm and the interrelationship between these elements and the people who use it. During the contextual analysis for the assessment, distinct landscape character zones were identified, generally based on the relationship between natural, built and community elements such as land use, vegetation cover, topography, heritage, or scenic value. Nine landscape character zones were identified, and these are shown in Figure 21.2 and described in section 21.2.2.

The potential landscape character impacts were determined based on the sensitivity of the landscape character zone and the magnitude of the impact. Sensitivity refers to how sensitive the existing character of the setting is to the proposed change. Magnitude refers to the physical size and scale of the impact at this location. The combination of sensitivity and magnitude determines the landscape character impact, which is rated from negligible to high as shown in Figure 21.1.

Visual amenity impact assessment

The area from where the project could be visible is referred to as the visual catchment or visual envelope. This is largely defined by the landform of the study area. Viewpoints were selected to illustrate the visual influence of the project both within and outside the project site. These generally represent publicly accessible views and vistas from a range of locations and viewing situations. A total of 26 viewpoints were selected for the assessment, and these are shown in Figure 21.3.

The potential visual impacts were determined based on the sensitivity of the viewpoint and the magnitude of the change. Sensitivity refers to the quality of the view and how it would be affected by the project. Magnitude refers to the physical size and scale of the project and the proximity relative to the viewer. Magnitude also considers overshadowing during the day and lighting at night. The combination of sensitivity and magnitude determines the visual impact, from negligible to high as shown in Figure 21.1.

SENSITIVITY / MAGNITUDE	High	Moderate	Low	Negligible
High	High impact	High to Moderate	Moderate	Negligible
Moderate	High to Moderate	Moderate impact	Moderate to Low	Negligible
Low	Moderate	Moderate to Low	Low	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

Figure 21.1 Impact significance rating matrix

A series of locations were selected for the production of visual representations. These were prepared to visually represent the views from selected locations with the introduction of the project (ie during operation). These visual representations are provided in section 21.4.

Tree assessment

A tree assessment was undertaken to identify significant trees within the project site. This involved a desktop review of relevant information and visual tree survey. The aim of the assessment was to confirm the following:

- Trees that would be removed or impacted during construction
- Trees that would be retained
- Measures to protect those trees that would be retained
- Trees with high landscape value that may be suitable for transplanting to a new location.

21.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Visual amenity risks with an overall assessed risk rating of medium or above, identified by the environmental risk assessment, included:

- Temporary visual impacts on sensitive visual receivers in the vicinity of construction work and from areas with views of the project site
- Permanent visual impacts on sensitive visual receivers as a result of the introduction of new road infrastructure visible from a number of viewpoints (including new bridges, other elevated sections of road infrastructure) and permanent noise mitigation measures
- Impacts on the landscape characteristics and visual amenity of Tempe Recreation Reserve once the project is operational
- Visual impacts on the character and appearance of Alexandra Canal as a result of the proposed new bridges, including the provision of any piers within the canal
- Visual impact as a result of the removal of mature trees and vegetation in some areas.

The landscape character and visual amenity assessment included consideration of these potential risks.

21.2 Existing environment

21.2.1 General visual environment

The landscape and visual environment of the study area is characterised by its highly developed urban nature. There are a number of land uses, features and infrastructure influencing the character and visual amenity of the project site. These include existing road and rail infrastructure, Alexandra Canal, commercial and industrial developments, and Sydney Airport and associated infrastructure. There are also public open space and residential areas located to the west of the project site in Tempe, and some residential properties also located to the north in Mascot.

The study area is relatively flat and gently sloping. The original landform has been extensively modified since the beginning of European settlement. As a result, there are very few remaining areas of natural ground. There are minimal areas of existing native vegetation with mostly planted native and exotic vegetation. Mature trees are located in some areas.

The location and setting of the project site is described in Chapter 2 (Location and setting). Further information on existing land uses is provided in Chapter 21 (Land use and property).

21.2.2 Landscape character zones

The landform, vegetation, views, settlement pattern and built structures define the landscape character of the study area. Nine landscape character zones were identified within the study area:

1. Terminal precincts
2. Green space
3. Alexandra Canal
4. Runway precinct
5. Freight and industrial
6. Residential
7. Warehousing and employment
8. Motorway
9. Airport support.

These landscape character zones were identified as having similar spatial or character properties, and similar landscape sensitivity. The landscape character zones are shown on Figure 21.2 and described in Table 21.1. Table 21.1 also includes the sensitivity rating assigned to each zone by the landscape character and visual amenity assessment.

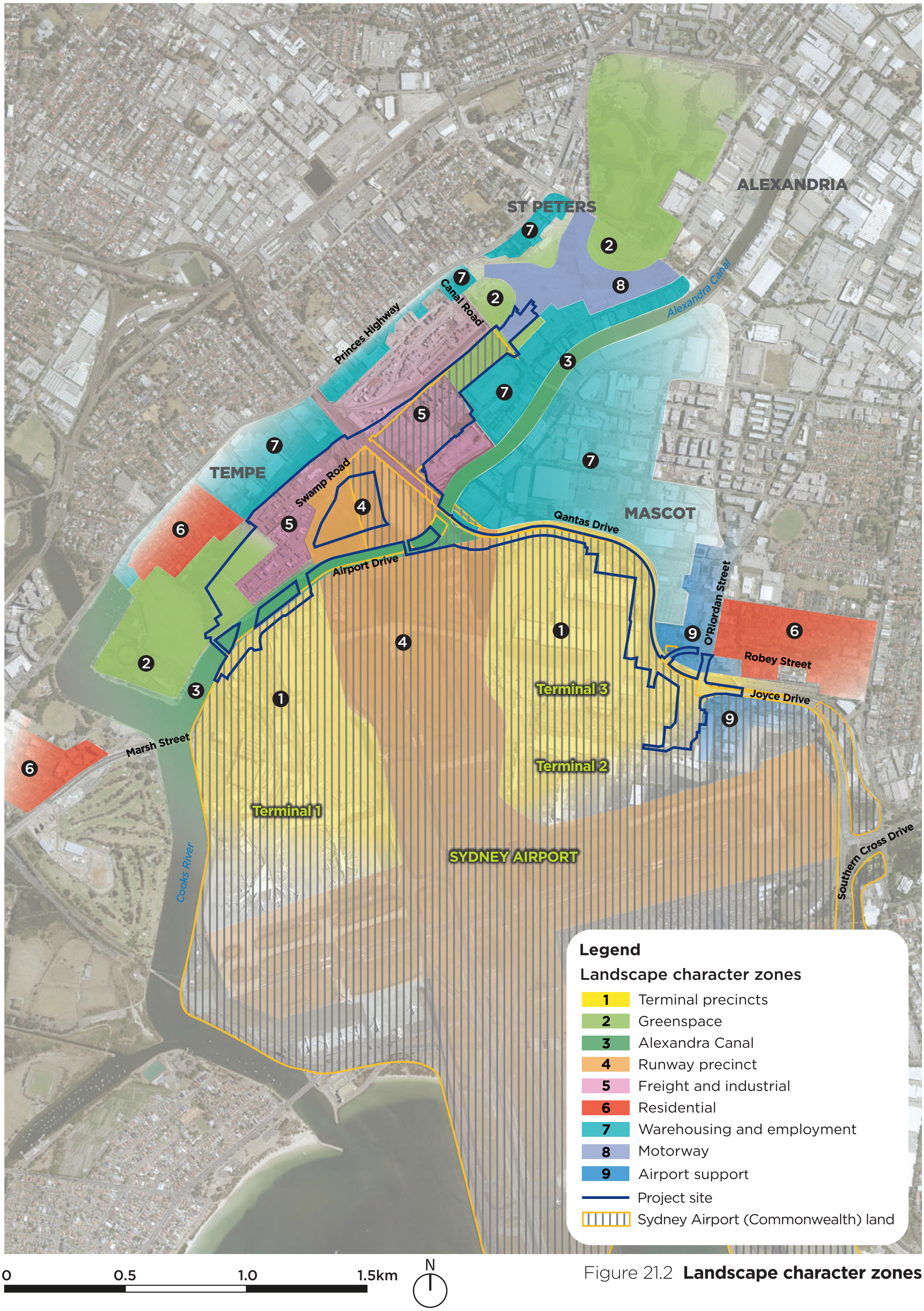


Figure 21.2 **Landscape character zones**

Table 21.1 Landscape character zones and sensitivity ratings

Landscape character zone	Description	Sensitivity
1 (Terminal precincts)	This landscape character zone includes the Terminal 1 and Terminal 2/3 precincts. This consists of the main built up areas of Sydney Airport land. This low-lying landscape would be sensitive to any changes due to its visibility from a large area. The landscape and visual values are derived from the flat open 'big sky' landscape, contrasting built form, aircraft movements and social values. The heritage listed Mascot (Robey Street) underbridge and Mascot (O'Riordan Street) underbridge, and buildings at Sydney Airport with heritage significance, are also located in this zone.	High
2 (Green space)	This zone is characterised by public open space including Tempe Recreation Reserve, the Tempe Lands (including Tempe Wetlands), Sydney Park, Cahill Park and Kogarah Golf Course. The generally flat and open setting allows for expansive views, including of Alexandra Canal. There is a close physical and visual relationship between this zone, zone 3 (Alexandra Canal), and the western part of zone 1 (Terminal precincts). This zone provides important recreation facilities and opportunities for access to open space. Areas of public open space are planned in the vicinity of St Peters interchange. There is also open, undeveloped land adjoining the Goodman St Peters business park and between Airport Drive, Alexandra Canal and the Botany Rail Line.	High
3 (Alexandra Canal)	This zone includes Alexandra Canal. The canal is a listed heritage item with a range of visual, cultural and heritage values. The landscape character attributes of this zone include the canal, scattered mature trees and other vegetation along the banks, vistas along the canal, and the open air space above the canal. The setting contrasts with surrounding precincts with their dense built form, providing visual relief. The heritage listed Mascot (Shea's Creek) Underbridge is also located in this zone.	High
4 (Runway precinct)	This zone includes Sydney Airport's main north–south runway, the Sydney Airport northern lands and the east–west runway. This zone is characterised by the flat and low-lying topography and a general lack of vertical form due to airspace limitations. The wide open sky is a key character element against which aircraft can be observed taking off and landing. Sydney Airport has heritage values that include both the contemporary airport and its stages of history and development. The runways are identified as the most aesthetically distinctive part of the airport as well as the 'big sky' landscape.	Moderate
5 (Freight and industrial)	This zone is characterised by freight and industrial uses. Built elements include Boral Concrete, Cooks River Intermodal Terminal, Tyne Container Services and part of the Botany Rail Line. Much of this zone provides a backdrop to and contrast with zone 4 (Runway precinct), with a rising landform and higher elements, including stacked shipping containers. While the zone has an industrial character, the heritage significance of the Cooks River Intermodal Terminal and the stacked shipping containers are signifiers of important port activities.	Low
6 (Residential)	This zone is located to the west of the project site in Tempe and near Wolli Creek and to the north-east of the project site in Mascot. The residential zone in Tempe consists mainly of detached dwellings on small blocks. The residential character is framed by vegetation (in the Tempe Lands) creating a sense of seclusion. There are also areas of traditional single dwelling houses near the Botany Rail Line and east of O'Riordan Street in Mascot. Wolli Creek is an urban renewal area located south of the Cooks River. It includes numerous medium and high density residential apartment buildings, surrounding waterways and open space.	High
7 (Warehousing and employment)	This is a large zone interfacing the project site in a number of areas. It includes employment areas in Tempe and Mascot, and a range of businesses with links to Sydney Airport. The zone also includes large 'big-box' retail businesses including Ikea. It is located along the Princes Highway with an outlook over lower lying areas, including over zones 1, 3, 4 and 5. This zone also includes mature trees and vegetation along the lot boundaries and street frontages, which define views.	Low

Landscape character zone	Description	Sensitivity
8 (Motorway)	This zone is associated with road infrastructure at St Peters interchange, which is currently under construction as part of the New M5 project.	Low
9 (Airport support)	This zone is a small zone at the eastern end of the project site. The main land uses include commercial and accommodation (hotels, serviced apartments, parking, logistics and retail), which predominantly service Sydney Airport.	Low

21.2.3 Representative viewpoints

Key viewpoints are shown on Figure 21.3. These have been selected as representative locations to assess the potential visual impacts of the project. The locations of the viewpoints are representative of the range of views available within and around the project site. The viewpoints and their assessed sensitivity to change are summarised in Table 21.2.

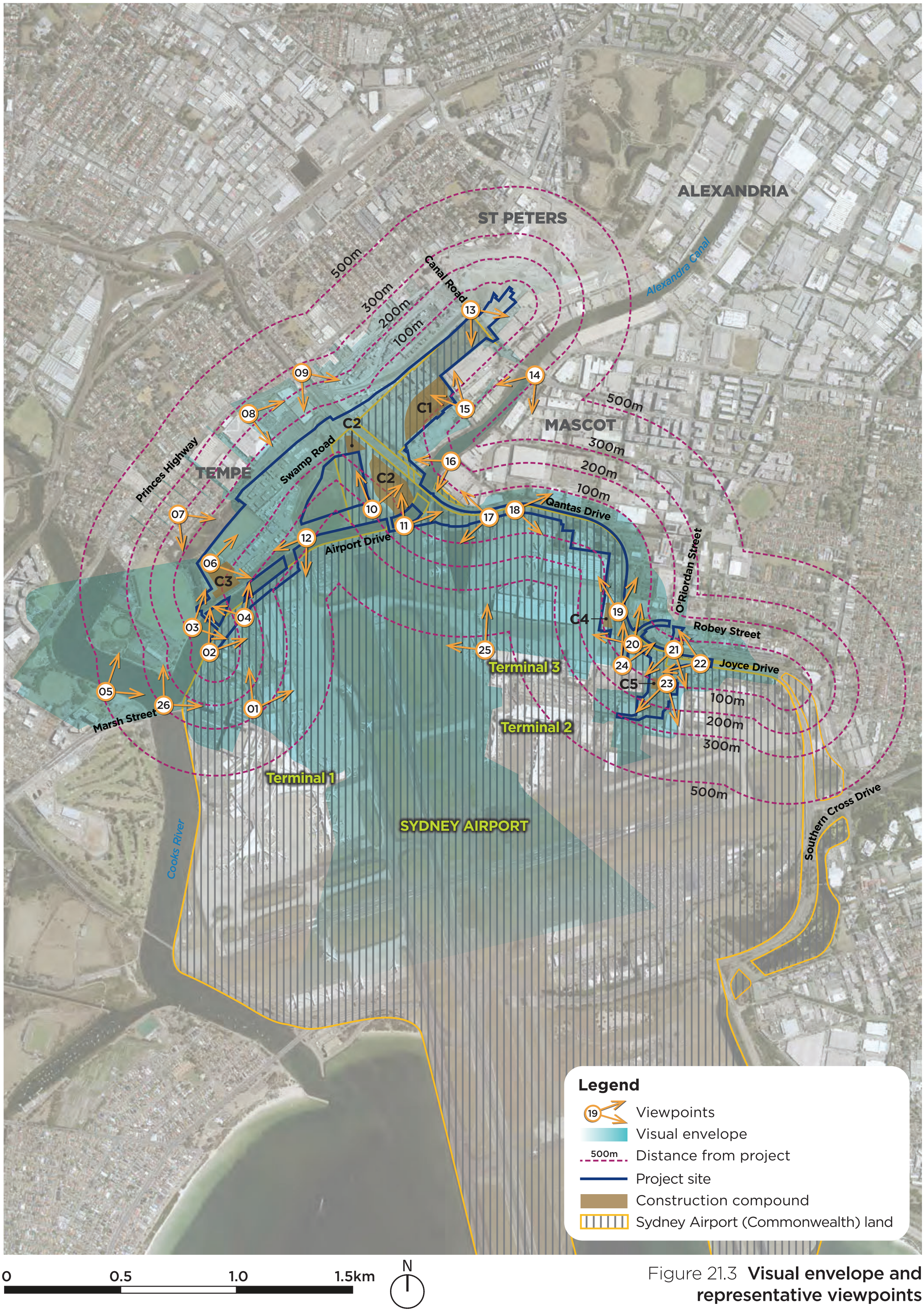


Figure 21.3 **Visual envelope and representative viewpoints**

Table 21.2 Viewpoints and sensitivity rating

Viewpoint (see Figure 21.3)	Location	Description	Sensitivity	Existing view
01	P2 car park at Terminal 1	This view includes open views towards the north–south runway and urban centres in the distance, giving this viewpoint a moderate sensitivity. It also includes vegetation on the banks of Alexandra Canal at Tempe Lands.	Moderate	
02	Alexandra Canal cycleway opposite Tempe Recreation Reserve	The moderate sensitivity of this viewpoint is derived from it water glimpses and from vegetation lining the road corridor and Alexandra Canal. The open nature of the sky above Sydney Airport is also a feature of the viewpoint.	Moderate	
03	Tempe Recreation Reserve	The high sensitivity of this viewpoint is derived from the open space setting with mature vegetation, including along Alexandra Canal and in Tempe Lands. The open nature of the sky above the airport and Alexandra Canal are features.	High	
04	Link Road at the intersection with Airport Drive	The open views across Alexandra Canal to Tempe Lands with its vegetated embankments give this viewpoint a moderate sensitivity. Vegetation along the canal is also sensitive to change. The shipping containers are also a visually prominent feature.	Moderate	

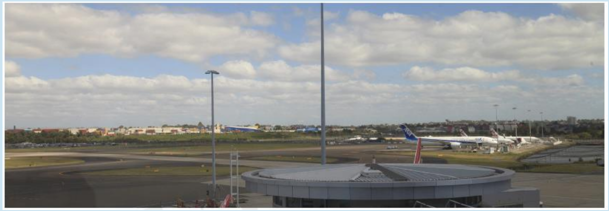
Viewpoint (see Figure 21.3)	Location	Description	Sensitivity	Existing view
05	Rowers on Cooks River restaurant and function centre, Wolli Creek hotels and apartments	The high sensitivity of this viewpoint is derived from the open character of the Cooks River and Alexandra Canal, open space at Tempe Recreation Reserve and the Tempe Lands, and mature vegetation.	High	
06	Tempe Lands car park	Although having low sensitivity, this viewpoint includes an open sky landscape, views towards the Sydney central business district, glimpses of Sydney Airport and vegetation. The shipping containers are also a visually prominent feature.	Low	
07	Wentworth Street, Tempe,Tempe residential streets	Open space and vegetation in Lori Short Reserve and in the Tempe Lands terminate the view and are sensitive to change. This viewpoint has a moderate sensitivity.	Moderate	
08	Ikea store	This open sky landscape, with views of Sydney Airport (including the Jet Base), is moderately sensitive. Vegetation provides visual relief in the densely developed urban setting.	Moderate	

Viewpoint (see Figure 21.3)	Location	Description	Sensitivity	Existing view
09	The Princes Highway bridge over the Botany Rail Line	This viewpoint is of low sensitivity. The sensitive elements include the open vista across the landscape and Terminal 3. This is one of very few open view corridors from the densely built up areas along the Princes Highway. The open sky landscape above Sydney Airport and the vegetation along the Botany Rail Line are also sensitive to change.	Low	
10	North Precinct Road	Much of the view has an industrial character with a low sensitivity to change. The established vegetation and openness of the landscape are important visual elements.	Low	
11	Alexandra Canal cycleway near Shea's Creek underbridge	The high sensitivity of this viewpoint is derived from the canal side open space character, established vegetation along Alexandra Canal, the expanse of sky above the canal, and the strips of green space along the canal.	High	
12	Access track along the western side of Alexandra Canal	Sensitive elements in this view are the large mature trees on both sides of Alexandra Canal, and the open sky and vista along the canal towards Wolli Creek.	High	

Viewpoint (see Figure 21.3)	Location	Description	Sensitivity	Existing view
13	Bus stop on the northern side of Canal Road	The moderate sensitivity of this viewpoint is derived from the large mature trees on both sides of the road corridor.	Moderate	
14	Canal Road bridge over Alexandra Canal	This is one of the key viewpoints of Alexandra Canal giving this viewpoint a high sensitivity. Visually sensitive elements include the waterway, mature trees along the bank, the vista towards Sydney Airport with aircraft visible at the terminals, and the open sky above the canal.	High	
15	Burrows Road South	Established mature trees provide amenity within the industrial estate giving this viewpoint a moderate sensitivity.	Moderate	
16	Alexandra Canal cycleway south of Coward Street	This viewpoint is of high sensitivity as a result of its waterway setting. Other sensitive elements include the mature trees along the canal and the open sky above the canal.	High	

Viewpoint (see Figure 21.3)	Location	Description	Sensitivity	Existing view
17	Qantas and Airport Drive junction	The main sensitive element in the view is the open sky and the long vista towards the Tempe Lands and Wolli Creek providing a moderate sensitivity. The park-like character of the land adjacent to Alexandra Canal provides visual relief through greenery.	Moderate	
18	Qantas Drive, near the Botany Rail maintenance overbridge	The moderate sensitivity of this viewpoint is derived from the mature trees lining the southern side of Qantas Drive and the grass and/or plantings in front of the advertising structures.	Moderate	
19	Qantas Drive between Robey and Ewan streets	Established mature tree cover is the main visually sensitive element, complemented by low level planting in the verges. This green setting for the roadway gives the viewpoint a moderate sensitivity.	Moderate	
20	Seventh Street at the intersection with Qantas Drive	The established tree cover, including a large mature fig tree south of Qantas Drive and a dense stand of mature vegetation on the northern side, contributes to the sensitivity of this viewpoint. The multi-storey building stock in the background is of low visual quality, leading to an overall moderate sensitivity.	Moderate	

Viewpoint (see Figure 21.3)	Location	Description	Sensitivity	Existing view
21	O'Riordan Street at the intersection with Qantas Drive	Much of this view is dominated by the large intersection. The mature vegetation and feature planting on the southern side of the intersection, the vista towards the Terminals 2/3 entrance, and the open sky above Sydney Airport, result in a moderate sensitivity. Nearby businesses would be sensitive to any changes to presentation and visibility.	Moderate	
22	Joyce Drive near Sir Reginald Ansett Drive	The low sensitivity of this viewpoint is derived from the long distance vista through the Sydney Airport Jet Base to the Tempe water tower. The viewpoint also includes a dense stand of mature trees west of O'Riordan Street and established palm trees at the entrance to Terminals 2/3.	Low	
23	Sir Reginald Ansett Drive	The view, which is framed by an advertising gantry, comprises mostly existing road pavement. Established mature trees along the road are sensitive elements as is the open sky above Sydney Airport, leading to a moderate sensitivity. Adjacent businesses would be sensitive to change in relation to visual exposure.	Moderate	
24	Seventh Street	The moderate sensitivity of this viewpoint is derived from the established mature tree cover on the northern side of Qantas Drive terminating the view. The tree cover also helps to screen some of the road furniture.	Moderate	

Viewpoint (see Figure 21.3)	Location	Description	Sensitivity	Existing view
25	Qantas Heritage Collection, Level 1, Terminal 3	Visually sensitive elements include trees along Alexandra Canal, and green space in the northern lands, Tempe Lands and between Sydney Airport's runways. They constitute only a relatively small portion of a busy view. The shipping containers add to the visual clutter, but the open sky character dominates. The view would be moderately sensitive to elements that alter the openness of the sky.	Moderate	
26	Giovanni Brunetti Bridge	The high sensitivity of this view is derived from the open waterway setting with vistas along Alexandra Canal towards the Sydney central business district. The vegetation along the canal, in Tempe Recreation Reserve, and on the embankment of the Tempe Lands, provides a natural frame and would be sensitive to change.	High	

21.2.4 Trees in and adjacent to the project site

Vegetation along the road network holds important visual value and contributes to the character of the area. The trees include large mature trees along Qantas Drive and in the Terminals 2/3 precinct, with stands along Sir Reginald Ansett Drive, Keith Smith Avenue, Ninth Street and Shiers Avenue.

Within the project site, 2,667 trees were identified by the tree assessment. The majority of the trees identified are planted native species. Exotic ornamental species comprised 209 trees. Other trees included native species originally occurring in the area.

Some of the trees and vegetation considered to have landscape value (ie visual screening, landscape features) include:

- Hill’s weeping figs growing along the edges of Qantas Drive, which provide screening and general visual amenity
- Planted trees (such as river oaks and eucalypts) along the northern side of Qantas Drive, which provide screening of the Botany Rail Line and soften the appearance of the large billboards and tall buildings in this area
- Broad-leaved paperbark, river oak and tallowwood below the rail embankment adjacent to the Robey Street intersection
- Eucalypts on the western side of Canal Road softening the visual appearance of the road
- Cabbage tree palms near the Sydney Airport entrance to Terminals 2/3
- Groups of trees and shrubs along the southern bank of Alexandra Canal
- Stand of planted trees and shrubs on the northern bank of Alexandra Canal, which provide some screening of shipping containers
- Hedges and trees along the southern side of Qantas Drive.

21.2.5 Landscape character and visual amenity within Sydney Airport (Commonwealth) land

A total of 23 of the 26 viewpoints considered by the assessment are located within Sydney Airport land or have views of Sydney Airport land. Sydney Airport land is located within landscape character zones 1 (Terminal precincts), 2 (Green space), 4 (Alexandra Canal) and 5 (Freight and industrial).

There are 993 planted trees (both native and exotic) located in the project site within Sydney Airport land.

The existing landscape character and visual amenity within Sydney Airport land is described in Table 21.1 and Table 21.2.

21.3 Assessment of construction impacts

21.3.1 Landscape character impacts

The main landscape character impacts during construction would include:

- Spatial and visual impacts as a result of temporary structures and construction activities
- Changes to access and connectivity
- Increased traffic and vehicle movements as a result of the project workforce, haulage and delivery movements.

The assessment concluded that construction would result in a:

- High impact to two landscape character zones (zones 1 and 2)
- Moderate impact to four landscape character zones (zones 3 to 6)
- Low impact to three landscape character zones (zones 7 to 9).

Landscape character zones 1 (Terminal precincts) and 2 (Green space) are the zones considered to have the highest impact due to their high sensitivity and high magnitude of potential impact. The landscape character impacts were derived from an assessment of the potential changes during construction and the scale of these changes, such as the construction footprint, construction activities including site preparation and construction of project elements, ancillary facilities and construction-related traffic movements. All assessed construction changes would result in a moderate or high impact to zones 1 and 2 (ie the zones with the highest overall impact).

The construction footprint extends across all landscape character zones, resulting in temporary restrictions to use and access by the public. This would result in temporary landscape character impacts affecting the ability of the public to access and enjoy certain locations. A large area of the Tempe Lands (within zone 2 (Green space)) would be within the construction footprint, and these areas would not be available for recreation uses during the construction period. The Alexandra Canal cycleway and the pedestrian and cycle bridge over the canal would not be available during construction. There would be a loss of buildings and facilities within zone 1 (Terminal precincts).

Construction activities would be undertaken in all landscape character zones, with the exception of zone 7 (Warehousing and employment). All zones would experience indirect impacts from works within other zones. Construction activities would involve temporary traffic diversions or other traffic management measures to maintain traffic flow and connectivity during construction. The activities would affect access and connectivity in the zones directly affected by construction. Landscape character zone 1 (Terminal precincts) would be the most affected due to the need to maintain traffic flow along Qantas Drive and Airport Drive throughout the construction period. Temporary visual impacts are also expected due to the presence of tall equipment and temporary structures. There may also be works outside standard construction hours with the potential for light spill impacts.

Temporary facilities would be established within some of the landscape character zones. These would include construction compounds, crane pads, work platforms and parking areas. Five sites have been identified that would be fenced off and generally covered in hardstand. The sites are located away from sensitive receivers, such as residential areas, and would temporarily alter the character of zones 1 to 5. In addition to changed land use and access arrangements, there would be changes to the spatial and visual character of the area. The ancillary facilities would also have some impact on the adjoining zones 6, 7 and 9. The construction compounds are shown in Figure 21.2 in relation to the landscape character zones.

Additional vehicle movements would also affect landscape character, with increased traffic and the presence of heavy vehicles and machinery. Construction-related traffic movements would have a temporary impact on all landscape character zones as all zones include or are located next to arterial roads. The most affected zones would be those with haulage and temporary access roads and access points, as well as those with construction compounds. These include zones 1, 2, 4 and 5, with a high magnitude of impact predicted for all except zone 4, which was assessed as having a moderate magnitude of impact.

Construction is temporary and short term in nature. The measures provided in section 21.6 would be implemented to minimise landscape and visual impacts during construction.

21.3.2 Visual impacts

The project would result in temporary visual impacts during construction. These impacts would be experienced by receptors (including residents, pedestrians, cyclists, motorists, airport users and local workers) in the vicinity of work areas and from the identified viewpoints to differing degrees. During construction, visible elements would include work areas, machinery and equipment, fencing, soil stockpiles, waste materials and partially constructed structures.

The potential visual impact would depend on the nature and intensity of construction work. Visual impacts would also be more significant at locations where residential or other sensitive receivers have an unscreened view of the project site.

In relation to impacts on viewpoints, the assessment concluded that there would be the potential for a:

- High impact at viewpoint 11 (Alexandra Canal cycleway near Shea's Creek underbridge)
- High to moderate impacts at 10 viewpoints (2 to 4, 13, 18 to 21, 23 and 24)
- Moderate impacts at six viewpoints (10, 14, 16, 17, 22 and 26)
- A moderate to low impact at five viewpoints (1, 8, 9, 15 and 25)
- A negligible impact at four viewpoints (5, 6, 7 and 12).

The viewpoints and their sensitivity are described in Figure 21.2.

These potential impacts would be temporary and limited to the construction phase. The actual impacts would vary depending on the final construction method and staging, and there would be times when the impacts are lower than predicted.

The use of lighting for works outside standard working hours may result in light spill and associated impacts on neighbouring properties. However, Sydney Airport and the surrounding road network is generally well lit at night, and additional lighting should not result in a significant increase in light spill. In addition, directional lighting would be used to minimise the potential for light spill. Lighting impacts on Sydney Airport operations is discussed in Chapter 11 (Airport operations).

The measures provided in section 21.6 would be implemented to minimise landscape and visual impacts during construction.

The potential for visual impacts on heritage listed items is discussed in section 17.4.1.

21.3.3 Tree removal

It is estimated that about 1,300 trees would need to be removed during construction, including 573 trees within Sydney Airport land. A total of about 1,367 trees could be retained (subject to the measures provided in section 21.6) with 420 of these located within Sydney Airport land. The tree retention numbers assume that the cabbage tree palms would be transplanted within the project site. All other trees were identified as not suitable for transplanting.

A number of trees that would need to be removed contribute to the amenity and character of the local area and/or screen views from sensitive receivers. The removal of the trees would have the potential to reduce some screening between the project site and nearby receivers, impacting visual amenity.

The project site offers limited potential for new tree cover due to space constraints. Other issues associated with planting new trees include the constraints associated with Sydney Airport's prescribed airspace and the need to select appropriate species to minimise the risk of wildlife strike. Saline soils and contaminated land also present environmental constraints.

The project currently provides for a total of 551 replacement trees, representing a net loss of 749 trees across the project site, including a net loss of 276 trees within Sydney Airport land. Trees that would be removed by the project would be replaced to ensure there is a net increase in tree canopy.

Trees that cannot be replaced within the project footprint would be replanted within Sydney Airport land and land subject to the EP&A Act, relative to the number of trees removed. Roads and Maritime is also committed to replanting trees that would be removed at the former Tempe landfill.

A tree management strategy would be prepared to identify how a net increase in tree canopy can be achieved (see section 21.6). The final number of trees impacted would be confirmed during detailed design and final construction planning. Impacts on trees would be minimised where practicable.

Sydney Airport Corporation would provide advice in relation to potential locations for replacement trees. Areas within Sydney Airport will be considered first, if available. If adequate space within the airport is not available, area(s) close to the airport will be selected, in consultation with the Airport Environment Officer and the relevant local council, ensuring consideration is given to *National Airports Safeguarding Framework Guideline C: Managing the Risk of Wildlife Strikes in the Vicinity of Airports*.

21.3.4 Summary of impacts on Sydney Airport (Commonwealth) land

The assessment concluded that there is the potential for landscape character impacts on Sydney Airport land as a result of construction within zones 1 (Terminal precincts), 2 (Green space), 4 (Alexandra Canal) and 5 (Freight and industrial). In summary:

- Landscape character zone 1 (Terminal precincts) was assessed as having the potential to be highly impacted due to the need to maintain traffic flow along Qantas Drive and Airport Drive throughout the construction period
- Landscape character zone 2 (Green space) was assessed as having the potential to be highly impacted as a result of the impacts on Tempe Lands, where areas would be within the construction footprint, with associated impacts from ancillary facilities and construction-related traffic
- Landscape character zone 4 (Runway precinct) was assessed as having the potential to be moderately impacted due to the moderate sensitivity and magnitude of impact
- Landscape character zone 5 (Freight and industrial) was assessed as having the potential to be moderately impacted due to a low sensitivity and high magnitude of impact
- Zones 1, 2, 4 and 5 are affected by haulage and temporary access roads and access points, as well as construction compounds. A high magnitude of impact was identified for all except zone 4, which was assessed as having a moderate magnitude of impact.

The assessment concluded that construction would result in a high (zones 1 and 2) and moderate (zones 4 and 5) impact to landscape character zones within Sydney Airport land.

The majority of the potential visual impacts on Sydney Airport land would occur as a result of construction along Airport Drive, Qantas Drive and Sir Reginald Ansett Drive.

Potential landscape and visual impacts during construction would be temporary and mitigated by implementing the measures provided in section 21.6.

About 573 trees are proposed to be removed from the project site where it is located on Sydney Airport land, with 297 replacement trees identified. This represents a net loss in trees within Sydney Airport land of 276 trees. The proposed approach to replacing trees is discussed in sections 21.3.3 and 21.6.

21.4 Assessment of operation impacts

21.4.1 Landscape character impacts

The assessment concluded that the significance of permanent landscape character impacts across the nine landscape character zones would range from negligible to high. These potential impacts are summarised in Table 21.3. The assessment rated the potential impacts of the presence of project infrastructure in terms of sensitivity and magnitude to provide an overall level of significance (see section 21.1.2). These ratings are provided in Table 21.3.

The assessment (summarised in Table 21.3) considered the options for the design of proposed emplacement mound(s) at the former Tempe landfill (see section 7.10.2):

- Option one would involve locating one mound between the Terminal 1 connection and one mound north of the freight link road
- Option two would involve locating one mound west of the Terminal 1 connection in the area of existing open space that also encompasses the off-leash dog exercise area. Another mound (also part of option three) is also proposed between the Terminal 1 connection and the freight link road.

The landscape character zones assessed for the mound design options include zones 1 (Terminal precincts), 2 (Green space), 5 (Freight and industrial), 6 (Residential) and 7 (Warehousing and employment). The placement of mounds would lead to different opportunities and layouts for future recreation facilities at Tempe Lands. The options would result in slightly different landscape character and visual impacts. However, due to the extent of the project's landscape character impacts, the preferred mound design would have little bearing on the landscape character impacts of the project overall.

The assessment concluded that there would be a high landscape character impact for three of the nine zones (1, 2 and 3) and a moderate landscape character impact for two of the zones (5 and 6). The remaining zones would experience moderate to low, low and negligible impacts. In summary, the impacts would be:

- Adverse for zones 1 (Terminal precincts), 3 (Alexandra canal), 6 (Residential) and 7 (Warehousing and employment)
- A combination of adverse and beneficial for zones 2 (Green space), 4 (Runway precinct), 5 (Freight and industrial) and 9 (Airport support)
- Neutral for zone 8 (Motorway).

Table 21.3 Permanent landscape character impacts

Landscape character zone	Sensitivity	Magnitude	Key landscape character changes	Landscape character impact
1 (Terminal precincts)	High	High	▪ Large increase in hard surfaces ▪ The Terminals 2/3 access would result in a notable change in character ▪ Removal of trees along Qantas Drive would change the spatial character and visual containment ▪ Removal of existing buildings adjacent to Qantas Drive would alter the built form ▪ This zone would also be affected by changes in adjoining zones (2 and 5) due to the changes in the outlook and potential effects on spatial character ▪ Both mound options would be equally visible from zone 1 and the adopted design would not affect the overall landscape character impact rating due to the high visual impacts in this zone: – Mound option one would have a smaller impact on the spatial character of the area as it would replace the shipping containers in zone 3 (Alexandra Canal) – Mound option two would introduce additional elevation with more effect on spatial character and three dimensional form ▪ A high magnitude of adverse landscape character impacts would result from extensive changes to the existing built fabric, tree cover, land use interface and views	High
2 (Green space)	High	High	▪ Green space would be replaced with road infrastructure in some locations resulting in substantial changes to the character ▪ Removal of trees with high amenity value on the embankments of Tempe Lands and along Canal Road with limited potential for reinstatement ▪ Embankments and retaining walls required for the St Peters interchange connection would be visible from adjoining zones ▪ The emplacement mound options would not substantially alter the spatial character and would create new opportunities for views over the surrounding areas ▪ Option two for the mound design would result in additional large elevation above existing open space in Tempe Lands, creating new landforms and altering the spatial character, outlook and views within this zone and adjoining areas. ▪ The magnitude and landscape character impact ratings are the same for both the option one and option two mound designs	High

Landscape character zone	Sensitivity	Magnitude	Key landscape character changes	Landscape character impact
3 (Alexandra Canal)	High	High	▪ The new bridges would result in a high impact on the character of open air space above and along Alexandra Canal ▪ Public access along Alexandra Canal would shift from the eastern side to the western side, following the closure of Airport Drive and relocation of the cycleway. ▪ Drainage works would impact on the heritage fabric of Alexandra Canal in some locations ▪ Limited reinstatement of trees removed alongside the canal resulting in permanent changes to views and vistas	High
4 (Runway precinct)	Moderate	Low	▪ New project elements would be consistent with the infrastructure and transport character of the zone ▪ Most project elements in this zone would be low-lying, following the existing landforms and located towards the perimeter of the zone ▪ The rising landform and built structures in the back drop would reduce the prominence of new elements ▪ The Qantas Drive bridge and Qantas Drive upgrade and extension would alter the open landscape character in the north-eastern part of the zone	Moderate to low
5 (Freight and industrial)	Low	High	▪ Land use changes (to road infrastructure) would result in a wide range of landscape character changes. ▪ Earth embankments and retaining walls would noticeably alter the form of this zone and would be visible from adjoining zones ▪ Beneficial new open space would be created in the southern part of the zone, offsetting green space losses in zone 2 (Green space) ▪ Structures, such as open concrete drainage channels and the flood mitigation basin, would be visible ▪ Both mound options would partially replace the shipping containers as a prominent feature, but would not substantially alter the spatial character in these locations ▪ Both mound options would create new opportunities for views over surrounding areas ▪ Mound option two also has the potential to provide for active recreation facilities ▪ The magnitude and landscape character impact ratings are the same for both option one and option two mound designs	Moderate

Landscape character zone	Sensitivity	Magnitude	Key landscape character changes	Landscape character impact
6 (Residential)	High	Low	▪ The majority of the project would be hidden from this zone in Tempe by sections of zone 2 (Green space) ▪ The Terminal 1 connection, Terminal 1 bridge and freight terminal bridge would alter the outlook from Wolli Creek affecting views for residents on the southern side of the Cooks River ▪ The impact on residents' views in the north-facing apartments on the southern side of the Cooks River would be reduced due to a distance from the project site (about 900 metres) ▪ Residents in the Mascot portion of zone 6 would not be affected by changes in the visual setting due to existing vegetation, buildings and elevated rail embankment ▪ Both mound design options would only be visible from more elevated areas close to the Princes Highway ▪ This zone would be impacted by works in the adjoining zones 2 and 5 (Green space and Freight and industrial) due to the change in outlook as a result of the mounds. The preferred option for the mound design would not affect the landscape character impact rating of this zone.	Moderate
7 (Warehousing and employment)	Low	Low	▪ Direct character impacts are limited ▪ Project elements within zones 1 (Terminal precincts), 2 (Green space) and 5 (Freight and industrial) would be visible from this zone ▪ Works in adjoining zones would alter the outlook from zone 7 with some effect on how zone 7 is perceived ▪ Businesses in the Mascot portion of zone 7 would experience a change in outlook due to tree removal ▪ The mounds would slightly alter the outlook from some areas along the Princes Highway. Both design options would offer a landscape element by replacing the existing shipping containers ▪ The magnitude and landscape character impact ratings are the same for both mound options.	Low
8 (Motorway)	Low	Negligible	▪ Areas within this zone are currently affected by construction of St Peters interchange ▪ The project is consistent with the future land use and character of the zone	Negligible
9 (Airport support)	Low	Moderate	▪ Project elements within surrounding zones would be highly visible from the eastern part of the zone, altering the outlook and affecting how zone 9 is perceived ▪ The visibility and presentation of business located east of Sir Reginald Ansett Drive would be altered by the Terminal 2/3 access in zone 1 (Terminal precincts) ▪ Tree removal would impact the existing visual buffer between zones 1 (Terminal precincts) and 9	Moderate to low

21.4.2 Visual impacts

The extent to which the project would be visible from the identified viewpoints would vary depending on existing topography, vegetation, buildings and land uses, as well as the form of the project when viewed from each viewpoint. The potential permanent visual impacts were assessed in relation to the identified 26 key viewpoints and groups of viewpoints shown on Figure 21.3 and described in Table 21.2.

Visual representations of the project are provided in Figure 21.4 to Figure 21.16 for key viewpoints to illustrate how the project may appear and affect views at these locations. Table 21.4 provides a summary of the results of the assessment of visual impact at each viewpoint. The assessment also considered the two design options for the proposed emplacement mounds at Tempe Lands (see section 21.4.1).

The assessment concluded that the project would have a high visual impact on viewpoint 11 and 12. Viewpoint 11 (Alexandra Canal cycleway near Shea's Creek underbridge) is considered to have a riverside parkland character with a high sensitivity to change. A number of large new structures would impact this view and change the outlook, including the Qantas Drive bridge, the terminal link bridge and the eastbound terminal link. This would result in a high magnitude of visual impact. Viewpoint 12 (access track along the western side of Alexandra Canal) is also considered to have a high sensitivity to change to its waterway setting. The presence of new infrastructure, including the proposed freight terminal bridge and Terminal 1 connection bridge, would result in a high magnitude of visual impact.

There would be high to moderate visual impacts on viewpoints 2 to 4, 13, 18 to 21, 23-24 and 26. As 13 of the assessed views have a high and high to moderate visual impact, the assessment concluded that the project has the potential to notably affect the views and visual qualities from these viewpoints. Other visual impacts were identified as being in the moderate and moderate to low range. There is one identified negligible impact at viewpoint 15. No difference in the visual impacts was identified for the mound design options.

The assessment concluded that 24 viewpoints would be impacted by the project. Over time, the level of impact may reduce at two viewpoints as landscaping becomes established. There would be limited reduction in impacts over time due to little potential for screening, either with landscaping or other measures, the preferred mound design, final landscaping and urban design for Tempe Lands and Sydney Airport's operational constraints.

Mitigation measures are provided in section 21.6.2 to minimise the adverse visual impacts as far as possible. Potential visual impacts on heritage listed items are discussed in section 17.4.1.

Table 21.4 Permanent visual impacts

Viewpoint	Location	Sensitivity	Magnitude	Nature of impact	Visual impact	Reduction over time
01[1]	P2 car park at Sydney Airport Terminal 1	Moderate	Low	Adverse	Moderate to low	No
02	Alexandra Canal cycleway opposite Tempe Recreation Reserve	Moderate	High	Adverse	High to moderate	Yes
03[1]	Tempe Recreation Reserve: Option one mound design	High	Moderate	Adverse	High to moderate	No
	Tempe Recreation Reserve: Option two mound design	High	Moderate	Adverse	High to moderate	No
04[1]	Link Road at the intersection with Airport Drive	Moderate	High	Adverse	High to moderate	No
05[1]	Rowers on Cooks River restaurant and function centre, Wolli Creek hotels and apartments	High	Low	Adverse	Moderate	No
06[1]	Tempe Lands car park	Low	High	Adverse	Moderate	No
07[1]	Wentworth Street, Tempe/Tempe residential streets	Moderate	Low	Adverse	Moderate to low	No
08	Ikea store	Moderate	Low	Adverse	Moderate to low	No
09	The Princes Highway bridge over the Botany Rail Line	Low	Moderate	Adverse	Moderate to low	No
10	North Precinct Road	Low	High	Adverse	Moderate	No
11	Alexandra Canal cycleway near Shea's Creek underbridge	High	High	Adverse	High	No
12	Access track along the western side of Alexandra Canal	High	High	Adverse	High	No
13	Bus stop on the northern side of Canal Road	Moderate	High	Adverse	High to moderate	Yes
14	Canal Road bridge over Alexandra Canal	High	Low	Adverse	Moderate	No
15	Burrows Road South	Moderate	Negligible	Neutral	Negligible	n/a
16	Alexandra Canal cycleway south of Coward Street	High	Low	Adverse	Moderate	No
17	Qantas and Airport Drive junction	Low	Moderate	Adverse	Moderate to low	No
18	Qantas Drive, near the Botany Rail maintenance overbridge	Moderate	High	Adverse	High to moderate	No
19	Qantas Drive between Robey and Ewan Streets	Moderate	High	Adverse	High to moderate	No
20	Seventh Street at the intersection with Qantas Drive	Moderate	High	Adverse	High to moderate	No
21	O'Riordan Street at the intersection with Qantas Drive	Moderate	High	Adverse	High to moderate	No

Viewpoint	Location	Sensitivity	Magnitude	Nature of impact	Visual impact	Reduction over time
22	Joyce Drive near the Sir Reginald Ansett Drive	Low	High	Adverse	Moderate	No
23	Sir Reginald Ansett Drive	Moderate	High	Adverse	High to moderate	No
24	Seventh Street	Moderate	High	Adverse	High to moderate	No
25	Qantas Heritage Collection, Level 1, Terminal 3	Moderate	Low	Neutral	Moderate to low	No
26[1]	Giovanni Brunetti Bridge	High	Moderate	Adverse	High to moderate	No

Notes: 1. Views assessed for mound design options.

Figure 21.4 Visual representation of the project at viewpoint 3 – Tempe Recreation Reserve

Figure 21.5 Visual representation of the project at viewpoint 4 – Link Road at the intersection with Airport Drive

Figure 21.6 Visual representation of the project at viewpoint 6 – Tempe Lands car park

Figure 21.7 Visual representation of the project at viewpoint 10 – North Precinct Road

Figure 21.8 Visual representation of the project at viewpoint 11 – Alexandra Canal cycleway near Shea's Creek underbridge

Figure 21.9 Visual representation of the project at viewpoint 12 – Access track along the western side of Alexandra Canal

Figure 21.10 Visual representation of the project at viewpoint 13 – Bus stop on the northern side of Canal Road

Figure 21.11 Visual representation of the project at viewpoint 14 – Canal Road bridge over Alexandra Canal

Figure 21.12 Visual representation of the project at viewpoint 17 – Qantas and Airport Drive junction

Figure 21.13 Visual representation of the project at viewpoint 19 – Qantas Drive between Robey and Ewan streets

Figure 21.14 Visual representation of the project at viewpoint 21 – O'Riordan Street at the intersection with Qantas Drive

Figure 21.15 Visual representation of the project at viewpoint 23 – Sir Reginald Ansett Drive

Figure 21.16 Visual representation of the project at viewpoint 24 – Seventh Street

21.4.3 Summary of impacts on Sydney Airport (Commonwealth) land

Landscape character impacts

The project is located within four landscape character zones including zones 1 (Terminal precincts), 2 (Green space), 4 (Alexandra Canal) and 5 (Freight and industrial). Zones 1 and 2 would be subject to high impact with zone 4 and 5 subject to moderate to low and moderate impact, respectively.

The impacts would result from the following activities:

- Elevated embankments above the existing landform in zones 1, 4 and 5
- Removal of vegetation, particularly in zone 1 along Qantas Drive
- Introduction of a new built form for zones 1, 4 and 5 impacting the 'big sky' landscape contributing to Sydney Airport's heritage values
- Removal of existing buildings within zone 1
- Drainage measures would potentially be highly visible in zones 2 and 5, altering the existing landscape character
- Land use changes in zones 2 and 5 from open space and freight/container storage areas to arterial road corridors.

These landscape changes would impact the zones within Sydney Airport land, in addition to other zones with views of Sydney Airport land.

Visual impacts

All viewpoints are located on Sydney Airport land with the exception of viewpoints 3, 6 and 7. The visual impact for the 23 viewpoints located on Sydney Airport land is described in section 21.4.2.

The assessment concluded that the project would have a high visual impact on viewpoint 11 and 12. Viewpoint 11 (Alexandra Canal cycleway near Shea's Creek underbridge) has a riverside parkland character with a high sensitivity to change. A number of large new structures would impact this view and change the outlook, including the Qantas Drive bridge, Terminal link bridge and eastbound terminal link. This would result in a high magnitude of visual effect. Viewpoint 12 (access track along the western side of Alexandra Canal) also has a high sensitivity to change to the waterway setting of this view. The presence of large infrastructure including the new freight terminal bridge and Terminal 1 connection bridge would result in a high magnitude of visual effect.

The project would result in long-term impacts on Sydney Airport land. Visual impacts would be the same irrespective of the mound design option chosen for the project (either option one or option two).

Consistency with the Sydney Airport Master Plan

Landscape character and visual impact commitments are not specifically identified in the *Sydney Airport Master Plan 2039* (SACL, 2019a). However, relevant commitments identified in relation to landscape include:

- Develop a strategy for providing planting within or in the vicinity of the airport site to compensate for vegetation removed during on-going development of the airport site.

The project would involve removing vegetation on Sydney Airport land. Consistent with the above commitment, a tree management strategy is proposed (see section 21.6.1)

21.5 Cumulative impacts

There would the potential for cumulative landscape and visual impacts between the project and other recent and proposed developments in the study area, including:

- Botany Rail Duplication
- Upgrade of the Boral Concrete St Peters facility
- Qantas Flight Training Centre relocation
- Airport West Precinct, Airport East Precinct and Airport North Precinct road upgrading project
- New M5
- M4-M5 Link
- Sydney Airport ground access solutions and hotel project (at Terminals 2/3).

21.5.1 Construction

Cumulative impacts would result from concurrent and consecutive construction activities viewed from a number of viewpoints. Based on the locations, duration and scale of ongoing works for major developments, the assessment concluded that the magnitude of cumulative effects on landscape character zones would be:

- High for landscape character zones 1 (Terminal precincts), 5 (Freight and industrial), 7 (Warehousing and employment) and 9 (Airport support)
- Moderate for landscape character zones 2 (Green space) and 4 (Runway precinct)
- Low for landscape character zones 3 (Alexandra Canal), 6 (Residential) and 8 (Motorway).

Of the 26 viewpoints, 16 viewpoints would experience additional visual impact from other major projects with two viewpoints considered to experience high to moderate additional impacts. The majority of the other viewpoints would have negligible or low additional impacts.

An assessment of the cumulative visual impacts (project impact with additional impact) results in a higher level of impact overall. There would be no reduction in visual impact and no change to 17 viewpoints. However, nine viewpoints would experience an increase in visual impact:

- From a high to moderate impact to a high impact at viewpoints 13, 18, 19, 20 and 24
- From a moderate impact to a high to moderate impact at viewpoints 10 and 22
- From moderate to low impact to a moderate impact at viewpoints 9 and 17.

The primary contributor to cumulative visual impacts would be from the Botany Rail Duplication which would occur immediately adjacent to, and in parallel with, the eastern part of project. While this would increase the magnitude of visual effect on some viewpoints during construction, concurrent construction would minimise the period of time during which visual impacts would be experienced.

21.5.2 Operation

New and upgraded infrastructure and structures associated with a number of other projects would be visible from viewpoints assessed as part of this project. The other developments would be visible from 16 of the 26 viewpoints. The magnitude of visual effects from other projects is predominantly negligible to low. This is generally due to the small portion of the view to other projects.

The exception is the Botany Rail Duplication and Qantas Flight Training Centre relocation. The Botany Rail Duplication would result in the removal of stands of vegetation along the rail corridor between King Street, Mascot and O'Riordan Street, Mascot. This vegetation makes a positive contribution to the visual and spatial character of the area. This is shown in viewpoints 19, 20, 22 and 24 (see Table 21.2). The Botany Rail Duplication would also include construction of a retaining wall close to Qantas Drive. The retaining wall would be visible from the same four viewpoints.

The combination of tree removal, retaining wall construction and space constraints that prevent re-establishment of trees along the road-rail interface would lead to cumulative permanent visual impacts. The cumulative impact would also be higher than the visual impacts resulting from the Sydney Gateway road project alone.

21.6 Management of impacts

21.6.1 Approach

Approach to mitigation and management

The assessment identified that the project would result in visual impacts, landscape character changes and the removal of trees. There would also be short-term and temporary visual impacts during construction.

Approach to managing the key potential impacts identified

Design development has included a focus on avoiding and/or minimising the potential for visual impacts during all key phases of the process. This is the primary form of mitigation. Further information on key design considerations, including urban design and place making, the need for an urban design and landscape plan, and how these have been integrated in the design process to date, is provided in sections 7.2.3 and 7.12.

The future design refinement process would be undertaken in accordance with relevant guidelines, including *Beyond the Pavement: Urban design policy, procedures and design principles* (Roads and Maritime, 2014), *Bridge Aesthetics: Design guideline to improve the appearance of bridges in NSW* (Roads and Maritime, 2019a), *Better Placed* (Government Architect NSW, 2017) and the *Noise wall design guideline. Design guideline to approve the appearance of noise walls in NSW* (Roads and Maritime, 2016a). A list of the guidelines that would guide the next stage of the urban design process is provided in section 7.12.4.

A tree management strategy would be prepared to manage the replacement of trees removed as part of the project. The strategy would identify:

- Trees and vegetation that can potentially be retained
- Tree replacement locations (including potential locations outside the project site) to provide a net increase in tree canopy, including locations for the translocation of cabbage tree palms
- Opportunities for rapid-growing replacement trees
- Suitable tree species with consideration of Sydney Airport's wildlife management plan, prescribed airspace and *National Airports Safeguarding Framework Guideline C: Managing the Risk of Wildlife Strikes in the Vicinity of Airports*
- Opportunities for high quality streetscapes

- Relevant on-site processes and tree protection measures.

Trees removed would be replaced to ensure there is a net increase in tree canopy. Trees that cannot be replaced within the project footprint would be replanted within Sydney Airport land and land subject to the EP&A Act, relative to the number of trees removed. The final location of replacement trees would be confirmed in consultation with Inner West Council and Sydney Airport Corporation.

Approach to managing other impacts

Implementing other relevant measures in Chapters 19 (Land use and property), 20 (Social and economic impacts) and 22 (Biodiversity) would assist in minimising the potential for landscape character and visual impacts during construction.

Expected effectiveness

Roads and Maritime has experience in managing potential urban design, landscape character and visual impacts as a result of road developments of a similar scale and scope to this project.

Urban design outcomes have been incorporated into the concept design and would be further refined during detailed design. The urban design outcomes have been guided by existing Roads and Maritime policies and procedures (such as Beyond the Pavement), which commit Roads and Maritime to providing excellent outcomes for the people of NSW, governed by overarching urban design principles that include both physical outcomes and performance based principles.

A range of mitigation measures are provided for incorporation into the project. These measures combine with the urban design concept to develop a solution that maximises the protection of the existing visual values and landscape character of the project site and adjoining areas. Mitigation measures may be considered under two categories:

- Primary mitigation measures are embedded in the design of the proposed works through an iterative process between the engineering and urban design teams. This form of mitigation is generally the most effective (see Chapter 7 (Project description))
- Secondary mitigation measures are designed to specifically address the remaining (residual) adverse effects arising from the proposed works.

An urban design and landscape plan would be prepared during detailed design in accordance with the urban design and place making strategy and concept plan. This would include urban design treatments to reduce the potential visual impacts during operation.

Audits and reporting of the effectiveness of environmental management measures is generally carried out to show compliance with management plans and other relevant approvals and would be outlined in detail in the CEMP (see Chapter 27 (Approach to environmental management and mitigation)). Procedures would also be developed for monitoring and maintaining landscaped areas to be implemented during operation to ensure planting becomes established and ensure the effectiveness of these treatments are appropriately implemented and maintained.

21.6.2 List of mitigation measures

Measures that will be implemented to address potential impacts on landscape character and visual amenity are listed in Table 21.5.

Table 21.5 Landscape character and visual amenity mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
General visual impacts	LV1	An urban design and landscape plan will be prepared to provide a consistent approach to project design and landscaping.	Detailed design
	LV2	Further design refinements of structures including bridges and the Terminals 2/3 access viaduct will be undertaken to minimise visual impacts as far as possible.	Detailed design
Managing the loss of trees	LV3	A tree management strategy will be developed including measures to offset the loss of trees and achieve a net increase in tree canopy. The final location of replacement trees will be confirmed in consultation with Inner West Council and Sydney Airport Corporation. The strategy will also include on-site processes and protective measures to ensure trees identified for retention are appropriately protected during construction.	Detailed design
Noise barriers	LV4	Where feasible and reasonable, the proposed noise barrier in the Tempe Lands will be designed to provide new active transport connectivity across the Terminal 1 connection and between the western and eastern portions of open space, and maximise passive surveillance of open space from the road.	Detailed design
	LV5	Noise barriers will be designed to minimise their visual prominence as much as possible.	Detailed design
Minimising light spill	LV6	Lighting for the project will be designed in accordance with AS4282-1997 Control of the obtrusive effects of outdoor lighting. Lighting will be designed to minimise glare and light spill into adjoining areas.	Detailed design
Visual impacts during construction	LV7	The design and maintenance of construction compound hoardings will aim to minimise visual amenity and landscape character impacts.	Construction
	LV8	The selection of materials and colours for hoardings will aim to minimise their visual prominence.	Construction
	LV9	Lighting of work areas, compounds, and work sites will be oriented to minimise glare and light spill impact on adjacent receivers.	Construction
Tree protection during construction	LV10	Trees to be retained will be protected prior to the commencement of construction in accordance with AS4970-2009 Protection of trees on development sites and the project's tree management strategy. Any tree pruning will be undertaken in accordance with the project's tree management strategy, guided by a tree report prepared by a qualified arborist.	Construction
Site rehabilitation	LV11	Following completion of construction, site restoration will be undertaken in accordance with the rehabilitation strategy (measure CS22). Temporary impacts on public open space will be rehabilitated in consultation with the relevant local council and/or landowner.	Construction

21.6.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 21.6.2).

It is anticipated the project would result in substantial changes to the landscape and visual character of the surrounding area. Some of the changes would reduce in severity over time as proposed vegetation establishes and matures. However, the project would result in the following long-term residual impacts:

- Alterations to the topography and three dimensional form
- Loss of built form within Sydney Airport land
- Loss of views and vistas along Alexandra Canal and between the canal and adjoining areas
- Land use changes
- Enlarged scale of road infrastructure
- Potential increase in light levels in parts of the project site with the potential for light spill.

Although the overall impact would not substantially reduce over time, the perception of the severity of the impact may reduce as people adjust to the changes. The project is also proposed in the context of land use changes and other projects planned for the area, including the New M5, M4-M5 Link and the Botany Rail Duplication. In the context of this landscape, it is anticipated that the long-term landscape character changes as a result of the project would be consistent with the future character and use of the area. As a result, long-term landscape character and visual impacts as a result of the project are not expected to be significant.

Chapter 22

Biodiversity

This chapter provides a summary of the biodiversity assessment. It describes existing biodiversity, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 14 (Biodiversity Development Assessment Report).

The SEARs relevant to biodiversity are listed below. There are no MDP requirements specifically relevant to biodiversity; however, there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)). Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
8	**Biodiversity**	
8.1	The Proponent must assess biodiversity impacts in accordance with the *Biodiversity Conservation Act 2016* (BC Act), the Biodiversity Assessment Method (BAM) and be documented in a Biodiversity Assessment Report (BDAR) unless a BDAR waiver had been sought, where applicable.	The Biodiversity Development Assessment Report (BDAR) (Technical Working Paper 14) was prepared in accordance with the *Biodiversity Conservation Act 2016* and the Biodiversity Assessment Method.
8.2	The BDAR must include information in the form detailed in section 6.12 of the BC Act, clause 6.8 of the Biodiversity Conservation Regulation 2017, and the BAM.	Section 22.1.2
8.3	The BDAR must be submitted with all digital spatial data associated with the survey and assessment as per Appendix 10 of the BAM.	Digital spatial data has been provided to the Department of Planning, Industry and Environment.
8.4	The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the *Biodiversity Assessment Method Order 2017* under section 6.10 of the BC Act	The BDAR was prepared by accredited assessors (refer to section 2.4 of Technical Working Paper 14).
8.5	The BDAR must include details of the measures proposed to address offset obligations.	The proposed measures are described in section 22.5.
8.6	The Proponent must assess any impacts on biodiversity values not covered by the BAM. This includes a threatened aquatic species assessment (Part 7A *Fisheries Management Act 1994* – FM Act) to address whether there are likely to be any significant impacts on listed threatened species, populations or ecological communities listed under the FM Act.	Potential impacts on aquatic biodiversity, matters of national environmental significance and cumulative impacts are described in sections 22.3 to 22.5.
8.7	The Proponent must identify whether the proposal, or any component of the proposal, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the BC Act, FM Act and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).	Section 22.3.5

22. Biodiversity

22.1 Assessment approach

Biodiversity impact assessment for major infrastructure projects in NSW is carried out by skilled and experienced biologists and ecologists in accordance with relevant legislation, guidelines and policies, and using a standard assessment approach (the Biodiversity Assessment Method). This method broadly involves:

- Reviewing existing information on biodiversity, which consists of the plants (flora), animals (fauna) and habitats in the study area
- Field investigations to identify and map flora and fauna species and communities – with particular emphasis on identifying native species, areas of native vegetation, and threatened and endangered species and communities
- Reviewing the project design and construction plan to identify potential impacts on biodiversity
- Assessing the significance of impacts
- Identifying ways to avoid impacts, and measures to minimise and/or offset impacts that cannot be avoided.

To provide a consistent approach and methodology to assessing the potential impacts of the project on biodiversity, the Biodiversity Assessment Method was applied to the project as a whole, including those parts located on Sydney Airport land. The Biodiversity Assessment Method was also applied as there is no equivalent method for land subject to the requirements of the Airports Act. Offset requirements were then determined in accordance with the Biodiversity Assessment Method for land subject to the assessment under NSW legislation, and with reference to the EPBC Act offsets policy for matters of national environmental significance on Sydney Airport land.

An overview of the approach to the assessment is provided below, including the legislative and policy context and a summary of the assessment methodology.

22.1.1 Legislative and policy context

The assessment has been undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, *Biodiversity Conservation Act 2016* (NSW) (the BC Act), Biodiversity Conservation Regulation 2017 (NSW), *Fisheries Management Act 1994* (NSW) (the FM Act), *Biosecurity Act 2015* (NSW) (the Biosecurity Act), EPBC Act, and the Airports Act and associated regulations
- *Biodiversity Assessment Method* (OEH, 2017)
- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (DEC, 2004b)
- *NSW Guide to Surveying Threatened Plants* (OEH, 2016a)
- *Survey guidelines for Australia's threatened frogs* (DEWHA, 2010)
- *Significant impact guidelines for the vulnerable green and golden bell frog (Litoria aurea)* (DEWHA, 2009)
- *Significant impact guidelines 1.1 – Matters of National Environmental Significance* (Department of the Environment, 2013)
- *Significant impact guidelines 1.2 – Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies* (DSEWPC, 2013)

- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

22.1.2 Methodology

Study area

The study area for the assessment includes the project site and adjoining areas, generally located within 500 metres of the project site as shown in Figure 22.1. The database searches were based on a search area within a radius of between five and 10 kilometres from the project site.

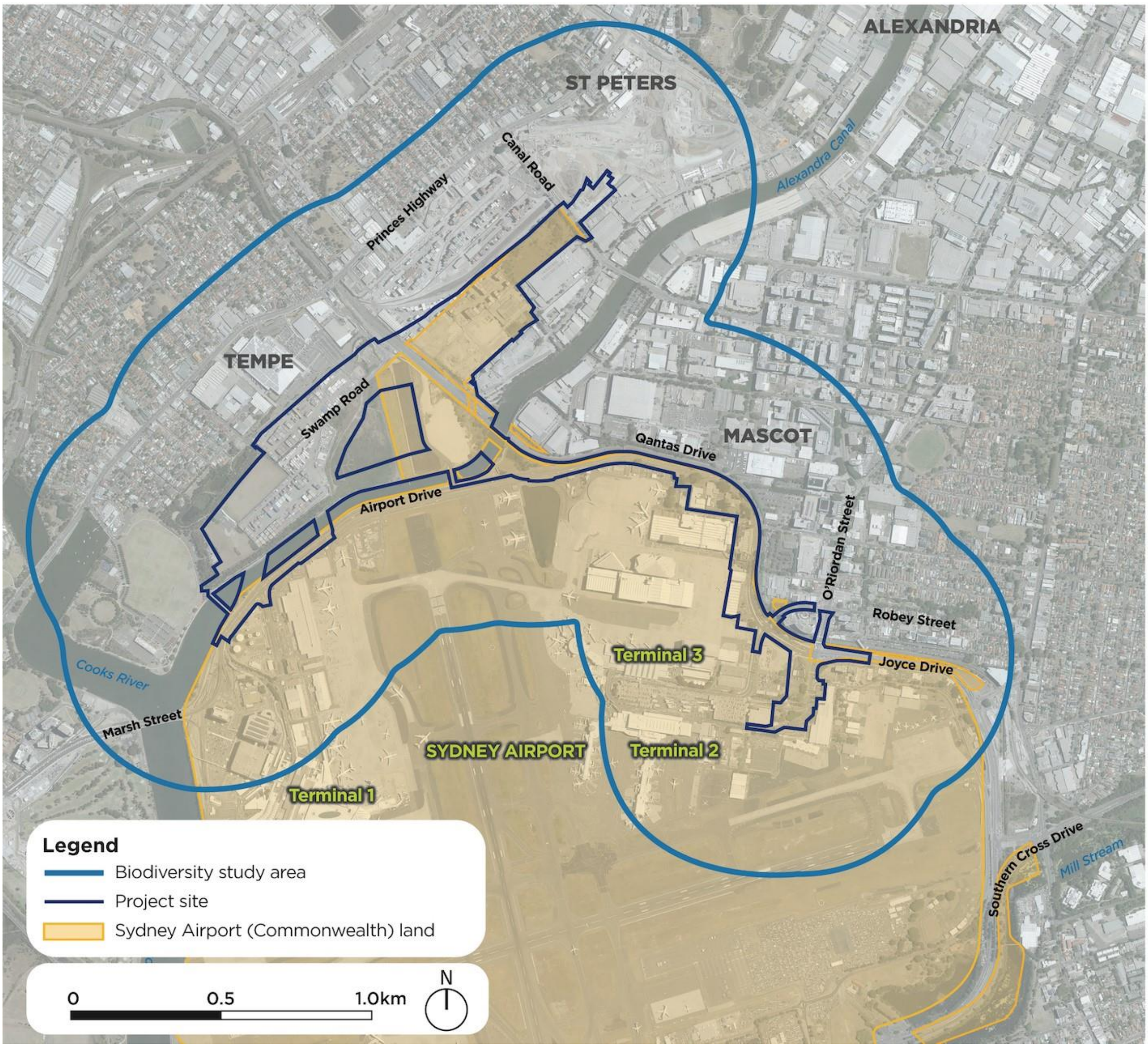


Figure 22.1 Biodiversity study area

Key tasks

The assessment involved:

- Background research, including reviewing previous assessments relevant to the study area and database searches, to confirm the:
  - likely distribution of native vegetation and threatened ecological communities

  - likely presence of threatened flora and fauna (listed under the BC Act, FM Act and/or the EPBC Act)
  - potential presence of groundwater dependent ecosystems and coastal wetlands
- Assessing the potential for species credit species to occur in the project site and be impacted by the project
- Terrestrial flora field surveys to map native and non-native vegetation and identify whether threatened flora species or communities listed under the BC Act and/or EPBC Act are present. Flora surveys were undertaken over four days on 14 September, 15 November, and 5 and 17 December 2018, and involved a range of survey techniques in accordance with the Biodiversity Assessment Method
- Terrestrial fauna field surveys to describe fauna habitats present and identify whether threatened fauna species listed under the BC Act and/or EPBC Act or migratory fauna species listed under the EPBC Act are present or likely to occur. Fauna surveys were undertaken over nine days/evenings on 26 June, 12 and 14 September, 3, 10, 11, 18 and 30 October, and 29 November 2018. The surveys involved a range of techniques in accordance with the Biodiversity Assessment Method
- An aquatic habitat survey on 3 October at Alexandra Canal, Tempe Wetlands and downstream areas of the Cooks River
- Assessing the potential impacts on native vegetation and habitats, threatened species, groundwater dependent ecosystems, key threatening processes, matters of national environmental significance and the environment of Commonwealth land (where relevant)
- Identifying measures to mitigate and offset the impacts identified, including a biodiversity offset strategy
- Preparing a Biodiversity Development Assessment Report to describe the results of the assessment in accordance with section 6.12 of the BC Act, clause 6.8 of the Biodiversity Conservation Regulation 2017 and the Biodiversity Assessment Method.

A detailed description of the assessment methodology is provided in section 3 of Technical Working Paper 14 (Biodiversity Development Assessment Report).

Potential impacts of the project on amenity trees are considered in Chapter 21 (Landscape character and visual amenity).

Species credits

Species credits are a type of biodiversity credit required under the Biodiversity Assessment Method for an impact on certain threatened species. All threatened flora species listed under the BC Act are species credit species, while some threatened fauna species listed under the BC Act or their breeding habitat are either species or ecosystem credit species.

The Biodiversity Assessment Method calculator uses geographic, vegetation and habitat data to generate a list of threatened species with the potential to occur in an area. These species are referred to by the Biodiversity Assessment Method as ‘candidate species credit species’. Targeted surveys are required to confirm or discount the presence of these species at a site. If present (or likely to occur), species credits must be calculated as part of any offset requirements under the BC Act.

22.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Risks to biodiversity with an assessed overall rating of medium or above, identified by the environmental risk assessment, included:

- Indirect impacts on aquatic habitats downstream of the project site (including as a result of reduced water quality)
- Impacts on foraging habitat for threatened species, such as the Grey headed flying fox

- Introduction and/or spread of weeds.

The biodiversity assessment included consideration of these potential risks.

22.2 Existing environment

22.2.1 Landscape scale biodiversity features

Landscape features contribute to the overall biodiversity value of the study area and are used to inform appropriateness of offsets, where these are required. The key landscape features, as defined by the Biodiversity Assessment Method, and how these relate to the study area, are summarised in Table 22.1.

Table 22.1 Landscape features

Landscape feature	Project site
Interim Biogeographic Regionalisation for Australia bioregion and subregion	The study area is located within the Sydney Basin Bioregion and the Pittwater subregion.
NSW landscape regions (Mitchell landscapes)	The study area is located within the Mitchell landscapes of Sydney–Newcastle Barriers and Beaches landscape.
Rivers and streams	The project site crosses Alexandra Canal. Alexandra Canal is a constructed watercourse with artificial banks that flows into the Cooks River downstream of the project site. Further information on the canal is provided in Chapter 14 (Flooding).
Important and local wetlands on, adjacent and downstream of the project site	Tempe Wetlands is a local wetland located adjacent to the project site. This wetland is an artificially constructed wetland surrounded by planted vegetation. Towra Point Estuarine Wetlands, listed as nationally important in the Directory of Important Wetlands in Australia, is located about 6.5 kilometres downstream of the project site. The Botany Wetlands, listed as nationally important in the Directory of Important Wetlands in Australia, is located about one kilometre to the south-east of the eastern end of the project site. Some areas of the Botany Wetlands, including Mill Pond and Engine Pond East and West, are located on Sydney Airport land. These areas are known as the Sydney Airport Wetlands. The Botany Wetlands (including the Sydney Airport Wetlands) are located outside the area of potential influence of the project and are not downstream of the project site. Parts of the southern end of Tempe Reserve alongside the Cooks River and Alexandra Canal (but outside the project site) are mapped as Coastal Wetlands under the *State Environmental Planning Policy (Coastal Management) 2018*. The proximity area for the wetland extends north along Alexandra Canal towards the footbridge, and adjoins the project site at this location.
Habitat connectivity features	The main habitat corridor within the project site is associated with Alexandra Canal. There is a vegetated link between the canal and Tempe Wetlands.
Areas of geological significance and soil hazard features	There are no mapped areas of geological significance. Soil hazard features include areas of high probability acid sulfate soil risk associated with Alexandra Canal and low probability areas over the majority of the project site.
Areas of outstanding biodiversity value under the BC Act	No declared areas of outstanding biodiversity value are located in the study area.

22.2.2 Terrestrial flora

Vegetation communities

The majority of the study area has been heavily modified by past and ongoing disturbances associated with urban and infrastructure development and landfill activities. This has resulted in a high level of disturbance and degradation of vegetation. The majority of vegetation in the project site comprises exotic or planted native species on highly modified landforms. There are small isolated patches of remnant or regrowth native vegetation. Native vegetation and habitat within the project site is in generally poor condition, and is impacted by operational activities, edge effects, weed infestation and exotic pests.

Vegetation communities within the project site are summarised in Table 22.2 and are shown on Figure 22.2 to Figure 22.6. Only a small proportion of the vegetation present (0.91 hectares) comprises native vegetation, the majority of which is located on Sydney Airport land.

Table 22.2 Existing vegetation communities within the project site

Plant community type	Vegetation class / formation	Condition	Conservation status	Total area in project site (ha)	Area in Sydney Airport land (ha)
Native vegetation communities					
Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion (Plant community type 1232)	Forested Wetlands / Coastal Swamp Forests	Recorded as low condition, generally as regrowth	Does not meet the criteria for listing as a threatened ecological community under the BC Act or EPBC Act	0.87	0.68
Mangrove Forests in estuaries of the Sydney Basin Bioregion and South East Corner Bioregion (Plant community type 920)	Saline Wetlands / Mangrove Swamps	Recorded as poor condition, generally as regrowth	Not listed under the BC Act or EPBC Act, protected under the FM Act	0.04	0.04
Total native vegetation				*0.91*	*0.72*
Disturbed areas and non-native vegetation					
Highly disturbed areas with no or limited native vegetation	-	Scattered or clumped areas of trees to exotic scrub, grassland and weeds	Not applicable	18.29	9.69
Urban exotic / native landscape plantings	-	Cleared/non-native vegetation	Not applicable	4.85	2.44
Total non-native vegetation				*23.14*	*12.13*
Total vegetation				***24.05***	***12.85***

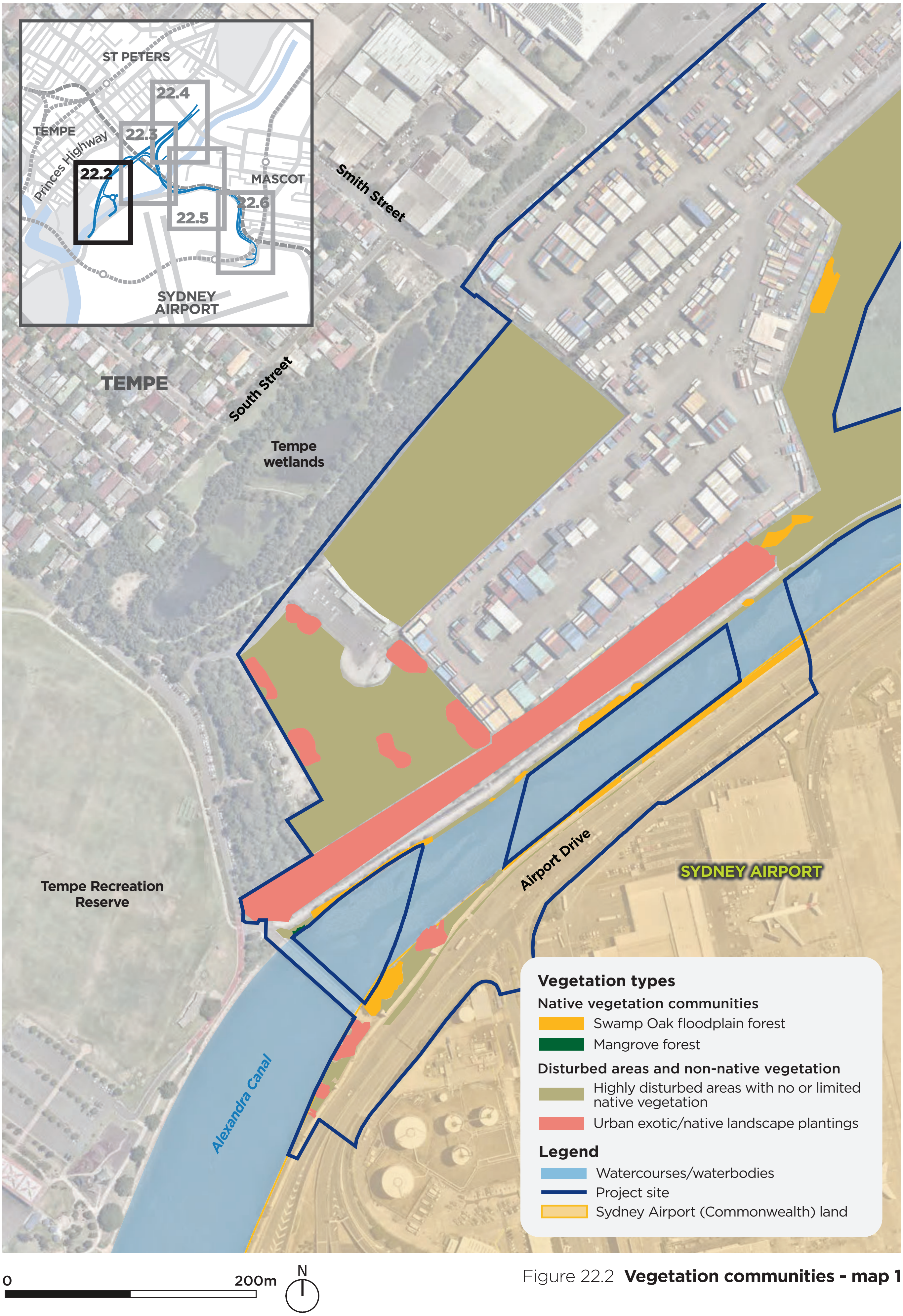


Figure 22.2 **Vegetation communities - map 1**

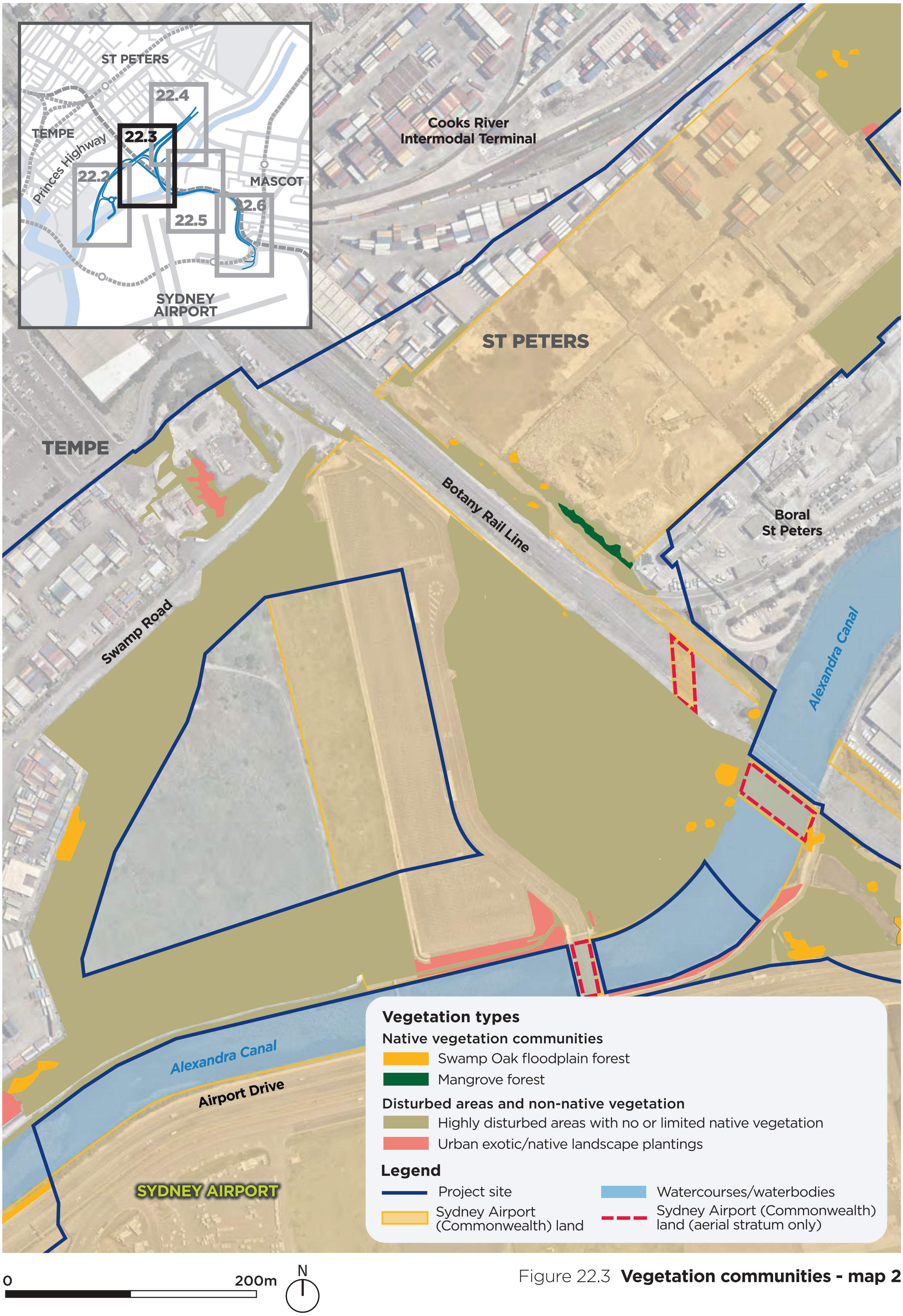


Figure 22.3 **Vegetation communities - map 2**

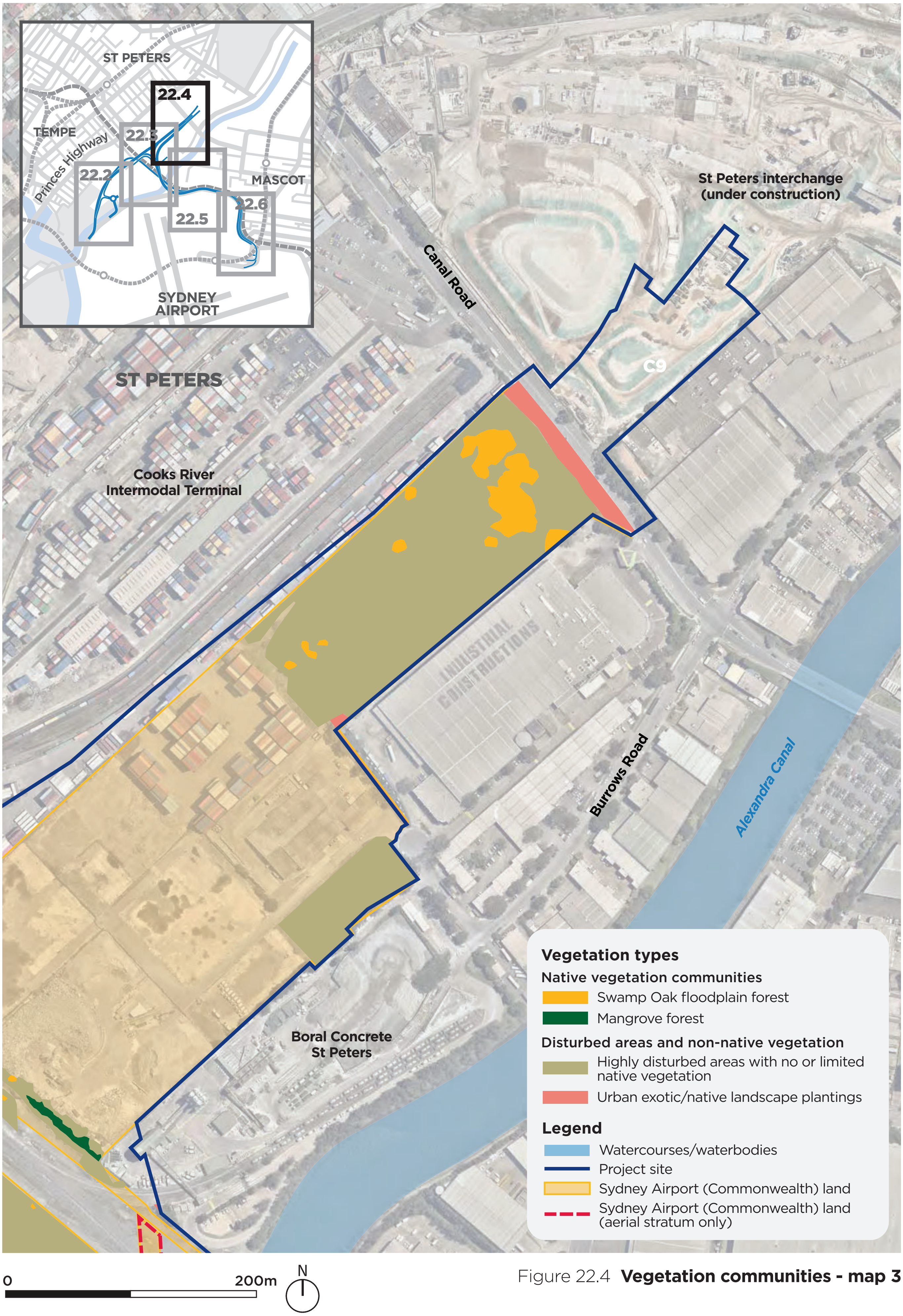


Figure 22.4 **Vegetation communities - map 3**

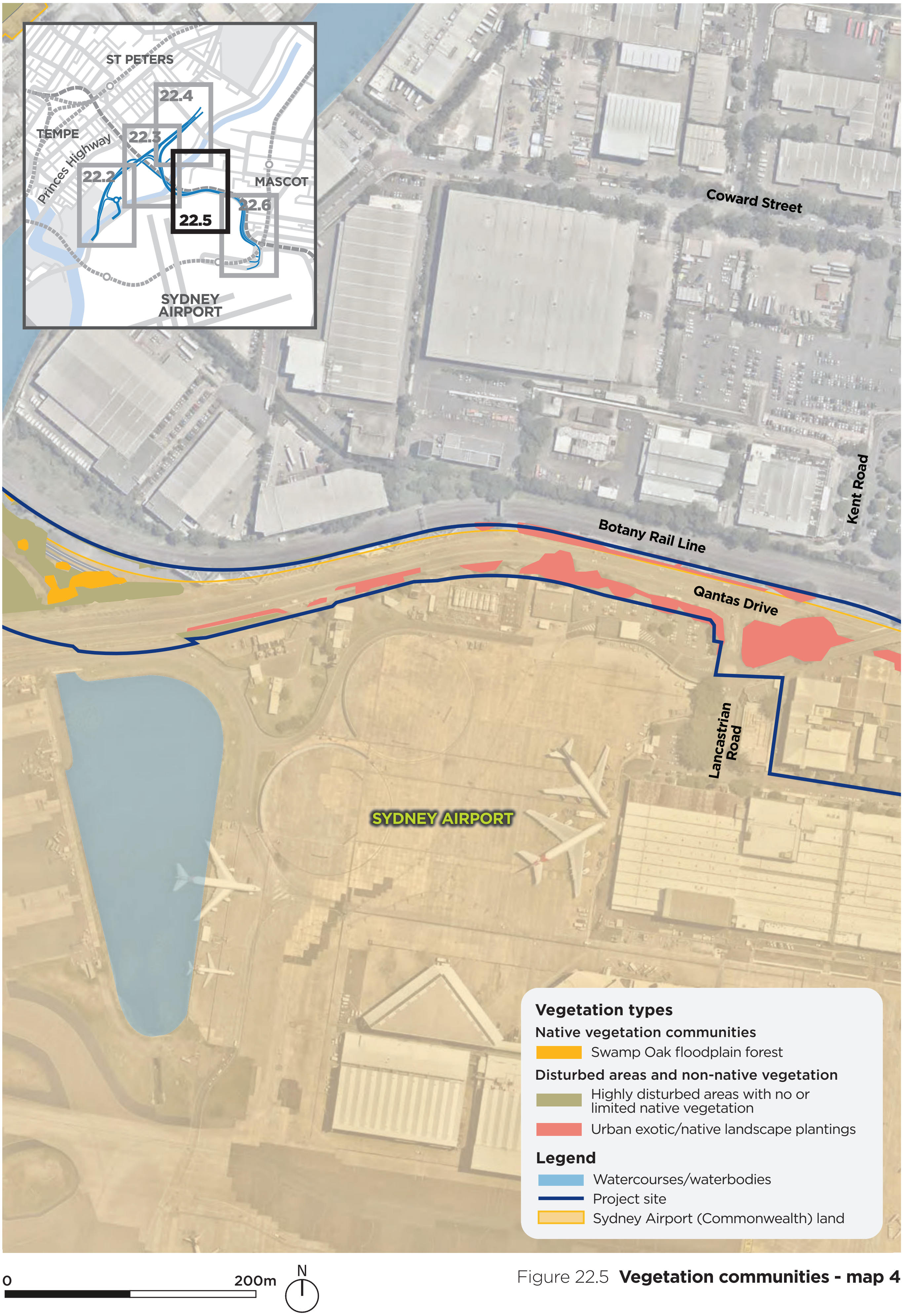


Figure 22.5 **Vegetation communities - map 4**

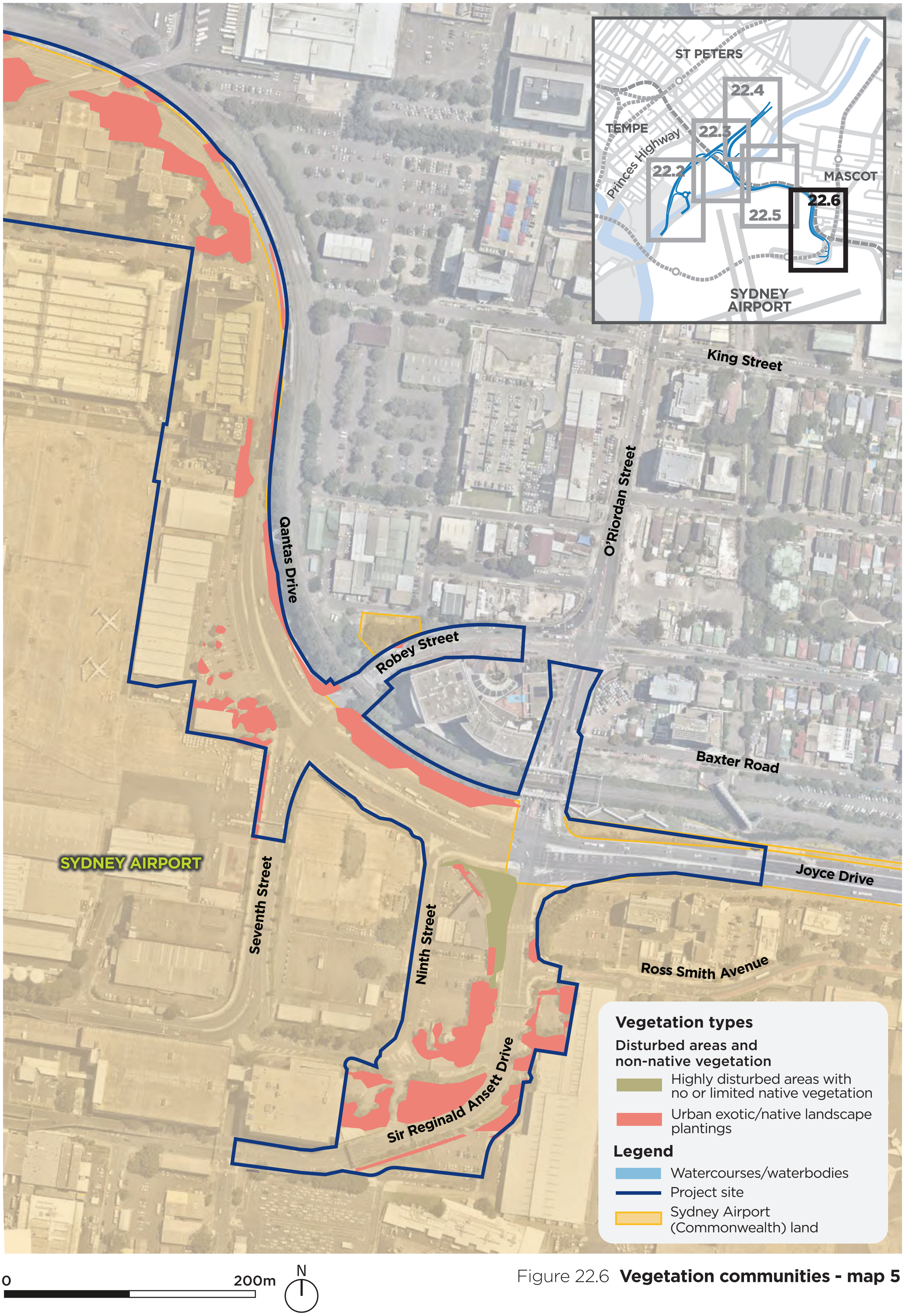


Figure 22.6 **Vegetation communities - map 5**

The Biodiversity Assessment Method requires the extent of native vegetation within the ‘project area’ (defined in this document, and referred to in this chapter, as the project site) to be mapped. Native vegetation in the project site has been classified into plant community types (PCTs) as shown in Figure 22.2 to Figure 22.6. The native vegetation communities in the project site are described below.

Swamp Oak floodplain forest (PCT 1232)

This vegetation occurs as isolated patches of regrowth, generally in areas subject to historic filling. The upper layer of vegetation is dominated by Swamp Oak (*Casuarina glauca*). It is assumed that the fill used in these areas contained a Swamp Oak soil seed bank. The middle and ground vegetation layers are mostly absent of native species and dominated by exotic species.

Most patches of this community do not appear to be associated with active coastal floodplain processes or influence by saline groundwater. The small linear patches fringing Alexandra Canal appear as regrowth on fill material associated with construction of the bentonite wall at the former Tempe landfill.

A representative patch of Swamp Oak floodplain forest is shown by Figure 22.7.

Figure 22.7 Representative patch of Swamp Oak floodplain forest

Mangrove forest (PCT 920)

Mangrove forest vegetation in the project site is dominated by Grey Mangrove (*Avicennia marina* subsp. *australasica*) with some native groundcover species typical of saline areas. It is associated with low-lying tidal drainage channels draining to Alexandra Canal and occurs in two small patches:

- A narrow linear strip associated with a tidal section of a stormwater channel adjacent to the Botany Rail Line in Tempe
- A small patch on the western side of Alexandra Canal.

Exotic species were common in this vegetation, which is considered to be opportunistic regrowth.

A representative patch of mangrove forest is shown by Figure 22.8.

Figure 22.8 Representative patch of Mangrove forest

Threatened ecological communities

No threatened ecological communities listed under the BC Act or EPBC Act are located within the project site.

The mapped patches of Swamp Oak floodplain swamp forest were assessed to determine whether they represent a threatened ecological community. The vegetation was compared with the final determination criteria for the BC Act listing of the *Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* threatened ecological community and the EPBC Act listing of the *Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland* threatened ecological community. Based on a review of existing landform, altitudinal range, soils, geology and vegetation structure, the recorded patches of Swamp Oak floodplain swamp forest are not considered to meet the BC Act or EPBC Act listings for these threatened ecological communities.

Threatened flora species

Database search results

The results of database searches indicated that 37 threatened flora species or populations listed under the BC Act, and 28 threatened flora species listed under the EPBC Act, have been recorded, or are predicted to occur, in the study area. A full list of the species identified is provided in Appendix B of Technical Report 14. The likelihood of most species occurring in the project site was considered to be low given the lack of suitable habitat and/or local records. The assessment identified two candidate species credit species for targeted surveys – Biconvex Paperbark (*Melaleuca biconvexa*) and Narrow-leafed Wilsonia (*Wilsonia backhousei*).

Flora field survey results

The field survey identified a total of 163 flora species in the project site. These comprised 33 native and 130 introduced species.

Biconvex Paperbark and Narrow-leafed Wilsonia were not observed during the targeted field surveys. The potential for these species to occur is considered to be low given the lack of evidence during surveys, lack of local records, and/or poor quality of potential habitat present. As a result, these species do not need to be included in the biodiversity credit calculations for the project.

Two threatened flora species were recorded as landscape plantings within the project site, being Narrow-leaved Black Peppermint (*Eucalyptus nicholii*) and Wallangarra White Gum (*Eucalyptus scoparia*). The natural distribution of these species does not occur within the Sydney Basin Bioregion although they have been widely distributed by the horticultural industry as ornamental landscape plantings. The occurrence of these species within the project site do not meet the final determination listing attributes (NSW Scientific Committee, 2002) or species profile descriptions (OEH, 2019a) for geographical distribution, geology or vegetation formation. As a result, they are not assigned the conservation significance of a threatened species, and no species credits were calculated.

Groundwater dependent ecosystems

Groundwater dependent ecosystems rely on a supply of groundwater to support the species composition, structure and function of the ecosystem. The closest groundwater dependent ecosystems (identified in the *Groundwater Dependent Ecosystem Atlas* (Bureau of Meteorology, 2019) and the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources*) are

- The Botany Wetlands and Lachlan Swamps, located about two kilometres south-east of the project site
- Vegetation along Wolli Creek, located about one kilometre west of the project site.

No groundwater dependent ecosystems are located in the project site.

Weeds

Weeds are common throughout the study area, and include environmental weeds and weeds with formal control measures identified. The Biosecurity Act identifies priority weeds in NSW that have been assigned a biosecurity duty (such as prohibitions on sale and control measures). Under the *Australian Weeds Strategy 2017 to 2027* (Invasive Plants and Animals Committee, 2016), 32 introduced plants have been identified as Weeds of National Significance. These weeds are regarded as the worst weeds in Australia because of their invasiveness, potential for spread, and economic and environmental impacts.

Of the 130 introduced species recorded within the project site, 12 species are listed by the Biosecurity Act as priority weeds for the Greater Sydney region. Eight of these 12 species are also listed as Weeds of National Significance. These include Madeira Vine (*Anredera cordifolia*), Ground Asparagus (*Asparagus aethiopicus*), Climbing Asparagus Fern (*Asparagus plumosus*), Bitou Bush (*Chrysanthemoides monilifera*), Lantana (*Lantana camara*), Prickly Pear (*Opuntia* spp.), Blackberry (*Rubus fruticosus* spp. agg.) and Fireweed (*Senecio madagascariensis*).

22.2.3 Terrestrial fauna

Terrestrial fauna habitats

A low diversity of species was recorded during field surveys, with the better quality habitats at Tempe Wetlands (predominantly outside the project site) contributing significantly to the range of species recorded.

The fauna habitat types identified during field surveys, and the potential for threatened and migratory fauna species to be present in these habitats, are described in Table 22.3.

Threatened fauna species

Database search results

A total of 81 threatened fauna species listed under the BC Act, and 36 threatened fauna species listed under the EPBC Act, have been previously recorded or are predicted to occur in the study area. A full list of these species is provided in Appendix B of Technical Report 14.

The assessment identified four candidate species credit species for targeted surveys – the Green and Golden Bell Frog (*Litoria aurea*), Southern Myotis (*Myotis macropus*), Pied Oystercatcher (*Haematopus longirostris*) and Sooty Oystercatcher (*Haematopus fuliginosus*). Targeted surveys were also conducted for the Grey-headed Flying-fox (*Pteropus poliocephalus*) as this species is also listed under the EPBC Act.

Table 22.3 Fauna habitats

Habitat	Description	Key habitat characteristics	Threatened fauna species recorded or likely to occur	Migratory fauna species recorded or likely to occur
Mangrove forest	These habitats, which are associated with low-lying tidal drainage channels draining to Alexandra Canal, and occur in two small patches: ▪ A narrow linear strip associated with a tidal section of a stormwater channel adjacent to the Botany rail line in Tempe ▪ A small patch on the western side of Alexandra Canal. A representative patch of mangrove forest is shown by Figure 22.8.	Foraging habitat for common bird and reptile species.	No threatened species recorded. The Eastern Bentwing-bat is likely to forage in the area.	No migratory species recorded. Given the very narrow and localised nature of the vegetation, migratory waders are unlikely to occur except on rare occasions.
Swamp Oak Floodplain Forest	Areas of this habitat do not appear to be associated with active coastal floodplain processes or influence by saline groundwater. The small linear patches fringing Alexandra Canal appear as regrowth on fill material associated with construction of the bentonite wall at the former Tempe landfill site. A representative patch of Swamp Oak floodplain forest is shown by Figure 22.7.	Marginal habitat for common bird species, Ringtail Possum, and common lizards and frogs.	No threatened species recorded. The Eastern Bentwing-bat is likely to forage in the area.	No migratory species recorded. Migratory woodland species (such as the Rufous Fantail) could occasionally use this habitat. However, they are unlikely to depend on it other than as stepping stones across the urban landscape.
Highly disturbed areas (exotic grassland and weeds)	These habitats are located along road reserves and on land adjacent to Alexandra Canal. A representative patch of this vegetation is shown by Figure 22.9.	Few habitat resources for most native species, with some foraging resources for relatively mobile and native fauna, including small birds and reptiles.	No threatened species recorded. Microchiropteran bats (microbats) may forage in this habitat.	No migratory species recorded and none are likely to occur.

Habitat	Description	Key habitat characteristics	Threatened fauna species recorded or likely to occur	Migratory fauna species recorded or likely to occur
Urban exotic and planted native species	These habitats are located on the former Tempe landfill site and the adjacent Tempe Recreation Reserve. They are dominated by a dense mid storey vegetation layer of variable complexity, including species such as Green Wattle, Parramatta Wattle, Native Blackthorn, Swamp Oak and Eucalyptus sp. Planted trees, including eucalypts and figs, are located along the sides of roads and at car parks. A representative patch of this vegetation is shown by Figure 22.9.	Foraging and breeding habitat for a range of common species typical of urban parks and gardens. No hollow-bearing trees were observed.	The Grey-headed Flying-fox may forage in planted eucalypts when they are flowering or fruiting. Microbats may occasionally forage in this habitat.	No migratory species recorded. Migratory woodland species (such as the Rufous Fantail) could occasionally use this habitat but are unlikely to depend on it.
Planted vegetation at Tempe Wetlands	Tempe Wetlands is an artificial wetland that acts as a detention basin for stormwater drainage from the surrounding area. It does not receive water from a natural watercourse. A range of planted native species are located around the three ponds in the wetlands, including Swamp Oak, eucalypts and acacias. A representative patch of this vegetation is shown by Figure 22.9.	Tempe Wetlands and surrounding plantings provide important habitats for a range of common and threatened fauna. No hollow-bearing trees were observed.	The Grey-headed Flying-fox was recorded foraging in planted eucalypts. The Eastern Bentwing-bat was recorded. The Eastern Freetail Bat may also forage in these habitats. No evidence of the Green and Golden Bell Frog was observed during targeted surveys.	No migratory species recorded. Migratory woodland species (such as the Rufous Fantail) could occasionally use this habitat but are unlikely to depend on it.
Mud flats at Alexandra Canal	Narrow bands of mud flats occur along the edges of Alexandra Canal in the project site. A representative patch of this vegetation is shown by Figure 22.9.	Foraging habitat for wading birds and other common bird species.	No threatened species recorded	No migratory species recorded. Migratory waders could occasionally use this habitat. However, these areas do not comprise important habitat for waders.
Bridges and culverts	The project site contains a pedestrian footbridge, rail bridge and culverts that open to Alexandra Canal.	Crevices and pipes in the underside of the bridge or in culverts are potential roost habitat for microbats.	No evidence of roosting bats was observed.	None

Exotic grasslands and weeds

Urban exotic and planted native species

Planted vegetation at Tempe Wetlands

Mud flats at Alexandra Canal

Figure 22.9 Representative patches of other habitats in the project site

Species credit species

Targeted surveys in appropriate conditions did not find any evidence of the four species credit species identified. Given the lack of evidence of these species, and/or poor quality of potential habitat present, the project is unlikely to impact habitat for these species. As a result, these species do not need to be included in the biodiversity credit calculations for the project.

Fauna field survey results

The field survey identified a total of 60 fauna species in the project site, including 45 bird species, seven mammal species, four reptile species and four frog species. Two threatened species were identified for which species credits are not required to be calculated:

- Eastern Bentwing-bat, listed as vulnerable under the BC Act
- Grey-headed Flying-fox, listed as vulnerable under both the BC Act and EPBC Act.

Some highly mobile species, such as the Eastern Freetail Bat, may occasionally occur within the project site. The Green and Golden Bell Frog was not recorded in the project site and is considered unlikely to be present.

22.2.4 Aquatic biodiversity

Aquatic habitats

The aquatic field survey targeted two aquatic habitats in the project site – Tempe Wetlands and Alexandra Canal. The downstream areas of Cooks River were also surveyed as they have the potential to be indirectly impacted by the project.

Alexandra Canal

Alexandra Canal is mapped as key fish habitat, despite its highly disturbed and artificial form. Narrow mud flats within the canal provide limited habitat for oysters, mangroves and Swamp Oak. Sparse woody debris and submerged habitat structures provide some refuge for common fish species, which were observed or are considered likely to be present. As described in section 22.2.2, two small patches of mangrove forest were identified near the canal.

Tempe Wetlands

Tempe Wetlands is an artificial wetland with no flow from a natural system. Water enters from a stormwater drain and the wetlands drain to Alexandra Canal.

A number of emergent aquatic plants were observed. Native fish are unlikely to occur in the wetlands given the lack of connectivity with Alexandra Canal and the Cooks River.

Cooks River

Near its confluence with Alexandra Canal the Cooks River is a highly modified habitat. The banks are typically concrete or stone blocks, with small areas of mud flats adjacent to these at low tide. Riparian vegetation is limited to occasional mangroves and planted trees.

Threatened aquatic species

Tempe Wetlands and Alexandra Canal do not provide habitat for any known threatened species. No threatened aquatic or migratory species were recorded during field surveys.

Parts of the southern end of Tempe Recreation Reserve adjacent to the Cooks River and Alexandra Canal (outside the project site) are mapped as coastal wetlands under *State Environmental Planning Policy (Coastal Management) 2018*.

22.2.5 Matters of national environmental significance

Threatened ecological vegetation communities

The protected matters search identified 11 threatened ecological communities, listed under the EPBC Act, as potentially occurring within the locality. One of these (*Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland*) was considered to have the potential to occur within the project site.

As described in section 22.2.2, none of the areas mapped as Swamp Oak floodplain swamp forest in the project site meet the EPBC Act listing criteria for a threatened ecological community.

Threatened flora and fauna species

The protected matters search identified 28 threatened flora species and 36 threatened fauna species listed under the EPBC Act as potentially occurring within the locality. The results of the field surveys and likelihood of occurrence assessments concluded that these species have a low likelihood of occurrence in the project site.

The Grey-headed Flying-fox was the only threatened species listed under EPBC Act identified during field surveys.

Migratory species

The protected matters search identified 41 migratory species (not including pelagic and marine species) listed under the EPBC Act as potentially occurring within the locality. There are no records of migratory species in the project site. The results of the field surveys and likelihood of occurrence assessments concluded that these species have a low likelihood of occurrence in the project site.

Wetlands of international importance

The Towra Point Nature Reserve, which is listed as a wetland of international importance under the Ramsar convention, is located about 6.5 kilometres from the project site, on the southern side of Botany Bay.

22.2.6 Biodiversity values on Sydney Airport (Commonwealth) land

The biodiversity values of Sydney Airport land within the project site are summarised below.

Terrestrial flora

Small areas of native vegetation are located on Sydney Airport land within the project site:

- Swamp Oak floodplain forest (0.68 hectares)
- Mangrove forest (0.04 hectares).

Small pockets of planted trees (predominantly eucalypts and figs) and shrubs are also located along roadsides and in carparks within Sydney Airport land. Other vegetation is summarised in Table 22.2.

No threatened flora species or communities listed under the BC Act or EPBC Act were recorded.

Terrestrial fauna

The small patches of native vegetation, planted trees and exotic vegetation provide habitat for common and widespread native fauna species typical of highly modified urban environments.

The Grey-headed Flying-fox would forage in planted eucalypts and fig trees when trees are flowering or fruiting. However, there is no roosting habitat for this species within the project site or adjoining areas. Microbats are also likely to occasionally forage over patches of vegetation.

Aquatic biodiversity

An artificial pond is located adjacent to Qantas Drive. This is covered by netting to prevent birds from using it. It does not provide habitat for threatened or migratory waders. Despite its disturbed and modified nature, it is mapped as key fish habitat and does contain some fish. However, the pond is unlikely to provide important habitat for native fish and it does not contain suitable habitat for any threatened aquatic species listed under the FM Act or EPBC Act.

22.3 Assessment of construction impacts

Potential impacts on biodiversity during construction include:

- Direct impacts as a result of vegetation clearing
- Indirect impacts on flora and fauna located outside the project site as a result of activities within the project site.

A summary of the results of the impact assessment is provided in the following sections.

22.3.1 Terrestrial flora

The project would mainly impact existing cleared and hardstand areas with no biodiversity values. During construction, about 24 hectares of vegetation would be removed, which includes 0.91 hectares of native vegetation.

No threatened ecological communities or species would be impacted.

22.3.2 Terrestrial fauna

The potential for direct impacts on fauna and their habitats are summarised in Table 22.4.

Table 22.4 Direct impacts on fauna

Impact	Description
Removal of habitat resources	The following habitat resources would be removed: ▪ 4.85 hectares of potential foraging habitat for the Grey-headed Flying-fox ▪ About 5.7 hectares of potential foraging habitat for the Eastern Bentwing-bat and other threatened fauna species ▪ About 18.3 hectares of highly disturbed areas that may provide foraging habitat for the Eastern Bentwing-bat ▪ About 0.04 hectares of mangroves that provide limited habitat for common fauna. This vegetation provides limited habitat resources for native fauna due to its highly modified nature and the surrounding urban environment. It includes foraging and shelter resources for common native fauna typical of urban environments. A small number of food trees for the Grey-headed Flying-fox, and foraging habitat for microbats, would be removed. This impact would not be significant in the context of available foraging habitat in the study area.
Removal of hollow-bearing trees	No large hollow-bearing trees suitable for nesting by threatened owls were recorded.
Injury and mortality	Construction has the potential to result in injury or mortality of some individuals of less mobile fauna species and other small terrestrial fauna that may be sheltering in vegetation. The potential injury or mortality of individuals is highly unlikely to affect an ecologically significant proportion of any local populations. More mobile native fauna, such as native birds, bats, terrestrial and arboreal mammals, are likely to be able to evade injury during construction.
Fragmentation and isolation of habitat.	Native vegetation within the project site is fragmented by existing urban development, roads and the rail corridor. The project would be unlikely to create an additional barrier to the movement of pollinator and seed dispersal fauna, such as insects and birds.
Impacts on key fish habitat and marine vegetation	There would be no loss of key fish habitat. A very small area of mangroves and highly disturbed mud flats would be removed. There would be no impacts on aquatic connectivity or fish passage along Alexandra Canal. The gaps in riparian vegetation would increase; however, this is unlikely to prevent the movement of any fauna along this corridor.
Impact on wetland habitat	There would be no direct impacts on any wetland habitats.
Impacts on threatened fauna species	The project would have minimal impacts on threatened fauna species. The main potential impacts relate to the loss of habitat resources, described above.

22.3.3 Aquatic ecology

The project would directly impact the mangrove forest community in the project site (shown on Figure 22.3), requiring removal of about 0.04 hectares of mangrove forest. The project would not directly impact any habitat for threatened aquatic species listed under the EPBC Act or FM Act.

The project includes construction of new bridges across Alexandra Canal, which is mapped as key fish habitat. The project has been designed to minimise potential impacts on the canal and the bridges do not include piers within the canal. As a result, fish passage would not be blocked. Additional measures would be implemented during construction to minimise the potential for water quality impacts. Further information is provided in Chapter 16 (Surface water quality).

The project would not directly impact Tempe Wetlands.

22.3.4 Indirect impacts

The potential for indirect impacts on terrestrial and aquatic biodiversity values are summarised in Table 22.5.

Table 22.5 Indirect impacts on biodiversity values

Impact	Description
Weed invasion and edge effects	‘Edge effects’ include increased noise and light, erosion and sedimentation, introduction of weeds, and associated degradation of vegetation at the interface of intact vegetation and cleared areas. The small native vegetation patches in the project site are already severely affected by edge effects and associated impacts such as weed infestation. The project would create few additional edge effects and is unlikely to significantly increase existing edge effects.
Pests and pathogens	Construction activities, particularly the movement of construction vehicles, have the potential to introduce pests and pathogens to a site, or transfer them to other sites. These could include plant pathogens (such as Phytophthora and Myrtle Rust) and frog pathogens (Chytrid fungus). The potential for impacts associated with these pathogens is low, given the existing levels of disturbance and access within the project site, and the lack of intact native vegetation in the vicinity of the project site.
Light, noise and vibration	Light, noise and vibration can impact breeding, foraging and roosting activities where fauna are located close to construction activities, particularly in environments that are not already subject to these affects. Fauna that occupy habitats within the project site and adjacent areas would be accustomed to existing lights and high noise and vibration levels originating from aircraft, road traffic, trains and the urban environment. While there would be localised increases during construction, these are unlikely to result in a significant impact.
Sedimentation, erosion and pollution	Uncontrolled erosion can spread weeds, reduce habitat values and stifle plant growth. Sediment laden runoff entering watercourses can affect water quality and adversely affect aquatic life. This is a particular is risk during construction within and near Alexandra Canal. The project has been designed to minimise this particular risk, by not including piers within the canal and limiting the activities that would take place on the banks of the canal. Additional measures would be implemented during construction to minimise the potential for water quality impacts. Further information is provided in Chapter 16.
Aquatic disturbance and pollution	Construction has the potential to mobilise contaminated sediments. The introduction of pollutants into the surrounding environment has the potential to impact on water quality and affect aquatic biodiversity values within and downstream of the project site, including habitat for fish, wading birds and other species that use downstream habitats. Measures would be implemented during construction to minimise the potential for mobilisation of contaminated sediments and associated surface and groundwater quality impacts. Further information on the potential for contamination, groundwater and surface water impacts is provided in Chapters 13, 15 and 16 respectively.

22.3.5 Impacts on key threatening processes

The BC Act, FM Act and EPBC Act list a series of key threatening processes. These are defined as an action, activity, project or potential threat that:

- Adversely affects two or more threatened species, populations, or ecological communities
- Could cause species, populations or ecological communities that are not currently threatened to become threatened.

The key threatening processes relevant to the project are considered in Table 22.6. The project itself does not constitute a key threatening process and is unlikely to exacerbate those processes.

Table 22.6 Key threatening processes relevant to the project

Key threatening process	Listing	Assessment
Clearing of native vegetation	BC Act EPBC Act	The project would involve removing less than one hectare of native vegetation. This minor reduction is highly unlikely to affect the viability of remnant vegetation in the project site or study area, or reduce the extent of habitat below a minimum size required for any fauna species.
Loss of hollow-bearing trees	BC Act	No mature trees with obvious large hollows would be removed.
Removal of dead wood and dead trees	BC Act	The project site contains very little fallen timber or dead trees. The small amounts that do occur may be removed or disturbed during construction.
The degradation of native riparian vegetation along NSW water courses	FM Act	Small areas of highly modified native vegetation and planted trees located along the edges of Alexandra Canal would be removed.
Human-caused climate change	BC Act, EPBC Act and FM Act	During construction, machinery and the production and transport of materials would emit carbon dioxide into the atmosphere, which is known to increase greenhouse gases responsible for climate change.

22.3.6 Impacts on matters of national environmental significance

The Grey-headed Flying-fox is the only identified matter of national environmental significance with the potential to be impacted by the project. An assessment of the potential impacts on this species was undertaken in accordance with the *Significant impact guidelines 1.1 – Matters of National Environmental Significance*.

The assessment concluded that the project would not have a significant impact on this species given the small area of planted vegetation that would be removed, and that there would be no direct impacts on any breeding camps. Further information is provided in Appendix G of Technical Working Paper 14 (Biodiversity Development Assessment Report).

22.3.7 Summary of impacts on Sydney Airport (Commonwealth) land

The project would mainly impact existing cleared and hardstand areas on Sydney Airport land. During construction, about 12.9 hectares of vegetation would be removed from within the project site on Sydney Airport land. This includes about 0.7 hectares of native vegetation. No threatened ecological communities or flora species would be impacted.

The vegetation that would be removed provides limited habitat resources for native fauna due to its highly modified nature and the surrounding urban environment. Fauna habitat resources that would be removed include foraging and shelter resources for common native fauna typical of urban environments.

The potential direct and indirect impacts on biodiversity values are consistent with those described in section 22.3. An assessment of the significance of potential impacts on the biodiversity values of Sydney

Airport land was undertaken in accordance with the *Significant impact guidelines 1.2* (DSEWPC, 2013). The assessment concluded that the project would not have a significant impact on biodiversity, as a result of the highly modified nature of the existing environment, the limited existing biodiversity values, and the small magnitude and extent of the potential impacts.

The Grey-headed Flying Fox may occasionally forage in planted trees on Sydney Airport land. However, these trees do not represent critical habitat, and the project would not have a significant impact on the species.

Sydney Airport land within the project site does not contain any threatened ecological communities or threatened flora listed under the EPBC Act, or any important habitat for threatened or migratory shorebirds. The project would not significantly impact any matters of national environmental significance (including threatened species or ecological communities). Further information is provided in Appendix G of Technical Working Paper 14 (Biodiversity Development Assessment Report).

Consistency with the Sydney Airport Master Plan

The *Sydney Airport Master Plan 2039* (SACL, 2019a) (the Master Plan) identifies biodiversity and conservation management as a key environmental issue. The main area of natural biodiversity value on Sydney Airport land is the Sydney Airport Wetlands, which are part of the Botany Wetlands. The marine environment of Botany Bay is also identified as an area of environmental sensitivity.

By implementing the Master Plan and associated *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b) (the Environment Strategy) Sydney Airport Corporation plans to manage and reduce potential impacts on the ecology and biodiversity of Sydney Airport and its surrounds by implementing (amongst other things):

- Ecological impact assessments for all major developments, in particular where potential impacts may occur to the Sydney Airport Wetlands, Botany Bay, listed flora and fauna species and communities
- Management and mitigation measures for developments to limit ecological and biodiversity impacts.

The five year plan for biodiversity in the Environment Strategy includes a range of actions, of which the following are of most relevance to the project:

- Ensure that, where appropriate, potential biodiversity impacts are assessed as part of the assessment of development proposals and, if necessary, managed
- Develop an airport wide vegetation strategy which incorporates biodiversity offsets.

The project is consistent with these measures. In particular, the project has been designed to avoid adverse consequences on the biodiversity values of Sydney Airport land. A rigorous impact assessment process has been undertaken to ensure biodiversity impacts are appropriately assessed and impacts minimised where practicable.

The project will not impact on sensitive areas at Sydney Airport, including Sydney Airport Wetlands or the Botany Bay marine environment, and is not in conflict with any of the identified biodiversity actions identified in the Environment Strategy.

Current biodiversity management practices at Sydney Airport predominantly relate to managing the Sydney Airport Wetlands and do not directly apply to the project, as the wetlands are located well outside the project site. The project may impact fig trees on Sydney Airport land (eg along Qantas Drive), however these are not located in the South East Sector where fig trees are being managed. Nevertheless, to ensure consistency with this management action within the project site, amenity trees (including fig trees) removed to construct the project would be replaced in accordance with the tree management strategy for the project (see section 21.6.1). Such trees may include fig trees and other food trees that provide foraging resources for the threatened Grey-headed Flying-fox, where there would be no increase in the risk of wildlife strike (see Chapter 11 (Airport operations)).

22.4 Assessment of operational impacts

The potential for biodiversity impacts during operation are summarised in Table 22.7.

Table 22.7 Potential operational impacts

Impact	Description
Light, noise, and vibration	The project would introduce additional light, noise and vibration associated with street lighting and the movement of vehicles. Fauna in the project site would be accustomed to existing light, noise and vibration associated with the operation of Sydney Airport and the surrounding road and rail network. In this context, the project is likely to comprise only a minor increase in these potential impacts. The project is unlikely to increase the extent, duration, or magnitude of these impacts, to the extent that there would be a significant impact on biodiversity values.
Vehicle strike	Few terrestrial fauna species occur in the project site that are at risk of vehicle strike, and those that occur are already subject to this risk. The project is unlikely to significantly increase the risk of vehicle collisions with fauna.
Erosion and sedimentation and discharge of pollutants	Any potential increase in contaminants or changes in water quality would have the potential to result in indirect impacts on adjoining or downstream habitats. For example, the discharge of stormwater into Alexandra Canal as a result of new or upgraded outlets has the potential to mobilise sediments, including contaminated sediments. The project has been designed to minimise the potential for these impacts. Potential contamination, soil and water quality impacts are considered in Chapters 13, 15 and 16. Appropriate mitigation measures would be implemented to effectively manage any potentially adverse impacts. As a result, no significant operational impacts on biodiversity are predicted.

22.5 Cumulative impacts

The main potential for cumulative biodiversity impacts relates to the combined impacts of the project with the proposed Botany Rail Duplication project. The project site for the Botany Rail Duplication contains small areas of remnant and regrowth native vegetation, including small patches of two endangered ecological communities listed under the BC Act (0.46 hectares of *Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* and 0.1 hectares of *Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*).

Construction of the Botany Rail Duplication would involve removing 0.72 hectares of native vegetation. Together, both projects would result in the removal of a total of 1.63 hectares of native vegetation.

Other road projects in the study area, including the New M5 and M4–M5 Link, have resulted in the removal of mainly planted vegetation and associated fauna habitats. Cumulatively, these projects would result in a minimal loss of biodiversity values. The main potential cumulative impact would be the further loss of habitat from an already modified environment with limited natural biodiversity values.

22.6 Management of impacts

22.6.1 Approach

Approach to mitigation and management

The overall approach to managing impacts on biodiversity is, in order of importance, to:

- Avoid impacts through the planning and design process
- Mitigate impacts using a range of mitigation measures
- Offset any residual impact that could not be avoided or mitigated as required by relevant legislation.

The majority of the project site is located on land that has been significantly modified by clearing and development. Impacts on biodiversity are substantially less than would be associated with an undisturbed greenfield site. Project infrastructure has been sited to maximise the use of existing cleared areas and avoid areas of native vegetation as far as practicable. The design would continue to be refined to minimise direct impacts on native vegetation as far as practicable.

The project would mainly impact existing cleared and hardstand areas with no biodiversity values. During construction, about 0.9 hectares of native vegetation would be removed, which includes about 0.7 hectares located on Sydney Airport land.

Measures are provided in section 22.6.2 to mitigate impacts that cannot be avoided. The potential for impacts during construction would be managed in accordance with a project-specific Biodiversity Management Plan, which would be implemented as part of the CEMP. The plan would detail processes and responsibilities to minimise potential impacts on biodiversity during construction. It would be prepared in accordance with relevant legislation, guidelines and standards, including the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011). Further information on the CEMP, including the Biodiversity Management Plan, is provided in Chapter 27 (Approach to environmental management and mitigation).

Measures to minimise potential impacts associated with noise, air quality, contamination and soils, flooding and water quality would assist in minimising potential indirect impacts to biodiversity. These mitigation measures are provided in Chapters 10 and 12 to 16.

The residual impacts of the project are described in section 22.6.3.

Expected effectiveness

Roads and Maritime has experience in managing potential biodiversity impacts for road developments of a similar scale to the project. This includes experience on projects with much higher levels of potential impacts, including those in locations that are more ecologically diverse and sensitive.

The proposed mitigation measures, including preparation of the Construction Biodiversity Management Plan, are based on best management practice and specialist experience. The management plan would be prepared in accordance with the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects*. These guidelines were developed in consultation with the relevant NSW government agencies, biodiversity specialists and Roads and Maritime staff, and have been successfully applied to a number of projects. The guidelines also outline specific and tailored requirements for monitoring and reporting to record the success of the biodiversity management measures.

As such, the measures are considered to be effective in managing potential impacts to biodiversity.

22.6.2 List of mitigation measures

Measures that will be implemented to address potential impacts on biodiversity are listed in Table 22.8. All measures apply to the project as a whole (ie to those elements of the project that are located on Sydney Airport land and those located on land subject to the EP&A Act).

Table 22.8 Biodiversity mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Avoiding impacts on biodiversity	BD1	Detailed design will avoid or minimise the need to remove and/or disturb native vegetation and fauna habitat, including impacts on mapped areas of mangrove forest and Tempe Wetlands.	Detailed design
	BD2	Vegetation clearing will be limited to the minimum necessary to construct the project. Micro-siting of infrastructure will be undertaken during detailed design to further minimise or avoid impacts on native vegetation where practicable. Exclusion areas will be established and maintained around any native vegetation adjoining the project site in close proximity to work locations to be retained.	Detailed design
Managing the potential for biodiversity impacts during construction	BD3	A Construction Biodiversity Management Plan will be prepared prior to construction and implemented as part of the CEMP. It will include measures to manage biodiversity and minimise the potential for impacts during construction. The plan will be prepared in accordance with relevant legislation, guidelines and standards.	Pre-construction, construction

22.6.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 22.6.2).

The project would result in some unavoidable residual impacts, including:

- Removal or modification of 0.91 hectares of native vegetation and associated habitat resources
- Removal or modification of five hectares of urban exotic/native landscape plantings and associated habitat resources
- Removal of 0.04 hectares of mangrove forest
- Impacts from noise, light, traffic and altered environmental conditions.

These impacts are minor in extent and magnitude, and would not result in a significant reduction in biodiversity values within the study area.

The offset obligations under NSW and Commonwealth legislation are discussed below.

Biodiversity offset obligations under the BC Act

Obligations to offset the biodiversity impacts of the project on land subject to assessment under NSW `legislation were determined using the Biodiversity Assessment Method calculator. A biodiversity offset for impacts on native vegetation and/or threatened species habitat is not required if the vegetation integrity score of the impacted plant community type is less than 17.

The project would remove 0.19 hectares of Swamp Oak floodplain swamp forest (PCT 1232) with a vegetation integrity score of 10.2 on land subject to NSW legislation. A biodiversity offset is not required for this impact, as the vegetation is under the thresholds for the assessment. In this regard, impacts to PCT 1232 have been determined to have an ecosystem credit obligation of zero.

Offsets are not required for impacts on non-native vegetation. No credits were calculated for miscellaneous ecosystems that would be impacted by the project, including the highly disturbed areas with no or limited vegetation and urban exotic/landscape plantings. As described in section 22.2.2 and 22.2.3, no species credit species were recorded in the project site and none are considered likely to be affected by the project. As a result, no offsets are required.

Offsetting impacts on protected marine vegetation and key fish habitat

The *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) provide for 'no net loss' of habitat. The project would not remove any fish habitat, including protected marine vegetation (eg mangroves) on land subject to the NSW legislation within the project site. As such, there are no offset obligations under the FM Act.

Biodiversity offset obligations under the EPBC Act – offset for significant impacts

Under the *Environmental Offsets Policy* (DSEWPC, 2012) biodiversity offsets are required to compensate for significant residual impacts on matters of national environmental significance. As no significant impacts were identified, no biodiversity offsets are required in relation to matters of national environmental significance.

Offsetting impacts for land clearing on Sydney Airport land

The Airport Building Controller, in consultation with the Sydney Airport Environment Officer, can impose conditions on building activity approvals, including a requirement to provide offsets for the removal of trees and vegetation. Roads and Maritime would consult with the Sydney Airport Environment Officer to identify any offset requirements for vegetation removal on Sydney Airport land.

Chapter 23

Health, safety and hazards

Potential hazards and risks to the operation of Sydney Airport, with a focus on aviation hazards, are considered in Chapter 11 (Airport operations). This chapter considers other potential human health, safety and hazard impacts associated with the project, and how these would be mitigated and managed during construction and operation. Further information about the potential for health and safety impacts is provided in Technical Working Paper 15 (Human Health).

The SEARs relevant to health, safety and hazards are listed below. There are no MDP requirements specifically relevant to health and safety, however there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)). Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
15	**Health and safety**	
15.1	The Proponent must assess the potential health impacts of the proposal, in accordance with the current guidelines.	The full assessment results are provided in Technical Working Paper 15, with a summary of the findings provided in this chapter, as indicated below.
15.2	The assessment must: (a) describe the current known health status of the affected population;	Section 23.2.2
	(b) assess health risks associated with exposure to environmental hazards;	Sections 23.3.1 and 23.4.1
	(c) assess the effect of the proposal on other relevant determinants of health such as the level of physical activity and access to social infrastructure;	Sections 23.3.1 and 23.4.1
	(d) assess opportunities for health improvement;	Sections 23.3.1 and 23.4.1
	(e) assess the distribution of the health risks and benefits;	Sections 23.3.1 and 23.4.1
	(f) assess the potential for construction fatigue and outline proposed management measures; and	Section 23.3.1
	(g) discuss how, in the broader social and economic context of the proposal, the proposal will minimise negative health impacts while maximising the health benefits.	Sections 23.3.1 and 23.4.1
15.3	The Proponent must assess the likely risks of the proposal to public safety, paying particular attention to pedestrian and cyclist safety, subsidence risks, bushfire risks and the handling and use of dangerous goods.	Sections 23.3.2 to 23.3.5 and 23.4.2 and 23.4.4 There are no subsidence risks
16	**Hazards and risks**	
16.1	The EIS must: (a) report on the consultation outcomes with all operators of high-pressure dangerous goods (HPDG) pipelines licensed under the *Pipelines Act 1967* within or in the vicinity of the proposal with regards to the relevant sections of the *Australian Standard AS 2885 Pipelines – Gas and liquid petroleum*;	Section 23.3.3

Reference	Requirement	Where addressed
	b) demonstrate that, during the construction and operation phases of the proposal, the proposal would not lead to non-compliance of the existing HPDG pipelines licensed under the *Pipelines Act 1967* with the current edition of *AS 2885 Pipelines – Gas and liquid petroleum*; and,	Sections 23.3.3 and 23.4.4
	c) include a preliminary risk screening completed in accordance with *State Environmental Planning Policy No. 33 – Hazardous and Offensive Development* and *Applying SEPP 33* (DoP, 2011), with a clear indication of class, quantity and location of all dangerous goods and hazardous materials associated with the proposal during construction and operation phase. Should preliminary screening indicate that the development is 'potentially hazardous', during construction and or operation phase, a Preliminary Hazard Analysis (PHA) must be prepared in accordance with *Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis* (DoP, 2011) and *Multi-Level Risk Assessment* (DoP, 2011).	Section 23.3.5
16.2	The EIS must outline the process for assessing the risks of the proposal on airport operations, including encroachment into the prescribed airspace, potential impacts to airport Communication, Navigation and Surveillance Systems, light spill and landscaping associated with the construction and operation of the proposal.	Chapter 11 and Technical Working Paper 3 (Airport Operations)

23. Health, safety and hazards

23.1 Assessment approach

Major road projects have the potential to cause health and safety impacts during construction and operation. The project site is located in a highly developed urban area, with a mix of transport, commercial, residential, industrial and recreational land uses. A health impact assessment is an important part of the environmental impact assessment process for infrastructure projects as it ensures the potential for health impacts on the community and the public safety risks of the project are considered as part of the approval process. In addition, this chapter also considers the potential for impacts associated with dangerous goods and hazardous materials. The recommended mitigation measures would reduce the potential for health and safety impacts on the public.

An overview of the approach to the assessment is provided below, including the legislative and policy context and a summary of the assessment methodology.

23.1.1 Legislative and policy context

The assessment has been undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, *Dangerous Goods (Road and Rail Transport) Act 2008* (NSW) Dangerous Goods (Road and Rail Transport) Regulation 2014, *Pipelines Act 1967* (NSW), *Gas Supply Act 1996* (NSW), *State Environmental Planning Policy No. 33 – Hazardous and Offensive Development,* the Airports Act and associated regulations
- *State Environmental Planning Policy No. 33 – Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (Department of Planning (DoP), 2011a) (the SEPP33 guidelines)
- *Environmental Health Risk Assessment, Guidelines for assessing human health risks from environmental hazards, Commonwealth of Australia* (enHealth, 2012)
- *Methodology for Valuing the Health Impacts of Changes in Particle Emissions* (NSW EPA, 2013)
- *Health Impact Assessment: A practical guide* (NSW Health, 2007)
- *Health Impact Assessment Guidelines* (enHealth, 2017)
- *Australian Standard AS 2885 Pipelines – Gas and liquid petroleum* (AS 2885)
- *Storage and Handling of Dangerous Goods Code of Practice* (Workcover, 2005)
- *Australian Code for the Transport of Dangerous Goods by Road & Rail* (National Transport Commission, 2017) (The Dangerous Goods Code)
- *Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis* (DoP, 2011b) and *Multi-Level Risk Assessment* (DoP, 2011c)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

23.1.2 Methodology

Study area

The study area varies for each health and safety issue addressed in this chapter. This is due to the different study areas used in technical assessments that provided inputs to the health impact assessment (Technical Working Paper 15).

In general, the study area for the air quality assessment is the largest of the individual study areas used by technical assessments. This area is shown in Figure 12.1. The area considered with respect to the potential for public safety impacts is in the immediate vicinity of the project site where the public may come into contact with construction works.

Key tasks

The assessment focuses on construction and operational activities with the potential to result in the following:

- Potential risks to public safety during construction, such as risks to public safety from construction works and the storage, handling and use of dangerous goods
- Potential health impacts during operation arising from changes such as the loss of public space, changes in air quality or noise impacts and road safety.

The human health assessment involved the following:

- Reviewing the relevant regulatory framework and applicable guidelines
- Identifying sensitive receivers and community infrastructure within the existing environment
- Identifying construction and operational activities with the potential to cause health and safety impacts to off-site receivers
- Assessment of potential health risks from the project, including review of the assessment results for other disciplines such as air quality, noise and vibration, surface water, groundwater, contamination, and social impacts, and estimation of short-term (acute), and long-term (chronic) impacts
- Identifying construction and operational activities with the potential to cause risks on human health
- Consideration of cumulative impacts resulting from the project in combination with other projects currently proposed or underway
- Consideration of the recommended mitigation measures identified in the technical working papers and where necessary, additional mitigation measures that may need to be considered to address community health and safety impacts.

This chapter also considers the potential impacts associated with dangerous goods and hazardous materials and the results of a preliminary risk screening undertaken in accordance with the *Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis* (DoP, 2011b) and *Multi-Level Risk Assessment* (DoP, 2011c).

23.1.3 Risks identified

A preliminary environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Health and safety risks with an overall assessed risk rating of medium or above, identified by the preliminary environmental risk assessment, included:

- Hazardous materials exposure during demolition of buildings/structures and impacts on the surrounding environment, including health impacts on nearby populations
- Accidental damage to, or interference with, live underground services during construction with impacts on utility users, including businesses and individuals
- Working within or adjacent to an operating road and rail environment
- Unauthorised public access to the site during construction, with the potential for public safety risks, as a result of the close proximity to sensitive receivers (such as members of the community travelling in the vicinity of the project site, residents, commercial properties)
- Accidental release of dangerous or hazardous materials to the environment in the event of an incident during operation
- Road safety risks for motorists, pedestrians and cyclists during operation.

The health impact assessment and this chapter included consideration of these potential risks.

The assessment does not take into account potential health and safety risks to site workers associated with normal construction operations, as these are regulated by workplace health and safety legislation (including the *Work Health and Safety Act 2011*), and are not relevant to approval of the project under Division 5.2 of the EP&A Act or section 90 of the Airports Act. Site management would be the responsibility of the construction contractor(s), who would be required (under the *Work Health and Safety Act 2011*) to manage the site in accordance with relevant regulatory requirements and take all necessary precautions in relation to the health and safety of the workforce.

23.2 Existing environment

The existing environment is described in Chapters 9, 10, 12, 13 and 20 in relation to traffic and access, noise and vibration, air quality, contamination and the socio-economic environment, respectively. A description of existing land use patterns and sensitive receivers surrounding the project area is provided in Chapter 19 (Land use and property). A profile of the local communities is provided in Chapter 20 (Socio-economic impacts).

23.2.1 Sensitive receptors and infrastructure

Other aspects relevant to the consideration of health and safety impacts are summarised below. Further information is provided in Chapter 4 of Technical Working Paper 15.

The urban setting of the project means that there is the potential for the community to be impacted. Sensitive receptors include the following:

- Members of the community travelling through the study area or located close to the project site
- Residents living near the project site
- Users on Joyce Drive, O’Riordan Street, Robey Street, Airport Drive and Qantas Drive
- Local businesses and commercial properties.

The suburbs of Mascot, Tempe and St Peters contain a range of community facilities and services including:

- Community/recreational facilities such as Mascot Library and Tempe Golf Range and Academy
- Educational facilities including schools and child care
- Footpaths, shared paths and cycleways
- Accommodation facilities

- Health services such as Mascot Medical and Dental Centre
- Places of worship
- Open space including Tempe Recreation Reserve and Tempe Lands.

As described in section 8.7, the project site and surrounding area contain overhead and underground utilities that are common in a developed urban area.

23.2.2 Health

The health of a local community is influenced by a combination of interacting factors including age, socio-economic status, social networks, behaviours, beliefs and lifestyle, life experiences, country of origin, genetic predisposition and access to health and social care. While it is possible to review existing health statistics for the local health district surrounding the project site and compare them to the Greater Sydney area and NSW, it is not possible to identify a causal source in relation to existing health or specifics for the project site and surrounding communities.

The project site is located in the local health districts of South Eastern Sydney and Sydney. The incidences of health-related behaviours (ie alcohol consumption, smoking, lifestyle factors) in these districts that are linked to poorer health status and chronic diseases (such as cardiovascular and respiratory diseases, cancers and other conditions, which account for much of morbidity and mortality in later life) are generally similar to those reported in the larger local health districts and the wider Sydney metropolitan area, and are slightly lower than the whole of NSW.

The South Eastern Sydney and Sydney local health districts have lower rates of physical inactivity and of being overweight and obese compared with NSW as a whole. A comparison of the rates of the key mortality indicators, for all potentially avoidable causes of cardiovascular disease, lung cancer and chronic obstructive pulmonary disease, indicates that the rates of mortality in the South Eastern Sydney and Sydney local health districts are significantly lower than those reported for NSW as a whole. However, chronic obstructive pulmonary disease and lung cancer were not significant for the Sydney local health district.

The rates of hospitalisations for indicators such as diabetes, cardiovascular disease, asthma (for people aged five to 34 years) and chronic obstructive pulmonary disease (for people aged 65 years and above) show significantly lower statistics for the South Eastern Sydney and Sydney local health districts than those reported for NSW. The rate of high or very high psychological distress for adults in the South Eastern Sydney local health district is slightly lower than the NSW average. The rate in the Sydney local health district is almost the same as the NSW average.

23.3 Assessment of construction impacts

23.3.1 Health impacts

This section considers the potential impacts on the health and wellbeing of the community during construction.

Air quality

Potential air quality impacts are summarised in Chapter 12 and assessed in detail in Technical Working Paper 4 (Air Quality). The assessment approach focused on emissions to air of dust or the generation of dust. This approach was reviewed in terms of the potential impacts on human health.

The risk of dust impacts arising in sufficient quantities to cause annoyance and/or health effects was separately determined by the following construction activity types: demolition, earthworks, construction and track out. The sensitivity of receptors/areas was determined to be either high or medium, and the resultant risk of impacts was similarly determined to be high or medium based on the adopted criteria and risk matrix (see section 12.4.2). The impacts would be temporary and minimised with the implementation of measures provided in section 12.7.

As discussed in section 12.4.3, exhaust emissions from on-site plant and construction traffic during construction are unlikely to substantially impact local air quality. This is not considered to result in any health impacts on the public.

Noise and vibration

Noise and vibration impacts are summarised in Chapter 10 and assessed in detail in Technical Working Paper 2 (Noise and Vibration).

Environmental noise has been identified as a growing concern in urban areas due to the negative effects on quality of life and wellbeing. It also has the potential to cause physiological health effects. Noise impacts have the potential to increase over time due to the growing population and increasingly urbanised societies.

Sound is a natural phenomenon which becomes noise when it has undesirable effects on people or animals. Noise can have both short-term and long-term adverse effects. In relation to short-term construction noise, the key potential health impacts relate to annoyance and sleep disturbance.

In most areas surrounding the project site, there are no exceedances of noise guidelines that are protective of community health. However, as discussed in Chapter 10 (Noise and vibration), construction noise impacts related to the use of noise intensive equipment are predicted at some residential receivers in Tempe to the north-west of Terminal 1 and in Mascot, near Baxter Road. Potential impacts are generally higher during the evening and night-time periods than during the daytime. Only one residential receiver on Baxter Road was identified as highly noise affected. The criteria for sleep disturbance are likely to be exceeded when works occur near residential receivers during the night-time.

There is the potential for ground-borne noise impacts at nearby receivers during works requiring vibration intensive equipment. Some receivers are also within the minimum working distance criteria for human comfort. Where impacts are perceptible, it is likely that they would only be apparent during the relatively short times when vibration intensive equipment such as rockbreakers or vibratory rollers are used. Perceptible vibration has the potential to cause annoyance or sleep disturbance; however, no data is available to evaluate health impacts associated with community exposure to perceptible vibrations.

The implementation of the mitigation measures provided in section 10.7 would minimise the potential for construction noise and vibration to adversely impact community health. However, there may still be some short-term noise impacts, where annoyance and potentially sleep disturbance occurs on some occasions.

Changes in social aspects on community health

There are a wide range of other factors (other than changes in air quality, noise and vibration) that influence health and wellbeing, specifically mental health. How these factors may affect community health has been addressed using a qualitative approach.

Adverse impacts may occur as a result of traffic changes during construction, property acquisitions, visual changes, noise impacts, loss of some green/open space and existing recreation facilities, changes to active transport and changes in access/cohesion of local areas. These may result in reduced opportunities for physical activity and social interaction and/or increased levels of stress and anxiety. In many cases, the impacts identified are either short-term (associated with construction only) and/or mitigation measures have been identified to minimise the impacts on the community.

Potential socio-economic impacts are considered in Chapter 20.

Construction fatigue

Construction fatigue can occur when people experience impacts from projects over an extended period of time with few or no breaks between construction periods. Construction fatigue typically relates to the effects of traffic and access disruptions, noise and vibration, air quality, visual amenity and/or social impacts from projects that have overlapping construction phases or occur one after the other. Construction impacts that occur in this manner are no longer considered to be transient and/or short-term.

The assessment of construction fatigue involved consideration of the cumulative and/or consecutive construction impacts of the Sydney Gateway road project together with other major projects in the study area, such as the Botany Rail Duplication, New M5 and M4-M5 Link projects. Cumulative and consecutive construction activities have the potential to affect the health and wellbeing of the community as a result of air quality impacts, noise and vibration impacts, traffic and transport impacts, and visual amenity impacts. The potential for these cumulative impacts is considered in Chapters 9 (Traffic, transport and access), 10 (Noise and vibration), 12 (Air quality), 20 (Socio-economic impacts) and 21 (Landscape character and visual amenity).

As described in section 12.7, dust would be managed during construction in accordance with standard construction management practices to minimise impacts and associated health risks. Such measures would need to be applied across all construction projects and would be subject to the requirements of the approvals for those projects.

As discussed in section 10.6.1, there is potential for construction fatigue to occur as a result of construction noise from the project and other concurrent/consecutive projects. The potential for construction fatigue would generally be limited to the eastern part of the study area in Mascot (noise catchment areas six, seven and eight). The majority of this area is commercial. However, some residential receivers and hotels are located at the intersection of Joyce Drive and O'Riordan Street.

Implementation of the mitigation measures provided in section 10.7 would minimise the potential for noise impacts. More specific measures would be developed as the design progresses and impacts from other projects (such as Botany Rail Duplication) are known.

During construction, the project team would build a working relationship with the teams for other major projects, to identify stakeholders or community members who may be susceptible to construction fatigue, and put in place appropriate management measures consistent with those provided in relevant chapters.

23.3.2 Public safety

Construction has the potential to affect public safety. The risks to public safety are outlined in Table 23.1. Damage and disruption to utilities are discussed in section 23.3.2. Storage, handling and transport of dangerous goods and hazardous substances are discussed in section 23.3.5. There would be no hazards or risks with the potential to impact public safety following implementation of the proposed mitigation measures.

Table 23.1 Potential safety hazards during construction

Hazard	Assessment of hazard
Contamination	Contamination is known to occur within the project site. There are five project areas with known contamination. These include the former Tempe landfill, Sydney Airport land (two locations), Sydney Airport leased areas and Alexandra Canal. Contamination may pose a safety risk to the surrounding communities when exposed. Exposure may occur as a result of earthworks, interception with contaminated groundwater and runoff from contaminated soil. Off-site, unmitigated risks to human health are characterised as medium and high during construction works in three of the five project areas. Construction activities also have the potential to result in the contamination of soil. This could occur due to accidental spills and leaks of materials, transport of materials, cross-contamination within the site, mobilisation of contaminants encountered during works and as a result of mishandling of potentially contaminated substances. These potential impacts are considered in Chapter 13 (Soils and contamination). The measures provided in that chapter would be implemented to manage these risks. With mitigation measures in place, the risk to public safety is reduced to low.

Hazard	**Assessment of hazard**
Landfill gas	During construction, there is a risk associated with the uncontrolled release of methane, hydrogen sulfide and carbon dioxide from works in the former Tempe landfill. In certain circumstances, accumulated landfill gases may result in a safety hazard and risk of explosion. These issues would be managed in accordance with the *Work Health and Safety Act 2011* in terms of worker health and safety. Chapter 12 (Air quality) assesses the landfill gas and odour impacts as a result of works within the former Tempe landfill. The impacts and associated mitigation measures are described in section 12.4.5.
Flooding	The assessment identified that Alexandra Canal is a major floodway for the area and therefore a number of construction work areas would have the potential to be affected by flooding during storms. Construction also has the potential to change flood behaviour and impact the surrounding environment. This may result in the potential for flooding to impact other properties, assets and infrastructure. The flooding risks during construction are considered to be of a minor nature. With the implementation of mitigation measures, no impacts on existing emergency management arrangements or public safety are expected. A flood mitigation strategy is proposed in Chapter 14 (Flooding) to reduce the risk of flooding impacts on properties, assets and infrastructure. The risk of potential impacts on health and public safety associated with large or multiple pools of stagnant water onsite, such as the risk of mosquitos establishing and attracting wildlife, would be managed in accordance with mitigation measures provided in Chapters 11 and 13 to 16.
Bushfire	The project is not located in a bushfire prone area. The highly urbanised project site does not contain large areas of vegetation that would be associated with bushfire risk. The risk to public safety is considered low. During construction, flammable materials and ignition sources may be used. High risk construction activities, such as welding and metal work, and works within the former Tempe landfill, would be subject to a risk assessment or ban on total fire ban days.
Traffic management during construction	Construction would result in changes to the local road network. Partial and full road closures and traffic diversions may pose a safety risk. This would include a risk to the safety of motorists and other road users using the surrounding road network. Changes to the existing pedestrian and cyclist network have the potential to impact pedestrian and cyclist safety. Construction traffic may impact the local community with the potential for changes to public safety and access. A construction traffic and access management plan would be developed and implemented as discussed in Chapter 9 (section 9.6) and Technical Working Paper 1. This would include, as a priority, measures to maintain public safety at all times. With the implementation of appropriate traffic management during construction, the risk to public safety is considered to be low.
Safety during construction	A number of other construction activities, although unlikely, could result in risks to the safety of the local community if improperly managed. These include: ▪ Items falling off vehicles during the transportation of equipment and material to and from site ▪ Settlement risks during construction activities such as ground compaction or dewatering ▪ Potential for risks to public safety resulting from unauthorised access to construction work areas. Safety risks during construction and transportation of materials by road would be managed by implementing standard workplace health and safety requirements, including the requirements of the Dangerous Goods Code. The potential for unauthorised access resulting in safety risks is considered to be low, based on NSW workplace safety laws. This requires construction sites to have adequate site security, which includes appropriate fencing and lighting. The construction contractor would need to ensure that construction sites are safe and secure at all times.

23.3.3 Utility management

Preliminary utilities investigations have been undertaken and consultation with asset owners has identified the utilities outlined in section 8.7. There are three broad project areas with a high density of utilities: Airport Drive/Qantas Drive, Sir Reginald Ansett Drive and Shiers Avenue. The majority of these utilities are located underground and include gas mains, fuel and water pipelines. However, some have above ground components including electrical and Telstra cables.

The Sydney Water desalination pipeline traverses the project site between Tempe Recreation Reserve and Canal Road, and includes above and below ground sections. The concept design and construction methodology has been developed to avoid physical interactions with the pipeline and minimise potential integrity risks. This would include providing physical protection for the above ground sections during construction (where required), in consultation with the operator, to ensure uninterrupted operation.

Potential impacts may include accidental damage or rupture, which may lead to disruption of supply and/or a loss of containment and the potential risk of a public safety incident. This risk would be greatest for utilities conveying dangerous goods, such as high pressure gas and fuel, located within the project site. The interface between construction activities and utility adjustments would be managed by the construction contractor in accordance with the *Work Health and Safety Act 2011*.

Three high pressure dangerous goods pipelines intersect the project site. These include primary and secondary gas mains (operated by Jemena) and a 150 millimetre diameter ethylene pipeline (operated by Qenos). The ethylene pipeline is licensed under the *Pipelines Act 1967* while the gas mains are operated in accordance with the *Gas Supply Act 1996*.

The ethylene pipeline is part of the Qenos Botany to Clyde Ethylene Pipeline (pipeline licence number 12), which was commissioned in 1962. The pipeline was designed and constructed in accordance with (now) obsolete standards, but is required to be operated and maintained in accordance with *AS 2885 Pipelines – Gas and liquid petroleum* (AS 2885). The operators of all licensed pipelines are required to undertake periodical monitoring and independent third party audits. A condition assessment of the pipeline was last performed in 2012. The pipeline is currently suspended from operation and charged with an inert gas (nitrogen) at around 400 kilopascals.

The project requires some sections of the ethylene pipeline to be relocated or removed, pending its decommissioning. Meetings with Qenos and the pipeline maintainer are ongoing. Recent meetings have highlighted the potential future use of the pipeline and whether it may be decommissioned at some time during the construction period.

All design, construction, inspection, testing, and any required alterations or relocations of sections of the ethylene pipeline, would comply with the requirements of the *Pipelines Act 1967* and AS 2885. A safety management study, as required by AS 2885, would be undertaken prior to construction. This study requires the identification of all relevant risks, and assessment of likelihood and consequence, to determine a risk ranking. Mitigation measures would be identified to reduce the risk to ‘as low as reasonably practicable’. The safety management study would include a workshop with all relevant stakeholders, including the pipeline owner and operator.

Measures to minimise the potential for safety impacts associated with utility adjustments are provided in section 23.6.2. Preliminary consultation with utility providers is ongoing. The nature and extent of adjustments required would be confirmed during detailed design and in consultation with the utility providers. Impacts on critical utilities that service Sydney Airport facilities would be prioritised to safeguard accidental disruption (in terms of contingency management arrangements). With the addition of any measures arising from the AS 2885 safety management study, the risk to public safety is considered low.

23.3.4 Emergency vehicle movements

Temporary traffic diversions, road occupation, road closures and changes to access arrangements may cause delays and/or potential restrictions to emergency services movement. Appropriate access for emergency vehicles would be maintained at all times. This could include traffic control to stop other traffic or works temporarily to allow emergency vehicles to pass.

Impacts from delays and potential access restrictions would be managed by the implementation of measures provided in the construction traffic and access management plan (see section 9.6). Ongoing communication with local councils, Sydney Airport Corporation and emergency services organisations would be undertaken during detailed design and as part of developing the Construction Traffic and Access Management Plan. This would confirm measures to mitigate potential impacts on emergency vehicle movements.

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

Dangerous goods are substances and objects that may pose acute risks to people, property and the environment due to their chemical or physical characteristics. Dangerous goods that may be used during construction include diesel, grease, hydraulic oil, acetylene, polyurethane foam, line marking aerosol, epoxies, bitumen and concrete binding agents. Leaks and spills from inappropriate storage and handling of dangerous goods have the potential to impact the surrounding community and environment. Excessive amounts of stored or transported dangerous goods would exacerbate the potential for fire, explosion or inhalation risks.

The preliminary risk screening undertaken in accordance with *State Environment Planning Policy No. 33 – Hazardous and Offensive Development* included a comparison of dangerous goods that may be used during construction with the storage and transport thresholds in the SEPP 33 guidelines. The thresholds in the SEPP 33 guidelines represent the maximum amounts of dangerous goods that can be stored or transported to and from the project site without causing a significant risk to the community or environment.

The preliminary risk screening concluded that the storage, handling and transport of dangerous goods would not exceed the SEPP 33 guideline thresholds. The screening was based on the conservative estimates of dangerous goods likely to be used.

The project includes five main construction compounds that would be used to receive and store the dangerous goods required during construction. The goods would be transported between compounds as required. Dangerous goods likely to be stored off-site and transported to site (without storage) include:

- Bitumen (including bitumen emulsion) (Class 9 – III)
- Concrete surface retarder (Class 3 – III)
- Concrete bonding agent hardener (Class 8 – II).

These materials would be transported to site at a maximum rate of once per day (seven times per week). This is typical of a road construction project. Other dangerous goods would be stored on site and transported on site only when stored quantities are low. The quantities of dangerous goods transported would be below the SEPP 33 transport screening thresholds. Given that movement of dangerous goods would be low, the potential risks during transportation are not considered significant.

The incorrect storage or mishandling of dangerous goods and chemicals could result in contamination and affect air, soils, surface water and/or groundwater. This could result in health and safety impacts on the community through inhalation and/or direct contact, fires and explosions. The storage, handling and transport of dangerous goods would be undertaken in accordance with the Dangerous Goods (Road and Rail Transport) Regulation 2009 and the Dangerous Goods Code. Measures relating to storage requirements and handling protocols would be included in the CEMP. This would minimise the risk of health and safety impacts.

23.3.6 Summary of impacts on Sydney Airport (Commonwealth) land

The potential impacts on Sydney Airport land are discussed in Chapters 9 to 16, 20 and 21.

The assessment of dust impacts considered receptors within Sydney Airport land, identifying a high risk of dust impacts at a number of these receptors. Mitigation measures provided in section 12.7 would minimise the potential for these impacts and protect human health.

Within Sydney Airport land, construction noise impacts would be limited to noise catchment areas five and seven (described in section 10.4.2). These catchment areas include existing or planned hotels, the Qantas Flight Training Centre as well as other commercial premises. Many of these receivers are of lower sensitivity generally and already subject to high levels of background noise. Where mitigation measures are implemented, there would be minimal potential for community health impacts as a result of noise generation during construction. However, there may still be some short duration noise impacts, where annoyance and potentially sleep disturbance occurs on occasion.

The project would require the temporary storage of dangerous goods within construction compounds on Sydney Airport land. However these would not be stored in quantities that exceed SEPP 33 guidelines. Additionally, the storage of these materials would not occur on any other Sydney Airport land.

Utilities adjustments would also be required on Sydney Airport land, including adjustments to high pressure dangerous goods pipelines. All utilities adjustments would be undertaken in accordance with the asset owner’s requirements, relevant legislation or plans, and in consultation with Sydney Airport Corporation.

Mitigation measures would be implemented as described in section 23.6 and other relevant chapters. With these measures in place, there would be no health impacts of concern or public safety risks specific to Sydney Airport land.

23.4 Assessment of operation impacts

23.4.1 Health impacts

This section summarises the potential impacts on the health and wellbeing of the community once the project is operational.

Air quality

The air quality assessment considered potential emissions from road traffic associated with the project’s operation. The assessment involved a quantitative assessment of exposure and risk. The assessment considered short-term (acute) exposures as well as long-term (chronic) exposures to pollutants derived from vehicle emissions. The assessment evaluated the total exposure that may occur in the community (ie existing air quality with the addition of the project) as well as the change in air quality as a result of the project, which may either increase or decrease.

The project is expected to result in a redistribution of impacts associated with vehicle emissions, specifically in relation to emissions from vehicles using surface roads. This would generally result in no measurable change or a small improvement (ie decreased concentrations and health impacts) for most of the community. However, for some areas located near key surface roads, an increase in pollutant concentrations may occur. These were assessed and determined to be low and not considered to be of significance (ie measurable) or of concern in relation to community health. Where the various changes were considered over the population as a whole, a small benefit to health outcomes was observed.

Noise and vibration

The assessment of health impacts as a result in changes in operational noise considered a range of potential health effects that relate to long-term exposures to road traffic noise. These health effects include annoyance, sleep disturbance, cardiovascular effects and cognitive effects. Increased levels of noise may also affect the use and enjoyment of outdoor space. Guidelines used to assess potential noise impacts are based on levels that are protective of these health effects. Hence, where the project complies with the relevant noise guidelines, community health will be adequately protected.

The project would introduce new road noise sources, with some areas identified as having potentially significant increases in noise levels. The noise assessment identified the potential for exceedances of operational road traffic noise criteria at 246 buildings (231 residential buildings). Without mitigation, the identified receivers would exceed the criteria designed to protect human health.

The approach to minimising the potential for noise impacts during operation is described in section 10.7. This would include consideration of treatment at or near the noise sources (such as noise barriers and low noise pavement) prior to the consideration of at-property treatments. At-property treatments are less certain in terms of acceptance and use, and their presence at a property also has the potential to affect the wellbeing of residents (particularly the use of outdoor spaces).

Receivers identified as requiring at-property noise mitigation would be identified and offered treatment prior to commencement of construction, where feasible and reasonable. Measures are provided in section 10.7.2 to mitigate impacts that cannot be avoided.

Changes in social aspects on community health

Potential socio-economic impacts are considered in Chapter 20. There are a wide range of factors that influence health and wellbeing. Permanent changes in the urban environment that have the potential to result in both positive and negative impacts on health and wellbeing include:

- Improved travel times and access, which may help improve general health and wellbeing. Without the project, worsening traffic conditions, traffic and accident risks could result in increased levels of stress and fatigue leading to potential health impacts.
- The relocation of businesses and impacts to open space areas could disrupt social networks and affect health and wellbeing due to increased levels of stress and anxiety, particularly during the process of negotiation. The mitigation measures provided in section 20.6, including consultation and implementation of business management plans, would assist in minimising potential impacts on businesses.
- On a broader scale, improving access and travel times to Sydney Airport would provide potential health benefits. These may be from improved employment opportunities, more time available for other active, family or community activities, and reduced levels of stress and anxiety.
- The project may result in localised economic impacts (eg to some businesses and land required for the project). However, the improved access and travel times provided by the project would provide economic benefits. These economic benefits are a factor influencing community health with lowered levels of stress and anxiety related to congestion, access to travel and transport and employment opportunities.

23.4.2 Public safety

Spills and leaks may cause minor and diffuse contamination risks during operation. A spill response procedure would be developed as part of the project’s incident management protocols, as detailed in section 23.6.1. The former Tempe landfill has been identified for long-term management of contamination. Mitigation measures provided in Chapter 13 (Contamination and soils) will reduce potential safety risks to the community.

The project has been designed to maximise safety and efficiency for road users, which would inherently minimise the likelihood of incidents and crashes. The project may also result in a reduction in traffic volumes on some roadways, which has the potential to reduce crash rates and improve pedestrian and cyclist safety. Overall, the project is expected to result in improvements to the road safety environment for vehicles. An assessment of potential impacts on transport, traffic and access during operation is provided in section 9.4 and Technical Working Paper 1 (Transport, Traffic and Access).

Crime prevention through environmental design principles have been, and would continue to be, incorporated into the project design to reduce safety risks to the local community (see section 7.12).

23.4.3 Emergency vehicle movements

Changes to access arrangements in local roads may change the preferred routes used by emergency services. This would be subject to consultation with emergency services organisations.

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

No areas within the operational footprint would be used for the permanent storage of chemicals.

The amount of hazardous materials and dangerous goods that would be used during maintenance activities would be much smaller than the volumes required during construction. Dangerous goods required during maintenance would include bitumen/bitumen emulsion, rubber sealant, line marking paint and aerosols, concrete for repairs and small volumes of greases, lubricants and petrol/diesel used by maintenance equipment. Potential health and safety impacts from exposure to these contaminants through inhalation and/or direct contact are considered to be negligible.

Transport of hazardous materials and dangerous goods along the completed roadways has the potential to impact the surrounding community and the environment through leaks and spills in the event of incidents. The transport of hazardous materials and dangerous goods would be the responsibility of the road operator/s and would be undertaken in accordance with relevant standards and regulatory requirements.

23.4.5 Summary of impacts on Sydney Airport (Commonwealth) land

The potential operational impacts on Sydney Airport land are discussed in Chapters 9 to 16, 20 and 21.

The air quality assessment involved consideration of 162 receptors located on Sydney Airport land. These are mainly commercial/industrial receptors, with a small number of park/sport/recreational and ‘other’ uses. Some of the maximum increases in pollutants are predicted within Sydney Airport land. There would be some reductions in particulates along Airport Drive to the north of Terminal 1. However, all health impacts from the changes in air quality within Sydney Airport land are considered low and not measurable within the community.

Impacted receivers on Sydney Airport land are mostly commercial premises of relatively low sensitivity. While there are predicted to be increases in noise levels greater than two dB and/or high increases in ground-based aircraft noise, the number of affected receivers is relatively small and would be reduced by implementing the mitigation measures provided in section 10.7. These increases in noise are not considered to be sufficiently elevated to result in health impacts to occupants.

Implementation of the proposed mitigation measures would reduce safety risks and result in no health impacts of concern within Sydney Airport land. This also applies to soil and water contamination that may be present within Sydney Airport land.

Mitigation measures would be implemented as described in section 23.6.2 and other relevant chapters. With these measures in place, there would be no health impacts of concern or public safety risks specific to Sydney Airport land.

Consistency with the Sydney Airport Master Plan

The *Sydney Airport Master Plan 2039* (SACL, 2019a) (the Master Plan) identifies numerous strategies to manage and reduce potential environmental impacts that may result in health and safety impacts. The environmental impacts include:

- Air quality (section 14.6.3 of the plan)
- Ground-based noise (section 14.6.4 of the plan)
- Water quality and water use (section 14.6.5 of the plan)
- Soil and land management (section 14.6.9 of the plan).

The project is generally consistent with the strategies proposed in the plan that relate to these issues. Strategies relating to health, safety and hazards have not been specifically identified in the Master Plan. The project is, however, consistent with strategies that apply to the health and safety of the community. Assessments of these potential impacts are summarised in Chapters 10 (Air quality), 12 (Noise and vibration), 13 (Contamination and soils) and 16 (Surface water).

The *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b) (the Environment Strategy) underpins Sydney Airport Corporation's commitment to continual improvement of environmental performance at the airport. Environmental action plans are provided for air quality (section 3.4 of the strategy), ground-based noise (section 3.5), ground transport (section 3.6), water quality and water use (section 3.7), soil and land management (section 3.11), and spill response and hazardous materials (section 3.12). These environmental issues have the potential to impact community health.

This assessment and the mitigation measures provided in section 23.6.2 and Chapters 9 to 16, 20 and 21 are consistent with the Master Plan and the Environment Strategy.

23.5 Cumulative impacts

The project would operate at the same time as other major projects underway and/or planned in the surrounding area, including the Botany Rail Duplication, M4–M5 Link and New M5. The cumulative impacts of traffic and access, noise and vibration, air quality, contamination, health, safety and hazards and social impacts are described in Chapters 9, 10, 12, 13 and 20 respectively.

As discussed in section 23.3.1, concurrent and consecutive construction activities from this project and other projects has the potential to increase stress and anxiety in the community as a result of the potential air quality impacts, noise and vibration, changes to traffic and transport conditions and visual amenity. It is noted that the areas where the community may be affected by consecutive construction activities, which may result in construction impacts occurring over a longer period of time, is small and the noise impacts to these areas are also low (see section 10.6).

The project would deliver a cumulative benefit to the health of the community during operation. Together with other infrastructure projects, the project would improve travel times and reduce congestion, provide improved access and connectivity, and improve pedestrian and cycling infrastructure. Potential cumulative health and safety impacts are not anticipated.

Cumulative impacts relating to storage and transportation of hazardous goods and utilities relocation during construction are also possible in relation to activities and work areas associated with the Botany Rail Duplication, which may be adjacent to the project's work areas. However, co-ordination of activities (where relevant) and mitigation measures would help to reduce these impacts and result in a low overall health risk.

23.6 Management of impacts

23.6.1 Approach

Approach to mitigation and management

The human health assessment did not identify any significant impacts on health during construction or operation, or any specific mitigation measures beyond those provided in other chapters. Measures to minimise potential impacts associated with noise, air quality, contamination, visual amenity and socio-economic impacts would assist in minimising the potential for community health impacts. These measures are provided in Chapters 10, 12, 13, 20 and 21.

The key potential safety impacts and hazards identified in sections 23.3 and 23.4 relate to the potential for spills, incidents during utility works, threats to public safety during emergency situations and the management of dangerous goods. A spill response procedure would be developed as part of the project's incident management protocols. An emergency response plan would be prepared to manage emergency situations with threats to public safety. Measures relating to storage requirements and handling protocols would be included in the CEMP.

Expected effectiveness

The proposed measures have been developed based on best management practice, relevant standards and guidelines, and Roads and Maritime's experience delivering major road infrastructure projects. Similar measures have been used on comparable large road infrastructure projects, such as the F6 extension, New M5, M4-M5 Link and M4 East.

Potential health and safety risks would be managed by implementing the measures provided in section 23.6.2, in addition to ongoing design development and construction planning, which would aim to avoid and minimise health and safety risks as far as possible. These processes also facilitate ongoing consultation with relevant stakeholders and would provide the detail required to manage safety risks and hazards to acceptable levels to protect community health. These processes and measures are therefore expected to be effective in reducing the identified impacts and issues to acceptable levels.

23.6.2 List of mitigation measures

Measures that will be implemented to address potential impacts on health and safety are listed in Table 23.2.

Table 23.2 Health, safety and hazards mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Spill response	HS1	A spill response procedure will be developed as part of the project's incident management protocols. The procedure and incident management protocols will detail processes, responsibilities and measures to manage hazardous substances and dangerous goods, including storage, handling and spill response, in accordance with legislative requirements.	Pre-construction, construction
Utility management	HS2	A utilities contingency management plan will be prepared and will include measures to manage any utility service disruptions during construction. This will include procedures to respond to and unplanned outages of services, particularly for critical Sydney Airport infrastructure.	Pre-construction, construction
Alterations to the ethylene pipeline	HS3	A safety management study will be prepared for any proposed alterations to the ethylene pipeline in accordance with *AS 2885 Pipelines – Gas and liquid petroleum*. The outcomes of the safety management study will be incorporated in construction planning.	Pre-construction, construction
Emergency response	HS4	An emergency response plan will be prepared and will include measures to manage emergency situations during construction, including those associated with fires, flooding or other threats to public safety.	Construction
Fire risk	HS5	All works involving potential ignition sources within the former Tempe landfill will be subject to a risk assessment or ban on total fire ban days.	Construction
Transport of dangerous goods and hazardous materials	HS6	The transport of dangerous goods will be undertaken in accordance with the Dangerous Goods (Road and Rail Transport) Regulation 2009 and the *Australian Code for the Transport of Dangerous Goods by Road & Rail* (National Transport Commission, 2017).	Construction

23.6.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 23.6.2).

Construction and operation may involve some level of residual impact, even with implementation of the proposed mitigation measures. An unplanned incident could still affect safety or result in emissions or harm to the public or the environment. There is the possibility that unplanned incidents could result in severe injury and/or death and may require the partial or full closure of the affected area for an extended period. This risk is inherent in the construction of any complex infrastructure project.

Within the ongoing design and construction planning process, through the continued application of risk avoidance and minimisation measures, as well as the mitigation measures identified in this chapter, the residual health, safety and hazards impacts are considered to be low.

Chapter 24

Waste management

This chapter summarises the waste management requirements for the project. It identifies potential waste management risks and how these risks have been and would continue to be managed. It provides a preliminary assessment of the types of wastes that would be generated by the project and measures to manage and minimise these wastes.

The SEARs relevant to waste are listed below. There are no MDP requirements specifically relevant to waste, however there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)). Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
18	**Waste**	
18.1	The Proponent must assess predicted waste generated from the proposal during construction and operation, including: (a) classification of the waste in accordance with the current guidelines	Sections 24.2.1 and 24.3.1
	(b) estimates / details of the quantity of each classification of waste to be generated during the construction of the proposal, including bulk earthworks and spoil balance;	Sections 24.2.1 and 8.2.3 (bulk earthworks and spoil balance)
	(c) handling of waste including measures to facilitate segregation and prevent cross contamination;	Sections 24.2.3 and 24.3.3
	(d) management of waste including estimated location and volume of stockpiles;	Sections 24.2.3, 24.3.3 and 24.5
	(e) waste minimisation and reuse;	Sections 24.2.3 and 24.3.3
	(f) lawful disposal or recycling locations for each type of waste; and	Section 24.2.3
	(g) contingencies for the above, including managing unexpected waste volumes.	Sections 24.2.3 and 24.5
18.2	The Proponent must assess potential environmental impacts from the excavation, handling, storage on site and transport of the waste particularly with relation to sediment/leachate control, noise and dust.	Sections 24.2.2 and 24.3.2

24. Waste management

24.1 Assessment approach

To facilitate waste avoidance and reduction planning and allow for considered and responsible management of unavoidable waste, the different types of waste that may be generated by a project need to be identified early in the project development process. Wastes need to be managed appropriately to avoid contaminating soils and water and generating leachate, odours and dust, with the associated potential for environmental, health and safety risks. Improper waste management can also lead to regulatory non-compliance, resulting in fines and reputational damage.

The waste management assessment considered the types, amounts and potential impacts associated with waste generated by the project. Based on the potential impacts identified, measures to manage waste during construction and operation are provided. The assessment has been undertaken in accordance with the resource management hierarchy outlined in the *Waste Avoidance and Resource Recovery Act 2001* and the *Environmental Sustainability Strategy 2019–23* (Roads and Maritime, 2019b). This hierarchy, which is considered at all stages of design development and construction planning, involves:

1. Avoiding unnecessary resource consumption
2. Promoting resource recovery, including reuse, reprocessing, recycling and energy recovery
3. Disposing wastes appropriately where avoidance and recovery are not feasible.

An overview of the assessment approach is provided below, including the legislative and policy context and a summary of the methodology.

24.1.1 Legislative and policy context to the assessment

The assessment was undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations, POEO Act, the *Waste Avoidance and Resource Recovery Act 2001* (NSW) and the Protection of the Environment Operations (Waste) Regulation 2014 (the Waste Regulation)
- *Environmental Sustainability Strategy 2019–2023* (Roads and Maritime, 2019b)
- *Environmental Guidelines: Solid waste landfills* (NSW EPA, 2016a)
- *Waste Classification Guidelines* (NSW EPA, 2014a)
- *NSW Waste Avoidance and Resource Recovery Strategy 2014-21* (NSW EPA, 2014b)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

24.1.2 Methodology

The waste management assessment was desktop based and involved:

- Reviewing the regulatory framework for waste management
- Reviewing the proposed construction methodology to identify potential waste generating activities
- Identifying the potential types, quantities and preliminary waste classifications, including a review of Technical Working Paper 5 (Contamination and Soils) and Technical Working Paper 16 (Former Tempe Landfill Assessment)

- Considering waste management options
- Providing measures to avoid, reduce and manage wastes during construction and operation.

It is noted that the waste types and quantities estimated as an outcome of this assessment are indicative, and have been identified for the purpose of determining potential waste impacts and waste management approaches. Although the quantities of waste generated by the project may differ from these estimates, the identified waste management approaches would be appropriate to the final waste quantities.

24.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Waste management risks with an overall assessed risk rating of medium or above, identified by the environmental risk assessment, included:

- Inappropriate management of waste during construction and operation resulting in environmental, health and amenity impacts, including contamination, water quality impacts, odour and dust
- Inappropriate management of waste generated during construction resulting in excessive waste being directed to landfill.

Potential risks and impacts associated with disturbing contaminated soils and waste materials at the former Tempe landfill are considered in Chapter 12 (Air quality) and Chapter 13 (Contamination and soils).

24.2 Assessment of construction impacts

24.2.1 Waste generation

Waste generated during construction would mainly be from works associated with site preparation, demolition, construction of road infrastructure and landscaping. The types and quantities of construction waste generated by the project would vary throughout construction. The main waste stream would be excavated material (spoil) from earthworks and other activities. Spoil would be generated by works requiring excavation, including:

- Piling for bridge and overpass abutments
- Roadways and the active transport link
- Drainage infrastructure
- Retaining walls
- Utility works.

Construction of road infrastructure over the former Tempe landfill would also involve excavation in landfilled waste materials.

The main construction activities anticipated to generate waste are listed in Table 24.1 together with the wastes that may be produced, and their likely waste classifications (in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste* (NSW EPA, 2014a) (the Waste Classification Guidelines). Construction waste quantities, including estimated spoil generation, spoil reuse, and spoil surplus quantities, would be confirmed during detailed design as would classifications and reuse/recycling/disposal locations.

Table 24.1 Construction waste estimates

Activity	Waste streams that may be produced	Likely classification of waste streams	Estimated quantities
Clearing and grubbing of vegetation, landscaped and/or turfed areas	Green waste	General solid waste (non-putrescible)	3,600 tonnes
Excavation and general earthworks	Spoil comprising virgin excavated natural material (VENM) or excavated natural material (ENM)	General solid waste (non-putrescible)	Up to 163,000 m^3 of excavated material, (subject to suitability for reuse on site)
	Contaminated soils (including asbestos containing materials)	Hazardous waste and/or special waste General solid waste (non-putrescible)	To be confirmed during detailed design
	Soils, general construction material and landfill capping material	General solid waste (non-putrescible)	To be confirmed during detailed design
Leachate management	Leachate	Liquid waste	200 to 450 kilolitres per day
Excavation within the former Tempe landfill	Spoil comprising virgin excavated natural material (VENM) or excavated natural material (ENM)	General solid waste (non-putrescible) General solid waste (putrescible) (small quantities only)	90,000 m^3
Construction of temporary ancillary facilities, new roads, road furniture, road widening, road surfacing, installing drainage structures, retaining walls and new bridges and other construction activities	Concrete, asphalt, aggregate, timber formwork, scrap metals, cable and packaging materials	General solid waste (non-putrescible)	25,000 tonnes
Demolition works	Timber, steel, fibre sheeting, brick, concrete, asphalt, road base, glass	General solid waste (non-putrescible)	See Table 24.2
Maintenance of construction plant, vehicles and equipment	Adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses	General solid waste (non-putrescible) Hazardous waste	1,000 litres
	Tyres	Special waste	Less than 10 tonnes
Activities at construction offices and compounds	Putrescibles (food and other organic waste)	General solid waste (putrescible)	2 tonnes per week
	Paper, cardboard, plastics, glass and printer cartridges	General solid waste (non-putrescible)	1 tonne per week
	Wastewater, sewage and grey water	Liquid waste	87,000 kilolitres
Dust suppression, wash down of plant and equipment	Sediment-laden and/or potentially contaminated wastewater	Liquid waste	Included above

Table 24.2 Estimated waste quantities from demolition activities

Waste stream	St Peters interchange connection	Botany rail corridor	Works location		
			Terminal 1 connection and eastern terminal link	Qantas Drive extension	Total
Timber (tonnes)	60	10	20	190	**280**
Steel (tonnes)	130	10	140	1,700	**1,980**
Fibre sheeting (m^3)	80	0	10	380	**470**
Brick (m^3)	170	0	20	2,490	**2,680**
Concrete (m^3)	4,190	0	70	4,760	**9,020**
Asphalt (m^3)	0	0	350	2,650	**3,000**
Road base (m^3)	0	80	1,500	10,360	**11,940**
Glass (m^3)	10	0	10	200	**220**

The estimated material cut and fill quantities associated with earthworks are provided in Table 8.2. This table indicates that about 163,000 cubic metres of material is proposed to be removed and about 706,000 cubic metres is proposed to be imported. This does not include about 90,000 cubic metres of excavated waste from the former Tempe landfill that would be emplaced within the project site in the proposed emplacement mounds (described in section 24.2.3) and 80,000 cubic metres of imported clean fill that would be used as emplacement mound capping material. Further details regarding the emplacement area and mounds is provided in Section 7.10.2. The estimated excavated waste volumes and mound locations are preliminary and would be subject to detailed design and consideration by a range of stakeholders.

The material to be excavated from the former Tempe landfill is expected to be comprised of mostly non-putrescible material such as general building rubble and capping material. The proposed management of this material is discussed in section 24.2.3.

During construction, the volumes of leachate generation at the former Tempe landfill would be around 200 kilolitres per day under annual average rainfall conditions, and up to around 450 kilolitres per day under 90th percentile wet weather conditions (if they occur) at the start of construction.

The classifications of all waste streams would be confirmed following finalisation of the detailed design and construction planning, prior to any transfer off site.

24.2.2 Potential impacts if waste is not managed appropriately

The potential impacts associated with aspects of waste generation and management during construction are summarised in Table 24.3.

Table 24.3 Potential impacts associated with waste generation and management

Aspect of waste management	Potential impacts
Generation of waste, including excavation and handling	▪ Energy and water consumption associated with packaging ▪ Impacts associated with extraction of resources ▪ Environmental impacts associated with generation and handling on site, including dust, odour, sediment laden/contaminated runoff, leachate generation and noise
Storage of waste on site	▪ Sediment laden/contaminated runoff and leachate generation ▪ Odours and dust ▪ Health and safety of site personnel and neighbouring community ▪ Littering ▪ Site access restrictions
Storage and segregation of waste on site	▪ Cross contamination of wastes ▪ Reduction in reuse of materials ▪ Contamination of recycling facilities
Storage and disposal of liquid and/or contaminated waste	▪ Odours ▪ Contamination of soils, groundwater and surface water
Waste transportation	▪ Dust, noise, traffic and odours ▪ Mud tracking on road
Non-classified or incorrectly classified waste transport and disposal	▪ Regulatory non-compliance ▪ Contamination of recycling facilities/landfills ▪ Contamination of soils, groundwater and surface water
Unlicensed waste contractors transporting waste	▪ Regulatory non-compliance ▪ Potential illegal dumping of waste

The potential environmental impacts associated with excavating, handling, storing on site and transporting waste are considered in the following chapters:

- Chapter 9 (Traffic, transport and access) for impacts associated with heavy vehicle movements, including transport of waste
- Chapter 10 (Noise and vibration) for noise impacts associated with the use of construction equipment for excavation and stockpiling, and heavy vehicle movements
- Chapter 12 (Air quality) for air quality impacts including vehicle emissions, odour and dust, associated with the excavation, handling and transport of material, including material excavated from the former Tempe landfill
- Chapter 13 (Contamination and soils), Chapter 15 (Groundwater) and Chapter 16 (Surface water) for impacts associated with sediment, extracted groundwater, leachate generation and handling and storage of material on the project site
- Chapter 26 (Climate change and greenhouse gas), for impacts associated with greenhouse gas emissions associated with the use of construction equipment for excavation, handling and transport of waste.

Construction waste management activities would not have a significant impact on the environment or human health, assuming:

- The mitigation measures provided in the chapters listed above are implemented
- Construction wastes are managed as described in section 24.2.3
- Additional waste mitigation measures provided in section 24.5 are implemented.

24.2.3 Waste handling and management

All waste generated during construction would be managed using the waste hierarchy approach of avoidance and reuse before consideration is given to disposal. All wastes would be managed in accordance with the waste provisions contained within the POEO Act and other relevant legislative and policy requirements, as outlined in section 24.1.1.

Should waste be found to be unsuitable for reuse or recycling, disposal methods would be selected based on the classification of the waste material in accordance with the Waste Classification Guidelines. The Waste Classification Guidelines provide direction on the classification of waste, specifying requirements for management, transportation and disposal of each waste category.

The proposed approach to managing the different types of construction waste, including measures to facilitate segregation and prevent cross contamination, are provided in Table 24.4. Additional mitigation measures, proposed as an outcome of the assessment, are provided in section 24.5.

Table 24.4 Management of construction waste

Waste type	Management
Spoil	Excavated materials would be reused on site as engineering fill where fit for purpose and practicable. A portion of the material excavated from the former Tempe landfill would be reinstated in on-site emplacement mounds where possible (see further information in section 7.10.2). Where excavated materials cannot be reused or retained on site they would be classified and taken off site for appropriate reuse or to a waste management facility that is lawfully permitted to accept that type of waste for reuse, recycling or disposal (see further information below the table).
Contaminated spoil (including asbestos containing materials) that is not capped on site, and acid sulfate soils	In situ testing of soils in areas of potential contamination concern would be undertaken to determine the appropriate waste classification. Contaminated spoil would be sampled before being transported and disposed of at a suitably licensed off-site location.
General construction waste (concrete, asphalt, timber formwork, scrap metals, cable and packaging materials etc)	General construction waste would be managed in accordance with the waste hierarchy. Waste would be segregated and stockpiled on site, with materials such as bricks and tiles, timber, plastic, and metals separated and sent to a construction and demolition waste recycling facility. Construction waste would be classified in accordance with the Waste Classification Guidelines and directed to a waste management facility that is lawfully permitted to accept that type of waste.
Liquid waste	Wastewater, sewage, and grey water would be disposed to sewer or transported to an appropriately licensed liquid waste treatment facility. Leachate generated at the former Tempe landfill would be managed in accordance with the leachate management plan (see section 15.6). Extracted groundwater would be managed in accordance with a dewatering management strategy (see section 15.6).
Adhesives, lubricants, waste fuels and oils, engine coolant, tyres	Waste from construction vehicle and plant maintenance activities would be collected and stored in designated waste storage areas for collection by an authorised contractor for disposal off site. Any potentially hazardous waste would be stored separately in clearly labelled receptacles and disposed of in accordance with its waste classification. Waste oil and oil filters would be stored in separate recycling bins and collected by an authorised contractor, and recycled off site, where feasible. Tyres would be collected by an authorised contractor for recycling or disposal off site at an appropriately licenced facility.

Waste type	Management
Office waste including kitchen waste, paper, cardboard, plastics, glass	Recyclable materials such as paper, cardboard, plastics, glass, ferrous, and non-ferrous containers would be stored at recycling bins for collection by an authorised contractor, and recycled off site. Where recycling is not feasible, waste would be collected and stored in designated waste storage areas for collection by an authorised contractor for disposal off site at a licenced waste facility
Green waste	As far as practicable, weed-free green waste would be chipped, mulched and reused on site, transferred to another site (in accordance with an agreement that the waste can be legally accepted for the intended use under section 143 of the POEO Act), or collected by an authorised contractor and recycled off site. Weeds would be disposed of in accordance with relevant guidelines/requirements

Unexpected waste material

Construction waste quantities, including estimated spoil generation, spoil reuse, and spoil surplus quantities, would be confirmed during detailed design. Classifications and reuse/recycling/disposal locations would also be confirmed at that stage. There is the potential for unexpected volumes of waste to be generated, including potentially contaminated material. Measures to manage unexpected waste material are provided in section 24.5.

Any spoil classified as contaminated in accordance with the Waste Classification Guidelines would be directed to a waste management facility that is lawfully permitted to accept that type of contaminated waste. As there are a number of solid waste landfills in Sydney that are licensed to accept contaminated soils it is anticipated that the volumes of contaminated spoil generated by the project could be readily accommodated at these facilities.

Off-site recycling and disposal locations

There are a number of locations for off-site recycling and disposal of construction waste generated by the project. Waste facilities in Sydney licensed to lawfully accept general solid waste (putrescible) and vegetation/green waste include (but are not limited to):

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

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

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

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

Specific facilities and collection contractors would be selected during the later stages of the project and documented in the CEMP.

24.2.4 Summary of impacts on Sydney Airport (Commonwealth) land

The potential waste sources, likely classifications and waste management approaches for waste generated on Sydney Airport land would be in accordance with those discussed in sections 24.2.1 and 24.2.3, with the exception that any spoil proposed for reuse would need to not exceed the limits for soil contamination provided in Schedule 3 of the Airports (Environment Protection) Regulations 1997.

The potential waste management impacts on Sydney Airport land would be generally in accordance with those described in section 24.2.2 with the exception that excavation and emplacement activities at the former Tempe landfill would expose waste material, which may have the potential to attract birds.

The presence of wildlife (birds and other animals such as flying foxes or bats) on or in the immediate vicinity of an airport site can create an aviation safety hazard. Wildlife strike can occur as a collision between a bird or other wildlife and an aircraft in flight or during take-off or landing. It is considered unlikely that material excavated from the former Tempe landfill would be of the type to attract wildlife (ie putrescible material). Nonetheless, measures would be implemented during construction at the former Tempe landfill to minimise this potential risk. These would include:

- Staging the excavation to minimise the area of disturbance at any one time
- Minimising the size and area of exposed stockpiles
- Ensuring material that has been disturbed, uncapped, or temporarily stockpiled is suitably covered at the end of each day.

Construction waste management activities would not have a significant impact on Sydney Airport land, assuming:

- The mitigation measures provided in the chapters listed in section 24.2.2 are implemented
- Construction wastes are managed as described in section 24.2.3
- Additional waste mitigation measures provided in section 24.5 are implemented.

24.3 Assessment of operation impacts

24.3.1 Waste generation

Waste generated by the operation of the project would be limited. The main waste streams would include:

- Oils, liquids and chemicals used for maintenance of plant and equipment used in road maintenance activities
- General litter along roads
- Landscape and vegetation waste
- Waste grit and soil from road sweepers.

Table 24.5 summarises the expected wastes during operation and their likely waste classification.

Table 24.5 Waste expected during operation

Activity	Waste streams that may be produced	Likely classification of waste streams
Road sweeping and road maintenance	Green waste, waste grit and soil from road sweepers, litter, asphalt	General solid waste (non-putrescible)
Maintenance activities	Oils, liquids and chemicals and containers	Hazardous waste General solid waste (non-putrescible)

24.3.2 Potential impacts

The impacts associated with waste generation and management during operation would be similar to those for construction (see section 24.2.2), albeit at a much smaller scale. Operational waste, including general litter clean-up, would be managed in accordance with existing operational maintenance requirements and the impact is expected to be minimal.

24.3.3 Waste handling and management

Table 24.6 outlines the proposed waste handling and management measures for operational waste.

Table 24.6 Management of operational waste

Waste type	Management
Oils, liquids and chemicals used for maintenance	Waste from maintenance activities would be collected and stored in designated waste storage areas, for collection by an authorised contractor for off-site disposal. Where feasible, any potentially hazardous waste would be stored separately in clearly labelled receptacles and disposed of in accordance with its waste classification. Waste oil and oil filters would be stored in recycling bins and collected by an authorised contractor, and recycled off site, where feasible.
General litter along roads	Any litter would be collected by an authorised contractor for recycling or disposal at a licenced waste facility.
Landscape and vegetation waste	As far as practicable, weed-free green waste would be chipped, mulched and reused on site, or collected by an authorised contractor and recycled off site. Weeds would be disposed of in accordance with relevant guidelines/requirements.
Waste grit and soil from road sweepers	Waste grit and soils from the road sweeper would be transported for recycling or disposal at a licensed waste facility.

Off-site recycling and disposal locations

The locations for recycling and disposal of wastes during operation would be the same as during construction (see section 24.2.3).

24.3.4 Summary of impacts on Sydney Airport (Commonwealth) land

The types of wastes expected to be generated on Sydney Airport land would not be greater or different to those identified for the project as whole. The proposed handling and management of these wastes would also address potential impacts on Sydney Airport land.

Consistency with the Sydney Airport Master Plan

The *Sydney Airport Master Plan 2039* (SACL, 2019a) (the Master Plan) identifies waste and resource recovery as key environmental issues. By implementing the Master Plan and associated *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b), Sydney Airport Corporation plans to manage and reduce potential impacts from waste and resource recovery by:

- Avoiding unnecessary resource consumption and waste generation
- Minimising waste by changing behaviours
- Recycling and recovering of beneficial materials
- Disposing of waste to landfill as a last resort.

Key relevant initiatives under the Master Plan include:

- Ensure that appropriate consideration for waste management and resource recovery is included in the planning and design for all major proposed developments within the airport site

- Ensure that waste management and resource recovery are considered for the construction phase of development proposals, aligning with Green Star requirements
- Continue to implement the tenant management strategy and ensure that tenants include waste management and resource recovery in their environmental management plans.

The project design has included a focus on waste management and resource recovery, by minimising the project footprint and incorporating reuse of material within design elements (for example the emplacement mounds). Implementation of the measures provided in section 24.5 will also ensure consistency with the Master Plan.

24.4 Cumulative impacts

Cumulative impacts would occur if other projects and activities also generate demand for resource recovery, recycling and disposal capacity in Sydney.

Construction of the project would potentially occur at the same time as the Botany Rail Duplication, the F6 Extension and the New M5 projects. However, as discussed in section 24.2.3, there are numerous facilities lawfully able to accept waste from the project and other projects. These facilities are considered to have significant capacity.

Therefore, there is not expected to be any substantial impact as a result of the interaction of the construction of the project with other proposed activities (including projects) locally and regionally.

Waste generation during operation is expected to be minimal and therefore no cumulative impacts are expected.

24.5 Management of impacts

24.5.1 Approach

Approach to mitigation and management

The project has been designed, as far as practicable, to minimise spoil volumes, and maximise the reuse of material by means of the proposed emplacement mounds. The approach to waste management would be guided by the waste management hierarchy, with a focus on reducing resource use and minimising waste generation as the highest priority. Wastes generated during construction would be reused and recycled where possible. Wastes that cannot be reused/recycled will be disposed of at appropriately licensed facilities.

Waste would be managed during construction in accordance with the CEMP. The CEMP would include a Construction Waste Management Plan, which will define the processes, responsibilities and management measures that would be implemented during construction to manage waste. This would include procedures for the assessment, classification, management and disposal of waste in accordance with the Waste Classification Guidelines. Further information on the CEMP, including the Construction Waste Management Plan, is provided in Chapter 27 (Approach to environmental management and mitigation).

There is the potential for unexpected volumes of waste to be generated, including potentially contaminated material. During construction planning, suitable areas would be identified to allow for contingency management of unexpected waste materials, including contaminated materials. Any previously unidentified contaminated material would be managed in accordance with the unexpected contaminated finds procedure described in Chapter 13 (Contamination and soils).

Expected effectiveness

Roads and Maritime has experience managing potential impacts associated with waste generation as a result of road developments of a similar scale and scope to this project.

All mitigation measures would be consolidated and described in the relevant environmental management plans for construction and operation. The plans would identify measures that are common between waste types and/or impact categories. Roads and Maritime would engage appropriately licensed waste contractors to manage the collection, recycling or disposal of waste that cannot be reused on site. Waste contractors would also be required to provide evidence of the works compliance with legislative requirements, conditions of approval and standards and guidelines.

Auditing and monitoring would be undertaken to ensure that management approaches provided in the environmental management plans are implemented and appropriate. As such, the management of waste throughout the project through implementing the measures outlined in Table 24.7 is considered to be effective.

24.5.2 List of mitigation measures

Measures that will be implemented to manage waste are listed in Table 24.7.

Table 24.7 Waste management mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Waste generation and recycling	WM1	Detailed design will include measures to minimise excess spoil generation. This will include a focus on optimising the design to minimise spoil volumes, and the reuse of material on site.	Detailed design
Construction waste and spoil management	WM2	A Construction Waste Management Plan will be prepared as part of the CEMP and implemented during construction. The plan will adopt the waste hierarchy principles contained in the *Waste Avoidance and Resource Recovery Act 2001* and will detail processes, responsibilities and measures to manage waste and minimise the potential for impacts during construction.	Pre-construction/ construction
	WM3	Construction waste will be minimised by accurately calculating materials brought to the site and limiting materials packaging where possible.	Construction
	WM4	All waste disposal will be in accordance with the *Waste Classification Guidelines* (NSW EPA, 2014a).	Construction
Attraction of wildlife at the former Tempe landfill	WM5	The following measures would be implemented during works at the former Tempe landfill to avoid attracting wildlife: ▪ Staging the excavation to minimise the amount of exposed waste at any one time ▪ Minimising the size and area of exposed stockpiles ▪ Ensuring material that has been disturbed, uncapped, or temporarily stockpiled is suitably covered at the end of each day.	Construction
Management of unexpected waste materials	WM6	Suitable areas will be identified to allow for contingency management of unexpected waste materials, including contaminated materials. Areas will be hardstand or lined areas that are appropriately stabilised and bunded, with sufficient space for stockpile storage.	Construction
Operational waste management	WM7	Operational waste, including general litter clean up, will be managed in accordance with existing operational maintenance requirements for the project and the waste hierarchy principles contained in the *Waste Avoidance and Resource Recovery Act 2001*.	Operation

24.5.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 24.5.2).

Construction waste quantities, including estimated spoil generation, spoil reuse, and spoil surplus quantities, would be confirmed during detailed design and construction planning. There is potential for unexpected volumes of potentially contaminated spoil to be generated. Any spoil classified as contaminated in accordance with the Waste Classification Guidelines would be directed to a waste management facility that is lawfully permitted to accept that type of contaminated waste. There are a number of solid waste landfills in Sydney that are licensed to accept contaminated soils. It is anticipated that the volumes of contaminated spoil generated by the project could be readily accommodated at these facilities.

Chapter 25

Sustainability

This chapter provides the sustainability assessment of the project. It identifies a target rating for the project according to the Infrastructure Sustainability Council of Australia's sustainability rating scheme and considers the application of relevant sustainability principles and guidelines to the project.

The SEARs relevant to sustainability are listed below. There are no MDP requirements specifically relevant to sustainability. However, there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)). Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
17	**Sustainability**	
17.1	The Proponent must assess the sustainability of the proposal in accordance with the Infrastructure Sustainability Council of Australia (ISCA) *Infrastructure Sustainability Rating Tool* and recommend an appropriate target rating for the proposal.	Section 25.2.1
17.2	The Proponent must assess the proposal against the current guidelines including targets and strategies to improve Government efficiency in use of water, energy and transport.	Section 25.2.2

25. Sustainability

25.1 Assessment approach

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

In the context of infrastructure projects, 'infrastructure sustainability' is defined by the Infrastructure Sustainability Council of Australia (ISCA) as 'infrastructure that is designed, constructed and operated to optimise environmental, social and economic outcomes of the long term'. Using a tool such as ISCA's infrastructure sustainability rating tool (the 'IS rating tool'), an assessment of the sustainability performance of an infrastructure asset can be undertaken.

The sustainability assessment for the project considered the application of sustainability principles, and the opportunities to achieve sustainability targets and outcomes aligned with best practice infrastructure projects. The sustainability targets and initiatives outlined have been developed in response to various guidance documents and will be integrated into the design, construction and operation of the project. An overview of the approach to the sustainability assessment is provided below, including key relevant guidelines and policies and a summary of the assessment methodology.

25.1.1 Legislative and policy context to the assessment

The assessment was undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations
- *2030 Agenda for Sustainable Development* (United Nations, 2015)
- *Environment and Sustainability Policy* (Transport for NSW, 2015)
- *Transport Environment and Sustainability Policy Framework* (Transport for NSW, 2013)
- *Environmental Sustainability Strategy 2019–2023* (Roads and Maritime, 2019b)
- *Infrastructure Sustainability rating scheme v1.2* (ISCA, 2017)
- *Sustainable Design Guidelines* (Transport for NSW, 2017)
- *Sydney Airport Sustainability Policy* (SACL, 2016)
- *NSW Government Resource Efficiency Policy* (OEH, 2019b)
- *NSW Waste Avoidance and Resource Recovery Strategy 2014-21* (NSW EPA, 2014b)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

25.1.2 Methodology

The *Environmental Sustainability Strategy 2019-2023* (Roads and Maritime, 2019b) and associated policies and frameworks provide direction to embed sustainability initiatives into the project. The sustainability assessment used an infrastructure sustainability rating scheme and tool developed and administered by ISCA. This scheme provides a comprehensive system for evaluating sustainability across the design, construction and operation of new infrastructure.

Version 1.2 of the rating scheme would be applied to the project. Using the rating scheme, credit points are allocated for providing verified evidence of sustainability actions across different performance categories which are then totalled to achieve an overall project score. The 'Design' and 'As Built' ratings would be applied to the project. The 'Design' rating is an interim verification step after detailed design is completed. This interim rating is later replaced with the 'As Built' rating, which covers both the design and construction stages. The themes and associated performance categories are shown in Figure 25.1.

Figure 25.1 IS rating scheme version 1.2 themes and categories

Key steps in the assessment process are set out in Figure 25.2.

The first step in the assessment process involves an initial assessment of category weightings, followed by analysis of credit requirements. This provides a project-specific context for identifying a target rating level that the project should seek to achieve.

Project information relevant to each category of sustainability initiatives would be reviewed in conjunction with relevant subject matter experts to provide an evidence base for determining the potential performance of the project. Project information was subsequently analysed using the IS rating tool to determine the project's potential score against each sustainability credit. A total potential score was calculated and a project target rating level identified.

Under the rating scheme, each project is allocated a calculated rating based on a score out of 100, with an additional 10 points available for innovation.

Figure 25.2 Infrastructure sustainability rating scheme methodology

25.2 Assessment results

25.2.1 Target rating

During the initial stages of the assessment, the weighting of potential credit scores was adjusted based on their relevance to the project. Each credit in the IS rating scheme has a default weighting shown in the IS scorecard and in the IS Technical Manual. Each default credit weighting reflects the importance and contribution set for the credit to the sustainability performance of a typical infrastructure project or asset.

Through the weightings assessment the default weightings are adjusted based on the importance of each credit for that specific project. The weightings assessment may retain, raise or lower the predetermined weighting of each credit in regard to its relative importance in the project. The credit categories: ‘energy and carbon’, ‘discharges to air’, ‘land and water’ and ‘innovation’ were considered to be most relevant to the project, and were therefore given higher weightings. This was, as outlined above, determined through answers to specific weightings assessment questions provided by the IS scorecard.

Key sustainability initiatives considered included:

- Climate change resilience - including initiatives to improve the resilience of the project to future extreme climate events and sea level rise
- Resource use and waste management including:
  - Initiatives for achieving efficiencies in water management
  - The management and re-emplacement of landfill waste at the former Tempe landfill as required
- Heritage – Aboriginal and non-Aboriginal - including initiatives for the preservation of heritage values
- Liveable communities – including the proposed active transport link
- Natural landscape and environment, including initiatives to minimise the construction boundary where practicable to protect sensitive areas (eg Tempe Wetlands) and design initiatives that minimise impacts to sensitive areas (eg Alexandra Canal).

By implementing initiatives linked to the identified sustainability targets in the sustainability assessment, the project would be designed, constructed and operated to maximise sustainability outcomes.

Based on the results of the assessment, a target rating level of ‘excellent’ was identified as appropriate for the project. The construction contractor(s) will be required to propose project-specific sustainability initiatives and implementation protocols to support achievement of the project’s target excellent ‘Design’ and ‘As Built’ rating. This will ensure ongoing consistency with the *Environmental Sustainability Strategy 2019–2023* (Roads and Maritime, 2019b).

25.2.2 Consistency with relevant guidelines and policies

The SEARs require an assessment of the project against current sustainability guidelines, including targets and strategies to improve government efficiency in the use of water, energy and transport.

The project’s consistency with relevant guidelines is considered below. The project’s consistency with strategic plans and policies relating to transport, freight planning and urban development is considered in Chapter 5 (Strategic context and project need).

A justification of the project in accordance with the principles of ecologically sustainable development (defined by Schedule 2 of the EP&A Regulation) is provided in Chapter 28 (Project justification and conclusion).

2030 Agenda for Sustainable Development

The 2030 Agenda for Sustainable Development was endorsed by the United Nations and the 193 Member States (including Australia) at the United Nations Sustainable Development Summit held in September 2015. The agenda, which responds to challenges faced by the world today and into the future, aims to integrate the social, environmental and economic dimensions of sustainable development. The agenda consists of 17 sustainable development goals and 169 targets.

The project would contribute to the following seven goals, shown in Figure 25.3:

- Goal 8: Decent work and economic growth – Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all. The project would provide direct and indirect employment as well as contribute to the economic growth through direct procurement and better flow of people and freight
- Goal 9: Industry, innovation and infrastructure – Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation. Innovative sustainable technologies and resilience to climate change have been, and would continue to be key considerations in the design development
- Goal 11: Sustainable cities and communities – Make cities and human settlements inclusive, safe, resilient and sustainable. One of the key benefits of the project is that it would reduce heavy vehicles and cars on local roads, making the city more sustainable and safer for local communities
- Goal 12: Responsible consumption and production – Implement responsible sourcing practices and policies and engage with suppliers. The project has the potential to apply responsible sourcing practice through active screening of, and engagement with, suppliers on sustainability issues.
- Goal 13: Climate action – Take urgent action to combat climate change and its impacts. A climate change risk assessment has been undertaken to ensure that resilience to climate change is embedded into design and construction. The assessment included identifying risks and adaptation measures to ensure that the project can withstand future climate change impacts (see Chapter 26 (Climate change and greenhouse gas)).
- Goal 15: Life on land – Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. While the project site is largely located within a disturbed environment, potential impacts to biodiversity, soils and water have been assessed and mitigation measures provided to ensure impacts are minimised.
- Goal 17: Partnerships for the goals – Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development. This project involves stakeholders from state, local and federal government, private sector, industry and community members, all of whom are contributing to advance this project’s sustainability outcomes.

Figure 25.3 2030 Agenda for Sustainable Development – goals relevant to the project

Transport for NSW Environment and Sustainability Policy and Framework

The NSW Government has obligations under the *Transport Administration Act 1988* (NSW) 'to promote the delivery of transport services in an environmentally sustainable manner'. To meet these obligations, Transport for NSW developed an *Environment and Sustainability Policy* (Transport for NSW, 2015), which states that Transport for NSW and associated agencies are 'committed to delivering transport services, projects, operations and programs in a manner that balances economic, environmental and social issues to ensure a sustainable transport system for NSW.'

The *Transport Environment and Sustainability Policy Framework* (Transport for NSW, 2013) provides a collective and coordinated approach to implement the *Environment and Sustainability Policy* and deliver the NSW Government's environmental and sustainability agenda across the transport network. The framework outlines a number of indicators and targets across eight themes. These themes and relevant actions have been incorporated into *Environmental Sustainability Strategy 2019-2023* and are considered below.

Roads and Maritime Environmental Sustainability Strategy

The *Environmental Sustainability Strategy 2019-2023* outlines ten sustainability focus areas for integrating sustainability into the design and construction of road projects. The focus areas are shown on Figure 25.4. A review of the project's consistency with these focus areas and associated objectives is provided in Table 25.1.

Figure 25.4 Environmental Sustainability Strategy 2019-2023 sustainability focus areas

Table 25.1 Consistency with the Environmental Sustainability Strategy 2019-2023 sustainability focus areas

Sustainability focus area	Objectives	Project consistency
Energy and carbon management	Minimise energy use and reduce carbon emissions without compromising the delivery of services to our customers.	A greenhouse gas assessment was undertaken to quantify the project's potential emissions during construction and operation. Mitigation and management measures are provided to minimise energy use and reduce carbon emissions (see Chapter 26 (Climate change and greenhouse gas)).
Climate change resilience	Design and construct transport infrastructure to be resilient or adaptable to climate change impacts.	A climate change risk assessment was undertaken to ensure that resilience to climate change is embedded into design and construction. This assessment included identifying risks and adaptation measures to ensure that the project can withstand future climate change (see Chapter 26).
Air quality	Minimise the air quality impacts of road projects and support initiatives that aim to reduce transport-related air emissions.	The potential impacts on air quality have been assessed and measures are provided to minimise the identified impacts (see Chapter 12 (Air quality)).
Resource use and waste management	Minimise the use of non-renewable resources and minimise the quantity of waste disposed to landfill.	As part of construction planning, the potential for unnecessary resource use would be avoided by making accurate predictions of the quantities of materials that would be required for construction. The management of construction and operation waste would include reuse and recycling of waste, where possible. This is discussed further in Chapter 24 (Waste management).
Pollution control	Minimise noise, water and land pollution from road and maritime construction, operation and maintenance activities	Potential noise, contamination, groundwater, soils and water quality impacts have been assessed and measures are provided to minimise the identified impacts (see Chapters 10 (Noise and vibration), 13 (Contamination and soils), 15 (Groundwater) and 16 (Surface water)).
Biodiversity	Improve outcomes for biodiversity by avoiding, mitigating or offsetting the potential impacts of road and maritime projects on plants, animals and their environments	The potential impacts on biodiversity have been assessed, and measures are provided to avoid, mitigate or offset the identified impacts (see Chapter 22 (Biodiversity)).

Sustainability focus area	Objectives	Project consistency
Heritage – Aboriginal and non-Aboriginal	Manage and conserve cultural heritage according to its heritage significance and contribute to the awareness of the past.	The potential impacts on Aboriginal and non-Aboriginal heritage have been assessed and measures are provided to minimise the potential impacts, including providing opportunities to contribute to an awareness of the heritage significance of the study area (see Chapters 17 (Non-Aboriginal heritage) and 18 (Aboriginal heritage)).
Liveable communities	Provide high quality urban design outcomes that contribute to the sustainability and liveability of communities in NSW.	The project would contribute to reducing congestion on the existing road network and improving connectivity in the surrounding area through faster travel times and reliability along many key arterial roads. The project would also improve the overall amenity of Tempe Lands and enhance opportunities for passive recreation for residents of Tempe. All of this would contribute to the sustainability and liveability of communities in NSW. Additional information is provided in Chapter 20 (Socio-economic impacts). An urban design strategy has been developed to guide future design stages, and considers the surrounding environment, place making and community considerations. Further information is provided in Chapter 21 (Landscape character and visual amenity).
Sustainable procurement	Procure goods, services, materials and works for infrastructure development and maintenance projects that over their lifecycle deliver value for money and contribute to the environmental, social and economic wellbeing of the community.	Goods, services and materials would be procured in accordance with Roads and Maritime's procurement policies, which incorporate sustainability considerations to deliver value for money and contribute to the environmental, social and economic wellbeing of the community.
Corporate sustainability	Communicate our sustainability objectives to employees, contractors and other key stakeholders, and foster a culture which encourages innovative thinking to address sustainability challenges.	Sustainability objectives would continue to drive design and construction. These objectives would be incorporated into the project's construction and operation environmental management plans and would be communicated to all project employees, contractors and stakeholders.

Transport for NSW Sustainable Design Guidelines

The *Sustainable Design Guidelines* (Transport for NSW, 2017), which are influenced by ISCA's IS rating scheme, seek to embed sustainability initiatives into the planning, design, construction, operation and maintenance of transport infrastructure projects. The guidelines do not specifically apply to road projects; however, the sustainability focus areas and objectives specified by the *Environmental Sustainability Strategy 2019-2023* are consistent with the sustainability initiatives of the *Sustainable Design Guidelines*. The *Sustainable Design Guidelines* are also similar to ISCA's sustainability initiatives.

NSW Government Resource Efficiency Policy

The aim of the *NSW Government Resource Efficiency Policy* (OEH, 2019b) is to reduce the NSW Government's operating costs and increase efficiency of resource use. The policy aims to drive resource efficiency by NSW Government agencies through specific measures, targets and minimum standards in four main areas – energy, water, waste and air emissions. These align with the sustainability focus areas in the *Environmental Sustainability Strategy 2019-2023* and would be achieved by implementing sustainability objectives and design strategies consistent with the target sustainability rating for the project.

Further information on the potential air quality, water, waste and energy impacts, and strategies to minimise these potential impacts and enhance the project's performance, consistent with the *NSW Government Resource Efficiency Policy*, are provided in Chapters 12 (Air quality), 14 (Flooding), 15 (Groundwater), 16 (Surface water), 24 (Waste management) and 26 (Climate change and greenhouse gas).

NSW Waste Avoidance and Resource Recovery Strategy

The *NSW Waste Avoidance and Resource Recovery Strategy 2014-21* (NSW EPA, 2014b) provides a framework for waste management in NSW. The goal of the strategy is to reduce the environmental impact of waste and use resources more efficiently.

The strategy provides long-term targets and key result areas for the management of waste. The potential impacts on waste and resources have been assessed and measures are provided to minimise the identified impacts (see Chapter 24). This includes measures to avoid, minimise or manage waste streams generated during construction and operation.

Sydney Airport Sustainability Policy

The *Sydney Airport Sustainability Policy* (SACL, 2016) aims to embed sustainability considerations into all of Sydney Airport's actions. The policy is further supported by the Sustainability Strategy and 2019-2021 Sustainability Commitments, which provide a framework for, and commitments to, sustainability at Sydney Airport.

The approach to sustainability at Sydney Airport is categorised into the three sustainability pillars shown in Figure 25.5.

Figure 25.5 Sydney Airport Master Plan 2039 – Approach to sustainability

The objectives and target areas defined by the policy have been incorporated into the *Sydney Airport Master Plan 2039* (SACL, 2019a) and *Sydney Airport Environmental Strategy 2019-2024* (SACL, 2019b) described below.

Sydney Airport Master Plan 2039

Sydney Airport Master Plan 2039 (the Master Plan) embeds sustainability considerations into planning for the future management and development of Sydney Airport. The Master Plan confirms a commitment to taking a sustainable approach to managing future growth at Sydney Airport, and delivering positive outcomes for customers, investors and the community.

The approach to sustainability, and the objectives and initiatives provided by the Master Plan, align with those in the *Environmental Strategy 2019-2023*. The project is consistent with the following sustainability strategies provided in the Master Plan:

- Community – making a positive contribution to the communities in which we operate
- Environmental efficiency – improving energy and water efficiency and reducing carbon intensity
- Climate change – building resilience and adapting to the physical impacts associated with climate change
- Materials and supply chain – sourcing responsible materials and managing the social and environmental impact of our procurement decisions
- Waste – minimising waste going to landfill
- Customer experience – enhancing customer experience through sustainability, including urban design.

Sydney Airport Environmental Strategy

The environmental action plans in the *Sydney Airport Environmental Strategy 2019-2024* include a sustainability and environmental management action plan. While the actions and initiatives in this plan are not specifically relevant to the project, the project is consistent with the broader objectives and policies that have guided development of the environment strategy, including '… adopting measures to use natural resources sustainably, including minimising our energy use and the generation of waste, doing our part to ensure the enduring wellbeing of the environment'.

25.3 Sustainability management

25.3.1 Approach and outcomes

Approach to sustainability management

A sustainability management plan would be developed to guide how the project would meet the target sustainability rating and how the project-specific sustainability initiatives would be implemented. The plan would establish governance structures, processes and systems to ensure that sustainability objectives and commitments continue to be implemented during detailed design, construction and operation. The aims of the plan would be to:

- Demonstrate sustainability leadership and continuous improvement
- Protect the natural environment and local heritage
- Contribute to liveable communities and facilitate urban revitalisation by easing congestion, connecting communities and integrating land use and transport planning
- Optimise resource efficiency (materials, energy, water and land) and waste management
- Increase resilience to the effects of future climate change
- Minimise and manage greenhouse gas emissions arising from construction, operation and maintenance (see Chapter 26 (Climate change and greenhouse gas))
- Procure sustainably, considering whole of life environmental, social and economic factors
- Maximise equitable/fair training and employment opportunities.

The plan would include objectives and actions to guide achievement of the targeted excellent rating. The plan would detail implementation protocols, including:

- The ISCA assessment and registration process and timeframes
- Proposed consultation and engagement with ISCA and other stakeholders
- The rating process and requirements for the provision of documentation to ISCA
- Key sustainability management roles and responsibilities
- Actions to achieve consistency with the objectives of the *Environmental Sustainability Strategy 2019–2023*.

The sustainability management plan would form part of the project's management system. The plan would be revised and updated regularly, including prior to the commencement of operation, to reflect changing designs and sustainability initiatives through each of the project phases.

Expected effectiveness

The proposed management measures provided in section 25.3.2 have been developed to provide a pathway to achieving the target sustainability rating. These are consistent with those implemented on similar infrastructure projects, and are expected to be effective.

25.3.2 List of mitigation measures

Measures that will be implemented to integrate sustainability considerations with the project and achieve the target rating are provided in Table 25.2.

Table 25.2 Sustainability mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Achieving the target sustainability rating	SU1	A sustainability management plan will be developed to ensure that sustainability considerations are implemented during the detailed design, construction and operation phases of the project. The plan will include project-specific sustainability initiatives and implementation protocols to support achievement of the project's target excellent 'Design' and 'As Built' rating under the Infrastructure Sustainability rating tool (v1.2) and to ensure ongoing consistency with the *Environmental Sustainability Strategy 2019–2023* (Roads and Maritime, 2019b).	Detailed design
	SU2	Prior to the commencement of operation, the sustainability management plan and sustainability initiatives will be reviewed and updated.	Operation

Chapter 26

Climate change and greenhouse gas

This chapter summarises the climate change and greenhouse gas assessments undertaken for the project. It identifies potential climate change risks, and how these risks have been and would continue to be managed. The chapter also provides preliminary estimates of the potential greenhouse gas emissions associated with the project and measures to manage these emissions.

The SEARs relevant to climate change are listed below. There are no SEARs relevant to greenhouse gas, and no MDP requirements relevant to climate change or greenhouse gas. However, there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)). Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed
Key issue SEARs		
19	**Climate Change Risk**	
19.1	The Proponent must assess the risk and vulnerability of the proposal to climate change in accordance with the current guidelines.	Section 26.1
19.2	The Proponent must quantify specific climate change risks with reference to the NSW Government's climate projections at 10 km resolution (or lesser resolution if 10 km projections are not available) and incorporate specific adaptation actions in the design.	The climate projections used are summarised in section 26.1.2 Risks and actions identified are provided in sections 26.2 and 26.3
19.3	The EIS must include a qualitative assessment of changes to the heat island effect in the local area.	Section 26.2.1

26. Climate change and greenhouse gas

26.1 Assessment approach

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

Greenhouse gas is a collective term for gases that absorb outgoing infrared radiation reflected from the earth. The process of absorbing infrared radiation in the atmosphere generates heat and gradually warms the atmosphere. This is known as the greenhouse effect, which is linked to climate change. Human activities, including the combustion of carbon-based fuels, increase the concentration of greenhouse gases in the atmosphere. This leads to greater absorption of infrared radiation and an increase in atmospheric temperature.

Identifying the likely scale of potential emissions associated with the project provides a baseline from which further greenhouse gas reduction measures can be developed.

Climate change and greenhouse gas assessments were undertaken to inform the development of the concept design. The risks that climate change poses to the project, and the project's potential contribution to future climate change were both considered. Risks that require further action were prioritised and the results of these assessments are summarised in this chapter.

An overview of these assessments is provided below, including the legislative and policy context and a summary of the methodologies.

It is noted that the SEARs for flooding also identify the need to assess impacts on flood behaviour for a full range of flood events, including taking into account sea level rise and storm intensity due to climate change. This is considered in Chapter 14 (Flooding).

26.1.1 Legislative and policy context to the assessment

The assessments were undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations, and the *National Greenhouse and Energy Reporting Act 2007* (Cth)
- *Climate Change Policy Framework* (OEH, 2016b)
- *Sea Level Rise Policy Statement* (DECCW, 2009)
- *AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk based approach*
- Draft *Technical Guide: Climate Change Adaptation for the State Road Network* (Issue 1) (Roads and Maritime, 2015c) (the 'Technical Guide')
- *Climate Change Impacts and Risk Management – A Guide for Business and Government* (Australian Greenhouse Office, 2006)
- *National Climate Resilience and Adaptation Strategy* (Department of the Environment, 2015)
- *Climate Change in Australia Projections for Australia's NRM Regions - East Coast Cluster Report* (Dowdy et al., 2015)
- *National Greenhouse Accounts Factors* (Department of the Environment and Energy, 2017)
- *Greenhouse Gas Assessment Workbook for Road Projects* (Transport Authorities Greenhouse Group (TAGG), 2013)

- *Environmental Sustainability Strategy 2019-2023* (Roads and Maritime, 2019b)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

26.1.2 Methodology

Climate change

The climate change risk assessment followed the approach set out in the *Draft Technical Guide: Climate Change Adaptation for the State Road Network* (Roads and Maritime, 2015c) (the Technical Guide). A preliminary assessment was undertaken to consider climate change risks, opportunities and adaptations to inform the design process.

The assessment approach and key tasks are summarised in Figure 26.1.

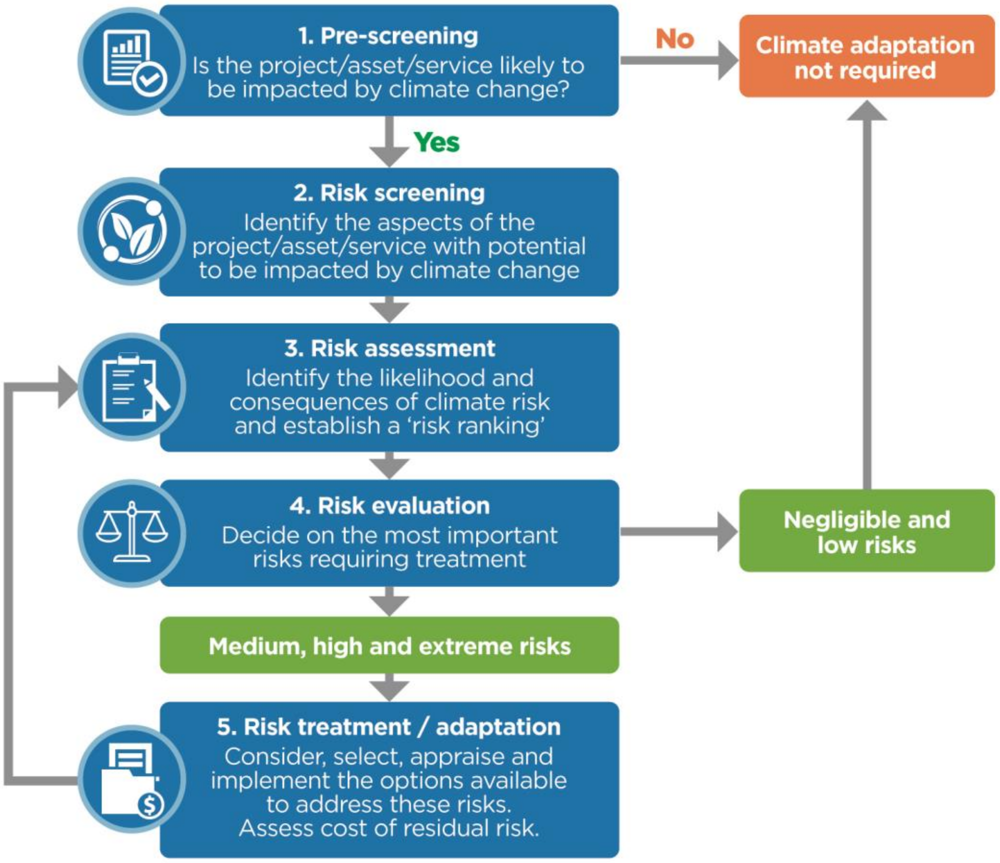


Figure 26.1 Climate change assessment – key steps

The long term nature of the effects of climate change makes it difficult to pinpoint potential impacts within relatively short duration and near term events such as those associated with construction of a project. Therefore, the focus of the climate change assessment was on the potential risks over the operational life of the project.

The key climate change risks considered during operation in the near (2030) and/or far future (2070) were:

- Extreme rainfall combined with sea level rise – rainfall events are predicted to become more intense, increasing the likelihood of flooding, sea levels are anticipated to rise, and more frequent storm surges are anticipated to be experienced in coastal areas
- Temperature – average annual temperatures are predicted to rise and the number of extreme heat days (days over 35 degrees) are expected to increase

- Atmospheric carbon dioxide (CO_2) – increases in CO_2 are predicted to cause changes in the pH levels of saline water which has been linked to increasing the corrosive effects of intertidal waters
- Wind speed – wind speeds are projected to increase
- Bushfire – climatic changes such as changing rainfall patterns, extreme heat and wind speed are predicted to increase the likelihood of severe bushfires.

Climate projections

Table 26.1 outlines the key climate change projections used by the assessment. The timescales used in these projections are considered appropriate for the design life of project elements.

Table 26.1 Key climate change projections

Feature	2030	2070	Source
Projected temperature changes			
Maximum temperature	Maximum temperatures are projected to increase in the near future by 0.7°C (0.3 to 1.0°C)	Maximum temperatures are projected to increase in the far future by 1.9°C (1.6 to 2.5°C)	NSW and ACT Regional Climate Modelling project (NARCLiM) (OEH, 2014)
Minimum temperatures	Minimum temperatures are projected to increase in the near future by 0.6°C (0.4 to 0.8°C)	Minimum temperatures are projected to increase in the far future by 2.0°C (1.4 to 2.5°C)	NARCLiM
Hot days	The number of hot days will increase in the near future	The number of hot days will increase in the far future	NARCLiM
	Average change +3.9 hot days per annum above 35°C	Average change +10.4 hot days per annum above 35°C	NARCLiM
Cold days	The number of cold nights will decrease in the near future	The number of cold nights will decrease in the far future	NARCLiM
Projected rainfall changes			
Mean rainfall	Rainfall is projected to decrease in spring and increase in autumn	Rainfall is projected to decrease in spring and winter. Rainfall is projected to increase in summer and autumn	NARCLiM
Rainfall Intensity	The intensity of rainfall events are projected to increase in the far future		CSIRO projections (Dowdy, A et al, 2015)
Projected sea level rise changes[1]			
Sea level	Sea level is projected to increase 0.08 to 0.18 m above 1986-2005 levels in the near future	Sea level is projected to increase 0.4 to 0.55 m above 1985-2005 levels in the far future	CSIRO projections
Increase in atmospheric CO_2			
Atmospheric CO_2	Atmospheric CO_2 levels are projected to increase in the near and far future		CSIRO projections
Projected forest fire danger index changes			
Fire weather	Average fire weather is projected to increase in spring in the near future	Severe fire weather days are projected to increase in summer and spring in the far future	NARCLiM

Feature	2030	2070	Source
Projected wind speed changes			
Wind speed	Minimal change in mean surface wind speed in the near future	Minimal change in mean surface wind speed in the far future	CSIRO projections

Note: 1. To undertake the risk assessment the flood sensitivity analysis scenarios modelled for the flooding assessment (see Technical Working Paper 6 (Flooding)) have been adopted. These scenarios include 0.4 metres for near future projections and 0.9 metres for far future projections. These are considered to be a more conservative approach to assessing the potential impacts of sea level rise.

Greenhouse gas

The greenhouse gas assessment involved:

- Identifying potential sources of greenhouse gases (including carbon dioxide, nitrous oxide, methane, and sulphur hexafluoride) during construction and operation
- Estimating emissions for each source (carbon dioxide equivalent emissions) and the total greenhouse gas emissions attributable to the project, in accordance with the *Greenhouse Gas Assessment Workbook for Road Projects* (TAGG, 2013) (the TAGG Workbook) and a qualitative assessment in relation to NSW's annual greenhouse gas emissions
- Identifying measures to reduce greenhouse gas emissions.

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

- Scope 1 emissions – direct greenhouse gas emissions into the atmosphere as a result of the project (such as from plant and equipment using fuel)
- Scope 2 emissions – indirect greenhouse gas emissions into the atmosphere from the consumption of energy (such as electrical lighting)
- Scope 3 emissions – other indirect emissions (not included in scope 2) due to upstream or downstream activities (such as emissions associated with road users or the embodied energy within a material used to construct the project).

Data obtained from Roads and Maritime's Strategic Travel Model was used to calculate scope 3 emissions from operational road users for the overall Sydney road network. Emissions were calculated for the 'without project' and 'with project' scenarios. The following scope 3 emissions were deemed to be immaterial (contributing less than five per cent of the total greenhouse gas emissions of a major activity) in accordance with the TAGG Workbook and therefore excluded from the assessment:

- Fugitive emissions (such as from intentional or unintentional leaks or evaporative sources)
- Employee travel to and from site
- International delivery of plant, equipment and materials
- Emissions from disposal of site waste other than spoil
- Transportation of maintenance materials.

The calculated emissions provide an indicative estimate of the project's greenhouse gas emissions and are appropriate to assess the significance of the emissions relative to sector, state and national emissions.

26.2 Assessment results

26.2.1 Climate change

The pre-screening assessment determined that the project has the potential to be impacted by climate change due to:

- Local topography and geographical location – including existing flooding characteristics in certain areas (see Chapter 14 (Flooding)) and the proximity of the project site to Botany Bay
- The design life of the project's key components (such as bridges, which have a design life of about 100 years).

The assessment determined that the major climate change risk variables relevant to the project are increases in the frequency and intensity of rainfall, and sea level rise. Potential risks were identified and rated.

As described in Chapter 14, the flood modelling undertaken for the project included an assessment of the impacts of increased rainfall intensity and sea level rise due to climate change. A number of risk scenarios were identified relevant to the flood impact assessment and these are included in Table 26.2. Existing characteristics associated with the site and surrounding area (described in Chapter 14) have constrained opportunities to incorporate significant flood mitigation in the design. For example, raising Qantas Drive and Airport Drive would have adverse impacts on flooding behaviour within Sydney Airport. The height of road infrastructure in places is also constrained by Sydney Airport's prescribed airspace.

Of the risks identified, three were rated as extreme, one risk was rated as high, and nine risks were rated as medium. These risks are summarised in Table 26.2. The approach to managing these risks is provided in section 26.3

Table 26.2 Climate change risks rated medium or above (prior to mitigation)

Project component	Risk statement / scenario	Risk rating
Extreme rainfall combined with sea level rise		
Roadway operation	Increase in rainfall intensity combined with sea level rise resulting in localised flooding of the roadway low points causing traffic delays, safety risks for road users and potential road closures.	Extreme
Roadway operation	Increase in rainfall intensity combined with sea level rise resulting in localised flooding at the upgraded sections of Airport Drive at Terminal 1 and the Freight Terminal, Qantas Drive upgrade and extension, Eastbound terminal link, northern lands access causing traffic delays, safety risks for road users and potential road closures.	Extreme
Roadway operation	Increase in rainfall intensity combined with sea level rise exacerbating the impacts of future development in the surrounding area, which may alter overland flow paths and drainage systems increasing the amount of floodwater on the road network or adjacent areas.	High
Roadway operation	Increase in rainfall intensity combined with sea level rise resulting in localised flooding at the access to Terminals 2/3, causing minor surface flooding and potential traffic delays.	Medium
Roadway operation	Increase in rainfall intensity and sea level rise causing flooding of the underpass on the active transport link (at Nigel Love bridge), causing a potential hazard to cyclists and/or an inconvenience due to closures.	Medium
Drainage	Reduced performance of surface drainage systems caused by increased rainfall intensity contributing to localised flooding.	Extreme

Project component	Risk statement / scenario	Risk rating
Drainage	Increased exposure of the outfalls at Alexandra Canal and the wider drainage system to inundation and saline conditions due to sea level rise resulting in increased risk of corrosion and increased deposit of sediments.	Medium
Road pavement	Sea level rise increasing the risk of storm surges causing scour damage to pavements and reducing the safety of road conditions.	Medium
Structures	Increase in rainfall intensity combined with sea level rise (and storm surges) resulting in overtopping of the terminal link bridge.	Medium
Electrical assets and power supply	Failure of electrical assets and power outages, caused by flooding as a result of an increase in rainfall intensity combined with sea level rise.	Medium
Temperature		
Structures / drainage	Increased mean maximum temperature and frequency and intensity of extreme heat events may lead to greater material degradation and structural fatigue due to thermal expansion of steel elements	Medium
Electrical assets and power supply	Extended periods of high temperatures may cause a high demand on the electricity grid causing blackouts and loss of traffic signals.	Medium
Wind speed		
Structures	Increase in wind speeds may impact the structural integrity of long span bridges.	Medium

Urban heat island effect

Development within cities such as Sydney can influence the surrounding atmosphere and interact with climatic processes resulting in their own microclimate. One aspect of these microclimates is the urban heat island effect where urban areas become warmer than surrounding areas due to the absorption of heat energy from the sun. The denser a city is, the higher its capacity to absorb and store heat and contribute to the urban heat island effect.

The heat island effect may be enhanced by heat produced by vehicles, public transport and mechanical plant. Conversely, vegetation can reduce the urban heat island effect by providing shading, reducing the footprint of absorptive materials such as asphalt, and providing evaporative cooling. Increases in temperature due to climate change are expected to exacerbate the urban heat island effect in urban areas. Land use changes can also impact the urban heat island effect.

The project site has the potential to experience a level of heat island effect due to the urbanised nature of the study area, including large expanses of paved areas associated with existing roads and Sydney Airport. The coastal nature of the study area means that sea breezes do and will continue to assist in cooling the local climate.

The project is located in an urbanised area with a large portion of the project either replacing existing roadways or industrial sites, which both contain absorptive materials that contribute to the urban heat island effect. The industrial areas consist mostly of concrete/gravel hardstand, warehouse-style buildings, and asphalt carparks with some areas used for storage of shipping containers.

There may be some changes to the urban heat island effect as a result of converting these areas to roadways due to the higher absorptive capacity of asphalt, however, the degree of change would not be as significant as those other areas which would be converted from vegetated areas to hardstand or roadway. During construction, about 24 hectares of vegetation would be removed (see Chapter 22 (Biodiversity)). The areas of vegetation that would be removed are small in comparison to the areas of the project that are already urbanised roadways or industrial sites. Additionally, some of the vegetated areas consist of open grasslands that provide fewer benefits (in terms of reducing the urban heat island effect) compared to areas of dense vegetated land.

New vegetation that provides shading would assist in reducing the urban heat island effect and provide localised relief for members of the public using surrounding public open space areas. New vegetation would be provided in accordance with the project's urban design and landscape plan.

As a result of the above, the project is expected to result in a minor change to the urban heat island effect within the local area.

Cumulative impacts

In terms of the potential for cumulative climate change impacts, the key projects are the Botany Rail Duplication project and the New M5.

While both projects are located within the same catchment, with the potential for cumulative impacts as a result of future increased rainfall intensity and sea level rise, modelling undertaken as part of the flooding assessment for the Sydney Gateway road project (see Chapter 14(Flooding)) concluded that the New M5 would result in negligible cumulative impacts.

The Botany Rail Duplication project is likely to include drainage and earthworks with the potential to impact on the rate of flow discharging to the drainage system that runs across Qantas Drive to Sydney Airport. The drainage systems for the Sydney Gateway road project and the Botany Rail Duplication project would be designed to minimise the potential for cumulative impacts. Further information is provided in Chapter 14.

Modelling undertaken as part of the flooding assessment for the Sydney Gateway road project (see Chapter 14) concluded that cumulative effects from the Botany Rail Duplication project would be minor. As a result, it is considered that the cumulative impacts of the Botany Rail Duplication project can be readily managed by implementing the mitigation measures provided in Chapter 14.

Other future developments and upgrades in the area surrounding the project site may result in changes to overland flow paths and drainage networks. Additionally, if the density of development increases and vegetation is removed, an increase in the urban heat island effect could result.

It is expected that the potential for cumulative impacts would be readily managed with the implementation of the measures provided in section 26.3.

26.2.2 Greenhouse gas

Construction

The estimated construction emissions by source and scope are provided in Table 26.3 and shown on Figure 26.2. The total greenhouse gas emissions for construction activities is estimated to be 422,970 tonnes of CO_2-equivalent (tCO_2-e) over a three-year period.

Scope 3 emissions account for the majority (80 per cent) of construction-related emissions, with the largest proportion of this coming from embodied emissions within materials used for the project. A total of 20 per cent of emissions come from plant and equipment that consume fossil fuels (scope 1 emissions). Vegetation removal accounts for less than one per cent of the project's construction emissions.

The project's structural elements (such as bridges and retaining walls) account for the majority of scope 1 emissions (from plant and equipment use) and scope 3 emissions (embodied emissions within materials). This is due to the amount of concrete and steel required and the number of bridges and retaining walls proposed.

Scope 1 emissions equate to an average of 27,020 tCO_2-e per annum, which accounts for less than two per cent of annual national greenhouse gas emissions associated with the construction industry in Australia.

Measures are provided in section 26.3 to reduce greenhouse gas emissions during construction.

Table 26.3 Annual greenhouse gas emissions by emission source and scope - construction

Summary of activities	Scope 1 (tCO2-e/year)	Scope 2 (tCO2-e /year)	Scope 3 (tCO2-e /year)	Total (tCO2-e /year)	Percentage of total emissions (%)
Site office / general areas	250	-	20	270	0.2
Demolition and earthworks	1,910	-	100	2,010	1.4
Construction of pavements	350	-	3,050	3,400	2.4
Construction of structures	23,770	-	108,800	132,570	94
Construction of drainage	720	-	580	1,300	0.9
Construction of road furniture	20	-	1,420	1,440	1
Total (per year as an average)	**27,020**[1]	**-**	**113,970**	**140,990**	**100**
Total (3 years)	**81,060**	**-**	**341,910**	**422,970**	**100**

Note: 1. The *Carbon Gauge* calculator assumes all construction phase energy is from diesel sources such as generators. For this reason there are no scope 2 emissions from electricity use. The comparative greenhouse gas emissions between diesel fuel and electricity is a factor of about 3.5, with higher emissions associated per unit of grid electricity. Therefore if electricity was available for site offices, this would result in about a two per cent increase in total scope 1 and 2 emissions.

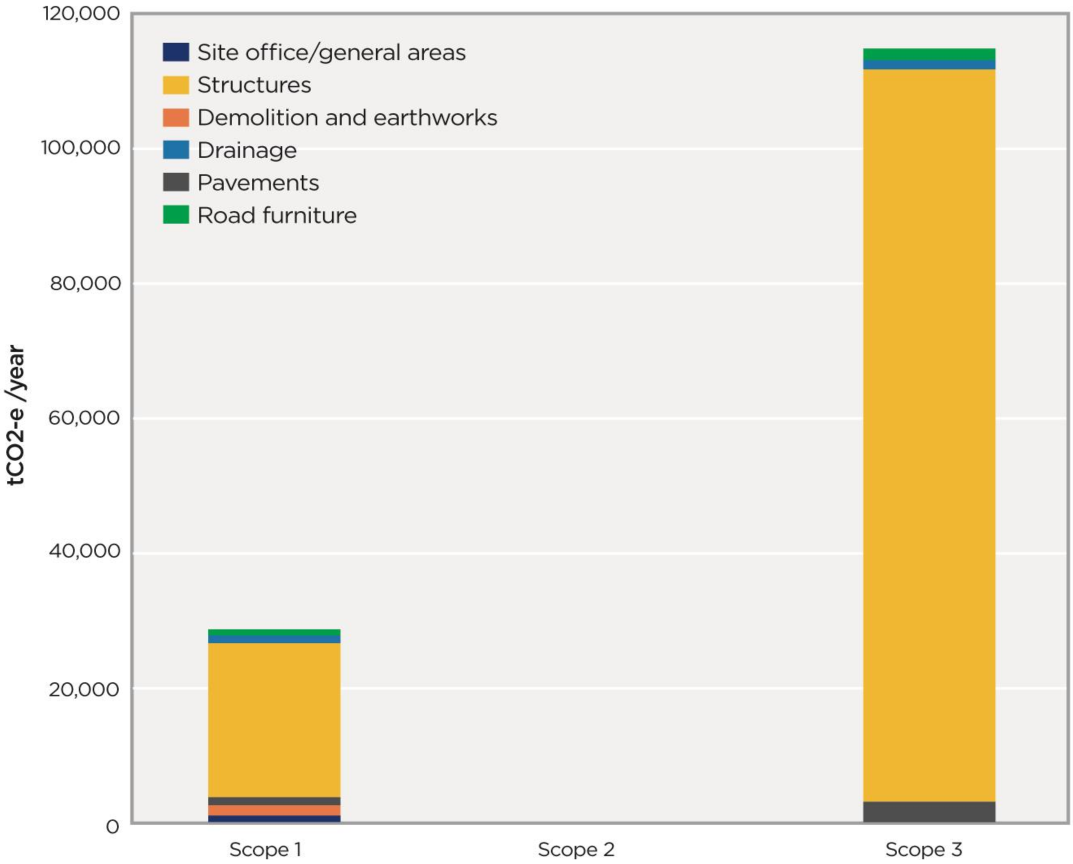


Figure 26.2 Annual greenhouse gas emissions by emission source and scope construction

Operation

Greenhouse gas emissions would be generated during operation of the project by activities including:

- Vehicles using the project
- Use of electricity (for street lighting, electronic signage, variable message signs and any other signalling and communication requirements)
- Maintenance of road infrastructure and pavement, including fuel use for the operation of maintenance equipment.

Greenhouse gas assessment results are provided in the following sections.

Emissions from road infrastructure operation and maintenance

Table 26.4 provides the estimated annual operational greenhouse gas emissions by source and scope. The total operational greenhouse gas emissions (including maintenance activities, but excluding road user emissions) is estimated to be 20,650 tCO_2-e over a 50-year operational period (prescribed period in the TAGG workbook). This is equivalent to 413 tCO_2-e per annum.

Table 26.4 Annual greenhouse gas emissions by emission source and scope - operation

Summary of activities	Scope 1 (tCO2-e/year)	Scope 2 (tCO2-e/year)	Scope 3 (tCO2-e/year)	Total (tCO2-e/year)	Percentage of total emissions
Lighting	-	260	50	310	75%
Traffic signals	-	10	3	13	3%
Maintenance of pavements	40	-	50	90	22%
Total (per year)	**40**	**270**	**103**	**413**	**100%**
Total (50 years)	**2,000**	**13,500**	**5,150**	**20,650**	**100%**

Emissions from operational road use

Table 26.5 provides the estimated operational greenhouse gas emissions from road users with and without the project. The results show that with the project in place, the following greenhouse gas emissions would be saved due to additional road infrastructure projects being completed:

- Up to 142,000 tCO_2-e (0.59 per cent of emissions without the project) would be saved annually during the first few years of operation (based on projected 2026 traffic data provided in Technical Working Paper 1 (Transport, Traffic and Access)
- Up to 180,000 tCO_2-e (0.61 per cent of emissions without project) in the future (based on projected 2036 traffic data provided in Technical Working Paper 1).

This saving is attributed to an increase in the average speed of vehicles across the network, which is most significant for improving the fuel consumption of heavy vehicles due to the reduced congestion and wait times.

The estimate of future traffic greenhouse gas emissions does not include changes in fuel efficiency or type of vehicle fuel used. Anticipated future improvements in fuel efficiency and vehicle type may further reduce greenhouse gas emissions throughout the transport system in NSW in the longer term.

Table 26.5 Summary of Sydney's road network user greenhouse gas annual emission

Year	Without project (tCO_2-e)	With project (tCO_2-e)	Change (tCO_2-e)	Change (%)
2026	24,163,790	24,021,600	-142,190	-0.59
2036	29,509,790	29,328,570	-181,220	-0.61

Cumulative impacts

Construction

The estimated construction emissions would only be generated during the construction period. However, emissions would contribute to the cumulative generation of greenhouse gases from the construction and manufacturing industries.

The total emissions (scope 1, scope 2 and scope 3) estimated to be produced during construction would account for about 0.5 per cent of NSW's manufacturing and construction sector emissions.

Operation

Direct scope 1 and scope 2, and embodied scope 3 greenhouse gas emissions associated with lighting, traffic signals and maintenance, are estimated to account for about 0.0003 per cent of NSW's total annual greenhouse gas emissions.

The operational road use assessment included a cumulative scenario, which estimated that about 198,750 tCO2-e (0.82 per cent of emissions without the project) would be saved annually during the first few years of operation (based on projected 2026 traffic data) and 180,000 tCO2-e (1.78 per cent of emissions without the project) would be saved in the future (based on projected 2036 traffic data).

It is expected that a net annual saving in greenhouse gas emissions would be realised across the overall Sydney network due to improved road network efficiency associated with the project and other future road projects.

26.2.3 Summary of impacts on Sydney Airport (Commonwealth) land

The potential climate change risks identified for Sydney Airport land would be similar to those identified for the project as a whole. The management measures in section 26.3 would also address potential impacts on Sydney Airport land.

Greenhouse gas emissions would be generated on or near Sydney Airport land during construction. During operation, greenhouse gas emissions would be generated by fuel consumption for maintenance activities, road traffic and electricity use.

Consistency with the Sydney Airport Master Plan 2039

The *Sydney Airport Master Plan 2039* (SACL, 2019a) (the Master Plan) and the *Environment Strategy 2019-2024* (SACL, 2019b) (the Environment Strategy) include an objective to proactively reduce greenhouse gas emissions and improve Sydney Airport's resilience to climate change.

The Environment Strategy notes that key climate change risks for Sydney Airport include inundation of critical systems, buildings and infrastructure leading to operational disruptions, and inundation of access roads to the airport. Undertaking the preliminary climate risk assessment at concept design stage (as described in this chapter) and undertaking a comprehensive climate change risk assessment during detailed design (see section 26.3), would ensure that potential climate change risks associated with the project are adequately considered. Implementing the measures provided in section 26.3 would increase the project's (and Sydney Airport's) resilience to climate change and is therefore consistent with the Master Plan.

The Environment Strategy identifies that the majority of the electricity consumed at Sydney Airport, and subsequently the scope 1 and scope 2 greenhouse gas emissions, result from operating the airport terminals (heating, cooling and lighting). The majority of scope 3 emissions are associated with the landing and take-off of aircraft and access to the airport.

While parts of the project would be located on Sydney Airport land, Sydney Airport Corporation would not construct the project. While greenhouse gas emissions as a result of construction are not directly attributable to Sydney Airport Corporation, emissions associated with operation of the road on Sydney Airport land would need to be accounted for in Sydney Airport Corporation's reportable emissions.

The predicted decreases in greenhouse gas emissions during operation, and the measures provided in section 26.3 to reduce emissions, are consistent with the objectives of the Master Plan.

26.3 Management of impacts

26.3.1 Approach

Climate change

Further consideration of the potential for climate change risks would be undertaken to support detailed design. This would include a detailed climate change risk assessment, considering both direct and indirect risks, conducted in accordance with *AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk based approach* and the Technical Guide. The risks and potential adaptations identified by the preliminary assessment would be considered and adaptation measures implemented where reasonable and feasible.

The flood management approach for the project (see Chapter 14 (Flooding)) would include consideration of future climate change-related flood risks and take an adaptive approach to managing these issues with co-ordination between the various stakeholders involved.

Greenhouse gas

Potential greenhouse impacts during construction and operational maintenance activities would be managed by implementing the sustainability management plan for the project (see Chapter 25 (Sustainability)) during construction and operation. The sustainability management plan will include measures to minimise and manage greenhouse gas emissions during construction and operation and maintenance.

Expected effectiveness

Roads and Maritime has experience in addressing potential climate change risks through the application of treatments and adaptation measures in the design and operation of road infrastructure. The proposed measures provided in section 26.3.2 are consistent with those implemented on similar infrastructure projects, and are therefore expected to be effective.

26.3.2 List of mitigation measures

Measures that will be implemented to address potential climate change and greenhouse gas impacts are listed in Table 26.6.

Table 26.6 Climate change and greenhouse gas mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Climate change risk assessment	CC1	A detailed climate change risk assessment, considering both direct and indirect risks, will be undertaken during detailed design in accordance with *AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk based approach* and the draft *Technical Guide: Climate Change Adaptation for the State Road Network* (Roads and Maritime, 2015c). Adaptation measures will be confirmed and actions implemented to address extreme and high risks where reasonable and feasible. Adaptation measures for medium risks will be considered and implemented where reasonable and feasible. Progress against implementation of confirmed adaptation measures and actions will be tracked. The assessment will include further modelling to optimise the design and reduce the impacts of climate change scenarios.	Detailed design

Impact/issue	Ref	Mitigation measure	Timing
Climate change related flood risks	CC2	The flood mitigation strategy (measure HF1) will include consideration of future climate change related flood risks, the potential impacts of future climate change on flooding, and adaptive measures for implementation.	Detailed design
Urban heat island effect	CC3	The urban design and landscape plan for the project will include consideration of appropriate landscape designs and species to reduce the impacts of urban heat island effect. Other measures to mitigate the impacts of the urban heat island effect will be investigated during detailed design and included in the urban design and landscape plan. Measures will include using light coloured pavements and shading structures for public spaces.	Detailed design
Emergency management planning	CC4	Operational procedures for emergency planning and management will be prepared to consider the increased risk of flooding and storm surges on the road and active transport link.	Operation
	CC5	Emergency management planning will be undertaken in consultation and collaboration with other key agencies and surrounding stakeholders, including Sydney Airport Corporation.	Operation
Greenhouse gas emissions	GHG1	The sustainability management plan (measure SU1) will include measures and targets to reduce greenhouse gas emissions during construction and operation. The plan will include targets to reduce the project's carbon footprint during construction and operation, considering scope 1, scope 2 and scope 3 emissions.	Detailed design
	GHG2	The final design will incorporate LED lighting in preference to fluorescent fittings or high-pressure sodium lights where fit for purpose, feasible and cost-effective.	Detailed design
	GHG3	The surface road network will be designed for long term performance and durability of materials, increasing asset design lives and reducing the frequency of maintenance activities.	Detailed design
	GHG4	An appropriate portion of construction phase energy will be purchased from an accredited GreenPower provider.	Construction
	GHG5	A minimum of six per cent of operational phase energy will be purchased from an accredited GreenPower product.	Operation

26.3.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see section 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 26.3.3).

Residual impacts would include:

- The emission of greenhouse gases from road vehicles using the project
- Ongoing emissions associated with the generation of electricity (eg to power signals and signs). It is noted that the assessment calculated these emissions based on emissions rates for current power generation. Future power generation is likely to be lower in emissions intensity, and as such, actual emissions may be lower than the rates adopted
- Emissions associated with maintenance activities.

It is expected that the residual impacts would be managed during operation via existing operation and maintenance protocols for similar road assets.