F6 Extension

New M5 Arncliffe to President Avenue, Kogarah

State Significant Infrastructure Scoping Report

NSW GOVERNMENT

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Executive summary

Introduction and need

Roads and Maritime Services (Roads and Maritime) proposes to construct and operate the F6 Extension (New M5, Arncliffe to President Avenue, Kogarah) (the project) which would comprise a new, multi-lane road link between the New M5 motorway tunnels at Arncliffe and President Avenue at Kogarah.

The project is the first stage of the F6 Extension and would provide a connection from the New M5 at Arncliffe to President Avenue at Kogarah. Currently all through traffic, including freight vehicles, use the Princes Highway and The Grand Parade to travel from southern Sydney to the Sydney Central Business District (CBD). The current volume of through traffic mixing with local traffic result in substantial traffic congestion, particularly during the AM and PM peaks. The project would relieve traffic congestion on these parallel roads, and provide improved travel times between Kogarah and the greater Sydney region.

The F6 Extension refers to the development of a proposed motorway that links the existing A1 Princes Highway at Loftus, with the Sydney motorway network at Arncliffe. The F6 Extension would become part of an important road link, connecting the Sydney motorway road network with the A1 Princes Highway at Loftus. Roads and Maritime is investigating options for future stages of the F6 Extension to connect the existing and proposed motorway network in Sydney with the Princes Highway at Loftus. Stage 1 of the F6 Extension is identified in the draft *Future Transport Strategy* as a committed initiative for the next 0 – 10 years (subject to funding and business case).

Project benefits

The project would provide a connection for motorists from Southern Sydney to the wider Sydney motorway network, improve travel times between southern Sydney and Sydney CBD and ease congestion on the local road network. The project would:

- Bypass up to 23 sets of traffic lights on the Princes Highway between St Peters and Kogarah
- Be built underground to minimise disruption to the community and environment
- Enable motorists to better access the Sydney motorway network
- Assist in the reduction of traffic congestion, particularly along the Princes Highway through Arncliffe, Rockdale and Banksia, and the Grand Parade, Brighton-le-Sands, and provide shorter travel times for road users
- Provide a motorway that is safe and reliable for road users
- Improve the amenity of the foreshore precinct at Brighton-le-Sands at the Grand Parade
- Reduce the number of heavy vehicles on surface roads
- Allow motorists coming to or from the north to avoid Sydney Airport traffic.

Project overview

The project would include twin motorway tunnels between the New M5 at Arncliffe and West Botany Street, near Rockdale Bicentennial Park. Each tunnel would be around four kilometres in length. A tunnel portal would be located at Brighton-Le-Sands within Rockdale Bicentennial Park and Memorial Fields (within the existing F6 reserved corridor), connecting to on- and off-ramps. The project would finish at a widened President Avenue, with slip lanes to provide connection to the project. Ancillary infrastructure, operational facilities, new service utilities and modifications to existing service utilities would be included as part of the project.

During construction of the project, temporary construction ancillary facilities would be required.

Planning and assessment process

The project is declared State significant infrastructure pursuant to section 5.12(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and would require the preparation of an environmental impact statement and approval from the Minister for Planning under Division 5.2 (section 5.14) of the EP&A Act.

Key environmental issues

The potential impacts of the project and their associated environmental, social and economic consequences have been identified through a preliminary risk assessment, preliminary investigations and community consultation. Based on these investigations the following key environmental issues for the project have been identified:

- Traffic and transport
- Air quality
- Noise and vibration
- Biodiversity.

Proposed scope of the environmental impact statement

These issues would be assessed in a future environmental impact statement for the project, and would describe the existing environment and the potential impacts during construction and/or operation, as well as identifying mitigation and management measures to avoid, minimise or manage the potential impacts.

A number of other environmental issues have also been identified. These issues are outlined in this report and are considered to be of lesser consequence, taking into consideration the project scope, the existing environment and the implementation of standard safeguards and management measures.

Contents

Attachments

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Abbreviations and glossary

ACTAQ	Advisory Committee on Tunnel Air Quality
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
BC Act	*Biodiversity Conservation Act 2016*
CBD	Central Business District
CLM Act	*Contaminated Land Management Act 1997*
CSIRO	Commonwealth Scientific Industrial Research Organisation
CO	Carbon monoxide
DECCW	Department of Environment, Climate Change and Water
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
Existing F6 reserved corridor	Land originally reserved for the F6 Extension
F6 Extension	The development of a proposed motorway that links the existing A1 Princes Highway at Loftus, with the Sydney motorway network at Arncliffe.
GDE	Groundwater dependant ecosystems
GSC	Greater Sydney Commission
Interchange	A separation of two or more roads with one or more interconnecting roadways
IPCC	Intergovernmental Panel on Climate Change
LEP	Local Environmental Plan
M4-M5 Link	A component of the WestConnex program of works. Linking the New M5 with M4 East
M4 East (New M4)	A component of the WestConnex program of works. Extension of the M4 Motorway in tunnels between Homebush and Haberfield via Concord.
LGA	Local government area

Memorial Fields	Sports fields located within Rockdale Bicentennial Park East (within the existing F6 reserved corridor) and to the east of Rockdale Bicentennial Park East
New M5	A component of the WestConnex program of works. A motorway project located from Kingsgrove to St Peters
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
NSW EPA	NSW Environment Protection Authority
NSW OEH	NSW Office of Environment and Heritage
OLS	Obstacle limitation surface
PACHCI	Roads and Maritime Services Procedure for Aboriginal Cultural Heritage Consultation and Investigation
PANS-OPS	Procedures for navigational services – aircraft operations surfaces
PM	Particulate matter
ppm	Parts per million
Rockdale Bicentennial Park	Park located within Rockdale and Brighton-Le-Sands, comprised of Illinden Sports Centre, Rockdale Bicentennial Park North and Rockdale Bicentennial Park East
Roads and Maritime	Roads and Maritime Services
RTA	Roads and Traffic Authority
SACL	Sydney Airport Corporation Limited
SEPP	State environmental planning policy
SIS	NSW State Infrastructure Strategy 2012-2032
Stub tunnel	Driven tunnels constructed to connect to potential future motorway links
Tunnel portal	The entry/exit structure at the end of the tunnel
UN	United Nations
Ventilation facility	Facility for the mechanical removal of air from the mainline tunnels, or mechanical introduction of air into the tunnels. May comprise one or more ventilation outlets
Ventilation outlet	The location and structure from which air within a tunnel is expelled

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1 Introduction

1.1 Overview of the project

Roads and Maritime Services (Roads and Maritime) proposes to construct and operate the F6 Extension (New M5, Arncliffe to President Avenue, Kogarah) (the project); which would comprise a new, multi-lane road link between the New M5 at Arncliffe and President Avenue at Kogarah. The project is shown on **Figure 1**.

The project would form the first stage of the F6 Extension. An overview of the F6 Extension is provided in **Section 1.2**.

The project would be located within the Bayside local government area (LGA). The location of the project is shown in **Figure 2**. The majority of the project would be located underground, with the majority of the operational surface infrastructure located within the land corridor reserved for the F6 Extension (the existing F6 reserved corridor).

The project would include twin motorway tunnels between the New M5 motorway tunnels at Arncliffe and West Botany Street, near Rockdale Bicentennial Park. Each tunnel would be around four kilometres in length. A tunnel portal would be located at Brighton-Le-Sands within Rockdale Bicentennial Park and Memorial Fields (within the existing F6 reserved corridor), connecting to on- and off-ramps. The project would finish at a widened President Avenue, with slip lanes to provide connection to the project. Ancillary infrastructure, operational facilities, new service utilities and modifications to existing service utilities would be included as part of the project.

During construction of the project, temporary construction ancillary facilities would be required.

The project is described in more detail in **Chapter 4**.

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KEY

- Major roads
- Rail
- Train station
- New M5
- Indicative tunnel
- Indicative surface
- Indicative surface works

Figure 1 The project

1.2 Overview of the F6 Extension

The existing M1 Princes Motorway extends from Wollongong to the Princes Highway just south of Waterfall on the southern outskirts of Sydney. There is currently no motorway connection between the existing M1 Princes Motorway and the Sydney motorway network.

The existing F6 reserved corridor between Arncliffe and Loftus was reserved in the 1950s to ensure land was available to accommodate the road infrastructure that would be required for such a motorway. Much of that same reservation remains in place today and forms part of the study area being considered in investigations for the F6 Extension. The F6 Extension refers to the development of a proposed motorway that links the existing A1 Princes Highway at Loftus, with the Sydney motorway network at Arncliffe.

The project would form the first stage of the F6 Extension, connecting the New M5 motorway tunnels at Arncliffe and President Avenue at Kogarah. The project would be predominately underground between the New M5 and West Botany Street, with surface infrastructure being mostly within the existing F6 reserved corridor and north of President Avenue.

1.3 Statutory process

The project is declared State significant infrastructure (SSI) pursuant to section 5.12(2) of the EP&A Act and in accordance with clause 14 and Schedule 3 of State Environmental Planning Policy (State and Regional Development) 2011. The project would require the preparation of an environmental impact statement and approval from the Minister for Planning under Division 5.2 (section 5.14) of the EP&A Act.

KEY

- Major Roads
- Rail
- Train station
- Indicative tunnel
- Indicative surface
- M4-M5 Link
- M4 East
- New M5
- Future Sydney Gateway
- Future Western Harbour Tunnel and Beaches Link

Figure 2 Location of the project

1.4 Purpose of this report

Roads and Maritime has prepared this scoping report to support a State significant infrastructure application under section 5.15 of the EP&A Act.

The requirements of clause 192 of *the Environmental Planning and Assessment Regulation 2000* for applications seeking approval of the Minister for Planning to carry out State significant infrastructure are addressed in Attachment A to this report.

The purpose of this scoping report is to assist the formulation of environmental assessment requirements by the Secretary of the Department of Planning and Environment under section 5.16 of the EP&A Act. The scoping report:

- Describes the project
- Considers the potential environmental issues for the project
- Considers issues potentially of concern to community and stakeholders
- Identifies key environmental issues for the further assessment in the environmental impact statement.

The scoping report and Secretary's environmental assessment requirements would inform the preparation of an environmental impact statement for the project. The form and content of the environmental impact statement would be in accordance with clauses 6 and 7 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*.

2 Background

2.1 Strategic context and project need

2.1.1 F6 Extension: the "missing" link

There is currently no motorway between the Sydney motorway network and the existing M1 Princes Motorway south of Waterfall. All local and through traffic is currently required to use the arterial road network to travel between the two (principally the A1 Princes Highway, the A3 King Georges Road and / or the A6 Heathcote Road / New Illawarra Road), resulting in traffic congestion leading to delayed travel times. The F6 Extension would provide a motorway grade link between the A1 Princes Highway at Loftus and the existing and proposed Sydney motorway network.

The F6 Extension would become part of an important link in the Sydney motorway road network and would connect the A1 Princes Highway at Loftus with the WestConnex New M5 Motorway, the M5 Motorway, the M4 Motorway, and the future Western Harbour Tunnel and Beaches Link.

The main objective of the F6 Extension would be to improve connections and travel times between Sydney and the Princes Highway at Loftus and improve connections for residents and businesses within the broader regional area. Redirecting through traffic onto the new motorway would reduce congestion on the local and arterial road network. The F6 Extension would also support economic development in the Sutherland Shire and the Illawarra.

History of the F6 Freeway (M1 Princes Motorway)

The F6 Freeway (now the M1 Princes Motorway) to connect Sydney and Wollongong was first contemplated in the late 1930s, with planning for the motorway corridor formally recognised in the 1951 County of Cumberland Planning Scheme. Early planning for the freeway included a corridor from Ultimo in Sydney to Bulli Tops near Wollongong, along a corridor to the east of the Princes Highway in the current Bayside LGA and crossing the Georges River at the existing Captain Cook Bridge. Land required for the freeway was progressively acquired and reserved.

Construction of the southern parts of the freeway from Waterfall to Wollongong proceeded in stages from 1959 until 1975. The only part of the freeway to be constructed in the Sydney region was the Captain Cook Bridge, which was completed and opened to traffic in 1965. In 1973, the Australian Government conducted a review of freeway proposals in each state, resulting in publication of the *Freeway Plans of State Capital Cities* (Commonwealth Bureau of Roads, 1974). The report precipitated several major changes in freeway proposals in Australia at the time, including the decision by the NSW Government in 1977 to abandon the northern part of the F6 Freeway between Ultimo and Alexandria. Land reserved for the F6 Freeway north of Alexandria was sold during the late 1970s. Following this, the reservation that passed through a section of the Royal National Park, south of Loftus and east of Heathcote, was removed.

Development of a motorway (or freeway) in the remaining section of the existing F6 reserved corridor from Alexandria to Waterfall has been revisited on several occasions since the 1980s but has not proceeded beyond preliminary investigations. In the intervening period, parts of the existing F6 reserved corridor reservation in the north between Alexandria and Tempe have been sold and developed. Other parts of the existing F6 reserved corridor, mainly south of Arncliffe (refer to **Figure 3**), are currently occupied by public recreation areas, other community facilities and wetlands, however, the reservation is still in place.

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Figure 3 Land included in the existing F6 reserved corridor between Arncliffe and Kogarah

The Project (New M5, Arncliffe to President Avenue, Kogarah)

The project would provide a connection from the New M5 at Arncliffe to President Avenue at Kogarah as the first stage of the F6 Extension.

Through reduction in traffic congestion, particularly along the Princes Highway through Arncliffe, Banksia and Rockdale, and The Grand Parade, Brighton Le Sands, the project would contribute to improvements in amenity at key locations including the Princes Highway corridor (north of President Avenue) and the foreshore precinct along The Grand Parade. It would also contribute to a reduction in traffic along General Holmes Drive.

2.1.2 Population and jobs

The Sydney transport network currently services a population of some 4.2 million people with about 15.5 million trips on a normal weekday. By 2031, Sydney's population is forecast to grow by around 1.6 million people with an additional 689,000 new jobs created (NSW Government, 2014).

In 2016 the Greater Sydney Commission (GSC) was tasked with the role of coordinated strategic planning that will shape the future of Greater Sydney. For strategic planning purposes, Greater Sydney has been divided into six districts. The project lies within the Eastern City District and would facilitate an improved connection with the South District (south of the Georges River).

The Greater Sydney Commission identifies that by 2036 the population in the South District is expected to grow by around 204,100 people (GSC, 2016b) and the population in the Eastern City District (which includes the Rockdale area) is expected to grow by around 325,000 people (GSC, 2016a). The population in the former Rockdale LGA alone is forecast to grow by 41,000 people from 2016 to 2036 (NSW Government, 2016). **Figure 4** shows the population projections for the Eastern City and South Districts of Greater Sydney.

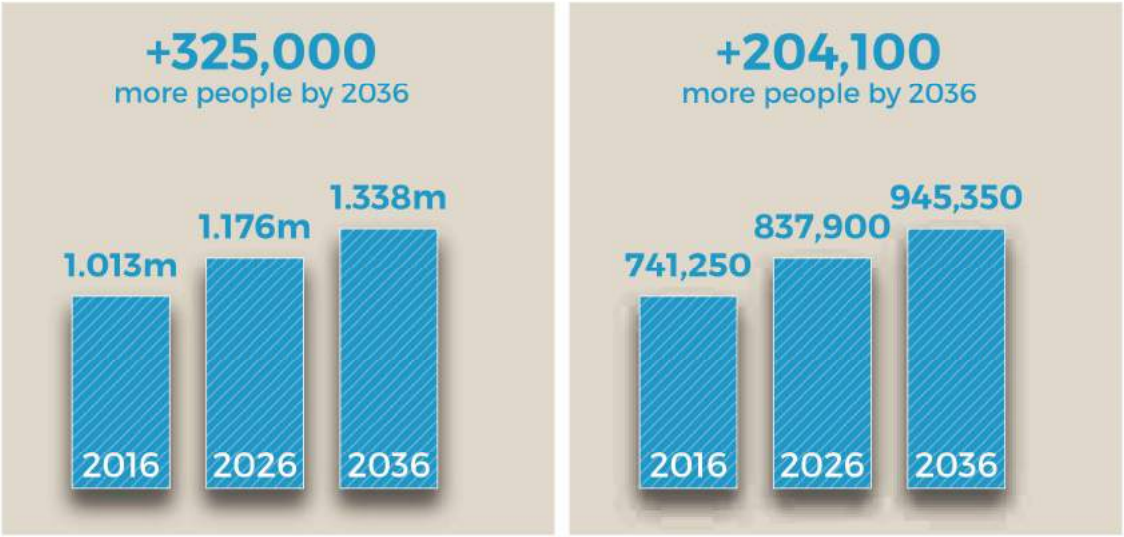

Figure 4 Population projections of Eastern City and South Districts of Greater Sydney
Source: Greater Sydney Commission (2016a and 2016b)

Many South District residents travel to work destinations outside of the District as there is an imbalance between the number and types of jobs available in the South District and the number of people in the labour force (refer to **Figure 5**). Work destinations for those living in the South District include employment clusters in Sydney City, Green Square-Mascot, Port Botany, Bankstown and Greater Parramatta. Nearly 20 per cent of the journeys to work from the South District are to the City of Sydney LGA (GSC, 2016b). This imbalance between population and jobs means that there will remain strong demand for workers to travel by car or public transport to employment clusters and non-peak hour business travel between the economic centres of south and central or northern Sydney.

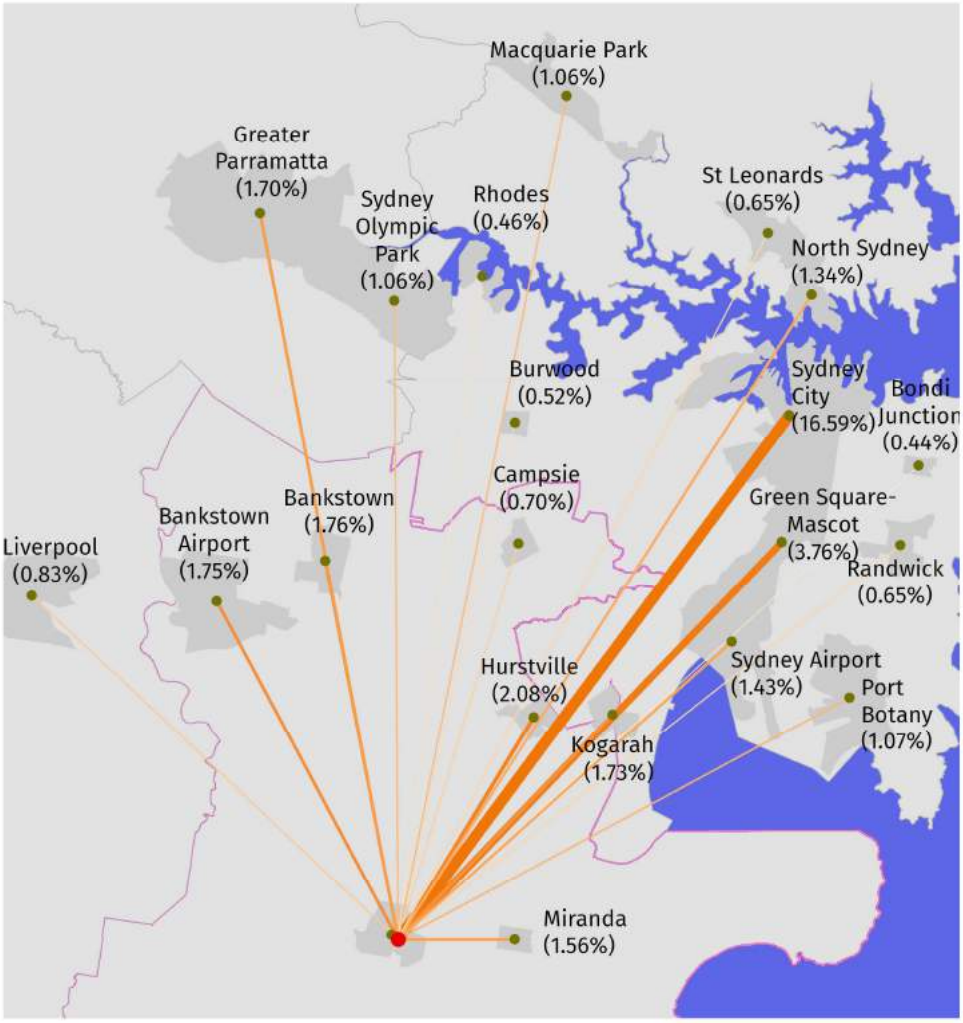

Figure 5 Percentage of journeys to strategic and district centres from South District
Source: Greater Sydney Commission (2016b). Note: only showing those journeys above 1000 trips per year (2011)

The need for additional capacity on the road network becomes increasingly apparent with the projected growth within the Sydney CBD and at the international gateways; Sydney Airport and Port Botany (refer to **Figure 6**). The Sydney Airport and Port Botany precinct is also the largest employment centre in Sydney after the Sydney Business District (Ernst and Young, 2011). Together, Sydney Airport and Port Botany currently generate around $10.5 billion of economic activity and handle close to $100 billion worth of freight each year. Further planned growth within this key employment precinct will result in further increase in journeys to work from the south.

Both the projected population growth and demand for the road network would place further pressure on the transport infrastructure. The project would assist in relieving this pressure and allow for better transport connections.

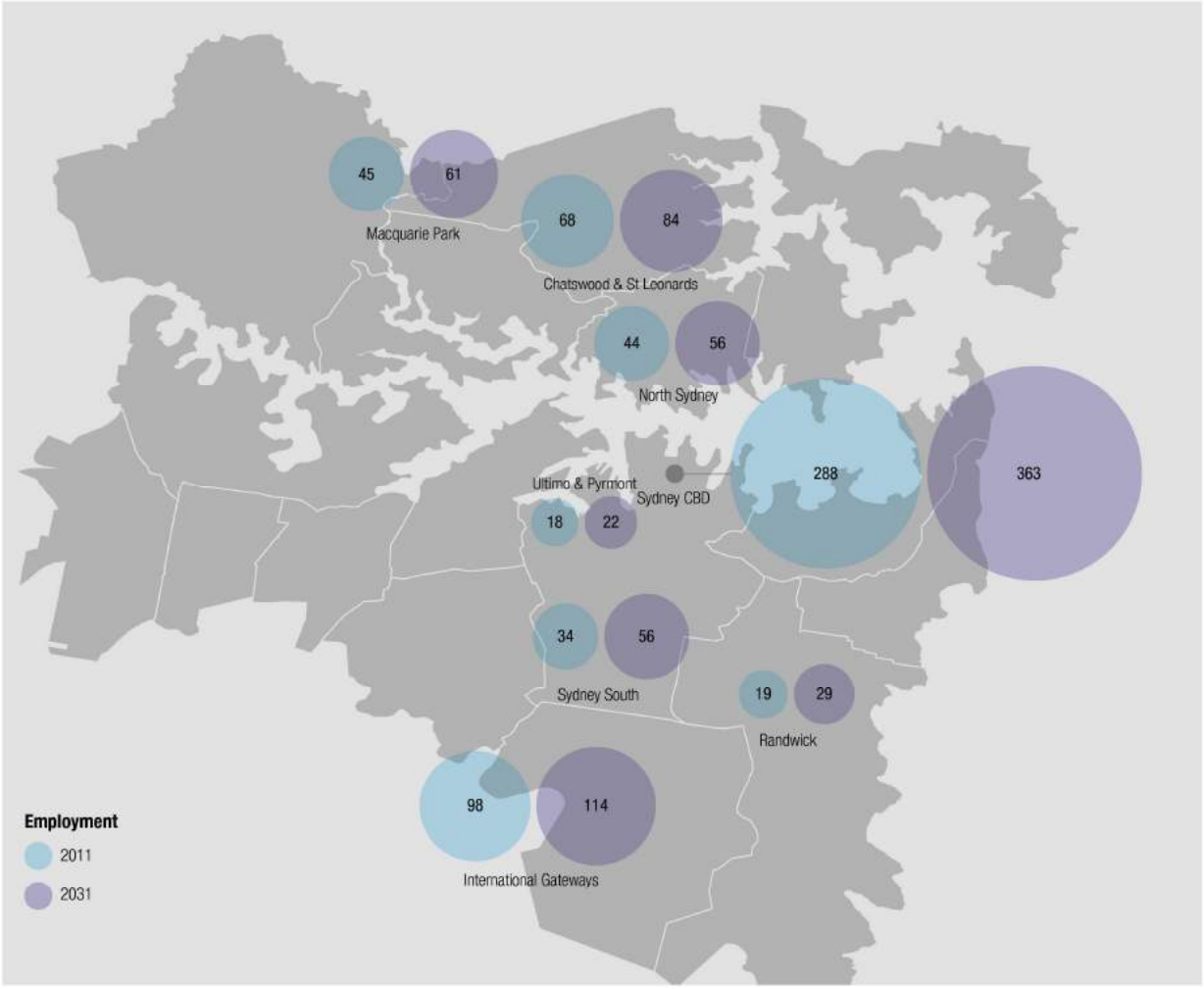

Figure 6 Projected growth in employment for key Global Sydney centres
Source: NSW Bureau of Transport Statistics: NSW State Infrastructure Strategy (2012). Note: All values are in ('000)

2.1.3 Economic impact of road congestion

Sydney's road network serves 93 per cent of passenger journeys and 86 per cent of port freight movements. This includes the approximate 850 bus routes operated in the region. Traffic on key corridors has grown by 50 per cent in the last 20 years, and investment in new roads has struggled to keep up with demand. Travel by road is the dominant transport mode in Sydney and, even with high growth in rail freight and public transport, is predicted to continue to be the most dominant over the next 20 years (Infrastructure NSW, 2012). **Figure 7** shows the mode share across Sydney and road vs non-road travel. Congestion across metropolitan Sydney is estimated to already cost up to $5 billion per annum, and will rise to $8 billion by 2021 if nothing is done.

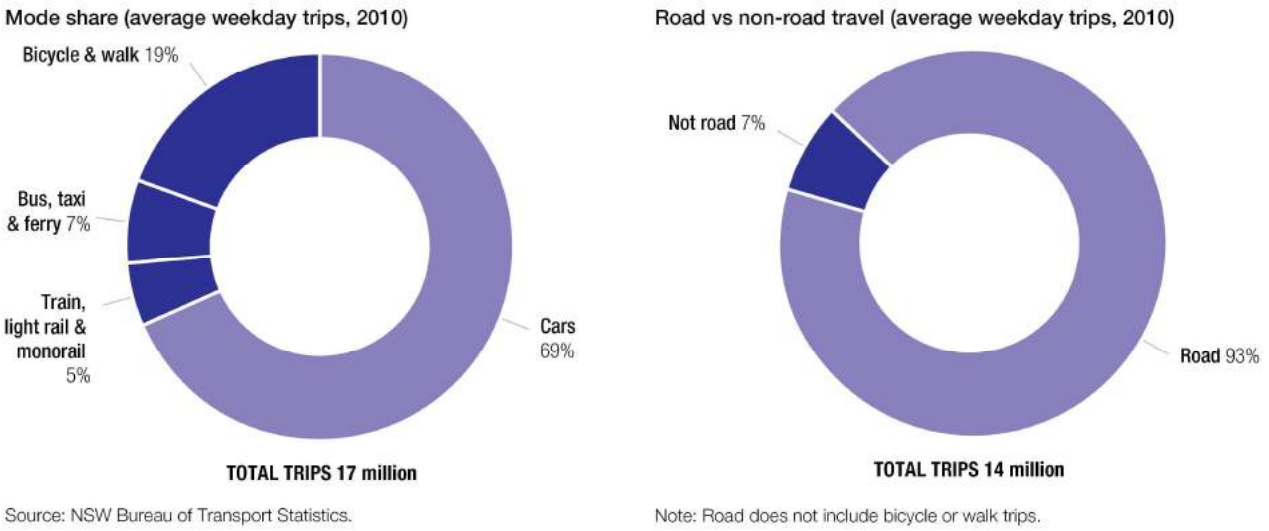

Figure 7 Moving around Sydney
Source: NSW Bureau of Transport Statistics: NSW State Infrastructure Strategy (2012)

Efficient economic journeys, such as business travel and freight movements, are critical to sustaining high levels of productivity and competitiveness: from individual firms and industries to regional, state and national economies. The project would help provide efficient economic journeys to and from southern Sydney by providing a motorway connection between Arncliffe and Kogarah which would enhance the movement of private vehicles, public transport and freight in this area.

2.1.4 Freight

Sydney's freight, service and business task is large and significant. Major freight activity precincts across Sydney are strategically located near or along the strategic road network and rail corridors, including Port Botany and Sydney Airport. Port Kembla plays an important role as an alternative freight hub to Port Botany. Transport of freight between Port Kembla and Sydney relies on the Princes Motorway/Highway as an important connection between these two centres.

By 2031, the freight task in NSW is projected to nearly double from 794 million tonnes compared to 2011 (Transport for NSW, 2013). The greater demand for imported goods would drive significant growth in port container traffic and result in increased land transport needs, particularly around Port Botany and along major arterial routes. Sydney Ports forecasts container trade through Port Botany to nearly quadruple by 2031, reaching seven million containers per year by 2031 (Infrastructure NSW, 2012).

Sydney Airport serves a growing freight market, with freight projected to increase from around 600,000 tonnes in 2012 to over one million tonnes per year by 2033 (Sydney Airport Corporation Limited (SACL), 2014). Air freight, such as fresh, frozen or chilled perishables, are typically time sensitive and generally unsuitable for rail transport (SACL, 2014). **Figure 8** shows the projected freight tonnage increase anticipated at Sydney Airport to 2033.

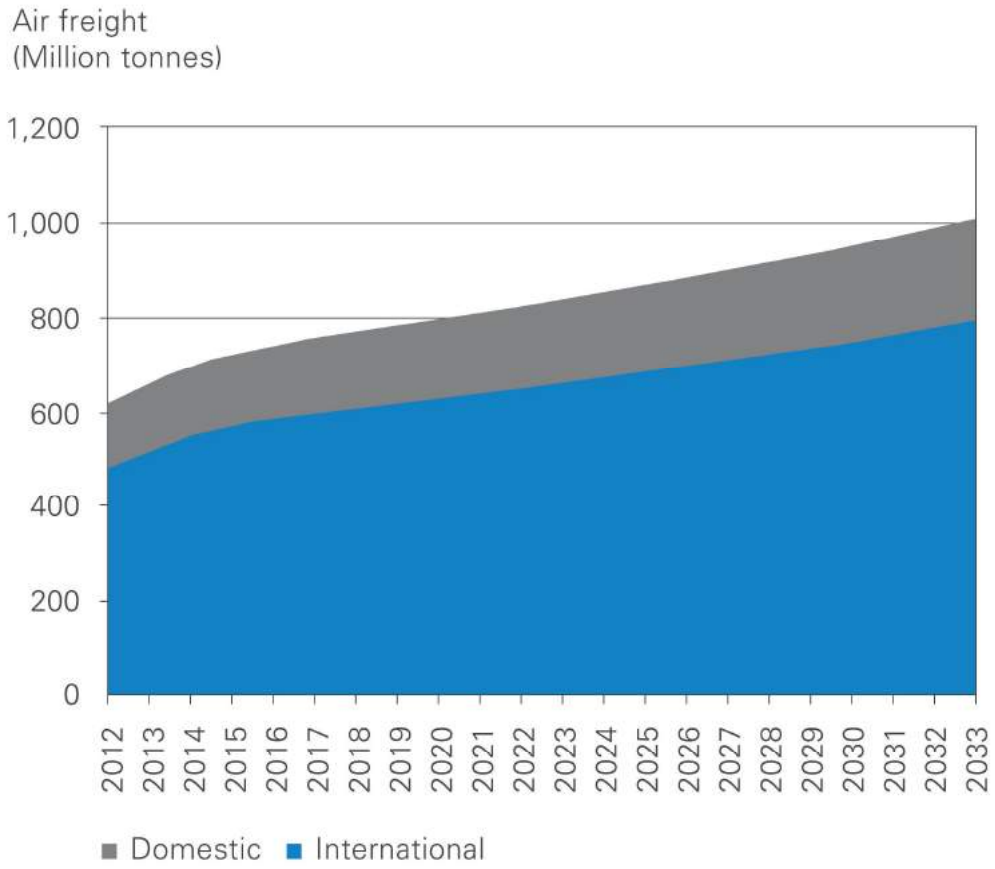

Figure 8 Forecast freight tonnage
Source: Sydney Airport Master Plan 2033 (2014)

The NSW Freight and Ports Strategy reinforces the NSW Government's commitment to its program of motorway connections, including priority freight movements. The strategy states that addressing the gaps in Sydney's motorway network is one of the most important steps in expanding capacity for freight on the motorway network and is particularly critical in creating a more efficient freight network to the nationally significant gateways of Sydney Airport, Port Botany and Port Kembla.

The project would assist in providing more efficient transport connections through a motorway connection for freight vehicles travelling to and from Sydney Airport and Port Botany.

2.1.5 Connectivity

Connectivity between major employment centres is critical in supporting the creation of jobs and businesses. Sydney's business task requires good access for workers as well as the distribution of goods and services across the Sydney region, which requires diverse and dispersed transport connections to support growth. Improved connections for workers, and to other centres, suppliers, trades and customers through improvements to the transport network, including the strategic road network, is needed to support the growth of these centres.

Sydney's transport network will be required to meet changing travel demands due to the diversification of places of employment, urban infill, higher density residential development within existing areas, as well as the ongoing spatial expansion of Sydney's fringe, in addition to regional areas such as Wollongong and the Illawarra.

The project is the first stage of the F6 Extension, which would eventually connect the Princes Highway at Loftus with the Sydney motorway network. The project alone would provide a connection from the New M5 at Arncliffe to President Avenue at Kogarah, providing a crucial link to the Sydney motorway network.

2.2 Strategic planning and policy context

2.2.1 State priorities

There are 18 State Priorities currently being actioned by the NSW Government. The project would contribute to achieving a number of these priorities including:

- Boosting apprenticeships - Increase the proportion of people completing apprenticeships and traineeships to 65% by 2019. The project would be a major employer in NSW.
- Improving road travel reliability – 90% of peak travel on key road routes is on time. The project would deliver travel time savings for motorists travelling from southern Sydney to the Greater Sydney region and enable better use of existing roads by redirecting traffic to the new motorway, and improve reliability.
- Ensure on-time running for public transport - Maintain or improve reliability of public transport services over the next four years. The project would allow for improved bus services on the motorway network and local roads.
- Reducing road fatalities - Reduce road fatalities by at least 30 per cent from 2011 levels by 2021. The project will generate a significant reduction in traffic incidents.

2.2.2 Future Transport 2056

In October 2017, the NSW Government released *Future Transport 2056* (NSW Government, 2017). The strategy is made up of three draft documents – the draft *Future Transport Strategy*, draft *Greater Sydney Services and Infrastructure Plan* and the draft *Regional NSW Services and Infrastructure Plan*. A number of other documents support the strategy.

Future Transport 2056 is an update of NSW's *Long Term Transport Master Plan* (Transport for NSW, 2012). This Master Plan specifically identified the gap in the motorway network between the M1 Princes Motorway at Waterfall and the Sydney motorway network and identifies connecting the F6 Freeway (M1 Princes Motorway) to Sydney's motorway network as a major long term priority.

Future Transport 2056 is currently seeking public feedback and will be finalised in 2018.

Future Transport Strategy 2056

The draft *Future Transport Strategy* sets the 40 year vision, directions and outcomes framework for customer mobility in NSW, which will guide transport investment over the long term. It will be delivered through a series of supporting plans.

Stage 1 of the F6 Extension is identified in the draft *Future Transport Strategy* as a committed initiative for the next 0 – 10 years (subject to Final Business Case).

Draft Greater Sydney Services and Infrastructure Plan

The draft *Services and Infrastructure Plan* for Greater Sydney sets the customer outcomes for the movement of people and freight to meet the customer needs and deliver responsive, innovative services. The plan will define the network required to achieve the service outcomes.

Stage 1 of the F6 Extension is identified in the draft *Greater Sydney Services and Infrastructure Plan* as a committed initiative for immediate detailed planning (subject to Final Business Case). The plan states that the proposed Stage 1 of the F6 Extension will provide better access for people and goods travelling between southern Sydney, the Illawarra and other parts of Greater Sydney.

2.2.3 Greater Sydney Region Plan

The draft *Greater Sydney Region Plan* (Greater Sydney Commission, 2017c) sets out a vision, objectives, strategies and actions or a metropolis of three cities across Greater Sydney. The purpose of the draft Plan is to:

- set a 40-year vision (to 2056) and establish a 20-year plan to manage growth and change for Greater Sydney in the context of economic, social and environmental matters
- inform district and local plans and the assessment of planning proposals
- assist infrastructure agencies to plan and deliver growth and change to align their infrastructure plans to place-based outcomes
- inform the private sector for the vision for Greater Sydney and infrastructure investments required to manage growth
- inform and engage the wider community so the draft Plan can best reflect the values and aspirations of all.

The draft *Greater Sydney Region Plan* is an update to *A Plan for Growing Sydney* (NSW Government, 2014). The investigation of a motorway link within the existing F6 reserved corridor was identified as a planning priority for southern Sydney in *A Plan for Growing Sydney*. It also identified Brighton-Le-Sands as a significant visitor economy and Rockdale as a 'commercial, retail and civic centre' for the region. Reducing the volumes of traffic in these areas would improve the amenity and vitality of these town centres, and provide additional capacity for public transport to connect key centres. Stage 1 of the F6 Extension is identified in the draft *Greater Sydney Region Plan* as a committed initiative (refer to **Figure 9**) for immediate detailed planning (subject to Final Business Case).

2.2.4 Revised Draft District Plans

Revised Draft Eastern City District Plan

The Revised *Draft Eastern City District Plan* (Greater Sydney Commission, 2017a) states planning for the F6 Extension will improve motorway access and freight movements from the Eastern Harbour City across Greater Sydney and to Port Kembla/Illawarra, supporting the functions of critical economic gateways and freeing up road capacity. The plan also identifies a long term vision for Sydney's Green Grid, including the Rockdale Wetlands Open Space Corridor. The plan identifies that parts of this corridor are currently zoned for a future motorway, which should be designed to retain and protect recreational open spaces and the ecological values of the corridor. The project will be designed to align with this vision, minimising impacts on recreational open space and ecological values within the project corridor.

Revised Draft South District Plan

The *Revised Draft South District Plan* (Greater Sydney Commission, 2017b) notes that planning is underway for the F6 Extension linking the New M5 near Sydney Airport and the Princes Highway at Loftus. The plan also acknowledges the northern parts of the F6 Extension are in the Eastern City District, yet delivery of this connection will improve connections between Wollongong and the Eastern Harbour City, particularly Sydney Airport and Port Botany.

2.2.5 Draft Bayside West Precincts Land Use and Infrastructure Strategy

The draft *Land Use and Infrastructure Strategy* for the Bayside West Precincts (Department of Planning and Environment, 2016) includes the Arncliffe Precinct, Banksia Precinct and the Cooks Cove Precinct. The strategy aims to create connected town centres for Arncliffe, Banksia and Cooks Cove, better transport connections, a vibrant Princes Highway corridor and new areas of open space. The project would reduce the traffic flow along the Princes Highway through Arncliffe and Banksia, allowing for the realisation of this strategy.

Figure 9 Future connections to and from Southern Sydney
Source: Draft Greater Sydney Region Plan (2017c)

2.3 Project objectives

Project objectives have been established to meet the strategic and project need. These objectives incorporate environmental, social and economic considerations.

Project objectives have been identified to address the key road network issues and project need outlined in **Section 2.1**. The objectives for the project (refer to **Table 2-1**) have been grouped according to the key focus areas of transport, economic productivity, city shaping, and community and environment.

Table 2-1 Project objectives

Focus	Objective
Transport	**Improve travel times and reliability for road users travelling between Southern Sydney and strategic centres in Greater Sydney while supporting faster and more reliable times for local bus customers and road users in Southern Sydney.** · Improve travel times and reliability for journeys between Southern Sydney and strategic centres in the metropolitan area · Improve travel times and reliability for bus services in Southern Sydney · Improve the journey experience for active transport users in Southern Sydney by improving cycling infrastructure near the new motorway corridor · Improve the safety of road users in Southern Sydney
Productivity	**Support the future growth and productivity of Southern Sydney by improving connectivity between these regions and strategic centres in Greater Sydney** · Attract commercial activity to Southern Sydney by improving access between local commercial areas and strategic centres in Greater Sydney · Facilitate future extension of the F6 to the south thus improving connectivity to the Illawarra.
City Shaping	**Provide opportunity for urban renewal by reducing through traffic along corridors that perform a key place function.** · Facilitate sustainable growth in Southern Sydney by improving accessibility and land use · Facilitate urban renewal at key locations on the Botany Bay foreshore and Princes Highway by reducing through traffic and improving amenity.
Community and Environment	**Minimises adverse impacts on the environment and the community during construction and operation.** · Minimise property acquisition inside and outside of the existing F6 reserved corridor · Minimise long term loss of public open space and recreational areas · Enhance community amenity · Provide active transport infrastructure and connectivity.

2.4 Selection of the preferred project

2.4.1 Overview

Selection of the preferred project follows several years of investigations, including:

- Strategic corridor options - confirmation of the preferred corridor to connect the M1 Princes Motorway with the Sydney motorway network
- F6 Extension alignment - review of the preferred corridor alignment
- F6 Extension staging - assessment of initial staging options.
- The project - assessment of design options

2.4.2 Strategic corridor options assessment

Roads and Maritime has undertaken preliminary environmental investigations into corridor options to link the M1 Princes Motorway with the existing and proposed motorway network in Sydney. This included the Southern Sydney Access Investigations study and the development of a strategic business case. These studies considered key environmental, land use and community facility constraints in addition to the feasibility of engineering options to inform the development of four primary corridor options.

Four corridor options were considered, being:

- F6 corridor option – broadly aligned with land currently reserved for the F6 Freeway
- A1 corridor option – broadly aligned with the existing A1/ A36 arterial road (Princes Highway)
- A3 corridor option – broadly aligned with the existing A1/ A3 arterial road (Princes Highway, King Georges Road)
- A6 corridor option – broadly aligned with the existing A6 arterial road (Heathcote Road, New Illawarra Road, Alfords Point Road, Davies Road and Fairford Road).

These four corridor options were analysed based on their ability to meet the core project objectives and the strategic need for the project (**Section 2.2.3**). During the options assessment, consideration was given to potential constraints and opportunities associated with key environmental, social and economic factors.

In parallel, consideration was made by Sydney Motorway Corporation into the feasibility of a motorway standard connection from the south to the WestConnex design to ensure this option was available should further analysis demonstrate it would be needed in the future.

Roads and Maritime used the information from these preliminary investigations to identify a preferred corridor for further consideration. The preferred corridor for the F6 Extension is broadly aligned with land currently reserved for the F6 Freeway (the F6 option), starting at the southern stub tunnels of the New M5.

2.4.3 F6 Extension alignment

Following the confirmation of the strategic corridor option being generally in line with the existing F6 reserved corridor, Roads and Maritime undertook further studies and investigation work along the existing F6 reserved corridor between Arncliffe and Loftus to help determine a preliminary concept design for the future motorway.

To assist with the development of the motorway connection of the M1 Princes Motorway with the Sydney motorway network, the preferred corridor - confirmed as being in the general area of the existing F6 reserved corridor - was divided into four sections, consisting of:

- Section A - New M5 stub tunnels in Arncliffe to President Avenue at Kogarah (the project)
- Section B - President Avenue at Kogarah to Taren Point
- Section C - Taren Point to the A1 Princes Highway in Loftus
- Section D - A1 Princes Highway in Loftus to M1 Princes Motorway in Waterfall.

Figure 10 provides an overview of this preferred corridor and the four sections.

Following this stage it was concluded that development would not proceed on the connection from Loftus to the M1 Princes Motorway in Waterfall, given that the demonstrated need is lower than the rest of the F6 Extension sections.

2.4.4 F6 Extension staging options

A staging analysis was also undertaken to confirm the most appropriate area to commence construction of the F6 Extension based on the defined geographic sections (A – C) above. The assessment was undertaken by considering the constraints and opportunities in the following criteria:

- Transport
- Productivity
- Social and environmental
- Cost and benefits

The assessment identified that Section A, or as now referred ‘New M5, Arncliffe to President Avenue, Kogarah’, is the preferred first stage by providing the most benefits to the community across the assessment criteria. This was on the basis of Section A having the greatest amount of traffic congestion, with peak hour speeds on the existing arterial network being amongst the lowest in Sydney, and that it provided a direct connection to the future motorway network in Sydney; a primary destination for current and future road traffic.

As a result of this analysis, Section A, providing a connection to the motorway network at Arncliffe to an interchange at Kogarah, was chosen to be developed in further detail.

In parallel, Roads and Maritime determined to continue with the investigation work along the preferred corridor for the F6 Extension between Kogarah and Loftus (Sections B to C) to identify any potential corridor adjustments for the future motorway.

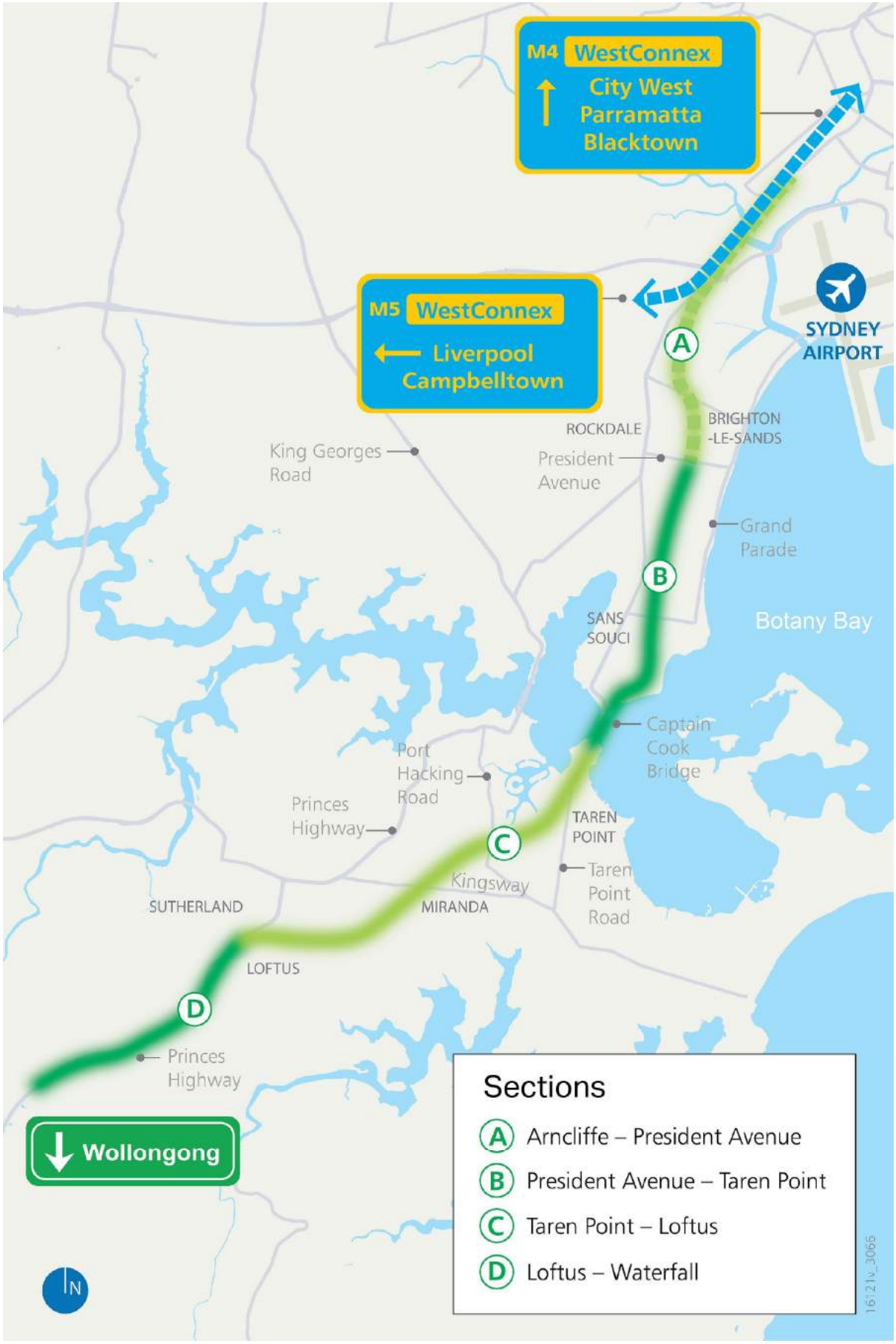

Figure 10 F6 Extension staging sections

2.4.5 Project design options

Subsequent to confirmation that Stage 1 should be delivered as the first stage of the F6 Extension, Roads and Maritime has developed the design options further and in doing so considered the following project components:

- Northern connection
- Tunnel alignment
- Southern connection.

The following criterion was taken into consideration in development and assessment of the surface connection options:

- Engineering
- Environmental
- Property
- Community
- Cost comparison
- Operating traffic performance
- Constructability.

Northern connection

The existing F6 reserved corridor extends from Campbell Road at the proposed WestConnex St Peters Interchange southwest across the Cooks River to the Kogarah Golf course and then in a southerly direction towards President Avenue, Kogarah, continuing to The Captain Cook Bridge at Sans Souci. In the north the St Peters Interchange will be connected to the New M5 project and will provide a key interchange point with Sydney's motorway network.

The New M5 will link the existing M5 South West Motorway at King Georges Road to Sydney's future motorway network. During the development of the New M5 project, integration of the future F6 reserved corridor and provision of a direct connection was included in the design. The New M5 and the associated St Peters Interchange has been specifically designed to connect with and facilitate this connection to the south. Stub tunnels in the vicinity of Arncliffe in a south-westerly direction were provided in the design, at a depth of approximately 75 metres to enable connection with the New M5. Merge and diverge caverns for a southern extension were also provided in the New M5 design.

The New M5 project identified that a tunnel connection for the F6 Extension was preferred over a surface connection at the St Peters Interchange. This decision was on the basis that a tunnel would better integrate with the planned motorway network and have reduced impacts on community and environment aspects, than if it had been designed as a surface road alignment. Recognition of the significant ecological and recreational resources that exist within the existing F6 reserved corridor between Arncliffe and Kogarah was a key factor in this consideration.

Tunnel alignment

Given the decision to locate southern facing tunnel stubs (at substantial depth) from the New M5 in the vicinity of Arncliffe, to provide a tunnel connection with the New M5 tunnels, the use of the most northern part of the existing F6 reserved corridor near Wolli Creek was precluded. In addition, consideration was given to whether the project could be feasibly constructed to the south either as slot or surface infrastructure, or one that was bored below ground. Investigations undertaken during the New M5 design development confirmed the significant challenges and adverse impacts associated with slot and surface solutions (either at-grade or on viaduct) for a southern connection.

Subsequently, further analysis on geotechnical conditions within the existing corridor identified that it was not optimal for tunnel construction. It was found that geological conditions improved west of the corridor, and that moving the tunnel alignment would reduce construction risk and the cost of the alignment. A decision was made to locate the tunnel alignment to the west of the existing F6 reserved corridor.

Southern connection

Options for the surface connection for the project were developed to provide a connection with the surface road network further south.

Interchange locations were considered to provide connection to the existing network at Bay Street and President Avenue and Princes Highway among other locations. The selected option of President Avenue was the best performing option against the criterion for a number of reasons, including:

- **Motorway gradient**: given the depth of the connection at the New M5 and the need to have uniform grade of alignment according to relevant design standards, the surface connection could not occur until after Bestic Street, Kogarah
- **Network connectivity**: the project should connect with the arterial road network associated with the existing A1, including Princes Highway and the Grand Parade. A President Avenue connection provides a connection to an arterial State road within an appropriate road environment with capacity to absorb additional traffic, providing optimal connectivity in the St George area and improving connectivity to both Princes Highway and the Grande Parade
- **Community and Environment**: community and environmental assets (including the Rockdale Wetlands and Recreation Corridor) are valued and impacts on land or property by the project is minimised, including the opportunity for amenity improvements along Grande Parade and the Bay Street cultural precinct.

Summary

On the basis of its performance relative to other corridor alignment and interchange options, the connection to New M5 at Arncliffe to an interchange at President Avenue, Kogarah, was identified as the preferred project corridor to be carried forward for further design development and assessment.

3 Consultation

Stakeholder and community consultation for the project forms an integral part of informing and scoping investigations for the environmental impact statement.

In addition to community members, key stakeholders for the project include State and Commonwealth agencies, local and regional councils, business groups and other transport and industry providers.

This chapter describes the consultation activities which have been undertaken to date for the project in addition to the communications and engagement activities that are proposed to be undertaken during the preparation of the environmental impact statement through to the construction phase of the project.

3.1 Communication strategy and objectives

A Community and Stakeholder Engagement Plan will be prepared to guide the communications and engagement activities that would be undertaken with the community and other stakeholders for the project.

Community and engagement objectives include:

- Provide information about the planning approval process and encourage community participation in this process.
- Communicate the rationale for the project, the benefits it will deliver and how it fits into the NSW Government's wider transport strategy
- Ensure the provision of timely and accurate information to all stakeholders
- Identify, understand and meet the information needs of all stakeholders
- Build and maintain community and stakeholder relationships.

3.2 Consultation activities undertaken to date

In October 2017 the NSW Government committed to the first stage of the F6 Extension from the New M5, Arncliffe to President Avenue, Kogarah (subject to business case). Community consultation activities that have been undertaken since the announcement include:

- The distribution of the 'F6 Extension and F6 Stage 1 Development' fact sheet
- Engagement with landowners and tenants of properties that would be directly impacted
- Updates to the project webpage including an interactive map to post feedback on the project
- Project email and 1800 number provided for feedback
- Community information displays at Rockdale and Kogarah shopping centres.

Specific information and feedback activities conducted to date are summarised in **Table 3-1**.

Table 3-1 Engagement activities undertaken to date

Activity	Commencement	Detail
Online community engagement map	October 2017	Over 100 comments were posted on specific topics by members of the community
Kogarah Public information display	October 2017	Six sessions held at Kogarah Town Centre Shopping Centre
Rockdale Public information display	October 2017	Three sessions held at Rockdale Plaza

Roads and Maritime will continue community consultation to receive feedback about the project from now until its completion.

3.3 Feedback received to date

Comments received from the community and stakeholders during community consultation activities that have been undertaken since the announcement generally fell within the categories of environment and heritage, public transport, parking, traffic and road safety, pedestrians and cyclists, property and access. Other issues that did not fall within these categories were also raised. The key issues raised are summarised in **Table 3-2**. Feedback has been used to assist in the identification of key and other issues considered in this scoping report.

Table 3-2 Comments raised during community consultation

Category	Comments
Environment and heritage	· Concerns were raised regarding the location and anticipated health and environmental impacts of ventilation outlets · Reassurance was sought that the parks and wetlands would be preserved · Concerns regarding the impacts to heritage-listed properties along Gibbs Street and Farr Street.
Traffic and road safety	· Support for the anticipated reduction in traffic along West Botany Street and The Grand Parade · Concerns regarding the impacts of the project on traffic and road safety included: - traffic congestion at President Avenue interchange - traffic congestion at motorway interfaces - increased traffic along President Avenue and Princes Highway, Kogarah - road safety for the local community.
Pedestrians and cyclists	· Concerns were raised regarding pedestrian and cyclist safety along Princes Highway and President Avenue, Kogarah · Suggestions were made to improve footpaths within the area and provide additional pedestrian and cycle paths, including a dedicated path south of Bestic Street.
Public Transport	· Comments around the unreliability of public transport along President Avenue, Kogarah · Requests were made for the public transport in the area to be improved.
Parking	· Concerns were raised with regard to the potential loss of street parking along President Avenue, Kogarah · Requests were made for a street parking management plan around St George's Private hospital, Kogarah.
Property and access	· Concerns were raised regarding the impacts to the Sheralee Tourist Caravan Park, private properties and property values · Questions were raised regarding compensation for settlement impacts · A request for a traffic management plan to be prepared to manage access to residential streets.

Category	Comments
Project design	· Suggestions were made to inform the design of the project including: - above ground route along existing F6 reserved corridor rather than underground - locate tunnel under existing F6 reserved corridor, rather than residential areas - links to M5 westbound and M1/Southern Cross Drive - one-way northbound along The Grand Parade - four lanes each way in the motorway tunnel - provide a right turn from Civic Avenue into President Avenue, Kogarah - provide a connection to General Holmes Drive.
Other issues	· Suggestions were made with regards to the project including: - no tolling for the entire project - provide housing development options on the existing F6 reserved corridor · Requests were made for further information in relation to the project including: - details on the design of the project - location of service buildings - road closure details - tunnel dimensions - location of the tunnel entry/exit points - location of the ventilation outlets · A comment was made requesting additional consultation for local residents · Concerns, suggestions and requests were made with regard to future stages of the F6 Extension.

3.4 Community contact points

The general project information and feedback mechanisms would continue to be available during design development and preparation of the environmental impact statement. The key community contact points are provided in **Table 3-3**.

Table 3-3 Community contact points

Activity	Detail
Community information	1800 789 297
Website	rms.nsw.gov.au/f6
Email	F6Extension@rms.nsw.gov.au

3.5 Stakeholder engagement

Liaising with relevant stakeholders will be imperative to ensure all agencies are clearly informed about the scope, potential impacts and risks of the project. This would include regular one-on-one meetings and communications, ensuring that key issues for these agencies are considered.

The government agencies to be consulted include:

- Bayside Council
- NSW Office of Environment and Heritage
- NSW Environmental Protection Authority
- The Department of Primary Industries – NSW Office of Water
- Commonwealth Department of Environment & Energy
- Commonwealth Department of Defence
- SafeWork NSW
- Greater Sydney Commission
- Fire and Rescue NSW
- Heritage Council of NSW
- Infrastructure NSW
- Sydney Water Corporation

3.5.1 Property owner engagement

Roads and Maritime have commenced engagement with landowners and tenants of properties that would be directly impacted. In October 2017 these property owners and tenants were assigned a dedicated case manager to work directly with them.

A Property Acquisition Engagement Plan has been developed to guide this engagement process and has been prepared in accordance with the property acquisition reforms introduced by the NSW Government in October 2016.

3.5.2 Consultation during the preparation of the environmental impact statement

Roads and Maritime is committed to conducting a high level of consultation and engagement activities with the community and other stakeholders throughout the development of the project. Community and other stakeholder consultation activities will be carried out throughout the development and exhibition of the environmental impact statement. A number of activities are planned during the preparation and exhibition of the environmental impact statement to collect feedback from stakeholders and to further inform the project and the management of environmental issues. Key elements of this consultation are outlined below.

Place Managers

Place Manager/s will act as the direct point of contact for the community, businesses and other stakeholders on behalf of the project. Place Manager/s will provide a vital link in maintaining close contact with local communities and stakeholders. The Place Manager/s will bring feedback on local issues to the project team.

Community consultation

The proposal will maintain the same points of contact listed in **Table 3-3** throughout the development and exhibition of the environmental impact statement and for the remainder of the planning and approval process.

Further updates on the project and engagement with the community would occur during the preparation of the EIS prior to the documentation being placed on exhibition.

Information will be sought from the community during exhibition about the potential impacts of the project (both during construction and operation) and how they could be managed, which will help inform the project development.

Government agency consultation

Roads and Maritime will hold regular meetings with the NSW Department of Planning and Environment and other government agencies as part of the planning approval process. Regular meetings would be held with other relevant government agencies to ensure key issues are addressed.

Major stakeholder consultation

Roads and Maritime engagement team will ensure Councils, major businesses, peak bodies and industry groups are proactively engaged and informed about the project. Regular briefings will be held as the project evolves to ensure stakeholders are informed and key issues are addressed.

3.6 Public Exhibition of the environmental impact statement

Public exhibition of the environmental impact statement will be for a minimum statutory period of 30 days as required by Clause 194 of the *Environmental Planning and Assessment Regulation 2000*. Advertisements would be placed in local newspapers to advise of the exhibition and provide details of where the environmental impact statement can be viewed, in addition to details on proposed community information sessions. During the exhibition period, any person may make a submission regarding the project and these submissions will be considered in the assessment of the environmental impact statement.

Consultation activities to support the exhibition of the environmental impact statement would include:

- Media releases
- Information sessions
- Community event stalls
- Doorknocks
- Newsletter letterbox drop
- Project website and online survey
- Newspaper advertising
- Static displays
- Stakeholder briefings
- Government stakeholder engagement
- Digital engagement tools

3.7 Consultation prior to and during construction

Should the project be approved, the project team would continue to consult with the community and other stakeholders during construction to ensure the community remains well informed about the project.

Roads and Maritime would lead a construction stakeholder and community engagement program which would involve;

- Development of a detailed construction stakeholder engagement plan
- Notifications for night work or work that might impact existing transport (e.g. road closures or changes to existing pedestrian routes or bus stops)
- 24 hour toll free community project information line
- Regular updates to the project website
- Regular newsletters, information brochures and fact sheets
- Regular construction updates
- Ongoing consultation with key stakeholders
- Development and implementation of a community complaints and response management system
- Media releases and regular project development advertisements in local and metropolitan papers
- Ongoing role of Place Manager/s to act as a single point of contact for the community
- Translator interpreter services.

4 Project description

4.1 Overview

Roads and Maritime proposes to construct and operate the project which would comprise a new multi-lane road link between the New M5 at Arncliffe and President Avenue at Kogarah.

Key features of the project include:

- An underground connection to the New M5 at Arncliffe
- Twin motorway tunnels between the New M5 at Arncliffe and Rockdale Bicentennial Park. Each tunnel would be around four kilometres in length
- A tunnel portal at Brighton-Le-Sands within Rockdale Bicentennial Park (within the existing F6 reserved corridor) connecting to on- and off-ramps
- A new road interchange at Brighton-Le-Sands within Rockdale Bicentennial Park and Memorial Fields (within the existing F6 reserved corridor), to provide connections to President Avenue, Kogarah
- A widened President Avenue at the location of the interchange with the project, including slip lanes to provide a connection to the project
- Mainline tunnel stubs to allow for connections to the future stages of the F6 Extension
- Ancillary infrastructure and operational facilities for signage (including electronic signage), ventilation structures and systems, operational water treatment facility, fire and safety systems, and emergency evacuation and smoke extraction infrastructure
- New service utilities and modifications to existing service utilities
- Temporary construction and ancillary facilities and temporary works to facilitate the construction of the project.

The alignment of the project would generally be within the project corridor shown on **Figure 1**.

The project may include tolling, however a decision is yet to be made on the tolling arrangements.

The anticipated design is described in **Section 4.2** to **Section 4.5**. The project design will be further developed the configuration and design of the project will be further developed to take into consideration the outcomes of further community and stakeholder engagement and environmental and technical investigations.

4.2 The motorway tunnel

The twin motorway tunnels between the New M5 and the ramps to connect to President Avenue interchange would each be around four kilometres in length. Mainline tunnel stubs would also be provided for connections to the future extension of the F6 Extension.

The final tunnel alignment would be determined as part of the design development process. The depth of the twin tunnels would be dependent on further investigations into the ground conditions between Bay Street and President Avenue, Kogarah.

The tunnels would have a posted speed limit of 80 kilometres per hour.

A tunnel portal would be located within Rockdale Bicentennial Park East (within the existing F6 reserved corridor).

4.3 President Avenue interchange

The President Avenue interchange would be located within Bicentennial Park East (within the existing F6 reserved corridor), north of President Avenue, Kogarah and adjacent to O'Neill Street, Brighton-le-Sands. The interchange would provide a link between the mainline tunnels and President Avenue, which connects to The Grand Parade to the east and the Princes Highway to the west.

The interchange would be constructed to maintain existing connectivity along the surface road network, including President Avenue and West Botany Street. President Avenue would be widened between O'Connell Street and Oakdale Avenue to accommodate the interchange.

On- and off-ramps at the President Avenue interchange would include sections of tunnel to provide connections from the mainline tunnel to President Avenue. The ramps which form the connections to and from President Avenue would be built two lanes wide.

4.4 Active transport

Cyclist and pedestrian infrastructure would be incorporated into the design of President Avenue interchange to maintain existing active transport connections, and improve connections between key centres.

4.5 Ancillary operational facilities

The project would require motorway operation facilities, including but not limited to maintenance facilities, ventilation structures and systems, fire and life safety systems, emergency evacuation and smoke extraction infrastructure, and operational water treatment facility.

In determining the size and location of the motorway operation facilities, existing land use activities, potential environmental impacts and amenity impacts on the surrounding community would be taken into account. The location of a southern ventilation outlet has not yet been determined. The location is subject to further design development and consultation, and would be located to minimise impacts on the surface.

The location and size of other ancillary operational facilities would be developed as part of determining the preferred project design and would be assessed in the environmental impact statement for the project. The exception to this is the northern ventilation outlet, which forms part of the ventilation system for the New M5 at Arncliffe, currently under construction.

4.6 Construction

Construction of the project would take up to four years and would include (but not be limited to) the following:

- Enabling and temporary works, including utilities relocation, construction power, construction water supply, site establishment, demolition works, vegetation removal, property and public transport modifications (if required)
- Construction of the road tunnels, interchange and roadside infrastructure
- Haulage of spoil generated during tunnelling and excavation activities
- Fit-out of the road tunnels and support infrastructure, including ventilation and emergency response systems
- Widening of President Avenue between O'Connell Street and Oakdale Avenue
- Potential network integration works within the vicinity of the President Avenue interchange as required
- Environmental management and pollution control facilities for the project.

Temporary works may be required during construction, such as temporary diversions for road traffic or pedestrians and cyclists near work areas, or alternative arrangements where property accesses may be temporarily disrupted.

Road headers would be used for the deeper parts of the alignment, while cut and cover construction methods would be required at shallow sections within Rockdale Bicentennial Park, in sections outside of the existing F6 reserved corridor. Other excavation activities likely to be undertaken include the creation of cross passages and caverns or shafts for other support infrastructure, as well as stub tunnels for a connection to future stages of the F6 Extension.

The project would require ancillary facilities during construction, including but not limited to: construction compounds, sedimentation basins, concrete batching plant, pre-cast yards and stockpiles. In determining the size and locations of the construction and ancillary facilities, existing land use activities, potential environmental impacts and amenity impacts on the surrounding community would be taken into account. At a minimum, construction and ancillary facilities would be required close to the portals to provide tunnelling support.

The location and size of construction and ancillary facilities would be developed as part of determining the preferred project design and would be assessed in the environmental impact statement for the project.

The project would not include some preliminary works for the purpose of the design or assessment of the project which are intended to be conducted prior to approval of the project, including:

- Surveys
- Test drilling and excavations
- Geotechnical, contamination and environmental investigations
- Site access and associated traffic management measures

Some of these preliminary works have already commenced to inform the development of the concept design for the project. There may be additional preliminary works that may be required, which would be further refined during the design process for the project, and be considered either exempt development or subject to the relevant separate environmental impact assessment requirements under the EP&A Act.

5 Key environmental issues

5.1 Overview

Key issues are those that may have high or moderate impacts (actual or perceived) and assessment is necessary to determine the level of potential impact and to develop appropriate measures to mitigate and manage the impacts.

The outcomes of the preliminary environmental investigations and feedback received from the community and stakeholders indicate the following key environmental issues for the project:

- Traffic and transport
- Air quality
- Noise and vibration
- Biodiversity.

A number of other environmental issues have also been identified. These issues are outlined in **Chapter 6** and are considered to be of lesser consequence taking into consideration the project scope, the existing environment and the implementation of standard management and safeguard measures. It is expected that these other environment issues would not likely be key issues; however the residual risk of each issue would be identified in the environmental impact statement for the project.

5.2 Traffic and transport

5.2.1 Overview

The existing road network surrounding the project is shown on **Figure 11**. The project would connect to the New M5 at Arncliffe via tunnel, and President Avenue at Kogarah.

The project would be an important link in the greater Sydney motorway road network (refer to **Figure 12**). The project would improve connections and travel times between Sydney and southern Sydney, and improve connections for residents and businesses. Redirecting traffic on the new motorway standard infrastructure would likely reduce traffic and congestion on key parallel roads, improving journey times for local and regional traffic and for public transport.

Current traffic volumes along key parallel roads have been obtained from traffic counts conducted by Roads and Maritime (Traffic Volume Viewer, 2017).

Table 5-1 Average Daily Traffic Counts (2017)

Location	Direction	Average Daily Traffic Count
Princes Highway, Rockdale	Northbound	19,081
Princes Highway, Banksia	Southbound	18,756
General Holmes Drive, Brighton-Le-Sands	Northbound	31,913
General Holmes Drive, Brighton-Le-Sands	Southbound	33,080

Public transport

The existing Princes Highway and most of the arterials within the vicinity of the project are used as bus routes. Along President Avenue, bus route 947 provides services between Kogarah and Hurstville Station. Bus routes along the Princes Highway, directly east of the project corridor, provide services to and from Rockdale Plaza, Rockdale Station and the Sydney CBD.

To the west of the project lies Arncliffe, Banksia, Rockdale and Kogarah train stations which provide services along the T4 Eastern Suburbs and Illawarra railway line. These train stations are accessed by Bestic Street, Bay Street and President Avenue from the east.

Active transport

The main cycle route within the vicinity of the project is along Grand Parade, around Muddy Creek and linking up to Marsh Street through Barton Park. There are some dedicated cycleways within Rockdale Bicentennial Park. There is also a stretch of walking track along the Rockdale Wetlands and Recreation Corridor from Sans Souci to Arncliffe, which incorporates the Scarborough Ponds Walking Trail and Rockdale Wetland Trail.

The main pedestrian paths in proximity to the proposed President Avenue interchange are along the north side of President Avenue, east and west sides of O'Neill Street, and east and west sides of West Botany Street. There is also a pedestrian path linking King Street to the east with West Botany Street to the west.

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KEY

- Indicative tunnel
- Indicative surface
- New M5
- Train station
- Bus stop
- Bus route
- Cycleway

Figure 11 Existing local traffic and transport network

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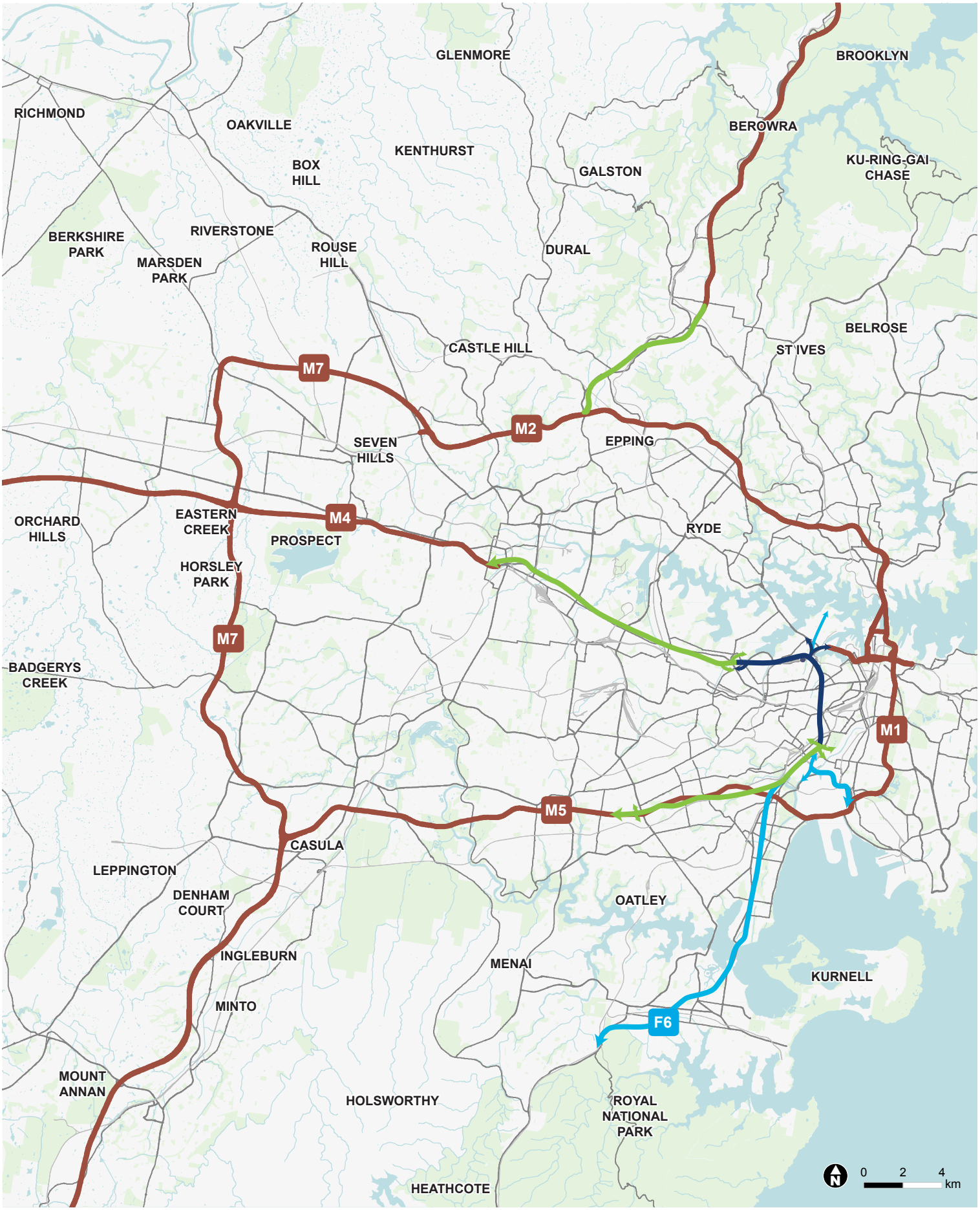


KEY

- Major Roads
- Rail
- Existing Motorway
- Under Construction
- Proposed Motorway (pending approval)
- Future Motorway (planning stage)

Figure 12 Sydney motorway network

5.2.2 Summary of issues

Construction

During construction there would be temporary traffic and transport impacts as the project would require works within existing roadways. This may include temporary or permanent closure to some local roads causing impacts to road traffic and bus routes. In particular, temporary traffic and transport impacts would occur at, and around:

- President Avenue, between O'Connell Street and Oakdale Avenue
- West Botany Street, north of French Street.

Construction of the project would require the use of heavy vehicles to deliver construction plant, equipment and materials as well as for the removal of waste, including general construction waste, office waste and spoil from tunnelling/excavation activities. The introduction of additional heavy and light vehicles may result in a temporary deterioration of intersection and traffic performance on the surrounding road network. This may also result in impacts to the functionality and travel times of surrounding bus services.

Surface construction works may also result in changes or modifications to existing property access, existing pedestrian and cyclist access, the location of bus stops and the speed limit within the road network.

Operation

The local road and arterial network currently experiences high traffic volumes and resultant poor traffic conditions. One of the desired outcomes of the project is to improve travelling conditions along these roads and the surrounding network. The operation of the project would provide an alternative route for through travel between the Sydney CBD and southern Sydney. As such, a number of traffic related benefits are anticipated including:

- Reduced heavy vehicle travel on parallel roads such as Princes Highway (north of President Avenue) and The Grande Parade
- Improved traffic flow and intersection performance
- Reduced crash rates
- Improved road safety for pedestrians, cyclists and motorists
- Improved travel times for bus services and motorists.

The project may result in an increase in traffic along President Avenue (west of the President Avenue interchange), Princes Highway (south of President Avenue) and Rocky Point Road.

The proposed President Avenue interchange would provide access to the new motorway infrastructure and requiring alterations to the surrounding road network and changes to operational traffic. This may include the introduction of new movements and altered timing of traffic lights, potential changes to traffic distribution on the road network as a result of the project, alterations to pedestrian movements at existing intersections and alterations to existing property accesses.

5.2.3 Proposed further assessments

The construction traffic and transport assessment would include (as a minimum):

- Identification and assessment of potential traffic and transport impacts on the road network, including consideration of public transport impacts, as well as pedestrian and cyclist access during construction of the project.
- Identification of potential construction traffic impacts including spoil haulage, route identification, details of the construction fleet, the nature of existing traffic, and the need to close, divert or otherwise reconfigure elements of the road network associated with construction of the project
- Identification of appropriate management and mitigation measures during construction
- Consideration of cumulative traffic and transport impacts from the construction of the project, and other projects within the same time period and/or area.

The operational traffic and transport assessment would include (as a minimum):

- Assessment of existing local and regional traffic volumes and traffic patterns against forecast volumes and potential changes to traffic patterns associated with the project
- Traffic modelling including for the opening year and 10 years from the anticipated opening date
- Direct and indirect operational traffic impacts on the local and regional road network, including consideration of freight and public transport users, and implications for pedestrians and cyclists
- A road safety analysis
- Identification of appropriate management and mitigation measures during operation.

The assessment would be prepared in accordance with *Guide to Traffic Generating Developments Version 2.2* (Roads and Traffic Authority, 2002).

5.3 Air quality

5.3.1 Overview

The *NSW State of the Environment 2012* (NSW EPA, 2012) provides a report on the status and condition of the major environmental resources in New South Wales (including the atmosphere) and examines the associated environmental trends. Air quality in Sydney is good by national and international standards. Carbon monoxide, nitrogen dioxide and sulfur dioxide concentrations are consistently well below the national standards. However, ozone and particulate matter concentrations occasionally exceed the national standards in the Sydney region, with no apparent downward trend in the concentrations of these pollutants (Advisory Committee on Tunnel Air Quality, 2014).

The air quality within the vicinity of the project corridor is considered to be typical of an urban area within the Sydney metropolitan area with variability relating to influences from several factors, including:

- Topography and meteorology (proximity to the coast, local and regional topography)
- Local and regional air emissions (proximity to local vehicle emission sources such as local arterial transport corridors, and proximity to regional emission sources including freight and transport hubs such as Sydney Airport and Port Botany).

The land use of the area predominately consists of residential properties, light commercial, open space and recreational areas, parkland and arterial/local roads.

The main contributors to air quality are emissions from high volumes of traffic on the existing road network (A1/ A36 Princes Highway, A3 King Georges Road, The Grand Parade), increased use of private vehicles and increased traffic congestion. With regard to emissions from vehicles, the key air pollutants are:

- Carbon monoxide (CO)
- Oxides of nitrogen (NOx), including nitrogen dioxide (NO_2)
- Particulate matter, including fine and ultra-fine particles (PM_{10} and $PM_{2.5}$)
- Air toxics, including benzene, toluene, xylenes, formaldehyde and polycyclic aromatic hydrocarbons which are predominately adsorbed to particulates.

These pollutants are potentially harmful to human health.

Other contributors to air quality include domestic solid fuel burning, commercial / recreational boating, lawn mowing, domestic / commercial solvent and aerosol use. Emissions from vehicles can be dependent on a number of factors including emission performance, fuel quality, flow and average speed, and the grade of the road.

The National Pollution Inventory (2015/2016 reporting year) identified the following facility air pollution sources within three kilometres of the project:

- Rockdale Resource Recovery Centre, Rockdale
- St George Private Hospital, Kogarah
- Shell, Sydney Airport, Mascot
- Sydney (Kingsford Smith) Airport, Mascot
- Qantas Sydney, Mascot
- Sydney Trains Sydenham Maintenance Centre, Sydenham.

The impact of these individual sources on local air quality within the project corridor is likely to be minor due to their separation from the project corridor. Key regional sources include the following:

- Shipping operations associated with Port Botany
- Aircraft emissions from Sydney Airport and associated take-off and approach paths
- Road vehicle emissions associated with the surrounding road network, including the existing and proposed motorways.

Given the broad extent and diffuse nature of the sources, their influence is likely to be less pronounced, whilst still forming a contribution to levels in the region of the project.

5.3.2 Summary of issues

Sensitive receivers that may be concerned with the perceived changes in air quality as a result of the construction and operation, or the location of tunnel ventilation outlets, of the project include:

- Students and staff at Brighton-Le-Sands Public School
- Users of Illinden Sports Centre
- Residents within the vicinity of President Avenue interchange
- Pedestrians and cyclists using President Avenue
- Other sensitive receivers such as schools, aged care and child care facilities in the vicinity of the project.

Construction

The construction of the project has the potential for the following air quality related impacts:

- Temporary increases in emissions associated with the use of the ancillary concrete batching plant vehicles, plant and machinery. This includes temporary ventilation systems within the tunnel during construction
- Temporary increases in dust which may occur as a result of:
  - Earthworks
  - Vegetation clearance
  - Use of the ancillary concrete batching plant
  - Construction activities
  - Stockpiling of construction materials
  - Increase in heavy vehicle movement
  - Temporary ventilation systems within the tunnel during construction.

The potential impacts of increased dust and emissions would be dependent on the scale of the activity, quantities of the material handled, and the proximity of sensitive receivers at a construction location. Any impacts would be temporary and minor in nature.

Depending on the development of this and other projects in the Sydney Region, construction works may be undertaken concurrently with the construction of other major infrastructure projects (e.g. WestConnex). As such, depending on the location of surface construction sites and haulage routes, there is potential for cumulative air quality impacts associated with vehicle emissions and dust generated from these projects.

Operation

During the operation of the project, the potential emissions to air are associated with vehicular fuel combustion. The primary air pollutants of concern are CO, NO_x and particulate matter ($PM_{2.5}$ and PM_{10}). There is also the potential for improvement in roadside air quality at locations expected to experience a decrease in traffic flow as a result of the project.

In-tunnel air quality

The length of tunnels, gradient, and mix of vehicles are the primary factors for the level of emissions from the project, as the primary source of air quality emissions is operation of vehicles. A significant factor in minimising the emissions generated from vehicles would be to maintain a free flow of traffic in the tunnel.

CO has historically been an indicator of the level of motor vehicle emissions in tunnels and has therefore been used as the basis for in-tunnel air quality criteria. Advances in vehicle technology have been effective in reducing the levels of CO emissions so that other emissions are now more relevant indicators of in-tunnel air quality. In particular these are NO_2 and particulate matter.

Consistent with other recent road tunnelling projects, it is expected that NO_2 would be the pollutant that determines the required airflow and drives the design of ventilation for in-tunnel pollution. The NSW Department of Planning and Environment issued a report that included discussion on this topic for the NorthConnex project in January 2015. Subsequently, in February 2016, the NSW Government Advisory Committee on Tunnel Air Quality (ACTAQ) released the In-Tunnel Air Quality (Nitrogen Dioxide) Policy (ACTAQ, 2016), which specifies that "*All new road tunnels over 1 kilometre in length shall be designed and operated so that the tunnel average nitrogen dioxide (NO_2) concentration is less than 0.5 ppm as a rolling 15 minute average.*"

The ACTAQ has published several technical papers since being established in 2013. These technical papers have been used to provide an overview of the existing air quality in Sydney and the policy framework relevant to a project such as this. Recommendations from the Advisory Committee would be considered further during project design development and preparation of the environmental impact statement.

Local air quality – surface roads

At a local level, air quality effects would be influenced by the emissions associated with vehicles on surface roads and in tunnels. The reduction in traffic congestion along surface roads, particularly along the Princes Highway (north of President Avenue) and The Grand Parade, has the potential to deliver air quality improvements to areas along key arterial roads. These local effects would be the subject of further investigation.

Local air quality – tunnel ventilation outlets

The project would require ventilation for the tunnel sections. Tunnel ventilation outlets represent a controlled engineering solution for the management of tunnel emissions, and have been reported to have immeasurable influences on ground level pollutant concentrations (ACTAQ, 2014). Compared to at-grade roads and viaducts, design flexibility is available with respect to the number, location, elevation and velocity of ventilation emission sources.

Well-designed ventilation facilities are very effective at dispersing tunnel emissions and would need to be designed and operated to meet both in-tunnel and local ambient air quality criteria. The tunnel ventilation design would also be optimised to avoid unnecessary capacity and minimise operational energy use, while ensuring air quality outcomes are met.

The ventilation facility currently being constructed as part of the New M5 project at Arncliffe would be used as part of the project's ventilation system which was designed to accommodate an extension to the south. This would minimise additional visual and property impacts.

The location of the southern outlet would be subject to further design development and located to minimise impacts on the surface, including avoiding sensitive environments and minimising the need for acquisition and property impacts.

Summary

The operation of the project has the potential for the following air quality impacts, and associated human health implications:

- Potential decrease in near roadside air pollutant concentrations due to reductions in traffic volumes on parallel surface roads
- Potential increase in near roadside air pollutant concentrations due to increases in traffic volumes on surface roads, or the introduction of new roads
- Potential increase in air pollutant levels near the ventilation facilities
- Potential exposure to air pollutants for motorists using long tunnels.

5.3.3 Proposed further assessments

A detailed air quality impact assessment would be prepared as part of the environmental impact statement. This assessment would identify the potential impacts of both construction and operation of the project, and would include:

- Mitigation and management measures to reduce and minimise the emission of dust and other pollutants during construction. Should a concrete batching plant be required, a quantitative assessment of particulate matter emissions would be undertaken
- An operational air quality assessment in accordance with the principles specified in the *Approved Methods for the Modelling and Assessment of Air Pollution in NSW* (NSW EPA, 2016) to predict direct pollutant emission levels (e.g. for CO, NO_2 and particulate matter), indirect emissions from significant changes in surface traffic, and to assess the potential impacts of these emissions on surrounding sensitive receivers. The operational air quality assessment is to apply modelling techniques endorsed in the guideline and relevant air quality criteria. The methodology applied to the assessment should be determined in consultation with the ACTAQ, the NSW Department of Planning and Environment and the NSW Environment Protection Authority
- The operational air quality assessment would also describe and analyse air discharged from tunnel ventilation outlets, changes in surface road traffic and in-tunnel air quality. This would include the assessment of emissions from the ventilation outlet at Arncliffe which is being constructed by the WestConnex New M5. The outlet would be fitted out and operated as part of the project. The assessment would be based on the location and design of the facilities, emissions to air, buildings and land use, and meteorological / topographical effects to determine changes in air pollution concentrations, if any, at sensitive receivers, elevated receivers and representative receiver locations across the air quality study area.
- Consideration of local dispersion conditions, existing background levels of pollutants, managed air emissions, and changes in vehicle emissions on surface roads.
- Identification of appropriate management and mitigation measures during operation
- Consideration of cumulative air quality impacts from the construction and operation of the project, and other projects within the same time period and/or area.

5.4 Noise and vibration

5.4.1 Overview

The project would be located in a noise environment that is characterised by a number of major roads and other transport infrastructure. The majority of the project would be located at a significant depth below the ground, which would inherently reduce the potential for noise and vibration impacts on surface development during construction and operation.

The main contributors to the existing noise environment are road traffic (including heavy vehicles, using the existing road network), air traffic and passenger and freight rail movements. Commercial and light industrial areas along and around Bay Street would also contribute to the local noise environment within the project corridor. The environment around the connection of the tunnel portal is adjacent to President Avenue and is dominated by road traffic noise.

A wide range of sensitive receivers are located within the project corridor, however it is only anticipated that receivers within close proximity to the surface infrastructure may be impacted including:

- Residential properties
- Brighton-Le-Sands Public School
- Rockdale Bicentennial Park

During construction, the project would result in elevated noise and vibration levels around construction sites, particularly for surface works, which would lead to exceedances of noise management levels during and outside standard construction hours. Construction noise and vibration impacts would be required to be managed using feasible and reasonable mitigation and management measures including scheduling of works, noise reduction measures for plant and equipment and provision of respite periods for sensitive receivers. Construction contractors would be required to minimise time and duration of impacts to sensitive receivers and keep them proactively informed of the likely timing and impacts of noisy and high vibration activities. Temporary noise barriers, solid hoarding and potentially acoustic enclosures could be used for construction compounds where required to minimise noise impacts to sensitive receivers.

Potential operational impacts would be associated with traffic, including heavy vehicles, travelling along new motorway infrastructure (except where in tunnel) which may previously have been recreational areas or other lower noise environments. This would change the noise environment as residents and recreational users may be impacted by elevated noise levels from the presence of traffic travelling along the new road.

5.4.2 Summary of issues

Construction

The construction of the project would likely result in the following noise and vibration issues:

- Airborne noise from surface works including at the interchange
- Airborne noise from construction ventilation systems, ancillary construction facilities and open cut sections of the project
- Ground-borne noise from blasting, tunnelling and piling
- Potential vibration impacts on buildings near to surface works, or buildings near to, or above, the tunnel alignment.
- Construction traffic noise from the use of heavy vehicles and construction equipment
- Potential vibration impacts on buildings generated by controlled blasting and rock breaking activities, which may be required depending on the geological conditions encountered
- Cumulative noise and vibration impacts where works with other major projects overlap.

It is likely that evening and night construction works would be required, with the potential for tunnelling and associated above-ground support activities (including spoil haulage) to occur 24 hours per day, seven days per week, resulting in impacts to sensitive receivers. Additional surface works at the President Avenue interchange are expected to be conducted during the evening and night-time periods for traffic safety and operational reasons as well.

Operation

The project would result in the re-distribution of traffic within the road network surrounding the project, which would change the operational noise environment of existing surface roads. The project is likely to result in localised changes in road traffic noise, including increases at the proposed President Avenue interchange, and decreases along The Grand Parade. There may also be the potential for traffic noise resulting from trucks breaking close to the tunnel portals.

Other sources of operational noise emissions may include ventilation infrastructure and other surface ancillary infrastructure.

5.4.3 Proposed further assessments

A detailed construction and operational noise and vibration impact assessment would be prepared as part of the environmental impact statement and would provide:

- Identification of potentially affected noise and vibration sensitive receivers
- Establishment of project specific construction noise management levels
- Establishment of construction vibration goals
- Identification of out of hours work required during construction
- An assessment of noise (airborne and ground-borne) and vibration impacts from the construction of the project on identified residential and other sensitive receivers. This includes the potential use of blasting as part of the excavation methodology (if required)
- An assessment of road traffic noise from the use of heavy vehicles and equipment during the construction of the project
- An assessment of noise from the operation of the project on identified residential and other sensitive receivers at the year of opening and 10 years after opening for the 'build' and 'no build/Do Nothing' scenarios
- If required, recommendations for feasible and reasonable noise and vibration mitigation measures to be implemented during construction and operation
- Identification of appropriate management and mitigation measures during construction and operation
- Consideration of cumulative noise and vibration impacts from the construction and operation of the project, and other projects within the same time period and/or area.

5.5 Biodiversity

5.5.1 Overview

Between the New M5 stub tunnels and President Avenue, the project corridor is characterised into two broad areas of ecological potential, with a comparatively lower biodiversity potential in the highly urbanised west and a higher biodiversity potential in the east. The remaining vegetation in the western zone is predominately small isolated patches of remnant and planted exotic/native vegetation in road corridors and residential properties.

The eastern zone predominately consists of land which has been historically reserved for the F6 Freeway. In being set aside, this corridor has been reasonably protected from development and consists of open space and wetlands. These areas of connecting natural and open space form part of the Rockdale Wetlands and Recreation Corridor, which provides foraging and roosting habitat for a range of migratory and non-migratory shorebirds and small bush birds (Rockdale City Council, 2014).

Wetlands include Eve Street, Marsh Street and Landing Lights wetlands which in combination form part of the only remaining migratory wading bird habitat on the western side of Botany Bay. Eve Street Wetland is listed on the Commonwealth Government's Directory of Important Wetlands in Australia. There are a number of threatened ecological communities and species within the wetland, protected under State and Commonwealth legislation.

The Kogarah golf course is located in the north of this section of the project corridor, part of which is proposed to be occupied by the New M5 motorway operations complex. Parts of the golf course and the wetlands to the south (Marsh Street and Eve Street Wetlands) form key habitat areas for the Green and Golden Bell Frog (Commonwealth listed species). New artificial Green and Golden Bell Frog habitat is due to be constructed adjacent to the Marsh Street Wetland as part of biodiversity offset package for the New M5.

With the exception of Groundwater dependent ecosystems (GDE), impacts to biodiversity are only anticipated to occur at the northern and southern ends of the project, where surface works or construction sites are anticipated. This is particularly the case within Rockdale Bicentennial Park (refer to **Figure 13**). **Table 5-2** provides an overview of biodiversity within the project corridor and the likely impacts as a result of the project. Impacts to biodiversity are not anticipated to occur where the project is underground.

Figure 14 and **Figure 15** show locations of recorded sightings of threatened species and migratory birds within the vicinity of the project corridor. **Attachment B** provides a list of the threatened flora and fauna listed under the *Biodiversity Conservation Act 2016* (BC Act) or *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) mapped within 10 kilometres of the project corridor.

KEY

Vegetation Communities (ELA 2016)

- Coastal Freshwater Swamp Forest (EEC)
- Estuarine Reedland
- Planted
- Urban Native and Exotic Cover
- Weeds and Exotics

Figure 13 Rockdale Bicentennial Park vegetation communities
(Source: EcoLogical Australia, 2016)

Table 5-2 Overview of biodiversity within the project corridor

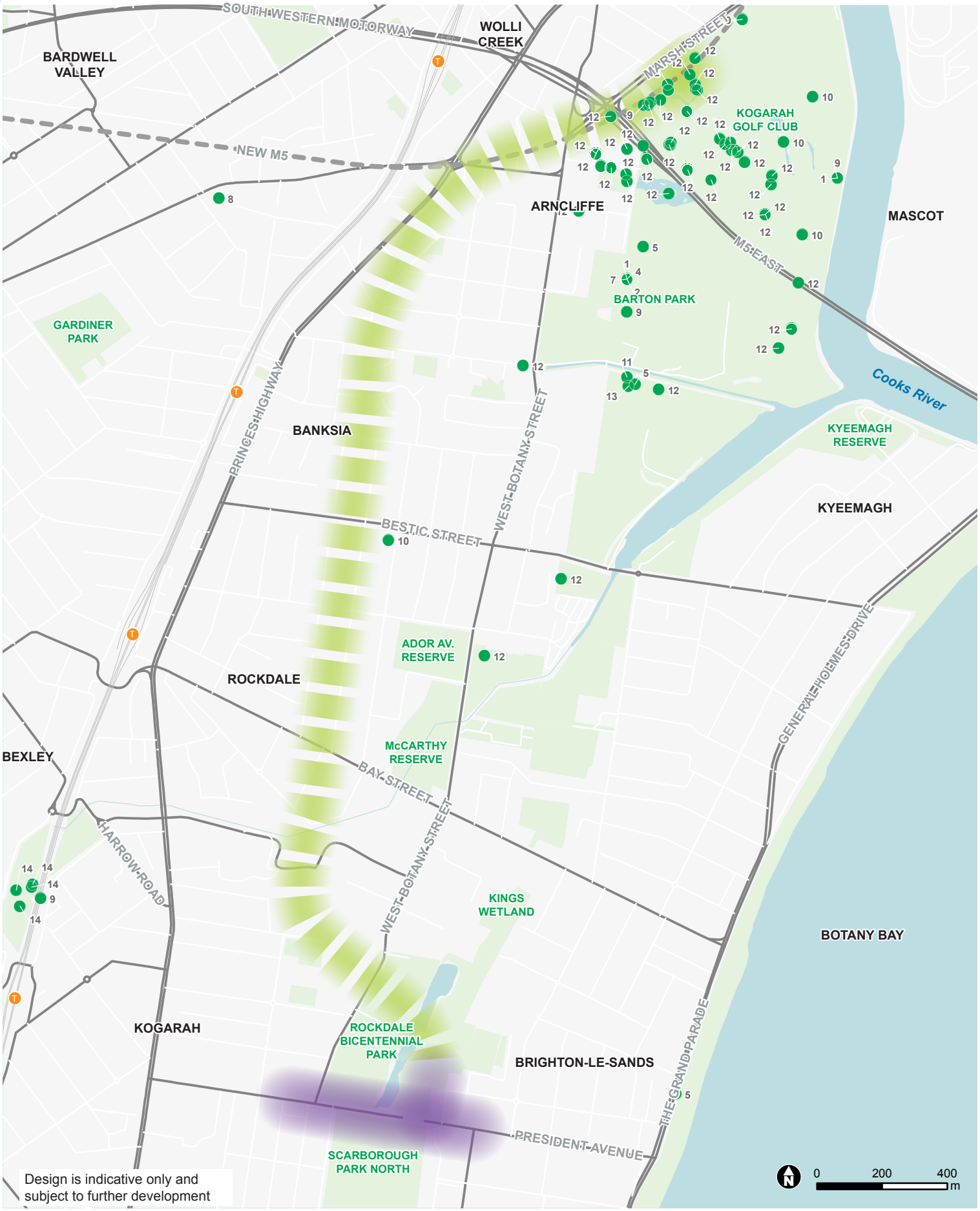
Category	Description
Coastal Management SEPP	The Coastal Management State Environmental Planning Policy (Coastal Management SEPP) establishes a new, strategic land use planning framework for coastal management. It supports implementation of the management objectives set out in the *Coastal Management Act 2016*. The Coastal Management SEPP identifies the Bicentennial Park Wetlands within Rockdale Bicentennial Park as coastal wetlands.
Threatened fauna	Threatened species listed under the EBPC Act (likely or with the potential to be present): - *Litoria aurea* (Green and Golden Bell Frog) – known at the Kogarah Golf Course
Threatened ecological communities	One threatened ecological community under the BC Act would be impacted as part of the project - Coastal Freshwater Swamp Forest within Rockdale Bicentennial Park.
Other vegetation communities	The project corridor has been predominately mapped as urban native and exotic cover, as part of the Native Vegetation of the Sydney Metropolitan Area dataset (NSW Office of Environment and Heritage, 2013a).
Aquatic habitat	Construction within Rockdale Bicentennial Park would require temporary management and mitigation measures to minimise impacts to Bicentennial Park Wetlands
Groundwater dependant ecosystems	GDEs are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater, such as wetlands and vegetation on coastal sand dunes. During construction, cut and cover tunnelling is likely to impact on GDEs if they are present within Rockdale Bicentennial Park.

5.5.2 Summary of issues

Construction and operation

The project has the potential to impact on biodiversity, including threatened and protected species, populations and communities. Impacts on biodiversity, including aquatic biodiversity (direct and indirect), would be mostly associated with areas of surface disturbance. However, indirect impacts could potentially occur as a result of surface water discharges, and groundwater drawdown could have impacts on GDEs (if further investigation identifies their presence within the project corridor). The mechanisms by which these impacts could occur include:

- Vegetation clearance at the location of the President Avenue interchange, President Avenue widening and ancillary facilities resulting in habitat loss and edge effects
- Altered flows into Kings Wetland as a result of the construction of the President Avenue interchange
- Potential loss of connectivity between habitat areas (wildlife corridors), resulting in habitat fragmentation
- Noise impacts resulting in disturbance to threatened bird and bat species
- Mortality of individuals during both the construction and operation of the project
- Introduction and / or spread of noxious weeds and other invasive species
- Impacts to groundwater levels due to changes in groundwater inflows during construction and operation
- Mobilisation of sediments into waterways and potential pollution from materials used in the process of construction and operation, resulting in downstream impacts to aquatic species and communities.



KEY

- Indicative tunnel
- Indicative surface
- Threatened species
- New M5

1: Pied Oystercatcher
2: Sooty Oystercatcher
3: Lesser Sand-plover
4: Greater Sand-plover
5: Curlew Sandpiper
6: Great Knot
7: Australasian Bittern
8: Powerful Owl
9: Grey-headed Flying-fox
10: Eastern Bentwing-bat
11: Wallum Froglet
12: Green and Golden Bell Frog
13: Magenta Lilly Pilly
14: Sunshine Wattle

Figure 14 Threatened species recorded within the vicinity of the project corridor
(Source: BioNet Atlas (OEH, 2017)

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KEY

- Indicative tunnel
- Indicative surface
- Migratory birds
- New M5

Figure 15 Migratory species recorded within the vicinity of the project corridor
(Source: BioNet Atlas (OEH, 2017)

5.5.3 Proposed further assessments

The following recommendations are made for consideration during the environmental assessment phase:

- An assessment of the impacts on biodiversity, including impacts of the project on threatened species populations and ecological communities
- An assessment of impacts of the project on fauna habitat, including native vegetation loss, habitat fragmentation, wildlife corridors, loss of ecological connectivity and weed infestation
- Assessment of matters of national environmental significance under the EPBC Act and preparation of a referral, if required, in accordance with the requirements of the EPBC Act
- Identification and management of key threatening processes associated with the construction and operation of the project
- Recommended safeguards and management measures to minimise the impacts of the project on flora and fauna, in particular, threatened species, populations and communities and critical habitat.
- Consideration of cumulative biodiversity impacts from the construction and operation of the project, and other projects within the same time period and/or area.

Throughout the environmental assessment process, opportunities to avoid, minimise and / or offset impacts to areas of ecological value would be investigated, where reasonable.

A biodiversity assessment would be prepared as part of the environmental impact statement for the project following the new *Biodiversity Assessment Method* in accordance with the BC Act, the *Fisheries NSW policy and guideline for fish habitat conservation and management* (Update 2013) (Department of Primary Industries, 2013), the *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (NSW Office of Water, 2012a).

6 Other environmental issues

6.1 Overview

Other environmental issues listed below are considered to be of lesser consequence taking into account the scope of the project, the existing environment and the implementation of standard and best practice management and mitigation measures. It is considered unlikely that these would be key issues for the project; however, further assessment would be undertaken as part of a future environmental impact assessment for the project. Environmental management and safeguard measures required to minimise and mitigate impacts would be documented as part of the environmental impact statement.

6.2 Human health

6.2.1 Overview

The health of the community within the study area is influenced by a range of interacting factors including age, socio-economic status, social capital, behaviours, beliefs and lifestyle, life experiences, country of origin, genetic predisposition and access to health and social care.

The population of the study area is largely located within the South Eastern Sydney Local Health District. *Our Community, Our Services… A Snapshot* (NSW Health, 2012) presents an overview of the health of the residents of South Eastern Sydney Local Health District and the services the Local Health District provides. Within this district, the key health trends are:

- Overweight and obesity rates are increasing, which is prime driver for the escalating rate of hospitalisations for diabetes among residents
- The increasing prevalence of diabetes is driving increases in people requiring dialysis for chronic kidney disease
- An estimated 22,000 residents are severely impaired by mental illness during any 12 month period, with a further 37,000 moderately impaired
- Risky drinking and related hospitalisations are much higher among residents than the NSW average
- Hospitalisation rates due to falls are much higher than the NSW average among residents
- Incidences of respiratory diseases, including bronchitis, emphysema and pneumonia, have been declining since late 2000's
- The Kogarah LGA in particular suffers higher incidences of respiratory cancer than the NSW average

Based on current trends, diabetes, followed by falls, are expected to have the greatest future impacts on the South Eastern Sydney Local Health District health system.

6.2.2 Summary of issues

Construction

There is the potential for the construction and operation of the project to adversely impact the health of the residents within the vicinity of the project corridor. Potential impacts to human health during construction and mitigation measures for these impacts are listed in **Table 6-1**.

Table 6-1 Potential human health impacts during construction

Potential impact	Management and safeguard measures
Exposure to increased noise levels from worksites, surface work and construction vehicles	The management and safeguard measures would be identified in the noise and vibration assessment (refer to **Section 5.4)**
Increases in dust which may occur as a result of earthworks, vegetation clearance, use of the concrete batching plant, general construction and stockpiling activities	The management and safeguard measures would be identified in the air quality assessment (refer to **Section 5.3)**
Increases in air emissions from construction traffic and machinery at surface sites	The management and safeguard measures would be identified in the air quality assessment (refer to **Section 5.3)**
Environmental and human health risks associated with the accidental release of hazardous materials due to improper handling or storage, or in the event of a traffic or vessel accident resulting in the release of hazardous material	Management and safeguard measures are identified in **Section 6.13.**
Exposure to contaminants arising from disturbance of unexpected contaminated materials	Management and safeguard measures are identified in **Section 6.4.**
Temporary loss of recreational areas as a result of establishing and operating worksites	The management and safeguard measures would be identified in the socio-economic assessment (refer to **Section 6.3)**
Work health and safety hazards to construction workers, road users or the general public that may arise due to a traffic incident, tunnel collapse, flooding or inundation during construction, or extreme weather during harbour-based work	Management and safeguard measures are identified in **Section 6.13** and **Section 6.14.**
Changed traffic and pedestrian access resulting in unsafe conditions or potentially affecting emergency services access	The management and safeguard measures would be identified in the traffic and transport assessment (refer to **Section 5.2)**
Rupture or interference with underground services during construction resulting in injury to workers or the public	Management and safeguard measures are identified in **Section 6.13.**
Indirect beneficial and adverse health effects arising from changes to access to workplaces, recreational areas (open space) and amenities	The management and safeguard measures would be identified in the traffic and transport assessment (refer to **Section 5.2)**

Operation

The project would pass through or under areas of medium to high density residential, commercial and light and heavy industrial land uses. Occupants of residential dwellings are likely to be the main receivers of changes in air quality or noise and vibration that may arise from the project. There are also a number of sensitive receivers in the vicinity of the project corridor that are likely to be more sensitive to changes in the environment and potential health impacts. This includes children, the elderly or those with existing health conditions. Sensitive receptor locations include schools, childcare facilities and health facilities.

Potential impacts to human health and mitigation measures for these impacts during operation are listed in **Table 6-2**.

Table 6-2 Potential human health impacts during operation

Potential impact	Mitigation measure
Changes in the urban environment also have the potential to result in impacts to health, primarily due to increased levels of stress and anxiety associated with rapid changes in the community.	The management and safeguard measures would be identified in the socio-economic assessment (refer to **Section 6.3)**
Beneficial or adverse health effects from decreases or increases in noise exposure during operation	The management and safeguard measures would be identified in the noise and vibration assessment (refer to **Section 5.4)**
Beneficial or adverse health effects from decreases or increases in air pollutants during operation	The management and safeguard measures would be identified in the air quality assessment (refer to **Section 5.3)**
Changes in access and amenity from changes to the local road network due to increased traffic volumes and/or road closures or access restrictions	The management and safeguard measures would be identified in the traffic and transport assessment (refer to **Section 5.2)**
Environmental and human health risks associated with traffic incidents.	The management and safeguard measures would be identified in the traffic and transport assessment (refer to **Section 5.2)**
Indirect beneficial and adverse health impacts arising from changed access to workplaces, recreational areas or amenities.	The management and safeguard measures would be identified in the traffic and transport assessment (refer to **Section 5.2)**

The human health risk assessments for NorthConnex and the WestConnex projects have shown that motorway tunnels typically result in an overall reduction in health risks by removing traffic noise and air emissions sources from surface roads

6.2.3 Proposed further assessments

A human health risk assessment is to be undertaken to assess the potential human health implications of in-tunnel air quality as well as the implications of changes in air quality external to the project as a result of the project. This would be undertaken in consultation with NSW Health and be based on the results of the air quality modelling for the project in accordance with the following guidelines:

- *Environmental Health Risk Assessment, Guidelines for assessing human health risks from environmental hazards* (enHealth, 2012)
- *Health Impact Assessment: A practical guide* (NSW Health, 2007).

Other potential human health impacts listed in **Table 6-1** and **Table 6-2** would be addressed in the relevant assessment or listed section of this report.

6.3 Social and economic

6.3.1 Overview

The proposal is located in the former Rockdale LGA and current Bayside LGA (as of 2016) and runs through or adjacent to seven suburbs, including Wolli Creek, Arncliffe, Kyeemagh, Rockdale, Kogarah, Brighton Le-Sands and Monterey. Key population statistics of the former Rockdale LGA are summarised in **Table 6-3**.

Table 6-3 Key population statistics (Australian Bureau of Statistics, 2012 and 2017)

Statistic	Description
Population*	109,404
Median age*	35
Main occupations	Professionals, Clerical and Administrative Workers and Technicians and Trades Workers
Average motor vehicles per dwelling*	1.5
Total in labour force	47,776
Main mode of travel to work	Car (as driver or passenger) (55.3%) or Train (18.2%)

*Statistics from the 2016 Census data. All other data is from the 2011 Census data.

Social

Between the New M5 stub tunnels and President Avenue, the project corridor is characterised into two broad zones split roughly by West Botany Street.

The eastern zone predominately consists of land which is reserved for the existing F6 reserved corridor. This area contains sensitive and other recreational land uses, including the Kogarah Golf Course, a corridor of natural and open space areas which forms part of the Rockdale Wetlands and Recreation Corridor, the Sheralee Tourist Park, Rockdale Women's Sports fields and netball courts. Wetlands include the Eve Street Wetlands, the Marsh Street Wetlands, Spring Creek Wetlands, and Landing Lights Wetlands.

The western zone contains predominately residential land uses, but also contains Rockdale Park, Ador Avenue Reserve, MacCarthy Reserve, and the Moorefield Bowling and Sports Club.

Sensitive land uses within the project corridor are provided in **Table 6-4** and shown on **Figure 16**.

Economic

Employment within the vicinity of the project corridor is predominately along the Princes Highway corridor, between Arncliffe and Kogarah. To the east of the project corridor, along The Grand Parade, are businesses centred on hospitality and tourism. To the north west of the proposed President Avenue interchange lies a light industrial area and Rockdale Plaza. Sydney Airport is the main source of employment within the vicinity of the project corridor which facilitates around 300,000 jobs contributes the equivalent of 6 per cent of the NSW economy (SACL, 2014).

A key objective of the project, amongst other things, is to support employment growth and productivity by improving connectivity.

KEY

- Major Roads
- Rail
- Train Station
- New M5
- Indicative tunnel
- Indicative surface

Figure 16 Sensitive land uses within the project corridor

Table 6-4 Sensitive land uses within the project corridor

Sensitive land use name
Public recreation / open space
Marsh Street Wetland, Marsh Street, Arncliffe*
Rockdale Bicentennial Park, West Botany Street and President Avenue, Rockdale
Scarborough Park North, Barton Street, Rockdale
Memorial Fields, Brighton-Le-Sands
Illinden Sports Centre , West Botany Street, Kogarah
Education
Arncliffe Public School, Princes Highway, Arncliffe*
Child Care
Busy Bee Long Day Child Care Centre, Marinea Street, Arncliffe*
Private recreation
Kogarah Golf Course, Marsh Street, Arncliffe
Community facilities
Sunnyhaven disability services and support organisation, Beach Street, Kogarah*
Rockdale Tennis Club, Chapel Street, Rockdale*

* The project would be in tunnel at this location, therefore impacts at surface to these facilities are not anticipated.

Rockdale Bicentennial Park

Bicentennial Park is a recreational area in Rockdale, bounded by West Botany Street to the west, President Avenue to the south, a residential area and Brighton-Le-Sands Public School to the east, and industrial land and King Street Wetland to the north.

The park features a bike track, athletics facilities and soccer and rugby league grounds. The park is divided into three sections known as Bicentennial Park North, Bicentennial Park South and Bicentennial Park East. Two ponds are linked by a creek to more wetlands in Scarborough Park, to the south. A footbridge over the ponds links Bicentennial Park East to the rest of the recreational area.

Rockdale Bicentennial Park is shown on **Figure 17**.

The project corridor passes through Rockdale Bicentennial Park and would result in temporary impacts during construction within the western portion of Bicentennial Park (north of the Illinden Sports Centre) and permanent impacts within Bicentennial Park East.

KEY

- Existing cycleway
- Public recreation (RE1)
- Infrastructure zoned land (SP2)

Figure 17 Rockdale Bicentennial Park

6.3.2 Summary of issues

Construction

- Temporary loss of community use of parts of Rockdale Bicentennial Park due to cut and cover construction
- Impacts associated with property acquisition, including uncertainty for residents and business owners about the property acquisition process and potential need to relocate
- Disruption to access to private properties, businesses and community facilities
- Loss of parking along President Avenue and potentially West Botany Street
- Some increased trade for local business during construction from the construction workforce
- Temporary changes to access and potential for traffic delays and disruptions near to construction work, including for motorists, public transport users, pedestrians and cyclists, commercial and freight transport operators, and emergency services
- Impacts on amenity for local residents, businesses and users of community facilities (including schools) located close to the construction compounds and proposed construction work, as a result of increased dust, noise and traffic from construction activities.
- Temporary disruption to pedestrian and cycle access near construction work, including potential changes along the President Avenue and within Rockdale Bicentennial Park
- Potential impacts on road safety for motorists, cyclists and pedestrians near to construction work and construction compounds, particularly at interchange locations.

Operation

- Permanent loss of sports fields within Bicentennial Park East
- Impacts as a result of changes in traffic, access, parking and amenity along President Avenue
- Improved accessibility for businesses that rely on the Sydney motorway network
- Reduced through traffic along the Princes Highway (north of President Avenue) and The Grand Parade.

6.3.3 Proposed further assessments

A socio-economic assessment would be prepared to provide (as a minimum):

- A description of the social and economic profile for the communities and businesses within a wider study area, surrounding the project
- Identification of any community facilities, including schools, that may be affected during construction or operation of the project within a wider study area
- An assessment of the potential positive and negative impacts of the project on the residents and users of community facilities during construction and operation within a wider study area
- Identification of appropriate management and mitigation measures during construction and operation
- Consideration of cumulative social and economic impacts from the construction and operation of the project, and other projects within the same time period and/or area.

The socio-economic assessment would be informed by the results of other specialist studies including property and land use, noise and vibration, air quality and traffic and transport which will be key potential socio-economic impacts.

The assessment would consider the *Environmental Planning and Impact Assessment Practice Note – Socio-Economic Impact Assessment* (Roads and Maritime, 2013a).

6.3.4 Management and safeguard measures

Property acquisition

All acquisitions would be under the terms of the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW) and in accordance with the *Land Acquisition Information Guide* (Roads and Maritime 2014).

Home owners would be supported to obtain alternate independent property valuations in accordance with the Land Acquisition Information Guide.

Access and connectivity

- A community involvement plan would be implemented to provide timely, regular and transparent information about changes to access and traffic conditions, details of future work programs and general construction progress throughout the construction phase of the project. Information would be provided in a variety of ways including letter box drops, media releases, internet site, signage and 24 hour project information line. Local residents, business owners and bus passengers would be notified of traffic management procedures. Ongoing consultation with communities would provide information on planned construction activities, changes to property access, and changes to any bus stop arrangements
- Bus stop, pedestrian and cycle way changes would be advertised locally, including to local social infrastructure providers
- Appropriate signage would be applied to ensure motorists understand how to access local businesses adjacent to construction works.

Amenity - Noise and vibration

Implement noise treatments at properties in advance of construction works. The potential for at property noise treatments would be investigated and implemented during the pre-construction phase for all properties likely to be significantly impacted by construction noise to reduce the impacts as much as possible.

Amenity – Visual

The design of the project would be in keeping with urban design principles for the project and the Roads and Maritime guideline *Beyond the Pavement: Urban Design Policy Procedures and Design Principles* (Roads and Maritime, 2014). A landscape plan would be prepared and implemented in consultation with the community to ensure the management approach contributes to sustaining community cohesion and identity throughout the construction period.

Business impacts

Businesses impacted by the project would be consulted with to ensure key issues are addressed such as access arrangements, traffic conditions, parking and local supplier opportunities.

A 24 hour project information line and website would be maintained to enable business owners and/or operators to receive prompt responses to their concerns, access information and view assistance measures in place during construction related work.

Social infrastructure

Consultation would continue with all key social infrastructure providers to assist them and their clients in planning for and adapting to the changes expected during the construction period.

Notification of any traffic and access changes during construction periods would be provided to emergency services well in advance of the changes occurring.

6.4 Flooding and drainage

6.4.1 Overview

The project would predominately be located within the Cooks River catchment, with the surface works near President Avenue within the Scarborough Ponds catchment, which flow directly into Botany Bay. Key watercourses within the vicinity of the project corridor are shown on **Figure 18**.

Flooding

Flood risk areas are associated with areas immediately surrounding waterways, areas along the coastal zone and other low lying areas. The areas along the project corridor are generally low lying, including the presence of wetland areas.

Increased impervious surfaces and/or changes to the total catchment area of existing drainage infrastructure due to project works may lead to potential localised flooding. Considerable increases to runoff at these locations could potentially require upgrades to existing drainage infrastructure, and may require additional mitigation measures (such as stormwater detention basins and the like).

Potential obstruction to flood flows as a result of new infrastructure or a reduction in flood plain areas, could have an impact on upstream or downstream flooding behaviour or on nearby existing developments.

Drainage

Land drainage is generally in a west to east direction draining across the project corridor to Muddy Creek, the lower Cooks River and Botany Bay. There are four wetlands in the north of this area, namely Marsh Street Wetlands, Eve Street Wetlands, Spring Street Wetlands and Landing Lights Wetlands.

Muddy Creek traverses the project corridor in a north-easterly direction draining stormwater run-off from the suburbs of Carlton, Kogarah, Rockdale, Banksia, Brighton-Le-Sands and Kyeemagh. It consists predominately of a brick and concrete-lined channel owned by Sydney Water. Its sub-catchment is around 5.7 square kilometres and mainly takes runoff from residential areas, with small pockets of commercial areas, parklands and a Chinese market garden.

Kings Wetland and the Rockdale Wetlands, within Rockdale Bicentennial Park, drain in a southerly direction to the Scarborough ponds within the central section of the Rockdale Wetlands and Recreation Corridor.

6.4.2 Summary of issues

Construction

Construction of the project has the potential to result in the following flooding impacts:

- Changes to local overland flows and existing minor drainage paths through the disruption of existing flow mechanisms, both of constructed drainage systems or those of overland flow paths
- Changes to flooding regimes from construction work and/or from the location of temporary construction infrastructure.

Operation

Operation of the project has the potential to result in the following flooding impacts:

- Increased impervious surfaces and/or changes to the total catchment area of existing drainage infrastructure due to surface work and the interchange. Should the capacity of the drainage system not be adequate this could lead to localised flooding. Increases to runoff at these locations could potentially require upgrades to existing drainage infrastructure, and may require additional mitigation measures

- Potential obstruction to flood flows as a result of new infrastructure or a reduction in flood plain area, which could likely have an impact on upstream or downstream flooding behaviour or on nearby existing developments.

6.4.3 Proposed further assessments

The environmental impact statement for the project would include an assessment of the flooding and drainage impacts including:

- Potential flooding impacts during construction and operation of the project. The assessment would consider the 100 year Average Recurrence Interval event, the Probable Maximum Flood and the impacts of higher intensity and more frequent storm events as a result of climate change (refer to **Section 6.14**)
- Operational drainage infrastructure required to convey stormwater flows
- Required alterations to existing road drainage infrastructure in the vicinity of surface work at President Avenue interchange
- Required connections to third party stormwater systems for operational surface ancillary facilities
- Identification of appropriate management and mitigation measures during construction and operation
- Consideration of cumulative flooding and drainage impacts from the construction and operation of the project, and other projects within the same time period and/or area.

6.4.4 Management and safeguard measures

Environmental management and safeguard measures relating to flooding and drainage for the construction and operation of the project would include:

- A Flood Mitigation Strategy will be prepared by a suitably qualified and experienced person in consultation with directly affected landowners and relevant public authorities
- Measures developed to manage potential flood impacts, as identified in the Flood Mitigation Strategy, will be incorporated into the design of temporary and permanent project components and construction and operational management systems as relevant
- Hydrologic and hydraulic assessments will be carried out for all temporary project components (including ancillary facilities) and permanent design features that have the potential to affect flood levels in the vicinity of the project
- The southern tunnel portal will be designed so that it is located above the peak level of the Probable Maximum Flood or the 100 year Average Recurrence Interval event plus 0.50 metres, whichever is greater
- Further hydrological and hydraulic modelling based on the detailed design will be undertaken to determine the ability of the receiving drainage systems to effectively convey drainage discharges from the project once operational.

Figure 18 Wetlands and major watercourses within the vicinity of the project corridor

6.5 Groundwater

6.5.1 Overview

Groundwater is present within the underlying Hawkesbury Sandstone. There are a substantial number of groundwater bores in close proximity to the project corridor according to a search of the Bureau of Meteorology Australian Groundwater Explorer database in September 2017. Of the 63 bores located within around 200 metres of the project corridor, the known purposes of some boreholes are:

- 35 for water supply for household needs (e.g. washing, toilet)
- 15 for community water supply
- Two for water supply for irrigated agriculture
- Two for water supply for recreational purposes.

The project corridor is located within land under regulation by the *Greater Metropolitan Region Groundwater Sources Water Sharing Plan*. The project corridor is also located across the Sydney Basin – Central and Botany Sand Beds groundwater management areas, a porous rock aquifer and an alluvial/coastal sand bed aquifer, respectively.

The Botany Sand Beds aquifer is located northeast of the project corridor. The aquifer is a large volume of underground water present in the sandy ground to the north of Botany Bay. The aquifer is highly vulnerable to contamination due to the permeability of the sands and the generally shallow water table. There is an embargo on the domestic use of groundwater in this area due to historic contamination.

6.5.2 Summary of issues

Potential groundwater impacts related to the project could include:

Construction and operation

- Groundwater drawdown due to construction activities and temporary dewatering:
  - Lowering of the water table and impacts on surface water bodies and groundwater dependent ecosystems
  - Lowering of the water table causing potential subsidence
  - Lowering of the water table and impacts on groundwater users. Hundreds of domestic groundwater extraction bores are located within and down-gradient of the project. These bores extract water primarily for irrigation purposes
  - Lowering of the water table causing oxidation of potential acid sulfate soils. Acid sulfate soils have been mapped within the project area
  - Increased salt water intrusion into the alluvium and Hawkesbury Sandstone hydrostratigraphic units (HSUs) as a result of long term groundwater drawdown resulting from groundwater dewatering activities.
- Extraction and discharge, and interception and discharge, of potentially contaminated groundwater
- Pollution of groundwater resulting from interception and discharge of groundwater
- Influencing or creating preferential pathways for the migration of existing dissolved or free phase groundwater contamination.

6.5.3 Proposed further assessments

As part of the design process and environmental impact statement, geotechnical, surface water, groundwater, and preliminary contamination investigations would be conducted. These investigations would identify the ground conditions for tunnelling, including further understanding of the hydrogeological conditions and other areas across the project corridor likely to experience increased rates of ingress (such as at the President Avenue interchange).

The results of these investigations would be used to undertake a groundwater impact assessment, which would consider local and regional hydrology impacts along the length of the project, and would include:

- A review of historical data held for local groundwater levels and quality, with consideration of supplementary data collected specifically for the project, or other nearby projects such as components of the WestConnex
- Estimates of groundwater inflow and the extent of drawdown that would occur, including cumulative impacts from construction of the New M5
- Consideration of the *Greater Metropolitan Region Groundwater Sources Water Sharing Plan and the NSW Aquifer Interference Policy* (NSW Office of Water, 2012b)
- Characterisation of the water quality of groundwater inflows along the tunnel to inform treatment requirements for potential discharge to surface water
- Characterisation of potential mobilisation of saline groundwater, contaminated groundwater and exposure of acid sulfate soils, and the associated impacts
- Impacts to existing groundwater users, surface water features and groundwater dependent ecosystems
- Identification of appropriate management and mitigation measures during construction and operation
- Consideration of cumulative groundwater impacts from the construction and operation of the project, and other projects within the same time period and/or area.

6.5.4 Management and safeguard measures

During detailed design of the project, Roads and Maritime would seek to minimise impacts to groundwater for construction and operation. Specific management and mitigation measures would include:

- Groundwater inflows within the tunnels will be minimised by designing the final tunnel alignment to minimise intersections with known palaeochannels and alluvium present in the project footprint
- Appropriate waterproofing measures will be identified and included in the detailed design to permanently reduce the inflow into the tunnels to below one litre per second per kilometre for any kilometre length of the tunnel
- Appropriate measures will be investigated and implemented at dive structures and shafts and for cut-and-cover sections of the tunnel to minimise groundwater inflow
- A detailed groundwater model will be developed by the construction contractor. The model will be used to predict groundwater inflow rates and volumes within the tunnels and groundwater levels (including drawdown) in adjacent areas during construction and operation of the project
- A groundwater monitoring program will be prepared and implemented to monitor groundwater inflows in the tunnels and groundwater levels as well as groundwater quality and inflows during construction.
- In accordance with the *Aquifer Interference Policy*, measures will be taken to ‘make good’ the impact on an impacted water supply bore by restoring the water supply to pre-development levels.

6.6 Soil and water quality

6.6.1 Overview

Topography

Lands within the vicinity of the project corridor are relatively flat and low lying with gentle undulating hills ranging from around two metres Australian Height Datum (AHD) to around 16 metres AHD. Areas with a greater elevation, up to around 36 metres AHD are located inland adjacent to the A1 Princes Highway.

Soils

Soils within the project corridor are identified from *Soil Landscapes of the Sydney 1:100,000 Sheet* (Chapman, G.A and Murphy, C.L., 1989). Lands within the vicinity of the project corridor contain mainly Warriewood, Newport, Tuggerah soil landscapes and patches of disturbed terrain. The area of mapped disturbed terrain includes:

- Kogarah Golf Course and Barton Park in Arncliffe and Banksia.
- The industrial area south of Bay Street and Rockdale Bicentennial Park

Disturbed terrain consists of land that has been reclaimed or filled with soil, sediment or anthropogenic waste materials that may be contaminated.

Geology

The geology along the project corridor is described in the *Geology of the Sydney 1:100,000 Sheet 9130* (NSW Department of Mineral Resources, 1983). From the New M5 stubs to around West Botany Street, the underlying geology consists of Hawkesbury sandstone. East of West Botany Street, the coastal geology consists of a mixture of peat, sandy peat, and mud; coarse quartz sand with varying amounts of shell fragments; and medium to fine grained marine sand with podsols.

Contamination

There are a number of current and former land uses within the vicinity of the project corridor which may have resulted in contamination. These include industry, rail (including maintenance), and service stations.

There are five known contaminated sites within 500 metres of the project corridor listed on the Environment Protection Authority's Contaminated Land record (NSW EPA, 2017):

- Kogarah Caltex Service Station, located adjacent to the project corridor at 29 President Avenue, Kogarah – regulation under the *Contaminated Land Management Act 1997* (CLM Act) not required
- Former Ausgrid Substation, located around 290 metres northeast of the project corridor at 13 Gertrude Street, Wolli Creek – regulation under CLM Act not required
- 7-Eleven Arncliffe, located around 330 metres northeast of the project corridor at 28 Princes Highway, Arncliffe – regulation under CLM Act not required
- 7 Eleven (former Mobil) Service Station, located around 410 metres west of the project corridor at 293 West Botany Street, Rockdale – regulation under CLM Act not required
- Kogarah 7-Eleven Service Station, located around 450 metres east of the project corridor at 736 Princes Highway, Kogarah – regulation under CLM Act not required

In addition to the above-mentioned contaminated sites, the project corridor would be located within an area of former fill, within Rockdale Bicentennial Park.

Acid sulfate soils

Acid sulfate soils and potential acid sulfate soils are naturally occurring soils containing iron sulfides which, on exposure to air, oxidise and create sulfuric acid. This increase in acidity can result in the mobilisation of aluminium, iron and manganese from the soils. Acid sulfate soil planning maps have been developed by the NSW Government to better manage works that could disturb acid sulfate soils. The maps establish five classes of land based on the probability of acid sulfate soils occurrence and the type of works that might disturb them. These are shown in **Table 6-5** below.

Table 6-5 Acid sulfate soil classes

Acid sulfate soils class	Work which would potentially expose acid sulfate soils
Class 1	Any work
Class 2	Work beyond the natural ground surface and work by which the water table is likely to be lowered.
Class 3	Work beyond one metre below the natural ground surface and work by which the water table is likely to be lowered beyond one metre below the natural ground surface.
Class 4	Work beyond two metres below the natural ground surface and work by which the water table is likely to be lowered beyond two metres below the natural ground surface.
Class 5	Work within 500 metres of adjacent Class 1, 2, 3, or 4 lands which are likely to lower the water table below 1 metre AHD on adjacent Class 1, 2, 3 or 4 lands.

A search of the Australian Soils Resource Information System indicated that the project corridor is located on lands within acid sulfate soil classes of 2, 3, 4 or 5. The majority of the project corridor comprises class 5 soils and is at a low risk of impacts associated with acid sulfate soils. However, areas in proximity to waterways or water bodies, namely at Rockdale Bicentennial Park and the Memorial Fields, are identified as being in areas of acid sulfate soils class 2 and 3. The highest risk of acid sulfate soils is in Rockdale Bicentennial Park and Scarborough Park North.

Water quality

The catchments located within the project corridor include the Cooks River and Scarborough Ponds catchments.

Stressors to the Cooks River catchment include urban and industrial stormwater, sewer overflows, Sydney Airport, Alexandra Canal, former landfills and contaminated groundwater including the Botany Sand Beds aquifer. The northern extent of the proposed project tunnels would start 400 metres southeast of the Cooks River at the New M5 tunnel stubs. Discharges to the Cooks River associated with the project would likely come from the operational water treatment facility and detention basins.

Muddy Creek is concrete lined from the head waters near Hurstville to Banksia. The creek passes through the Rockdale industrial area and dis, charges into the Cooks River and ultimately the receiving waters of Botany Bay. The creek passes above the proposed project tunnel locations. The main impacts to surface water quality caused by the project could arise from runoff from surface earthworks, groundwater discharge from the operational water treatment facility from tunnel dewatering, additional stormwater runoff from complete surface roads or changes in hydrogeology where there are surface and groundwater interactions.

Rockdale Wetlands originally formed part of a low lying back swamp system that has been partially drained and filled. The wetlands are connected to Scarborough ponds via a culvert. The Rockdale Wetlands are surrounded by Rockdale Bicentennial Park which contains an old landfill (history unknown) on the western side. The Rockdale Wetlands were modified from their original extent during land reclamation. Leachate and contaminated groundwater could potentially be discharging into the water body. Impacts to the surface water quality could be from construction runoff associated with bulk earth works, long term runoff from complete surface roads, or changes in hydrogeology where there are surface and groundwater interactions.

Outside of the project corridor to the northwest is the Botany Sand Beds aquifer which is a large volume of underground water present in the sandy ground to the north of Botany Bay. The aquifer is highly vulnerable to contamination due to the permeability of the sands and the generally shallow water table. There is an embargo on the domestic use of groundwater in this area due to historic contamination.

6.6.2 Summary of issues

Construction

Construction of the project has the potential for the following soil, water and contamination related impacts:

- Impacts to water and soils due to spills or leaks of fuels and / or oils from construction plant and equipment and / or from vehicle / truck incidents
- Exposure of soils during construction resulting in direct erosion impacts. This may lead to dirty water runoff and sedimentation in local watercourses including Scarborough Ponds or Muddy Creek, as well as downstream waterbodies including the Cooks River and Botany Bay
- Generation of a net surplus of spoil as tunnelling would comprise a large component of the project. Construction of a tunnel within the project corridor would likely occur within the Hawkesbury Sandstone geological units
- Interaction with quaternary aged sediments present within the project corridor may include soft clays and organic soils, loose silts and sands. These can pose a constraint to construction for reasons such as instability, low bearing capacity and settlement. These constraints are commonly encountered and established treatment options are available for structures, earthworks and pavements
- Disturbance of contaminated soils, especially if surface work is undertaken within land known to be contaminated, or on land which has been identified as potentially contaminated based on current and historic activities. Disturbance of contaminated soils has the potential to result in offsite pollution
- Exposure of soil containing acid sulfides to oxygen, resulting in the production of sulfuric acid, which may become bio-available in the environment and affect local aquatic ecosystems, water quality and visual amenity
- Interaction with the unknown fill within Rockdale Bicentennial Park, resulting in potential contamination of the surrounding environment

Operation

Potential impacts during operation would include:

- Impact to water quality of receiving watercourses due to the discharge of treated groundwater and from other waste waters (such as tunnel wash or deluge system water). The discharge would likely be into a local watercourse such as Muddy Creek, or the Cooks River. This could have an impact on the water quality of the receiving waterway, depending on the discharge volumes, treatment and the point of discharge
- Impact to water quality of receiving watercourses due to increased runoff roads. This would typically contain oils and greases, petrochemicals and heavy metals as a result of vehicle leaks, operational wear, road wear and atmospheric deposition. Increased flows could also lead to increased potential for scouring of soils and watercourses
- Spills or leaks of fuels and / or oils from vehicle accidents, or from operational plant and equipment.

6.6.3 Proposed further assessments

Geotechnical investigations would inform the design and therefore the expected quantities of spoil including from tunnelling activities. The quantity of spoil would also depend on the tunnelling technique adopted for the project. Spoil management is discussed further in **Section 6.10**.

The environmental impact statement for the project would also include:

- Identification of waterways and groundwater systems that may be impacted by the construction and operation of the project
- Assessment of the potential impacts to soil and water, including field investigations
- Assessment of the risk of erosion and sedimentation in accordance with Roads and Maritime's Erosion and Sedimentation Management Procedure (Roads and Maritime, 2008)
- Likely groundwater discharge volumes into local watercourses during construction and operation, and the associated impacts on water quality. Associated impacts on biodiversity values are considered in **Section 5.5**
- Assessment of potential settlement along the tunnel alignment and the potential impacts to structures and infrastructure
- Identification of appropriate management and mitigation measures during construction and operation
- Identification of areas of known contamination or with potential contamination (soil and groundwater) that could be impacted by the project, and the potential impacts associated with the disturbance of these areas. This would be supported by further investigations to identify, quantify and assess the contamination. A remediation action plan would be developed and implemented as part of the project, if required
- Identification of appropriate management and mitigation measures during construction and operation.

6.6.4 Management and safeguard measures

During detailed design of the project, Roads and Maritime will seek to minimise impacts to soil and water quality for construction and operation.

A Construction Environmental Management Plan will be prepared in accordance with the principles and requirements in *Managing Urban Stormwater – Soils and Construction, Volume 1* (Landcom 2004) and *Volume 2D* (Department of Environment, Climate Change and Water (DECCW), 2008), commonly referred to as the 'Blue Book'.

6.7 Non-Aboriginal heritage

6.7.1 Overview

The project corridor commences underground in Arncliffe, which is mostly residential. There are also some medium residential areas and areas of commercial and light industrial developments. The first non-Aboriginal settlers included British, Irish and Chinese from the goldfields and Germans who tended their vegetable gardens. Arncliffe has a long multicultural history which has resulted in a rich cultural diversity in population as well as architectural style, ranging from Victorian through Federation era cottages to latter-day 'statement mansions', mosques and churches.

The project corridor extends from Arncliffe through Rockdale to Kogarah. This area saw a rise in development in the late 1800s with improved transport links to Rockdale, including the tramway built along Bay Street from Rockdale to Lady Robinson Beach, and the extension of Bay Street from Rockdale to the coast. Considerable expansion of the area occurred after World War I until the 1930s.

There are three items within the vicinity of the project corridor listed on the Register of the National Estate:

- Southern and Western Suburbs Ocean Outfall Sewer
- Banksia Urban Conservation Area
- Brighton-Le-Sands Urban Conservation Area.

Three items are listed on the State Heritage Register within the vicinity of the project corridor:

- Main Western Outfall Sewer (item number 4571738) – part of the South Western Sydney Ocean Outfall Sewer (SWSOOS)
- Arncliffe Market Gardens – located 212 West Botany St Arncliffe. Constructed 1892 to 1930
- Wilson’s Farmhouse, 310 West Botany Street Rockdale.

In addition to these State heritage listed items there are also 34 locally listed heritage items within the vicinity of the project corridor. These include houses, cottages, Rockdale Public School, St Francis Xavier Church group, Brighton-Le-Sands Public School, Kings Wetland and Patmore Swamp. There are also several items listed on Section 170 Heritage and Conservation Register, such as Kings Wetland. **Table 6-6** provides a list of non-Aboriginal heritage items which have the potential to be impacted by the project. **Figure 19** shows the heritage items within the vicinity of the project corridor.

Table 6-6 Heritage items within the vicinity of the project corridor

ID	Item	Address	Legislation
I34	Sandstone Victorian cottage*	15 Kyle Street, Arncliffe, NSW (Lot 1, DP 1096423; Lot 2, DP 1096423; Lot 3, DP 1096423)	Rockdale Local Environmental Plan (LEP) 2011
I42	Arncliffe Public School and 'Teluba'*	168–170 Princes Highway, Arncliffe, NSW (Lot 1, DP 124274; Lot 10, DP 1066280; Lot 11, DP 1066280)	Rockdale LEP 2011
I56	House*	73 West Botany Street, Arncliffe (Lot 25, Section 3, DP1633)	Rockdale LEP 2011
I35	House*	31 Kyle Street, Arncliffe (Lot 7, Section 4, DP 1633)	Rockdale LEP 2011
4305029 (SHI)	Footings of 1933 Pedestrian Bridge at Arncliffe School (Archaeological)*	Footings of former Roads and Traffic Authority (RTA) Bridge No. 27 (no longer extant), Princes Highway, Arncliffe, NSW	RMS Section 170 Heritage and Conservation Register
I45	Victorian house*	23 Segenhoe Street, Arncliffe (Lot A, DP 339374)	Rockdale LEP 2011
I46	Victorian house*	25 Segenhoe Street, Arncliffe (Lot 16, Section E, DP 2271)	Rockdale LEP 2011
I47	Californian Bungalow house*	27 Segenhoe Street, Arncliffe (Lots 17–18, Section E, DP 2271)	Rockdale LEP 2011
I70	House*	15 Cameron Street, Banksia (Lot 11, Section 12, DP 2248)	Rockdale LEP 2011
I74	Part of single-storey terraced cottages known as Jackson's Row*	11 Gibbes Street, Banksia, NSW (Lot 1, DP 900433)	Rockdale LEP 2011
I75	Part of single-storey terraced cottages known as Jackson's Row*	18 Gibbes Street, Banksia, NSW (Lot 2, DP 984067)	Rockdale LEP 2011
I207	Rock Lynn*	58 Bestic Street, Rockdale, NSW (Lot 1, Section 11, DP 1677)	Rockdale LEP 2011
I169	Kings Wetland	Kings Road, Brighton- Le-Sands (Lot 1, DP 229723; Part Lot 1, DP 214047)	Rockdale LEP 2011
3490033 (SHI)	Kings Wetland	As above	Section 170 Heritage and Conservation Register
I202	Patmore Swamp	99 President Avenue, Monterey, NSW	Rockdale LEP 2011

* The project would be in tunnel at this location, therefore impacts at surface to these heritage items are not anticipated.

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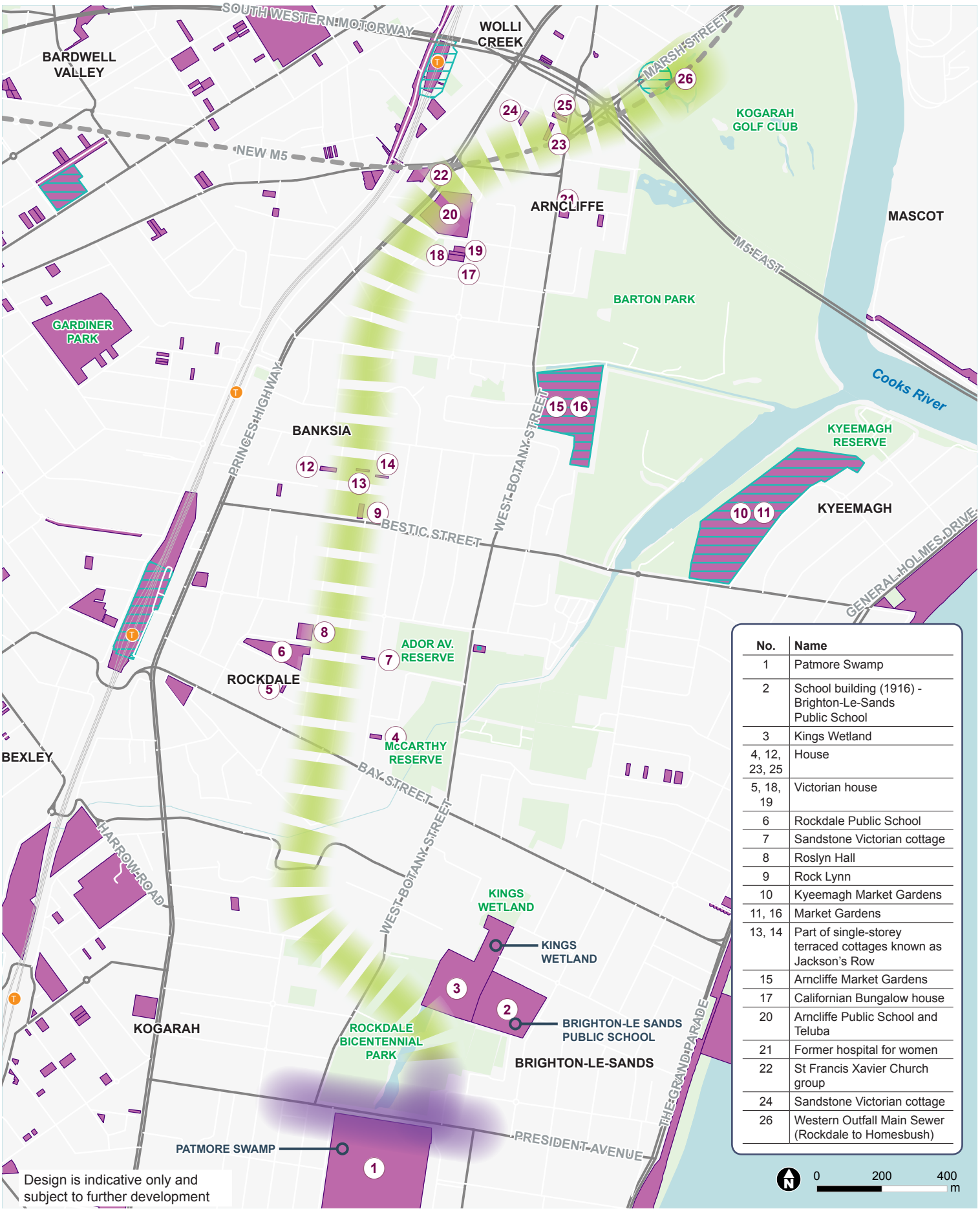

No.	Name
1	Patmore Swamp
2	School building (1916) - Brighton-Le-Sands Public School
3	Kings Wetland
4, 12, 23, 25	House
5, 18, 19	Victorian house
6	Rockdale Public School
7	Sandstone Victorian cottage
8	Roslyn Hall
9	Rock Lynn
10	Kyeemagh Market Gardens
11, 16	Market Gardens
13, 14	Part of single-storey terraced cottages known as Jackson's Row
15	Arncliffe Market Gardens
17	Californian Bungalow house
20	Arncliffe Public School and Teluba
21	Former hospital for women
22	St Francis Xavier Church group
24	Sandstone Victorian cottage
26	Western Outfall Main Sewer (Rockdale to Homesbush)

KEY

- Indicative tunnel
- Indicative surface
- New M5
- State heritage registered
- Local listed item

Figure 19 Heritage items within the vicinity of the project corridor

6.7.2 Potential impacts

Construction

There is the potential for direct and indirect impacts to non-Aboriginal heritage items and conservation areas to occur during the construction of the project. Potential construction impacts include:

- Direct impacts on the heritage item or within its curtilage. This could include permanent impacts such as partial or complete demolition of the item, or could include temporary impacts to the curtilage of a heritage listed item due to temporary use of the site for construction areas or other facilities
- Structural damage to a heritage item due to vibration and settlement associated with tunnelling or surface works
- Impacts on the sustainability and resilience of the heritage significant Chinese market gardens which rely in part on aquifer water for agricultural production
- Impacts on views to or from heritage items and within heritage conservation areas.

None of the State heritage listed items would likely be directly impacted by surface works and ground borne vibration would be managed during construction by strict adherence to limits set to prevent impacts to heritage structures.

There is the potential for additional non-Aboriginal heritage items to be identified during the construction process. These are likely to be archaeological remains of earlier habitation, historic market gardening and industrial activities.

Kings Wetland

This heritage item is listed on the NSW Department of Planning and Environment (formerly Department of Urban Affairs and Planning) State Heritage Inventory (Section 170 Heritage and Conservation Register) and the Rockdale LEP 2011. The heritage item is located approximately 50 metres north of the project near President Avenue. Kings Wetland would likely experience altered flows during construction. Impacts to this feature would be subject to further assessment.

Patmore Swamp

Pat Moore's Swamp or Patmore Swamp was granted to Patrick Moore, and was originally part of a 24 hectare (60 acre) land grant from Governor Macquarie in 1812. It was a former tidal swamp that was drained and filled and artificial lakes created with the assistance of the government relief programme during the 1930s depression. The wetlands provide important habitats for a variety of animal and plant species.

The heritage item is listed on Rockdale LEP (ID #I202) and comprises Civic Avenue Reserve, Tanner Reserve and Scarborough Park.

The heritage item would be directly impacted by the widening of President Avenue.

Operation

It is anticipated that direct physical impacts to heritage items would be largely contained to the construction stage of the project. Potential residual direct and indirect impacts to non-Aboriginal heritage items and conservation areas could occur during operation. Potential impacts during operation would include:

- Physical impact on the item or within the curtilage of the item as a result of architectural treatment to buildings for operational noise attenuation
- Structural damage due to settlement associated with tunnelling works
- Changes to views to or from heritage items due to permanent motorway operation facilities
- Permanent alteration to curtilage of a heritage listed item
- Changes in groundwater regimes.

Depending on the final location and design of surface infrastructure, there would be opportunity to avoid and / or minimise the potential for permanent operational impacts.

6.7.3 Proposed further assessment

The following recommendations are made for consideration during the environmental assessment phase:

- Undertake updated searches of non-Aboriginal heritage databases and literature review
- An assessment of significance for known local heritage items within the project corridor in accordance with the *Burra Charter* (International Council on Monuments and Sites, 1999) and the *Assessing Heritage Significance, NSW Heritage Manual 2, 2001* (NSW Heritage Office, 2001) and *Statements of Heritage Impact, 1996* (NSW Heritage Office, 1996)
- Assessment of potential impacts to items of local and state heritage significance
- An archaeological assessment, where required, to determine the presence of potential non-Aboriginal archaeological items and the potential impacts as a result of the project. The need for an archaeological assessment would be determined based on the outcomes of the literature review, the investigations identified above and the nature of the potential impact. It may include archaeological test excavations
- Identification of appropriate management and mitigation measures during construction and operation to minimise impacts to identified non-Aboriginal heritage values.

6.7.4 Management and safeguard measures

The detailed design and construction of the project would be managed to ensure that the identified potential heritage and archaeological impacts are minimised and/or avoided as far as practical, by implementing a range of environmental management and safeguard measures. These measures would be included in the environmental impact statement for the project.

6.8 Property and land use

6.8.1 Overview

The project would span the Bayside LGA. Land use and existing development within and around the project corridor is predominately urban in nature, containing a mix of residential, commercial and industrial development, with a large corridor of recreational areas.

Land uses of high social value are present across the project corridor including: public recreation/ open space, sporting facilities, hospitals, aged care facilities, educations facilities and places of worship.

There are several major transport corridors located in or adjacent to the project corridor, including A1/ A36 Princes Highway, A3 King Georges Road, The Grand Parade, Sydney Airport, and the T4 Eastern suburbs and Illawarra rail line.

Land use zoning

Land use zonings within the project corridor are set by the following environmental planning instruments:

- Sydney Regional Environmental Plan No.33 – Cooks Cove
- Rockdale LEP 2011 (current plan for Bayside Council).

Under these instruments, the zoning of the project corridor comprises a mix of land uses, including:

- **Infrastructure**: A significant area of land within the vicinity of the project has been zoned SP2 Infrastructure under the Rockdale LEP 2011. This land was progressively acquired and reserved during the 1960s for the development of the F6 Freeway. Successive governments have largely retained this corridor for the potential future development of this connecting link. Having been set aside for the development of a motorway connection, this area has largely been protected from development; however there are some areas which have been developed for residential and other purposes in the interim.
- **Residential**: land zoning for the purposes of residential use within the project corridor is predominantly low density residential, with medium and high density residential zones located in areas close to public transport, along major roads and near the Botany Bay coastline.
- **Open space**: Following, and adjacent to the existing F6 reserved corridor, is a strip of lands zoned as open space, public recreation and private recreation. This area is known as the Rockdale Wetlands and Recreation Corridor.
- **Industrial and commercial**: Within the Bayside LGA there is an area of light industrial zoned land south of Bay Street, Brighton-Le-Sands and an enterprise corridor along the Princes Highway at Arncliffe.
- **Social infrastructure and other sensitive land uses**: Community facilities, churches, schools, child / aged care facilities, medical and veterinary centres are located along the length of the project corridor. Social infrastructure and other sensitive land uses are further discussed in **Section 6.3**.

Land zoning within the vicinity of the project corridor is shown on **Figure 20**.

Figure 20 Land use zoning

KEY

- B1 Neighbourhood Centre
- B2 Local Centre
- B4 Mixed Use
- B6 Enterprise Corridor
- IN2 Light Industrial
- R2 Low Density Residential
- R3 Medium Density Residential
- R4 High Density Residential
- RE1 Public Recreation
- RE2 Private Recreation
- RU4 Primary Production Small Lots
- SP2 Infrastructure
- SP3 Tourist
- UL Unzoned Land
- Trade and Technology
- Indicative tunnel
- Indicative surface

Strategic planning initiatives

A number of strategic planning initiatives are underway within the project corridor. This includes:

- *Revised Draft Eastern City District Plan* (Greater Sydney Commission)
- *The Princes Highway Corridor Strategy* (Rockdale City Council)
- *Bayside West Precincts* (NSW Department of Planning and Environment).

The revised draft *Eastern City District Plan* (Greater Sydney Commission, 2017a) recommends the investigation of the potential F6 Extension to strengthen regional connections to the Illawarra region and protection of the existing F6 reserved corridor for future long-term transport needs.

The *Princes Highway Corridor Strategy* (Rockdale City Council, 2013) was adopted by the Council in late 2013. The strategy focuses on revitalising the Princes Highway corridor within the Rockdale LGA for employment uses and growing the Arncliffe town centre. This strategy recommends changes to the distribution of residential, mixed use and business zones, as well as increased densities.

The Bayside West Precincts encompasses land around Banksia and Arncliffe Stations, and Cooks Cove. The strategy aims to create connected town centres for Arncliffe, Banksia and Cooks Cove, better transport connections, a vibrant Princes Highway corridor and new areas of open space.

6.8.2 Summary of issues

Construction

During construction, potential impacts to land use and property issues could occur as a result of;

- Ancillary construction facilities and infrastructure, such as site compounds or construction sediment basins, if located outside of existing road reserves. This would potentially require full or partial land acquisition and a temporary change in land use
- Temporary closure of parts of Rockdale Bicentennial Park. Potential impacts to Rockdale Bicentennial Park would be identified in the environmental impact statement and managed in consultation with Bayside Council.
- Potential use of New M5 construction compound within Kogarah Golf Course. Potential impacts resulting from extending the use of this construction compound would be identified in the environmental impact statement.
- Alteration and / or temporary disruption to property access. Alternative arrangements would be negotiated with the affected parties in order to enable continued access and to minimise disruption as much as reasonably possible.

The locations and size of construction and ancillary facilities would be developed during the design development process for the preferred project design and described and addressed in the environmental impact statement.

Existing land uses, site accessibility and potential opportunities to co-locate permanent operation facilities would be considered when determining the size and location of construction facilities. In the event that land is required that is not owned by the NSW Government, discussions would be held with the affected property owner concerning the purchase or lease of the land required during construction.

Operation

Impacts on land use and property could occur as a result of:

- Full or partial property acquisition (surface and subsurface) to accommodate surface and subsurface infrastructure and activities, such as construction compounds, at-surface roads, interchange and ancillary infrastructure. The need for acquisition would be minimised, where possible, and the location of surface infrastructure would consider potential impacts on land uses
- Ground settlement resulting damage to buildings, structures or utility infrastructure
- Severance and sterilisation of land. Options for incorporating sterilised or fragmented land into the future road corridor would also be investigated, or alternatively, suitability for the land to be consolidated and resold, or dedicated to being a recreational area, following the completion of construction would be explored
- Changes in property access. In some cases, accesses would require permanent relocation to cater for new or widened road reserves. The extent of such changes, including the number of properties affected and whether access would be lost or relocated, would be assessed and identified in the environmental impact statement
- Changes to development potential of properties
- Impacts on land uses along key surface roads within the project corridor due to the associated improvements to amenity and local network efficiencies. Improvements to travel times would also deliver benefits to businesses that would support the continued growth of key employment areas in the immediate vicinity of the project corridor

With the majority of the project being in tunnel, substantial direct land use impacts would be avoided in terms of surface acquisition, severance or sterilisation. As such, direct land use and property impacts are anticipated to be limited to areas where surface components are proposed that extend outside existing road corridors, particularly within Rockdale Bicentennial Park (within the existing F6 reserved corridor).

The project provides support for the Princes Highway Corridor Strategy and the Bays West Precincts strategic planning initiative, as it would remove traffic from this section of the Princes Highway, providing opportunity for urban renewal.

6.8.3 Proposed further assessments

A land use and property assessment would be prepared to provide (as a minimum):

- Identification of land uses, existing access arrangements and potential property acquisition for both public and private land adjacent to the project
- Assessment of the potential impacts of the project on property, land use (including approved developments) and access arrangements for both construction and operation
- Investigation into likely ground subsidence impacts as result of tunnelling
- Identification of potential mitigation and management measures to avoid and/or minimise these impacts.

6.8.4 Management and safeguard measures

Management and safeguard measures would be adopted to minimise impacts to property and land use including:

- Land acquisition for the project would be undertaken in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and the *Roads and Maritime Services Land Acquisition Information Guide* (Roads and Maritime, 2014a) and the land acquisition reforms announced by the NSW Government in 2016
- The requirement for temporary changes to property access would be minimised during development of the detailed construction methodology. Affected landowners would be consulted when temporary, short-term changes to access to their property would occur. This would include advanced notification of relevant project schedules, construction works and changes to access arrangements.

6.9 Urban design and visual amenity

6.9.1 Overview

The project corridor can be characterised into two broad landscape zones based on the existing land uses. The western zone (predominately west of West Botany Street) generally consists of medium to low residential development, with a light industrial area south of Bay Street and the M5 East Motorway to the north. The area is characterised predominately by residential development with landscaping limited to a mixture of planted (exotic / native) and remnant bushland trees associated with properties and a limited number of parkland areas. There are many businesses and some medium to high density residential developments.

The eastern zone (predominately east of West Botany Street) generally consists of land which has been historically reserved for the project. This zone includes a corridor of important wetlands and open space areas. This section is relatively flat with views across the broader area generally restricted by buildings, apart from at the fringes.

Rockdale Wetlands and Recreation Corridor

The Rockdale Wetlands and Recreation Corridor is a corridor of connecting natural and open space areas, most of which is located on land owned by Roads and Maritime and designated as SP2 Infrastructure in the Rockdale LEP 2011. It is a key biodiversity corridor linking the estuarine, wetland and bushland habitats between the Cooks River and Georges River. The Rockdale Wetlands and Recreation Corridor, and other open space within the vicinity of the project corridor, is shown in **Figure 21**.

In being set aside for the development of a motorway, the project corridor has been reasonably protected from development and consists of recreational areas and wetlands. The corridor provides one of the last remaining areas of green space in the project area and allows open views across many of the playing fields and recreation parks. Wetlands and parklands contain many local walking tracks with views of these environments. Further details on the wetlands are provided in **Section 5.5**.

6.9.2 Summary of issues

Construction

Construction of the project has the potential for the following urban design and visual amenity impacts:

- Visual impacts from active construction areas and the introduction of associated construction ancillary facilities and storage areas, including lighting
- Vegetation clearing within the project corridor
- Construction traffic management measures such as road barriers and associated construction lighting
- Construction management measures such as fencing and noise hoarding
- Temporary impacts on views to and from heritage items.

Operation

Operation of the project has the potential for the following urban design and visual amenity impacts:

- Visual impact of new infrastructure on existing views from residences and surrounding development including:
  - The President Avenue interchange and tunnel portal
  - Surface infrastructure such as ventilation facilities
  - Gantries and signs
  - Noise mitigation measures, such as noise barriers and noise mounds, if required.
- Impact to the motorist's experience due to visual quality of new motorway infrastructure, structures and elements, and changes to the existing landscape, views and visual characteristics of existing roads
- Impact on the landscape characteristics of existing open spaces adjacent to the project, and views to and from these spaces
- The removal of mature trees and vegetation, if unavoidable through design
- Overshadowing caused by operational surface infrastructure such as noise walls
- Impacts to existing pedestrian and cycle pathways adjacent to, along and across the project corridor in particular within Rockdale Bicentennial Park
- Impact on residential receivers where residential lots back onto new road infrastructure which is currently considered open space (i.e. Rockdale Bicentennial Park)
- Negative visual impacts due to severing existing recreational areas and affecting the permeability and cohesion of these areas.

The visual impacts of the project would be dependent on the design features of the President Avenue interchange and other surface infrastructure, landscape treatments and the exploration of opportunities to integrate the surface infrastructure elements with the surrounding features of the area. Design of the portals, the interchange and surface infrastructure would take into consideration their visibility and presence within their context to ensure an appropriate design response.

KEY

- Indicative tunnel
- Indicative surface
- Open space and recreational areas

Figure 21 Open space within the vicinity of the project corridor

6.9.3 Proposed further assessments

Further assessment of the potential for visual impacts and landscape character impacts along the project corridor would be conducted as part of the environmental impact statement, which would include as a minimum:

- Identification of the visual qualities present, including the existing landscape character of the region, sensitive locations and receivers, catchments and key viewpoints
- An assessment of visual impacts from the construction and operational stages of the project on existing views and landscapes. This includes a review of relevant heritage items
- An assessment of the urban design elements of the project
- Identification of urban design mitigation measures, where required.

The design of the project would be in keeping with urban design principles for the project, and the Roads and Maritime guideline *Beyond the Pavement: Urban Design Policy Procedures and Design Principles* (Roads and Maritime, 2014b), which identifies the following urban design principles regarding road infrastructure:

- Contributing to urban structure and revitalisation
- Fitting with the built fabric
- Connecting modes and communities
- Fitting with the landform
- Responding to the natural pattern
- Incorporating heritage and cultural contexts
- Designing roads as an experience in movement
- Creating self-explaining road environments
- Achieving integrated and minimal maintenance design.

The preparation of the environmental impact statement and detailed design would be informed by the *Environmental Impact Statement Practice Note: Guidelines Character and Visual Impact Assessment* (Roads and Maritime, 2013b).

6.9.4 Management and safeguard measures

The detailed design and construction of the project would be managed to ensure landscape and visual impacts are minimised by implementing the following general mitigation measures:

- Ancillary facilities, including the locations of visible structures and plant and perimeter fencing and treatments, would be developed to minimise visual impacts for adjacent receivers where feasible and reasonable
- Site lighting would be designed to minimise glare issues and light spillage in adjoining properties and would be generally consistent with the requirements of Australian Standard 4282-1997 Control of the obtrusive effects of outdoor lighting
- Architectural design and detailing of the project, including ancillary facilities should achieve articulation, visual interest, and integrate with the streetscape.

6.10 Resource management and waste minimisation

6.10.1 Overview

Resource management and waste minimisation would be considered throughout various stages of the project from design and construction through to operation. Large quantities of materials would be required for the construction of the project such as concrete, asphalt, steel, gravel, sand, aggregate and road base. This would need to be sourced from quarries, manufacturers and suppliers, which would generally be from areas outside the project corridor. Waste associated with the project would be generated from a number of streams.

All wastes would be managed using the waste hierarchy approach of waste avoidance, waste re-use before consideration of waste disposal. All wastes would be managed in accordance with the waste provisions contained within the *Protection of the Environment Operations Act 1997* and, where reused off site, would comply with relevant NSW Environment Protection Authority resource recovery exemptions.

The most significant waste stream associated with the project is likely to be spoil generated from the excavation of the road tunnels that is in excess of project requirements. Spoil that is in excess of project requirements would be preferentially/ beneficially re-used in other road projects and non-road development sites that may require engineered fill, or other land rehabilitation projects. This would be managed in accordance with a spoil management strategy for the project.

Water resources would be required during construction, particularly during tunnelling. In addition, water resources would be required in the performance of other activities such as compaction of pavement materials, dust suppression and concrete batching. Water resources could be sourced from within or outside the project corridor. Higher quality water for some construction activities may be sourced from potable water supplies. Water from groundwater sources may also be used. The final volume, source and quality requirements for water supplied to the project would be determined through the design development process for the preferred project design and reflected in the environmental impact statement.

6.10.2 Summary of issues

Construction

Impacts associated with resource use and waste generation are likely to be predominantly associated with the construction of the project. These include:

- Potential impact on resource availability as a result of resource use requirements for the project
- Generation of waste during construction of the project, including:
  - Demolition wastes from existing structures that require removal
  - Excavated wastes, such as soil and rock, primarily from tunnelling and cutting
  - Depending on the final locations of excavation activities, these wastes are expected to be largely characterised as Virgin Excavated Natural Material although contaminated spoil may be generated
  - Vegetation waste from the removal of trees, shrubs and ground covers that are unable to be mulched and reused within the project
  - Packaging materials such as crates, pallets, cartons, plastics and wrapping materials
  - Surplus construction material and general site reinstatement such as fencing, sediment, concrete, steel, formwork and sand bags
  - Site compound waste such as liquid wastes from cleaning, repairing and maintenance, waste from spillages, fuel or oil waste, effluent from site amenities and general office wastes.

Operation

The operation of the project has the following resource use and waste management related impacts:

- Generation of wastes from operational maintenance and repair activities required over the life of the project. The type and volume of wastes generated would be dependent on the nature of the activity, but would predominantly consist of green waste, oil, road materials, as well as contaminated waste resulting from potential fuel spills and leaks
- Supply of water for the deluge system, which would form part of the fire and life safety system
- Water used as part of the deluge system or for tunnel washing would be captured, and treated using the operational water treatment facility, prior to being discharged into the environment. This is discussed in **Section 6.2**
- Litter generated by road users.

With the implementation of standard work practices during routine maintenance and repair activities, the overall impact of operational waste streams and volumes would be minimal.

6.10.3 Proposed further assessments

The environmental impact statement would provide further details on waste and resource management for the project, including:

- Estimates of the quantity of spoil that would be generated
- Identification of a management hierarchy to reduce the volume of excess spoil generated by the project, such as through design, through use within the project, or use in other projects
- Identification of the approximate resource requirements for the project, including estimation of the material and water requirements
- Identification of available materials in the region including from quarries, potential material suppliers, and reuse of materials
- Identification of available water supplies in the region and the locality (including recycled water)
- Identification of specific waste impacts of the project and the waste management approach
- Identification of management and mitigation measures for resource use and waste across the project including potential spoil re-use and disposal sites and transport impacts. This includes strategies to minimising the export of excavated materials off-site, maximising re-use opportunities and minimising the volume of excavated material disposal to landfill
- Identification of opportunities to use recycled materials provided they are fit for purpose and meet engineering requirements.

6.10.4 Management and safeguard measures

Resource use and waste management can be managed and mitigated through the development of the Construction Environmental Management Plan and implementation of standard approaches.

- Measures to avoid, minimise or manage resource consumption and waste streams generated as a result of the project would ensure that all wastes generated during the construction and operation of the project are effectively stored, handled, treated, reused, recycled and/or disposed of lawfully and in a manner that protects human health and environmental values.

6.11 Aboriginal heritage

6.11.1 Overview

The traditional owners of the land within the study area are the Gameygal people of the Eora Nation. The Gameygal (or Camerigal) people are believed to have occupied the western edge of Botany Bay from the Cooks River to Georges River. Previous investigations in the area suggest Aboriginal people relied on the banks of the Cooks River for food and medicinal plants (Attenbrow 1992). The Cooks River Valley was originally covered in a network of tracks providing trade and social and ceremonial linkages which played a key role in the social and economic structure of Aboriginal society.

Since early European settlement, the project corridor has been subject to significant disturbance from agricultural uses, residential, industrial and infrastructure uses. Items and sites of Aboriginal heritage significance are most likely to occur in areas associated with water sources, especially swamps (Smith 1988). Therefore, it is likely there may be areas of Aboriginal heritage significance located along areas adjoining the shorelines of the creeks and within undisturbed wetland areas. There is potential that areas of archaeological sensitivity are considerably inland and / or buried beneath fill material as a result of extensive historic disturbance and development in the area, including land reclamation and the realignment of creeks, as well as sea level rise.

Aboriginal shell midden material was used historically by market gardeners to sweeten (de-acidify) acid sulphate prone soils. Note that this shell material remains protected under the National Parks and Wildlife Act 1974 as an Aboriginal object.

Known Aboriginal heritage sites were identified through a search of the Aboriginal Heritage Information Management System (AHIMS) database. There were no AHIMS sites found within 500 metres of the project corridor.

6.11.2 Potential impacts

Construction

Direct or indirect impacts on previously recorded AHIMS sites are not anticipated given that the review undertaken did not identify any registered sites within 500 metres of the project corridor. However, there is potential for previously unrecorded Aboriginal sites to be identified and impacted by the project as a result of excavation at surface work locations.

The risk of impacts to Aboriginal sites is likely to be low given that most of the project would be located greater than 20 metres below ground. This risk is further mitigated by the disturbed and highly urbanised environment along most of the project corridor. Further assessment would inform design refinement and further avoidance of any impact, where possible.

Areas of reclaimed foreshore or re-worked midden material in former market gardens may be subject to risk.

Operation

The project would be designed and constructed to minimise the potential for direct and indirect impacts on known Aboriginal heritage sites, therefore potential direct or indirect impacts on Aboriginal sites are not anticipated during operation. The potential impact on Aboriginal heritage and identification of management measures would be determined during the preparation of the environmental impact statement.

6.11.3 Proposed further assessment

An Aboriginal cultural heritage assessment report would be prepared for the project, including completion of at least Stage 2 of the Roads and Maritime *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI) (Roads and Maritime, 2011). The Aboriginal cultural heritage assessment report would include but not be limited to:

- An archaeological survey of the project corridor to identify known and potential Aboriginal objects, places and cultural values
- A review of relevant plans or diagrams showing the location of the project corridor in relation to known and potential Aboriginal objects, places or cultural values
- An assessment of significance of known and potential Aboriginal objects, places and cultural values
- An assessment of known and potential impacts to Aboriginal objects, places and cultural values resulting from the construction and implementation of the project
- Consultation with the Aboriginal community in accordance with both Roads and Maritime *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI) (Roads and Maritime, 2011) (if Stage 2 assessment concludes necessary to advance to Stage 3 of the PACHCI guideline)
- Identification of mitigation measures required to minimise impacts of the project.

The Aboriginal cultural heritage assessment report would be prepared in accordance with the following policy documents and heritage guidelines:

- The Roads and Maritime *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI) (Roads and Maritime, 2011)
- *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010a)
- *Code of practice for archaeological investigation of Aboriginal Objects in NSW* (DECCW, 2010b).

6.11.4 Management and safeguard measures

Standard management and safeguard measures would be considered through the design development process for the preferred project design and preparation of the environmental impact statement including the implementation of stop works and referral procedures in the event of unexpected finds of Aboriginal heritage items.

6.12 Greenhouse gas

6.12.1 Overview

The transport sector contributes around 17 per cent of Australia's total greenhouse gas emissions (NSW Department of the Environment, 2015a). Around 90 per cent of these emissions are considered to be attributed to the combustion of fuel for road transport (Climate Change Authority, 2014; Maddocks et al., 2010). Reducing the contribution of emissions from road transport would therefore have a significant impact on emissions reduction for the transport sector, and for Australia's overall emissions profile.

In NSW there are a number of policies which aim to reduce greenhouse gas emissions, including the *NSW Energy Efficiency Action Plan* (NSW Office of Environment and Heritage (NSW OEH), 2013b) and *NSW Government Resource Efficiency Policy* (NSW OEH, 2014e). In addition, the *Future Transport Strategy* (NSW Government, 2017) states that "to minimise the impact of the transport network, all investments across the transport cluster will improve the resilience of the network in a changing climate and support the NSW Government's aspirational target to achieve net-zero greenhouse emissions by 2050".

Emissions of greenhouse gas emissions sources can be categorised into three different scopes (1, 2 or 3) in accordance with the *World Business Council for Sustainable Development and World Resources Institute Greenhouse Gas Protocol* (2005), and the Australian Government greenhouse gas accounting and reporting systems. Specifically:

- Scope 1 emissions, also referred to as direct emissions, are emissions generated by sources owned or controlled by the project such as the use of diesel fuel in project-owned construction plant, equipment or vehicles and the clearing of vegetation
- Scope 2 emissions, also referred to as indirect emissions, are emissions generated from the consumption of purchased electricity in project-owned or controlled equipment or operations. These emissions are generated outside the project's boundaries, for example, the electricity used to power tunnel ventilation systems and lights
- Scope 3 emissions, also referred to as indirect upstream/downstream emissions, includes emissions generated in the wider economy due to third party supply chains and road users as a consequence of activity within the boundary of the project, for example greenhouse gas emissions associated with the mining, production and transport of materials used in construction.

6.12.2 Potential impacts

Construction

The construction of the project would contribute to greenhouse gas emissions, either directly or indirectly, as a result of:

- Fuel consumption for transporting materials to site and the operation of construction plant and site vehicles
- Spoil and waste removal
- Vegetation clearance
- Electricity used to power construction plant and site offices
- Indirect greenhouse gas emissions such as through embodied energy of construction materials
- Decomposition of waste.

Operation

The key sources of greenhouse gas emissions during the operation of the project would include:

- Fuel consumed by vehicles travelling along the project route (operational road use)
- Road maintenance activities (fuel and materials)
- Electricity used to power tunnel systems (such as tunnel ventilation, computer systems, lighting and the operational water treatment facility).

Key contributors to operational emissions are likely to be operational road use and mechanical tunnel ventilation systems. Energy consumption by tunnel ventilation systems can be reduced by good road design and efficient ventilation design. The air quality approach for the project, and the selected ventilation infrastructure, would be a key component of determining the energy consumption for the project.

There is likely to be some offset of total emissions due to increased vehicle fuel efficiency within the road network. Reductions in operational emissions would be achieved by developing an optimal design, including the vertical and horizontal alignments and reduction of stop start driving. These reductions would be cumulative over the design life of the project. Energy efficient ventilation and lighting system designs would also be key areas of consideration for achieving optimal energy efficiency outcomes during the operational phase.

6.12.3 Proposed further assessment

A greenhouse gas assessment would be conducted for the construction and operation of the project and include as a minimum:

- Identify the assessment boundary and sources of greenhouse gas emissions associated with the construction, operation and maintenance of the project
- Determine the quantity of each emissions source in line with the Greenhouse Gas Assessment Workbook for Road Projects (the TAGG Workbook) (Transport Authorities Greenhouse Group (TAGG), 2013).
- Quantify the greenhouse gas emissions associated with each greenhouse gas source using equations specified in the NGA Factors and the TAGG Workbook
- Present the greenhouse gas emissions associated with the construction, operation and maintenance of the project
- Identify opportunities (mitigation measures) which may be implemented to reduce greenhouse gas emissions associated with the project.

It is anticipated that the greenhouse gas assessment would be undertaken in accordance with the following:

- *Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard* (World Council for Sustainable Business Development and World Resources Institute, 2005)
- *National Greenhouse and Energy Reporting Act 2007* (Commonwealth)
- AS/ISO 14064.1:2006 *Greenhouse Gas Part 1: Specification with guidance at the organisational level for quantification and reporting of greenhouse gas emissions and removals*
- The current Australian National Greenhouse Accounts: National Greenhouse Accounts Factors (NGA Factors) (Department of the Environment, 2015b)
- The TAGG Workbook (TAGG, 2013).

6.12.4 Management and safeguard measures

Greenhouse gas and climate change issues are commonly encountered on road projects and can be managed and mitigated through the implementation of standard approaches. Standard management and safeguard measures have been identified below, which would be considered through the design development process for the preferred project design and identified as appropriate in the environmental impact statement for the project. These may include:

- Consideration of the preferential selection of materials, vehicles and construction equipment with characteristics such as lower embodied energy and greater fuel efficiency, where feasible
- Construction plant and equipment would be maintained to reduce energy efficiency losses associated with damaged or unmaintained equipment
- Construction transport requirements would be reduced wherever reasonably possible, for example through use of local staff, resources, suppliers, and landfills
- Vegetation clearance would be minimised wherever reasonably possible
- Develop an energy efficient and optimal road design.

6.13 Hazards and risk

6.13.1 Overview

Hazard and risk impacts associated with the project have the potential to affect the surrounding environment and human health. Potential impacts are likely to arise during both the construction and operation of the project and are likely to evolve predominantly from the use of the tunnelling system. These potential impacts may involve leakage, spillage and accidental release from the incorrect handing or storage or hazardous materials.

Potential impacts arising from the operation phase would involve tunnel air quality and vehicle and personal safety.

Sydney Airport is located to the south-west of the project corridor. The Airports (Protection of Airspace) Regulations 1996 (Commonwealth) (Airspace Regulations), was established to protect airspace at and around regulated airports in Australia, including Sydney Airport. The Airspace Regulations define the 'prescribed airspace' for Sydney Airport as the airspace above any part of either the obstacle limitation surface (OLS) or procedures for air navigation services – aircraft operations surfaces for the airport (PANS-OPS). OLS is an invisible level that defines the limits to which objects may project into the airspace around an aerodrome so that aircraft operations may be conducted safely. PANS-OPS protection surfaces are invisible surfaces in space that establish the airspace that is to remain free of any potential disturbance (including physical objects and other disturbances such as plumes) so that aircraft operations may be conducted safely.

Under the *Airports Act 1996* (Commonwealth), a controlled activity in relation to a prescribed airspace must not be carried out or caused to be carried out without the approval of the Secretary of the Commonwealth Department of Infrastructure and Regional Development or is otherwise exempt under the Airspace Regulations. Controlled activities include (depending on the precise event or occurrence):

- The construction of buildings and structures that intrude into prescribed airspace
- Artificial light sources that exceed specified intensity levels
- Activities that result in air turbulence that exceed specified levels
- Activities that involve the emission of smoke, dust, other particulate matter, steam or other gas that exceed specified levels.

With respect to emissions, the Civil Aviation Safety Authority prohibits discharge of emissions at a velocity of greater than 4.3 metres per second at the PANS-OPS protection surfaces.

6.13.2 Potential impacts

Construction

Potential impacts associated with the construction of the project may include:

- Environment and human health risks associated with the accidental release of hazardous materials due to improper handling or storage, or in the event of a traffic accident resulting in the release of hazardous material. All hazardous substances that may be required for construction would be stored and managed in accordance with the *Work Health and Safety Act 2011* and the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005)
- Potential for the rupture or interference with underground services during construction
- Occupational health and safety hazards, such as dangers to construction workers, road users and the general public may also occur during construction. This could include tunnel collapse or flooding and inundation during construction. Such risks would be carefully considered during detailed design and managed through the implementation of an occupational health and safety plan
- Aviation hazards, associated with construction activities (e.g. cranes) that intrude into the OLS or construction lighting that exceeds specified levels. Such risks would be managed so that structures do not intrude into the OLS, and that construction lighting would adhere to the established guidelines on the location and permitted intensities of ground lights within a six kilometre radius of Sydney Airport.

Operation

Potential impacts associated with the operation of the project may include:

- Environment and human health risks associated with the accidental release of hazardous materials in the event of a traffic accident resulting in the release of hazardous material
- Spills or leaks from minor vehicle accidents
- Large fires or explosions from major vehicle accidents
- Tunnel collapse or subsidence
- Flooding and inundation during operation
- Potential aviation hazards.

Contaminants associated with either a spill, fire suppression (including deluge system) or clean up would be contained and treated by the tunnel drainage system. At the President Avenue interchange, contaminants have the potential to enter the environment from paved or unpaved surfaces. Water quality treatment measures would reduce the risk of contaminants discharging to the receiving environment.

The project would involve the construction and operation of one ventilation facility, and the use of an existing facility. Emissions from these ventilation facilities may have the potential to penetrate the obstacle limitation surface and the PANS-OPS, and as such, the design of these facilities would need to consider these constraints so that emissions into the PANS-OPS are at a velocity of no greater than 4.3 metres per second. Physical structures would be designed to not protrude into the OLS.

6.13.3 Proposed further assessment

Hazards and risks would be considered in the environmental impact statement. As part of this, a screening of dangerous goods and hazardous materials against the *Applying SEPP 33: Hazardous and Offensive Development Application Guidelines* (NSW Department of Planning, 2011) thresholds would be undertaken. Design features of the project to manage risk and hazards during the operational stage of the project would also be outlined within the environmental impact statement, which would include an assessment of the potential hazards associated with chemicals associated with clean-up activities or deluge systems.

The requirements of the *Airports Act 1996* (Commonwealth) and the Airport Regulations would be considered during design development. This would be supported by a plume rise assessment for the ventilation structures. The Civil Aviation Safety Authority would be consulted on the outcomes of this assessment to determine whether or not the project would be deemed a controlled activity under the *Airports Act 1996* (Commonwealth). An approval under that Act, if required, would be sought separately to the planning approvals required under State legislation.

6.13.4 Management and safeguard measures

To ensure the continued management of hazards and risks during the operation of the project, standard mitigation strategies would be implemented such as:

- Prohibition of dangerous goods within the project.
- Tunnel monitoring equipment to observe traffic conditions within the tunnel.
- Fire protection systems, which would include a fire suppression and firefighting system and would allow egress for pedestrians and access for emergency services.
- The ventilation system would be designed to ensure conditions are provided for the safe egress of passengers and to vent smoke in the event of a fire.
- Visual and audible communications systems would be used to also communicate incidents to motorists within and outside the tunnel.
- An Incident Response Plan to respond to accidents or spills.
- Appropriate design criteria for portal flood immunity and drainage infrastructure capacities.

6.14 Climate change risk and adaptation

6.14.1 Overview

Increases in global concentration of greenhouse gases have led to an increase in the average surface temperature, contributing to the phenomenon of climate change. The State of the Climate 2012 (CSIRO and the Australian Bureau of Meteorology, 2012) confirms the long term warming trend over Australia's land and oceans, showing that in Australia, each decade has been warmer than the previous since the 1950s. Other observed trends include an increase in record hot days, a decrease in record cold days, ocean warming, sea-level rise and increases in greenhouse gas concentrations. Due to long lag times associated with climate processes, even if greenhouse gas emissions are mitigated and substantially reduced, the warming trend is expected to continue for centuries (Intergovernmental Panel on Climate Change, 2007) (IPCC).

The IPCC Fifth Assessment Report (IPCC, 2013) states with high confidence that Australia is already experiencing impacts from recent climate change, including a greater frequency and severity of extreme weather events. Certain current and predicted climate events and trend pose a risk to road infrastructure, by way of physical damage, accelerated deterioration of assets and reduced network capacity and road safety (Maddocks et al, 2010). As a result it is important to understand the most likely and 'worst case' implications of climate change on high-value infrastructure, such as the project.

The physical implications of climate change on major road infrastructure projects are typically considered during the design and environmental assessment process for such projects. Using climate change projections produced by the IPCC, both the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology have produced regional downscaled projections for Australia. In 2015, the CSIRO and the Bureau of Meteorology released the *East Coast Cluster Report, Climate Change in Australia* (CSIRO and the Bureau of Meteorology, 2015). In summary, climate change predictions for the East Coast Cluster (Rockhampton QLD to Sydney NSW) include:

- Higher average temperatures (0.4 - 1.3 degrees Celsius higher than average by 2030)
- Higher rainfall in all seasons except winter
- Increased intensity of heavy rainfall events
- Increased evaporation rates and reduced soil moisture
- Harsher fire-weather climate
- Higher sea levels and more frequent sea level extremes.

6.14.2 Potential impacts

Climate variables identified as potentially generating risks for the project include:

- Mean annual temperature change and extreme temperature events
- Mean annual rainfall change and extreme rainfall events
- Increased mean annual potential evaporation
- Increased solar radiation
- Extreme events, particularly storms (rainfall, hail, wind, dust, lightning), drought and bushfires
- Changes to groundwater levels.

Road infrastructure is particularly vulnerable to very high temperatures, changes in soil moisture and the ground stability of sloping land forms. The increased frequency and intensity of extreme weather events, increased rainfall, bushfires and rising temperatures are already causing strain on existing road networks. Recent flood events and bushfire events in NSW have highlighted the susceptibility of the transport sector to extreme events. More extreme weather events are likely to damage road infrastructure and by 2030, design criteria for extreme events are very likely to be exceeded more frequently.

The key climate change risks to road projects are associated with changes in rainfall intensity which may typically result in the following:

- Increased potential for localised flooding impacting on road infrastructure and potential increases in road maintenance activities and costs
- Increased risk of road closures
- Drainage and stormwater impacts
- Erosion impacts, resulting in sediment loss from the site
- Watercourse impacts, including changes to channel structure and other characteristics resulting from changes in hydrological conditions.

Risks to infrastructure associated with climate change may also generate knock-on effects or additional risks (Maddocks et al, 2010), such as:

- Risks to road user health and safety
- Interruption or delays to commuter travel
- Interruption or delays to commercial activities that depend on road transport
- Increased maintenance and replacement costs
- Increased liability resulting from damage to road infrastructure
- Higher insurance costs for road authorities.

6.14.3 Proposed further assessment

A climate change risk assessment for the project would be undertaken in accordance with the Roads and Maritime Technical Guide for Climate Change Adaptation for the State Road Network (Roads and Maritime Unpublished, 2015c). The assessment would include:

- Identification of key climate variables such as temperature, rainfall and extreme events
- Identification of potential climate change scenarios, based on the latest and relevant climate projections that broadly identify how each climate variable may change over the design life of the project
- Identification of climate-based risks that may impact on the project as a result of climate change
- An assessment of potential impacts of priority climate change risks based on the consequence and likelihood of each risk
- Recommendation of adaptation options to mitigate climate risks.

6.14.4 Management and safeguard measures

Construction of the project would aim to minimise greenhouse gas emissions, largely through:

- Regularly maintaining construction plant and equipment to reduce energy efficiency losses associated with damaged or unmaintained equipment.
- Reduce construction transport requirements wherever reasonably possible, for example through use of local staff, resources, suppliers, and landfills.

The management of risks associated with the impacts of climate change on the operation and maintenance of the project would be through undertaking a climate change risk assessment and discussion with project design project engineers to adequately design and plan for predicted changes in climatic conditions.

Safeguards and management measures to minimise the emission of greenhouse gases associated with the operation and maintenance of the project would include:

- Consideration of the preferential selection of materials, vehicles and construction equipment with characteristics such as lower embodied energy and greater fuel efficiency, where feasible.
- The minimisation of vegetation clearance where reasonably possible.
- Development of an optimal design, including the vertical and horizontal alignments and reduction of stop start driving. These reductions would be cumulative over the design life of the project.

6.15 Sustainability

6.15.1 Overview

Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development calls for concerted efforts towards building an inclusive, sustainable and resilient future for people and planet. For sustainable development to be achieved, it is crucial to harmonize three core elements: economic growth, social inclusion and environmental protection. These elements are interconnected and all are crucial for the well-being of individuals and societies (UN, 2016).

In 2016, 17 Sustainable Development Goals of the United Nation's (UN) 2030 Agenda for Sustainable Development officially came into force. The Sustainable Development Goals that directly relate to the project are:

- No. 8 - Decent work and economic growth
- No. 9 - Industry, innovation and infrastructure
- No. 11 - Sustainable cities and communities

Roads and Maritime are committed to embedding sustainability considerations into its business to minimise its environmental footprint and deliver positive economic outcomes for the people of NSW. The Roads and Maritime *Environmental Sustainability Strategy 2015-19* aims to:

- Contribute to a more sustainable transport system in NSW
- Reduce the environmental footprint of Roads and Maritime activities
- Minimise the resources used in building and maintaining roads and maritime infrastructure
- Reduce the environmental impacts associated with the goods and services purchased and help improve the sustainability performance of organisations Roads and Maritime do business with.

It is anticipated that the project will develop project specific sustainability objectives and targets in line with the Roads and Maritime *Environmental Sustainability Strategy 2015-19* prior to the commencement of the detailed design phase.

6.15.2 Potential impacts

Construction

During the construction phase, key issues to address in terms of sustainability would include;

- Resource consumption of fuel, water and materials for construction
- Scope 1, 2 and 3 greenhouse gas emissions generated during construction (refer to **Section 6.12**)
- Generation of waste (including that produced by the project and by construction workers)
- Waste arising from potential contaminated lands
- Sustainable procurement – whole of life environmental, social and economic considerations.

Strategies for addressing the above are included within the Sustainability Strategy and include the use of recycled products to reduce the demand on resources, in instances where the use of such materials is cost and performance competitive. This may include the use of fly ash and slag within concrete mixes. Wherever possible, resource recovery principles would also be applied to the construction of the project, including recovery of resources for reuse, recycling and reprocessing.

Operation

Issues to address in terms of sustainability during the operation phase would include:

- Resource consumption of fuel, water and materials for maintenance activities
- Scope 1, 2 and 3 greenhouse gas emissions generated during operation, particularly as a result of energy use to power operational systems such as ventilation, lighting etc.
- Sustainable procurement – whole of life environmental, social and economic considerations
- Climate change mitigation and adaptation.

6.15.3 Proposed further assessment

During detailed design, a project-specific Sustainability Management Plan would be prepared to guide the implementation of the sustainability strategy throughout the design and construction phases. The Sustainability Management Plan will facilitate the achievement a project sustainability rating. The rating will be undertaken using the Infrastructure Sustainability Council of Australia sustainability ratings tool or an equivalent alternative tool.

6.15.4 Management and safeguard measures

Management measures developed to mitigate environmental impacts would consider and be consistent with the Sustainability Strategy.

6.16 Cumulative impacts

6.16.1 Overview

A cumulative impact refers to the result of the impact of an action coinciding or interacting with other impacts during the same time period and/or in the same area. Cumulative impacts are likely to have an effect, particularly on the following areas:

- Traffic and transport
- Air quality
- Noise and vibration
- Flooding and drainage
- Biodiversity
- Groundwater
- Social and economic.

A desktop assessment has identified developments which have the potential to interact with the project. It is likely the majority of cumulative impacts have the potential to occur during the construction of the project. Cumulative impacts around operational traffic, air quality and noise would likely occur during operation of the project.

6.16.2 Potential impacts

Key major projects that have the potential to interact with the project include:

- WestConnex M4 (Parramatta to Haberfield). This includes the M4 Widening between Pitt Street and Homebush Bay Drive, and M4 East between Homebush Bay Drive to Parramatta Road and Haberfield. The M4 Widening is now open to traffic. The M4 East is now under construction and continues the M4 in tunnel from Homebush Bay Drivel to Haberfield. This section is planned for completion in 2019
- WestConnex New M5 (Beverley Hills to St Peters). The New M5 will run from the existing M5 corridor at Beverley Hills via tunnel to an interchange at St Peters. This stage is scheduled for completion in 2019
- WestConnex M4-M5 Link would link the New M5 at St Peters with the M4 East at Haberfield. Construction is expected to commence in 2019 (pending approval), and is expected to be operational in 2023
- Sydney Gateway and other associated ground transport improvements identified by Sydney Airport Corporation within its *Sydney Airport Master Plan 2033* (SACL, 2014). In the long term, these projects are expected to assist in improving traffic flows to/from WestConnex and the connections to employment areas in the Sydney Airport and Port Botany area. Sydney Gateway would link to the St Peters interchange
- Other Sydney Airport projects. The *Sydney Airport Master Plan 2033* (SACL, 2014) identifies a number of construction activities associated with its aprons, airfield and terminals over the next 19 years, including works within the first five years and 10 year periods
- The Western Harbour Tunnel and Beaches Link. The planning and assessment process is in its early stages
- The Sydney Metro project, being delivered by Transport for NSW, this project involves 65 kilometres of a new stand-alone railway network from Rouse Hill to Bankstown, via the CBD. This project has commenced construction and is expected to be completed by 2024.

Construction

Concurrent or consecutive construction of the project with one or a number of the abovementioned projects has the potential to result in some adverse cumulative construction impacts for sensitive receivers. Cumulative impacts would be largely related to biodiversity, air quality, noise and vibration and traffic and transport.

Operation

Operation of the project simultaneously with other large road infrastructure projects and residential developments has the potential to generate cumulative impacts. Such cumulative impacts would be localised and would be largely related to amenity impacts on local residents, the local community and increasing demand for recreational areas within and in the vicinity of the project corridor. This may potentially include impacts to local traffic conditions, noise and vibration, air quality, social and economic impacts as well as impacts to visual amenity. Cumulative groundwater impacts may also occur and would need to be investigated further as part of the environmental impact statement.

6.16.3 Proposed further assessments

Project-specific assessments that would be completed for the project would consider the potential for cumulative impacts with other projects, including the potential cumulative impacts associated with the completed WestConnex. The environmental impact statement would consider the interrelationships between the project, the WestConnex and other major developments, and provide an understanding of the potential cumulative impacts associated with these interactions and identify appropriate management and mitigation strategies.

6.16.4 Management and safeguard measures

The mitigation and management of cumulative impacts associated with the proposal would be overseen and managed by Roads and Maritime. The cumulative impact resulting from other major developments would be dependent on the scheduling of those developments in the context of this project. Mitigation and management measures would be identified in the Construction Environmental Management Plan, and through coordination between the relevant construction contractors (if required).

7 Conclusion

Roads and Maritime is seeking approval to construct and operate the F6 Extension (New M5, Arncliffe to President Avenue, Kogarah); which would comprise a new, multi-lane road link between the New M5 at Arncliffe and President Avenue at Kogarah (the project).

The project would include twin motorway tunnels between the New M5 at Arncliffe and West Botany Street, near Rockdale Bicentennial Park. Each tunnel would be around 4 kilometres in length. A tunnel portal would be located at Kogarah within Rockdale Bicentennial Park and Memorial Fields (within the existing F6 reserved corridor), connecting to on- and off-ramps. The project would finish at a widened President Avenue, with slip lanes to provide connection to the project. Ancillary infrastructure, operational facilities, new service utilities and modifications to existing service utilities would be included as part of the project.

During construction of the project, temporary construction ancillary facilities would be required.

The project is declared State significant infrastructure (SSI) pursuant to section 5.12(2) of the EP&A Act and in accordance with clause 14 and Schedule 3 of State Environmental Planning Policy (State and Regional Development) 2011. The project would require the preparation of an environmental impact statement and approval from the Minister for Planning under Division 5.2 (section 5.14) of the EP&A Act.

The key environmental issues identified for the project include:

- Traffic and transport
- Air quality
- Noise and vibration
- Biodiversity.

The environmental impact statement would include the following:

- A detailed description of the project including its components, construction activities and potential staging
- A comprehensive assessment of the potential impacts on the key issues including a description of the existing environment, assessment of potential direct and indirect impacts, and construction, operation and staging impacts
- Description of measures to be implemented to avoid, minimise, managed, mitigate, offset and/or monitor the potential impacts
- Identify and address issues raised by stakeholders.

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Attachment A

Requirements of the Environmental Planning and Assessment Regulation 2000

Requirements of the Environmental Planning and Assessment Regulation 2000

Clause 192 of the *Environmental Planning and Assessment Regulation 2000* requires that an application for approval of the Minister to carry out State significant infrastructure must include:

a. details of any approval that would, but for section 5.23 of the Act, be required for the carrying out of the State significant infrastructure, and

b. details of any authorisations that must be given under section 5.24 of the Act if the application is approved, and

c. a statement as to the basis on which the proposed infrastructure is State significant infrastructure, including, if relevant, the capital investment value of the proposed infrastructure.

Approvals that would otherwise apply

Approvals that may be required to carry out the SSI, if not for section 5.23 of the EP&A Act, include:

- A permit under section 201, 205 or 219 of the *Fisheries Management Act 1994*.
- An approval under Part 4, or an excavation permit under section 139, of the Heritage Act 1977.
- An Aboriginal heritage impact permit under section 90 of the *National Parks and Wildlife Act1974*.
- A water use approval under section 89, a water management work approval under section 90 or an activity approval under section 91 of the *Water Management Act 2000*.

Section 5.23 does not remove the need to obtain an aquifer interference approval under the *Water Management Act 2000*, if that were to be otherwise required.

Authorisations if the application is approved

Authorisations that may be required for the project under section 5.24 of the EP&A Act include:

- An environment protection licence under Chapter 3 of the *Protection of the Environment Operations Act 1997*.
- Consent under section 138 of the *Roads Act 1993* (if required).

State significant infrastructure statement

The project is declared State significant infrastructure (SSI) pursuant to section 5.12(2) of the EP&A Act and in accordance with clause 14 and Schedule 3 of State Environmental Planning Policy (State and Regional Development) 2011. The project would require the preparation of an environmental impact statement and approval from the Minister for Planning under Division 5.2 (section 5.14) of the EP&A Act.

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Attachment B

Threatened flora and fauna species list

Table B-1 Listed threatened flora species with the potential to occur or previously recorded within the project corridor

Scientific name	Common name	Commonwealth listing (EPBC Act)		NSW listing (BC Act)	
		Yes/No	Status	Yes/No	Status
Flora (species)					
Acacia bynoeana	Bynoe's Wattle	Yes	Vulnerable	Yes	Endangered
Acacia terminalis subsp. terminalis	Sunshine Wattle	Yes	Endangered	Yes	Endangered
Syzygium paniculatum	Magenta Lilly Pilly	Yes	Vulnerable	Yes	Endangered
Caladenia tessellata	Thick Lip Spider Orchid	Yes	Vulnerable	Yes	Endangered
Persoonia hirsuta	Hairy Geebung	Yes	Endangered	Yes	Endangered
Acacia prominens	Gosford Wattle, Hurstville and Kogarah Local Government Areas	No	-	Yes	Endangered population
Wilsonia backhousei	Narrow-leafed Wilsonia	No	-	Yes	Vulnerable
Tetratheca juncea	Black-eyed Susan	Yes	Vulnerable	Yes	Vulnerable
Acacia pubescens	Downy Wattle	Yes	Vulnerable	Yes	Vulnerable
Maundia triglochinoides	-	No	-	Yes	Vulnerable
Melaleuca deanei	Deane's Paperbark	Yes	Vulnerable	Yes	Vulnerable

Table B-2 Listed threatened fauna species and populations with the potential to occur or previously recorded within the project corridor

Scientific name	Common name	Commonwealth listing (EPBC Act)		NSW listing (BC Act)	
		Yes/No	Status	Yes/No	Status
Fauna (species)					
Litoria aurea	Green and Golden Bell Frog	Yes	Vulnerable	Yes	Endangered
Botaurus poiciloptilus	Australasian Bittern	Yes	Endangered	Yes	Endangered
Haematopus longirostris	Pied Oystercatcher	No	-	Yes	Endangered
Calidris ferruginea	Curlew Sandpiper	Yes	Critically Endangered	Yes	Endangered
Dugong dugon	Dugong	No	-	Yes	Endangered
Eubalaena australis	Southern Right Whale	Yes	Endangered	Yes	Endangered
Perameles nasuta	Long-nosed Bandicoot population in inner western Sydney	No	-	Yes	Endangered population
Epthianura albifrons	White-fronted Chat population in the Sydney Metropolitan Catchment Management Area	No	-	Yes	Endangered population
Anthochaera phrygia	Regent Honeyeater	Yes	Critically Endangered	Yes	Critically endangered
Crinia tinnula	Wallum Froglet	No	-	Yes	Vulnerable
Ptilinopus superbus	Superb Fruit-Dove	No	-	Yes	Vulnerable
Hieraaetus morphnoides	Little Eagle	No	-	Yes	Vulnerable
Haematopus fuliginosus	Sooty Oystercatcher	No	-	Yes	Vulnerable

Scientific name	Common name	Commonwealth listing (EPBC Act)		NSW listing (BC Act)	
Epthianura albifrons	White-fronted Chat	No	-	Yes	Vulnerable
Artamus cyanopterus cyanopterus	Dusky Woodswallow	No	-	Yes	Vulnerable
Pteropus poliocephalus	Grey-headed Flying-fox	Yes	Vulnerable	Yes	Vulnerable
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	No	-	Yes	Vulnerable
Myotis macropus	Southern Myotis	No	-	Yes	Vulnerable
Arctocephalus pusillus doriferus	Australian Fur-seal	No	-	Yes	Vulnerable
Calyptorhynchus lathami	Glossy Black-Cockatoo	No	-	Yes	Vulnerable
Lophochroa leadbeateri	Major Mitchell's Cockatoo	No	-	Yes	Vulnerable
Callocephalon fimbriatum	Gang-gang Cockatoo	No	-	Yes	Vulnerable
Neophema pulchella	Turquoise Parrot	No	-	Yes	Vulnerable
Ninox strenua	Powerful Owl	No	-	Yes	Vulnerable
Tyto novaehollandiae	Masked Owl	No	-	Yes	Vulnerable

Table B-3 Listed migratory bird species and populations with the potential to occur or previously recorded within the project corridor

Scientific name	Common name	Commonwealth listing (EPBC Act)		NSW listing (BC Act)	
		Yes/No	Status	Yes/No	Status
Migratory birds (species)					
Diomedea exulans	Wandering Albatross	Yes	Endangered, JAMBA	Yes	Endangered
Calidris ferruginea	Curlew Sandpiper	Yes	Critically Endangered, CAMBA, JAMBA and ROKAMBA	Yes	Endangered
Sternula albifrons	*Little Tern*	Yes	JAMBA**	Yes	Endangered
Hirundapus caudacutus	White-throated Needletail	Yes	CAMBA*, JAMBA and ROKAMBA***	No	-
Ardenna pacificus	Wedge-tailed Shearwater	Yes	JAMBA	No	-
Ardea ibis	Cattle Egret	Yes	CAMBA, JAMBA	No	-
Pluvialis fulva	Pacific Golden Plover	Yes	CAMBA, JAMBA and ROKAMBA	No	-
Actitis hypoleucos	Common Sandpiper	Yes	CAMBA, JAMBA and ROKAMBA	No	-
Arenaria interpres	Ruddy Turnstone	Yes	CAMBA, JAMBA and ROKAMBA	No	-
Calidris acuminata	Sharp-tailed Sandpiper	Yes	CAMBA, JAMBA and ROKAMBA	No	-
Calidris canutus	Red Knot	Yes	Endangered, CAMBA, JAMBA and ROKAMBA	No	-
Calidris ruficollis	Red-necked Stint	Yes	CAMBA, JAMBA and ROKAMBA	No	-

Scientific name	Common name	Commonwealth listing (EPBC Act)		NSW listing (BC Act)	
Gallinago hardwickii	Latham's Snipe	Yes	CAMBA, JAMBA and ROKAMBA	No	-
Limosa lapponica	Bar-tailed Godwit	Yes	CAMBA, JAMBA and ROKAMBA	No	-
Numenius madagascariensis	Eastern Curlew	Yes	Critically Endangered, CAMBA, JAMBA and ROKAMBA	No	-
Tringa brevipes	Grey-tailed Tattler	Yes	CAMBA, JAMBA and ROKAMBA	No	-
Tringa glareola	Wood Sandpiper	Yes	CAMBA, JAMBA and ROKAMBA	No	-
Tringa incana	Wandering Tattler	Yes	JAMBA	No	-
Tringa stagnatilis	Marsh Sandpiper	Yes	CAMBA, JAMBA and ROKAMBA	No	-
Hydroprogne caspia	Caspian Tern	Yes	CAMBA, JAMBA	No	-
Haliaeetus leucogaster	White-bellied Sea-Eagle	Yes	CAMBA	Yes	Vulnerable
Charadrius leschenaultii	Greater Sand-plover	Yes	Vulnerable, CAMBA, JAMBA and ROKAMBA	Yes	Vulnerable
Charadrius mongolus	Lesser Sand-plover	Yes	Endangered, CAMBA, JAMBA and ROKAMBA	Yes	Vulnerable
Calidris alba	Sanderling	Yes	CAMBA, JAMBA and ROKAMBA	Yes	Vulnerable
Calidris tenuirostris	Great Knot	Yes	Critically Endangered, CAMBA, JAMBA and ROKAMBA	Yes	Vulnerable

Scientific name	Common name	Commonwealth listing (EPBC Act)		NSW listing (BC Act)	
Limicola falcinellus	Broad-billed Sandpiper	Yes	CAMBA, JAMBA and ROKAMBA	Yes	Vulnerable
Limosa limosa	Black-tailed Godwit	Yes	CAMBA, JAMBA and ROKAMBA	Yes	Vulnerable
Xenus cinereus	Terek Sandpiper	Yes	CAMBA, JAMBA and ROKAMBA	Yes	Vulnerable

* CAMBA – China-Australia Migratory Bird Agreement: Refers to species listed in the Bilateral Agreement between the Government of Australia and the Government of the People's Republic of China for the protection of Migratory Birds and their Environment (Subdivision A of Division 1 of Part 5, Commonwealth EPBC Act 1999).
**JAMBA – Japan-Australia Migratory Bird Agreement: Refers to species listed in the Bilateral Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (Subdivision A of Division 1 of Part 5, Commonwealth EPBC Act 1999).
***ROKAMBA - Republic of Korea-Australia Migratory Bird Agreement: Refers to species listed in the Bilateral Agreement between the Government of Australia and the Government of the Republic of Korea for the protection of Migratory Birds and their Environment (Subdivision A of Division 1 of Part 5, Commonwealth EPBC Act 1999).

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