Roads and Maritime Services

M1 Princes Motorway, Mount Ousley Interchange
Review of environmental factors

November 2017

Prepared by Roads and Maritime Services

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Executive summary

The proposal

Roads and Maritime Services proposes to upgrade the M1 Princes Motorway and Mount Ousley Road intersection to a grade-separated interchange to improve road safety, travel times and cater for the efficient movement of future freight.

The main benefits of the proposal are:

- improved travel times
- safer access to and from the motorway to Mount Ousley Road
- improved access to the Wollongong CBD and University of Wollongong
- improved safety by separating cars and heavy vehicles travelling down Mount Ousley
- improved amenity for pedestrians and cyclists
- reduced vehicle operating costs
- provides for future traffic growth.

The main features of the proposal are:

- an overpass for safe access between Mount Ousley Road, the M1 Princes Motorway and the University of Wollongong
- a dedicated heavy vehicle bypass lane, to separate heavy vehicles from general southbound traffic on the M1 Princes Motorway and light vehicles exiting at Mount Ousley Road
- a dedicated southbound heavy vehicle exit ramp onto Mount Ousley Road, to separate heavy and light vehicles exiting the M1 Princes Motorway to Mount Ousley Road
- a new access to the University of Wollongong to and from the M1 Princes Motorway and Mount Ousley Road
- new roundabouts at Mount Ousley Road, servicing the new entrance to the University of Wollongong and for vehicles exiting the M1 Princes Motorway at Mount Ousley Road
- a new southbound service road, which would replace the existing southbound access from the M1 Princes Motorway to University Avenue
- two new heavy vehicle safety ramps
- a new pedestrian and cyclist bridge over Mount Ousley Road and the M1 Princes Motorway, and a new shared path connecting suburbs to the north with the University of Wollongong and the TAFE NSW Wollongong campus
- upgrades to the existing pedestrian bridge over the M1 Princes Motorway at Northfields Avenue
- a new commuter car park, relocated to the southern side of the M1 Princes Motorway, with additional formalised parking spaces
- new noise walls along the M1 Princes Motorway, between the motorway and nearby residential areas
  - on the northern side of the M1 Princes Motorway, extending the existing noise wall along Dumfries Avenue as far as Foothills Road
on the southern side of the M1 Princes Motorway, extending the existing noise wall along the edge of the motorway as far as the proposed western roundabout

- New noise walls along Mount Ousley Road, between the M1 Princes Motorway interchange and Gowan Brae Avenue.

**Need for the proposal**

The M1 Princes Motorway is the main road linking Sydney and the Illawarra. More than 50,000 vehicles use the motorway at the base of Mount Ousley near Wollongong each day, with heavy vehicles representing up to 15 per cent of daily vehicle movements.

The proposal is needed to address a number of current road safety, efficiency and accessibility issues.

The southbound approach to the M1 Princes Motorway/Mount Ousley intersection is steep, with grades of up to 10 per cent.

In the southbound direction, the M1 Princes Motorway has a sign-posted speed limit of 80 km/h for light vehicles and 40 km/h for heavy vehicles. This speed difference creates conflicts as faster moving light vehicles (travelling in the right lane) are required to weave and merge across groups of slower moving heavy vehicles (travelling in the left lane) to exit at Mount Ousley Road. This presents safety concerns and affects the smooth flow of traffic.

The M1 Princes Motorway/Mount Ousley Road intersection is the only location on the motorway between Heathcote and Albion Park Rail where vehicles are required to make an at-grade right turn (give way to through traffic) to access the motorway. Between July 2011 and June 2016, 56 crashes were reported near the intersection. These included one fatal crash, 23 injury crashes and 32 non-injury crashes.

Further south on the M1 Princes Motorway, the southbound morning queue from University Avenue regularly extends back toward the motorway with vehicles accessing the university and surrounds. This creates traffic flow breakdown on the Princes Motorway and increases the risk of crashes as vehicles intending to exit to University Avenue slow down on the motorway. Modelling shows that in the future, these queues will regularly extend back onto the motorway and past the Mount Ousley Road intersection, blocking access into Wollongong by this route.

Freight movements are increasing on the M1 Princes Motorway. Many of the heavy vehicles continue on the M1 Princes Motorway to Port Kembla, which is one of the largest mixed commodity ports on the east coast. Further, general traffic volumes are increasing, with the motorway intersections with Mount Ousley Road and University Avenue (southbound) already operating over capacity during peak periods, with substantial delays.

Without the proposal, the safety and the efficiency of the M1 Princes Motorway and its intersection with Mount Ousley Road and University Avenue interchange will continue to experience congestion and a high crash rate, which would worsen over time.

Roads and Maritime has identified the M1 Princes Motorway/Mount Ousley Road intersection as needing to be upgraded to improve road safety, improve travel time and traffic efficiency, provide for the needs of the growing freight industry, and enhance accessibility to and from the motorway, the Wollongong CBD and surrounding suburbs, the University of Wollongong and Port Kembla.
Proposal objectives and development criteria

In 2015, Roads and Maritime investigated the need, justification and feasibility of upgrading the M1 Princes Motorway/Mount Ousley intersection, and assessed a number of options. During this process, specific objectives were identified for the proposal to guide its planning and development.

Proposal objectives

The objectives of the proposal are to:

- improve safety by addressing conflicting movements and the interaction between light and heavy vehicles
- improve travel time and efficiency for vehicles travelling on this length of the M1 Princes Motorway
- provide for the growing freight task including supporting the expanding port at Port Kembla
- enhance accessibility to/from the M1 Princes Motorway and the Wollongong CBD.

Urban design objectives

Urban design objectives and principles were also developed to guide the physical design of the proposal in a way that is consistent with the overall proposal objectives. These objectives involve improving road network connectivity and the location and placement of traffic signage, achieving a well-integrated design, preserving the existing landscape character where possible and providing a unique experience to mark the entry to North Wollongong and the CBD from the M1 Princes Motorway. The urban design objectives are set out in detail in Section 6.4.

Options considered

Prior to developing a concept design for the proposal, Roads and Maritime carried out early investigations to identify and assess options against the objectives referred to above. These investigations and assessments are captured in the following reports:

- Preliminary Environmental Investigation (PEI) (January, 2015)
- Value Management Study (December, 2015)
- Strategic Business Case (February, 2016)
- Preferred Option Report (June, 2016).

The value management study was carried out to identify the option that would best meet the overall needs of road users and the local community.

Strategic options

Roads and Maritime developed four strategic options that would address the need for the project. The four options (described and illustrated in Section 2.4) adopted different design strategies for:

- separation of light and heavy vehicles
- grade-separation of the right turn from Mount Ousley Road onto the M1 Princes Motorway
- access to and from the University of Wollongong
- connections to the M1 Princes Motorway and to adjoining roads.

In summary, to separate light and heavy vehicle movements at the base of Mount Ousley, Options 1 and 2 provided grade separated access ramps in the middle of the motorway for vehicles entering and exiting the motorway at Mount Ousley Road, and Options 3 and 4 provided heavy
vehicle bypass lanes. All options provided a new entry to the University of Wollongong but only Option 4 provided a new exit from the University of Wollongong.

‘Do minimum’ scenario

In addition to the strategic options, two low-cost or ‘do-minimum’ options were also considered:

- a ban on right turns from Mount Ousley Road onto the M1 Princes Motorway
- grade separation of the right turn from Mount Ousley Road onto the M1 Princes Motorway, and signalising the roundabouts at the University Avenue interchange.

Neither of these options would fully meet the project objectives or address the existing and future issues of traffic congestion, conflicts between light and heavy vehicles, road safety and overall network efficiency. Therefore, the ‘do-minimum’ scenario options were not considered further.

Commuter car park options

Two options were considered for relocation of the commuter car park near the Mount Ousley Road and Princes Motorway intersection:

- a site south of the M1 Princes Motorway between the M1 Princes Motorway and the proposed overpass in land currently owned by the University of Wollongong (option 1)
- a site located south of Mount Ousley Road and east of the M1 Princes Motorway (option 2).

Following the development of the preferred option design to include a new service road between Mount Ousley Road and University Avenue, option 1 for the commuter carpark has been selected.

Options analysis

Analysis of options focused on the relative benefits and disadvantages of each option in relation to proposal objectives, and their performance against the assessment criteria including functional, environmental and socio-economic criteria.

The main findings were:

- Option 4 scored highest on functional criteria of road safety, travel reliability and efficiency, sight distances for road network signage, and reducing work health safety risks in construction, operation and maintenance
- Option 1 scored consistently higher against socio-economic and environmental criteria, primarily based on the relative size of the option footprints.

When the strategic cost comparisons for each option were applied in the calculation of benefit-cost ratios (BCR) for each option, Option 4 performed the best.

Preferred option

Option 4 was selected as the preferred option as it provides a value for money solution that best addresses the traffic and safety issues on the M1 Princes Motorway and nearby intersections. Option 4 also provides an exit from the University of Wollongong onto the M1 Princes Motorway, reducing congestion within the university and surrounding local road network particularly in the afternoon peak. This option can largely be constructed offline providing safety and traffic management advantages during construction. Option 4 was selected by all stakeholders who participated in the value management study in December 2015 as the option to progress for further development.
Design refinements to the preferred option

During development of the concept design, the preferred option was refined and enhanced in response to recommendations made in the value management study and community consultation on the preferred option. The changes involved closer investigation of:

- heavy vehicle off ramp and heavy vehicle bypass design
- heavy vehicle safety ramps design and location
- alignment of Mount Ousley Road and the new bridge over the M1 Princes Motorway
- addition of the southbound service road between Mount Ousley Road and the University Avenue interchange
- inclusion of northbound access to the interchange
- shared pedestrian/cycle paths design and connections to existing pedestrian/cyclist routes
- location, layout and access arrangements for a new commuter car park.

All of the above design refinements are described in detail in Section 3.2.

Community and stakeholder consultation

Roads and Maritime carried out formal consultation between December 2015 and August 2016 to seek community and stakeholder input to the proposal's early planning phase, the identification of options and selection of the preferred option.

Key stakeholders including Wollongong City Council and the University of Wollongong were directly involved in the options selection and assessment process, and actively participated in the value management study.

Roads and Maritime also formally consulted with Wollongong City Council in line with the requirements of the *State Environmental Planning Policy (Infrastructure) 2007* (ISEPP).

The community was invited to provide feedback on the preferred option design between Tuesday 21 June 2016 and Monday 1 August 2016. Special interest groups including the Illawarra Bicycle User Group (IBUG) and Neighbourhood Forum 5 were also contacted directly and invited to give feedback on the preferred option. Community feedback on the preferred option was received via the project information telephone number, project email address, letters, community information sessions, on the M1 Princes Motorway/Highway Facebook page and an online survey.

As part of consultation activities during the display period, in total Roads and Maritime:

- spoke to over 80 people at information sessions and over the phone
- received 60 email or mailed submissions
- received 395 online survey submissions
- received 21 comments on the M1 Princes Motorway/Princes Highway upgrade Facebook page.

Additional targeted consultation was also carried out with Mount Ousley residents regarding commuter car park options. Roads and Maritime will continue to consult with the community and stakeholders during development of the proposal.
Roads and Maritime invites comments on this REF. Submissions received during the public display period will be addressed in a formal submissions report and, if a decision is made to proceed with the proposal, will be considered during detailed design of the proposal.

Statutory and planning framework

Clause 94 of ISEPP permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent.

As the proposal is for the purpose of a road and is to be carried out by Roads and Maritime, development consent from Wollongong City Council is not required. The proposal is not State significant infrastructure or State significant development, and can be assessed under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

Roads and Maritime is the determining authority for the proposal. The proposal is not considered likely to have a significant impact on the environment and would not require the preparation of an Environmental Impact Statement (EIS). This Review of Environmental Factors (REF) has been prepared as part of the assessment process.

Environmental impacts

The development of the proposal would have some impacts during construction. There would also be longer term impacts and benefits once the proposal is operating. These are summarised below.

Traffic and access

During construction, access to all properties adjoining the proposal area would be maintained under a construction staging strategy developed by Roads and Maritime and the construction contractor. The proposed construction method and staging would ensure that the M1 Princes Motorway, Mount Ousley Road and connections with local roads would remain open to traffic at all times. Private property access, and access to major land uses such as the University of Wollongong, would be maintained during construction and in operation. During construction some routes, such as the right turn from Mount Ousley Road onto the Princes Motorway and northbound access to the Princes Motorway from Northfields Avenue, would be impacted for periods. Temporary detours would be required which would result in short term increases in delays and travel times.

Due to the proposed southbound service road between Mount Ousley Road and University Avenue, which would remove the impacts of queues from the motorway, southbound heavy vehicles including buses would no longer be able to directly access University Avenue. These vehicles would instead need to exit at Mount Ousley Road and either use the Gaynor Avenue or Princes Highway roundabouts to return westbound on Mount Ousley Road and access the southbound service road towards University Avenue.

With the proposal built and operating, the capacity of the M1 Princes Motorway/Mount Ousley Road interchange would improve substantially. The proposal would achieve the primary objectives of improving travel time and efficiency, accommodating future growth in freight transport and enhancing accessibility between the M1 Princes Motorway and the Wollongong CBD. As well as improving the level of service at the intersection of the motorway with Mount Ousley Road, the proposal would also reduce congestion at the southbound exit to University Avenue, which currently performs poorly, particularly during the morning peak.
The proposal would also contribute to improved road safety by eliminating the only at-grade right turn onto the M1 Princes Motorway between the southern outskirts of Sydney and Albion Park. It would also eliminate existing southbound merge and weave movements that occur when vehicles enter or exit the motorway at Mount Ousley Road, and therefore eliminate points of conflict between light and heavy vehicles.

The proposal includes a new access road from the M1 Princes Motorway and Mount Ousley Road into the northern side of the University of Wollongong. The proposed northern access road would alleviate traffic congestion by spreading the demand across all university access points, particularly during peak times.

**Noise and vibration**

During construction, predicted noise levels indicate there would be noise impacts at locations close to the proposal. Construction noise would mostly impact residents in Falder Place, Dumfries Avenue and Mount Ousley Road. The majority of construction activities would take place during normal daytime working hours. However, some construction activities would be carried out outside of standard construction hours, where it is unsafe to carry out those works close to live traffic. For example, where existing noise barriers are required to be removed and relocated to accommodate the works, performing this activity outside periods of heavy traffic potentially allows closure of one traffic lane for worker safety without adversely impacting overall traffic flow. Where construction noise is predicted to exceed noise management levels, including planned night time or weekend works, this would be mitigated through construction noise management techniques outlined in an out of hours work procedure in line with the Construction Noise and Vibration Guideline (Roads and Maritime, 2016).

Residential (and other sensitive) receivers around the proposal currently experience high road traffic noise from the existing Princes Motorway and Mount Ousley Road, including some locations in Falder Place, Dumfries Avenue and Mount Ousley Road where noise levels exceed the acute road traffic noise criteria. Where Roads and Maritime completes road upgrade works in locations with existing acute road traffic noise levels, Roads and Maritime considers implementing measures to reduce road traffic noise experienced by these sensitive receivers where feasible and reasonable. Although less than one per cent of receivers are predicted to experience an increase of more than 2.0 dB as a result of the works, i.e. less than one per cent of receivers would experience a perceptible increase in noise levels, Roads and Maritime is proposing a range of noise mitigation measures for the proposal including:

1. A noise barrier along the northern side of the M1 Princes Motorway and the southern side of Dumfries Avenue, between the end of the existing noise wall and about Foothills Road,
2. A noise barrier along the southern side of the M1 Princes Motorway and the northern side of Falder Place, between about the mid-way point of Binda Street and the proposed western roundabout,
3. A noise barrier along the southern side of Old Mount Ousley Road, between the cul-de-sac at the western end and Gowan Brae Avenue, and continuing to the south from the cul-de-sac, so as to shield the properties at the end of Old Mount Ousley Road,
4. At-property treatments at residential receivers where noise levels are still predicted to exceed road traffic noise criteria.

This REF has assessed a range of noise barrier heights which have varying noise benefits and visual impacts. The final location, placement and height of noise barriers would be confirmed during detailed design and in consultation with impacted residents.
With the proposal and after the erection of proposed noise barriers, about 52 residences near the proposal would continue to experience operational noise impacts. These residences would be eligible for consideration of at-property treatments to mitigate operational noise. The majority of these residences are located close to the existing road alignment (such as Dumfries Avenue, Falder Place and Mount Ousley Road) and already experience high noise levels during the day and night. For those areas where noise barriers are either not proposed or would not be effective, individual at-property treatments would be considered for residences where noise management levels are predicted to be exceeded. Noise mitigation, where reasonable and feasible, would be considered during detailed design and in consultation with impacted residents.

**Biodiversity**

The proposal involves works in an existing main road corridor, but would result in disturbance through clearing and earthworks in vegetated areas north and south of the existing M1 Princes Motorway. The proposal requires extensive clearing during construction of about 7.58 hectares of two (non-threatened) plant community types, about 5.05 hectares of roadside and urban plantings, and about one hectare of weed dominated vegetation.

Vegetation removal during construction would have a direct impact on fauna habitat, including the removal of about 19 hollow bearing trees, including dead trees.

The proposal would involve clearing nationally listed threatened species habitat (ie habitat for *Syzygium paniculatum* (Magenta Lilly Pilly) and Grey-headed Flying-fox). As more than one hectare of habitat in moderate to good condition would be cleared, offsets or supplementary measures would be implemented for the proposal, as discussed in Section 6.3.

In addition to offsets, the proposal area would be improved and landscaped with native vegetation unique to the lower Illawarra escarpment and coastal plain following construction.

No threatened aquatic species are likely to occur in streams impacted by the proposal, due to their poor condition and lack of characteristic habitat features associated with listed species. Significant impacts to aquatic ecosystems are unlikely to occur as a result of the proposal.

**Landscape character and visual impacts**

Visual and landscape impacts would occur during the proposal's construction and operation. Construction impacts would include a changed visual environment from construction plant, equipment, the construction compound and stockpiles. Local landscapes would be altered by earthworks and vegetation clearing creating a wider road corridor, changing the sight lines between the road corridor and surrounding land. During construction, residents in Dumfries Avenue would potentially have a temporary view to the M1 Princes Motorway, where they currently overlook an area of dense vegetation. Similarly, views from the northern side of the University of Wollongong would be temporarily opened up to the motorway during construction.

Once the proposal is built, there would be permanent visual and landscape changes throughout the proposal area. The main visual changes would be due to the major new structures proposed, such as the bridge over the M1 Princes Motorway, the large retaining wall supporting the western end of Mount Ousley Road and noise walls. Early assessments have indicated substantial noise wall heights may be required, which could visually impact the 'gateway' to Wollongong. Urban design features of noise walls will be investigated and the community further consulted during the detailed design process.
Some changes may have a negative impact on the visual landscape, such as the loss of vegetated areas between Dumfries Avenue and the M1 Princes Motorway and its replacement with road infrastructure, including two heavy vehicle safety ramps, a heavy vehicle off ramp and a heavy vehicle bypass. These structures would include associated earthworks formations and retaining walls.

The local landscape would be permanently altered by changed road surface levels, the two bridges (including the pedestrian bridge over Mount Ousley Road), retaining walls and other new road infrastructure.

Some of the changes would be beneficial, such as the improved pedestrian and cyclist facilities, and roadside landscaping. The proposed new interchange has been designed with urban design objectives of creating a new ‘gateway’ to Wollongong that improves the location and placement of traffic signage and the driver experience.

The visual impact would be softened over time as the proposed landscape and plants reach maturity. The proposed landscaping and revegetation would also provide an effective visual shield for surrounding residential areas (see Section 6.4).

**Hydrology and flooding**

The proposal would cross two main natural drainage channels and would impact on the flood behaviour of a third, as documented in Section 6.5. As a result of the increased impervious area, the proposal would result in minor flooding increases on the motorway carriageways and some downstream areas during extreme rain events. During these events, some upstream areas would also experience increases in flood levels, but these would be mostly contained within the existing channels. Some areas downstream from the proposal would experience flood level reductions as a result of the proposal.

The flood modelling and investigations carried out for the proposal show that some properties to the south of University Avenue, on both sides of the M1 Princes Motorway in Murphys Avenue, Graham Avenue and College Place, would experience increases in flood levels during the 1% AEP (Annual Exceedance Probability) event (sometimes referred to as the 1 in 100 year storm event) of up to 0.06 metres. Investigations show that properties in these areas already experience some flooding during extreme events. The modelling also showed that the inundation duration at impacted locations would either remain about the same or be reduced slightly.

It is recommended that flood impact criteria be adopted so that future design iterations can work towards a target flood impact where no floor levels of properties that are not currently impacted by the 1% annual exceedance probability (AEP) event would be impacted as a result of the proposal.

**Surface and groundwater quality**

Construction works have the potential to impact on surface water quality during construction. The biggest risk is from sediment-laden run-off caused by excavation, vegetation removal and other surface work, particularly before or during periods of heavy rainfall. Erosion and sedimentation control measures are therefore proposed to manage potential water quality issues.

During construction, the proposal may reach the groundwater table. As a result, minor dewatering activities may be required during construction activities. However as the interaction with the groundwater is minimal and very localised, dewatering activities would be unlikely to impact on any nearby groundwater dependent ecosystems or watercourses.
During operation, run-off from the proposal could potentially impact on local surface water quality by washing litter, debris and pollutants (such as hydrocarbons) from the road pavement into surrounding natural drainage lines and water courses. Operation of the proposal would not impact groundwater as there would not be any ongoing dewatering activities and any surface run-off would be captured within drainage infrastructure and channelled into existing drainage lines.

To protect water quality during operation, all run-off from the road would be captured and conveyed by new pavement drainage systems to existing drainage lines along the M1 Princes Motorway. Existing cross-drainage infrastructure, such as culverts, would be upgraded or replaced where required, to capture and convey overland flows and to channel them into existing drainage lines.

Spill containment basins would be constructed to protect downstream water quality in the event of any pollutant spillage incidents on the M1 Princes Motorway and vegetated drainage swales would be implemented to reduce impacts.

Social and economic factors

The proposal has the potential for both regional and local benefits in the medium to longer term through reduced traffic congestion, improved access and road safety, and more efficient connectivity between the M1 Princes Motorway and key destinations in and around the City of Wollongong including the University of Wollongong.

However, there would be adverse impacts during both construction and operation. The combined effect of construction noise, dust and general disturbance caused by construction activity, construction traffic and machinery movements would result in a short term, temporary loss of amenity for residents, motorists, workers and others who live near the proposal area and those who visit the proposal area on a regular basis.

The existing commuter car park would be closed during the construction process, and the proposed new car park would not be opened until work is completed. Therefore, commuters who rely on this facility would need to seek alternative temporary parking options in surrounding local streets until construction of the proposal is complete. When opened, the new commuter car park would have increased parking spaces and improved access to and from the motorway and surrounding areas.

The long term effect would be an overall social benefit, through improvements to the transport network in and around the proposal area. The proposal would not only provide improved conditions for motorists, it would improve pedestrian and cycle connectivity, improve safety for all road users and reduce traffic noise impacts for some receivers. The proposal would achieve this benefit without private property acquisition or any impact on local heritage.

Cumulative impacts

The M1 Princes Motorway improvements between Picton Road and Bulli Tops is a proposal to improve safety, capacity and travel times on this section of the motorway. This proposal is located about 7 kilometres north of the M1 Princes Motorway Mount Ousley interchange proposal. There is potential for the construction periods of the two proposals to overlap, which may result in some additional delays for vehicles travelling along this route. Traffic management of both proposals would be considered to minimise delays.

There is potential for the proposal to result in a cumulative impact with works being carried out or proposed under the current University of Wollongong campus masterplan. Depending on the program of development for the masterplan, this could include the in-combination impact of
construction traffic on the local road network, and related noise and air quality impacts on nearby receptors. The University of Wollongong masterplan and the proposal would improve the visual landscape, help to enhance local biodiversity and enhance connectivity and public access for the town of Wollongong in the operation of the proposal.

**Justification and conclusion**

The proposed upgrade of the intersection of the M1 Princes Motorway and Mount Ousley Road is subject to assessment under Part 5 of the EP&A Act. The REF has examined, and taken into account to the fullest extent possible, all environmental matters affecting or likely to be affected by the proposal.

A number of potential environmental impacts from the proposal have been avoided or reduced during the concept design and options assessment process, particularly in relation to the proposed resolution of existing traffic and transport issues and conflicts, and the proposed construction methodology and staging.

The proposed upgrade of the M1 Princes Motorway Mount Ousley interchange, as described in this REF, best meets the proposal objectives. However, it would still result in some potential impacts during construction and operation including construction noise and vibration, changes to access and traffic delays during construction, increased flooding at some locations, and visual and landscape changes. Mitigation measures would seek to manage and minimise these potential impacts.

The proposal’s environmental impacts are not considered significant and an environmental impact statement is not required. Therefore, approval is not required from the Minister for Planning under Part 5.1 of the EP&A Act. The proposal is unlikely to significantly affect threatened species, populations or ecological communities or their habitats, within the meaning of the *Threatened Species Conservation Act 1995* or *Fisheries Management Act 1994* and a Species Impact Statement is not required. The proposal is unlikely to affect Commonwealth land or have a significant impact on any matters of national environmental significance.

The proposal would reduce traffic congestion, provide additional capacity and improve road user safety on the M1 Princes Motorway and Mount Ousley Road by separating light and heavy vehicles at the base of Mount Ousley, providing an overpass from Mount Ousley Road onto the M1 Princes Motorway and enhancing connectivity for pedestrians and cyclists.

On balance, the proposal’s long term benefits would outweigh its impacts, and the proposal is considered to be justified.
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1 Introduction

1.1 Proposal identification

Jacobs has been appointed by Roads and Maritime Services to undertake the concept design and environmental assessment for the upgrade of the M1 Princes Motorway Mount Ousley interchange. The primary goals of the proposed upgrade are to improve road safety, travel times and to cater for the growing freight task.

The M1 Princes Motorway is the primary road link between Sydney and the Illawarra with average daily traffic of more than 50,000 vehicles per day using this link at the base of Mount Ousley near Wollongong. Heavy vehicles represent up to 15 per cent of total daily vehicle movements. The M1 Princes Motorway and Mount Ousley Road currently experience heavy traffic congestion particularly during weekday, weekend and holiday peaks. The intersection of these two roads is the only location on the M1 Princes Motorway between Waterfall and Albion Park Rail (a distance of about 60 km) where vehicles turning right to access the motorway need to give way to oncoming motorway traffic. In addition to poor road network performance, 56 crashes were recorded in the vicinity of the intersection during the five year period between July 2011 and June 2016 (inclusive). Of the 56 crashes, one crash resulted in one fatality and four injuries, and 23 were injury crashes. The two most common crash types were intersection and rear end crashes.

The southbound carriageway of the M1 Princes Motorway has a signposted speed limit of 80 km per hour for light vehicles and 40 km per hour for heavy vehicles (trucks and buses). This speed differential creates conflicts between light and heavy vehicles as faster moving light vehicles (travelling in the median lane) are required to cut across groups of slower moving heavy vehicles (travelling in the kerbside lane) to access the exit at Mount Ousley Road. Conflicting interactions between light and heavy vehicles create road safety risks as well as contributing to flow breakdown (stop-start or acceleration and braking) conditions, thus affecting the efficiency of the network in this area. In turn, this reduces the efficiency of access to nearby destinations, such as the Wollongong CBD and University of Wollongong.

Further south on the M1 Princes Motorway, the southbound morning traffic queue at the University Avenue off ramp is observed to tail back toward the motorway, comprising vehicles mostly bound for the university. This also creates flow breakdown on the motorway and increases the risk of crashes between through traffic and vehicles slowing down to exit the motorway. Modelling shows that in the future years, without intervention these queues would regularly extend back onto the M1 Princes Motorway in peak times, blocking the Mount Ousley Road intersection and southbound access into Wollongong.

Additionally, the M1 Princes Motorway creates a barrier for safe pedestrian and cyclist movements between the University of Wollongong and suburbs to the north. Within three km of the university, 23 percent of students live to the north of the campus. However, only four percent of people who walk to the university come from suburbs to the north.

1.1.1 The proposal

The proposal is situated at the base of the Illawarra escarpment at Mount Ousley, where the M1 Princes Motorway enters Wollongong via an existing at-grade intersection with Mount Ousley Road, as shown in Figure 1-1. The main features of the proposal, illustrated in Figure 1-2 include:

- An overpass from Mount Ousley Road to allow northbound traffic to safely access the M1 Princes Motorway
• A dedicated heavy vehicle bypass lane, to separate heavy vehicles from general southbound traffic on the M1 Princes Motorway and light vehicles exiting at Mount Ousley Road

• A dedicated southbound heavy vehicle exit ramp to Mount Ousley Road, to separate heavy and light vehicles exiting the M1 Princes Motorway to Mount Ousley Road

• A new entry to the University of Wollongong from the M1 Princes Motorway, for both northbound and southbound vehicles, via a new overpass from Mount Ousley Road and a new (northbound) motorway exit ramp

• A new exit from the University of Wollongong to the M1 Princes Motorway northbound, and to Mount Ousley Road via the new overpass

• New roundabouts at Mount Ousley Road, servicing the new entrance to the University of Wollongong and for vehicles exiting the M1 Princes Motorway (from northbound and southbound lanes) at Mount Ousley Road

• A new southbound service road, which would replace the existing southbound access from the M1 Princes Motorway to University Avenue

• Two new heavy vehicle safety ramps

• A new pedestrian and cyclist bridge over Mount Ousley Road and the M1 Princes Motorway, and a new shared path connecting suburbs to the north with the University of Wollongong and the TAFE NSW Wollongong campus

• Upgrades to the existing pedestrian bridge over the M1 Princes Motorway at Northfields Avenue, including extending the bridge span and changes to the eastern access ramp

• A new commuter car park, relocated to the southern side of the M1 Princes Motorway, with additional formalised parking spaces

• New noise walls along the M1 Princes Motorway, between the motorway and nearby residential areas
  − On the northern side of the M1 Princes Motorway, extending the existing noise wall along Dumfries Avenue as far as Foothills Road
  − On the southern side of the M1 Princes Motorway, extending the existing noise wall along the edge of the motorway as far as the proposed western roundabout.

• New noise walls along Mount Ousley Road, between the M1 Princes Motorway interchange and Gowan Brae Avenue.

A more detailed description of the proposal, including details about the proposed design and the likely construction method and schedule, is provided in Chapter 3.

1.1.2 Need for the proposal

The proposal is needed to address a number of current road safety, efficiency and accessibility issues. The primary objectives of the proposal include:

• Improve safety by addressing conflicting movements and the interaction between light and heavy vehicles

• Improve travel time and efficiency for vehicles travelling on this length of the M1 Princes Motorway

• Provide for the growing freight task including supporting the expanding port at Port Kembla

• Enhance accessibility to/from the M1 Princes Motorway and the Wollongong CBD.

The need for the proposal is discussed in greater detail in Chapter 2.
1.1.3 Location of the works

The regional and local context of the proposal is provided below. A detailed description of the existing environment of the proposal area is provided in Chapter 6.

1.1.4 Regional context

The proposal area is located within the City of Wollongong local government area, which covers an area of about 71,544 hectares (including waterways) of coastal and escarpment land about 70 km south of the Sydney CBD. The City of Wollongong is bounded by the Tasman Sea (to the east), the Illawarra escarpment (to the west), the Royal National Park (to the north) and the entrance to Lake Illawarra and the Macquarie Rivulet (to the south).

The M1 Princes Motorway forms part of the National Land Transport Network – an integrated network of national and inter-regional transport corridors that are of strategic importance in supporting national and regional economic growth and connectivity. It connects Sydney to the Wollongong CBD (via Mount Ousley Road and the Princes Highway), the broader Illawarra region and the NSW South Coast. It provides a vital road link for the following travel purposes:

- Commuters travelling between Sydney and the Illawarra region
- Tourist traffic travelling between Sydney, the Illawarra region and the NSW South Coast
- Commuters travelling to and from the University of Wollongong, from the north and south
- Road freight traffic travelling between the Illawarra region (particularly Port Kembla), the South Coast, Sydney and the northern Illawarra collieries.

Within or adjacent to the proposal area, the M1 Princes Motorway, Mount Ousley Road and the Princes Highway are the only approved 25/26 m-long B-double routes. These roads are generally also an approved travel route for vehicles over 4.6 m high, with the exception of about 700 m of the M1 Princes Motorway located immediately to the south of Northfields Avenue. Overheight vehicles are prohibited from travelling under the University Avenue overbridge due to low clearance, and are instead directed to detour via Mount Ousley Road and Memorial Avenue. As a result, Mount Ousley Road forms part of the strategically important road freight transport corridor providing access between Port Kembla, Sydney and the northern Illawarra collieries.

There is a large number of significant trip generating and attracting land uses within or adjacent to the proposal area. These land uses include the following, but not limited to:

- Wollongong CBD
- Fairy Meadow Town Centre
- University of Wollongong campus
- TAFE NSW Wollongong campus
- Wollongong High School of the Performing Arts
- Keira High School
- Port Kembla.

The M1 Princes Motorway currently forms a physical barrier between the University of Wollongong, the TAFE NSW Wollongong campus and the residential areas of Mount Ousley and Mount Pleasant. While signage along the M1 Princes Motorway provides direction to motorists wishing to enter the commercial centre of the city, the existing intersection does not provide a clear sense of arrival at Wollongong. Instead, there is a sense of travelling along and through the edges of urban
and industrial development without a clear orientation in respect to the city of Wollongong, the coast or any other landmarks.
Legend

- Proposal area

Figure 1-1: Location of the proposal
M1 Princes Motorway, Mount Ousley Interchange
Review of Environmental Factors

Figure 1-2: The proposal

Subject to detailed design
1.1.5 Local context

The proposal area generally comprises steeply sloping land associated with the lower slopes and foothills of the Illawarra escarpment (comprising the north-western portion of the proposal area), as well as areas of relatively flat coastal plain located at the base of the escarpment (comprising the south-eastern portion of the proposal area).

The landscape character of much of the proposal area is defined by the steep, forest covered slopes of the Illawarra escarpment. The distinct landform of Mount Keira, which is located west of the proposal, forms a landmark that is highly visible from surrounding areas.

The M1 Princes Motorway generally passes through the proposal area as a five-lane divided carriageway that provides two southbound and three northbound traffic lanes north of Mount Ousley Road. South of Mount Ousley Road to University Avenue, there are three southbound and two northbound traffic lanes. The existing motorway corridor at the Mount Ousley intersection is generally flat, but being situated at the base of the escarpment, the M1 Princes Motorway climbs steeply as it heads west and north, with maximum grades in the proposal area reaching ten per cent. Locally, the land on the northern side of the M1 Princes Motorway and Mount Ousley Road also rises steeply over a short distance in the vicinity of Dumfries Avenue. An existing heavy vehicle safety ramp and arrestor bed is built into this natural landform next to the Mount Ousley Road exit.

The residential suburb of Mount Ousley adjoins the motorway corridor to the north and east of the proposal area, while the University of Wollongong, the TAFE NSW Wollongong campus and the residential suburbs of North Wollongong, Keiraville and Gwynneville adjoin the corridor to the south and east.

Mount Ousley Road is located at the base of the Illawarra escarpment and meets the M1 Princes Motorway as a two-lane undivided road. The western end of Mount Ousley Road connects to the M1 Princes Motorway via an at-grade priority controlled T-intersection with priority given to the motorway.

Land use patterns surrounding the proposal area include:

- Low density residential development typically concentrated on the northern and eastern side of the M1 Princes Motorway close to Mount Ousley Road in the suburb of Mount Ousley
- Small areas of low density residential development on the southern and western side of the M1 Princes Motorway in the suburbs of Keiraville and Gwynneville
- University of Wollongong and the TAFE NSW Wollongong campus, located at the base of the Illawarra escarpment on the western and eastern sides of the M1 Princes Motorway, respectively
- Recreational open space associated with the University of Wollongong and the TAFE NSW Wollongong campus
- A small pocket of densely vegetated land straddling both sides of the M1 Princes Motorway within the proposal area, bounded by Dumfries Avenue to the north and the University of Wollongong to the south.

Land covered by the proposal area falls within the Fairy Creek and Cabbage Tree Creek catchments. One tributary of Cabbage Tree Creek and one tributary of Fairy Creek are located within the proposal area (see Section 6.6 for further details). The surface waterways within the
The proposal area generally drain in an easterly direction from the Illawarra escarpment and across the coastal plain to the Tasman Sea.

The location of the proposal is shown in Figure 1-1, while an overview of the key features of the proposal is provided in Figure 1-2.

1.1.6 Key design features
The design includes the following key features:

- Use of the existing M1 Princes Motorway footprint where possible, with minimal acquisition of adjoining land
- Separation of light and heavy vehicles
- Removal of the at-grade right turn from Mount Ousley Road onto the M1 Princes Motorway
- Clearing of substantial areas of existing regrowth vegetation
- Diversions of utilities including water, gas, telecommunications and optic fibre.

1.1.7 Key structural features
Key structures that would be constructed as part of the proposal include:

- Retaining structures to accommodate bridge and bypass lanes
- A two-span bridge over the M1 Princes Motorway and proposed southbound service road
- A pedestrian/cyclist bridge and shared pathway from Dumfries Avenue to the University of Wollongong and the TAFE NSW Wollongong campus
- A cut-and-cover underpass structure to form the heavy vehicle bypass.

Chapter 3 describes the design and structures in more detail.

1.1.8 Proposed construction and/or operational staging of the proposal
The construction of the proposal is proposed to be completed in three stages, as follows:

- Stage 1 – major civil works. Offline construction would allow traffic to remain in the existing configuration while major earthworks and structures are completed
- Stage 2 – cut and cover works, mainline motorway adjustments. Traffic would be progressively switched onto the new roadworks as they are completed
- Stage 3 – motorway median and shoulder works. Most of the new infrastructure would be complete.

Stages 1 and 2 would be built over three discrete sites (two to the north of the M1 Princes Motorway, and one to the south), while stage 3 would occupy two sites (one to the north and one to the south of the M1 Princes Motorway).

The proposed construction method and staging are described in detail in Chapter 3.

1.2 Purpose of the report
This review of environmental factors (REF) has been prepared by Jacobs on behalf of Roads and Maritime. For the purposes of these works, Roads and Maritime is the proponent and the determining authority under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act).
The purpose of the REF is to describe the proposal, to document the likely impacts of the proposal on the environment, and to detail protective measures to be implemented.

The description of the proposed work and associated environmental impacts have been undertaken in the context of clause 228 of the Environmental Planning and Assessment Regulation 2000, the factors in Is an EIS Required? Best Practice Guidelines for Part 5 of the Environmental Planning and Assessment Act 1979 (Is an EIS required? guidelines) (DUAP, 1995/1996), the Threatened Species Conservation Act 1995 (TSC Act), the Fisheries Management Act 1994 (FM Act), and the Australian Government’s Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

In doing so, the REF helps to fulfil the requirements of:

- Section 111 of the EP&A Act wherein Roads and Maritime must examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity
- The strategic assessment approval granted by the Federal Government under the EPBC Act in September 2015, with respect to the impacts of Roads and Maritime’s road activities on nationally listed threatened species, populations, ecological communities and migratory species.

The findings of the REF would be considered when assessing:

- Whether the proposal is likely to have a significant impact on the environment and therefore the necessity for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning under Part 5 of the EP&A Act
- The significance of any impact on threatened species as defined by the TSC Act and/or FM Act, under section 5A of the EP&A Act and therefore the requirement for a Species Impact Statement
- The significance of any impact on matters of national environmental significance under the EPBC Act, including whether the activity may threaten the long-term survival of nationally and internationally important flora, fauna or ecological communities, and whether offsets are required and able to be secured
- The potential for the proposal to significantly impact any other matters of national environmental significance or Commonwealth land and the need to make a referral to the Australian Government Department of the Environment and Energy for a decision by the Commonwealth Minister for the Environment on whether assessment and approval is required under the EPBC Act.
2 Need and options considered

2.1 Strategic need for the proposal

2.1.1 Background

More than 50,000 vehicles use the link between Sydney and the Illawarra on approach to Wollongong every day, of which around 15 per cent are heavy vehicles. The section of motorway under investigation is steep, with grades exceeding eight per cent for a large proportion of the length and up to ten per cent in some parts. The M1 Princes Motorway and Mount Ousley Road currently experience heavy traffic congestion particularly during weekday, weekend and holiday peaks.

In the southbound motorway carriageway, due to the difference in speed limits for heavy vehicles such as trucks and buses (40 km/h) and light vehicles (80 km/h), conflicts exist as faster moving light vehicles weave and merge across the path of slower moving heavy vehicles to exit the M1 Princes Motorway at Mount Ousley Road. This presents safety concerns and contributes to flow breakdowns (stop-start or repeated accelerating and braking).

Adding to safety concerns, the M1 Princes Motorway/Mount Ousley Road intersection is the only location on the motorway between Heathcote and Albion Park Rail where vehicles are required to make an at-grade right turn to access the motorway. Between July 2011 and June 2016, 56 crashes were reported along Princes Motorway from New Mount Pleasant Road to Memorial Drive, and along Mount Ousley Road from Princes Motorway to Princes Highway. These included one fatal crash (resulting in one fatality and four injuries), 23 injury crashes, and 32 non-casualty crashes.

Freight movements are increasing on the M1 Princes Motorway. Many of the heavy vehicles continue on the M1 Princes Motorway to Port Kembla, south of Wollongong which is the largest vehicle importing hub in Australia, the largest grain terminal on the east coast and the second largest coal export facility in NSW.

Substantial congestion exists, particularly in the AM peak at the University Avenue interchange, located 1.2 km south of the Mount Ousley Road intersection, which can lead to extensive queueing to and from the M1 Princes Motorway. As traffic grows, journey times to the University of Wollongong and Wollongong CBD from the M1 Princes Motorway would increase.

2.1.2 Strategic planning and policy framework

The strategic importance of the proposal area’s road network in terms of supporting economic growth for the Illawarra region is reflected in its designation as part of the National Land Transport Network – an integrated network of national and inter-regional transport corridors that are of strategic importance in supporting national and regional economic growth and connectivity.

Strategic planning and policy documents relevant to the proposal include the following:

NSW 2021: A Plan to Make NSW Number One

NSW 2021 is the NSW government’s strategic business plan, setting priorities for action and guiding resource allocation. It is a 10 year plan to rebuild the economy, provide quality services, renovate infrastructure, restore government accountability, and strengthen the local environment and communities. The plan includes 32 goals to achieve the five core strategies of government.
The intent of the proposal is consistent with the strategic direction of the NSW government’s State Plan (NSW 2021). The goals considered most relevant to the proposal are outlined below.

**Goal 1: Improve the performance of the NSW economy**

The proposal is strongly aligned with this goal by targeting the following transport outcomes:

- Reduce congestion and improve freight and passenger vehicle times
- Cater for a broad set of freight, commercial and passenger travel demands through and within the Illawarra
- Make better use of the existing motorway network to support residential and employment opportunities between the Illawarra, Sydney and the growing Western Sydney markets
- Improve network capacity and performance which will aid in boosting business productivity and employment opportunities in regional NSW.

**Goal 7: Reduce travel times**

The proposal is strongly aligned with the NSW government’s goal to reduce travel times, particularly during the morning and evening peak periods, given that it will improve travel speed and reliability, reduce queuing and reduce conflict between light and heavy vehicles.

**Goal 10: Improve road safety**

The proposal would improve road safety by improving the separation between conflicting light and heavy vehicle movements at the M1 Princes Motorway/Mount Ousley Road intersection. The proposal would also remove the only at-grade right turn onto the M1 Princes Motorway between Heathcote and Albion Park Rail. Travel speeds and reliability would be improved, with a reduction in ‘stop-start’ traffic flows and weaving manoeuvres and a reduction in the risk of crashes (particularly rear-end crashes).

**Goal 19: Invest in critical infrastructure**

Improvement of the M1 Princes Motorway and Mount Ousley Road intersection would align with the goal of investing in the right infrastructure in the right places. As the M1 Princes Motorway is the only approved travel route for 26 m B-Doubles and Mount Ousley Road is the only approved travel route for overheight vehicles into the Illawarra from the north, these roads form a strategically important road freight transport corridor between Port Kembla, Sydney and the northern Illawarra collieries. The proposal would greatly enhance safety for freight vehicles travelling from the Illawarra to Sydney and the upgraded interchange would improve capacity for freight transport.

**Goal 20: Build liveable cities**

Investing in critical transport and access routes, such as the M1 Princes Motorway and Mount Ousley Road, plays a key role in the NSW government’s commitment to provide accessible and liveable towns and cities. Strategic planning for the proposal would enhance the ease of travel between work, home and study for people in the Illawarra region. Additionally, improved commuter and tourist access and freight accessibility would support economic growth for the Illawarra region.

**NSW Long Term Transport Master Plan**

The NSW Long Term Transport Master Plan (LTTMP) provides a framework to deliver an integrated, modern transport system by identifying NSW’s transport actions and investment priorities over the next 20 years. The Plan identifies six key themes and challenges for the NSW
transport network over the long term. Importantly the LTMP specifically notes a short term priority for the government as being to

“…continue to deliver a road network that supports strong growth. We will continue to improve the F6 (M1), Princes Highway (A1) and Mount Ousley Road to boost capacity, improve travel time, support public transport operations and provide efficient freight connections to Port Kembla”.

Specifically, the proposed upgrade of the M1 Princes Motorway aligns with the following LTMP initiatives.

Theme 3: Sustaining growth in Greater Sydney

The LTMP identifies the need for an efficient and sustainable transport system in Greater Sydney that can tackle congestion and accommodate future growth. As part of its plan to achieve this goal, the NSW government has committed itself to investing in targeted measures to improve congestion and road safety and respond to growing pressure on the road network.

The proposal would reduce congestion and enhance safety on this crucial commuter and freight route. It would do this by removing the only at grade right turn onto the Princes Motorway between Heathcote and Albion Park Rail. In addition, congestion would be reduced and safety would be improved, especially due to separation of movements associated with the differential speeds for trucks and light vehicles and weave manoeuvres at the southbound exit to Mount Ousley Road. An additional access to the University of Wollongong would also address congestion and safety issues on the M1 Princes Motorway from the University Avenue interchange. This would result in improved travel speeds and reliability and shorter travel times for residents. It would also assist freight operators travelling outside of the Illawarra to safely access employment opportunities and markets in Sydney and western Sydney.

Theme 5: Supporting efficient and productive freight

The LTMP emphasises the importance of efficient movement of freight for every person in NSW. It proposes actions to grow the future freight network capacity through targeted investments that expand capacity and maintain strong international, interstate and intrastate connectivity. The LTMP notes that:

“Port Kembla is the NSW port for vehicle imports and also supports export trades such as coal, iron ore, minerals and grains. Over 14 million tonnes of coal was handled in 2010-11, with the total overall trade reaching nearly 34 million tonnes. The current capacity of the Port Kembla car import terminal is estimated at around 847,000 vehicles per annum, and it is estimated by Transport for NSW that the freight task will approach 1.2 million by 2036”.

The M1 Princes Motorway and Mount Ousley Road are the major transport links supporting this freight task in the Illawarra. The upgrade of the M1 Princes Motorway/Mount Ousley Road intersection would contribute to greater freight efficiency along this route by improving travel speeds and reliability, therefore reducing travel times and vehicle operating costs for freight vehicles travelling on the motorway.

NSW Government State Infrastructure Strategy and Update

The NSW government State Infrastructure Strategy (2014) is the NSW government’s response to the recommendations made by Infrastructure NSW in the State Infrastructure Strategy Update (2014). The strategy identifies and prioritises the delivery of critical public infrastructure to drive productivity and economic growth in NSW.
The update made the following specific references to Port Kembla, which have specific relevance to the current proposal.

“Both road and rail projects that improve connectivity into these ports (Port Kembla and the Port of Newcastle) will be developed and assessed on an economic needs basis.

Assess projects that secure freight paths for regional exporters at Port Kembla

Recommendations will be adopted to support the continued development of Port Kembla. Capacity constraints at either port cannot be allowed to hinder the economic growth of our State. This includes constraints relating to entry to and exit from the port.”

Once Port Botany reaches capacity, Port Kembla will become NSW’s second container port, in addition to continuing to accommodate an increasing number of bulk exporters and motor vehicle imports. The importance of Port Kembla and efficient access for freight to and from the Port will require a multi-modal focus on road and rail connections to ensure the productive capacity of the port is maximised. The proposed upgrade to the interchange between the M1 Princes Motorway and Mount Ousley Road and the provision of a dedicated heavy vehicle bypass lane clearly align with this need.

The NSW Freight and Ports Strategy

The NSW Ports and Freight Strategy (TfNSW, 2013) identifies Port Kembla as a major trading port handling 9 million tonnes of freight per annum. The strategy acknowledges the State Infrastructure Strategy with the statement that:

“New port infrastructure at … Port Kembla may be required to help relieve [capacity constraints at Port Botany], and will need to be supported by significant land freight network improvements.”

The Strategy makes reference to specific programs of work for which planning had commenced at the time of its publication:

- Planning for additional climbing lanes on Mt Ousley Road between Picton Road and Bulli Pass
- Options for the construction of a grade-separated interchange where Mt Ousley Road meets the M1 Princes Motorway
- Construction of a third southbound lane from the existing arrestor bed to the junction of Mt Ousley Road and the M1 Princes Motorway (TfNSW, 2013).

The NSW Ports and Freight Strategy outlines the NSW government’s response to the growing freight task within NSW over the next 20 years. The Strategy comprises three Strategic Action Programs, 19 actions and 49 underlying tasks that target specific challenges associated with the expected increase in freight volumes passing through NSW.

In addition to establishing priority actions to address the growing freight task within NSW, the NSW Ports and Freight Strategy also contains a Freight Infrastructure Program, which lists the priority projects to be delivered over the next 10 years. These priority projects correlate with the actions of the NSW Ports and Freight Strategy. The proposal is included in the Freight Infrastructure Program and is therefore a priority project for the next 10 years.
Nation Partnership Agreement

The Australian Government entered into a new National Partnership Agreement (NPA) with the NSW Government on 10 October 2014. The NPA aims to facilitate achievement of the following outcomes:

- Improved land transport infrastructure that supports economic growth and productivity
- Improved connectivity for communities, regions and industry
- Improved transport safety
- Integrated and innovative network-wide planning for land transport infrastructure projects.

The M1 Motorway is part of the National Land Transport Network (NLTN) and a key focus for improving national freight efficiency and productivity given the relatively high volumes of road freight carried on this route. The proposed upgrade will reduce delays currently experienced by freight vehicles on this section of the motorway by improving travel speeds/reliability and reducing crash risk, and therefore reducing travel times and vehicle operating costs, for freight vehicles travelling on the M1 Princes Motorway.

National Road Safety Strategy 2011-2020

The National Road Safety Strategy 2011-2020 was released on 20 May 2011 by the Australian Transport Council (ATC), with a vision that no person should be killed or seriously injured on Australia’s roads. The strategy presents a 10-year plan to reduce the annual numbers of deaths and serious injuries on Australian roads by at least 30 per cent (ATC, 2011). The proposal is consistent with the strategy given it would improve the safety of the road network, assisting to reduce injuries and fatalities including those between vehicles and cyclists or pedestrians. The key component of the safety improvement would be the removal of the at-grade connection between the M1 Princes Motorway and Mount Ousley Road.

NSW Road Safety Strategy 2012-2021

NSW Road Safety Strategy 2012-2021 aims to make roads safer through at least a 30 per cent annual reduction in road deaths and serious injuries by the end of 2021. The proposed improvements to the M1 Princes Motorway will remove the at-grade connection to between the M1 Princes Motorway and Mount Ousley Road and separates light and heavy vehicles at the base of Mount Ousley which would greatly contribute to the State-wide goal.

Roads and Maritime 2020 Strategy

The Roads and Maritime 2020 Strategy (Roads and Maritime, 2015) outlines the five key areas in which Roads and Maritime must succeed over the next five years to meet their challenges. The five key areas of focus for Roads and Maritime are:

- Making safety paramount
- Delivering our infrastructure program
- Meeting customer and community needs
- Being an organisation that delivers
- Enhancing economic and social outcomes.

The proposal would improve road user safety, and improve the traffic efficiency for freight and other road users by providing additional intersection and lane capacity and eliminating conflicting traffic movements. It would also reduce travel delays for motorists currently using Mount Ousley Road to access the M1 Princes Motorway by removing the need for vehicles to wait for a sufficient
gap in traffic before merging into the southbound lane. The proposal was identified as the best value for money option assessed with the greatest economic benefit.

**Sydney-Wollongong Corridor Strategy**

The Sydney-Wollongong Corridor Strategy is a statement of the shared objectives and strategic priorities of the Australian and NSW governments for the long-term (to 2020-25) development of the Sydney-Wollongong corridor. It documents current and future condition and adequacy of the transport links that make up the corridor; and estimates strategic priorities for the integrated development of the corridor, based on the best available information and economic projections.

The proposal would address the following short-term strategic priorities of the Sydney-Wollongong Corridor Strategy:

- Improve safety and efficiency of Mount Ousley Road, especially in wet and peak periods
- Manage the increased freight on the corridor as a result of the Port Kembla expansion.

**Illawarra Regional Transport Plan**

The *Illawarra Regional Transport Plan* (Transport for NSW, 2016) provides a blueprint for the future and a strategic direction for the delivery of major transportation infrastructure over the next 20 years. The plan looks at population changes in the Illawarra region, considers the impact of urban growth in suburbs such as West Dapto, Nowra and Shellharbour, and accommodates anticipated employment growth and an increasing tourism market. Key commitments include:

- Major investment in Mount Ousley and the Princes Highway
- Reduced travel times between Sydney and Wollongong
- Better connections within Illawarra to jobs, study and town centres
- Improved management of freight as part of the *Port Kembla Growth Plan*

In the short term, the *Illawarra Regional Transport Plan* will be focussed on the Growth Centres Road Plan which will deliver improvements to the M1 Princes Motorway, Princes Highway (A1) and Mount Ousley Road to increase capacity, improve travel times, support public transport operations and provide more efficient freight connections to Port Kembla.

**Illawarra Regional Strategy 2006-2031**

The *Illawarra Regional Strategy 2006–2031* (Department of Planning, 2007) was prepared to guide sustainable growth and economic development in the Illawarra over the next 25 years. The primary purpose of the Regional Strategy is to ensure that adequate land is available and appropriately located to suitably accommodate the projected housing and employment needs of the Illawarra region's population.

One of the aims of the Illawarra Regional Strategy 2006–2031 is to ensure that existing and proposed transport corridors are protected to support freight transport and improve network efficiencies. The Regional Strategy specifically identifies the regional importance of the M1 Princes Motorway as the major north-south corridor linking Sydney to the NSW South Coast. The Strategy also identifies the importance of Mount Ousley Road as a major external access point into the Illawarra region.

The proposal would address the following actions identified in the *Illawarra Regional Strategy 2006–2031*:
• Protect important existing transport corridors within and out of the Illawarra region, including the Princes Highway and the F6 (M1) transport corridor
• Roads and Maritime is to continue to monitor the ongoing performance of the regional road network, including Mount Ousley Road, in light of future regional traffic growth and freight movement. Monitoring will identify any potential planning requirements for future access to the Illawarra region
• Ensure the timely implementation of major transport infrastructure projects.

The proposal would protect one of the major strategically important transport corridors within the Illawarra region by providing additional capacity at the M1 Princes Motorway/Mount Ousley Road intersection and additional lane capacity on the M1 Princes Motorway. This additional capacity would support future traffic growth predicted to occur within the region and would help underpin economic growth for the Illawarra region. The heavy vehicle bypass lanes have been designed to cater for a future third southbound lane on the M1 Princes Motorway to the base of Mount Ousley and therefore would not prevent its construction in the future.

Illawarra/South Coast Regional Action Plan
The Illawarra/South Coast Regional Action Plan identifies the immediate actions that the NSW Government will take to address the priorities raised by communities in the Illawarra/South Coast region. Priority actions identified in the Illawarra/South Coast Regional Action Plan complement both the long term strategies of NSW 2021 and existing regional strategies, including the Illawarra Regional Strategy 2006–2031.

The proposal would address the following priority actions of the Illawarra/South Coast Regional Action Plan:

• Priority 2: Provide accessible, efficient and integrated regional transport. The proposal would enhance freight accessibility into and out of the Illawarra region (including the expanding Port Kembla) by creating additional capacity at the M1 Princes Motorway/Mount Ousley Road intersection and by inclusion of a dedicated heavy vehicle bypass lane. The proposal would also remove the existing at-grade right turning movement across the southbound carriageway of the M1 Princes Motorway (for vehicles entering the motorway from Mount Ousley Road).
• Priority 3: Deliver infrastructure to support population needs. The proposal would support the needs of the Illawarra region through enhancing the ease of travel between work, home and study for people in the Illawarra region. Through the creation of additional capacity along Mount Ousley Road, the proposal would support economic development and urban expansion within the region. Additionally, improved commuter and tourist access and freight accessibility would help underpin economic growth for the Illawarra region.

University of Wollongong – Transport Survey and Strategy 2015
The University of Wollongong Transport Project commenced in 2008 with a mandate to improve the transport experience for students and staff and achieve a shift from private vehicles to more sustainable forms of transport by addressing some of the barriers to public transport, walking or cycling. The proposed connections for pedestrians/cyclists adjacent to the intersection of the M1 Princes Motorway and Mount Ousley Road would directly support the overall key drivers of the University’s Transport strategy as listed below:

• Improve the transport experience of staff and students by improving commute times, commuter choice and safety
• Reduce the ecological impact of the University to meet our sustainability goals and targets
• Improve health and wellbeing of staff and students through active transport options and facilities to support this
• Reduce the social cost of private vehicle use (including injury) by providing and supporting alternatives
• Maximise space utilisation and reduce ongoing financial costs associated with unsustainable transport modes.

2.2 Existing infrastructure
At the base of the Illawarra escarpment, the M1 Princes Motorway connects to Mount Ousley Road before curving about 90 degrees to the south, passing under a pedestrian footbridge, the University Avenue overbridge and the overbridge for the on/off ramps for Memorial Drive interchange. From the Memorial Drive interchange, the M1 Princes Motorway continues south through the relatively flat coastal plain located at the base of the Illawarra escarpment, providing access to the southern Illawarra region and the NSW South Coast.

The M1 Princes Motorway/Mount Ousley Road intersection is currently an at-grade priority controlled T-intersection, with vehicles on the motorway having priority over vehicles entering from Mount Ousley Road.

Mount Ousley Road is the primary access route for southbound vehicles travelling between the M1 Princes Motorway and the Wollongong CBD (via the Princes Highway). Mount Ousley Road is also the only approved travel route for overheight vehicles into the Illawarra from the north, given the 4.6 m height limit on the M1 Princes Motorway at the University Avenue overbridge. Therefore, Mount Ousley Road is a strategically important road freight transport corridor, providing access between Port Kembla, Sydney and the northern Illawarra collieries.

2.2.1 Existing structures
Existing structural features in the proposal area include the following:

• Numerous large drainage culverts
• Noise walls along the southbound and northbound M1 Princes Motorway carriageway
• Sign structures along the M1 Princes Motorway, including one full-width gantry structure
• Lighting structures and signage structures along Mount Ousley Road
• A pedestrian bridge over the M1 Princes Motorway at Northfields Avenue
• A vehicular overpass and on/off ramp structures at University Avenue
• Shared pedestrian and cycle path along the eastern side of the M1 Princes Motorway adjacent to the TAFE NSW Wollongong campus.

2.2.2 M1 Princes Motorway
Through the proposal area, the M1 Princes Motorway comprises a five-lane divided carriageway providing three northbound and two southbound traffic lanes north of Mount Ousley Road. South of Mount Ousley Road to University Avenue, there are three southbound and two northbound traffic lanes.

The southbound carriageway of the M1 Princes Motorway has a signposted speed limit of 80 km/h for light vehicles and 40 km/h for heavy vehicles (trucks and buses).
The M1 Princes Motorway currently represents a barrier for pedestrians, cyclists and motorists travelling between the University of Wollongong, the TAFE NSW Wollongong campus and the residential areas of Mount Ousley and Mount Pleasant. In addition, the entrance to the Wollongong CBD and the University of Wollongong from the motorway are not clear, relying heavily on signage to assist navigation.

2.2.3 Mount Ousley Road

Mount Ousley Road is located at the base of the Illawarra escarpment and provides an east-west link between the M1 Princes Motorway (to the west) and the Princes Highway (to the east). Mount Ousley Road connects to the M1 Princes Motorway via an at-grade priority controlled T-intersection.

East of the M1 Princes Motorway intersection, Mount Ousley Road comprises a two-lane partially divided road, with an additional turning lane added at the eastbound approach to the Princes Highway.

Extensive queuing of traffic generally occurs on the eastbound and northbound approaches to the Mount Ousley Road/Princes Highway roundabout during the morning peak.

2.2.4 M1 Princes Motorway/Mount Ousley Road intersection

The M1 Princes Motorway/Mount Ousley Road intersection is currently an at-grade priority controlled T-intersection with vehicles on the motorway having priority over vehicles entering via Mount Ousley Road. The intersection is configured to provide left and right turn entry lanes and one exit lane from the M1 Princes Motorway as well as dedicated turning lanes for access to a formalised commuter carpark (for both eastbound and westbound vehicles) located next to the eastbound lane of Mount Ousley Road.

The M1 Princes Motorway/Mount Ousley Road intersection is the only location on the motorway between Heathcote and Albion Park Rail where vehicles are required to make an at-grade right-turn to access the motorway.

The intersection is configured to allow for the following traffic movements:

- Exit from the M1 Princes Motorway southbound into Mount Ousley Road eastbound. This traffic movement is provided for via a single traffic lane that diverges from the southbound kerbside lane of the M1 Princes Motorway.
- Right turns from Mount Ousley Road westbound onto the M1 Princes Motorway northbound. This traffic movement is provided for via a dedicated northbound refuge lane in the median of the M1 Princes Motorway, which allows northbound vehicles to enter the motorway without having to simultaneously negotiate two opposing streams of motorway traffic, using the refuge lane to accelerate and merge safely into the northbound motorway lanes.
- Left turns from Mount Ousley Road into the M1 Princes Motorway southbound. This traffic movement is provided for via a dedicated slip-lane (about 110 m in length), which creates a third southbound lane between Mount Ousley Road and University Avenue interchange.

2.3 Proposal objectives and development criteria

2.3.1 Proposal objectives

In 2015, Roads and Maritime prepared a Strategic Business Case and undertook an options assessment process to determine the need, justification and feasibility of the proposed upgrade of the M1 Princes Motorway Mount Ousley interchange. During this process, specific objectives were
identified and have been adopted throughout the proposal's planning and development. The objectives of the proposal are to:

- Improve safety by addressing conflicting movements and the interaction between light and heavy vehicles
- Improve travel time and efficiency for vehicles travelling on this length of the M1 Princes Motorway
- Provide for the growing freight task including supporting the expanding port at Port Kembla
- Enhance accessibility to/from the M1 Princes Motorway and the Wollongong CBD.

While achieving the above objectives Roads and Maritime would seek to:

- Consider enhanced accessibility to/from the M1 Princes Motorway and the University of Wollongong
- Maintain or improve the visual driving experience and amenity in this section of the M1 Princes Motorway
- Improve amenity by considering the needs of pedestrians, cyclists and public transport
- Minimise disruptions and delays to traffic during construction and ensure that road users are kept informed of travel conditions during works
- Minimise the broader social and environmental impacts of the development
- Achieve an overall result that provides the best value for money for the entire project lifecycle.

2.3.2 Development criteria

The development and assessment of options was carried out with specific reference to functional, socio-economic and environmental criteria to determine how well the options would perform in achieving the proposal objectives. The development criteria are described in Section 2.4.1.

2.3.3 Urban design objectives

During the concept design development process, objectives and principles for urban design were developed to guide the physical design of the proposal in a way that is consistent with the overall proposal objectives. Details relating to the development of urban design objectives and how the proposal was designed to achieve them are explained in more detail in Section 6.4.

2.4 Alternatives and options considered

2.4.1 Methodology for selection of preferred option

Prior to commencing the preparation of the concept design for the proposal, Roads and Maritime undertook preliminary investigations to identify and assess strategic options against a range of environmental, social, engineering and economic performance requirements and criteria. These investigations are captured in the following documents, which have all contributed to the appraisal of the different options associated with the project:

- Preliminary Environmental Investigation (PEI) (January, 2015)
- Value Management Study (December, 2015)
- Strategic Business Case (February, 2016)
- Preferred Option Report (June, 2016).
Preliminary environmental investigation

In January 2015, Roads and Maritime prepared a PEI Report that considered environmental constraints and opportunities within a study area that broadly consisted of a 200 m buffer either side of the existing road corridor for M1 Princes Motorway and Mount Ousley Road. The study area adopted for the PEI extended from the University Avenue interchange, north along the M1 Princes Motorway for about 4 km to north of New Mount Pleasant Road.

Value management study

A value management workshop was held on 9 December 2015, with participants from Roads and Maritime, Transport for New South Wales, the University of Wollongong, and Wollongong City Council. The aim of the workshop was to identify the option that would best meet the overall needs of road users and the local community.

The key objectives of the workshop were to review the work undertaken to date, and to recommend a preferred option or options to progress the proposal to the next stage of development.

Participants carried out a weighted assessment of options against two categories of assessment criteria based on what was considered to be important to the proposal. The criteria did not include capital costs.

The categories of assessment criteria included:

- Functional criteria such as road safety, travel reliability and efficiency, pedestrian and cycle connectivity, constructability, road and network legibility, and the ability to stage delivery to match funding availability
- Socio-economic and environmental criteria such as visual and landscape impacts, impacts on nearby residents and landholders, impacts on biodiversity, construction environmental impacts, and access to a (relocated) commuter car park.

The functional criteria were weighted relative to one another, and the socio-economic and environmental criteria were weighted relative to one another.

The workshop identified the primary advantages and disadvantages of each option, then evaluated the performance of each option against weighted assessment criteria. The options were then scored, and compared to a strategic capital cost and benefit cost ratio (BCR) assessment. Comparison of the different scores resulted in the determination of the preferred option. Further details on the options analysis is provided in Section 2.4.3.

Strategic business case

The strategic business case provides the justification for the project by appraising traffic, safety, economic and financial factors and seeks funding for concept design and environmental assessment of the proposal. Following completion of these tasks a final business case would be prepared to seek funding for detailed design. The strategic business case states the proposal objectives, outlines the need/reason for the expenditure, the proposed funding mechanisms, and how the proposal would be procured and managed (see also Section 2.1 and Section 2.3).

Preferred option report

The preferred option report builds on the findings of the value management study and provides further assessment of the advantages and disadvantages of the options in terms of property, traffic, road safety, utilities, environmental, constructability, risk and economic considerations. It
presents further justification for the preferred option. It also considers other options that would form the ‘do minimum’ scenario.

2.4.2 Identified options

Roads and Maritime developed four strategic options in response to the following identified issues:

- Safety of the at-grade intersection of Mount Ousley Road and the M1 Princes Motorway
- Traffic congestion at University Avenue interchange and flow on impacts to the M1 Princes Motorway
- Weave conflict between southbound trucks in the kerbside (slow lane) on the M1 Princes Motorway and vehicles seeking to exit at Mount Ousley Road
- Safety of pedestrian and cyclist connections between the University of Wollongong and suburbs to the north
- Southbound traffic capacity.

The four strategic options developed are described below.

**Strategic Option 1**

Option 1 involved the following:

- Separated light vehicle and heavy vehicle lanes for accessing Mount Ousley Road from the M1 Princes Motorway southbound. The light vehicle lane would be an overpass from the right lane of the motorway to Mount Ousley Road
- An overpass lane from Mount Ousley Road to the M1 Princes Motorway northbound
- An additional entry access to the University of Wollongong.

**Strategic Option 2**

Option 2 involved the following:

- Separated light vehicle and heavy vehicle lanes for accessing Mount Ousley Road from the M1 Princes Motorway southbound. The light vehicle lane would be an overpass from the right lane of the motorway to Mount Ousley Road and a loop road would enable southbound vehicles to access the University of Wollongong from the north
- An overpass lane from Mount Ousley Road to the M1 Princes Motorway northbound
- An additional entry access to the University of Wollongong.

**Strategic Option 3**

Option 3 involved the following:

- Separated heavy vehicle bypass lanes to access Mount Ousley Road or travel under Mount Ousley Road and merge back onto M1 Princes Motorway southbound
- An overpass lane from Mount Ousley Road to the Princes Motorway northbound
- An additional entry access to the University of Wollongong.

**Strategic Option 4**

Option 4 involved the following:

- Separated eastbound heavy vehicle bypass lanes to access Mount Ousley Road or travel under Mount Ousley Road and merge back onto M1 Princes Motorway southbound
- An overpass lane from Mount Ousley Road to the M1 Princes Motorway northbound
- An additional roundabout entry access to the University of Wollongong
- An additional exit from the University of Wollongong to the M1 Princes Motorway northbound and Mount Ousley Road.

Figure 2-1 Strategic option 1

![Proposed interchange at Princes Motorway and Mt Ousley Road Option 1](image)

Figure 2-2 Strategic option 2

![Proposed interchange at Princes Motorway and Mt Ousley Road Option 2](image)
Figure 2-3 strategic option 3

Figure 2-4 Strategic options 4
‘Do minimum scenario’

Two low cost options (together considered as the ‘do minimum scenario’) have also been considered. These include:

**Banning the right turn from Mount Ousley Road onto the Princes Motorway**

A ban of the right turn would work by redirecting traffic from Mount Ousley road intending to travel northbound on the M1 Princes Motorway to either the University Avenue interchange or to the Memorial Drive loop to access the M1 Princes Motorway northbound. While this option would improve road safety at the intersection of Mount Ousley Road and the M1 Princes Motorway, this option is not being considered further as it would increase pressure on the weave that is required for southbound traffic on Memorial Drive to access the M1 Princes Motorway northbound entry ramp and the University Avenue interchange which is already at capacity. In addition, this option would not address the greater network traffic congestion mainly associated with the University Avenue interchange and its impacts on the operation of the M1 Princes Motorway, or the existing conflict between light and heavy vehicles on the motorway.

**Grade separating the right turn from Mount Ousley Road onto the Princes Motorway and signalising the roundabouts on the University Avenue interchange.**

This option would include queue detection on the M1 Princes Motorway exit ramps to University Avenue to manage queues and their impact on motorway operation. This would reduce queuing and delays on the southbound off ramp to University Avenue by up to one minute. This option was also discounted, as traffic modelling showed that using traffic signals to prioritise traffic flows from the southbound off ramp, would cause queues and delays to increase substantially on the northbound off ramp (from the M1 Princes Motorway into Irvine Street), also impacting on the Memorial Drive loop to the motorway. There would be no overall reduction in average vehicle delay for this option and it was therefore not considered further.

In addition, this option would not address the greater network traffic congestion mainly associated with the University Avenue interchange and its impacts on the operation of the M1 Princes Motorway, or the existing conflict between light and heavy vehicles on the motorway.

**Commuter car park options**

Two options were considered for relocation of the commuter car park near the intersection of Mount Ousley Road and the Princes Motorway:

- A site south of the M1 Princes Motorway between the M1 Princes Motorway and the proposed overpass in land currently owned by the University of Wollongong (option 1)
- A site located south of Mount Ousley Road and east of the M1 Princes Motorway (option 2).

Following the development of the preferred option design to include a new service road between Mount Ousley Road and University Avenue, option 1 for the commuter carpark has been selected.

The preferred commuter car park option is described in Chapter 3.

2.4.3 Analysis of options

As discussed in Section 2.4.1, participants at the value management workshop identified the advantages and disadvantages of the options prior to evaluating the relative importance of the options against each of the criteria. The advantages and disadvantages of each of the four options discussed in the workshop are documented below:
Option 1

**Advantages**
- The proposal area is relatively small.

**Disadvantages**
- Safety concerns regarding vehicles exiting the M1 Princes Motorway from lane 3
- Difficulty associated with the construction and maintenance of the bridges and approaches as they are in the middle of the M1 Princes Motorway
- Reliance on the roundabout at Mount Ousley Road/Gaynor Avenue for access to the university
- The design of a northbound exit from the university would be difficult
- Difficult access to proposed commuter car park.

Option 2

**Advantages**
- Easier access to the university relative to Options 1 and 3.

**Disadvantages**
- The proposal area is relatively large
- Difficulty associated with the construction and maintenance of the bridges and approaches as they are in the middle of the M1 Princes Motorway
- The design of a northbound exit from the university would be difficult
- Poor road legibility
- More difficult to maintain generally due to the large complex bridge structures
- Cyclists and pedestrians are not well catered for
- Difficult access to proposed commuter car park.

Option 3

**Advantages**
- Bridge structures are simpler and easier to construct and maintain
- Much of the construction is offline and therefore safer to construct
- Provides for full separation of heavy and light vehicles until after Mount Ousley Road
- Provides better road legibility.

**Disadvantages**
- Access to university for southbound traffic is less efficient than other options
- More embankment material would be required on the southern side of the M1 Princes Motorway which impacts on construction methodology.

Option 4

**Advantages**
- Provides the best accessibility for all movements
- Provides the best road user legibility
- Much of the construction is offline and therefore safer to construct
• Provides for full separation of heavy and light vehicles until after Mount Ousley Road.

Disadvantages
• The proposal area is relatively large
• More embankment material would be required on the southern side of the M1 Princes Motorway which impacts on construction methodology.

Following the scoring of the options using the weighted criteria, the main findings were as follows:

• Functional criteria: Options 3 and 4 scored consistently higher than options 1 and 2 against functional criteria. Option 4 was the best performer in terms of road safety, travel reliability and efficiency, and road network legibility
• Socio-economic and environmental criteria: Option 1 scored consistently higher against socio-economic and environmental criteria, primarily based on the relative size of the option footprints and the amount of earthworks and/or clearing required. Option 1 scored highest against all criteria except for driver experience, and access to a (relocated) commuter car park, for which Option 4 scored highest.

The options rankings, comparative costs and BCR are summarised in Table 2-1.

Table 2-1 Summary of option rankings

<table>
<thead>
<tr>
<th>Option</th>
<th>Functional (rank and score)</th>
<th>Socio-economic and environmental (rank and score)</th>
<th>Cost</th>
<th>BCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
<td>3 (236)</td>
<td>1 (364)</td>
<td>1.05</td>
<td>2.1</td>
</tr>
<tr>
<td>Option 2</td>
<td>4 (186)</td>
<td>4 (186)</td>
<td>1.67</td>
<td>1.4</td>
</tr>
<tr>
<td>Option 3</td>
<td>2 (341)</td>
<td>2 (300)</td>
<td>1.00</td>
<td>2.0</td>
</tr>
<tr>
<td>Option 4</td>
<td>1 (400)</td>
<td>3 (242)</td>
<td>1.05</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Other considerations
In addition to the value management workshop, other advantages and disadvantages of the options were investigated in terms of property, traffic, road safety, utilities, environmental, constructability, risk and economic considerations.

Property
Options 1 to 4 would all involve property acquisitions at the University of Wollongong. Option 1 would require the least amount of property acquisition, followed by Option 2, 3 and 4 in that order. Although Option 4 would involve the acquisition of the most land from the University of Wollongong, the university indicated that it was generally in support of Option 4.

Traffic
In terms of traffic, transport and access, Options 1 and 2 would involve construction of an exit ramp from the right lane of the M1 Princes Motorway, meaning that traffic would need to be diverted around the work site with difficulty for access into and out of the work site for construction vehicles which is of particular concern at the base of a steep grade with a high volume of heavy vehicles. Options 1 and 2 would also include complex bridge structures. Conversely, Options 3 and 4 would be largely constructed offline causing less disruption to traffic on the M1 Princes Motorway, and would have simple bridge structures which could be erected quickly during planned road closures.
Option 4 would achieve the greatest network improvements including reduction in vehicle hours travelled (VHT) and average vehicle delay. Substantial travel time reductions for the key affected routes from the M1 Princes Motorway north to the Wollongong CBD and University of Wollongong would also be achieved.

**Road safety**

While all options were considered to have substantial safety improvements by grade separating the right turn from Mount Ousley Road to the Princes Motorway and providing options for light vehicles to exit the motorway without conflicting with heavy vehicles, Options 3 and 4 were considered to have better safety outcomes than Options 1 and 2 given they have conventional exits from the left hand side avoiding potential confusion of an uncommon exit from the right lane on a motorway.

**Utilities**

A number of utilities conduits are located within the proposal area (see Section 3.5). However, as most of these utilities are situated close to the existing intersection with Mount Ousley Road, or adjacent to the M1 Princes Motorway, consideration of these utilities would be required for all options.

**Urban design and visual impact**

Options 1 to 4 were assessed with regards to landscape character and visual impacts, driver experience and community issues. Options 3 and 4 were found to perform the best when assessed against factors such as:

- Landscape character impact
- Safety and road legibility
- Physical form of the built elements and their integration in the setting
- User experience and how the interchange acts as a gateway
- Potential views and vistas
- Community issues.

**Constructability**

In September 2015 Roads and Maritime conducted a constructability review of Options 1 to 4. Key constraints for Options 1 and 2 included the construction of ramps in the middle of the M1 Princes Motorway, which would have access and safety implications; and the more complex bridge structures that would likely take greater motorway closures to complete. Options 3 and 4 were generally considered superior from a constructability, traffic management and safety perspective.

**Risk**

A risk workshop was held in August 2015 attended by internal and external stakeholders, including representatives from Wollongong City Council and the University of Wollongong. Key risks included constructability, work health and safety (WHS) and traffic management risks during construction. It was concluded that Options 1 and 2 would have greater traffic management risks due to construction of ramps in the middle of the M1 Princes Motorway; WHS risks for workers operating in tight workspaces within the site; and driver confusion of the unconventional road layout leading to further safety risks. Safety risks were less for Options 3 and 4 due to the offline construction and more conventional layout.
**Economic**

During the value management workshop, a comparison of the cost of Options 1 to 4 showed Option 2 to be substantially the most expensive option. The other three options were estimated to be a similar cost, with Option 3 the cheapest option. In terms of the benefit/cost ratio (BCR), Option 4 was most favourable option, followed by Option 1, 3 and 3 respectively.

**Analysis of ‘do nothing’ scenario / ‘do minimum’ scenario**

If a ‘do nothing’ or ‘do minimum’ approach were to be undertaken as described in Section 2.4.2, the proposal objectives would not be achieved. The traffic along this section of the M1 Princes Motorway and on Mount Ousley Road would continue to rise and contribute to further crashes and the operating performance of the motorway would deteriorate.

**2.5 Preferred option**

Option 4 was selected as the preferred option as it provides a value for money solution that best addresses the traffic and safety issues on the M1 Princes Motorway and nearby intersections. Option 4 also provides an exit from the University of Wollongong onto the M1 Princes Motorway, reducing congestion within the university and surrounding local road network particularly in the afternoon peak. This option can largely be constructed offline providing safety and traffic management advantages during construction. Option 4 was selected by all who attended the Value Management Workshop in December 2015 as the option to progress for further development.

The preferred option would consider the environmental, social and economic aspects at each phase of the project.

Environmental impacts would be minimised as far as is reasonably practicable while still achieving the proposal objectives. For example a number of retaining walls have been designed to reduce the overall proposal footprint; and energy use, waste, resource use and pollution would be minimised in construction and operation of the project.

Social aspects would be managed by engaging with stakeholders on aspects such as access, land acquisition and opportunities for input to urban design elements and pedestrian and cyclist access.

**2.6 Design refinements**

Outputs from the value management workshop and community consultation resulted in recommendations for potential enhancements to the overall design of the proposal. Possible enhancements discussed were as follows:

- Investigate options to further minimise or eliminate weaving movements in the design, particularly at interchange on and off ramps
- Review the options for the location of the commuter car park
- Investigate options for heavy vehicle safety ramps
- Investigate potential northbound access to the interchange
- Further consideration of pedestrian and cyclist connections.

Following the decision to adopt Option 4 as the preferred option, Roads and Maritime engaged Jacobs to prepare the concept design for the M1 Princes Motorway Mount Ousley interchange. The proposed concept design, which is the subject of this REF, has developed and refined the preferred option with consideration of the possible enhancements listed above to optimise its
performance, improve its safety and constructability, and reduce its environmental impacts. These and other aspects of the concept design would be further refined during detailed design.

The key refinements to the design that have been made during concept design are listed below, and illustrated in Figure 1-2. Detailed descriptions of these (and other) elements of the proposed concept design are provided in Chapter 3.

2.6.1 Heavy vehicle off ramp

Heavy vehicle off ramp
The concept design sought to optimise alignment and gradient of the heavy vehicle off ramp to Mount Ousley Road to manage heavy vehicle speeds on approach to the lower end of Mount Ousley Road.

Heavy vehicle bypass
The Heavy Vehicle Bypass has been shifted slightly to balance the cut and fill volumes as much as possible and make sufficient room for the addition of the Southbound Service Lane.

2.6.2 Heavy vehicle safety ramps

During preparation of the concept design, further investigation was completed regarding heavy vehicle safety ramp options. This was in response to strong community representation during the display of the preferred option regarding heavy vehicle safety. It was agreed that an additional heavy vehicle safety ramp would be implemented.

Heavy Vehicle Safety Ramp 2 has been design as an alternative option for errant heavy vehicles that find themselves in the M1 Princes Motorway southbound offside lanes after navigating the left hand curve to the north of the proposal area near Mount Pleasant. In the event that there is a convoy of vehicles in the left hand lane of the motorway or the Heavy Vehicle Bypass, these vehicles may be unable to safely access Safety Ramp 1.

The concept design has therefore been refined to incorporate two new safety ramps at the bottom of Mount Ousley to replace the one existing safety ramp.

2.6.3 Southbound service road and southbound on ramp

Following community consultation there were remaining concerns in the strategic design relating to the merge from Mount Ousley Road onto the Princes Motorway southbound and the weave between heavy vehicles merging back onto the Princes Motorway and traffic exiting at University Avenue interchange.

To address these concerns, the current concept design now provides a single exit from the Princes Motorway southbound to Mount Ousley Road and University Avenue, a service road between Mount Ousley Road and University Avenue and a left turn from the eastern roundabout to access the service road.

2.6.4 Shared path and commuter car park

Shared path
The concept design sought to maximise the connectivity and utility of the proposed pedestrian/ cycle connection, by ensuring that it would be connected to both the University of Wollongong and the TAFE NSW Wollongong campus, and make use of the existing shared path along the eastern side of the M1 Princes Motorway. The design also aimed to ensure that the alignment and gradient
of the shared path were suitable to cater for all potential users, and that it would be safe and easily accessible.

**Commuter car park**

The options evaluation process concluded that the proposed new commuter car park would be located on the southern side of the M1 Princes Motorway between the motorway and Mount Ousley Road. The concept design therefore sought to maximise the accessibility of the car park, improve its capacity (over the existing), minimise its visual impact, and ensure that it could be accessed safely from all directions of travel.

### 2.6.5 Northbound access to the interchange

A northbound access has been added to the interchange through the inclusion of the Mount Ousley Road Northbound Off Ramp which provides for all movements at the interchange. This solution has been adopted to enable ready access for users of the commuter car park, with the intention of avoiding vehicles stopping on the motorway shoulder to pick up / drop off commuters.

The existing commuter car park is not currently accessible from the motorway northbound. Anecdotal evidence from the community indicates that pedestrians currently cross the M1 Princes Motorway from the Commuter carpark / Mount Ousley Road to access vehicles travelling northbound, or to access the University of Wollongong.

Traffic modelling of the Mount Ousley Road Northbound Off Ramp found that the addition of this exit would reduce the morning peak congestion at University Avenue, and allow motorists to reach the campus from two locations. This addition was supported by University stakeholders, as it also reduces congestion on their internal networks.

All of the above design refinements are described in detail in Section 3.2.
3   Description of the proposal

This chapter describes the proposal and provides descriptions of existing conditions, the design parameters including major design features, the construction method and associated infrastructure and activities.

3.1 The proposal

Roads and Maritime proposes to upgrade the M1 Princes Motorway interchange with Mount Ousley Road, Mount Ousley. An important feature of the proposal is grade-separation of the intersection to improve the safety and efficiency of the road network at this road junction and to remove the existing at-grade right turn from Mount Ousley Road onto the M1 Princes Motorway.

The proposal is shown in Figure 1-2.

Key features of the proposal would include:
- An overpass for safe access between Mount Ousley Road, the M1 Princes Motorway and the University of Wollongong
- A dedicated heavy vehicle bypass lane, to separate heavy vehicles from general southbound traffic on the M1 Princes Motorway and light vehicles exiting at Mount Ousley Road
- A dedicated southbound heavy vehicle exit ramp onto Mount Ousley Road, to separate heavy and light vehicles exiting the M1 Princes Motorway to Mount Ousley Road
- A new access to the University of Wollongong to and from the M1 Princes Motorway and Mount Ousley Road
- New roundabouts at Mount Ousley Road, servicing the new entrance to the University of Wollongong and for vehicles exiting the M1 Princes Motorway at Mount Ousley Road
- A new southbound service road, which would replace the existing southbound access from the M1 Princes Motorway to University Avenue
- Two new heavy vehicle safety ramps
- A new pedestrian and cyclist bridge over Mount Ousley Road and the M1 Princes Motorway, and a new shared path connecting suburbs to the north with the University of Wollongong and the TAFE NSW Wollongong campus
- Upgrades to the existing pedestrian bridge over the M1 Princes Motorway at Northfields Avenue
- A new commuter car park, relocated to the southern side of the M1 Princes Motorway, with additional formalised parking spaces
- New noise walls along the M1 Princes Motorway, between the motorway and nearby residential areas
- On the northern side of the M1 Princes Motorway, extending the existing noise wall along Dumfries Avenue as far as Foothills Road
- On the southern side of the M1 Princes Motorway, extending the existing noise wall along the edge of the motorway as far as the proposed western roundabout
- New noise walls along Mount Ousley Road, between the M1 Princes Motorway interchange and Gowan Brae Avenue.
The proposal extends on the M1 Princes Motorway from about 450 m west to just over 1,000 m south of the existing intersection with Mt Ousley Road, and about 650 m east on Mt Ousley Road between the M1 Princes Motorway and Gaynor Avenue, as shown in Figure 1-2. The overall footprint of the proposed interchange extends north of Mt Ousley Road up to the southern edge of Dumfries Avenue, and into the land occupied by the University of Wollongong on the southern side. The proposed works extend south along the M1 Princes Motorway corridor as far as the University Avenue interchange and overpass. Along the eastern side, the proposal’s footprint would encroach into a narrow strip of land occupied by the TAFE NSW Wollongong Campus. In addition, an existing parcel of Roads and Maritime owned land bounded by the M1 Princes Motorway, Mount Ousley Road, Gowan Brae Avenue and the TAFE NSW Wollongong Campus, would be temporarily used as a site compound (and potentially permanently as a traffic incident response unit).

Key features of the proposal are illustrated in Figure 1-2 and described in greater detail below.

3.2 Design

The overall approach to design has been driven by Roads and Maritime’s key proposal objectives (refer to Section 2.3.1) relating to improving road safety, accessibility and transport efficiency at the existing intersection between the M1 Princes Motorway and Mount Ousley Road. Other factors influencing the design are the challenging topography of the site, and the importance of a construction sequence and schedule that is safe, and which avoids interruptions to traffic flows along the M1 Princes Motorway in both directions.

Details about the proposal’s design, engineering and construction are discussed in the following sections.

3.2.1 Design criteria

Design speed and speed limits

The proposal is designed to accommodate the need for different classes of vehicle to travel at different speeds. The guiding principles are to maintain the existing posted speed limits on and adjacent to the M1 Princes Motorway and adjoining roads, and to create a safe motoring environment that is easy to navigate and provides for the transitions between a motorway and the surrounding road hierarchy.

The design speeds and the proposed operating or signposted speeds on each section of road are listed in Table 3-1. The proposed layout of the new M1 Princes Motorway Mount Ousley interchange is illustrated in Figure 1-2, with each of the carriageway components in Table 3-1 labelled for ease of reference.

<table>
<thead>
<tr>
<th>Carriageway</th>
<th>Posted speed limit</th>
<th>Design speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main alignment and northbound on ramp</td>
<td>80 km/h</td>
<td>90 km/h</td>
</tr>
<tr>
<td>University Access Road</td>
<td>50 km/h</td>
<td>60 km/h</td>
</tr>
<tr>
<td>Mount Ousley Road and southbound service road</td>
<td>60 km/h</td>
<td>70 km/h</td>
</tr>
<tr>
<td>Carriageway</td>
<td>Posted speed limit</td>
<td>Design speed</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>-------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Northbound off ramp and southbound on ramp</td>
<td>60 km/h</td>
<td>70 km/h</td>
</tr>
<tr>
<td>Heavy vehicle bypass lane (approaching diverge)</td>
<td>40 km/h</td>
<td>70 km/h</td>
</tr>
<tr>
<td>Heavy vehicle bypass (after diverge)</td>
<td>80 km/h</td>
<td>90 km/h</td>
</tr>
<tr>
<td>Heavy vehicle off ramp to Mount Ousley Road (after diverge)</td>
<td>40 km/h</td>
<td>50 km/h</td>
</tr>
</tbody>
</table>

### 3.2.2 Key design elements – details

#### Bridges and structures
The proposed design of the M1 Princes Motorway Mount Ousley interchange requires construction of a number of structures to achieve the desired grade separation of the intersection, and separation between heavy vehicles and light vehicles.

The most prominent structure would be a new two lane bridge (one lane in each direction) connecting Mount Ousley Road with the M1 Princes Motorway northbound, and with the proposed northern entry to the University of Wollongong. The new bridge is proposed as a two span structure with one central pier located in the median between the M1 Princes Motorway main alignment and the heavy vehicle bypass. At the bridge’s eastern abutment, it would adjoin a proposed new roundabout at Mount Ousley Road.

At the western abutment the bridge would transition to an elevated road (Mount Ousley Road) that would be supported on its southern side by a large retaining wall. Because of the topography in this location and the existence of a natural drainage channel, the retaining wall would be up to about 11 m in height, with the height gradually decreasing toward the western end of Mount Ousley Road.

Mount Ousley Road would terminate at its western end at a new roundabout, which would provide access to the proposed University Access Road, a new northbound motorway on ramp and the proposed new commuter car park. A new northbound motorway off ramp would also connect with the western roundabout. The proposed University Access Road would be a two lane road (one lane in each direction) on an embankment that decreases in height as it approaches the university’s northern car park.

A new bridge would be constructed across Mount Ousley Road adjacent to the proposed eastern roundabout for use by pedestrians and cyclists. The proposed pedestrian/cycle bridge would be a single span precast structure designed to connect the suburbs to the north of the M1 Princes Motorway to the University of Wollongong and the TAFE NSW Wollongong Campus via the existing shared path that runs along the eastern side of the motorway.

The proposed Mount Ousley Road vehicular bridge would incorporate a shared pedestrian/cycle path along its southern side. Both of the new bridges would be fitted with throw screens.

The existing pedestrian/cycle bridge across the M1 Princes Motorway adjacent to Northfields Avenue would be upgraded by extending the span of the bridge to accommodate the widened
motorway carriageway beneath and modifying the shared path access ramp on the eastern side to suit.

On the northern side of the M1 Princes Motorway, the proposed road design results in a complex road formation requiring further structures. Most prominent would be the heavy vehicle bypass, which would be constructed in a deep cutting passing beneath the Mount Ousley Road off ramp and the southbound service road. The heavy vehicle underpass would be constructed at a highly skewed angle. The cutting would be enclosed on both sides by retaining walls up to 7 m in height. The underpass itself would be a cut-and-cover construction, with a reinforced concrete deck supporting the road surfaces above.

Retaining walls of varying length and height would be constructed at numerous locations where the proposed road design does not allow sufficient space for battered embankments or cuttings. Along the edges of the proposal where it would pass close to residential areas or other sensitive receivers, noise barriers would be erected on top of retaining walls. Final extent, material and height of noise walls would be determined during detailed design and after community consultation.

![Figure 3-1 Proposed noise barrier location](image)

**Heavy vehicle off ramp**

The proposed vertical and horizontal alignment of the heavy vehicle off ramp to Mount Ousley Road has been refined to achieve an optimised gradient and to maintain separation from light vehicle traffic until a merge point between the interchange and the existing Gaynor Avenue roundabout. The alignment has been designed to manage the speeds of heavy vehicles entering the lower reaches of Mount Ousley Road.

**Heavy vehicle bypass**

The proposed heavy vehicle bypass and heavy vehicle off ramp (to Mount Ousley Road) would both be accessed from the left (southbound) lane of the M1 Princes Motorway, thereby providing...
clear delineation between the heavy vehicle lanes and light vehicle lanes. From the exit the bypass would descend into an open ‘slot’ structure, passing under the Mount Ousley Road southbound off ramp and the proposed southbound service road in a cut-and-cover structure. An even curve radius would be maintained through the length of the bypass, improving safety and allowing heavy vehicles to accelerate back to 80 km/h before merging back onto the M1 Princes Motorway from the left lane.

The proposed merge point has been designed with safety as a priority, in that southbound heavy vehicles would re-join the M1 Princes Motorway from the bypass after the interchange, exiting the curve onto a straight, level section of the motorway. The merge zone would be free of other merging traffic (traffic that previously exited at this location towards University Avenue) and all vehicles would be driving to the same speed limit.

**Heavy vehicle safety ramps**

The single existing safety ramp at the bottom of Mount Ousley would be replaced by two new safety ramps. The safety ramps would diverge from both sides of the proposed heavy vehicle bypass/off ramp, close to the location of the existing safety ramp entry. Both ramps would be about 200 metres in length.

Safety ramp 1 would replace the existing safety ramp, exiting from the left lane and following a straight alignment parallel with Dumfries Avenue taking advantage of the steep rise in the natural topography. Deceleration would be assisted by a pea-gravel arrestor bed. Safety ramp 2 would diverge from the right hand side of the heavy vehicle exit, following a curved alignment (with a similar radius to the existing safety ramp) along the side of the heavy vehicle bypass. This location ensures that safety ramp 2 is easily accessible from both southbound motorway lanes, if necessary. Deceleration would be achieved by using a deeper layer of pea-gravel in the arrestor bed due to the lack of a steep uphill grade. Because of the limited distance between the heavy vehicle exit and the heavy vehicle underpass structure, a ‘soft’ barricade would be erected before the underpass as an additional safety precaution.

**Mount Ousley Road**

The alignment of Mount Ousley Road and its connectivity to and from adjoining roads has been refined by including the following design initiatives:

- The alignment of Mount Ousley Road has been modified, allowing for a shorter bridge span across the M1 Princes Motorway and a reduced bridge skew angle
- A northbound off ramp to Mount Ousley Road has been added to the design, thereby improving access and connectivity to the University of Wollongong, the commuter car park and Mount Ousley Road
- The left turn from Mount Ousley Road onto the M1 Princes Motorway has been removed and replaced by the southbound service road to University Avenue thereby removing another traffic merge point and enabling the construction of the heavy vehicle bypass and the southbound service road (see below).

**Southbound service road and southbound on ramp**

The proposed southbound service road has been included in the concept design to provide a dedicated southbound access to University Avenue and to separate this traffic from the M1 Princes Motorway. The southbound service road would diverge from the Mount Ousley Road southbound off ramp and removes the need for a southbound exit from the M1 Princes Motorway directly into University Avenue.
The southbound service road would merge with a proposed new southbound on ramp, which would be reached from Mount Ousley Road via the eastern roundabout. Because the southbound service road would not re-join the M1 Princes Motorway, the southbound on ramp would only partially replace the existing left turn from Mount Ousley Road onto the motorway (which would be removed). Southbound vehicles originating from Mount Ousley Road and wishing to enter the M1 Princes Motorway would need to travel along the southbound service road through University Avenue to access the M1 Princes Motorway southbound.

The southbound service road and on ramp mean that university-bound traffic coming from the north would exit the M1 Princes Motorway earlier than it does under the existing arrangement. This removes the risk of vehicles exiting at University Avenue needing to weave across heavy vehicles exiting the heavy vehicle bypass and ensures that any queuing at University Avenue interchange is physically separated from the Princes Motorway.

**Pedestrian/cycle shared path**

The proposed pedestrian/cycle connection from Dumfries Avenue to the University of Wollongong has been refined and connected to the existing shared path along the western side of the TAFE NSW Wollongong campus. The shared path would cross Mount Ousley Road on a new single span bridge then cross the southbound on ramp next to the eastern roundabout. It would then follow Mount Ousley Road across the M1 Princes Motorway bridge and the proposed University Access Road, into the university campus. The proposed new pedestrian and cycle facilities would improve overall connectivity and safety for pedestrians and cyclists and reduce the severance effect of the M1 Princes Motorway between the University of Wollongong and the communities to its north and east.

**Commuter car park**

The proposed new commuter car park would be located in the otherwise redundant space on the southern side of the M1 Princes Motorway between the motorway and Mount Ousley Road. It would be reached via a left-in, left-out only access; however, the provision of two roundabouts at the interchange enables access from all directions. This provides for safer access with less possible turn movements in a confined area without affecting the car park’s overall accessibility to and from all adjoining roads.

**Typical cross section**

The proposal comprises a complex grade-separated arrangement designed to accommodate the desired separation between light and heavy vehicles and separation between motorway through traffic and exiting traffic, through a corridor where terrain is variable. This results in an interchange design that includes underpass, overpass and at-grade sections of road and a cross section that changes constantly. There is therefore no ‘typical’ cross section.

The proposed design has adopted a consistent traffic lane width of 3.5 m, and a typical shoulder width of 3 m. A concrete safety barrier would separate opposing traffic streams and would also be used in some locations as a kerb barrier. Where concrete safety barriers are not suitable, a steel guard rail would be used.

**Bus facilities**

Buses would continue using the M1 Princes Motorway and Mount Ousley Road. In consultation with University of Wollongong, Transport for NSW and bus companies there is the potential for the proposed interchange to accommodate new public transport routes providing an alternative to the Northfields Avenue bus interchange.
Landscaping

Substantial earthworks would be required to construct the proposal, as described in Section 3.3. The final road formation would comprise a combination of the structures described above, and other areas where embankments and cuttings would be constructed with engineered batter slopes of varying gradients. All earthworks batters, as well as other areas of the site disturbed during construction, would be landscaped at completion of the proposed works in accordance with the proposed landscape plans which are described in detail and illustrated in Section 6.4.

3.2.3 Engineering constraints

The proposal would be constructed within and around the existing M1 Princes Motorway road reservation. This area is tightly constrained by topography, surrounding vegetation, adjoining land uses, utility corridors, natural drainage lines and the need to keep the existing motorway operating safely at all times during construction. Geotechnical conditions were also considered. The design of the proposed interchange has addressed these issues while achieving a cost-effective solution and meeting Roads and Maritime’s objectives.

The ways in which the design has responded to these engineering issues and constraints is outlined in Table 3-2.

Table 3-2 Engineering constraints and proposed design response

<table>
<thead>
<tr>
<th>Issue / constraint</th>
<th>Proposed design response</th>
</tr>
</thead>
</table>
| Topography and geotechnical conditions | • Design utilises existing motorway footprint where possible  
• Land within the proposed construction footprint falls steeply from the north and north-west to the south. Because of limited space, the proposed design includes considerable length of ‘slot’ cuts requiring extensive retaining walls. Where possible, engineered batter slopes are proposed on top of retaining walls, to limit the height of the walls  
• Prevailing ground conditions require adoption of flat, wide batter slopes at most locations (3:1 horizontal to vertical) in order to achieve the required stability and to encourage landscaping plant growth  
• Geotechnical investigations showed that material proposed to be excavated does not have the required properties to be used as engineered fill, but could be used as general fill. Therefore, all structural fill material (e.g. for bridges, elevated carriageways) would need to be imported |
| Natural drainage lines                 | • Three spill containment basins and two vegetated swale drains are included in the design, on or near the main drainage line from Dallas Street branch of Cabbage Tree Creek which crosses M1 Princes Motorway adjacent to University of Wollongong  
• Existing motorway cross-drainage locations would remain unchanged and new drainage infrastructure would augment the existing |
### Issue / constraint | Proposed design response
--- | ---
Existing utilities | • Numerous existing underground utilities (electricity, gas, water, telecommunications) cross beneath or run alongside the M1 Princes Motorway. The concept design was therefore constrained firstly by the need to locate utilities, and then either to design around them, or to incorporate new utility corridors and easements into the design

Adjoining land uses | • The design has largely avoided acquisition/resumption of adjoining land. A small amount of partial/strip acquisition would be required at University of Wollongong and the TAFE NSW Wollongong campus. No acquisition of private residential land would be required however some modifications to existing noise walls adjoining private property would be required.

### 3.2.4 Safety in design

A safety in design workshop was conducted during the concept design phase, to address issues of constructability such that the proposal could be constructed without undue risk to construction workers, road users, adjoining landowners and residents. The workshop also sought to ensure that the concept design would incorporate features to enable the safe ongoing maintenance of built infrastructure.

The construction methodology and sequence is detailed in Section 3.3, and aims to balance construction safety with safe operation of the M1 Princes Motorway during the construction period. Other elements of the proposal for which safety in design is a key consideration include:

The proposed Mt Ousley Road bridge across M1 Princes Motorway has been designed as a two-span bridge with central pier to be constructed in the median, outside the live traffic zone, during the first stage of construction.

Major components of new infrastructure can be constructed off-line, remote from live traffic environment.

The proposed design achieves separation between light and heavy vehicles, and hence between slower and faster-moving vehicles. It would therefore improve road safety for all road users.

### 3.2.5 Urban design and visual amenity

The major features of the design would contribute to a substantial change in the motorist’s experience when driving through the interchange, as well as an altered visual landscape (described and assessed in Section 6.4). Urban design features are illustrated in Photo 3-1 and 3.2 and described in the context of the overall proposed urban design and landscape strategy, in Section 6.4. Additional illustrations and viewpoints of the proposal are shown in Appendix G.
3.3 Construction activities

The proposal would be constructed within a tightly constrained corridor under live traffic, where road closures would be possible only during regular scheduled night time maintenance closures of the M1 Princes Highway. In addition to the corridor constraints, the proposed design is complex due to the steep topography and mix of heavy vehicles. Careful consideration has therefore been given to the likely construction method, sequence and scheduling. Details of the proposed construction method, sequence and scheduling are provided in the following sections.

3.3.1 Work methodology, sequence and staging

Following site establishment, construction of the proposal is proposed to be completed in three stages, each of which is described in detail below and is based on the concept design. The construction methodology would be further refined during detailed design prior to construction. The proposed initial stage of construction (Stage 1) would allow all existing traffic flows to remain unchanged, with construction activities taking place offline. With completion of each consecutive
stage, more of the new road infrastructure would be opened to traffic, thus enabling construction of the next stage to commence.

Site establishment and early works

After engagement of a contractor, activities would commence to begin site establishment. A number of tasks are required before civil construction works can commence, including:

- Erection of fencing, temporary buildings (site offices etc.) and site compound setup including vehicular access
- Relocation of some utilities and installation of temporary sediment controls
- Project plans and approvals – preparation of management plans, and securing of any other approvals (e.g. environmental protection licence, if required).

Before any construction works can commence, a site compound would be established on land adjacent to the M1 Princes Motorway that is owned by Roads and Maritime, between the motorway and Gowan Brae Avenue. Details of the site compound and all other ancillary facilities required to construct the proposal are described in detail in Section 3.4.

Stage 1 – major civil works, offline construction

Stage 1 construction, as illustrated in Figure 3-2, would take place over three discrete sites; one south, and two north of the M1 Princes Motorway. The Stage 1 works have been designed to be undertaken offline, allowing all existing traffic flows to be maintained. However, reduced lane and shoulder widths would be implemented, to maximise the construction area and to ensure that minimum safe working clearances are maintained between work areas and live traffic.

Figure 3-2 Construction stage 1 plan
**Stage 1, site 1 works**

Stage 1, site 1 would be located north of the M1 Princes Motorway between the northern limit of works and the existing heavy vehicle safety ramp. Proposed works within site 1 include:

- New heavy vehicle safety ramp, and decommissioning of the existing safety ramp
- The first sections of the heavy vehicle bypass lane and the heavy vehicle off ramp, between the northern limit of works and the existing heavy vehicle safety ramp
- Initial drainage works (pipe jacking of cross drainage pipes).

The existing heavy vehicle safety ramp is to remain operational until the new safety ramp is constructed. Construction vehicle movements would need to be managed during this stage in accordance with the TMP.

**Stage 1, site 2 works**

Stage 1, site 2 would be located north and east of the M1 Princes Motorway, between Mount Ousley Road and University Avenue as shown in Figure 3-2.

Proposed construction works at site 2 include:

- Heavy vehicle off ramp between the existing commuter car park and the limit of works
- Mount Ousley Road, westbound approach to the new eastern roundabout
- New eastern roundabout
- New bridge over the M1 Princes Motorway
- Southbound service road between the new bridge and University Avenue
- Southbound on ramp, from the eastern roundabout to the merge with the southbound service road
- Reconstruction/modification of the existing pedestrian bridge at Northfields Avenue, between the TAFE NSW Wollongong campus and the University of Wollongong.

The proposed new bridge over the M1 Princes Motorway would be a two span structure with a central pier located between the heavy vehicle bypass land and the southbound carriageway. Stage 1, site 2 works would require night time closures for the placement of bridge deck planks. Night works would also be required for drainage work.

Once traffic is switched to the heavy vehicle off ramp, the existing commuter carpark would need to be closed, as access would no longer be possible.

**Stage 1, site 3 works**

Stage 1, site 3 would be located south of the M1 Princes Motorway for the extent of the works, including the proposed new University northern access road.

Proposed construction works at site 3 include:

- Mount Ousley Road from the new bridge over the M1 Princes Motorway to the new western roundabout
- New western roundabout
- New commuter car park
- University northern access road
- Northbound on ramp to M1 Princes Motorway.
Site 3 construction works would require substantial earthworks. A large amount of imported fill would be required in order to construct the proposed reinforced soil wall at the interface between Mount Ousley Road and the University of Wollongong. Substantial earthworks would also be required to construct the new commuter car park and the new university northern access road. A number of construction vehicle movements would therefore be generated in, out and around this site, potentially involving use of internal university roads. The expected construction traffic generation associated with these earthworks is likely to be one vehicle per hour, and these movements would be limited to the eastern extent of the university ring road. Construction traffic is addressed in more detail in Section 3.3.6 below.

Construction of the western roundabout would include the formation of the northbound roundabout approach from the new northbound off ramp. However, the off ramp would not be constructed or commissioned until Stage 3, due to the required sequencing for construction of new median drainage and new pavement along the main carriageways of the M1 Princes Motorway.

**Stage 2 – cut and cover works, mainline motorway adjustments**

Stage 2 construction, as illustrated in Figure 3-3, would also take place at three discrete sites; two north of the M1 Princes Motorway, and one in the motorway median area. New road infrastructure constructed during Stage 1, including the new bridge over the M1 Princes Motorway, the eastern and western roundabouts, and the new heavy vehicle safety ramp, would be in operation during Stage 2.

Figure 3-3 Construction stage 2 plan
At Stage 2, through lanes of the M1 Princes Motorway would need to be adjusted to 3.2 metre width, with reduced shoulders to be implemented so that there is sufficient separation between the work zones and live traffic. For Stage 2 site 2, this would mean adjusting the southbound lanes toward the median while for site 3, the southbound lanes would be adjusted toward the nearside shoulder, maximising the width of the median where site 3 works would take place (see below).

The existing Mount Ousley Road entry to the M1 Princes Motorway would be permanently closed in Stage 2. Mount Ousley Road westbound traffic would be switched to the final configuration, with traffic using the eastern and western roundabouts to access the M1 Princes Motorway.

The M1 Princes Motorway southbound exit to University Avenue would be permanently closed in Stage 2, with traffic diverted via a temporary exit from the M1 Princes Motorway onto the southbound service road, which would then provide an alternative access to the University Avenue off ramp.

The location of the southbound exit to Mount Ousley Road would be adjusted to allow eastbound traffic to use the existing westbound carriageway through the area of the cut and cover. Eastbound traffic would then use the heavy vehicle off ramp (constructed in stage 1) to rejoin Mount Ousley Road before the Gaynor Avenue roundabout.

Stage 2, site 1 works

As shown in Figure 3-3 site 1 would be located north of the M1 Princes Motorway between the existing heavy vehicle safety ramp and Mount Ousley Road.

Proposed construction works within site 1 include:

- Heavy vehicle bypass lane from the existing heavy vehicle safety ramp to the existing Mount Ousley Road westbound carriageway. This includes a section of the cut and cover under Mount Ousley Road
- Heavy vehicle off ramp from the existing heavy vehicle safety ramp to east of the existing commuter car park
- Pedestrian bridge over Mount Ousley Road.

The new heavy vehicle safety ramp (constructed in Stage 1) would be commissioned for Stage 2, allowing the existing safety ramp to be decommissioned, facilitating further construction of the heavy vehicle bypass lane and the heavy vehicle off ramp.

Construction of the cut and cover would be complicated by the skew at which the heavy vehicle bypass lane passes under the existing Mount Ousley Road. To enable the cut and cover to be constructed without closing Mount Ousley Road, eastbound traffic would need to be diverted onto the existing westbound carriageway. This would enable construction of sufficient width of the cut and cover in Stage 2, to ensure that Mount Ousley Road can remain open to traffic in Stage 3.

An overnight closure of Mount Ousley Road would be required for placement of the proposed pedestrian bridge.

Stage 2, site 2 works

Site 2 would be located on the eastern side of the M1 Princes Motorway between the approximate merge point for the southbound service road and the southbound on ramp, and the limit of works at University Avenue Figure 3-3.

Proposed construction works within site 2 include:
• Southern continuation of the heavy vehicle bypass lane
• Concrete safety barrier and completion of drainage (between the southbound service road and the M1 Princes Motorway) along the entire length of site 2 to University Avenue
• Implementation of the over-height vehicle exit to University Avenue.

During construction of the safety barrier and drainage between the southbound service road and the M1 Princes Motorway, traffic lane and shoulder widths on either side would be reduced to 3.2 m and 0.5 m respectively and adjusted away from the work, to create a safe working area.

The over-height vehicle exit (along the edge of the southbound service road) would be constructed as early as possible in Stage 2, thus providing a possible alternate route for vehicles trapped on the service road, in the event of a breakdown.

**Stage 2, site 3 works**

Site 3 would occupy the median of the M1 Princes Motorway from the northern limit of works to near the merge point of the heavy vehicle bypass with the motorway.

Proposed construction works within site 3 include:

• Median drainage and concrete barrier
• Northbound pavement construction.

**Stage 3 – final connections and motorway shoulder works**

By stage 3, much of the construction would be completed. The remaining construction would take place in two areas, one north of the highway and one south of the highway, as shown in Figure 3-4

Figure 3-4 Construction stage 3 plan
Reduced lane and shoulder widths would be maintained on the M1 Princes Motorway, with through traffic lanes adjusted towards the median for the extent of the works. Southbound motorway traffic bound for Mount Ousley Road would use the heavy vehicle off ramp.

The diversion for traffic previously exiting at University Avenue (implemented in Stage 2) would remain in operation during Stage 3.

**Stage 3, site 1 works**
Site 1 would be located north of the M1 Princes Motorway between the heavy vehicle off ramp and the new motorway overbridge, as shown in Figure 3-4. Proposed construction works within site 1 would include:

- Heavy vehicle bypass lane from the cut and cover section to the new motorway overbridge, including completion of cut and cover works under Mount Ousley Road
- Southbound off ramp, from the M1 Princes Motorway exit to the eastern roundabout
- Southbound service road, from the southbound off ramp to the new motorway overbridge.

Completion of the Stage 3 site 1 works would allow all final traffic switches to be made for Mount Ousley Road, the eastern roundabout, the southbound service road and the heavy vehicle bypass.

**Stage 3, site 2 works**
Site 2 would occupy the shoulder of the M1 Princes Motorway between the new motorway overbridge and the new northbound on ramp as shown in Figure 3-4. Proposed construction works at site 2 would include:

- Completion of the northbound off ramp and M1 Princes Motorway northbound shoulder.

**General scope of construction activities**
Throughout construction of the proposal, two lanes of traffic would be kept open at all times in both directions on the M1 Princes Motorway. Existing speed limits on the M1 Princes Motorway (40 km/h for trucks and buses in the southbound direction, 80 km/h for all other vehicles) would be maintained, with the possible exception of occasional periods when works are being carried out under traffic control.

Concrete barriers or other crash protection would be installed on the road shoulder to provide separation between through traffic and any works being undertaken within the work site, and to provide for worker safety. Existing line marking may need to be removed or altered. Where required, temporary line markings would clearly delineate lanes and edges throughout the construction zone.

Prior to final commissioning of the new interchange, finishing works would include the installation of permanent pavement markings and road furniture, construction of tie-ins between new and existing works, landscaping works, removal of temporary crash barriers and the opening of all new works to traffic.

**3.3.2 Construction hours and duration**
No funding or timing has been confirmed for the M1 Princes Motorway Mont Ousley Interchange proposal at this time. As outlined in Section 3.3.1, the construction process has been broken into three stages. The overall construction duration has been estimated at about 2.5 years, including site establishment, all preliminary works, and an allowance for wet weather.
The following sections describe the proposed construction program, and the proposed working hours for each stage of the proposed works should funding be secured for construction.

Program and duration of works

Stage 1 works
Stage 1, as described in Section 3.3.1, comprises a major proportion of the overall earthworks and civil works required to construct the proposal. As the most intensive stage of the proposal’s construction, Stage 1 works are programmed to take about 15 months to complete.

Stage 2 works
The Stage 2 works, as described in Section 3.3.1, comprise works in the median of the M1 Princes Motorway, the tie-in for the motorway and the southbound service road, and the major cut and cover works in Mount Ousley Road. The Stage 2 works are scheduled to take about seven months to complete.

At completion of the site 2 works, after the concrete median traffic barrier has been installed, the traffic switch would be made for commencement of Stage 3.

Stage 3 works
The Stage 3 works, as described in Section 3.3.1, would comprise the remaining works to complete the heavy vehicle bypass lane and cut and cover structure, the southbound off ramp and southbound service road, and the northbound off ramp and shoulder. These works are programmed to be completed in about five months, across two sites on either side of the M1 Princes Motorway just to the north of the new bridge.

After final drainage, pavement and finishing works, final line marking, and installation of signage, landscaping and road furniture, the works would be handed over. With allowance for wet weather delays and other contingencies, the proposed works have a total estimated duration of about 2.5 years.

Construction hours
The construction of the proposal would generally be within standard working hours following the Interim Construction Noise Guideline (DECC, 2009) (ICNG) and the Roads and Maritime Noise and Vibration Guideline (2016):

Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- No work would take place on Sundays or on public holidays.

Under the ICNG, however, there are five categories of work that can be carried out outside the recommended standard hours, as follows:

- Delivery of oversized plant or structures, where police or other authorities have determined that special transport arrangements are required
- Emergency work, to avoid the loss of life or damage to property, or to prevent environmental harm
- Maintenance and repair works, where disruption to essential services and/or safety considerations do not allow work within standard hours
• Public infrastructure work that would shorten the duration of a project and are supported by the affected community
• Work where a proponent demonstrates and justifies the need to operate outside the standard hours.

Given the need to keep the M1 Princes Motorway open to traffic throughout construction, it would be necessary to carry out some construction activities outside standard working hours when traffic volumes are lower and temporary lane closures, detours or slow zones can be better accommodated. For example, where existing noise barriers are required to be removed and relocated to accommodate the works, performing this activity outside periods of heavy traffic potentially allows closure of one traffic lane for worker safety without adversely impacting on overall traffic flow.

Similarly, placement of bridge deck elements across the M1 Princes Motorway would involve delivery and placement of large pre-fabricated concrete girders and planks, and is likely to require oversize vehicles, cranes and a substantial workforce. This work could be carried out safely only with closure of the road, either at night or during a scheduled quarterly maintenance closure of the M1 Princes Motorway.

Other activities likely to be conducted at night or on weekends may include:
• Utility relocation works either in, or in close proximity to live traffic zones
• Placement of pedestrian/cycle bridge deck elements across Mount Ousley Road and the M1 Princes Motorway.

Issues relating to construction noise, out-of-hours work and impacts on nearby receivers are discussed in detail in Section 6.2.

### 3.3.3 Plant and equipment

During the construction period, a range of equipment would be used. The final equipment and plant requirements would be identified by the construction contractor. An indicative list of plant and equipment for the proposal is included in 3-3.

Table 3-3 Potential construction plant and equipment

<table>
<thead>
<tr>
<th>Potential construction plant and equipment</th>
<th>Asphalt pavers</th>
<th>Concrete pumps</th>
<th>Hydraulic hammer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt profiling machines</td>
<td>Concrete mixers</td>
<td>Hydraulic jacks</td>
<td></td>
</tr>
<tr>
<td>Backhoes</td>
<td>Cranes</td>
<td>Lighting units</td>
<td></td>
</tr>
<tr>
<td>Bobcats</td>
<td>Dewatering pumps</td>
<td>Line marker</td>
<td></td>
</tr>
<tr>
<td>Bulldozers</td>
<td>Drill/boring rigs</td>
<td>Mobile cranes</td>
<td></td>
</tr>
<tr>
<td>Cherry pickers</td>
<td>Dump trucks</td>
<td>Piling rigs</td>
<td></td>
</tr>
<tr>
<td>Chipping machines</td>
<td>Elevated working platforms</td>
<td>Rock breakers</td>
<td></td>
</tr>
</tbody>
</table>
### Potential construction plant and equipment

<table>
<thead>
<tr>
<th>Chainsaws</th>
<th>Excavators</th>
<th>Road rollers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compactors</td>
<td>Front-end loaders</td>
<td>Road sweepers</td>
</tr>
<tr>
<td>Compressors</td>
<td>Fork lift</td>
<td>Scrapers</td>
</tr>
<tr>
<td>Compressed air machinery</td>
<td>Flatbed trucks</td>
<td>Vibratory Rollers</td>
</tr>
<tr>
<td>Concrete pavers</td>
<td>Generators</td>
<td>Water carts</td>
</tr>
<tr>
<td>Concrete saws</td>
<td>Graders</td>
<td></td>
</tr>
<tr>
<td>Concrete trucks</td>
<td>Hand tools</td>
<td></td>
</tr>
</tbody>
</table>

#### 3.3.4 Earthworks

The proposal would involve earthworks, with the overall aim of maximising the re-use of material on site, to reduce material import, and minimise traffic movements on the road network in and around construction zones.

During construction, it would be necessary to move a large amount of excavated materials within the proposal area from cuttings to fill areas. Where feasible, excavated materials would be re-used to meet general fill material requirements, such as the foundations for fill embankments.

A proportion of the fill material would be imported from local quarries, and the M1 Princes Motorway would be used by trucks transporting the material to access the proposal area. There are a number of quarries available in Bombo, Dunmore or Oak Flats, about 30 km south of the proposal area.

Table 3-4 shows the overall estimated earthworks cut and fill balance. The construction site where most fill would need to be imported would be site 3, during Stage 1 of construction, to build up the formation for Mount Ousley Road, the commuter car park, the western roundabout and the University Access Road. At most other construction sites, excavation works would leave an overall material surplus. However, construction of items such as reinforced soil retaining walls, pavements and drainage require ‘select’ fill material, which cannot be sourced from the earthworks because most of the excavated material would be of insufficient quality. Therefore, the initial estimate shows that about 22,000 m$^3$ of fill material would be required to be imported during the earthworks period. Earthwork requirements would be confirmed during detailed design.

Table 3-4 Estimates earthworks volume during construction

<table>
<thead>
<tr>
<th>Stage</th>
<th>Site</th>
<th>Cut (-) / Fill (+) (m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>+36,000</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>+7,000</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>-57,500</td>
</tr>
<tr>
<td>Stage</td>
<td>Site</td>
<td>Cut (-) / Fill (+) (m³)</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>------------------------</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>+25,000</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>+12,000</td>
</tr>
</tbody>
</table>

3.3.5 Source and quantity of materials

Construction of the proposal would require, but is not limited to, the following materials:

- Earthworks materials, such as topsoil, general fill material, select fill for use in the Selected Material Zone (SMZ) and verge, bridging layers and drainage layers
- Aggregates for drainage construction, concrete and asphalt production and spray seals
- Sand for drainage construction and concrete and asphalt production
- Concrete for drainage construction, pavement construction, bridgeworks and miscellaneous works such as barrier kerbs, kerbs and gutters, paving and signpost footings
- Bitumen for spray seals and asphalt production
- Cement and fly ash for concrete production
- Road base for the construction of flexible pavements
- Precast concrete elements for drainage construction (culverts, pits and headwalls) and miscellaneous works
- Steel for barrier railings and reinforcement in concrete
- Super-T bridge beams
- Erosion and sediment control materials (sandbags, spill kits, sediment fences)

The source and quantity of materials required to construct the proposal would be finalised during detailed design through the development of a construction materials and resources plan. Materials would be sourced from appropriately licensed facilities, and where possible from the Illawarra region. Nearby quarries would be used as possible material sources as they are located close to the proposal area. Material source would comply with relevant Roads and Maritime specifications concerning material quality.

The accuracy of estimates for the amount of fill material required is subject to variations in bulking factors for excavated material, the relative compaction achieved for placed material, and the volume of usable material once it has been excavated. This would be refined during detailed design.

The amount of water that would be required during construction is unknown at this stage. The amount would depend on material sources and methodologies applied by the contractor.

Surplus material that cannot be used on site would be re-used or disposed of in the following order of priority:

- Transfer to other Roads and Maritime projects for immediate re-use in line with the NSW Environmental Protection Authority (EPA) Excavated Public Road Material resource recovery exemption
- Transport off site for re-use by a third party in line with a relevant EPA resource recovery exemption
• Disposal at an approved materials recycling or waste disposal facility
• As otherwise provided for by the relevant waste legislation.

3.3.6 Traffic management and access
Prior to commencement of construction, the contractor would be responsible for planning and producing the Construction Traffic Management Plan, Traffic Staging Plans and Traffic Control Plans.

Speed limits
The existing speed limits on the M1 Princes Motorway (40 km/h for trucks and buses in the southbound direction, 80 km/h for all other vehicles) and Mount Ousley Road (40 km/h for trucks and buses in the eastbound direction, 60 km/h for all other vehicles) would be maintained during construction where possible. Occasional slow speed zones may be implemented during specific construction tasks, such as where construction workers are operating in close proximity to the live traffic zone, or when a temporary lane closure is in force. In some cases traffic control may be required to ensure that traffic flows safely around or through a particular work zone. The contractor’s Construction Traffic Management Plan would govern these decisions, and where and when they are implemented.

Parking restrictions
No parking is currently permitted on the M1 Princes Motorway or Mount Ousley Road within the proposal area. The existing commuter car park located next to the eastbound lane of Mount Ousley Road would be closed in Stage 1, after the construction of the new heavy vehicle safety ramp (and decommissioning of the existing safety ramp). The construction would be approximately 6 months. After this, the heavy vehicle off ramp would be need to be constructed (as Stage 2 traffic relies on this link), which would require the closure of the car park. While the commuter car park is being constructed in Stage 1, it would not have full connectivity until completion of the works.

Road closures / potential delays
There would be no permanent road closures as a result of the proposal. However, there would be a temporary closure of the Northfields Avenue on ramp to construct the retaining wall and drainage on the nearside shoulder. During these works, northbound access to the M1 Princes Motorway would be available via Mount Ousley Road and the northbound on ramp constructed in Stage 1.

The M1 Princes Motorway is subject to scheduled quarterly night time closures, for maintenance and repairs to road and drainage infrastructure, signage, lighting and road furniture. As described in Section 3.3.1, placement of deck planks across the M1 Princes Motorway for the southern span of the proposed Mount Ousley Road bridge, would be carried out during a scheduled closure. Similarly, deck planks for the proposed new pedestrian/cycle bridge over Mount Ousley Road could also be placed during a scheduled night time closure. These components of the proposed works would therefore be carried out without any additional unscheduled interruption to traffic flows on the M1 Princes Motorway.

Two lanes in each direction of the M1 Princes Motorway would be maintained for bi-directional traffic flow at all times. Drivers and residents in Dumfries Avenue may experience potential delays during construction of the retaining walls and piling activities adjacent to the road.
**Diversions / detours**

Some diversions would be required to maintain the flow of traffic. Traffic switches at tie-ins to the existing carriageway would be required at various stages throughout the construction works, where traffic would be redirected from the existing carriageway to the newly constructed road. No road closures or temporary diversions would be required for Stage 1. During Stages 2 and 3 it would be necessary to close the southbound exit to University Avenue to allow the construction of the concrete safety barrier and drainage pits between the southbound carriageway and the southbound service road. Traffic would therefore be diverted via a temporary exit from the M1 Princes Motorway onto the southbound service road, which would then provide an alternative access to the University Avenue off ramp.

**Impacts to existing access**

Access to residential property, the University of Wollongong and TAFE NSW Wollongong campus would be unaffected during the construction of the proposal. At some locations, the design would allow for heavy vehicles to access the working area close to residential property, but these activities would not impact on access to residential property. Access for emergency services would be maintained with the contractor required to undertake the necessary consultation before implementing any changes to traffic conditions.

**Construction vehicle access**

Construction vehicles would generally access the work sites from the M1 Princes Motorway, which would result in a temporary but imperceptible increase in heavy vehicle movements along the M1 Princes Motorway. During civil works during construction Stage 1 (site 3), construction vehicles would be able to enter this site from the northbound lanes of the M1 Princes Motorway. However, because of insufficient turning space and difficulties associated with providing safe entry back into the M1 Princes Motorway’s northbound lanes, it would be necessary for some construction traffic to exit the work site via the University of Wollongong’s internal ring road, regaining access to the motorway via Northfields Avenue and/or University Avenue. Construction traffic volumes are discussed in the next section, below.

Access in and out of the main site compound, on the north east side of the M1 Princes Motorway between Mount Ousley Road and Gowans Brae Avenue, would initially be from the southbound lanes of the motorway via the existing gates. Once the southbound on ramp (from Mount Ousley Road) has been constructed however (during Stage 1), an alternate entry/exit to the site compound would be established from the service road.

Access to Stage 1 site 1 (between the M1 Princes Motorway, Mount Ousley Road and Dumfries Avenue) would be from the existing Mount Ousley Road exit and the existing safety ramp exit. It would also be necessary for some construction vehicles to access this site from Dumfries Avenue, principally for piling works associated with construction of retaining walls for the proposed new safety ramp.
Construction traffic volumes
Estimated construction traffic volumes are shown in Table 3-5.

Table 3-5 Estimate construction traffic volumes

<table>
<thead>
<tr>
<th>Type</th>
<th>Movements per day (estimate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light vehicles</td>
<td>100-300</td>
</tr>
<tr>
<td>Trucks – external earth</td>
<td>30-80</td>
</tr>
<tr>
<td>Trucks – internal earth</td>
<td>30-80</td>
</tr>
<tr>
<td>Water trucks</td>
<td>0-10</td>
</tr>
<tr>
<td>Trucks – external road surface</td>
<td>30-80</td>
</tr>
<tr>
<td>Concrete trucks</td>
<td>10-70</td>
</tr>
</tbody>
</table>

Construction traffic would be greatest during the main earthworks and civil construction and would comprise vehicles transporting equipment, materials and spoil, and construction workers accessing the site. Construction workers would generally arrive by car and limited parking for light vehicles would be provided at the main site compound.

Impacts of construction vehicles on road users
The slowing down, entering and turning movements of construction traffic into and out of work sites has the potential to impact the safety of other road users. This would be mitigated by ensuring that adequate roadwork signage, truck turning signage and the roadwork speed limit are planned and implemented in accordance with a Traffic Control Plan prepared by the contractor, and approved by Roads and Maritime prior to commencement of construction.

An increase in construction vehicles on the adjacent road network may slightly increase the travel times for other road users. However, this is not expected to be significant as the majority of the construction traffic movements would occur outside of peak traffic periods.

Haul routes
During construction it would be necessary to move a large amount of on-site excavated materials from cuttings to fill areas, or to transport import material to the site and excess spoil material away from the site. During works for Stage 1, site 3 (Mount Ousley Road, new western roundabout, University northern access road), spoil would be removed via a dedicated haul road along the southern and western side of the motorway, and only use the easternmost section of the University ring road and Northfields Avenue to safely rejoin the M1 Princes Motorway. This route would minimise impacts on the university and the local road network.

Any haulage movement across or along the M1 Princes Motorway, or on local roads, would be in accordance with an approved Traffic Management Plan.
3.4 Ancillary facilities

One primary site compound area of approximately 125,000 m² would be provided adjacent to the proposed southbound on ramp, and bounded to the east by Gowan Brae Avenue and Mount Ousley Road property boundaries as shown in Figure 3-2. The site compound would accommodate the site offices, worker amenities such as crib rooms, toilets and first aid provisions, a limited amount of construction parking and plant. Some materials would be stockpiled at the site compound, in particular during utility relocations along the eastern side of the M1 Princes Motorway.

The site compound would be located in close proximity to residences in Gowan Brae Avenue and Old Mount Ousley Road. The compound is likely to result in some minor disturbance to residents in these areas, particularly during site establishment. However, once established, no noisy activities would be conducted in the compound site, and the site would generally operate during standard working hours.

A drainage channel known as the Dallas Street Branch runs from west to east adjacent to the southern boundary of the proposed site compound site. Investigations for the proposal included flood modelling for this channel, which captures runoff from the nearby escarpment. The modelling showed that flooding would not extend far beyond the channel, even for the ‘probable maximum flood’ (PMF) event (see Section 6.5), and that flood impacts on the proposed compound site would not be significant as long as temporary works are located outside the 5% annual exceedance probability (AEP) flood extent. The site however may be subject to overland flows, and erosion and sediment controls would therefore be implemented prior to construction to minimise sediment that could be transported into the Dallas Street Branch. Likewise, with the proposed stockpile and laydown sites, erosion and sediment controls would be implemented in conjunction with an erosion and sediment control plan.

Following completion of construction, Roads and Maritime would consider converting part of the main compound site for permanent use as a traffic incident response unit which would improve response times to incidents on Mount Ousley and the surrounding area.

As previously discussed, vehicle access in and out of the main site compound would be from the M1 Princes Motorway, until formation of the proposed southbound on ramp is complete. Once complete, this would become the main site compound access route.

There are likely to be small areas of stockpiling locally within the individual sites (locations to be determined) to be used for temporary spoil management, and for materials such as pre-cast drainage and other concrete elements. The stockpile areas would be used for short periods only and would be established and managed in accordance with the Stockpile Site Management Guideline (Roads and Maritime, 2015).

No concrete batch plant would be required for the proposal.

Some vegetation clearing would be required in order to establish the main site compound. Vegetation clearing, and the associated impacts on biodiversity are assessed in Section 6.3.

Sites would be securely fenced with temporary fencing. Signs would be erected advising the general public of access restrictions. Upon completion of construction, the temporary site compound, work areas and stockpiles would be removed, and the sites would be cleared and rehabilitated in accordance with the overall landscaping and rehabilitation strategy. The site
compound may be converted into a traffic incidence response facility during operation. The landscaping concept plan for the proposal is discussed and illustrated in Section 6.4.

Ancillary facilities would be predominantly utilised during standard construction hours. However, in some instances these facilities may need to be utilised outside of standard construction hours to facilitate construction activities. In these instances, appropriate management measures would be implemented in accordance with the Construction Environmental Management Plan (CEMP) and consultation would occur with potentially impacted receivers to minimise impacts.

3.5 Public utility adjustment

A number of public utility relocations and adjustments would be required during construction of the proposal. The existing public utilities within the proposal area, and the adjustments required, are described in the following sections.

3.5.1 Electrical (Endeavour Energy)

There is a large bank of electrical conduits that run southbound along the eastern side of the M1 Princes Motorway, adjacent to the TAFE NSW Wollongong campus. These would be impacted by the proposal and would require relocation. A narrow corridor of TAFE NSW Wollongong campus land would therefore be acquired for an easement, and the utilities relocated. This corridor runs between the Zone substation near Helen Street to just south of the Northfields Avenue footbridge. This would be a major asset relocation, and is likely to require a minimum three months of works. The works would be progressed based on the assumption that the electrical junction pit near to the basketball court (south of the footbridge) does not need to be relocated.

There is an electrical cable (possibly 11kV, though not confirmed) crossing the M1 Princes Motorway from the University of Wollongong to Helen Street. This would need to be protected or relocated during detailed design.

There is an 11kV cable that connects overhead wiring on Falder Place to Dumfries Avenue. This runs diagonally under the M1 Princes Motorway and Mount Ousley Road. This cable would require relocation or protection through construction. There are also some 11kV overhead cables on both Falder Place and Dumfries Avenue that would need to be relocated for construction and operational phase maintenance.

There are a number of street lighting conduits within the road reserve that would be impacted by the works. All of these would be removed or abandoned and replaced with new lighting conduits, better suited to the proposed new design.

3.5.2 Water (Sydney Water)

There are existing 500 mm and 250 mm water mains crossing the M1 Princes Motorway from Falder Place to Dumfries Avenue. The proposal has allowed for relocation of both of these water mains during construction. This would be confirmed during detailed design.

There is also an existing 100 mm water main that crosses the M1 Princes Motorway under the Northfields Avenue pedestrian bridge. Due to the proposed extension of the pedestrian bridge in this area, this asset would also need to be relocated.

The new or relocated water mains would be constructed and connected prior to disturbance or removal of the existing pipes, in order to maintain continuity of supply.
3.5.3 Gas (Jemena)

An existing gas main crosses Mount Ousley Road and the M1 Princes Motorway from Dumfries Avenue to Falder Place. This was not able to be located onsite. However, it is assumed that this would need to be relocated or protected during construction.

3.5.4 Optical fibre (Telstra, AARNet, Optus and NBNCo)

There is an existing optical fibre cable that diagonally crosses the M1 Princes Motorway and Mount Ousley Road from Falder Place to Dumfries Avenue. Currently, it is assumed that this would be relocated or protected during construction.

There is also an optical fibre cable crossing the M1 Princes Motorway from the University of Wollongong to Helen Street, which would need to be protected or relocated during design.

There is an optical fibre asset located along the eastern side of the southbound lane of the M1 Princes Motorway near to the TAFE NSW Wollongong campus. It has been assumed that this would need to be relocated for construction works, and that the asset would be relocated within the same easement proposed for relocation of electricity assets as discussed in Section 3.5.1.

3.5.5 Telecommunications – Telstra / Optus

An existing telecommunications asset crosses the M1 Princes Motorway between Falder Place and Dumfries Avenue. This would need to be relocated or protected during construction. There is also a telecommunications asset located along the eastern side of the southbound lane of the M1 Princes Motorway near to the TAFE NSW Wollongong campus. It has been assumed that this would need to be relocated for construction works, and that the asset would be relocated within the same easement proposed for relocation of electricity assets as discussed in Section 3.5.1.

3.6 Property acquisition

The proposal would require acquisition of land owned by the TAFE NSW Wollongong Campus and the University of Wollongong. The proposal would not require any full acquisition of properties, nor any acquisition of private property. The extent of property impacts would be refined and confirmed during detailed design in consultation with affected property owners.

All acquisitions would be conducted in accordance with the Roads and Maritime Land Acquisition Policy, and compensation would be based on the requirements of the Land Acquisition (Just Terms) Compensation Act 1991.

The description of the acquisitions and further information is provided in Table 3-6. The location of these acquisitions is shown in Figure 3-5.
Table 3-6 Proposed property acquisition

<table>
<thead>
<tr>
<th>Area ID</th>
<th>Description</th>
<th>Total area</th>
<th>Acquisition type</th>
<th>Current owner</th>
<th>Lot and DP</th>
<th>Land use zone (LEP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Two strips of land adjacent to the M1 Princes Motorway would need to be acquired in order to relocate the high voltage bank of electrical assets. These are estimated to comprise areas of 1,441 square metres, and 2,210 square metres respectively.</td>
<td>3,651 square metres (approx.)</td>
<td>Required acquisition</td>
<td>TAFE NSW Wollongong Campus</td>
<td>Lot 4 and 5 DP 843929</td>
<td>SP2</td>
</tr>
<tr>
<td>2</td>
<td>Three areas of land would need to be acquired from the University of Wollongong. These include a relatively large area of land north of the recreational playing fields which comprises approximately 25,877 square metres. Multiple strips of land alongside the M1 Princes Motorway comprising approximately 1,451 square metres and 1,259 square metres respectively would also need to be acquired.</td>
<td>28,587 square metres (approx.)</td>
<td>Required acquisition</td>
<td>University of Wollongong</td>
<td>Lot 1 DP 1188267 and Lot 2 DP 214022</td>
<td>SP2</td>
</tr>
</tbody>
</table>
Figure 3-5 Proposed property acquisition
4 Statutory and planning framework

This chapter provides the statutory and planning framework for the proposal and considers the provisions of relevant state environmental planning policies, local environmental plans and other legislation.

4.1 Environmental Planning and Assessment Act 1979

The NSW Environmental Planning and Assessment Act 1979 (EP&A Act) is the main piece of legislation regulating land use planning and development assessment in NSW. The applicable planning approvals pathway for a development under the EP&A Act is generally dependent on the development’s size, environmental impact and capital cost, as well as relevant planning provisions under other pieces of NSW legislation, including State Environmental Planning Policies (SEPPs) and Local Environmental Plans (LEPs). Further discussion on SEPPs and LEPs likely to be applicable to the proposal is provided in Sections 4.1.2 and 4.1.3, respectively.

The main part of the EP&A Act that is relevant to the proposal (as a development for the purposes of a road that would be carried out by or on behalf of Roads and Maritime) is Part 5 which is discussed in the following section.

4.1.1 Part 5 of the EP&A Act

Part 5 of the EP&A Act applies to activities that are permissible without consent, and are generally undertaken by a public authority. Activities under Part 5 of the EP&A Act are assessed and determined by either a Minister or public authority – referred to as a determining authority.

Under Section 111 of the EP&A Act, Roads and Maritime, as the proponent and determining authority for the purposes of Part 5 of the EP&A Act, must:

- Examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity, in accordance with section 111 of the EP&A Act
- Establish whether or not an environmental impact statement (EIS), or a species impact statement (SIS), or both, are required for the activity, in accordance with section 112 of the EP&A Act.

An EIS would be required for the proposal if Roads and Maritime considers that the proposal is likely to significantly affect the environment, including critical habitat or threatened species, populations or ecological communities and their habitats. Clause 228 of the Environmental Planning and Assessment Regulation 2000 contains a detailed list of factors that must be taken into account when assessing the impact of an activity on the environment. Where the only anticipated significant impacts relate to threatened species, population or ecological communities or their habitats or critical habitat, then a Species Impact Statement (SIS) may be prepared instead of an EIS.

The proposal is not likely to have significant impact on the environment including threatened species, populations or ecological communities or their habitats or critical habitat (refer to Chapter 6); therefore neither an EIS or SIS is required.

Activities assessed under Part 5 of the EP&A Act may require a number of additional approvals and licences to be obtained under other NSW environmental legislation and planning instruments.
4.1.2 State Environmental Planning Policies

State Environmental Planning Policy (Infrastructure) 2007

State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) aims to facilitate the effective delivery of infrastructure across the State.

Clause 94 of ISEPP permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent.

As the proposal is for a road and road infrastructure facilities and is to be carried out by Roads and Maritime, it can be assessed under Part 5 of the EP&A Act. Development consent from Wollongong City Council is not required.

The proposal does not affect land or development regulated by State Environmental Planning Policy No. 14 - Coastal Wetlands, State Environmental Planning Policy No. 26 - Littoral Rainforests, State Environmental Planning Policy (State and Regional Development) 2011 or State Environmental Planning Policy (Major Development) 2005.

Part 2 of the ISEPP contains provisions for public authorities to consult with local councils and other public authorities prior to the commencement of certain types of development. Consultation is discussed in Chapter 5 of this report.

Relevant to the proposal, Roads and Maritime has consulted with Wollongong City Council (in accordance with the requirements specified in Division 1, Part 2 of the ISEPP) in relation to the following:

- Potential impacts on council related infrastructure and services, including stormwater management services provided by council, excavation adjacent to roads for which council is the roads authority (clause 13(1) of the ISEPP)
- Development with impacts on flood liable land (clause 15(1) of the ISEPP). As outlined in Section 6.5, flood liable land is present at various locations throughout the proposal area.

Under Division 1, Part 2 of the ISEPP refers to consultation with the NSW Office of Environment and Heritage in relation to development adjacent to land reserved under the National Parks and Wildlife Act 1974. The Illawarra Escarpment State Conservation Area is situated to the west of the proposal area, separated from it by the Wollongong Botanic Garden and the suburb of Keiraville. The proposal is not directly adjacent to the Illawarra Escarpment State Conservation Area and therefore the NSW Office of Environment and Heritage has not been consulted under ISEPP.

Other SEPPs

Illawarra Regional Environmental Plan No.1

The Illawarra Regional Environmental Plan No. 1 (Illawarra REP) provides a framework for coordinated action to ensure best use of land resources, improvement in the quality of life, protection of regional needs and interests and the establishment of a stable and attractive climate for public and private investment. The Illawarra REP is referred to under legislation as a ‘deemed’ SEPP in accordance with the provisions of clause 120 of Schedule 6 to the EP&A Act.

The following provision of the Illawarra REP is applicable to the biodiversity study area:

- Section 14(4) of the Illawarra REP restricts the clearing of vegetation or removal of trees from land supporting rainforest vegetation species without the consent of the consent authority (Wollongong City Council).
Notwithstanding the above consent requirements, Clause 94 of ISEPP has the effect that the proposal would be permissible without consent, provided that the proposal is not carried out on land reserved under the National Parks and Wildlife Act 1974, which it is not. Section 8 of the ISEPP has the effect that, where an inconsistency occurs between the ISEPP and the Illawarra REP, the ISEPP prevails to the extent of the inconsistency. Therefore, while the Illawarra REP applies to the proposal area, the provisions of this deemed SEPP would not apply to the proposal.

4.1.3 Local Environmental Plans

The proposal area is located entirely within the City of Wollongong LGA. Development within the proposal area is regulated by the Wollongong Local Environmental Plan 2009 (Wollongong LEP).

Wollongong Local Environment Plan 2009

The following land zones (established under the Wollongong LEP) are located within the proposal area:

- SP2 (Infrastructure)
- R2 (Low Density Residential).

Development for the purposes of a road is generally permitted with consent in the above land zones. The ISEPP provides that the proposal could be carried out by or on behalf of Roads and Maritime without development consent from Wollongong City Council.

4.2 Other relevant NSW legislation

Other NSW legislation that is relevant to the proposal includes the following:

4.2.1 Protection of Environment Operations Act 1997

The Protection of the Environment Operations Act 1997 (the POEO Act) administers environment protection licences for specific activities relating to air, water and noise pollution, and waste management. The NSW Environment Protection Authority and local government, where relevant, administer the POEO Act. Development activities require an environment protection licence under the POEO Act if those activities meet the assessment criteria outlined in Schedule 1 of the Act.

Scheduled activities that are likely to apply to the proposal comprise:

- Land-based extractive activities, defined under Schedule 1(19) as the extraction, processing or storage of extractive materials, either for sale or re-use, by means of excavation, blasting, tunnelling, quarrying or other such land-based methods. Extractive materials are defined as clay, sand, soil, stone, gravel, rock, sandstone or similar substances that are not minerals within the meaning of the Mining Act 1992.
- Based on the estimated earthworks, the proposal would require an Environmental Protection Licence (EPL) due to the need to extract over 30,000 tonnes of material per annum. The need for an EPL would be confirmed during detailed design.

4.2.2 NSW Biodiversity Conservation Act 2016

The BC Act sets out the environmental impact assessment framework for threatened species, threatened ecological communities and Areas of Outstanding Biodiversity Value (formerly critical habitat) for Part 5 activities (amongst other types of development).

However, the transitional provisions of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017* applies to the proposal because the environmental impact assessment of the activity began under Part 5 of the EP&A Act before the commencement of the new Act (Cl29(1b)). Consequently, the proposal has been assessed in accordance with the *Threatened Species Conservation Act 1995*.

The biodiversity assessment conducted for this proposal is documented in Section 6.3. The proposal would not have a significant impact on threatened species or ecological communities or critical habitat and therefore a SIS has not been prepared.

### 4.2.3 Threatened Species Conservation Act 1995

Notwithstanding the enactment of the BC Act, potential biodiversity impacts of the proposal were assessed in accordance with the requirements of the TSC Act.

The TSC Act lists threatened species, populations or ecological communities to be considered in deciding whether there is likely to be a significant impact on threatened biota, or their habitats. If a significant impact is likely, a species impact statement that addresses the requirements of section 5A of the EP&A Act must be completed.

The proposal would not result in significant impacts on any listed flora, fauna or communities, and a species impact statement is, therefore, not required. Further information is provided in Section 6.3.

### 4.2.4 Heritage Act 1977

The *Heritage Act 1977* aims to provide for the identification, registration and conservation of items of State heritage significance.

As reported in Section 6.10, there are no items of State or local heritage significance that would be affected by the proposal, and therefore approval under section 57 (for work to a place, building, work, relic, moveable object, precinct, or land listed on the State Heritage Register), or an excavation permit under section 139 (to disturb or excavate any land containing or likely to contain a relic) of the Heritage Act 1977 would not be required.

If any item or material is uncovered during construction of the proposal that has potential heritage value or significance, Roads and Maritime would follow an established unexpected finds procedure. Under this procedure, all work at the location of the find would cease until the item or material can be investigated by a suitably qualified person, to establish whether the item or material is of heritage significance, and whether any further actions are warranted for its removal and/or protection.

### 4.2.5 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act) is the primary legislation dealing with Aboriginal cultural heritage in NSW. Items of Aboriginal cultural heritage (Aboriginal objects) or Aboriginal places (declared under section 84) are protected and regulated under the NPW Act. Aboriginal objects are protected under section 86 of the Act. Under section 90(1) of the Act the
Director-General may issue an Aboriginal heritage impact permit (AHIP) for an activity which will harm an Aboriginal object.

Under section 90(1) of the Act, where harm to an Aboriginal object or Aboriginal place cannot be avoided, an Aboriginal Heritage Impact Permit (AHIP) is required. As discussed in Section 6.9, Roads and Maritime completed an extensive Aboriginal Heritage Information System (AHIMS) search for the proposal. No previously recorded Aboriginal heritage items were identified within the proposal area during the search.

A site walkover was completed with a member of the Illawarra Local Aboriginal Land Council during preliminary environmental investigations. It was concluded that given previous disturbance to the site for road construction and associated activities, the potential for unexpected items of Aboriginal heritage or Aboriginal archaeological remains to be present within the proposal area is considered low. The Roads and Maritime Standard Management Procedure - Unexpected Heritage Items would be followed in the event that an unknown or potential Aboriginal object, including skeletal remains, is found during construction.

### 4.2.6 Fisheries Management Act 1994

The Fisheries Management Act 1994 (FM Act) aims to conserve, develop and share the fisheries resources of the State for the benefit of present and future generations, including conserving fish stocks and key fish habitats and promoting ecologically sustainable development.

Part 7 of the FM Act provides for the protection of aquatic habitats in NSW through (among other things):

- Preventing blockage of fish passage within a waterway (under Part 7 Division 8 of the Act). A permit may be required under Section 219 of the FM Act for any works undertaken by a public authority that could result in the temporary or permanent blockage of fish passage within a waterway.

Part 7A of the FM Act aims to conserve threatened species, populations and ecological communities of fish and marine vegetation through ensuring appropriate assessment, management and regulation of actions that may damage critical or other habitat for a listed threatened species, or may otherwise significantly affect a threatened species, population or ecological community.

Schedules 4, 4A and 5 of the FM Act lists species, populations and ecological communities that have been identified as being ‘endangered’, ‘critically endangered’ and ‘vulnerable’ to extinction, respectively. If a threatened species, population, ecological community or their habitat could be impacted by an activity, an assessment that addresses the requirements of section 5A of the EP&A Act must be completed to determine the significance of the impact.

The proposal area contains a number of first and second order ephemeral drainage lines, being tributaries of Fairy Creek and Cabbage Tree Creek. Aquatic habitats and water quality are assessed in detail in Sections 6.3 and 6.6 respectively. The assessments concluded that these tributaries are degraded in quality and are not defined as key fish habitat.

### 4.2.7 Noxious Weed Act 1993

The Noxious Weeds Act 1993 (Noxious Weeds Act) provides for the identification, classification and control of noxious weeds in NSW. Responsibility for the control of noxious weeds lies with the owner and/or occupier of private land and Crown land, local councils and other public authorities.
on land they occupy. Under the Noxious Weeds Act, the Minister for Primary Industries may declare a plant to be a noxious weed. Control notices can be issued by the Minister and local control authorities to ensure obligations are met.

A total of six noxious species were recorded within the biodiversity study area. Weeds within the proposal area would need to be managed during construction in accordance with Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011).

4.2.8 Water Management Act 2000

An approval under the Water Management Act 2000 (WM Act) would be required if access to ground or surface water is required during construction, owing to the existence of the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011. Some provisions of the Act (eg for stock and domestic uses and harvestable rights) enable some activities or works to be undertaken without the need for licences, provided certain conditions are met.

Roads and Maritime, in conjunction with relevant landholders, would consult with the NSW Department of Primary Industries Water to ensure that all applicable licences and/or approvals for any impacts to surface and ground water are obtained prior to construction.

4.2.9 Land Acquisition (Just Terms Compensation) Act 1991

The proposal would require Roads and Maritime to acquire strips of land in the proposal area to accommodate the proposed road upgrade. All land acquisitions would be carried out in accordance with the Land Acquisition (Just Terms Compensation) Act 1991.

4.3 Commonwealth legislation

4.3.1 Environment Protection and Biodiversity Conservation Act 1999

Under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) a referral is required to the Australian Government for proposed actions that have the potential to significantly impact on matters of national environmental significance or the environment of Commonwealth land. These are considered in Section 6.3.

A referral is not required for proposed road activities that may affect nationally listed threatened species, populations, endangered ecological communities and migratory species. This is because requirements for considering impacts to these biodiversity matters are the subject of a strategic assessment approval granted under the EPBC Act by the Australian Government in September 2015.

Potential impacts to these biodiversity matters are also considered in Section 6.3 of the REF.

Findings – matters of national environmental significance (other than biodiversity matters)

The assessment of the proposal’s impact on matters of national environmental significance and the environment of Commonwealth land found that there is unlikely to be a significant impact on relevant matters of national environmental significance or on Commonwealth land. Accordingly, the proposal has not been referred to the Commonwealth Department of the Environment under the EPBC Act.
Findings – nationally listed biodiversity matters

The assessment of the proposal’s impact on nationally listed threatened species, populations, endangered ecological communities and migratory species found that there is unlikely to be a significant impact on relevant matters of national environmental significance. Section 6.3 of the REF describes safeguards and management measures to be applied to minimise impacts on biodiversity.

4.4 Confirmation of statutory position

The proposal is categorised as development for the purpose of a road and road infrastructure facilities and is being carried out by or on behalf of a public authority. Under clause 94 of the ISEPP the proposal is permissible without consent. The proposal is not State significant infrastructure or State significant development. The proposal can be assessed under Part 5 of the EP&A Act.

Roads and Maritime is the proponent and determining authority for the proposal. This REF fulfils Roads and Maritime’s obligation under clause 111 of the EP&A Act to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity.

Roads and Maritime has formed the view that the proposal is not likely to significantly affect the environment and would not require the preparation of an Environmental Impact Statement (EIS).

A number of other permits, approvals and statutory consultation requirements under other legislation would likely be required for the proposal. A summary is provided in Table 4-1.
Table 4-1: Licences, approvals and statutory consultation requirements likely to be applicable to the proposal

<table>
<thead>
<tr>
<th>Legislation/planning instrument</th>
<th>Additional permits, approvals and statutory consultation potentially required under legislation/planning instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Legislation under Part 5 of the EP&amp;A Act</strong></td>
<td></td>
</tr>
<tr>
<td>Protection of the Environment Operations Act 1997 (NSW)</td>
<td>Environment protection licence for land-based extraction activities where applicable threshold is exceeded</td>
</tr>
<tr>
<td>Noxious Weeds Act 1993 (NSW)</td>
<td>Requirement to manage the growth of noxious weeds to reduce their numbers, spread and incidence, and continuously inhibits their reproduction</td>
</tr>
</tbody>
</table>
| Water Management Act 2000 (NSW)                                                                           | The following approvals and licences would be required, where applicable:  
  - Aquifer interference approval if groundwater is intercepted during construction  
  - Water access licence to take water from a bore  
  - Water supply work approval to construct a bore  
  - Water use approval to use the water |
| **Environmental planning instruments (NSW)**                                                              |
| State Environmental Planning Policy (Infrastructure) 2007                                                | Statutory consultation requirements with Wollongong City Council in relation to:  
  - Potential impacts on council related infrastructure and services  
  - Potential impact that is not minor or inconsequential on a local heritage item  
  - Development with impacts on flood liable land |
5 Consultation

This chapter provides an overview of the consultation activities that have been, and will continue to be, carried out for the proposal. Community and stakeholder consultation carried out so far has supported the options assessment. Consultation will continue as the proposal progresses through the display of the concept design and this REF.

A Community and Stakeholder Engagement Plan (CSEP) was developed at the start of the options assessment and concept design stage, which described the communication and consultation approach and activities to be carried out.

5.1 Consultation objectives

The objectives of the community and stakeholder consultation for the proposed Mount Ousley Interchange upgrade are to:

- Provide the community and stakeholders with regular and targeted information to build awareness about the project and keep them informed
- Engage with various community and stakeholder groups using methods of engagement and communication that are suited to the audience (letter, phone call, face to face, email, pop-ups, community information sessions, and online methods)
- Provide clear information about what we are seeking feedback on, when, why and how feedback will be used
- Ensure community and stakeholder feedback is continuously fed into communication, engagement and project development
- Be transparent in all that we do
- Ensure that project information is distributed in an effective and timely manner.

In addition to the community and stakeholder consultation objectives, the following Roads and Maritime values underpin consultation activities carried out for the project:

- Customer focus – We place the customer at the centre of everything we do
- Collaboration – We value each other and create better outcomes by working together
- Integrity – We take responsibility and communicate openly
- Safety – We prioritise safety for our people and our customers

5.2 Consultation process and activities to date

A number of key consultation activities were carried out during the early planning phase between December 2015 and August 2016 in order to identify design options and select a preferred option for the proposal.

Four options were investigated and assessed as part of a Value Management Workshop held in December 2015. The workshop was attended by technical experts and key project stakeholders who assessed these options against agreed criteria such as safety, constructability, traffic efficiency and environmental impacts. Key stakeholders including Wollongong City Council and the University of Wollongong were also involved during the option selection process to help refine the interchange design and the environmental assessment.
The community were invited to provide feedback on the preferred option between Tuesday 21 June 2016 and Monday 1 August 2016. Special interest groups including the Illawarra Bicycle User Group (IBUG) and Neighbourhood Forum 5 were also contacted directly and invited to give feedback on the preferred option. Community feedback on the preferred option was received via a dedicated information telephone number, email, letters, community information sessions, on the M1 Princes Motorway/Princes Highway Facebook page and an online survey.

During these consultation activities during the display period, Roads and Maritime:

- Spoke to over 80 people at information sessions and over the phone
- Received 60 email or mailed submissions
- Received 395 online survey submissions
- Received 21 comments on the M1 Princes Motorway/Princes Highway upgrade Facebook page.

Studies that assist with the preparation of the environmental assessment started in November 2016 and continued throughout 2017. Investigations and studies include noise monitoring and modelling, traffic and transport, biodiversity, flooding and water quality, geotechnical investigations (ground condition) and visual assessment. Consultation with the community and key stakeholders continued during the preparation of the Review of Environmental Factors for the proposal. This included meetings and briefings with community members and key stakeholders.

5.2.1 Consultation tools and activities

The following communication and engagement activities and tools were used to provide information about the proposal and to gather community and stakeholder feedback on the preferred option.

Webpage

A dedicated web page was established on the Roads and Maritime Services website as a source of information about the proposal, which has been and will continue to be updated regularly throughout the proposal’s life cycle.

Information phone line

A telephone information line, 1800 792 918 was established for the duration of the project as a direct communication channel with the project team for community members and stakeholders to ask questions, arrange individual meetings and discuss individual questions.

Email address

Community members and stakeholders were invited to provide their comments on the preferred option via the project email address: mountousleyinterchange@rms.nsw.gov.au. The email address will remain for the length of the project lifecycle as a channel for formal submissions to be made during public display periods as well as a direct communication channel for general community enquiries outside of display periods.

Meetings and briefings

Meetings and briefings have been held with key government agencies, local councils and key stakeholders to explain specific details of the project and gather feedback. Opportunities for meetings and briefings with stakeholders will continue throughout the life of the project.
Workshops
A Value Management Workshop was held in December 2015 which was attended by technical experts, key project stakeholders as well as Wollongong Council and Wollongong University. The workshop was to assess the design options against agreed criteria such as safety, constructability, traffic efficiency and environmental impacts.

Risk workshops related to the proposal were also held and attended by representatives from the University of Wollongong and Wollongong City Council in August 2015 and March 2017.

Online ‘Have your Say’ survey
Roads and Maritime also developed an online survey to capture feedback on the preferred option. The survey was available for the duration of the consultation period on the proposal website and on the Roads and Maritime M1 Princes Motorway/Princes Highway upgrade Facebook page. The online survey was completed 395 times.

Community information sessions
The community was invited to drop in and speak with project team members during two community information sessions held at Fairy Meadow Community Centre on Thursday 30 June and Saturday 2 July 2016. The purpose of these sessions was to hear ideas and concerns from the community about the preferred option, respond to questions and provide further information on the planning and design process. Project team members from a range of technical backgrounds including road design, environment, traffic, engineering, project management and communications attended the information sessions to assist in providing information to community members. Community updates, maps and visualisations were available at the information sessions. Attendees were encouraged to provide feedback via the online survey or to send in individual submissions. Around 80 people attended these sessions.

Commuter carpark surveys
Roads and Maritime staff also surveyed a number of users of the commuter carpark on site during the consultation period.

Media coverage
During the display of the preferred option, media coverage of the proposal featured in:

- Newspaper: Illawarra Mercury
- Television: WIN TV News
- Radio: ABC Illawarra and i98FM.

A range of communications materials was also developed as follows, to support the consultation period and to enable the community and stakeholders to provide feedback:

- Media announcements made by the NSW Parliamentary Secretary for the Illawarra on 27 June 2016 resulting in local newspaper, radio and TV coverage
- Printed flyers sent to 3500 households within Mount Ousley, Mount Pleasant, Keiraville and Gwynneville on Wednesday 22 June 2016
- Printed community updates available at unstaffed displays and at information sessions
- Information materials available on the website, at information sessions, Wollongong City Council offices and at the University of Wollongong
• The M1 Princes Motorway/Princes Highway upgrade Facebook page was used to promote the preferred option display. More than 14,000 people were reached via Facebook
• Roadside signage including portable variable message signs on the M1 Princes Motorway, Mount Ousley Road and in the commuter carpark promoting the preferred option display
• Feature in the University of Wollongong student app and both staff and student e-newsletters.

5.3 Issues raised by the community
As part of the preferred option display a number of concerns were raised by local residents around the options for relocating the commuter car park. As a result the project team organised two targeted information sessions on 26 and 29 September 2016 to provide more detail around carpark options and to better understand community concerns. Invitations were sent to residents living close to the carpark Option 2 location (at the western end of Old Mount Ousley Road) and a total of 35 people attended the sessions. A summary of the workshop was sent to attendees in November 2016.

The majority of comments received during feedback period agreed with the need for an upgrade of this intersection and were happy about the progress of the project. Of those who did not agree with the need for the proposal, the majority said that it either was not a big enough problem to warrant such a large investment or that safety could be improved by simply banning the right turn onto the M1 Princes Motorway from Mount Ousley Road.

Most submissions received during the display provided comments and suggestions or raised concerns about the features and functionality of the proposal. Key issues raised included:

• Road safety
• Proposal design features
• Access
• Environmental and visual impacts
• Construction impacts
• Options identification and selection process.

A summary of issues raised by the community is provided in Table 5-1.

This feedback was considered as the design for the proposal was developed and refined. Feedback was collated and summarised in a consultation summary report which was published on the proposal website in November 2016.
<table>
<thead>
<tr>
<th><strong>Issue raised</strong></th>
<th><strong>Response/where addressed in REF</strong></th>
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<tbody>
<tr>
<td><strong>Road safety:</strong> A number of community members acknowledged improved safety due to the removal of the right turn onto the M1 Princes Motorway from Mount Ousley Road. However, there were concerns that the proposal introduces safety risks at new merging points</td>
<td>The proposal would eliminate the need for unsafe weave and merge movements. The proposed design would relocate merge points to controlled, safe areas on the M1 Princes Motorway and on Mount Ousley Road, where the gradients are even, sight lines are improved, and all vehicles are travelling to the same speed limit. See Chapter 3 of this REF.</td>
</tr>
<tr>
<td><strong>Project design:</strong> Many submissions commented on design features and functionality of the preferred option. Comments focused on interchange roundabouts, lane layout on the M1 Princes Motorway, heavy vehicle safety ramp, Mount Ousley Road overpass, truck bypass lanes, and merging traffic movements</td>
<td>In separating light and heavy vehicles travelling through the Mount Ousley interchange, the proposal creates the appearance of multiple additional ‘decision points’ particularly for motorists travelling south on the M1 Princes Motorway. In effect however, the proposal would result in no additional ‘decisions’. Traffic destined for Wollongong or the University would exit at Mount Ousley Road; all other traffic would stay on the motorway. The principle difference would be that heavy vehicles and light vehicles would be separated, and heavy vehicles would exit the motorway (via the bypass) earlier than light vehicles. All movements would be well signposted in advance. See Chapter 3 of this REF.</td>
</tr>
<tr>
<td><strong>Access:</strong> Comments focused on northbound access to the interchange from the M1 Princes Motorway, Southbound access to the M1 Princes Motorway at New Mount Pleasant Road, access to the interchange from Keiraville, the need to close access to Mount Ousley Road to heavy vehicles, and additional access to and from the university</td>
<td>The proposal would maintain all existing accesses to and from the M1 Princes Motorway, for all locations in the vicinity of the Mount Ousley interchange. Mount Ousley Road would need to remain open to heavy vehicles, for access into Wollongong and to avoid the low clearance point at the University Avenue overbridge. The proposed northern university access road would provide an additional entry to the University of Wollongong that would be accessible to both northbound and southbound vehicles. See Chapter 3 of this REF.</td>
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</table>
### Environment:

Submissions raised concerns about noise and vibration, pollution, tree clearing, visual impacts and drainage.

The proposal would maintain or replace all existing noise walls and has proposed additional noise walls. The height and materials used for the noise walls would be determined following community consultation. The noise assessment carried out for the proposal also made recommendations for investigation during detailed design of at-property treatments for some dwellings where noise walls alone would not provide the necessary attenuation for traffic noise.

See Section 6.2 of this REF.

The proposal would require clearing of vegetation across the proposal area. Cleared areas would be rehabilitated with new planting and landscaping on completion of the proposal.

See Sections 6.3 and 6.4 of this REF. Visual impacts are addressed in Section 6.4.

The proposal would include new and upgraded drainage infrastructure (pits, pipes, culverts etc.) to ensure that flooding impacts are minimised.

See Section 6.5 of this REF.

### Construction:

Submissions raised concerns about noise, additional traffic, and the importance of continued consultation.

Construction traffic and noise are discussed in Chapter 3, and assessed in detail in Sections 6.1 and 6.2 of this REF, respectively.

Consultation with residents and other stakeholders would continue throughout construction of the proposal.

### Commuter carpark:

Most survey respondents (30%) preferred option 1 to option 2 (23%). Concerns about option 1 were that it could encourage the evening commuter drop off on the eastbound offload ramp and increase pedestrian activity on the overpass, as well as reduce parking in the university and become a flood risk. Concerns about option 2 related to pedestrian safety and the potential impact on local residents.

Option 1 (adjacent to Mount Ousley Road near the proposed western roundabout) has been adopted as the preferred option, as provision of the southbound service road eliminated option 2.

See Chapter 3 of this REF.
## Issue raised

| Pedestrians and cyclist facilities: | The proposal would enhance pedestrian and cycle access and safety, through the provision of a new grade separated connection from the suburbs to the north of Mount Ousley Road, across Mount Ousley Road and the M1 Princes Motorway, to the University of Wollongong. It would also maintain and improve the existing pedestrian/cycle connection to the TAFE NSW Wollongong campus, and the existing shared path toward the south. Roads and Maritime has consulted with and will continue to consult with Wollongong City Council and IBUG to ensure pedestrian and cyclist connections match with existing and future plans for pedestrian and cyclist networks in the area. 

See Chapter 3 of this REF. |
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<tr>
<td>Some submissions stated there was not enough information in the preferred option report about how the connection would work and suggested it must integrate with existing cycleway plans. Some submissions also stated that providing this connection to the university could lead to increased parking in local suburbs and the potential for council to implement parking restrictions.</td>
<td></td>
</tr>
</tbody>
</table>

## Process: | Roads and Maritime has established numerous communication channels and points of contact with the community and stakeholders, and has conducted a number of public events to raise awareness about the proposal and to seek feedback during its planning phases. The consultation period in July 2016 was extended by two weeks to allow more time for the community to make comment on the preferred option. These activities will continue, and the communication channels will remain open throughout the project lifecycle. 

See Chapter 5 of this REF. |
| There were some comments that not all residents close to the project received the letter box drop and that more time and information was needed in order to comment appropriately on the proposal. There were also comments doubting community feedback would be taken into consideration, as well as suggestions of a complete redesign of the project. |  |

## 5.4 Aboriginal community involvement

The Illawarra Local Aboriginal Land Council was consulted in September 2014 for a site walkover to determine if the project was likely to have any impacts on Aboriginal Heritage. Following this site walkover it was determined that due to the highly disturbed nature of the site, the project was unlikely to affect any significant known or potential Aboriginal cultural heritage features.

## 5.5 Government agency and stakeholder involvement

Roads and Maritime has consulted on an ongoing basis with key stakeholders and government agencies. This consultation was designed to ensure stakeholder issues and concerns were understood, documented and addressed, and that attendees had an opportunity to discuss any aspect of the project. Consultation has included phone calls, emails and face-to-face meetings.
Table 5-2 provides a summary of the consultation undertaken and issues raised by government agencies and other key stakeholders and where these issues have been addressed in the REF.

### Table 5-2 Issues raised through stakeholder consultation

<table>
<thead>
<tr>
<th>Agency</th>
<th>Issues</th>
<th>Response/where addressed in REF</th>
</tr>
</thead>
</table>
| Illawarra Bike Users Group (iBUG) | • The gradient of the bicycle path should not exceed 5% as steeper paths become difficult for commuting and social riders.  
• Concerns about wider connectivity and wayfinding including suggestions that the shared path should link with the existing shared path along the western side of the TAFE NSW Wollongong campus. | The proposal would enhance bicycle access and safety, through the provision of a new grade separated connection from the suburbs to the north of Mount Ousley Road, across Mount Ousley Road and the M1 Princes Motorway, to the University of Wollongong. The shared path has been extended to improve the existing bicycle connection to the TAFE NSW Wollongong campus, and the existing shared path toward the south. The shared path has been designed in accordance with current best practice in terms of gradient, width and alignment. See Chapter 3 of this REF. |
| Neighbourhood Forum 5         | • There should be a direct exit from the M1 for northbound traffic to the university, as well as the extension of the proposed pedestrian/cyclist shareway over Mount Ousley Road to those at TAFE/Keira High School which then link through to Gwynneville and the CBD  
• Other suggestions include a service centre south-east of the overpass, an additional pedestrian/cyclist shareway, and a direct link from Robsons Road to the new interchange  
• Called for interchange to be completed before the Albion Park Rail Bypass. | • The proposal would provide a direct exit from the M1 Princes Motorway into the University of Wollongong  
• No change is proposed to pedestrian/cycle connectivity through the TAFE NSW Wollongong campus to Keira High School or Gwynneville. There is an existing connection to Gwynneville via Foleys Lane and University Avenue  
• Proposal options and alternatives are discussed in Chapter 2  
• Project description provided in Chapter 3. |
<table>
<thead>
<tr>
<th>Agency</th>
<th>issues</th>
<th>Response/where addressed in REF</th>
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</table>
| Wollongong City Council        | • Possibility of the free bus route utilising the interchange by travelling through the University.  
• Raised concerns with the northbound on ramp and the interaction between slower moving heavy vehicles heading towards the left lane in the vicinity of the on ramp given the steep grades and requested further analysis. | • The proposal would create opportunities for buses to use the interchange to travel through the university. This would be subject to consultation with bus operators, TfNSW and University of Wollongong  
• Performance of the northbound on ramp has been modelled during traffic assessment and found to operate to a satisfactory level of service for forecast traffic volumes. See Section 6.1. |
| University of Wollongong       | • Provision for pedestrians and cyclists  
• Integration with the university internal network and masterplan  
• Impact on parking  
• Construction staging. Priority for University would be to grade separate right turn onto M1 and provide additional entry to university. | • Pedestrians and cyclists would be catered for by the proposed new shared path  
• Consultation with the University of Wollongong has taken place and would continue in relation to detailed design for northern access road, parking, and future developments under university masterplan  
• Construction staging would consider impacts on all adjoining landowners and stakeholders. |
| NSW Road Freight Advisory Council (RFAC) | • No issues raised. Generally supportive of proposal to separate light and heavy vehicles. | • The proposal would improve conditions for freight/heavy vehicles through separation from light vehicles. |

### 5.6 Ongoing or future consultation

Following the exhibition of this REF, Roads and Maritime will continue to identify and manage issues of interest or concern to the community during the assessment and approval process and, if the project is approved, during its construction. The aims of ongoing communications and consultation are to provide the community with:

- **Accurate and accessible information** regarding the processes and activities associated with the proposal
- **Information in a timely manner**
- **Appropriate avenues** for providing comment or raising concerns, and to ensure that stakeholders are aware of these avenues
• A high level of responsiveness to stakeholder issues and concerns throughout development and delivery of the proposal.

5.6.1 Consultation during REF exhibition

The Concept Design and Review of Environmental Factors (REF) for the proposal is on public display in November and December 2017. The display provides a detailed assessment of project benefits and potential project impacts. During the display period, engagement activities would include ‘drop in’ information sessions, briefings, meetings and an updated proposal website.

The REF is on public display for a minimum of 28 days. The REF is available for viewing at the following locations:

• Wollongong City Council - 41 Burelli Street, Wollongong
• NSW Roads and Maritime Wollongong Office - Level 4, 90 Crown Street, Wollongong
• University of Wollongong Library - Building 16, Wollongong Campus, Northfields Avenue, Keiraville
• TAFE NSW Wollongong - Foleys Lane, North Wollongong.

Staffed displays and stakeholder/community meetings will be held during the display of the REF to enable community members to ask questions and to provide further information for consideration in the assessment process. During the REF exhibition, the community, government agencies and other interested parties are invited to make written submissions on the project. Staffed displays will be held at:

Fairy Meadow Community Centre
Corner of Princes Highway and Cambridge Avenue, Fairy Meadow
Monday 20 November, 5pm to 8pm and Saturday 9 December, 10am – 1pm

Wollongong Friday Markets
Crown Street Mall, Wollongong
Friday 17 November 9am – 12pm

Wollongong Central
200 Crown Street, Wollongong
Saturday 2 December 9am – 2pm

Following the exhibition all submissions will be formally considered and responses provided in a submissions report, which will also be made available to the public.

5.6.2 Consultation during construction stages

Should the proposal proceed to construction, the project team would continue to consult the community, as well as internal and external stakeholders where required, to ensure they are informed about the proposal and have opportunities to provide feedback to the project team. Key involvement activities and tools would include:

• Meetings with individual landowners likely to be impacted by noise during and/or after construction to discuss potential impacts and mitigation measures
• Development and implementation of a detailed construction communications plan
• Notification of upcoming construction work (including targeted letterbox drops)
• 24-hour toll-free project information phone line
• Transport Management Centre (TMC) communication channels; radio crosses and interviews, variable message signs throughout the Illawarra road network
• Live Traffic and Transport Info websites and TMC 24-hour Traffic Information Line (132 701)
• Complaints management process
• Regular updates to the project website
• Newsletters, information brochures and fact sheets
• Clear signage at construction sites
• Media releases and project advertisements in local and metropolitan papers
• Construction updates (including for councils, emergency services and bus operators).
6 Environmental assessment

This section of the REF provides a detailed description of the potential environmental impacts associated with the construction and operation of the proposal. All aspects of the environment potentially impacted upon by the proposal are considered. This includes consideration of:

Potential impacts on matters of national environmental significance under the EPBC Act

The factors specified in the guidelines *Is an EIS required?* (DUAP 1995/1996) as required under clause 228(1) of the *Environmental Planning and Assessment Regulation 2000* and the *Roads and Related Facilities EIS Guideline* (DUAP 1996). The factors specified in clause 228(2) of the *Environmental Planning and Assessment Regulation 2000* are also considered in Appendix A.

Site-specific safeguards and management measures are provided to mitigate the identified potential impacts.

6.1 Traffic and transport

The potential benefits and impacts of the proposal on traffic and transport are assessed in the Traffic and Transport Report (Jacobs, 2017), which is provided in Appendix D. A summary of the assessment is presented in this section.

6.1.1 Methodology

The key areas examined as part of the traffic and transport impact assessment include:

- Existing traffic and transport conditions in the study area
- Assessment of the impacts of future developments and growth in travel demand in future year scenarios 2021, 2031 and 2041
- Assessment of the impacts of the proposal in 2021, 2031 and 2041
- Assessment of the impacts on pedestrians, cyclists and public transport
- Identifying mitigation measures required to address impacts.

Study area

The traffic and transport assessment investigated an area larger than the REF proposal area, centred on the M1 Princes Motorway between Mount Pleasant Road and the Memorial Drive Interchange, as well as Mount Ousley Road between the M1 Princes Motorway and the Princes Highway.

The investigation area included intersections and interchanges of the M1 Princes Motorway with Mount Ousley Road, Memorial Drive and University Avenue and the Princes Highway from north of its intersection with Mount Ousley Road to south of its intersection with Ajax Avenue.

Traffic modelling

Traffic modelling is a core component of the appraisal of the proposal and has been used to forecast and evaluate traffic impacts of future land use and planned road network improvements on the M1 Princes Motorway at Mount Ousley and surrounding network. The traffic modelling assessment process for the proposal involved the following:

- Development of a micro simulation traffic model of the Mount Ousley area under existing traffic conditions (the 2015 base case)
Development of future year (2021, 2031 and 2041) forecasts for the Mount Ousley area and testing of the proposed upgrade in the micro simulation traffic model.

A traffic model representing the investigation area has been developed using the AIMSUN modelling platform (version 8.1.0) and has been calibrated and validated according to the principles outlined in the *Roads and Maritime Services Traffic Modelling Guidelines, 2013*. The details of this calibration and validation are provided in *Traffic Modelling for the Proposed Interchange at Mount Ousley Road on the M1 Princes Motorway Base model calibration, validation and options testing report* (Parsons Brinckerhoff, 2015).

Micro simulation modelling provides a framework to undertake detailed assessment of the proposed route and any intersections along it, allowing for the assessment and visualisation of the corridor as a whole.

**Desired traffic assessment criteria**

The assessment criteria for road network planning for the proposal relate to:

- Provision of adequate capacity on the higher order road network to cater for forecast traffic based on a minimum intersection Level of Service D for morning and evening peak period operation (see Table 6-1)
- Avoiding impact on the operation of the M1 Princes Motorway by ensuring that queuing of traffic from the Mount Ousley Road interchange does not extend beyond the ramp storage and impede flow on the M1 Princes Motorway
- Minimising queue length and avoiding turn bay overflow along Mount Ousley Road
- Minimising travel times along the M1 Princes Motorway during peak periods
- Provision of optimum intersection configurations that are sensitive to physical constraints and land ownership
- Providing improvements for other road users such as public transport, pedestrian and cyclists.

**Existing road network performance assessment criteria**

The performance of the existing road network is largely dependent on the operating performance of intersections which form critical capacity control points. The ‘Level of Service’ (LoS) is the standard measure used to assess the operational performance of the network and intersections. Level of services is ranked from LoS A to LoS F with LoS A representing the best performance and LoS F the worst. The assessment of intersection operation is based on criteria outlined in Table 6-1, as defined by Roads and Maritime within the RTA guide to Traffic Generating Development 2002.

**Table 6-1 Level of service criteria for intersections**

<table>
<thead>
<tr>
<th>Level of service</th>
<th>Average Delay per Vehicle (sec)</th>
<th>Traffic Signals. Roundabouts</th>
<th>Give way &amp; Stop Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&lt;14</td>
<td>Good operation</td>
<td>Good operation</td>
</tr>
<tr>
<td>B</td>
<td>15 to 28</td>
<td>Good with acceptable delays and spare capacity</td>
<td>Acceptable delays and spare capacity</td>
</tr>
<tr>
<td>Level of service</td>
<td>Average Delay per Vehicle (sec)</td>
<td>Traffic Signals. Roundabouts</td>
<td>Give way &amp; Stop Signs</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------------</td>
<td>-----------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>C</td>
<td>29 to 42</td>
<td>Satisfactory</td>
<td>Satisfactory, but accident study required</td>
</tr>
<tr>
<td>D</td>
<td>43 to 56</td>
<td>Operating near capacity</td>
<td>Near capacity &amp; accident study required</td>
</tr>
<tr>
<td>E</td>
<td>57 to 70</td>
<td>At capacity; incidents would cause excessive delays at signals Roundabouts require other control modes</td>
<td>At capacity, requires other control mode</td>
</tr>
<tr>
<td>F</td>
<td>&gt;70</td>
<td>Over Capacity; unstable operation</td>
<td>Over capacity; unstable operation.</td>
</tr>
</tbody>
</table>


**Road safety trends criteria**

An analysis of crash history data has been carried out in the investigation area. Crash statistics recorded by Roads and Maritime are confined to those crashes that conform to the national guidelines for reporting and classifying road vehicle crashes. The main criteria are:

- The crash was reported to the police
- The crash occurred on a road open to the public
- The crash involved at least one moving vehicle
- The crash involved at least one person being killed or injured or at least one motor vehicle being towed away.
- Minor crashes where drivers exchange details are not required to be recorded and are not included in the crash data.

**6.1.2 Existing environment**

**Existing traffic volumes**

Traffic surveys were conducted to obtain hourly traffic volumes on Mount Ousley Road, and on the M1 Princes Motorway north of New Mount Pleasant Road.

**M1 Princes Motorway**

Hourly volumes were recorded throughout the month of October in 2016. The reported ADT (Average Daily Traffic) was 26,253 vehicles northbound and also 28,373 vehicles southbound.

On an average weekday, the total traffic peaked from 6am to 9am, and from 3pm to 6pm. Heavy vehicle volumes were more evenly distributed throughout the day, with high volumes observed from 5am to 6pm with no distinct peak hour.
**Mount Ousley Road**

Hourly volumes were recorded on Mount Ousley Road east of the M1 Princes Motorway from 13 May to 20 May 2015. The reported ADT was 5,755 vehicles in the eastbound direction and 6,316 vehicles westbound.

Analysis of average weekly traffic flows showed a distinct morning peak hour between 8am and 9am with a longer evening peak period 3pm and 6pm.

A traffic survey was also undertaken at the car park on Mount Ousley from 23-29 November 2016. On the average weekday, the number of car park entries peaked between 4am and 6am, while vehicle exits peaked between 3pm and 5pm.

**Existing travel characteristics**

As of 2011 there were 5,323 people employed within the travel zones adjacent to the proposal, and 3,804 residents.

An analysis of the Journey to Work data from the 2011 census showed that car driver and car passenger were the predominant mode of travel for people living and working within the investigation area (83 per cent of the total trips). 10 per cent of trips to work in the area were made by public transport, of which 70 per cent use bus as their primary mode. This analysis did not consider journey characteristics of non-residents studying at the University of Wollongong and the TAFE NSW Wollongong campus.

**Public transport**

Public transport in the investigation area is provided by a mixture of bus services operated by Premier Illawarra and Busabout, including the free ‘Gong’ and ‘North Gong’ shuttle services. There are no bus stops located on the M1 Princes Motorway or Mount Ousley Road within the proposal area. There are however, bus stops within the University of Wollongong campus, in Irvine Street, and on the Princes Highway adjacent to Mount Ousley Road.

The following bus routes service the investigation area and adjoining suburbs. Bus routes are illustrated in Figure 6-1.

Route 887 (Busabout) operates between Campbelltown and Wollongong via the M1 Princes Motorway. Services are hourly during weekday periods, and every two hours at other times. On weekends there are only two services per day in each direction.

Routes 6 and 7 (Premier Illawarra) operate between North Wollongong Station along the Princes Highway and east-west on residential streets north of Mount Ousley Road.

Routes 55 (the ‘Gong Shuttle’) operates between Wollongong and Wollongong University via University Avenue. The service operates every 10 minutes in each direction during the day, and every 20 minutes at other times.

Routes 9 and 9N (the ‘North Gong Shuttle’) is a loop service between North Wollongong and University of Wollongong via University Avenue. It operates approximately every 10 minutes during the day, with reduced services in the evening and out of university sessions.

The Gwynneville – Kieraville Shuttle operates in both directions between Wollongong and University of Wollongong via Gwynneville and Kieraville, accessing the university via University Avenue. It operates during university sessions only, with clockwise services running every 30
minutes throughout the day, and anti-clockwise services every 30 minutes during peak periods only.

Routes 1U and 4U (Dion’s bus service) operate to University of Wollongong via Austinmer South and Bulli South, travelling via University Avenue. There are services every 30 minutes during peak periods, and every 2 hours during the day. These routes operate on weekdays only.

Routes 11, 41 and 53 (Premier Illawarra) operate to the University of Wollongong from Wollongong, Dapto and Shellharbour respectively. These routes enter the investigation area from the south via Robsons Road and do not travel on the M1 Princes Motorway within the vicinity of Mount Ousley Road.

The nearest train stations are North Wollongong to the south and Fairy Meadow to the north, a distance of 2 km and 4 km respectively.

![Figure 6-1 Bus routes servicing the proposal area](image)

**Freight routes**

The M1 Princes Motorway and Mount Ousley Road perform a significant north-south freight function in the Illawarra region. In particular, Mount Ousley Road functions as a connection between the M1 Princes Motorway and coastal areas accessed via the Princes Highway.

Higher Mass Limit vehicles are permitted to use the M1 Princes Motorway and Mount Ousley Road in the investigation area.
Active transport

Between the M1 Princes Motorway and Gaynor Avenue, Mount Ousley Road has very narrow road shoulders, and no pedestrian footpath. Between Gaynor Avenue and the Princes Highway, there is a pedestrian footpath on the northern side of Mount Ousley Road only.

A pedestrian footpath and unmarked on-road cycle facilities are provided on Dumfries Avenue, immediately north of Mount Ousley Road, providing pedestrian and cyclist access to local streets. Besides Dumfries Avenue, Gaynor Avenue is also designated as an (unmarked) north-south cycle route by Wollongong City Council.

There is a formal shared path between the intersection of the Princes Highway/Mount Ousley Road to University Avenue and beyond, running adjacent to the TAFE NSW Wollongong campus.

Existing intersection operation

Level of Service for key intersections within the investigation area, derived from the base (2015) M1 Mount Ousley microsimulation traffic model, is shown in Table 6-2.

Table 6-2 Existing intersection performance along the proposal corridor

<table>
<thead>
<tr>
<th>Intersection</th>
<th>7am-8am</th>
<th>8am-9am</th>
<th>4pm-5pm</th>
<th>5pm-6pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 Princes Motorway/Mount Ousley Rd</td>
<td>54</td>
<td>D</td>
<td>&gt;100</td>
<td>F</td>
</tr>
<tr>
<td>M1 Princes Motorway SB Off-ramp/Uni</td>
<td>27</td>
<td>B</td>
<td>&gt;100</td>
<td>F</td>
</tr>
<tr>
<td>Irvine Street/University Av</td>
<td>1</td>
<td>A</td>
<td>3</td>
<td>A</td>
</tr>
<tr>
<td>Irvine Street/M1 Princes Motorway NB</td>
<td>4</td>
<td>A</td>
<td>16</td>
<td>B</td>
</tr>
<tr>
<td>Mount Ousley Road/Princes Highway</td>
<td>3</td>
<td>A</td>
<td>5</td>
<td>A</td>
</tr>
</tbody>
</table>

* Delay in seconds

The micro simulation model shows that the following intersections operate at capacity during peak periods:

- M1 Princes Motorway and Mount Ousley Road (northbound right turn)
- M1 Princes Motorway southbound off-ramp and University Avenue (southbound off-ramp in the morning and eastern approach in the evening)
- Irvine Street and M1 Princes Motorway northbound off-ramp (evening peak).
All other intersections within the investigation area currently operate satisfactorily during peak periods.

**Existing road safety trends**

The number of crashes per year has remained relatively constant over the past five years (2011 to 2016) with an average of 11 crashes per year.

Analysis of the distribution and type of crashes through the investigation area indicates clustering of crashes at the following locations:

- **Intersection of M1 Princes Motorway and Mount Ousley Road**: The majority of casualty crashes within the study area are located near this intersection, particularly associated with the right turn from Mount Ousley Road to the Princes Motorway northbound which was the location of a fatal crash. A large number of crashes involve vehicles leaving the carriageway on the Princes Motorway bend and Mount Ousley westbound approach. There is also a concentration of rear-end crashes around the approaches to this intersection, indicative of cars travelling at higher speeds crashing into slowed traffic exiting at Mount Ousley Road particularly due to the presence of groups of slower moving heavy vehicles. The incidence of rear-end crashes may be exacerbated by the steep descent travelling eastbound from Mount Pleasant along the M1 Princes Motorway.

- **M1 Princes Motorway between Mount Ousley Road and University Avenue**: The majority of crashes on this section of road did not result in a casualty. There are several crashes caused by rear-end collisions and changing lanes, which are likely associated with vehicle manoeuvring to and from University Avenue and Memorial Drive and along the straight section of the Princes Motorway.

Rear-end type collisions were the most prevalent reported crashes, accounting for 31 per cent of all crashes.

In terms of the severity of the crashes between 2011 and 2016, one was fatal, 23 involved an injury (47% reported as serious) and 32 did not involve any injury. The fatal crash occurred at the intersection of Mount Ousley Road (westbound) and the M1 Princes Motorway in December 2012. Crashes were most likely to occur during the AM peak period from 6-9 AM, as well as during the evening from 5-6 PM.

An assessment of heavy vehicle crash data within the investigation area showed that a total of 13 heavy vehicle crashes occurred on the M1 Princes Motorway or Mount Ousley Road between July 2011 and June 2016. No fatalities were recorded, however 38 per cent of crashes involving a heavy vehicle resulted in one or more injured persons.

Heavy vehicle crash data shows that the most common crash types were rear-end collisions (31 per cent), accidents due to a vehicle changing lanes (31 per cent) and vehicles travelling off the carriageway to the left on a curved section of road (23 per cent).

Additional analysis of the crash data indicated that 46 per cent of all accidents involving a heavy vehicle occurred upstream of the M1 Princes Motorway off-ramp onto Mount Ousley Road. In addition, one crash was recorded on Mount Ousley Road east of the existing interchange. This supports the need for an effective arrestor bed within the immediate vicinity of the interchange.
6.1.3 Potential impacts

Construction

The majority of traffic generated during the construction stages would be from plant, equipment and material deliveries, and removal of excess spoil. The majority of this traffic would likely travel along the M1 Princes Motorway, with a small proportion travelling along Mount Ousley Road, Memorial Drive and Princes Highway to and from the north east and south east.

As construction would be taking place on roads that have limited property access, construction activities would not have a substantial impact on property access.

Construction activities would be staged (see Section 3.3) to minimise impacts on road capacity through the course of construction. Construction impacts on traffic through the proposal area would be minimised through the staging of construction, allowing the existing speed limits to be maintained throughout most construction activities. Occasional speed reductions through construction zones would be required, where works must be carried out in close proximity to live traffic, or where night works are required in or near live traffic. Traffic control may be implemented in these situations.

Construction activity is likely to impact traffic operation during the following activities:

- The implementation of a roadwork speed limit may be required on a periodic basis when works under traffic control are being undertaken. This would generally require traffic to slow down to 40 km/hr in the vicinity of work areas.
- At the tie-in locations where traffic is switched between existing and new carriageways, additional delays are likely to cause further delays due to constraints in the temporary alignment at the cross over points.
- The reduction in shoulder width to 0.5 m (minimum) to allocate sufficient space for temporary safety barriers is likely to cause traffic disruption and delays in the event of a vehicle break down within the construction zone.
- The arrival and departure of construction traffic to / from construction access points.
- The arrival and departure of workers at shift rotations may result in increased traffic demand through the construction zone and turning manoeuvres to / from the site access points. However, the start and finish of work shifts will most likely occur outside peak traffic periods (i.e. 6.00 am to 7.00 am and 3.00 pm to 4.00 pm).
- Closure of Northfields Avenue on-ramp during Stage 2 for three months, after the Mount Ousley Road northbound on-ramp is opened. This is likely to affect up to 110 vehicles per hour in the morning peak and 320 vehicles per hour in the evening peak. The majority of the affected vehicles originate from residential properties to the south of Northfields Avenue and Porter Street in the morning peak and less than half originate from these areas in the evening peak while the remainder is University related traffic. These trips are likely to use the newly opened northbound on-ramp at Mount Ousley Road as an alternative to the Northfields Avenue ramp. Use of this new ramp as an alternative to the Northfields Avenue on-ramp would result in these trips travelling through the University campus during Stage 2 of construction.

Overall, the proposal would have minimal impacts on local roads and access in the investigation area during construction. The primary impact would be during Stage 1 of construction when the right turn from Mount Ousley Road to M1 Princes Motorway (northbound) would be closed requiring a temporary detour of 2.6 kilometres via University Avenue interchange. However as
described in Section 3.3, the proposed new bridge and northbound motorway on ramp would be
opened to traffic on completion of Stage 1, and hence the northbound through connection would
be reinstated.

The existing shared path between Helen Street and the pedestrian overbridge, adjacent to the
TAFE, would need to be relocated to ensure adequate separation between the shared path and
the works zone. The existing access between the shared user path at Helen St and Mount Ousley
Road may need to be closed for a period during construction. Options to complete the shared path
relocation as early works will be investigated during detailed design or an alternative path could be
provided through the Wollongong TAFE campus by opening a temporary connection from the
existing shared path to the TAFE carpark reconnecting through to the pedestrian bridge at the
carpark on the southern edge of the TAFE campus.

Northfields Avenue Pedestrian Bridge would require closure while it is being extended to cater for
proposed road widening. During that period, shared path users would be able to cross the M1 via
the University Avenue road bridge.

Operation

During operation, travel times on the M1 Princes Motorway and Mount Ousley Road, and
intersection delays would be reduced, particularly at the intersection of M1 Princes Motorway and
Mount Ousley Road, and the intersections on Irvine Street and Northfields Avenue.

Travel times for heavy vehicles are also likely to be reduced with the heavy vehicle bypass
separating cars from heavy vehicles at Mount Ousley Road and the removal of traffic queues from
University Avenue onto M1 Princes Motorway reducing conflict between heavy vehicles and
stationary vehicles queued on this off-ramp.

Intersection performance with the proposal is shown in Appendix D, Table C.1. The modelled
Levels of Service for each key intersection indicate the following:

• The proposed new roundabouts at the Mount Ousley Interchange would perform
  satisfactorily to the forecast 2041 horizon

• The intersection of the proposed service road with University Avenue is likely to continue to
  operate unsatisfactorily with the proposal, however the southbound queue would be reduced
  and would not affect southbound traffic on the M1 Princes Motorway due to the separation of
  the service road from the M1 Princes Motorway. The southbound delay is reduced however
  the delay on the eastern approach increases, which has a very low volume.

• The intersection of Northfields Avenue and Irvine Street is likely to operate satisfactorily with
  the proposal due to the proposed new northern access to the University of Wollongong. This
  access would reduce the volumes of traffic on Northfields Avenue as traffic heading to the
  northern part of the university campus, or exiting the university to travel north, could use the
  new northbound off-ramp at Mount Ousley Road and the new northbound on-ramp to the M1
  Princes Motorway

• Reductions in traffic on University Avenue, Irvine Street and Northfields Avenue would also
  reduce average delays at the following intersections:
    − Northfields Avenue and Irvine Street (up to 140 seconds)
    − Irvine Street and University Avenue (up to 6 seconds)
    − M1 Southbound Off-ramp and University Avenue (up to 114 seconds)
Modelled travel times for general traffic and heavy vehicles have been reported for the following routes through the study area with the proposal:

- M1 Princes Motorway between New Mount Pleasant Road and Mount Keira Road
- M1 Princes Motorway from New Mount Pleasant Road to University Avenue roundabout (southbound only)
- Mount Ousley Road between Princes Highway and New Mount Pleasant Road.

Analysis of the changes in modelled travel times with the proposal shows the following:

- The proposal would reduce travel times northbound and southbound along the M1 Princes Motorway (when compared to without the proposal, or with existing performance) by up to 94 seconds for cars and 37 seconds for heavy vehicles
- Small reductions in travel time on the M1 Princes Motorway under the proposal would be primarily due to the relocation of southbound traffic heading to University Avenue via the Mount Ousley Road off-ramp. These vehicles would still experience delays at the intersection of University Avenue and the service road. However, these delays would no longer impact southbound traffic on the M1 Princes Motorway
- Travel times for vehicles travelling on the M1 Princes Motorway to University Avenue are likely to decrease by up to 4 minutes in the morning peak. This is due primarily to the redistribution of traffic heading to the northern University of Wollongong campus. This traffic would no longer need to travel along University Avenue and would substantially reduce congestion at both roundabouts on University Avenue
- Travel times for vehicles travelling westbound along Mount Ousley Road and turning right at M1 Princes Motorway are likely to decrease by up to 100 seconds for cars and more than two minutes for trucks. This is due to the new intersection treatment for this northbound right turn movement, which has substantially higher capacity than the current priority arrangement.

The proposal would have minimal impact on public transport. No routes or bus stops would be relocated or limited in access as a result of the proposal. The existing 887 service between Campbelltown and University of Wollongong would be required to exit the M1 Princes Motorway at Mount Ousley Road and travel through the eastern roundabout onto the southbound service road instead of exiting the M1 Princes Motorway at the southbound University Avenue off-ramp. This change would affect no existing stops along the route. It would increase the length of the service by less than one kilometre, and the overall journey time by less than two minutes, which would equate to an increase of less than three percent over the entire journey from Campbelltown to Wollongong.

The construction of a new northern access to the University of Wollongong would create opportunities for new bus routes to service this part of the University and potentially reduce travel times for other bus routes.

The proposal would improve reliability and travel times for freight on M1 Princes Motorway by providing additional traffic capacity on the primary freight route between Sydney and Wollongong. The proposal would introduce a number of improvements for pedestrians and cyclists along in the study area. These improvements include:
• A new shared path between Dumfries Avenue (north of the M1 Princes Motorway) and the University of Wollongong (south of the M1 Princes Motorway), via pedestrian bridges over Mount Ousley Road and a shared path on the new bridge over the Princes Motorway
• A shared path connection between the new pedestrian bridge over Mount Ousley Road and the existing shared path alongside the TAFE NSW Wollongong campus.

The proposal would have minimal impacts on on-street parking, as there is currently no on-street parking permitted on Mount Ousley Road or the M1 Princes Motorway. The proposal would result in the following improvements to road safety:

• Improved safety for vehicles travelling along the M1 Princes Motorway due to the removal of the existing priority right turn from Mount Ousley Road. Removal of this right turn would eliminate the conflict between these vehicles and opposing traffic on the M1 Princes Motorway, reducing the risk of crashes.
• Remove southbound queueing at the University Avenue southbound off-ramp from the M1 Princes Motorway, reducing the risk of rear-end collisions for vehicles travelling southbound towards the back of this queue.
• Provision of two new safety ramps to manage out-of-control heavy vehicles, reducing the risks of trucks crashes with other vehicles.
• Provision of a formalised crossing for pedestrians and cyclists across the M1 Princes Motorway and Mount Ousley Road via pedestrian and cyclist bridges and shared path connections, reducing the risk of pedestrians crossing informally across Mount Ousley Road and the M1 Princes Motorway.
• Provision of a heavy vehicle bypass and service road to reduce weave movements between slow moving heavy vehicles and faster moving traffic exiting at Mount Ousley and travelling to University Avenue on the M1 Princes Motorway, reducing the risk of crashes associated with these weave movements.
• Smart Motorway infrastructure to allow for faster detection and confirmation of incidents and more rapid incident response in the event of a crash or other incident.

### 6.1.4 Safeguards and management measures

Safeguards and management measures for potential impacts of the proposal on traffic and transport are listed in Table 6-3.
### Table 6-3 Safeguards and management measures for traffic and transport

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic and transport</td>
<td>A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the Roads and Maritime Traffic Control at Work Sites Manual (RTA, 2010) and QA Specification G10 Control of Traffic (Roads and Maritime, 2008). The TMP will (but is not limited to):</td>
<td>Contractor</td>
<td>Detailed design / Pre-construction</td>
<td>Core standard safeguard TT1 Section 4.8 of QA G36 Environment Protection</td>
</tr>
<tr>
<td></td>
<td>• Include individual traffic management requirements at each phase of construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Outline the general principles and procedures for the development of specific construction Traffic Management Plans (CTMPs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ensure safe and continuous traffic movement for construction workers and the general public</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Maintain the capacity of existing roads where possible</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• Identify the requirements for temporary speed restrictions where traffic may pose a safety risk to workers</td>
<td></td>
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<tr>
<td></td>
<td>• Maintain continuity of access to local roads and properties, particularly along Mount Ousley Road and University Avenue (may require temporary u-turn facilities)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• Provide temporary traffic control where necessary</td>
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<tr>
<td></td>
<td>• Identify requirements and placement of traffic barriers</td>
<td></td>
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<tr>
<td></td>
<td>• Provide appropriate warning and signage for traffic in the vicinity of work areas</td>
<td></td>
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<tr>
<td></td>
<td>• Include methods to minimise road user delays such as</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Environmental safeguards</td>
<td>Responsibility</td>
<td>Timing</td>
<td>Standard / additional safeguard</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
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<td>---------------------------------</td>
</tr>
</tbody>
</table>
| Traffic and transport          | undertaking works around live traffic including tie-in and bridge work outside of peak periods  
                                | • Undertake construction activities off-line where possible to minimise the requirement to operate temporary traffic control and reduced speed zones  
                                | • Develop a communication plan to advise local residents and businesses of any changes to traffic conditions during construction. | Contractor | Detailed design | Additional safeguard |
| Traffic and transport          | Requirements for any changes to local traffic and access arrangements will be confirmed during detailed design in consultation with Roads and Maritime, Wollongong City Council and any affected landowners, including any temporary alternative access arrangements as required. | Contractor | Pre-construction/Construction | Additional safeguard |
| Traffic and transport          | Pedestrian and cyclist access will be maintained throughout construction. Where that is not feasible or necessary, temporary alternative access arrangements would be provided following consultation with affected residents, Roads and Maritime and Wollongong City Council. | Contractor | Pre-construction/Construction | Additional safeguard |
| Traffic and transport          | Access for public transport services will be maintained. The requirements for any temporary changes will be confirmed following consultation with local bus operators and the community. | Contractor | Pre-construction | Additional safeguard |
6.2 Noise and vibration

The potential impacts of the proposal on noise and vibration are assessed in the Noise and Vibration Impact Assessment Report (SLR Consulting, 2017), which is provided in Appendix E. A summary of the assessment is presented in this section.

6.2.1 Methodology

General methodology related to noise and vibration is included in the sections below. Full details of the methodologies, criteria and guidance used are included in Appendix E.

Study area

The study area includes nine Noise Catchment Areas (NCAs) surrounding the proposal area which are described in Section 6.2.2 and shown on Figure 6-2.

General guidance and policy

Noise and vibration

Construction noise has been assessed in accordance with the *Interim Construction Noise Guideline* (ICNG) (DECC 2009), and with reference to the *Construction Noise and Vibration Guideline* (CNVG) (RMS, 2016). Construction road traffic noise has been assessed in accordance with the NSW *Road Noise Policy* (RNP) (NSW EPA, 2011).

Operational road traffic noise impacts have been assessed in accordance with guidance provided in the *Road Noise Policy* (RNP) (NSW EPA, 2011) and with reference to the *Noise Criteria Guideline* (NCG) and the Noise Mitigation Guideline (NMG) (Roads and Maritime, December 2014).

Vibration from construction and operation has been assessed in accordance with *Assessing Vibration: A Technical Guideline*, DEC, 2006 and *DIN 4150:Part 3-1999 Structural vibration – Effects of vibration on structures* (Deutsches Institute fur Normung, 1999).

BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2 (BSI, 1993) has been used in the assessment of vibration impacts (damage) to non-heritage sensitive structures. DIN 4150:Part 3-1999 Structural vibration – Effects of vibration on structures (Deutsches Institute fur Normung, 1999) has been used for the screening assessment of vibration impacts (damage) to heritage sensitive structures, if structure is found to be unsound.

Unattended noise monitoring methodology

Noise loggers continuously measured noise levels in 15-minute sampling periods to determine the existing relevant statistical noise levels during the daytime, evening and night-time periods.

The noise loggers were designed for compliance with relevant Australian Standards, and were checked for calibration before and after each survey. The loggers were set up with microphones at 1.5 m above the ground level. All microphones were fitted with wind shields.

The results of the noise monitoring were processed to exclude noise identified as extraneous (e.g. aeroplane noise; barking dogs) and/or data affected by adverse weather conditions (such as strong wind or rain) so as to establish representative noise levels in each area.
Noise modelling methodology

To quantify noise levels from the construction activities a computer noise prediction model was developed using SoundPLAN software. Local terrain, receiver buildings and structures were digitised in the noise model to develop a three-dimensional representation of the construction sites and surrounding environment. In accordance with the ICNG, noise levels were predicted for all receivers in the various catchment areas surrounding the proposed works.

Operational noise

A maximum noise level assessment was conducted in accordance with the procedure Preparing an Operational Noise and Vibration Assessment (Roads and Maritime, 2011) using guidance contained in Practice Note iii of the Environmental Noise Management Manual (ENMM).

6.2.2 Existing environment

Identification of noise and vibration sensitive receivers

The main sensitive receivers close to the proposal area include residential areas and the education centres of the University of Wollongong and the TAFE NSW Wollongong campus. The existing ambient noise environment is typically dominated by road traffic noise from the M1 Princes Motorway.

The project has been split into a number of NCAs which represent the various receiver areas and changing land use which surround the project. These include:

- NCA1 – the residential area to the immediate north of the M1 Princes Motorway, including the nearest receivers at Highbank Place, Sunninghill Crescent and Dumfries Avenue which are around 10 m from the proposed works.
- NCA2 – the residential area to the north of Mount Ousley Interchange including the nearest receivers on Dumfries Avenue around 30 m from the proposed works.
- NCA3 – mainly residential receivers to the north of Mount Ousley Road at the point where the proposal ties in with the existing road. The nearest receivers are on Dumfries Avenue around 30 m from the proposed works.
- NCA4 – the residential receivers to the south of the M1 Princes Motorway including the nearest receivers on Binda Street and Falder Place around 30 m from the proposed works.
- NCA5 – educational receivers at the University of Wollongong. The nearest university buildings are located around 30 m from the proposed works.
- NCA6 – the residential receivers located to the east of the M1 Princes Motorway. The nearest receivers are on Irvine Street and are over 100 m from the proposed works.
- NCA7 – mainly residential receivers to the south of Mount Ousley Road. The nearest receivers are near to Gowan Brae Avenue and are around 20 m from the proposed works.
- NCA8 – educational receivers at the TAFE NSW Wollongong campus. The nearest receivers are around 50 m from the proposed works.
- NCA9 – the residential receivers to the east of the M1 Princes Motorway. The nearest receivers are on College Place and over 100 m from the proposed works.

The sensitivity of receivers to noise and vibration is dependent upon the occupancy type and the nature of the activities performed within the affected premises. Sensitivity to noise is a subjective response varying for different individuals and can depend on the existing noise environment.
For the purpose of this assessment, receivers potentially sensitive to noise and vibration have been categorised as:

- Residential dwellings
- Commercial and industrial properties
- Other – education institutions.

This assessment considers all residences to be sensitive during both construction and operation. Commercial receivers are considered to be sensitive to construction noise and vibration impacts.

Receivers sensitive to noise and vibration (other than residential dwellings or commercial premises) identified in proximity to the proposal area are detailed in Table 6-3.

Table 6-3 Other noise and vibration sensitive receivers

<table>
<thead>
<tr>
<th>NCA</th>
<th>Description</th>
<th>Address*</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCA03</td>
<td>Mount Ousley Public School</td>
<td>31 McGrath Street, Fairy Meadow</td>
<td>Education</td>
</tr>
<tr>
<td>NCA05</td>
<td>University of Wollongong</td>
<td>Northfields Avenue, Mount Ousley</td>
<td>Education</td>
</tr>
<tr>
<td>NCA07</td>
<td>Elonera Montessori School</td>
<td>21 Mount Ousley Road, North Wollongong</td>
<td>Education</td>
</tr>
<tr>
<td>NCA08</td>
<td>TAFE NSW Wollongong campus</td>
<td>Foleys Lane, North Wollongong</td>
<td>Education</td>
</tr>
<tr>
<td></td>
<td>Keira High School</td>
<td>Lysaght St, Fairy Meadow</td>
<td>Education</td>
</tr>
<tr>
<td></td>
<td>Wollongong High School of the Performing Arts</td>
<td>Lysaght St, Fairy Meadow</td>
<td>Education</td>
</tr>
</tbody>
</table>

* Address is approximate and has been generated from a NSW Land and Property Information (LPI) database and has not been verified on site.

**Ambient noise surveys and monitoring locations**

In November 2016, a baseline noise monitoring survey consisting of one week of continuous noise measurements was undertaken at six locations close to the proposal area. The measured noise levels have been used to establish existing noise levels as a basis for assessing potential noise impacts of the project.

The noise monitoring locations were selected to be representative of receivers and communities potentially affected by the construction and operation of the proposal and are shown in Table 6-4.
Table 6-4 Ambient noise survey locations

<table>
<thead>
<tr>
<th>ID</th>
<th>NCA</th>
<th>Noise monitoring location address</th>
</tr>
</thead>
<tbody>
<tr>
<td>BG01</td>
<td>NCA01</td>
<td>1 Dumfries Avenue, Mount Ousley</td>
</tr>
<tr>
<td>BG02</td>
<td>NCA03</td>
<td>1A Bass Street, Mount Ousley</td>
</tr>
<tr>
<td>BG03</td>
<td>NCA04</td>
<td>Binda Street, Keiraville</td>
</tr>
<tr>
<td>BG04</td>
<td>NCA05</td>
<td>Wollongong University, Mount Ousley</td>
</tr>
<tr>
<td>BG05</td>
<td>NCA07</td>
<td>Gowan Brea Avenue, Mount Ousley</td>
</tr>
<tr>
<td>BG06</td>
<td>NCA08</td>
<td>TAFE NSW Wollongong campus, North Wollongong</td>
</tr>
</tbody>
</table>

The NCAs that make up the study area, and the noise monitoring locations are shown in Figure 6-2.
Figure 6-2 NCAs and monitoring locations
Noise monitoring results

The results of the noise monitoring surveys are shown in Table 6-5, where RBL is the Rating Background Level (representative of the typical lowest ambient noise level not exceeded for more than 90% of the daytime, evening, or night-time period); and LA_{eq} is the A-weighted equivalent noise level (basically the average noise level, approximating human hearing). Noise levels for the ICNG daytime, evening and night-time periods were recorded.

Table 6-5 Summary of noise monitoring results

<table>
<thead>
<tr>
<th>Noise monitoring location</th>
<th>Measured noise level (dB)</th>
<th>RBL</th>
<th>LA_{eq}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daytime</td>
<td>Evening</td>
<td>Night</td>
</tr>
<tr>
<td>BG01</td>
<td>59</td>
<td>53</td>
<td>40</td>
</tr>
<tr>
<td>BG02</td>
<td>51</td>
<td>45</td>
<td>38</td>
</tr>
<tr>
<td>BG03</td>
<td>56</td>
<td>51</td>
<td>40</td>
</tr>
<tr>
<td>BG04</td>
<td>65</td>
<td>55</td>
<td>41</td>
</tr>
<tr>
<td>BG05</td>
<td>60</td>
<td>55</td>
<td>46</td>
</tr>
<tr>
<td>BG06</td>
<td>63</td>
<td>54</td>
<td>43</td>
</tr>
</tbody>
</table>

Note 1: ICNG Governing Periods – Day: 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening: 6.00 pm to 10.00 pm; Night: 10.00 pm to 7.00 am Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Monitored night-time level was found to be higher than the evening and daytime level, therefore the INP requires that the night-time level used for assessment purposes be reduced to match the evening level.

Attended noise measurement observations

Attended noise measurements were undertaken at the time of deployment of the noise equipment at each of the monitoring locations. The purpose of these measurements is to allow a greater understanding of the relative contributions from the various sources of existing noise at each location.

At each location the attended measurements were performed for 15 minutes using a calibrated Brüel and Kjær 2260 Precision Sound Level Meter. Wind speeds were less than 5 m/s at all times, and all measurements were performed at a height of 1.5 m above ground level. Calibration of the sound level meter was checked before and after each measurement and the variation in calibration at all locations was found to be within acceptable limits at all times. Detailed results are shown in Appendix E.

6.2.3 Potential impacts

Construction

Noise

During the construction of the proposal, the use of construction equipment and vehicles close to sensitive receivers at times would produce increased noise levels.
Consistent with the requirements of the ICNG, the construction noise assessment provided a ‘realistic worst-case’ noise impact assessment based on the required construction works within any 15-minute period. This is typically associated with works located nearest to a particular receiver.

In reality, the potential construction noise impacts at any particular location can vary greatly depending on factors including the following:

- The position of the works within the site and distance to the nearest sensitive receiver
- The overall duration of the works
- The intensity of the noise levels
- The time at which the works are undertaken
- The character of the noise.

Noise levels at sensitive receivers can also be significantly lower than the worst-case scenario when the construction works move to a more distant location in a works area. When works move away from a receiver the noise levels from the operation of the construction equipment would reduce accordingly.

**Construction Activity Source Noise Levels**

Sound power levels for typical construction equipment have been applied in construction noise modelling, based on known sound performance of these items of plant. Typically, construction machinery with the highest sound power levels are those that operate percussively, such as jackhammers, rockbreakers or vibratory rollers. Other construction machinery emit a persistent noise, such as front end loaders, piling rigs and concrete trucks.

**Predicted worst-case construction noise levels**

Predicted noise levels (without additional mitigation) are representative of the worst-case impacts at that particular receiver type, where works are at their closest, and are intended to give an overview of the likely noise levels from the construction works. Specific noise impacts are predicted relative to established Noise Management Levels (NMLs) for each type of receiver. ‘Exceedance bands’ have been applied, noting that the impact of potential exceedances would depend on the period in which they were to occur (most people are typically more sensitive to night-time noise than daytime or evening noise):

<table>
<thead>
<tr>
<th>Noise Level</th>
<th>Impact Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 10 dB above NML</td>
<td>impacts would typically be marginal to minor</td>
</tr>
<tr>
<td>11 dB to 20 dB above NML</td>
<td>impacts would typically be moderate</td>
</tr>
<tr>
<td>&gt;20 dB above NML</td>
<td>impacts would typically be high</td>
</tr>
</tbody>
</table>

For most construction activities, construction noise levels would frequently be lower than predicted at the most-exposed receiver, as the noise levels presented are based on a realistic worst-case assessment.

The predicted construction noise levels and NML exceedances indicate that:

The highest noise levels and NML exceedances are generally predicted during works which require noise intensive plant items, such as a rock-breaker or concrete saw. This includes the following activities:

- Service relocation
- Earthworks with rockbreaker (daytime works)
- Pavement and infrastructure works
The highest impacts are generally seen in NCAs that have receivers in close proximity to the worksites, and includes:

- **NCA01** to **NCA03** – to the north of the motorway, where construction works are required near to residential receivers and where existing noise barriers are required to be removed and relocated
- **NCA04** – to the south of the motorway, where construction works are required near to residential receivers and where existing noise barriers are required to be removed and relocated
- **NCA07** – near to Mount Ousley Road where construction works are required near to residential receivers
- Works activities that do not include high noise generating items of plant generally result in considerably lower impacts

Works during out of hours periods would likely result in high impacts at the nearest receivers to the works. This is generally apparent at the northern end of the project, near to Dumfries Avenue and Falder Place, where night-time works may be required near to existing noise barriers are required to be removed and relocated to accommodate the works, and also at the southern end of the project near to Irvine Street.

It is noted however that rock-breaking is only proposed to be undertaken during the night-time in locations that are relatively distant from the nearest residential receivers. This would limit the potential for highly noise affected receivers during the night-time period.

**Highly Noise Affected Residential Receivers**

The ICNG considers residential receivers that are subject to predicted noise levels of 75 dBA or greater to be Highly Noise Affected. The number of identified Highly Noise Affected receivers is summarised in Table 6-6. The table shows the number of residential receivers in terms of works activity and NCA.

Table 6-6 Predicted number of highly noise affected residential receivers by works and NCA

<table>
<thead>
<tr>
<th>Activity</th>
<th>NCA01</th>
<th>NCA02</th>
<th>NCA03</th>
<th>NCA04</th>
<th>NCA05</th>
<th>NCA06</th>
<th>NCA07</th>
<th>NCA08</th>
<th>NCA09</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D</td>
<td>N</td>
<td>D</td>
<td>N</td>
<td>D</td>
<td>N</td>
<td>D</td>
<td>N</td>
<td>D</td>
</tr>
<tr>
<td>Clearing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Service Relocation</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Earthworks (w. breaker DAYTIME)</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Earthworks (w. breaker NIGHT-TIME)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Earthworks (no breaker)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Noise Barriers - (DAYTIME)</td>
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<tr>
<td>Noise Barriers - (NIGHT-TIME)</td>
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<tr>
<td>Piling</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>Pavement &amp; Infrastructure Works</td>
<td>3</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>16</td>
<td>-</td>
</tr>
<tr>
<td>Bridges (DAYTIME)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Bridges (NIGHT-TIME)</td>
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<tr>
<td>Concrete Works (DAYTIME)</td>
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<tr>
<td>Concrete Works (NIGHT-TIME)</td>
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<tr>
<td>Signage &amp; Line Marking</td>
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</tr>
</tbody>
</table>

Note: D = Day, N = Night
Table 6-6 shows the number of Highly Noise Affected receivers to be relatively low, apart from in NCA02 to NCA04, and NCA07 during pavement and infrastructure works, where several receivers are predicted to be subject to noise levels of 75 dBA or greater during the daytime period.

No receivers are predicted to be Highly Noise Affected during the night-time.

The locations of the Highly Noise Affected residential receivers, from all works and in any time period, are shown in Figure 6-3.
Figure 6-3 Highly Noise Affected residential receivers (construction noise)
The NCAs that are likely to experience the highest noise impacts in the construction period include:

- The nearest residential receivers within NCAs 1, 2 and 3 to the north of the M1 Princes Motorway
- The nearest residential receivers at NCA 4 to the south of the M1 Princes Motorway
- The nearest residential receivers at NCA 7 close to Mount Ousley Road.

The most impacted receivers are typically dwellings which surround and have direct line of sight to the various works locations. Front row receivers are predicted to be Highly Noise Affected, however this would only be likely where high noise generating works are being carried out immediately adjacent to nearby residential receivers. Noise levels would reduce as the distance to the receiver increases.

The areas potentially most affected are:

- Along the western end of Dumfries Avenue and Falder Place, where existing noise barriers would be required to be removed and relocated as part of the works
- Along the eastern end of Dumfries Avenue and near to Gowan Brae Avenue, where works are required at the tie-in to Mount Ousley Road and residential receivers are in close proximity.

Other sensitive receivers (University of Wollongong, TAFE NSW Wollongong Campus)

Other sensitive receivers potentially impacted by construction noise include the TAFE NSW Wollongong campus, and the University of Wollongong. These land uses are considered potentially sensitive to construction noise when the properties are in use. The ICNG has established a NML of 45 dBA (internal noise level), applied when the rooms or buildings are in use.

These receivers have been assessed against the ‘educational’ NML, taking into consideration all construction scenarios associated with the proposal. The assessment showed that, given the large number of buildings at the university and TAFE campuses adjacent to the proposed works areas, the potential impacts at these locations are predicted to exceed NMLs by clear margins at times, when noise intensive works are carried out in close proximity. Once again, earthworks with rockbreaker, and pavement and infrastructure works, were the activities assessed as resulting in the highest number of NML exceedances. These buildings are likely to have been constructed with noise attenuating materials and would be further investigated during the detailed design phase.

Sleep disturbance

The construction noise assessment showed that predicted exceedances at the nearest noise sensitive receivers are likely to exceed the sleep disturbance criterion, when night works are occurring adjacent to residential receivers, for the majority of works scenarios.

At this early stage in the proposal, the assessment has included predictions of maximum noise impacts for assessment of potential sleep disturbance. However, it is noted that the ICNG only requires the proposal to consider maximum noise levels where construction works are planned to extend over more than two consecutive nights. Final requirements for out of hours work would be determined by the contractor, during detailed design.

Recommended strategies for managing out of hours work in relation to activities with potential for sleep disturbance are listed in Section 6.2.4.
**Cumulative construction noise impacts**

Cumulative noise impacts warrant assessment where more than one works scenario occurs at any one time, such that a single receiver is impacted by noise from more than one construction activity. The assessment of predicted worst-case noise levels (above) includes concurrent operation of multiple plant items within the same construction scenario where these may be operating at the same time, in similar locations.

Prediction of cumulative noise levels from multiple construction activities operating close to one another is complex, given the number of sources and possible locations of a particular combination of construction works. It is not always possible to specify the precise location of more than one activity for the same 15-minute period and the assessment becomes overly conservative if calculating cumulative impacts based on all nearby works operating on a worst-case basis at the same time.

Since the works are anticipated to be of a similar nature, concurrent construction works would likely have a minimal effect on the worst-case predictions, but may increase the number of 15-minute periods during construction where the predicted worst-case noise impacts are apparent.

In practice, noise levels would vary as plant and equipment move about the work sites. Machinery would not all operate concurrently; there would be times when equipment is not operating.

Given the number of work sites and activities associated with the proposal, it is likely that receivers would occasionally be subject to potential cumulative noise impacts from work sites with activities operating concurrently in the same area. It is unlikely that cumulative impacts would result in an increase above the worst-case impacts presented for any one scenario in isolation, as multiple items of equipment have been included in each scenario and modelled at the closest location to the receivers.

**Construction traffic noise**

The movement of construction traffic on the local road network in the proposal area has the potential to cause noise impacts at sensitive receivers near the haulage routes. The anticipated construction vehicle movements associated with the proposal are provided in Table 6-7.

**Table 6-7 Construction traffic movements**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Site</th>
<th>Route</th>
<th>Activity</th>
<th>Duration</th>
<th>HGV Per day</th>
<th>Max per hour</th>
<th>Light Vehicles Per day</th>
<th>Night Works?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>UoW – internal ring road</td>
<td>Clearing/grubbing, Spoil removal</td>
<td>2 months</td>
<td>15</td>
<td>2</td>
<td>6</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Import fill, precast units, RCP</td>
<td></td>
<td>8</td>
<td>1</td>
<td>6</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Piling works</td>
<td></td>
<td>6</td>
<td>1</td>
<td>6</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Northfields Ave on ramp – closure</td>
<td>Retaining wall, drainage works, M1 on ramp</td>
<td>4 months</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Re-route via new NB on ramp – closure</td>
<td>Gantry footings, ITS conduits</td>
<td>3 months</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>No</td>
</tr>
<tr>
<td>Stage</td>
<td>Site</td>
<td>Route</td>
<td>Activity</td>
<td>Duration</td>
<td>HGV Per day</td>
<td>Max per hour</td>
<td>Light Vehicles Per day</td>
<td>Night Works?</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>-------</td>
<td>----------</td>
<td>----------</td>
<td>-------------</td>
<td>--------------</td>
<td>------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Dumfries Avenue</td>
<td>Clearing/grubbing</td>
<td>4 weeks</td>
<td>6</td>
<td>1</td>
<td>6</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Piling works</td>
<td>9 months</td>
<td>6</td>
<td>1</td>
<td>6</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Earthworks – cut</td>
<td>9 months</td>
<td>15</td>
<td>2</td>
<td>6</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Retaining wall</td>
<td>4 months</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Old Mount Ousley Road</td>
<td>Spoil removal/earthworks</td>
<td>1 months</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Retaining wall, pedestrian bridge abutment</td>
<td>4 months</td>
<td>6</td>
<td>1</td>
<td>6</td>
<td>Yes¹</td>
</tr>
<tr>
<td>2</td>
<td>Old Mount Ousley Road; M1 via SB on ramp</td>
<td>Eastern roundabout, SB on ramp, HV bypass, SB service road</td>
<td>3 months</td>
<td>6</td>
<td>2</td>
<td>6</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Foleys Lane/ TAFE access road</td>
<td>Utilities relocations, drainage</td>
<td>8 months</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pedestrian bridge works</td>
<td>4 months</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>Yes¹</td>
</tr>
<tr>
<td>2</td>
<td>University Ave.</td>
<td>S-bound service road (including utilities works)</td>
<td>6 months</td>
<td>8</td>
<td>2</td>
<td>3</td>
<td>Yes¹</td>
<td></td>
</tr>
<tr>
<td>2/3</td>
<td>UoW – internal ring road; Mount Ousley Road</td>
<td>New bridge over M1: Piling, abutments, central pier Bridge beams, deck</td>
<td>6 weeks</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 weeks</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>Yes²</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Mount Ousley Road</td>
<td>Clearing, earthworks, piling, cut and cover construction</td>
<td>5 months</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Drainage, pavement works</td>
<td>4 weeks</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>Mount Ousley Road</td>
<td>Piling, retaining walls, earthworks, cut and cover</td>
<td>4 months</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Drainage, pavement, finishing works</td>
<td>4 weeks</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>No</td>
</tr>
</tbody>
</table>

Note 1: The majority of the work will likely occur during the daytime, however some night-works may be required at times.

Note 2: Bridge beams and deck units would be erected at night during a scheduled motorway closure.

Construction traffic volumes (estimates) shown above are relatively small and are unlikely to result in a noticeable increase in road traffic noise levels (ie a greater than 2.0 dB over existing). The majority of construction traffic movements would be undertaken during the less sensitive daytime period.

Where haul routes are near to major roads, construction traffic is not anticipated to result in any perceptible difference in noise levels, because of the high existing traffic volumes on these routes. If construction traffic routes are required on less busy local roads, away from the major sources of road traffic noise, then noticeable increases in noise may be apparent.
Further investigation of construction traffic would be undertaken during detailed design, during preparation of the contractor’s Construction Traffic Management Plan.

**Construction vibration**

The major potential sources of vibration from the proposed construction activities are during vibratory rolling, vibratory piling and when using a rockbreaker.

Up to 39 buildings may be within the minimum safe working distances for cosmetic damage should a large rock-breaker be used at the outer extents of the construction footprint. Around 61 receivers are predicted to fall within the nominated minimum safe working distance for human comfort vibration during the use of a large rock-breaker at the outer extents of the proposal area.

**Operational noise impacts**

In operation, future traffic flows associated with the proposal have the potential to influence noise levels at adjacent receivers. The NSW *Road Noise Policy* (RNP) identifies strategies that address road traffic noise issues from:

- Existing roads
- New road projects
- Redevelopment projects
- New traffic-generating developments.

The proposal has been assessed with guidance of the *Noise Criteria Guideline* (NCG), which documents Roads and Maritime’s interpretation of the RNP, and provides a consistent approach to identifying road noise criteria for Roads and Maritime projects. Although it is not mandatory to achieve the noise assessment criteria in the NCG, proponents need to provide justification where this achievement is not considered feasible or reasonable.

The NCG recognises that the scope to reduce noise impacts from existing roads and corridors in established urban areas is typically limited. It sets out four key principles to guide the assessment:

1. Criteria are based on the road development type that a receiver would be affected by due to the road project
2. Adjacent and nearby residences should not have significantly different criteria for the same road
3. Criteria for the surrounding road network are assessed where a road project generates an increase in traffic noise greater than 2 dB on the surrounding road network
4. Protect existing quiet areas from excessive changes in amenity due to traffic noise.

The proposal has been assessed with regard to relevant NCG assessment criteria for residential receivers as shown in Table 6-8, and for other sensitive receivers as shown in Table 6-9.
### Table 6-8 NCG criteria – residential

<table>
<thead>
<tr>
<th>Road Category</th>
<th>Type of Project / Land Use</th>
<th>Assessment Criteria (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Freeway/arterial/sub-arterial roads</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors</td>
<td>LAeq(15hour) 55 (external) LAeq(9hour) 50 (external)</td>
</tr>
<tr>
<td></td>
<td>2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads</td>
<td>LAeq(15hour) 60 (external) LAeq(9hour) 55 (external)</td>
</tr>
<tr>
<td></td>
<td>3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The criteria at each facade are determined from the existing traffic noise level plus 12 dBA.

### Table 6-9 NCG criteria – Other sensitive land uses

<table>
<thead>
<tr>
<th>Existing sensitive land use</th>
<th>Assessment Criteria (dBA)</th>
<th>Additional considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>School classrooms (Internal noise levels)</td>
<td>LAeq(1hour) 40 (internal)</td>
<td>In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the ‘maximum’ levels shown in Australian Standard 2107:2000 (Standards Australia 2000).</td>
</tr>
<tr>
<td>Open space (active use)</td>
<td>LAeq(15hour) 60 (external) when in use</td>
<td>Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.</td>
</tr>
<tr>
<td>Open space (passive use)</td>
<td>LAeq(15hour) 55 (external) when in use</td>
<td>Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, eg playing chess, reading.</td>
</tr>
</tbody>
</table>
Identification of impacts

The predicted noise levels at all receiver facades were compared to the corresponding assessment criteria listed in Table 6-8 and Table 6-9. An analysis against the NMG mitigation triggers was undertaken to determine the extent of likely impacts. The comparison (Build minus No Build) for 2021 indicates the potential for any noise issues at the commencement of the proposal. The comparison for 2031 indicates the potential for noise impacts in the longer term once the proposal is well established and the surrounding road network has stabilised.

The noise impacts without mitigation have been identified with existing noise barriers in place and the reference dense graded asphalt (DGA) pavement for all sections of road (Figure 6-4).

Assessment

The assessment compares predicted noise levels with the proposal in 2021 (modelled as the year ‘at opening’) and 2031 (modelled as 10 years after opening) with those predicted without the proposal. Overall, the comparison between the No Build and Build scenarios in each of these timeframes indicates that the proposal is predicted to result in a negligible change in noise level for the majority of receivers. The proposal is predicted to result in a minor reduction in noise levels for some receivers at the University of Wollongong due to vehicles being moved further away from these receivers, and the construction of the Mount Ousley Road retaining wall creating a barrier against noise generated by the M1 Princes Motorway. Receivers close to the proposed new northern access to the university would however experience a small increase in noise levels.

Noise predictions throughout the proposal area indicate that receivers adjacent to the proposal are subject to existing road traffic noise impacts which exceed the NCG controlling criterion in many cases, as shown in the No Build scenarios in Table 6-10.

Table 6-10 Receivers exceeding the NCG controlling criteria without mitigation

<table>
<thead>
<tr>
<th>NCA</th>
<th>Receiver Type</th>
<th>Floor</th>
<th>2021</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>No Build</td>
<td>Build</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Day Night</td>
<td>Day Night</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No Build</td>
<td>Build</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Day Night</td>
<td>Day Night</td>
</tr>
<tr>
<td>NCA01</td>
<td>All</td>
<td>All</td>
<td>37 44</td>
<td>37 43</td>
</tr>
<tr>
<td>NCA02</td>
<td>All</td>
<td>All</td>
<td>55 57</td>
<td>57 59</td>
</tr>
<tr>
<td>NCA03</td>
<td>All</td>
<td>All</td>
<td>24 27</td>
<td>23 26</td>
</tr>
<tr>
<td>NCA04</td>
<td>All</td>
<td>All</td>
<td>22 30</td>
<td>19 30</td>
</tr>
<tr>
<td>NCA05</td>
<td>All</td>
<td>All</td>
<td>97 0</td>
<td>99 0</td>
</tr>
<tr>
<td>NCA06</td>
<td>All</td>
<td>All</td>
<td>0 0</td>
<td>0 0</td>
</tr>
<tr>
<td>NCA07</td>
<td>All</td>
<td>All</td>
<td>47 47</td>
<td>46 49</td>
</tr>
<tr>
<td>NCA08</td>
<td>All</td>
<td>All</td>
<td>54 0</td>
<td>57 0</td>
</tr>
<tr>
<td>NCA09</td>
<td>All</td>
<td>All</td>
<td>0 0</td>
<td>0 0</td>
</tr>
</tbody>
</table>

The predicted change in noise levels (Build minus No Build) for the controlling scenario (year 2031 night-time) across the investigation area is summarised in Figure 6-4.

Receivers considered for additional noise mitigation

Receivers where predicted noise levels are above the NCG controlling criteria do not necessarily qualify for additional noise mitigation. Consideration of ‘reasonableness’ is used to decide which of those receivers are eligible for additional noise mitigation measures.
‘Reasonableness’ relates to the application of wider judgements. The factors to be considered are:

- The noise reduction provided and the number of people protected
- Cost of mitigation, including the total cost and cost variations with different benefits provided
- Community views and wishes
- Visual impacts
- Existing and future noise levels, including changes in noise levels
- The benefits arising from the proposed road or road development.

Selecting reasonable measures from those that are feasible involves judging whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the abatement measure. To make such a judgement, consideration may be given to noise impacts, noise mitigation benefits, the cost effectiveness of noise mitigation and community views.

Receivers identified for consideration of additional noise mitigation are shown in Figure 6-5. Further discussion of the project noise impacts (without mitigation) is presented in Table 6-11. In the detailed design phase, further investigation would be undertaken to determine which properties would be eligible for additional noise mitigation.

Table 6-11 Receivers eligible for consideration of additional noise mitigation

<table>
<thead>
<tr>
<th>NCA</th>
<th>Receiver Type</th>
<th>Receiver Floors (Buildings)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCA01</td>
<td>Residential</td>
<td>6 (4)</td>
<td>Residential receivers to north of the highway</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>NCA02</td>
<td>Residential</td>
<td>46 (31)</td>
<td>Residential receivers to north of the highway</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>NCA03</td>
<td>Residential</td>
<td>-</td>
<td>No triggers</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>NCA04</td>
<td>Residential</td>
<td>7 (6)</td>
<td>Residential receivers to south of the highway</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>NCA05</td>
<td>Residential</td>
<td>-</td>
<td>Educational receivers at University of Wollongong</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>74 (43)</td>
<td></td>
</tr>
<tr>
<td>NCA06</td>
<td>Residential</td>
<td>-</td>
<td>No triggers</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>NCA07</td>
<td>Residential</td>
<td>19 (11)</td>
<td>Residential receivers to east of the highway</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>NCA08</td>
<td>Residential</td>
<td>-</td>
<td>Educational receivers at TAFE NSW Wollongong campus</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>28 (13)</td>
<td></td>
</tr>
<tr>
<td>NCA09</td>
<td>Residential</td>
<td>-</td>
<td>No triggers</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>ALL</strong></td>
<td>Residential</td>
<td>78 (52)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>102 (47)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td>180 (99)</td>
<td></td>
</tr>
</tbody>
</table>
Figure 6-4 Predicted change in noise levels (Build minus No Build) without mitigation
Figure 6-5 Locations eligible for consideration of additional mitigation

Note: Triggered categories are as per the three types of possible triggers that then require investigation of additional mitigation
In summary, a total of 180 receivers (99 individual buildings) are predicted to have exceedances of the operational road traffic noise criteria for the project and are therefore considered eligible for consideration of additional noise mitigation. The 180 exceedances fall into the following categories:

**Trigger 1 only** – the predicted Build noise level exceeds the NCG controlling criterion and the noise level increase due to the project is greater than 2 dB. No receivers are triggered on this criterion alone

**Trigger 2 only** – the predicted Build noise level is 5 dB or more above the criteria (exceeds the cumulative limit) and the receiver is significantly influenced by project road noise, regardless of the incremental impact of the project. A total of 84 receivers are triggered on this criterion alone

**Trigger 3 only** – where the noise level contribution from the road project is acute (daytime LAeq(15hour) 65 dBA or higher, or night-time LAeq(9hour) 60 dBA or higher) then it qualifies for consideration of noise mitigation even if noise levels are dominated by another road. No receivers are triggered on this criterion alone.

**Any combination of triggers** – 96 receivers qualify for consideration of noise mitigation due to exceeding a mix of the above mitigation triggers.

The NCAs with the most triggered receivers are NCA02, NCA05, NCA07 and NCA08. These catchments are generally located where the proposal would widen the existing road corridor and/or introduce new trafficable lanes

A total of 78 residential (52 individual buildings), and 102 other sensitive (47 individual buildings) are predicted to have exceedances of the operational road traffic noise criteria for the project and are therefore considered eligible for consideration of additional noise mitigation

The other sensitive receivers are primarily located at the University of Wollongong and TAFE NSW Wollongong campus.

Along Dumfries Avenue, most of the residential properties show a mix of triggered receivers. There are some instances where isolated properties do not fall within this group of triggered receivers due to noise levels being very close to the criteria along this section of road and some of the properties being set back further from the road than others.

**Additional mitigation – consideration**

**Low noise pavements:**

The noise assessment considers the use of quieter pavement in the form of dense graded asphalt across the extent of the project. To test the potential effectiveness of low noise pavement, an additional modelling iteration was undertaken, using a better performing low noise pavement than standard dense graded asphalt. The assumed performance of the upgraded low noise pavement is -2 dB compared to DGA. Adoption of this option would therefore result in a reduction (by six) of the number of properties considered eligible for treatment.

The use of low noise pavement to further reduce road traffic noise at the source would be further investigated during detailed design.

**Noise barriers:**

New or extended noise barriers were considered and analysed where four or more triggers are apparent on the noise exceedance map. The analysis considered a range of barrier heights with a range of noise benefits. Initial investigations showed that some of the closest properties to the
proposal, e.g. along Dumfries Avenue would experience the greatest change in noise levels. Further investigations will be undertaken in the detailed design phase to determine a more accurate representation of the change in noise levels for the receivers close to the proposal area.

Noise barriers were investigated for a number of locations in terms of where the predicted operational noise exceeded NCG criteria. The analysis concluded with a recommendation for noise barriers to be incorporated into the concept design at the following three locations:

- Along the northern side of the M1 Princes Motorway and the southern side of Dumfries Avenue, between the end of the existing noise wall and about Foothills Road
- Along the southern side of the M1 Princes Motorway and the northern side of Falder Place, between about the mid-way point of Binda Street, and the proposed western roundabout (part of this barrier would be a replacement for the existing barrier, which is about 3.5 m in height)
- Along the southern side of Old Mount Ousley Road, between the cul-de-sac at the western end and Gowan Brae Avenue, and continuing to the south from the cul-de-sac, so as to shield the properties at the end of Old Mount Ousley Road.

The height and extent of noise walls would be determined during detailed design, with consideration for the following issues:

- Potential noise benefits
- Potential visual impacts
- Potential urban design impacts
- Potential community safety/crime prevention considerations such as isolated walkways
- Potential overshadowing impacts
- Preferences of the local community as gauged during the community consultation phase
- Cost and constructability.

At-property treatments

At-property architectural treatments would also help to address the predicted exceedances to the residential properties. The preferred noise mitigation option (low noise pavement, noise barrier, architectural treatments, a combination or other) would be determined during detailed design taking into account whole-of-life engineering considerations and the overall social economic and environment benefits.

During detailed design, ownership details would be obtained for all receivers identified as eligible for consideration of at-property treatment. Once an internal inspection of the property is undertaken, consideration of the internal layout of habitable spaces and subsequently the most appropriate form of at-property treatment can be confirmed.

This would also include confirmation of appropriate external criteria for other sensitive receivers on a case by case basis. External criteria for other sensitive receivers have been derived using a 10 dB factor to convert internal to external noise levels. For some non-residential receivers this assumption may be overly conservative as the facade area to window ratios are often larger when compared to residential receivers, or windows may not be openable and the internal criteria may be achievable without additional at-property treatment. See Appendix E for further details.
### 6.2.4 Safeguards and management measures

Safeguards and management measures for potential impacts of the proposal on noise and vibration are listed in Table 6-12.

#### Table 6-12 Safeguards and management measures for noise and vibration

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
</table>
| Noise and vibration     | A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the CEMP. The NVMP will generally follow the approach in the *Interim Construction Noise Guideline* (ICNG) (DECC, 2009) and identify:  
  • All potential significant noise and vibration generating activities associated with the activity  
  • Feasible and reasonable mitigation measures to be implemented, taking into account *Beyond the Pavement: urban design policy, process and principles* (Roads and Maritime, 2014).  
  • A monitoring program to assess performance against relevant noise and vibration criteria  
  • Arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures  
  • Contingency measures to be implemented in the event of non-compliance with noise and vibration criteria.  
  In addition to the above, the NVMP will also consider:  
  • Place as much distance as possible between the plant or equipment and residences | Contractor | Detailed design / pre-construction | Core standard safeguard NV1  
<p>|                          |                                                                                         |                |                               | Section 4.6 of QA G36 Environment Protection |</p>
<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>and other sensitive land uses, particularly at site compounds.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Use of temporary site buildings and materials stockpiles as noise barriers where possible (e.g. on site compounds).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Scheduling construction of any permanent walls so that they can be used as early as possible as noise barriers where possible.</td>
<td></td>
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<tr>
<td></td>
<td>• Where practical, scheduling the use of vibration intensive equipment for less sensitive times of the day.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• Avoid multiple vibration intensive activities occurring at the same time where possible.</td>
<td></td>
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<tr>
<td></td>
<td>• Selection of ancillary sites location shall consider the proximity of the sites to sensitive receivers. Where compounds are close to residences, additional care shall be taken in layout and utilising structures and stockpiles as noise screens.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Where possible, works outside of standard construction hours will be planned so that noisier works are carried out in the earlier part of the evening or night time.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Examining different types of machines that perform the same function and compare the noise level data to select the least noisy machine. For example, rubber wheeled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Environmental safeguards</td>
<td>Responsibility</td>
<td>Timing</td>
<td>Standard / additional safeguard</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>-------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Noise and vibration</td>
<td>tractors can be less noisy than steel tracked tractors.</td>
<td>Contractor</td>
<td>Detailed design / pre-construction</td>
<td>Core standard safeguard NV2</td>
</tr>
<tr>
<td></td>
<td>• Selecting appropriately sized equipment for the task rather than using large equipment when not necessary.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reducing throttle setting and turn off equipment when not being used.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Regularly inspecting and maintaining equipment to ensure it is in good working order. Also check the condition of mufflers.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Where acceptable from a work health and safety perspective, quieter alternatives to reversing alarms (such as spotters, closed circuit television monitors and ‘smart’ reversing alarms) will be used particularly during out of hours activities.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Noise monitoring will be undertaken to assess compliance with noise management levels (NMLs) and assess the effectiveness of noise mitigation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• All noise complaints will be investigated and appropriate mitigation measures implemented where practicable to minimise further impacts.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All sensitive receivers (e.g. schools, local residents) likely to be affected will be notified at least five days prior to commencement of any works associated with the activity that</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Environmental safeguards</td>
<td>Responsibility</td>
<td>Timing</td>
<td>Standard / additional safeguard</td>
</tr>
<tr>
<td>------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------</td>
<td>-----------------------</td>
<td>---------------------------------</td>
</tr>
</tbody>
</table>
| Noise and vibration    | may have an adverse noise or vibration impact. The notification will provide details of:  
  - The project  
  - The construction period and construction hours  
  - Contact information for project management staff  
  - Complaint and incident reporting and how to obtain further information. | Roads and Maritime Services | Detailed design / pre-construction | Additional safeguard            |
| Noise and vibration    | Further assessment of reasonable and feasible operational noise mitigation in the form of noise barriers and at-property treatments will be assessed and determined during detailed design. At-property treatments will be determined and implemented in consultation with impacted property owners. | Roads and Maritime Services | Detailed design / pre-construction | Additional safeguard            |
| Noise and vibration    | Where works are required outside standard construction hours, an out of hours work procedure will be developed in accordance with the Roads and Maritime Construction Noise and Vibration Guideline as an appendix to the NVMP. Construction programming will be developed in consultation with Roads and Maritime to minimise noise impacts – this may include agreement on completing construction in as short a time as possible or implementing time and duration restrictions and respite periods subject to community consultation. | Contractor               | Pre-construction       | Additional safeguard            |
6.3 Biodiversity

The potential impacts of the proposal on biodiversity are assessed in the Biodiversity Assessment (Jacobs, 2017), which is provided in Appendix F. A summary of the assessment is presented in this section.

6.3.1 Methodology

Investigation area

This assessment uses the following terms:

The ‘proposal area’: This term is defined in Chapter 3.

The ‘locality’: The area within a 10 kilometre radius of the proposal area

The ‘investigation area’: Includes the proposal area and the area that may be indirectly impacted by the proposal (refer to Figure 6-6).

Desktop review

A desktop review of literature, mapping, relevant ecological reports and databases was carried out to identify threatened species, populations and communities, important habitat for migratory species and critical habitat with a likelihood of occurrence in the investigation area and locality.

Databases searched during the desktop review included:

- Atlas of NSW Wildlife and the NSW Office of Environment and Heritage's (OEH) BioBanking Threatened Species Profile Database, within a 10 kilometre search area (accessed in November 2016)
- EPBC Act Protected Matters Search Tool, within a 10 kilometre search area (accessed in January 2017)
- OEH’s critical habitat register (accessed in November 2016)
- OEH Vegetation Information System (VIS) and Vegetation Types Database databases (accessed in November 2016)
- Department of Primary Industry’s Aquatic Threatened Ecological Communities (TECs) and freshwater threatened species distribution maps (accessed in November 2016).

Habitat assessment

The habitat assessment compared the preferred habitat features for threatened flora and fauna species with habitats identified in the investigation area in order to determine the likelihood of the species to be present. The criteria used in the habitat assessment are detailed in Table 6-13.
Figure 6-6 – Biodiversity investigation area
### Table 6-13 Likelihood of occurrence classification and criteria

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recorded</td>
<td>The species was observed in the investigation area during the current survey.</td>
</tr>
<tr>
<td>High</td>
<td>It is highly likely that a species inhabits the investigation area and is dependent on identified suitable habitat (ie for breeding or important life cycle periods such as winter flowering resources), has been recorded recently in the locality (10 kilometres) and is known or likely to maintain resident populations in the investigation area. Also includes species known or highly likely to visit the investigation area during regular seasonal movements or migration.</td>
</tr>
<tr>
<td>Moderate</td>
<td>Potential habitat is present in the investigation area. Species unlikely to maintain sedentary populations however may seasonally use resources within the investigation area opportunistically or during migration. The species is unlikely to be dependent (ie for breeding or important life cycle periods such as winter flowering resources) on habitat within the investigation area, or habitat is in a modified or degraded state. Includes cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.</td>
</tr>
<tr>
<td>Low</td>
<td>It is unlikely that the species inhabits the investigation area and has not been recorded recently in the locality (10 kilometres). It may be an occasional visitor, but habitat similar to the investigation area is widely distributed in the local area, meaning that the species is not dependent (ie for breeding or important life cycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the investigation area or the species are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.</td>
</tr>
<tr>
<td>None</td>
<td>Suitable habitat is absent from the investigation area.</td>
</tr>
</tbody>
</table>

#### Field survey

**Vegetation survey**

The vegetation survey was completed using field survey methods in accordance with Chapter 5 of the *Framework for Biodiversity Assessment (FBA) – NSW Biodiversity Offsets Policy for Major Projects* (OEH, 2014). The survey was carried out over a five day period (28-30 November 2016 and 1-2 December 2016).

Preliminary vegetation mapping reviewed existing vegetation mapping prepared for the preliminary environmental investigation for the proposal (Biosis, 2014) and used aerial photography to identify vegetation extent. Broad-scale soil and vegetation mapping was adapted from the *Soil Landscapes of the Wollongong-Port Hacking 1:100,000 Map Sheet* (Hazelton and Tillie, 1990) and *Native Vegetation of the Illawarra Escarpment and Coastal Plain* (NSW National Parks and Wildlife Service, 2003). Contour and waterway data were used to stratify vegetation within the investigation area. Preliminary vegetation mapping was ground-truthed and mapped as Plant Community Types (PCTs) according to the OEH VIS Classification Database (OEH, 2014).

The condition of PCTs was assessed in accordance with Chapter 5 of the FBA. Vegetation zones were assigned by comparing the dominant canopy species, general description of location, soil
type and other attributes as described in the Threatened Species Profile Database and VES Classification Database (OEH, 2014). ‘Moderate-good’ vegetation zones were classified into a sub-condition class of Poor, Medium, Good or Other. The criteria for these classes are provided in Appendix F.

A plot-based full floristic survey focused on indicative vegetation zones using a series of 20 by 20 metre quadrats located inside a 20 by 50 metre transect. Twelve plots/transects were completed to record stratum and layer, growth form, species name, cover and abundance rating (refer to Appendix F).

Areas of roadside landscape plantings and disturbed vegetation dominated by weeds were sampled in plots and mapped to identify the composition and abundance within the investigation area. These areas were not assigned vegetation zones as they are not naturally occurring and cannot be matched to a PCT.

**Targeted flora surveys**

Targeted flora surveys were carried out for identified flora species following the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft* (Department of Environment and Conservation, 2004). A combination of random meander surveys using paired parallel transects as described in the *NSW Guide to Surveying Threatened Plants* (OEH, 2016) and floristic plot surveys was carried out to identify, search and record any candidate species.

The threatened flora species targeted and details of surveys carried out are shown in Table 6-14.

Table 6-14 Targeted species survey technique for threatened flora with a potential to occur in the investigation area

<table>
<thead>
<tr>
<th>Threatened flora species</th>
<th>Status TSC Act</th>
<th>Status EPBC Act</th>
<th>Survey technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>White-flowered Wax Plant (Cynanchum elegans)</td>
<td>V</td>
<td>V</td>
<td>Targeted surveys and random meanders carried out throughout the investigation area did not identify this species. A reference population was confirmed on steep eastern slopes of Mount Keira, about 560 metres west of the investigation area.</td>
</tr>
<tr>
<td>Illawarra Socketwood (Daphnandra johnsonii)</td>
<td>E</td>
<td>E</td>
<td>Targeted surveys and random meanders carried out in moist eucalypt forest throughout the investigation area did not identify this species.</td>
</tr>
<tr>
<td>Gossia acmenoides population</td>
<td>EP</td>
<td>-</td>
<td>Targeted surveys and random meanders carried out throughout the investigation area did not identify this species.</td>
</tr>
</tbody>
</table>
### Threatened flora species

<table>
<thead>
<tr>
<th>Threatened flora species</th>
<th>Status</th>
<th>TSC Act</th>
<th>EPBC Act</th>
<th>Survey technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solanum celatum</td>
<td>E</td>
<td>-</td>
<td></td>
<td>Targeted surveys and random meanders carried out throughout the investigation area did not identify this species. Surveys targeted disturbed forest edges and clearings.</td>
</tr>
<tr>
<td>Rainforest Cassia (Senna acclinis)</td>
<td>E</td>
<td>-</td>
<td></td>
<td>Targeted surveys and random meanders carried out throughout the investigation area did not identify this species. Surveys targeted disturbed forest edges and clearings. A reference population was confirmed on eastern upper slopes of Mount Keira, about 610 metres west of the investigation area.</td>
</tr>
<tr>
<td>Magenta Lilly Pilly Syzygium paniculatum</td>
<td>E</td>
<td>E</td>
<td></td>
<td>Two individuals of this species were recorded in riparian Blue Gum Forest with a rainforest mid-storey in the north east of the University of Wollongong campus. One plant was recorded in the vegetation off the end of Mount Ousley Road. One plant was recorded in planted vegetation near the heavy vehicle safety ramp. Targeted surveys comprised general traverses throughout areas of suitable habitat.</td>
</tr>
</tbody>
</table>

**Targeted fauna surveys**

The location and method of terrestrial fauna surveys were guided by the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft* (Department of Environment and Conservation, 2004) and the *Threatened species survey and assessment guidelines: field survey methods for fauna – Amphibians* (Department of Environment and Climate Change, 2009). The following Commonwealth survey guidelines were also accessed:

- **Survey Guidelines for Australia’s Threatened Bats** (Department of the Environment Water Heritage and the Arts, 2010a)
- **Survey Guidelines for Australia’s Threatened Birds** (Department of the Environment Water Heritage and the Arts, 2010b)
- **Survey Guidelines for Australia’s Threatened Frogs** (Department of the Environment Water Heritage and the Arts, 2010c)
- **Survey Guidelines for Australia’s Threatened Mammals** (Department of Sustainability Environment Water Population and Communities, 2011).

The fauna survey was conducted across the investigation area over a five-day period (28-30 November 2016 and 1-2 December 2016). Anabat recording was carried out from 31 January 2017 to 2 February 2017. The investigation area was stratified into PCTs/habitat types in order to focus survey effort on targeted species. Targeted and opportunistic surveys were conducted in all habitat types. Survey methods and effort per habitat strata are provided in Appendix F.
**Fauna habitat assessment survey**

Fauna habitat assessments were completed to assess the likelihood of threatened fauna occurring in the investigation area. Fauna habitats were assessed by examining characteristics such as the structure and floristics of the canopy, understorey and ground vegetation; the structure and composition of the litter layer; and other habitat attributes important for feeding, roosting and breeding. The criteria used to evaluate the condition of general fauna habitat values are outlined in Appendix F.

**Aquatic habitat assessment**

Habitat assessment for threatened aquatic species was carried out for the two first-order streams which occur in the investigation area. Aquatic habitats were assessed by examining characteristics such as the structure and floristics of aquatic vegetation, channel width, the presence of surface water, water flow, water depth, turbidity, visible pollutants, erosion, the presence of shelter (rocks, submerged vegetation and woody debris) and channel substrate.

Characteristics observed did not match habitat characteristics of any threatened aquatic species known or predicted to occur in the locality. As such, targeted surveys for aquatic species were not required.

### 6.3.2 Existing environment

#### Plant community types

Plant community types (PCTs) identified within the investigation area are shown in Figure 6-7. The majority of native vegetation is confined to the central and northern portions of the investigation area. Land use activities such as vegetation clearing, weed and pest invasion, rubbish dumping and human interaction have modified the extent and condition of native vegetation. Disturbed areas are heavily weed infested with a cover of Lantana (greater than 75 per cent in some areas) as well as a high cover of Coral Tree (*Erythrina x sykesii*), Box-elder Maple (*Acer negundo*), Panic Veldtgrass (*Ehrharta erecta*) and Kikuyu (*Cenchrus clandestinus*).

A total of 234 flora species were recorded in the investigation area, including 124 local native species, 31 planted non-indigenous species and 79 exotic plant species, six of which are noxious species. Flora species recorded in the investigation area are listed in Appendix F.

The vegetation survey identified moderate to good condition PCTs within the investigation area (refer to Table 6-15). Non-native vegetation type extents are summarised in Table 6-16.

<table>
<thead>
<tr>
<th>Plant community type (PCT)</th>
<th>Vegetation zone</th>
<th>Condition class</th>
<th>Threatened ecological community?</th>
<th>Area (ha) in investigation area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (694)</td>
<td>1</td>
<td>Moderate/Good</td>
<td>No</td>
<td>5.6</td>
</tr>
<tr>
<td>2</td>
<td>Moderate/Good_MEDIUM</td>
<td></td>
<td></td>
<td>0.8</td>
</tr>
<tr>
<td>3</td>
<td>Moderate/Good_OTHER</td>
<td></td>
<td></td>
<td>0.8</td>
</tr>
<tr>
<td>Sydney Blue Gum x</td>
<td>4</td>
<td>Moderate/Good</td>
<td>No</td>
<td>2.9</td>
</tr>
</tbody>
</table>
Table 6-16 Summary of non-native vegetation and extent in the investigation area

<table>
<thead>
<tr>
<th>Type</th>
<th>Area (ha) in investigation area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadside and landscape plantings</td>
<td>9.6</td>
</tr>
<tr>
<td>Disturbed areas dominated by weeds</td>
<td>1.4</td>
</tr>
</tbody>
</table>
Figure 6-7 Plant community types
Threatened ecological communities
No PCTs identified in the investigation area qualified as threatened ecological communities (TEC) listed under the TSC Act or the EPBC Act.

Threatened species and populations
The background review identified 27 threatened flora and 69 threatened fauna species (listed under the TSC Act and EPBC Act) with a potential to occur in the investigation area. Three threatened flora species and nine threatened fauna species were considered to have a moderate to high likelihood of occurring based on the presence of suitable habitat and recent records from the locality.

Threatened species recorded within the investigation area during field surveys are shown in Figure 6-8. One threatened flora species, four individual specimens of *Syzygium paniculatum* were recorded in the investigation area, in three locations. In the absence of evidence to suggest these plants have been planted, they were considered likely to be naturally occurring. An additional two threatened plant species, *Eucalyptus nicholii* and *Eucalyptus scoparia*, were also recorded in the investigation area planted adjacent to the M1 Princes Motorway as street trees. These species are not naturally occurring and impacts to these species have not been assessed, as they are not expected to be significantly impacted by the proposal. Two other threatened flora species, *Senna acclinis* and *Solanum celatum*, are considered to have a moderate likelihood to occur based on the presence of suitable habitat.

Three threatened fauna species were recorded in the investigation area, including the Grey-headed Flying Fox, Eastern Bentwing-bat and Little Bentwing-bat. The Grey-headed Flying Fox was observed at night flying over and foraging in the habitat in the investigation area. The Eastern Bentwing-bat and Little Bentwing-bat were recorded via Anabat. All PCTs in the investigation area are considered to provide suitable foraging habitat for these three species. Six additional threatened fauna species are considered moderately likely to occur within the investigation area due to the presence of suitable habitat (refer to Table 6-17).

Table 6-17 Threatened fauna habitat recorded in the investigation area

<table>
<thead>
<tr>
<th>Species</th>
<th>Ecosystem or species credit species</th>
<th>Status</th>
<th>Habitat or individuals in the investigation area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gang-gang Cockatoo</td>
<td>Ecosystem credit species</td>
<td>V</td>
<td>9.95 ha of potential foraging and roosting habitat in PCTs</td>
</tr>
<tr>
<td><em>(Callocephalon fimbriatum)</em></td>
<td></td>
<td></td>
<td>9.88 ha of potential foraging habitat in planted vegetation</td>
</tr>
<tr>
<td>Varied Sittella</td>
<td>Ecosystem credit species</td>
<td>V</td>
<td>9.95 ha of potential foraging, roosting and breeding habitat in PCTs</td>
</tr>
<tr>
<td><em>(Daphoenositta chrysoptera)</em></td>
<td></td>
<td></td>
<td>9.88 ha of potential foraging habitat in planted vegetation</td>
</tr>
<tr>
<td>Species</td>
<td>Ecosystem or species credit species</td>
<td>Status</td>
<td>TSC Act</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------------------------------------------------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>Little Lorikeet <em>(Glossopsitta pusilla)</em></td>
<td>Ecosystem credit species</td>
<td>V</td>
<td>-</td>
</tr>
<tr>
<td>Swift Parrot <em>(Lathamus discolor)</em></td>
<td>Ecosystem credit species</td>
<td>E</td>
<td>CE</td>
</tr>
<tr>
<td>Powerful Owl <em>(Ninox strenua)</em></td>
<td>Ecosystem credit species</td>
<td>V</td>
<td>-</td>
</tr>
<tr>
<td>Little Bent-wing Bat <em>(Miniopterus australis)</em></td>
<td>Ecosystem and Species credit (breeding habitat) species</td>
<td>V</td>
<td>-</td>
</tr>
<tr>
<td>Eastern Bentwing-bat <em>(Miniopterus schreibersii oceanensis)</em></td>
<td>Ecosystem and Species credit (breeding habitat) species</td>
<td>V</td>
<td>-</td>
</tr>
<tr>
<td>Grey-headed Flying-fox <em>(Pteropus poliocephalus)</em></td>
<td>Ecosystem credit species</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Greater Glider <em>(Petauroides volans)</em></td>
<td>Not applicable</td>
<td>-</td>
<td>V</td>
</tr>
</tbody>
</table>
Figure 6-8 Recorded threatened species
Fauna species richness
The investigation area is considered to have moderate fauna species richness, typical of a small fragmented forested area. A total of 58 fauna species was recorded, comprising 42 birds, six terrestrial mammals, one bat, five frogs, four reptiles and one fish species (refer to Appendix F). The total includes six exotic fauna species.

Aquatic habitat
The aquatic habitat in the investigation area is limited to two unnamed streams. Stream banks are heavily exposed and moderately unstable in some areas, likely due to excessive stormwater flow volume and velocity and soil disturbance caused by Rusia Deer (*Cervus timorensis*) activity.

The streams lack visible submerged native aquatic macrophytes with occasional patches of disturbance-tolerant native emergent aquatic macrophytes such as Bullrushes (*Typha* spp.) and Knotweeds (*Persicaria* spp). Exotic plant species such as Trad (*Tradescantia fluminensis*), Crofton Weed (*Ageratina adenophora*) and *Brassica* sp. are the dominant stream edge vegetation.

Due to the lack of permanent flow, rubbish accumulation, increased turbidity, weed proliferation, paucity of native aquatic vegetation, siltation and evidence of physical disturbance of the streams, these streams are considered to be in moderately to highly degraded condition. These streams are considered likely to provide habitat for very disturbance-tolerant species such as the Longfinned Eels (*Anguilla reinhardtii*) which was observed during field surveys.

The streams do not have characteristics suitable for threatened aquatic species known or predicted to occur in the locality. There are no wetlands of significance (SEPP 14 wetlands or wetlands listed in the Directory of Important Wetlands) within eight kilometres of the investigation area.

Groundwater dependent ecosystems
The level of groundwater dependence of vegetation communities in the investigation area has been identified using the Atlas of GDE (Bureau of Meteorology, 2017) and the Risk Assessment Guidelines for Groundwater Dependant Ecosystems released by the NSW DPI (Kuginis et al., 2012). The degree of groundwater dependence of ecosystems is classified in three broad categories including non-dependent ecosystems, facultative GDEs, or obligate GDEs. A description of each of these categories is provided in Appendix F.

The level of groundwater dependence and potential for interaction of terrestrial ecosystems in the investigation area is identified in Table 6-18.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney</td>
<td>Illawarra Gully Wet Forest</td>
<td>High potential for groundwater interaction</td>
<td>Groundwater dependent terrestrial ecosystem (phreatophytic)</td>
<td>Facultative - Opportunistic Likely to use groundwater where available during times of water stress but to be dependent chiefly on</td>
</tr>
</tbody>
</table>
### Ecosystems and Groundwater Dependence

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Basin Bioregion (PCT 694)</td>
<td></td>
<td></td>
<td></td>
<td>high local rainfall.</td>
</tr>
<tr>
<td>Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion (PCT 1245)</td>
<td>Warm Temperate Layered Forest</td>
<td>High potential for groundwater interaction</td>
<td>Groundwater dependent terrestrial ecosystem (phreatophytic)</td>
<td>Facultative – Opportunistic Likely to use groundwater where available during times of water stress but to be dependent chiefly on high local rainfall.</td>
</tr>
<tr>
<td>Shallow first-order streams with ephemeral flow</td>
<td>Part of communitie s listed above</td>
<td>Non-dependent ecosystems</td>
<td>N/A</td>
<td>The shallow, disturbed first-order streams of the site have only ephemeral flow, lack baseflow characteristics and are unlikely to be dependent on groundwater.</td>
</tr>
</tbody>
</table>

### Wildlife Connectivity Corridors

The investigation area does not contain viable linkages to larger contiguous vegetation and is highly fragmented by roads and low-density housing. The Escarpment Moist Forest Fauna Linkage (about 500 metres to the west of the investigation area) is characterised by vegetation that has a rainforest component and connecting bands of moist forest. While the investigation area is separated from the Escarpment Moist Forest Fauna Linkage by residential development, roads and cleared land, some connectivity for species which are more tolerant to disturbance does exist.

Habitats within the investigation area are fragments that have formed since the initial habitat clearing that occurred with the development of the suburbs of Mount Ousley, Keiraville, Gwynneville and North Wollongong. The M1 Princes Motorway and Mount Ousley Road divides remaining habitats within the investigation area into four main fragments. Barriers of the M1 Princes Motorway and Mount Ousley Road restrict fauna movements between habitat patches for terrestrial and arboreal species. The permeability of landscapes for different fauna species varies and habitat connectivity for more mobile species (eg birds, flying-foxes, insectivorous bats, plants) is present with the escarpment to the west. Connectivity for sedentary species and smaller species such as frogs and reptiles is likely to be minimal.

Fauna can cross the road and disturbed areas but would do so less frequently than in natural habitats and would be at greater risk of mortality during movements. It is likely that fauna move between the escarpment habitats and habitats within the investigation area. It is also likely that plant pollinators and seed dispersers move pollen and seed (or other vegetative reproductive material) between habitat patches within the investigation area and the escarpment. Functional connectivity for many species exists between the investigation area and the escarpment despite the level of fragmentation that has occurred.
Migratory species

Three migratory species listed under the EPBC Act may potentially occur within the investigation area. Of these, the White-throated Needletail has a moderate potential of occurring in the investigation area. This species may fly over the investigation area on occasion during seasonal migration but is unlikely to land in the investigation area to utilise the habitats. The full list of migratory species considered in this assessment is provided in Appendix F.

State Environmental Planning Policy 44 (SEPP 44) – Koala Habitat Protection

State Environmental Planning Policy 44 (SEPP 44) – Koala Habitat Protection does not apply to proposals that are being assessed under Part 5 of the EP&A Act. However, the Koala (Phascolarctos cinereus) is listed as vulnerable under the Commonwealth EPBC Act and in NSW under the TSC Act. There was no evidence of core or potential Koala habitat in the investigation area.

6.3.3 Potential impacts

Potential impacts for the construction and operational phases are identified below, with safeguards and management measures to be implemented to reduce the potential impacts of the proposal outlined in Section 6.3.4.

Construction

**Removal of native vegetation**

The proposal would result in the clearing of about 7.5 hectares of two PCTs (refer to Table 6-19). This would include:

- 6.6 hectares of Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (PCT 694)
- 0.8 hectares of Sydney Blue Gum x Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion (PCT 1245).

The local occurrence of each PCT is defined as the area of the PCT that occurs within the investigation area and adjacent areas that form part of a larger contiguous area of the PCT, in which movement of individuals and exchange of genetic material across the boundary of the investigation area can be demonstrated. The PCTs within the investigation area are within 500 metres of the vegetation along the escarpment so are considered to be connected and part of the local occurrence. Movement of individuals and exchange of genetic material from the vegetation on the escarpment to and from the PCTs within the investigation area can be expected.

The proposal would result in the removal of about 4.8 hectares of roadside and urban plantings and about one hectare of weed dominated vegetation (refer to Table 6-20).
Table 6-19 Predicted impacts to PCTs in the investigation area

<table>
<thead>
<tr>
<th>Plant community type (PCT)</th>
<th>Veg. zone</th>
<th>Condition class</th>
<th>Threatened ecological community?</th>
<th>Area (ha) in investigation area</th>
<th>Impact (ha)</th>
<th>Total PCT impact (ha)</th>
<th>Proportional impact to the local occurrence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (PCT 694)</td>
<td>1</td>
<td>Moderate/Good</td>
<td>No</td>
<td>5.6</td>
<td>5.2</td>
<td>6.6</td>
<td>0.6% (mapped local occurrence of 1,058 ha)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Moderate/Good_ Medium</td>
<td></td>
<td>0.8</td>
<td>0.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Moderate/Good_ Other</td>
<td></td>
<td>0.8</td>
<td>0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sydney Blue Gum x Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion (PCT 1245)</td>
<td>4</td>
<td>Moderate/Good</td>
<td>No</td>
<td>2.9</td>
<td>0.5</td>
<td>0.8</td>
<td>0.03% (mapped local occurrence of 2,478 ha)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Moderate/Good_ Poor</td>
<td></td>
<td>0.2</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Moderate/Good_ Other</td>
<td></td>
<td>0.1</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6-20 Predicted impacts to non-native vegetation in the investigation area

<table>
<thead>
<tr>
<th>Type</th>
<th>Area (ha) in investigation area</th>
<th>Predicted impact (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadside landscape plantings</td>
<td>9.6</td>
<td>4.8</td>
</tr>
<tr>
<td>Disturbed areas dominated by weeds</td>
<td>1.4</td>
<td>1</td>
</tr>
</tbody>
</table>

**Removal of threatened fauna habitat**

Vegetation removal during the construction phase of the proposal would have a direct impact on suitable habitat for a range of threatened fauna species listed under the TSC Act and EPBC Act. Impacts to threatened fauna and fauna habitat as a result of the proposal are listed in Table 6-21.

Nineteen hollow-bearing trees (including dead trees) would be removed during the construction phase of the proposal. These trees contain hollows that may be suitable habitat for a range of tree roosting insectivorous bats (including threatened species), arboreal mammals including the Brushtail Possum and Sugar Glider, and small to medium sized birds (including threatened species such as the Little Lorikeet). These hollows are present in the larger trees and stags. The size and number of hollows to be removed is estimated as follows:
- Nine small sized hollows ≤ 5cm wide in living trees
- Three small sized hollows ≤ 5cm wide in dead trees
- Six medium sized hollows >5 cm to ≤10 cm wide in living trees
- Two medium sized hollows >5 cm to ≤10 cm wide in dead trees.

Table 6-21 Impacts to threatened fauna and fauna habitat

<table>
<thead>
<tr>
<th>Species</th>
<th>Status</th>
<th>TSC Act</th>
<th>EPBC Act</th>
<th>Habitat or individuals in the investigation area</th>
<th>Habitat or individuals to be impacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gang-gang Cockatoo (<em>Callocephalon fimbriatum</em>)</td>
<td>V</td>
<td>-</td>
<td></td>
<td>10.4 ha of potential foraging and roosting habitat in PCTs</td>
<td>7.5 ha of habitat removal from PCTs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.6 ha of potential foraging habitat in planted vegetation</td>
<td>4.8 ha of habitat removal from planted vegetation</td>
</tr>
<tr>
<td>Varied Sittella (<em>Daphoenositta chrysoptera</em>)</td>
<td>V</td>
<td>-</td>
<td></td>
<td>10.4 ha of potential foraging and roosting habitat in PCTs</td>
<td>6.9 ha of habitat removal from PCTs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.6 ha of potential foraging habitat in planted vegetation</td>
<td>4.8 ha of habitat removal from planted vegetation</td>
</tr>
<tr>
<td>Little Lorikeet (<em>Glossopsitta pusilla</em>)</td>
<td>V</td>
<td>-</td>
<td></td>
<td>10.4 ha of potential foraging and roosting habitat in PCTs</td>
<td>7.5 ha of habitat removal from PCTs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.6 ha of potential foraging habitat in planted vegetation</td>
<td>4.8 ha of habitat removal from planted vegetation</td>
</tr>
<tr>
<td>Swift Parrot (<em>Lathamus discolor</em>)</td>
<td>E</td>
<td>CE</td>
<td></td>
<td>10.4 ha of potential foraging and roosting habitat in PCTs</td>
<td>7.5 ha of habitat removal from PCTs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.6 ha of potential foraging habitat in planted vegetation</td>
<td>4.8 ha of habitat removal from planted vegetation</td>
</tr>
<tr>
<td>Powerful Owl (<em>Ninox strenua</em>)</td>
<td>V</td>
<td>-</td>
<td></td>
<td>10.4 ha of potential foraging and roosting habitat in PCTs</td>
<td>7.5 ha of habitat removal from PCTs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.6 ha of potential foraging habitat in planted vegetation</td>
<td>4.8 ha of habitat removal from planted vegetation</td>
</tr>
</tbody>
</table>
### Species Table

<table>
<thead>
<tr>
<th>Species</th>
<th>Status</th>
<th>TSC Act</th>
<th>EPBC Act</th>
<th>Habitat or individuals in the investigation area</th>
<th>Habitat or individuals to be impacted</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eastern Bentwing-bat</strong></td>
<td>V</td>
<td>-</td>
<td>-</td>
<td>10.4 ha of potential foraging and roosting habitat in PCTs</td>
<td>7.5 ha of habitat removal from PCTs</td>
</tr>
<tr>
<td><em>(Miniopterus schreibersii oceanensis)</em></td>
<td></td>
<td></td>
<td></td>
<td>9.6 ha of potential foraging habitat in planted vegetation</td>
<td>4.8 ha of habitat removal from planted vegetation</td>
</tr>
<tr>
<td><strong>Little Bentwing-bat</strong></td>
<td>V</td>
<td>-</td>
<td>-</td>
<td>10.4 ha of potential foraging and roosting habitat in PCTs</td>
<td>7.5 ha of habitat removal from PCTs</td>
</tr>
<tr>
<td><em>(Miniopterus australis)</em></td>
<td></td>
<td></td>
<td></td>
<td>9.6 ha of potential foraging habitat in planted vegetation</td>
<td>4.8 ha of habitat removal from planted vegetation</td>
</tr>
<tr>
<td><strong>Grey-headed Flying-fox</strong></td>
<td>V</td>
<td>V</td>
<td>-</td>
<td>10.4 ha of potential foraging and roosting habitat in PCTs</td>
<td>7.5 ha of habitat removal from PCTs</td>
</tr>
<tr>
<td><em>(Pteropus poliocephalus)</em></td>
<td></td>
<td></td>
<td></td>
<td>9.6 ha of potential foraging habitat in planted vegetation</td>
<td>4.8 ha of habitat removal from planted vegetation</td>
</tr>
<tr>
<td><strong>Greater Glider</strong></td>
<td>-</td>
<td>V</td>
<td>V</td>
<td>10.4 ha of potential foraging and roosting habitat in PCTs</td>
<td>7.5 ha of habitat removal from PCTs</td>
</tr>
<tr>
<td><em>(Petauroides volans)</em></td>
<td></td>
<td></td>
<td></td>
<td>7.5 ha of habitat removal from PCTs</td>
<td></td>
</tr>
</tbody>
</table>

### Removal of threatened flora

Impacts of the proposal on threatened flora habitat are outlined in Table 6-212. The proposal would impact the habitat of three threatened plant species, including:

- *Syzygium paniculatum* (Endangered – TSC Act, Vulnerable EPBC Act)
- *Senna acclinis* (Endangered – TSC Act)

The proposal would remove four *Syzygium paniculatum* plants. Habitat for this species is present throughout PCT 694 and PCT 1245.

*Senna acclinis* and *Solanum celatum* were not found within the proposal area but are considered moderately likely to occur. These two species are known from the locality and have persistent soil stored seed banks. These species may be present as seed in the soil stored seedbank within PCT 694 and PCT 1245.
Table 6-22 Impacts on threatened flora habitat

<table>
<thead>
<tr>
<th>Threatened species</th>
<th>Ecosystem or species credit species</th>
<th>Status</th>
<th>TSC Act</th>
<th>EPBC Act</th>
<th>Habitat or individuals in the investigation area</th>
<th>Habitat or individuals to be impacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainforest Cassia (Senna acclinis)</td>
<td>Species credit species</td>
<td>E</td>
<td>-</td>
<td>No known plants</td>
<td>10.4 ha of potential habitat in the investigation area</td>
<td>No known plants to be removed 7.5 ha of habitat removal</td>
</tr>
<tr>
<td>Magenta Lilly Pilly (Syzygium paniculatum)</td>
<td>Species credit species</td>
<td>E</td>
<td>V</td>
<td>4 plants</td>
<td>10.4 ha of potential habitat in the investigation area</td>
<td>4 plants to be removed 7.5 ha of habitat removal</td>
</tr>
<tr>
<td>Solanum celatum</td>
<td>Species credit species</td>
<td>E</td>
<td>-</td>
<td>No known plants</td>
<td>10.4 ha of potential habitat in the investigation area</td>
<td>No known plants to be removed 7.5 ha of habitat removal</td>
</tr>
</tbody>
</table>

Aquatic impacts

Potential impacts of the proposal on aquatic habitats are discussed in Table 6-23. The proposal would result in modification to some aquatic habitat along two first-order streams. No threatened species listed under the FM Act are likely to occur in these streams due to their poor condition and lack of characteristic habitat features associated with listed species. Significant impacts to aquatic ecosystems are unlikely to occur as a result of the proposal.

Table 6-23 Potential impacts of the proposal on aquatic habitats

<table>
<thead>
<tr>
<th>Potential impacts of activities in aquatic habitats</th>
<th>Impact of proposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activation of acid sulfate soils and associated acid metal pollution of water</td>
<td>No acid sulfate soil has been recorded within the proposal area. The proposal area is not considered likely to contain acid sulfate soils. The proposal would be unlikely to cause impacts on aquatic habitats associated with acid sulfate soils.</td>
</tr>
<tr>
<td>Changed hydrology; flow velocity, depth, turbulence, flooding regime</td>
<td>The proposal would likely result in some changes to hydrology including flow velocity, depth, turbulence and flooding regimes. These hydrological factors are different from their natural condition and changes associated with the proposal are likely to occur over small areas. As such, the impact of the proposal on hydrology is unlikely to be significant.</td>
</tr>
<tr>
<td>Potential impacts of activities in aquatic habitats</td>
<td>Impact of proposal</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Changes in shading regime and temperature</td>
<td>The proposal would result in a short-term reduction in shading and an increase in water temperature associated with removal of native and exotic riparian vegetation. This impact would occur over small areas and is likely to be temporary as native riparian vegetation would be restored to streamside areas where feasible at the completion of the proposal. The impact of the proposal on shading and temperature is unlikely to be significant.</td>
</tr>
<tr>
<td>Loss of aquatic habitat</td>
<td>The proposal would result in the loss and modification of a small amount of aquatic habitat. This habitat is degraded and is likely to be occupied by common disturbance-tolerant species. The loss and modification of this habitat is unlikely to significantly impact the aquatic ecosystems of the affected streams.</td>
</tr>
<tr>
<td>Obstruction to fish passage</td>
<td>The affected streams contain potential obstructions to fish passage in the form of culverts, are degraded and are likely to contain disturbance-tolerant fish species such as eels. While the proposal would require structures that may affect fish passage, it is unlikely to significantly change fish movements in the waterways which are likely to be affected by existing structures.</td>
</tr>
<tr>
<td>Potential impacts of tannins entering waterways from mulch</td>
<td>Riparian revegetation activities associated with the proposal could result in tannins entering the streams. Given that the streams appear to be moderately polluted, the ecosystems they contain are unlikely to be very sensitive to a moderate increase in tannins. The risk of substantial tannin pollution of the streams is considered to be low with the implementation of safeguards and management measures outlined in Section 6.7.4.</td>
</tr>
<tr>
<td>Temporary displacement of fauna</td>
<td>The proposal would result in the modification of a small area of habitat where it crosses the two first-order streams. As the streams are highly modified and degraded, their aquatic fauna is likely to consist entirely of common disturbance-tolerant species. These species are unlikely to be significantly affected by the proposal.</td>
</tr>
</tbody>
</table>
Potential impacts of activities in aquatic habitats

<table>
<thead>
<tr>
<th>Potential impacts of activities in aquatic habitats</th>
<th>Impact of proposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity and sedimentation</td>
<td>Proposal construction activities could result in sediment entering the streams. The risk of substantial amounts of sediment entering the streams is considered to be low with the implementation of safeguards and management measures outlined in Section 6.7.4. Small amounts of sediment may enter the streams despite the installation of sediments controls. Due to the very low flow conditions, sediment is likely to settle almost entirely in the immediate vicinity of the proposal area and is unlikely to significantly affect habitat downstream.</td>
</tr>
</tbody>
</table>

**Injury and mortality**

Vegetation clearing during construction has the potential to result in fauna injury or death. Less mobile species (e.g., ground dwelling reptiles), or those that are nocturnal and nest or roost in trees during the day (e.g., arboreal mammals and microchiropteran bat species), may find it difficult to rapidly move away from clearing when disturbed. The investigation area contains a number of hollow dwelling species including Brush-tailed Possums, Ringtail Possums, Sugar Gliders, and birds that may be injured or killed during vegetation removal. Reptiles and frogs may also be injured or killed during construction as habitat is cleared.

Entrapment of wildlife in trenches or pits could occur if the trenches are deep and steep sided. Wildlife may also become trapped in or may choose to shelter in machinery that is stored in the investigation area overnight. If these animals were to remain inside the machinery, or under the wheels or tracks, they may be injured or may die once the machinery is in use.

**Noise, light and vibration**

The construction phase of the proposal would result in increased noise and vibration levels in the investigation area due to activities such as vegetation clearing, ground disturbance, machinery and vehicle movements, and human presence. Noise and vibration from construction activities would potentially disturb resident fauna and may disrupt foraging, reproductive, or movement behaviours. Some night works would be required during construction and lighting would be installed on the roadside. Ecological light pollution may affect nocturnal fauna by interrupting their life cycle. Some species (i.e., light tolerant microchiropteran bats) may benefit from the lighting due to increased food availability (insects attracted to lights) around these areas. Due to the frequency and sustained nature of the lighting, it is unlikely that animals would habituate to the light disturbance.

**Invasion and spread of weeds**

Vegetation clearing has the potential to result in the spread of weeds during the construction phase of the proposal. The spread of weeds has the potential to impact the quality and integrity of TECs and threatened species habitat. The potential for habitat modification from weed invasion is highest where activities occur in relatively intact areas that exhibit low weed diversity and abundance.

Without safeguards and management measures, the proposal has the potential to disperse weeds into areas of remnant vegetation where weed species are currently limited or in low density. The
The proposal also has the potential to import new weed species into the investigation area. The most likely causes of weed dispersal and importation associated with the proposal include earthworks, movement of soil, and attachment of seed (and other propagules) to vehicles and machinery.

**Invasion and spread of pests**

The proposal has the potential to reduce the quality of the habitat in the locality for the Rusa Deer (*Cervus timorensis*) as the vegetated area would be reduced and sheltering opportunities would become more limited. As such, the deer may be dispersed out of the investigation area. The increased road area may also result in deer posing a greater risk to motorists if they are to graze on newly constructed grassed roadside edges. Safeguards and management measures to discourage the use of the proposal area by deer are outlined in Section 6.3.4.

**Invasion and spread of pathogens and disease**

Several pathogens known from NSW have potential to affect biodiversity as a result their movement and infection during the construction phase of the proposal. Of these, three are listed as a key threatening process under either the EPBC Act and/or TSC Act, including:

- Dieback caused by Phytophthora (Root Rot; EPBC Act and TSC Act)
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis (EPBC Act and TSC Act)
- Introduction and establishment of exotic Rust Fungi of the order *Pucciniales* on plants of the family *Myrtaceae* (TSC Act).

While these pathogens were not observed or tested for in the investigation area, the potential for pathogens to occur should be treated as a risk during the construction phase.

**Groundwater dependent ecosystems**

The proposal may cause minor local impacts to groundwater such as slight, localised changes to groundwater depth but it is unlikely to cause significant alteration to groundwater conditions outside of the immediate vicinity of the proposal area. While there may be minor alteration to groundwater conditions in the locality, the proposal is unlikely to result in permanent damage or loss of groundwater dependent ecosystems outside of the proposal footprint.

**Operation**

**Wildlife connectivity and habitat fragmentation**

The proposal would result in an increase in isolation of habitats as two remaining habitat patches would be separated by a barrier (ie the proposed new interchange) by a distance of about 200 metres.

Isolation that may be caused by the proposal is not expected to have a substantial impact on nomadic or migratory species such as birds. However, opportunities for dispersal may be affected and roadkill may be increased due to the increased road area and traffic that would be moving through areas of previously continuous habitat. The habitats contain populations of arboreal mammals including Brushtail Possums, Ringtail Possums and Sugar Gliders. Dispersal of these animals between habitat patches is likely to be hindered by increased habitat isolation. The proposal is considered likely to be detrimental to the dispersal of arboreal mammals and other species including frogs and reptiles.

Reduced connectivity can also lead to crowding effects and increased competition within the remaining habitat patches.
The predicted level of isolation from the proposal is not expected to prevent the breeding and dispersal of plant pollinators or the dispersal of plant propagules (i.e., seed or other vegetative reproductive material) between habitat patches. Functional connectivity for many species would remain in the investigation area. However, local division of some wildlife populations, isolation of key habitat resources, loss of genetic interchange, and loss of population viability for some species may occur.

**Edge effects on adjacent native vegetation and habitat**

Edge effects refer to the changes in environmental conditions (e.g., altered light levels, wind speed, temperature) that occur along the edges of habitats. These new environmental conditions along the habitat edges can promote the growth of different vegetation types (including weeds), promote invasion by pest animals specialising in edge habitats, or change the behaviour of resident animals (Moenting and Morris, 2006). Edge zones can be subject to higher levels of predation by introduced mammalian and native avian predators.

The proposal area is currently subject to a high level of edge effects from the existing roadways, urban development, and the TAFE NSW Wollongong campus and University of Wollongong. The proposal would remove current edge habitats and would introduce some new edges where habitats are retained. This may create new areas of vegetation subject to edge effects. As vegetation in the investigation area does not possess large areas of undisturbed habitat, the introduction of a new edge would be an impact of low magnitude.

**Groundwater dependent ecosystems**

The PCTs which are found in the proposal area are listed as having a high potential for groundwater interaction in the NSW Department of Water Groundwater Dependent Ecosystem (GDE) Atlas (BoM, 2017). The PCTs which are found in the proposal area are classified as groundwater dependent terrestrial ecosystems, do not occur solely in association with waterbodies, are not found on floodplains, in association with springs, swamps or other areas of impeded drainage and are located in areas with high annual rainfall. They are likely to be in the Facultative-Oppportunistic dependence class of GDEs and are unlikely to be heavily dependent on groundwater.

The small, shallow, ephemeral flowing first-order streams (aquatic ecosystems) of the site appear to be fed by rainfall and surface water flows and are unlikely to be groundwater dependent.

The proposal may result in minor local impacts to groundwater such as slight, localised changes to groundwater depth but it is unlikely to cause significant alteration to groundwater conditions outside of the immediate vicinity of the proposal area. While there may be minor alteration to groundwater conditions in the locality, the proposal would be unlikely to result in permanent damage or loss of groundwater dependent ecosystems outside of the proposal area.

**Injury and mortality**

The proposal has the potential to result in fauna mortality during operation through vehicle collision (i.e., roadkill). Mammals, reptiles, amphibians, and birds are all at risk of vehicle strike, particularly those common species (e.g., macropods) that are tolerant of disturbance and/or those species that can utilise roadways for movement pathways or as foraging habitat. As there are no definitive data on current rates of roadkill or fauna population densities in the investigation area, the consequences of vehicle strike on local populations is unknown. The impact on threatened species is expected to be minimal. Based on evidence from other roadways in the locality, most vehicle
strike impacts can be expected to occur to common mammals such as birds and possums and exotic animals including foxes.

**Noise, light and vibration**

Operation of the proposal has the potential to result in increased noise, light and vibration within the investigation area due to vegetation removal, vehicle movements and roadside lighting. Safeguards and mitigation measures to manage the impact of noise, light and vibration as a result of the proposal on biodiversity are listed in Section 6.3.4.

**Invasion and spread of weeds**

The proposal has the potential to result in the spread of weeds during the operation phase.

**Cumulative**

Cumulative impacts of historic vegetation clearing for agriculture, urban development, and development and maintenance of infrastructure would likely include continued loss of biodiversity in the region. The investigation area is situated between two Mitchell Landscapes: the Lake Illawarra Barrier (93 per cent cleared) and the Dapto-Wollongong Coastal Slopes (71 per cent cleared). The likely expansion of the greater Wollongong urban area has the potential to further impacts to biodiversity in the region.

Suitable data for a quantitative analysis of cumulative impacts from planned future proposals in the Lake Illawarra Barrier or the Dapto-Wollongong Coastal Slopes is not freely available. However, in the context of historic vegetation removal, any future vegetation clearing would result in incremental cumulative impact that would detrimentally affect biodiversity. It has been proposed that when a landscape reaches a vegetation retention threshold of ~30 per cent, most species would be lost from the ecosystem (McAlpine et al. 2002). With only seven per cent of the original vegetation remaining in the Lake Illawarra Barrier landscape, irreversible damage to the biodiversity of this region has already been done and while the proposal would further contribute to the cumulative impacts in this landscape, most species have already been lost. The Dapto-Wollongong Coastal Slopes landscape retains only 29 per cent of the original vegetation and may be approaching (or may have already crossed) a threshold where irreversible species loss would occur. The proposal would contribute to the cumulative impacts to this landscape and may result in detrimental impacts to biodiversity.

**Conclusion on significance of impacts**

The proposal is not likely to significantly impact threatened species, populations or ecological communities or their habitats, within the meaning of the TSC Act or FM Act and therefore a Species Impact Statement is not required.

The proposal is not likely to significantly impact threatened species, populations, ecological communities or migratory species, within the meaning of the EPBC Act.
### 6.3.4 Safeguards and management measures

Safeguards and management measures for potential impacts of the proposal on biodiversity are listed in Table 6-24.

**Table 6-24 Safeguards and management measures for biodiversity**

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard/additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity</td>
<td>A Flora and Fauna Management Plan (FFMP) will be prepared and implemented as part of the CEMP. The FFMP will include the following:</td>
<td>Contractor</td>
<td>Detailed design/prior to construction</td>
<td>Core standard safeguard B1</td>
</tr>
<tr>
<td></td>
<td>• Native vegetation removal will be minimised where reasonably practicable through detailed design.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Pre-clearing surveys will be carried out in accordance with <em>Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</em> (RTA, 2011).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Vegetation removal will be carried out in accordance with <em>Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</em> (RTA, 2011).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Habitat will be replaced or re-instated in accordance with <em>Guide 5: Re-use of woody debris and bushrock and Guide 8: Nest boxes of the Biodiversity</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Native vegetation will be re-established in accordance with <em>Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</em> (RTA, 2011).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Environmental safeguards</td>
<td>Responsibility</td>
<td>Timing</td>
<td>Standard/additional safeguard</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>--------------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>The unexpected species find procedure will be followed under Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).</td>
<td>Contractor</td>
<td>During construction / prior to construction</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td></td>
<td>Exclusion zones will be set up at the limit of clearing in accordance with Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011). The unexpected species find procedure is to be followed under Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011) if threatened flora species that have not been assessed in the biodiversity assessment, are identified in the proposal area. This procedure is important to identify any threatened species that may germinate in disturbed areas during and after construction. <em>Senna acclinis</em> and <em>Solanum celatum</em> may be present as seed in the soil seed bank and as these species are disturbance specialists, the work areas must be monitored to check whether these species germinate in areas of disturbed soil or topsoil stockpiles. An option that can be considered during the detailed design to reduce the impact to the <em>Syzygium paniculatum</em> plants</td>
<td>Contractor</td>
<td>During construction / prior to construction</td>
<td>Additional safeguard</td>
</tr>
</tbody>
</table>

Mt. Princes Motorway, Mount Ousley Interchange
Review of Environmental Factors
<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard/ additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>within the proposal area may be to implement a salvage program. Seed could be harvested from the plants to be removed, grown off site in a nursery, and reused in landscaping required for the proposal. This will retain the genetics of these plants in the habitat and will lead to an overall increase in the size of the local population.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Aquatic habitat will be protected in accordance with Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011) and Section 3.35.2 Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management Update 2013 (DPI (Fisheries NSW, 2013)).</td>
<td>Contractor</td>
<td>During construction</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Interruptions to water flows associated with groundwater dependent ecosystems will be minimised through detailed design where possible.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Changes to existing surface water flows will be minimised through detailed design where possible.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Fauna will be managed in accordance with Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011).</td>
<td>Contractor</td>
<td>During construction</td>
<td>Additional safeguard</td>
</tr>
</tbody>
</table>
### Biodiversity offsets

#### Quantification of impacts

The proposal is not likely to have a significant impact on any threatened biodiversity listed under the TSC Act or EPBC Act. Roads and Maritime would provide biodiversity offsets or where offsets are not reasonable or feasible, provide supplementary measures (activities such as funding research, funding conservation management activities as part of the OEH Saving our Species program, or funding vegetation restoration activities in partnership with local landcare groups) for impacts that exceed the offset thresholds identified in Appendix F.

The proposal would involve clearing of nationally listed threatened species habitat (i.e., habitat for *Syzygium paniculatum* and Grey-headed Flying-fox). As more than one hectare of habitat in moderate to good condition would be cleared, offsets or supplementary measures would be implemented for the proposal.
The PCTs that would be removed as part of the proposal are not listed as TECs under the TSC Act or EPBC Act. As such, the most appropriate form of offset is to use a ratio as outlined in Table 6-25. According to the Roads and Maritime offset ratios, a suitable offset for the proposal would be a 3:1 ratio for loss of threatened fauna species habitat (refer to Table 6-26). The most appropriate offset would be to focus on the loss of natural habitats rather than planted vegetation. The direct impact to habitat for threatened fauna species is likely to be 7.5 hectares. The direct impact to threatened flora species is loss of four individuals of *Syzygium paniculatum*. This would result in an offset requirement of 22.5 hectares of habitat for the threatened flora and fauna species identified as being impacted by the proposal. For *Syzygium paniculatum*, there is an offset requirement of 12 individuals.

### Table 6-25 Roads and Maritime offset ratios

<table>
<thead>
<tr>
<th>Impact type</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of threatened ecological community</td>
<td>Offset at a ratio of 4:1 where the offset sites are in moderate to good condition</td>
</tr>
<tr>
<td></td>
<td>Offset at a ratio of 8:1 where the offset sites are in poor condition including rehabilitation sites</td>
</tr>
<tr>
<td>Loss of threatened fauna species</td>
<td>Offset area of habitat lost at a ratio of 3:1</td>
</tr>
<tr>
<td>Loss of threatened flora species</td>
<td>Offset individuals lost at a ratio of 3:1</td>
</tr>
</tbody>
</table>

### Biodiversity offset strategy

The final offset requirement for the proposal would be determined during development of the offset package. During the detailed design phase the proposal footprint may change from that assessed here which would result in a different offset requirement for the proposal than what is presented in this report. A biodiversity offset strategy (BOS) would be prepared prior to works commencing and will have a basic goal of offsetting the residual impacts to threatened fauna habitat and threatened flora species at a 3:1 ratio (refer to Table 6-26).

### Table 6-26 Potential offset targets based on the 3:1 offset ratio

<table>
<thead>
<tr>
<th>Plant community type (PCT)</th>
<th>Predicted impact (ha)</th>
<th>Potential offset required (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (694)</td>
<td>6.69</td>
<td>20.07</td>
</tr>
<tr>
<td>Sydney Blue Gum x Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion (1245)</td>
<td>0.89</td>
<td>2.67</td>
</tr>
<tr>
<td><em>Syzygium paniculatum</em></td>
<td>4 plants</td>
<td>12 plants</td>
</tr>
</tbody>
</table>
6.4 Landscape character and visual impacts

The potential impacts of the proposal on landscape character and visual impacts are assessed in the Landscape Character and Visual Impact Assessment (Spackman Mossop + Michaels, 2017), which is provided in Appendix G. A summary of the assessment is presented in this section.

6.4.1 Methodology

The method used to undertake this study follows the Roads and Maritime Guideline for Landscape Character and Visual Impact Assessment EIA-N04 (Roads and Maritime, 2013). It involved the following:

- Undertaking site visits and field investigations, reviewing relevant literature, analysing aerial photographs and topographic maps to understand the proposal area
- Reviewing the proposed concept design and supporting material
- Defining landscape character through a contextual analysis
- Identifying and describing landscape character zones and evaluating the likely impact on them
- Identifying the visual catchment of the proposed works
- Selecting viewpoints within the visual catchment representing a range of different land uses
- Evaluating the visual impact of the proposed upgrade by comparing the sensitivity of viewpoints and the magnitude of the proposal’s impact on them
- Identifying urban design and landscape opportunities and methods of mitigating adverse visual impacts for consideration in the detail design phase of the proposal.

Landscape character impact assessment

Contextual analysis involved identification of a number of Landscape Character Zones (LCZ) based generally on the proposal area’s surrounding land use, vegetation and topography. By dividing the proposal area into character zones, the assessment process is easier to undertake and to understand.

Within each LCZ the proposed upgrade is assessed as follows:

- The impact of the proposal on each LCZ based on the sensitivity of the zone, and the magnitude of the proposal’s impact in that zone
- Sensitivity refers to how sensitive the existing character of the setting is to the proposed change, or its inherent capacity to absorb change. For example, a pristine natural environment will be more sensitive to change than an industrial area
- Magnitude refers to the physical size and scale of the project. For example, a large interchange will have a greater magnitude than a localised road widening, and therefore have a greater impact on the landscape character
- The combination of sensitivity and magnitude provides the rating of the landscape character impact for each LCZ (refer to Figure 6-9)
Visual impact assessment

The extent of area from where the proposed works would be able to be seen is referred to as the visual catchment. It is largely defined by topography and landform, but is also influenced by a viewer’s direction of travel and how this affects the visibility of the proposal. Factors such as built structures or vegetation need to be considered where they limit or obscure views. However, vegetation, while often blocking potential views, is not considered as a permanent obstruction as it can be removed or destroyed.

Within the LCZs, a number of viewpoints have been identified for key locations and directions of view. The impact of the proposal has been assessed by considering both the sensitivity of the view and the magnitude of the proposed works within that view. Sensitivity refers to the quality of the view and how it would be affected by the proposal. Magnitude refers to the physical character, size and scale of the change and its proximity relative to the viewer. The combination of sensitivity and magnitude provides the rating of the visual impact.

Qualitative assessment

For the purposes of this environmental assessment, existing landscape character and the likely magnitude and sensitivity of viewers have been described in a qualitative manner.

This has been based on the authors’ experience in the field of landscape character and visual assessment. While these methods aim to provide a consistent and unbiased approach to the landscape character and visual impact assessment, the highly individualistic perception of landscape character and scale of proposed works still often leads to differing opinions with regards to the likely impact of a proposal.

Urban design objectives

The urban design objectives for the proposal are described below:
**Objective 1**

To provide a highly legible and easy to navigate interchange with clear visual cues in relation to direction and destination within the interchange.

*Design principles – objective 1*

- Identify the visual hierarchy of structural elements and ensure that the design of structures supports legibility at the interchange.
- Strengthen the visual cues to identify Mount Ousley Road as the northern entry to Wollongong CBD through suitable urban design treatments to retaining walls, noise walls, road safety barriers and pedestrian bridge design.
- Landscape planting to strengthen the road hierarchy and legibility, thereby providing visual cues for the M1 Princes Motorway alignment, Mount Ousley Road and entry to the University of Wollongong.

**Objective 2**

To provide a unique experience at the entry to North Wollongong and the CBD from the M1 Princes Motorway.

*Design principles:*

- Establish a clear identity for the interchange through the integrated design of the various structural elements and landscape.
- Design of the interchange to relate to, and be inspired by, the culture and history of Wollongong.
- Promote the experience of place and maximise views east towards the Pacific Ocean and peripheral views to surrounding areas, which are naturally forested.
- Landscape planting to strengthen the road hierarchy and legibility thereby providing visual cues for the M1 Princes Motorway alignment, Mount Ousley Road and entry to the University of Wollongong.
- Promote a sense of journey and context for motorists.
- Provide views out to the distant mountains and Pacific Ocean for pedestrians and cyclists where possible from shared path and bridges.

**Objective 3**

To ensure that connectivity is enhanced for pedestrians and cyclist between Mount Ousley, North Wollongong and Keiraville residential areas, and the key land uses of the University of Wollongong and the TAFE NSW Wollongong campus.

*Design principles:*

- Retain and enhance the accessibility and connectivity between surrounding communities for all users including pedestrians, cyclists and motorists.
- Ensure enhanced connectivity to the local road and cycle network from new shared path and footpaths.
- Urban design to incorporate CPTED (Crime Prevention Through Environmental Design) principles in the design of structures and planting near paths.
- Maximise the visibility of pedestrian and shared paths from adjoining residential areas and from the road to provide passive surveillance.
• Ensure the improved connections are safe and comfortable for people to use, and respond to natural desire lines
• Optimise vehicle and pedestrian connectivity and legibility to the University of Wollongong and the TAFE NSW Wollongong campus.

**Objective 4**
To ensure that the various structural and functional elements – retaining walls, noise walls, bridges, road safety barriers, gantries, fences and arrester beds – are integrated in design and contribute positively to the overall identity of the interchange.

*Design principles:*
• The design of the various structural elements of the interchange should support the overall design intent for the upgrade
• The design of various structures adjacent to each other should be considered in relation to each other and present an integrated design outcome
• Design of structures to assist in ensuring the road corridor design is self-explanatory, legible and easy to navigate.

**Objective 5**
To ensure that visual impacts on surrounding residents, as well as motorists, are considered and mitigated as far as possible in the design of structures and planting.

*Design principles:*
• Mitigate visual impacts on the public realm through the considered design of structural elements and the provision of new planting and retention of key established vegetation groupings, where possible
• Maximise space for planting adjacent to new noise walls to screen and soften their appearance and reinstate/reinforce a planted interface towards residential properties
• Rationalise the height and extent of retaining walls and noise walls to reduce the impact on the residential and institutional setting
• Views to the road are to be screened as far as possible from immediate residential areas
• Privacy to residential properties is to be considered in the design of shared paths.

**Objective 6**
To ensure that the character of the M1 Princes Motorway Mount Ousley interchange sits well within the dramatic slopes and natural remnant forests of the local area.

*Design principles:*
• Enhance and reinstate native vegetation – to integrate the proposal with the existing setting, enhance the sense of place, restore ecological values and assist in biodiversity protection and recovery
• The design of bridges, noise walls and retaining walls is to maximise and encourage views to the surrounding environment and broader distant views
• Reinstate indigenous planting to disturbed areas to reinforce the sense of place and natural forested setting
• Design major earthworks and embankments to integrate with the existing natural topography of the setting where feasible.
6.4.2 Existing environment

The M1 Princes Motorway is a major arterial road that connects Sydney to the Wollongong CBD (via Mount Ousley Road and the Princes Highway) and broader Illawarra region. The Proposal area is located around the Mount Ousley Road intersection with the M1 Princes Motorway within the outer suburbs of Wollongong, Mount Ousley and Keiraville. The residential suburbs follow the lower slopes and foothills of the Illawarra Escarpment close to Mount Keira.

The descending landform provides dramatic views over the lower suburbs of Wollongong to the Pacific Ocean. The topography of the Illawarra Escarpment also provides a scenic backdrop when travelling or facing west. Due to its proximity to the Illawarra Escarpment, extensive areas of native vegetation also surround the proposal area. These contribute to an attractive and scenic driving experience through the proposal area as well as accessing the local residential areas and key destinations.

Close to the proposal area are popular local destinations including the University of Wollongong, TAFE NSW Wollongong and Wollongong Botanical Gardens. The M1 Princes Motorway currently forms a physical barrier between the University of Wollongong, TAFE NSW Wollongong Campus and the residential areas of Mount Ousley and Mount Pleasant. Thick vegetation provides a visual buffer between the M1 Princes Motorway and buildings associated with TAFE NSW Wollongong Campus, University of Wollongong and residences in Mount Ousley.

Landscape character zones

The landform and vegetation, views and vistas, settlement pattern and built structures within and adjoining the proposal area combine to define the landscape character of the proposal area. The landscape character defines a set of visual values associated with areas that shape the experience of both motorists and viewers in surrounding areas. As can be expected, there are a number of different Landscape Character Zones (LCZs) within the study area (refer to Figure 6-10).

![Figure 6-10 Landscape Character Zones within the study area](image-url)
**Zone 1 – Mount Ousley – North Residential**

Situated north of the interchange, Mount Ousley is a residential suburb located at the foothills of Mount Keira. The topography is undulating and creates an intimate character and from the higher grounds towards the west, panoramic and district views are attainable towards the CBD and the Tasman Sea. Mount Keira provides an elevated, vegetated backdrop to the west of the suburb. A densely vegetated natural drainage line originating in Mount Keira travels through the suburb. Vegetation is mostly limited to exotic trees and shrubs within front setbacks of private properties. A commercial strip is concentrated along the Princes Highway to the east of the residential area.

**Zone 2 – Vegetation – North of M1 Motorway**

This zone is the area lying central to the proposal area and north of the interchange where the M1 Princess Motorway and Mount Ousley Road converge. There is a mix of both young and dense remnant forest to the north and east of the Motorway alignment that contribute to the forest character and amenity of surrounding zones. A commuter carpark lies on the northern verge of the Mount Ousley Road. The topography generally rises from south to north.

**Zone 3 – Keiraville Residential**

This zone is the small residential suburb of Keiraville at the foot of Mount Ousley, situated in a steeply undulating gully between the M1 Princess Motorway and the University of Wollongong. Mount Keira provides the backdrop to this well established residential area. The suburb overlooks the University grounds, while some properties enjoy district views toward the CBD and the Tasman Sea due to a more elevated position. Vegetation is mostly limited to mature exotic trees and shrubs within front setbacks of private properties and a dense band of vegetation to the rear of the properties adjacent to the Motorway alignment.

**Zone 4 – Vegetation – South of M1 Motorway**

This zone is the area lying central to the proposal area and south of the interchange where the M1 Motorway and Mount Ousley Road converge. This zone sits east of LCZ 3 and directly north of the University of Wollongong and generally slopes away from the Motorway alignment in a north-west to south east direction. This zone is densely vegetated and includes a creekline running west to east and crossing the Motorway and is the general low point west of the Motorway corridor. The vegetation provides a visual screen between the M1 Princess Motorway and the University of Wollongong and contributes to the character and amenity of the surrounding character zones.

**Zone 5 – Mount Ousley - South Residential**

This character zone is the residential suburb of Mount Ousley, located south of Mount Ousley Road. The topography falls from west to east. Vegetation is mostly limited to exotic trees and shrubs within front setbacks of private properties. A small commercial strip is located along the eastern edge of the suburb along the Princes Highway.

**Zone 6 – Institutional - University of Wollongong**

This zone is the campus of the University of Wollongong, lying east of Mount Keira and the state conservation area and is bounded by the M1 Motorway to the north and east. The campus consists of a variety of multi-storey buildings in a landscape setting within a simple ring road design. There are sport fields, open grassed areas, generous landscaped building setbacks and established streetscapes. Vegetation is predominantly native tree plantings that provide established screening to surface and multi-storey carparks and campus buildings. The topography is generally flat with a gentle east-west slope. A densely vegetated creekline draining from Mount Keira crosses the south-west corner of the campus at its low point and feeds into ponds throughout the campus.
Zone 7 – Institutional - TAFE NSW Wollongong campus

This character zone is the Wollongong campus of TAFE NSW Wollongong campus, located east of the M1 Motorway corridor and the University of Wollongong. The topography of this zone is generally flat. The campus consists of numerous multi-storey buildings arranged in a grid like layout with central courtyards, green spaces and paved pedestrian zones between buildings. Large car parking areas sit along the entire length of the boundaries eastern and western edges of the site. Established vegetation consists predominantly of native tree species, while Mount Keira provides a densely vegetated backdrop to the west.

6.4.3 Potential impacts

Zone 1 – Mount Ousley – North Residential

The proposal would introduce an increased area of pavement, retaining walls and noise walls, as well as impact upon the screening vegetation to the south of Dumfries Avenue. However, due to the elevation of the properties in relation to the road, and the retaining walls facing away from properties, LCZ 1 is not visually impacted by these elements. The noise walls on either side of the M1 Princes Motorway, together with the removal of the existing screening vegetation introduces a structure to the landscape and view, particularly impacting dwellings facing Dumfries Avenue. Noise walls are proposed to comprise partially of transparent panels to minimise the visual impact. Vegetation screening in front of the walls would be provided, however would take time to establish and achieve adequate height to screen the noise wall.

The removal of the mature vegetation in LCZ 2 would also impact upon the visual amenity of residents along Dumfries Avenue. It is assumed that the removal of this vegetation may open up views to the Pacific Ocean and Wollongong CBD. These areas would undergo revegetation, however larger trees and screen planting would take time to mature and re-establish the existing forested character of the area (Photo 6-1). The magnitude of the proposed changes is considered to be moderate in the first five years, reducing substantially over time as the revegetation and screen planting mature.

The combination of the sensitivity of the character zone and the magnitude of the proposed change provide an integrated landscape character impact of high-moderate.

Photo 6-1 Proposal showing mature planting at approximately 10 years after road opening looking south east from the corner of Dumfries Avenue and Bellbrae Avenue (subject to further design and consultation)
Zone 2 – Vegetation – North of M1 Princes Motorway

The proposal would introduce considerable changes to this character zone, notably, vegetation clearing required to facilitate the new works for the road widening, heavy vehicle safety ramp, heavy vehicle bypass lane and heavy vehicle off ramp.

The proposal would transform the landscape character by the removal of large areas of vegetation and modification of the landform. It would change the spatial quality of the area and impact on views for both motorists on the M1 upgrade and also local roads including Dumfries Avenue as well as residents along Dumfries Avenue. The changes to this landscape character therefore result in the magnitude being assessed as high. It should be noted that the rating would reduce over time when the proposed trees and shrubs mature. The combination of the sensitivity of the character zone and the magnitude of the proposed change provide an integrated landscape character impact of high.

Zone 3 – Keiraville Residential

The proposal introduces a number of changes associated with this character zone including road widening for the northbound on ramp, and the proposed University Access Road. Other changes within the character zone could include:

- A retaining wall extending along the southern side of the northbound on ramp
- A noise wall positioned on top of retaining wall
- A concrete road barrier performing as low retaining wall.

The proposal would introduce an increase of pavement and removal of roadside vegetation adjacent to the M1 Princes Motorway along Falder Place. A noise wall along Falder Place is proposed to partially comprise clear transparent panels to reduce visual intrusion and overshadowing of properties along Falder Place. New planting of screening shrubs and trees are provided to mitigate the impact of new retaining and nose walls. The magnitude of the proposed changes is therefore considered to be moderate in the first five years reducing over time as the tree planting matures. The combination of the sensitivity of the character zone and the magnitude of the proposed change provide an integrated landscape character impact of high-moderate.

Zone 4 – Vegetation – South of M1 Princes Motorway

The proposed upgrade to the M1 Motorway would involve clearing of vegetation in this landscape character zone for the proposed works including:

- A roundabout near the University Access Road
- Retaining wall extending along the southern side of the northbound on ramp
- Retaining wall on the southern side of Mount Ousley Road. This wall would continue and return as retaining wall as the western abutment wall beneath the bridge over M1 Princes Motorway
- Two spill containment basins, one located west of University Access Road, and one located south of Mount Ousley Road and retaining wall
- New landscaped fill embankments along the western and eastern sides of the University Access Road
- New shared path proposed adjacent to Mount Ousley Road and the University Access Road
- Commuter car park.
The removal of vegetation within this character zone would change the spatial qualities of this area and would reduce this natural visual barrier between the motorway and areas beyond and compromise the character of this vegetated roadside environment substantially. The magnitude of the proposed changes is considered to be high in the first five to 10 years reducing over time as the trees mature. The combination of the sensitivity of the character zone and the magnitude of the proposed change provide an integrated landscape character impact of high.

**Zone 5 – Mount Ousley - South Residential**

The proposal would introduce a number of changes associated with this character zone including road widening of Mount Ousley Road and removal of vegetation between Mount Ousley Road and the southbound on ramp and between the southbound on ramp and the backs of properties along Gowan Brae Avenue.

Other changes within close proximity to the character zone include.

- A retaining wall along the southern side and facing Mount Ousley Road, beginning at Gowan Brae Avenue and continuing to just past the pedestrian bridge over Mount Ousley Road
- A noise wall extends along the top of the retaining wall between Gowan Brae Avenue and the pedestrian bridge over Mount Ousley Road
- A noise wall is proposed on the southern side of Mount Ousley Road
- Pedestrian bridge over Mount Ousley Road.
- Vegetation removal for the regrading of the proposed shared path connecting the pedestrian bridge over Mount Ousley Road; east towards Old Mount Ousley Road; west towards the pedestrian crossing at the southbound on ramp and the University of Wollongong; and south to TAFE NSW Wollongong campus
- Screen planting along the back of noise walls
- Revegetation of cleared areas between Mount Ousley Road and the southbound on ramp and between the southbound on ramp and the backs of properties along Gowan Brae Avenue.

The removal of vegetation along Mount Ousley Road, near the eastern roundabout and along Old Mount Ousley Road will impact on the character of this area. The magnitude is considered to be moderate in the first five to ten years reducing over time as the tree plantings in LCZ 2 matures. The combination of the sensitivity of the character zone and the magnitude of the proposed change provide an integrated landscape character impact of moderate.

**Zone 6 – Institutional - University of Wollongong**

The proposal includes the following changes:

- University Access Road, provides a new road and shared path connection to the University of Wollongong with fill embankments on either side of the road
- Widening of the M1 Princes Motorway and clearing of roadside vegetation along the eastern boundary of the University of Wollongong
- Revegetation of native species along the eastern boundary of the character zone adjacent to the M1 Princes Motorway.

The following elements would occur within close proximity to this character zone:

- Retaining walls on the southern side of Mount Ousley Road
• A concrete road barrier performing as a low retaining wall
• Two spill containment basins, one located west of University Access Road, and one located south of Mount Ousley Road and retaining wall
• Realignment of Mount Ousley Road and new roundabout at junction with University Access Road and northbound on ramp
• Widening of M1 Princes Motorway and clearing of roadside vegetation along the eastern boundary of the University of Wollongong
• Widening of the M1 Princes Motorway east of the University of Wollongong and removal or roadside vegetation
• Revegetation of Escarpment Moist Blue Gum Forest and the Escarpment Blackbutt Forest associated with LCZ4, north of this character zone
• Gantry spanning across the motorway to the east.

The proposal would impact upon existing vegetation along the eastern boundary of the University and remove considerable roadside vegetation within the adjacent LCZ4 and to the western boundary of this character zone. Removal of vegetation would substantially reduce the visual buffer between the M1 Princes Motorway and associated road infrastructure in the short to medium term until the new vegetation matures. The changes to this landscape character results in a magnitude being assessed as moderate. The combination of the sensitivity of the character zone and the magnitude of the proposed change provide an integrated landscape character impact of moderate-low in the first five to ten years reducing over time as the trees and understory planting matures (Photo 6-2). The combination of the sensitivity of the character zone and the magnitude of the proposed change is assessed as moderate overall impact.

Photo 6-2 Proposal showing mature planting at approximately 10 years after road opening looking north east from the University of Wollongong (subject to further design and consultation)
Zone 7 – Institutional - TAFE NSW Wollongong campus

The proposal includes the following changes closely associated with the character zone:

- Widening of the M1 Princes Motorway providing for the southbound off ramp including fill embankments
- Adjustment to the existing shared path adjacent to the eastern side of the M1 Princes Motorway
- Removal of roadside vegetation adjacent to motorway associated with the road widening
- Pedestrian bridge extension over M1 Princes Motorway near Northfields Avenue and new shared path access ramp on the eastern side of the bridge
- Revegetation of native trees and understory planting between TAFE NSW Wollongong campus and the M1 Princes Motorway.

The proposal would remove some roadside vegetation between the M1 Princess Motorway and TAFE NSW Wollongong campus. The changes to this landscape character results in a magnitude being assessed as low. The combination of the sensitivity of the character zone and the magnitude of the proposed change provide an integrated landscape character impact of low.

### 6.4.4 Safeguards and management measures

Safeguards and management measures for potential impacts of the proposal on landscape character and visual amenity are listed in Table 6-27.

**Table 6-27 Safeguards and management measures for landscape character and visual amenity**

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
</table>
| Landscape character and visual impact | An Urban Design Plan (UDP) will be prepared to support the final detailed project design and implemented as part of the CEMP. The UDP will present an integrated urban design for the project, providing practical detail on the application of design principles and objectives identified in the environmental assessment. The Plan will include design treatments for:  
  - Location and identification of existing vegetation and proposed landscaped areas, including species to be used  
  - Built elements including retaining walls, bridges and noise walls | Contactor       | Detailed design / pre-construction | Core standard safeguard UD1          |
<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
</table>
|        | • Pedestrian and cyclist elements including footpath location, paving types and pedestrian crossings  
|        | • Fixtures such as seating, lighting, fencing and signs  
|        | • Details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage  
|        | • Procedures for monitoring and maintaining landscaped or rehabilitated areas. | | | |
| Landscape character and visual impact | The UDP will be prepared in accordance with relevant guidelines, including:  
| | • Beyond the Pavement urban design policy, process and principles (Roads and Maritime, 2014)  
| | • Landscape Guideline (RTA, 2008)  
| | • Bridge Aesthetics (Roads and Maritime 2012)  
<p>| | • Noise Wall Design Guidelines (RTA, 2006) | Contractor | Detailed design | Additional safeguard |
| Landscape character and visual impact | The UDP is to provide details on tree planting with an emphasis on reinstating vegetation character, framing views and providing amenity in public open space. | Contractor | Detailed design | Additional safeguard |
| Landscape character and visual impact | Bridge design is to include throw screens, transparent fences and safety barriers. Opportunities for views from the bridge along the M1 Princes Motorway and toward the Illawarra Escarpment will be maximised. | Contractor | Detailed design | Additional safeguard |</p>
<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscape character and visual impact</td>
<td>Detailed design solutions to minimise the visual impacts of noise walls will be developed in accordance with the RTA Noise wall design guideline.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>Landscape character and visual impact</td>
<td>A consistent design for retaining walls, including surface treatment, colour and detailing will be developed.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>Landscape character and visual impact</td>
<td>Project work sites, including construction areas and supporting facilities (such as storage compounds and offices) will be managed to minimise visual impacts, including appropriate fencing or screening (eg use of shade cloth), storage of equipment, parking, stockpile screening and arrangements for the storage and removal of rubbish and waste materials.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>Landscape character and visual impact</td>
<td>Compound and ancillary facilities will be decommissioned and the sites rehabilitated to their existing condition or as otherwise agreed with the landowner on completion of works.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>Landscape character and visual impact</td>
<td>Temporary lighting will be sited and designed to avoid light spill into residential properties and identified sensitive receptors.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>Landscape character and visual impact</td>
<td>Lighting will be designed to minimise light spill into residential properties and sensitive receptors.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>Landscape character and visual impact</td>
<td>• All reasonable measures shall be taken to minimise the loss of vegetation at and surrounding</td>
<td>Contractor</td>
<td>Construction</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>Impact</td>
<td>Environmental safeguards</td>
<td>Responsibility</td>
<td>Timing</td>
<td>Standard / additional safeguard</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------</td>
<td>--------</td>
<td>--------------------------------</td>
</tr>
</tbody>
</table>
| impact | the interchange, including rationalisation of the requirements for maintenance access  
- At locations where higher visual impacts have been identified, the specification and planting of more mature sized shrubs and trees shall be adopted to help reduce the visual impact at opening of the road. Further, early planting shall be considered in relation to construction staging to achieve a greater maturity of plants at opening  
- Management of the natural environment will include rehabilitation of any affected areas of important native habitat and creek embankments; use of endemic vegetation in these and other areas where habitat values are important; during the detailed design phase identify and retain as many mature trees as possible; rehabilitate and replace any lost public uses. |  |  |  |
| Landscape character and visual impact | The number and location of signage and gantries shall be rationalised to avoid visual clutter and ensure that strategic views are not blocked.  
The location of light posts shall be rationalised to ensure integration with other structures such as retaining walls, noise walls, bridges and pedestrian lighting. | Contractor | Detailed design | Additional safeguard |
<p>| Landscape character | The design development of spill containment basins shall aim to | Contractor | Detailed design | Additional safeguard |</p>
<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td>and visual impact</td>
<td>achieve a naturalised form and detailing.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.5 Hydrology and flooding

The potential impacts of the proposal on hydrology and flooding are assessed in the Hydrology and Flooding Report (Jacobs, 2017), which is provided in Appendix H. A summary of the assessment is presented in this section.

6.5.1 Methodology

The methodology for the hydrology and flooding assessment involved:

- Reviewing background information relevant to the proposal, including:
  - Previous flood investigations including Fairy and Cabbage Tree Creeks Flood Study (BMT WBM, 2009), Fairy and Cabbage Tree Creeks Floodplain Risk Management Study and Plan (Bewsher, 2010) and Memorial Drive Off Ramp Upgrade, North Wollongong – Review of Environmental Factors (Cardno, 2016).
  - Flood modelling (including hydrological and hydraulic modelling). These included the Fairy and Cabbage Tree Creeks Flood Study (BMT WBM, 2009) Watershed Bounded Network Model (WBNM) hydrologic model and TUFLOW linked one dimensional-two dimensional (1D-2D) hydraulic model; and Memorial Drive Off Ramp Upgrade, North Wollongong, Review of Environmental Factors (Cardno, 2016) TUFLOW hydraulic model. This model was based on the flood study model, with some additional updates and was used and updated for the current assessment.
  - Survey data, including topographical survey within the proposal boundary of the road, road features and drainage as well as aerial laser survey (ALS) data.
  - GIS data including aerial photography, cadastre and Council’s drainage layer.
  - Utilisation of the available hydrological and hydraulic models to assess the existing flood conditions. This involved updating the existing models with the latest available information including Wollongong City Council’s latest blockage policy (2016) and refinement of the hydraulic model for the study area to better assess the flood behaviour. Wollongong City Council (Council) completed a review of their Conduit Blockage Policy in 2016 to ensure that the policy meets the current and future requirements of Council and the community in a fair and reasonable way. Based on the outcomes of the policy review, data compilation and probabilistic modelling analysis, it was recommended that Council’s Conduit Blockage Policy be revised. The revised blockage policy is set out in the Review of Conduit Blockage Policy Summary Report (WMAwater, 2016).
  - Utilisation of the hydrological and hydraulic models to assess the flood conditions with the proposal. This involved updating the models with the proposed design.
  - Identifying potential impacts on flood behaviour as a result of the proposal and identifying additional potential mitigation measures.

Wollongong City Council Blockage Policy

Wollongong City Council (Council) completed a review of their Conduit Blockage Policy in 2016 to ensure that the policy meets the current and future requirements of Council and the community in a fair and reasonable way. Based on the outcomes of the policy review, data compilation and probabilistic modelling analysis, it was recommended that Council’s Conduit Blockage Policy be revised. The revised blockage policy is set out in the Review of Conduit Blockage Policy Summary Report (WMAwater, 2016).
The revised policy includes the application of two different blockage factors, “Design” blockage factors and “Risk Management” blockage factors. “Design” blockage factors are to be applied for infrastructure design, assessing changes to flood behaviour resulting from proposed development, assessing the benefit of proposed flood mitigation works, estimating flood damages and assessing flood risk for insurance purposes. “Risk Management” blockage factors are for setting Flood Planning Levels, determining the Flood Planning Area and delineating Flood Risk Precincts. “Design” blockage factors are applicable to the Mount Ousley Interchange and should be used for the estimation of design flood levels, velocities and depths for flood studies and the infrastructure design. Details of the “Design” blockage factors are shown in Table 6-28.

Table 6-28 Design blockage factors

<table>
<thead>
<tr>
<th>Design AEP</th>
<th>Bridge / Culvert Classification</th>
<th>Debris Blockage of Overtopping Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class 1</td>
<td>Class 2</td>
</tr>
<tr>
<td>20% AEP or more frequent (e.g. 50% AEP, 20% AEP)</td>
<td>35%</td>
<td>25%</td>
</tr>
<tr>
<td>Rather than 20% AEP and more frequent than 2% AEP (e.g. 10% AEP, 5% AEP)</td>
<td>50%</td>
<td>40%</td>
</tr>
<tr>
<td>2% AEP or greater (e.g. 2% AEP, 1% AEP, PMF)</td>
<td>70%</td>
<td>50%</td>
</tr>
</tbody>
</table>


Culvert and bridge classifications are defined as follows:

- **Class 1.** Pipes 1.2 m internal diameter or smaller. Box culverts or bridges with a diagonal opening less than 1.5 m, and a width or height less than 0.9 m.
- **Class 2.** Pipes greater than 1.2 m internal diameter. Box culverts or bridges with a diagonal opening of more than or equal to 1.5 m, less than 3 m and minimum dimension of 0.9 m for both width and height.
- **Class 3.** Box culverts or bridges with a diagonal opening of more than or equal to 3 m, less than 6 m, and a minimum dimension of 1.2 m for both width and height.
- **Class 4.** Box culverts or bridges with a diagonal opening greater than or equal to 6 m, and a minimum dimension of 2.5 m for both width and height.

For “Design” applications, flooding is to be assessed using the following two scenarios:

- No blockage; and
- “Design” blockage factors.
6.5.2 Existing environment

Proposal area and local catchments

As illustrated in Figure 6-11, the catchment drains east, down the steep slopes of Mount Keira to the proposal area. The M1 Princes Motorway runs generally north/south, almost parallel to the escarpment at the start of its descent, before crossing a tributary of Cabbage Tree Creek and heading south east.

Figure 6-11 shows the local catchments and indicates that the proposal crosses two unnamed creeks (both ephemeral, conveying water in periods of high rainfall only), south of the proposed interchange. The northern creek runs west to east along the northern edge of the University of Wollongong sporting facilities and is referred to as the Dallas Street Branch in the Fairy and Cabbage Tree Creeks Flood Study (BMT WBM, 2009). The creek is an incised channel, with a steep 15 m high batter on its northern edge up to the M1 Princes Motorway and a 5 m high batter on the southern side to the University of Wollongong sporting facilities. It currently crosses the M1 Princes Motorway via 3 x 1350 mm diameter culverts. The catchment draining to this culvert is approximately 50 ha. The creek discharges into Cabbage Tree Creek approximately 1.4 km downstream of this crossing. There is also another minor culvert crossing for this catchment just to the east of the University of Wollongong sporting fields. The culvert is a 2 x 1350 mm (W) x 600 mm (H) box culvert.

The second crossing is just south of Northfields Avenue at the southern end of the proposal boundary. This is referred to as the University branch in the flood study. The open channel is conveyed into 4 x 1400 mm diameter pipes between the University of Wollongong bus bays and the multi-deck car park. This flows for approximately 380 m before being discharged into an open channel downstream of Irvine Street. It is then conveyed under the M1 Princes Motorway by 4 x 1800 mm (W) x 900 mm (H) box culverts. The catchment draining to this culvert is approximately 85 ha in area. The waterway discharges into Fairy Creek.

In addition to these major drainage catchments, there is a smaller catchment between the M1 Princes Motorway / Mount Ousley Road and Dumfries Avenue that drains south into the proposal area. The M1 Princes Motorway also captures water from road runoff and water in excess of the capacity of cross drainage culverts.
Figure 6-11 Waterways
Existing flood model

The flood model developed for the “Fairy and Cabbage Tree Creeks Flood Study” (BMT WBM, 2009) was updated by Cardno in 2016 for the proposed Memorial Drive Off Ramp Upgrade. This updated existing model was then used for the modelling and analysis contained in this assessment.

The hydraulic model covers an area of 561 hectares and a separate model domain was developed for Wellington Drive covering an area of 7 hectares. The 2D domain was developed using LiDAR data from several sources. The model incorporates 1D structures such as open channels, culverts and bridges to allow the exchange of water through a 2D embankment. Upstream of the 2D domain, there are 1D channels defined to route flows down the Illawarra escarpment into the 2D domain. This includes the representation of the M1 Princes Motorway. A total of 21 cross drainage culverts along the M1 Princes Motorway were represented in the model as individual flow paths. In conjunction with the culverts, the overflow to the M1 Princes Motorway was represented by weirs at the level of the western road crest at the culvert location. The overflow is then conveyed by steep channels representing the flow along the M1 Princes Motorway. Cross sections for the road were also included in the representation.

The TUFLOW model was calibrated to flood events of August 1998 and October 1999. Considering the nature of the variables, such as rainfall distribution and blockages of conduits, it was concluded that the models (hydrological and hydraulic) accurately represented the flooding characteristics of the catchment sufficient for defining flooding behaviour with design storm events.

The calibrated flood model was run for the 20%, 5%, 2% and 1% annual exceedance probability (AEP) events plus the probable maximum flood (PMF) for the flood study. A number of blockage scenarios were also run, using Council’s Conduit Blockage Policy (2002). An envelope approach was used to define the peak flood levels across the catchments.

Updated flood model

The existing flood model was reviewed and updated to more accurately represent features in the vicinity of the proposal. The updated model was then used as the baseline case, representing the existing conditions, for the flood impact assessment. At each stage of updating, the flood behaviour was checked against the behaviour simulated by the flood study model to ensure consistency. The purpose of updating the model was to:

- Improve the accuracy of the topographic survey information and utilise a smaller grid, for higher resolution
- improve the definition of terrain, with more detailed catchments and sub-catchments
- include existing transverse drainage structures in the model
- include provisions in the model for Wollongong City Council’s Conduit Blockage Policy.

Council’s Conduit Blockage Policy presents revised blockage factors to be adopted across the Wollongong LGA, and was applied to the structures within the flood model. Since the proposal area is located at the upper end of the catchment, two scenarios were used to define the flood behaviour in the proposal area: an unblocked scenario and a blocked scenario where all culverts across the catchment were blocked to the degree outlined within Council’s Conduit Blockage Policy depending on the size of the culvert (e.g. by flood debris). The blockage of structures includes those along the M1 Princes Motorway down the Illawarra Escarpment.
Existing flood behaviour

The baseline case hydraulic model was run for the 20%, 10%, 5%, 2% and 1% AEP design events plus the PMF event for the 2 hour storm duration, which produced the peak flood levels in the vicinity of the proposal (BMT WBM, 2009). For each event, two scenarios were run – one with no blockage of hydraulic structures and one with blockage of hydraulic structures according to Council’s updated blockage policy (2016). The peak water levels, peak depths and peak velocities were defined for both the unblocked and blocked scenarios.

Existing flood behaviour for unblocked scenario

Flooding along the Dallas Street Branch is a result of local catchment runoff and flows running down the M1 Princes Motorway. Overland flow along Dallas Street is present in all events downstream of the intersection with Robsons Road and Binda Street. Flood water is conveyed along Dallas Street before breaking out into an open grassed area before the intersection with Ashcroft Place. A twin 800 mm diameter culvert conveying water from the western end of Dallas Street also discharges at this location. Water flows into a channel located between properties on Ashcroft Place and the University of Wollongong Building 31. This channel flows east before being conveyed into a single 900 mm diameter culvert near the University of Wollongong northern car park. The culvert discharges approximately 100 m downstream into another channel. The upstream channel contains flood water up to and including the 1% AEP event, with flood depth reaching almost 4 m. In the PMF event, the high ground in between these two channels is overtopped and water flows into University of Wollongong northern car park and continues east onto the hockey field. From the second channel, there is another culvert (single 900 mm diameter pipe) that carries flow into the larger incised channel located between the University of Wollongong sporting facilities and the M1 Princes Motorway. Another channel joins at this location which carries flow past 17 Falder Place. Once these two channels join, water flows east along the incised channel, being contained by the M1 Princes Motorway embankment to the north and the University of Wollongong sporting fields to the south. Water is generally contained within the channel up to and including the 1% AEP event.

In the 20% to 1% AEP events, overland flows enter the channel laterally from the M1 Princes Motorway. This flow originates from the transverse drainage catchment runoff exceeding the capacity of the structures along the M1 Princes Motorway as it descends the Illawarra Escarpment. It has been assumed that the concrete F-type median barrier would contain these overflows to the northbound carriageway and allow them to continue all the way down to the proposal area. Noise barriers located along the M1 Princes Motorway where the road aligns in an east-west direction prevents water from flowing down the hill into the urban area around Dallas Street. Floodwater can reach over 1 m in the gutter of the northbound carriageway in the 1% AEP event, with velocities of up to 5 m/sec. On the southern side of the M1 Princes Motorway, the noise barrier containing the flow stops near the intersection with Mount Ousley Road. It is here that overland flow starts to cascade down the slope and into the incised creek channel. Cross drainage structures running north to south also contribute to this flow. The overflow occurs over a distance of approximately 270 m and flows are generally shallow (less than 0.3 m deep) in events up to the 1% AEP.

In the PMF event, overland flows enter the channel laterally from both the M1 Princes Motorway and the University of Wollongong. The overland flow breaking out of the channel through the University of Wollongong northern car park and into the hockey field can then flow north, back to the creek or south east to the soccer field. From there, overland flow continues through the University of Wollongong, along the access road and through the sporting fields. The flow is generally shallow (less than 0.3 m) but can be up to approximately 1 m deep around buildings in
the 1% AEP event. Water can flow to the north back to the creek or east toward the M1 Princes Motorway sag point. At the sag point, water ponds on the western side of the M1 Princes Motorway in all events from the 20% AEP to the PMF. The 2 x 1350 mm (W) x 600 mm (H) culvert at the sag point does not have capacity to convey even the 20% AEP event runoff that ponds at this location. Along this section of the M1 Princes Motorway, there are concrete F-type barriers, which are just overtopped in the 5% AEP event.

The southbound carriageway is flooded by water flowing down the M1 Princes Motorway from the Illawarra Escarpment that is trapped on the southbound carriageway by the F-type barrier. This is also added to by overland flow from the catchment to the north of the proposal area exceeding cross drainage capacity. This water ponds at the low point and combines with water overtopping the barrier from the northbound carriageway. The depth reaches approximately 0.6 m in the 1% AEP event at the barrier. When the ponding level exceeds the outer kerb edge, water flows east through the TAFE NSW Wollongong campus, joining flows from the low point culvert. To the north, the main culvert crossing the M1 Princes Motorway (3 x 1350 mm diameter pipes), takes flow from the Dallas Street Branch and discharges it on the downstream side into a channel. Water remains in the channel upstream of this culvert in events up to the 2% AEP. In the 2% AEP event, water just overtops the southern channel bank just upstream of the culvert and water flows toward the low point on the M1 Princes Motorway. Downstream of the Dallas Street Branch culvert and the low point on the M1 Princes Motorway, overland flows and channelised flows combine as flow exceeds the channel capacity and spreads across the floodplain in all events.

From the intersection of the M1 Princes Motorway with Mount Ousley Road, water that exceeds the capacity of the cross drainage structures can also flow east, down Mount Ousley Road. This flow path is activated in the PMF event. The flow is generally very shallow (less than 0.1 m deep), with velocities generally less than 0.5 m /sec, upstream of Gaynor Avenue. This combines with flows coming down Dumfries Avenue (where the stormwater network capacity is exceeded in the 5% AEP event) near Gaynor Avenue. Overland flow continues down Dumfries Avenue and the three separate carriageways of Mount Ousley Road toward the Princes Highway.

Along the University Branch, channelised flows are currently conveyed into a 4 x 1400 mm diameter culvert between the University of Wollongong bus bays and the multi-deck car park. The 20% AEP starts to break out of the channel, but the extent is minor. Only in the PMF event is overland flow high, flowing down Northfields Avenue and causing flooding through the University of Wollongong to the north. The culvert discharges immediately downstream of Irvine Street into a channel before being conveyed into 4 x 2200 mm (W) x 1350 mm (H) box culvert under the M1 Princes Motorway northbound off ramp. Another short open channel is present before water is conveyed through a 4 x 1800 mm (W) x 900 mm (H) box culvert under the M1 Princes Motorway. In the 10% AEP event, water starts to break out of the channel upstream of the M1 Princes Motorway culvert and flow south along the road verge, eventually joining another channel south of the University Avenue overpass. In the 5% AEP event, water starts to break out of the channel upstream of the M1 Princes Motorway off ramp as well, flowing south. The northbound carriageway of the M1 Princes Motorway starts to be affected in the 5% AEP event, with depths of up to 0.3 m in the gutter.

In the more extreme 2% and 1% AEP events, the northbound carriageway of the M1 Princes Motorway becomes inundated, but this is contained to the northbound carriageway by the existing concrete median barrier. Depths reach up to 0.5 m in the 1% AEP, with velocities of approximately 1.5 m/sec. In the PMF event, water breaks out of the University Channel Branch upstream of the M1 Princes Motorway to the north and south, causing extensive inundation.
Downstream of the M1 Princes Motorway on the University Branch, there is a channel conveying flows around the south western edge of a sporting field before crossing under Foleys Lane and Memorial Drive and continuing through the urban areas of North Wollongong. Flows are contained within the channel up to and including the 10% AEP event. In the 5% AEP event, water starts to break out across University Avenue and join another channel (Botanic Gardens Branch) to the south. This is evident in events up to the 1% AEP. Water can also break out of the channel at the upstream end and can cause inundation of the M1 Princes Motorway southbound off ramp to University Avenue in the 2% and 1% AEP event, up to 0.2 m deep. In the PMF event, water also breaks out of the channel to the east and water can flow through the sporting field.

**Existing flood behaviour for blocked scenario**

For the blocked scenario, Council’s Blockage Policy (2016) (refer to Section 6.5.1) was implemented for all hydraulic structures across the catchment. This typically results in the maximum flooding within the proposal area upstream of the M1 Princes Motorway. One large difference between the two scenarios relates to the flows coming down the M1 Princes Motorway from the Illawarra Escarpment. In the blocked scenario, the transverse drainage structures along the M1 Princes Motorway have reduced capacity, resulting in substantial overflows into the proposal area. A comparison of these overflows entering the hydraulic model domain along the M1 Princes Motorway is provided in Table 6-29 below.

Table 6-29 Existing flood behaviour: overflows entering the model domain along M1 Princes Motorway

<table>
<thead>
<tr>
<th>Flood event</th>
<th>Unblocked scenario flow (m³/s)</th>
<th>Blocked scenario flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20% AEP</td>
<td>0.04</td>
<td>2.23</td>
</tr>
<tr>
<td>10% AEP</td>
<td>1.48</td>
<td>7.22</td>
</tr>
<tr>
<td>5% AEP</td>
<td>3.89</td>
<td>13.65</td>
</tr>
<tr>
<td>2% AEP</td>
<td>6.49</td>
<td>36.07</td>
</tr>
<tr>
<td>1% AEP</td>
<td>9.59</td>
<td>52.04</td>
</tr>
<tr>
<td>PMF</td>
<td>66.07</td>
<td>122.00</td>
</tr>
</tbody>
</table>

For the 20% AEP event, the flood behaviour is similar to that of the unblocked case. There is more flow that comes down the M1 Princes Motorway, but there is minimal change in flood behaviour. There is less than 0.1 m flood level increase in the creek of the Dallas Street Branch, and negligible changes downstream of the M1 Princes Motorway. There is increased flooding on the University Branch, with flows breaking out of the channel upstream of the M1 Princes Motorway crossing and continuing south to join with the channel south of the University Avenue overpass. Flood levels are decreased immediately downstream of the M1 Princes Motorway crossing since flows do not overtop the road and are controlled by the culvert capacity.

In the 10% AEP event, the combination of more flows entering the Dallas Street Branch and the blockage of the main culvert under the M1 Princes Motorway causes a flood level increase of almost 1.5 m at the upstream end of the culvert. This causes water to begin overtopping the bank.
and flowing toward the low point on the M1 Princes Motorway. In the 10% (and rarer) AEP events, flooding is more prolific both upstream and downstream of the M1 Princes Motorway waterway crossings due to both the afflux of water on the upstream side of the blocked structures and increase in flows overtopping the road. In the 10% AEP event there is an increase in overbank flows on the University Branch upstream of the M1 Princes Motorway, which flow south. There is also overbank flooding which occurs on the University Branch downstream of the M1 Princes Motorway, which inundates University Avenue. In the 5% AEP event, culvert blockages near the University of Wollongong northern car park cause overbank flooding, with overland flows running through the university, in a similar fashion to the unblocked PMF event flood behaviour. Flooding at the low point is also increased, causing water to flow south over a small crest and join overland flows from the University Branch. Due to culvert blockages on the University Branch, overland flooding affects Northfields Avenue in the 5% AEP event, and worsens in rarer events.

In the 1% AEP event, flood levels in the Dallas Street Branch upstream of the M1 Princes Motorway increase by up to 1.2 m under blocked conditions, causing flooding on the M1 Princes Motorway above the culvert crossing. Flood levels on the M1 Princes Motorway low point increase by approximately 0.4 m. For the PMF event, flood extent is increased with the blocked scenario. The flood levels increase in the Dallas Street Branch channel by up to 0.5 m and at the M1 Princes Motorway low point by up to 0.15 m. Increased overtopping of the concrete median barrier causes an increase in flooding downstream of the M1 Princes Motorway also. The flood level increase along the University Branch (along Northfields Avenue) during the PMF event is generally up to 0.4 m, with reductions immediately downstream of the M1 Princes Motorway crossing, since flows do not overtop the road. The shallow overland flooding remains similar on Mount Ousley Road, upstream of Gaynor Avenue.

6.5.3 Potential impacts

Construction

A number of construction activities have the potential to increase the potential for flooding. These include the inclusion of temporary fill (stockpiles), temporary crossings of watercourses and the establishment of the construction compound. Nevertheless, the potential construction phase impacts are expected to be minor overall.

If stockpiles are to be located within the floodplain, the obstruction of flow paths and loss of floodplain storage has the potential to cause flooding impacts. Loose material stored within the floodplain has the potential to be mobilised during a flood, which can become a hazard and may also contribute to blockage of hydraulic structures.

The proposed stockpile site at the site of the proposed commuter car park is subject to overland flows coming down the M1 Princes Motorway. These flows would be diverted around the stockpile site to ensure stockpiles are not subject to high velocity overland flows. The proposed stockpile site near Northfields Avenue would be located adjacent to the University Branch creek line on the downstream side of the M1 Princes Motorway. Flooding in the 1% AEP event would not extend onto the site.

Temporary watercourse crossings may be required for the Dallas Street Branch to facilitate the construction of the University Access Road and works on the M1 Princes Motorway. Temporary watercourse crossings may result in disturbance of the watercourse bed and banks resulting in erosion and sedimentation; partial obstruction of low flows, resulting in minor modification of downstream flow; and scour of the bed near the culvert inlets and outlets.
The modelling shows that the main compound site near Gowan Brae Avenue is generally flood free for the 1% AEP event. The southern boundary of this site adjoins the Dallas Street Branch, but due to the nature of the terrain in this location, flood water does not overtop the stream bank on its northern edge.

**Operation**

Potential changes in flood behaviour in the operational phase could arise due to:

- Increased impervious areas causing an increase in surface runoff volumes and peak flows
- Drainage and culvert upgrades and additions altering existing flow distributions
- Proposed earthworks encroaching onto the existing creek flow paths causing a reduction in channel conveyance and floodplain storage
- Proposed earthworks causing a redistribution of flows from the M1 Princes Motorway at the foot of the Illawarra Escarpment and local overland flows flowing north to south across the proposal toward the Dallas Street Branch
- Proposed traffic barriers causing an increase in ponding levels and a redistribution of flows, including an increase in cross-catchment flows between the Dallas Street Branch, University Branch and Botanic Gardens Branch.

The proposed conditions TUFLOW model was run for the 2 hour storm for the 20%, 5%, 2% and 1% AEP and PMF events, since the 2 hour event was critical in this location. Both blocked and unblocked scenarios were run using Council’s current blockage policy (2016).

An overview of the predicted changes in flood behaviour is provided below. Flood depth and velocity maps illustrating the modelled flood extents for the proposed operational phase conditions in each storm event can be found in Appendix H.

A large proportion of flow coming down the M1 Princes Motorway from the Illawarra Escarpment would be diverted off the motorway and along the new northbound motorway on ramp. This would result in less flow being conveyed along the M1 Princes Motorway, with water diverting ultimately into the Dallas Street Branch either via the University northern access road, or through the proposed commuter car park.

Flows upstream of the University northern access road on the Dallas Street Branch would be restricted by the proposed road embankment. Water would therefore be conveyed via culverts and surface channels, back into the main Dallas Street Branch creek line.

The proposed Mount Ousley Road retaining wall could constrict the flows in the Dallas Street Branch. Velocities in the creek would be up to 3 m/s in the vicinity of the retaining wall for the 1% AEP event.

There are trapped low points in the proposed design along the heavy vehicle off ramp and heavy vehicle safety ramp 1, where ponding of water may occur. There would be depths of up to 0.4 m on the heavy vehicle off ramp and 0.5 m on the heavy vehicle safety ramp in the 1% AEP event.

The existing flood impacts at the low point on the southbound carriageway of the M1 Princes Motorway would increase slightly, due to channelling effects of proposed new concrete barriers between the southbound lanes and the southbound service road. In less frequent events, when the depth of ponding at this location is high enough, water could flow along the western side of the M1 Princes Motorway to the south. There is a small crest which divides the catchment of the Dallas
Street Branch and the University Branch. Ponding at the low point could cause additional water to flow from this low point to the University Branch.

Along Mount Ousley Road from the eastern roundabout down to Gaynor Avenue, there would be no overflow from the M1 Princes Motorway, as there is in the existing case. These flows would be trapped at low points in the proposed design.

Flood impact maps comparing the existing and proposed operational phase flooding conditions can be found in Appendix H. The flood maps have been prepared for both the unblocked and blocked scenarios, for each of the 20%, 5%, 2%, 1% and PMF events. For each event, the critical storm duration of 2 hours is depicted by the flood maps.

The proposal would be refined during detailed design to provide immunity at the floor levels of properties up to the 1% AEP storm event (sometimes referred to as the 1 in 100 year event). Flood level impacts for both the unblocked and blocked scenarios are described in the following sections, with emphasis on the impacts during the 1% AEP event.

**Flood level impacts – unblocked scenario**

The predicted changes in flood levels for the 1% AEP storm event for the unblocked scenario are illustrated on the map in Figure 6-12. The main conclusion that can be drawn from this map is that under an unblocked scenario, changes in flood levels resulting from the proposal would mostly be less than 0.1 m. Downstream from the proposal area, flood levels in most areas would be reduced.
Figure 6-12 Flood level changes with the proposal – 1% AEP event, unblocked scenario
Dallas Street Branch upstream of M1 Princes Motorway

There would be flood level increases in the Dallas Street Branch channel between Ashcroft Place and the University northern carpark, but in events up to and including the 1% AEP event, flood waters would remain within the creek corridor. In the PMF event, the flood level increase would be just 0.01 m, which would affect the edge of the existing University northern carpark.

There is one private property adjoining the proposal boundary (17 Falder Place, which is set above natural ground level with a retaining wall about 1.5 m high at the boundary. While no accurate survey data exists for this property, available ALS data indicates a ground level at about RL 26.0. The flood model results indicate that at the proposal boundary, the flood levels for all events up to the PMF, would be lower than RL 26.0. This property would therefore not be impacted by water building up behind the proposed embankment.

Downstream of the proposed University northern access road, flood levels would increase. Flood levels are predicted to increase outside the proposal boundary, by up to 0.35 m in the 1% AEP and 0.6 m in the PMF event. Floodwaters however would remain contained within the channel and would not inundate university facilities. Further downstream toward the M1 Princes Motorway culvert crossing, flood levels would be reduced by up to 0.08 m in the 1% AEP, and up to 0.35 m in the PMF event. In the 20% to 2% AEP events however, there would be increases in peak flood levels of up to 0.6 m but again, these increases would be contained within the channel.

M1 Princes Motorway low point and Dallas Street Branch downstream

At the low point on the M1 Princes Motorway, there would be a reduction in flood level in the northbound carriageway, ranging from 0.23 m in the 20% AEP event, to 0.14 m in the 1% AEP event. In the southbound carriageway however, there would be an increase in flood levels for the 20% to 1% AEP events. This increase would be evident along the southbound carriageway up the hill, indicating that more water is being diverted along this carriageway than in the existing conditions.

In the PMF event, flood levels would increase at the low point on both the northbound and southbound carriageways, by up to 1 m in some locations and extending both upstream and downstream. On the upstream side, flood level increase would be up to 0.3 m at the proposal boundary, and would affect a portion of the university sporting field. On the downstream side, the largest increase outside the proposal boundary, being up to 0.3 m, would occur in the TAFE NSW Wollongong campus. Generally, there would be decreases in flood level of up to 0.1 m downstream of the M1 Princes Motorway in the PMF event.

Downstream of the main culvert on the Dallas Street Branch under the M1 Princes Motorway, flood levels would increase. The largest increase would be up to 0.1 m in the 2% AEP event within the channel, and this would not affect any properties outside of the drainage reserve. Overland flow downstream of the M1 Princes Motorway through the TAFE and residential areas generally experience a decrease in flood levels of up to 0.1 m, with some isolated areas experiencing increases.

Dumfries Avenue

For all storm events modelled, flood levels along Dumfries Avenue would increase (at the eastern end) by up to 0.03 m due to the increase in catchment draining to this area.
University Branch and Botanic Gardens Branch

The flood level along the University Branch would generally increase both upstream and downstream of the M1 Princes Motorway. In the 20% to 1% AEP events, the increase on the upstream side would be approximately 0.01 m and would not extend into private property. The downstream flood levels would increase by up to 0.09 m at the proposal boundary, but would be contained within the channel and would not extend more than 100 m downstream of the proposal boundary.

Downstream of this, including the Botanic Gardens Branch channel located to the south of the University Branch, the flood level would generally decrease in the urban areas. In the PMF event however, with the increase in ponding level at the M1 Princes Motorway low point, more water would flow south along the M1 Princes Motorway to the University Branch.

While similar flood level increases to the more frequent events are expected within the channel on both the upstream and downstream sides, overland flows to the south and east would increase, resulting in flood level increases of up to approximately 0.05 m over an extensive area on the Botanic Gardens Branch. The most impacted areas would be those around College Place and Graham Avenue.

Flood level impacts – blocked scenario

The predicted changes in flood levels for the 1% AEP storm event for the blocked scenario are illustrated on the map in Figure 6-13. The main conclusion that can be drawn from this map is that under a blocked scenario, the greatest increases in flood levels would occur within the proposal area, in the vicinity of the Dallas Street Branch upstream of the M1 Princes Motorway, and along the motorway carriageway itself. Flood levels would also increase in the area between Irvine Street and College Place/Graham Avenue, where the University and Botanic Gardens Branches intersect. Elsewhere, the proposal would result in decreases in flood levels.
Figure 6-13 Flood level changes with the proposal – 1% AEP event, blocked scenario

Legend

- Proposal area
- Change in flood extent
  - Grey: Previously flooded
  - Pink: Newly flooded

<table>
<thead>
<tr>
<th>Change in flood level (m)</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; -0.25</td>
<td>Blue</td>
</tr>
<tr>
<td>-0.1 to -0.25</td>
<td>Blue</td>
</tr>
<tr>
<td>-0.05 to -0.1</td>
<td>Blue</td>
</tr>
<tr>
<td>-0.01 to 0.05</td>
<td>Green</td>
</tr>
<tr>
<td>0.01 to 0.05</td>
<td>Yellow</td>
</tr>
<tr>
<td>0.05 to 0.1</td>
<td>Orange</td>
</tr>
<tr>
<td>0.1 to 0.25</td>
<td>Red</td>
</tr>
</tbody>
</table>

Mt Princes Motorway, Mount Ousley Interchange
Review of Environmental Factors
Dallas Street Branch upstream of M1 Princes Motorway

Upstream of the University northern carpark, flood levels would increase by up to 0.23 m in the 20% AEP event, but just 0.01 m in the 1% AEP event. For the less frequent events, these increases would encroach onto the carpark, but for more frequent events up to and including the 10% AEP event, water would remain within the creek channel. While there would be flood level increases of up to 0.6 m upstream of the University northern access road, these would generally be contained within the proposal boundary up to and including the 1% AEP event.

The private property adjoining the proposal boundary at 17 Falder Place would not be impacted by water building up behind the proposed embankment.

In the PMF event, while the predicted flood impact in the channel between Ashcroft Place and the UOW northern carpark is negligible, the flood impact upstream of the proposed University Access Road would be quite large, with flood levels increasing by almost 3 m at the proposal boundary. It is only in the PMF event that water would exceed the proposed channel capacity located on the eastern side of the University Access Road and flow through the university. Under existing conditions, water flows through the university in the 5% AEP event. However, under the proposal all water up to and including the 1% AEP event would be diverted back to the main Dallas Street Branch channel.

Downstream of the proposed University Access Road, flood levels would generally increase downstream of the culvert crossing and around the base of the proposed retaining wall. The flood impact would be up to 0.8 m in the 1% AEP event at the proposal boundary. However, flows would remain within the channel up to and including the 1% AEP event. From the end of the retaining wall to the M1 Princes Motorway, flood levels outside the proposal boundary would decrease in all events modelled, by up to 0.25 m for the 1% AEP event. In the PMF event, the flood level decreases by up to 0.4 m. In this event, there are also decreases in flood levels across the university of up to 0.43 m.

M1 Princes Motorway low point and Dallas Street Branch downstream

At the low point on the M1 Princes Motorway, there would be reductions in flood level for the northbound carriageway for the 20% and 10% AEP events of up to 0.23 m. In the southbound carriageway however, there would be increases of the same magnitude. In less frequent events, there would be increases at this location in both carriageways. This is due to the new concrete barriers proposed on the eastern side of the road. The predicted flood level increase is up to 0.24 m in the northbound lanes and up to 1 m in the southbound lanes in the 1% AEP event. However, the existing M1 Princes Motorway is already inundated at this location during the 1% AEP event. Only in the 1% AEP event would this impact extend upstream beyond the proposal boundary, where the predicted flood impact is up to 0.13 m adjacent to the Dallas Creek Branch channel.

Downstream of the M1 Princes Motorway low point and in the Dallas Street Branch creek, flood levels would increase. At the proposal boundary these would generally be up to 0.2 m in the 1% AEP event and would mostly be confined within the channel. There would be some residual impacts through the TAFE of up to 0.06 m in the 1% AEP event on the paved areas adjacent to the channel. The PMF event would have additional impacts of up to 0.3 m to the south east of the M1 Princes Motorway low point. Generally, however, flood levels and overland flows would decrease along the Dallas Street Branch downstream of the proposal.
Dumfries Avenue
For all storm events modelled, flood levels along Dumfries Avenue would increase (at the eastern end) by less than 0.05 m due to the increase in catchment area draining to this location.

University Branch and Botanic Gardens Branch
From the M1 Princes Motorway low point, water would start to flow south to the University Branch in the 5% AEP event, as it does in existing conditions with the blocked scenario. However, since the flood level at the low point would increase, the flow would also increase. This would impact on flood levels along the northbound carriageway of the motorway and in the University Branch channel, both upstream and downstream of the motorway crossing. This would also cause an increase in overland flow to the south, towards the Botanic Gardens Branch, south of the University Avenue overpass.

The largest area of impact would be around College Place, where flood levels could increase by up to 0.06 m in the 1% AEP event. There are areas downstream of this that would experience both increases and decreases in flood levels. Flood level increases of more than 0.05 m would generally be constrained to within the downstream channels. Areas upstream of the M1 Princes Motorway would experience increases in flood level of up to 0.02 m in the 1% AEP event.

In the PMF event, some properties around Murphys Avenue and Irvine Street would experience flood level increases of approximately 0.03 m. Downstream, College Place and Graham Avenue would experience flood level increases of up to 0.13 m. There would be increases further downstream of up to 0.06 m around Porter Street, Railway Crescent and Crawford Avenue. The area impacted by increased flood levels downstream of the proposal in the PMF event would be quite large.

Duration of inundation impacts
The duration of inundation was assessed for the 1% AEP event at various locations. The results have been summarised in Table 6-30 below.

Table 6-30 Summary of impacts to duration of inundation for the 1% AEP flood at key locations

<table>
<thead>
<tr>
<th>No</th>
<th>Location</th>
<th>Unblocked scenario</th>
<th>Blocked scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Upstream of University Access Road</td>
<td>At this location, the flood level rises quicker with the proposal, peaks at a higher level and recedes slower than the existing case. The increase in duration of inundation at any one particular level would be up to about 15 minutes.</td>
<td>For the blocked scenario, the duration of inundation does not substantially change with the proposal. The duration of inundation would be similar to the existing case.</td>
</tr>
<tr>
<td>2</td>
<td>Upstream of new culvert crossing University Access Road on the Dallas Street Branch</td>
<td>Flooding would peak at a similar level for the existing case. However, there would be a reduction in the duration of inundation during the rising and receding limbs of the flood.</td>
<td>Since this is located upstream of a new culvert crossing, the blocked scenario would cause a substantial increase in peak water level. The duration of inundation above the existing peak flood level would be about 45 minutes.</td>
</tr>
<tr>
<td>No</td>
<td>Location</td>
<td>Unblocked scenario</td>
<td>Blocked scenario</td>
</tr>
<tr>
<td>----</td>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3</td>
<td>Upstream of the M1 Princes Motorway culvert crossing on the Dallas Street Branch</td>
<td>The proposed peak flood level would be slightly lower than the existing case, however, the water generally would take longer to drain out. The increase in duration of inundation is between 15 minutes and 1 hour, depending on the flood level where the duration is assessed.</td>
<td>The proposed peak flood level would be slightly lower than the existing case. However, like the unblocked scenario, the water would take a longer time to drain away. The increase in duration of inundation would be approximately 15 minutes.</td>
</tr>
<tr>
<td>4</td>
<td>At the M1 Princes Motorway low point, northbound lanes</td>
<td>The peak flood level would be lower for the proposal and the duration of inundation would be shorter than the existing case. Flooding would recede quicker under the proposal, and the decrease in duration of inundation would be about 30 minutes, taking into account both the rising and receding limbs of the flood.</td>
<td>In the blocked scenario, flooding would peak at a higher level, but would rise and recede quicker than the existing conditions. At elevations near the peak flood levels, the duration of inundation would increase by about 30 minutes, but at lower elevations the duration of inundation would reduce by about 30 minutes.</td>
</tr>
<tr>
<td>5</td>
<td>Upstream Princes Motorway culvert crossing on the University Branch</td>
<td>At this location there would be no discernible change in the duration of inundation.</td>
<td>At this location there would be no discernible change in the duration of inundation.</td>
</tr>
</tbody>
</table>

### 6.5.4 Safeguards and management measures

Safeguards and management measures for potential impacts of the proposal on hydrology and flooding are listed in Table 6-31.

Table 6-31 Safeguards and management measures for hydrology and flooding

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrology and flooding</td>
<td>Prior to construction commencing, final flood and hydrology assessments will be undertaken to inform detail design measures to minimise risks to the environment, properties and the project.</td>
<td>Contractor</td>
<td>Pre-construction</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>Impact</td>
<td>Environmental safeguards</td>
<td>Responsibility</td>
<td>Timing</td>
<td>Standard / additional safeguard</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------</td>
<td>--------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Hydrology and flooding</td>
<td>Further flood modelling shall be undertaken at detailed design. Floor level surveys shall be conducted at dwellings subject to increased flood levels during the 1% AEP storm event. This will determine if there is any increase in above floor flooding. No new property floor levels will be subject to inundation in the 1% event as a result of the proposal.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>Hydrology and flooding</td>
<td>Debris control structures are to be designed for inclusion at culvert inlets, to minimise blockages and ensure that drainage structures function effectively</td>
<td>Contractor</td>
<td>Detailed design and Construction</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>Hydrology and flooding</td>
<td>Scour protection measures shall be considered to protect culvert outlets; and at the base of the retaining wall adjacent to the Dallas Street Branch creek.</td>
<td>Contractor</td>
<td>Detailed design and Construction</td>
<td>Additional safeguard</td>
</tr>
</tbody>
</table>
6.6 Surface water and groundwater

The potential impacts of the proposal on surface water and groundwater are assessed in the Water Quality Working Paper (Jacobs, 2017), which is provided in Appendix I. A summary of the assessment is presented in this section.

6.6.1 Methodology

Surface water quality

The assessment of likely and potential impacts of the proposal on surface water quality during construction and operation included:

- Review of existing literature relating to the proposal, available water quality data and existing conditions using available non-proposal literature to obtain background information on catchment history and land use to aid in interpreting the existing conditions
- Assessment of the impact of construction activities on water quality with reference to the ANZECC/ARMCANZ (2000) water quality guidelines for protection of the relevant environmental values of aquatic ecosystems and visual amenity
- Review of water quality treatment measures that could be used to mitigate the impact of construction on water quality, following the principles of Managing Urban Stormwater–Soils and Construction Volume 1 (Landcom, 2004) and Volume 2D (DECC, 2008)
- Review of water quality treatment measures that could be used to mitigate the impact of the operation of the proposal on water quality following the principle of Procedure for Selecting Treatment Strategies to Control Road Runoff (RTA, 2003), Roads and Maritime Water Policy (RTA, 1997) and Roads and Maritime Code of Practice, Water Management (RTA, 1999).

There are a number of guidelines and management procedures relevant to the assessment of surface water quality. These guidelines and procedures have been used to determine existing water conditions along the proposal and identify the appropriate water quality management and mitigations measures for implementation during the construction and operational phases of the proposal (refer to Appendix I). The guidelines seek to minimise land degradation and water pollution from road construction sites in NSW, and have been used to identify appropriate management procedures and physical controls to minimise erosion and to prevent sediment moving off site during construction works.

Three spill containment basins and two swales would be required to manage the operational impacts of the proposal. Further details regarding the methodology for spill containment basins and swales are provided in Appendix I.

Groundwater

A desktop groundwater assessment was carried out to establish groundwater conditions, levels, quality and potential impacts associated with the proposal. Inputs to the groundwater assessment included:

- Geotechnical Factual Report (Jacobs, 2017)
- Proposed interchange at the Mount Ousley Road on the M1 Princes Motorway, Preliminary Environmental Investigation (Jacobs, 2015)
- NSW PINEENA groundwater database
• Bureau of Meteorology Groundwater Dependent Ecosystems Atlas.

**Water quality objectives**

The key water quality objective of the proposal is that irrespective of the current condition of waterways, the proposal should not further degrade water quality. As such the key objective of the proposal is to minimise the potential impacts on downstream receiving waters, so that the proposal changes the existing water regime by the smallest amount practicable. This objective is consistent with the *Water Policy 1997* (RTA, 1997) and *Code of Practice for Water Management 1999* (RTA, 1999). Roads and Maritime approach to water quality management is to provide operational water quality control measures for the following sensitive receiving waters:

(i) Class 1 or Class 2 fish habitat waterways (in accordance with the DPI guideline “Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (2003)”);

(ii) Any waterway that discharges into SEPP 14 wetlands that are located within 500 metres of the project;

(iii) Any waterway that discharges to waters that are used for the purposes of human consumption and located within 500 metres of the project;

(iv) Any water sensitive threatened species habitat, endangered ecological communities, or other identified areas of biodiversity conservation significance.

None of the above sensitive receiving environments are located within the proposal area.

6.6.2 Existing environment

Proposal area

The proposal area is situated on the foothills of the Illawarra escarpment, which ranges from 250 to 500m above sea level and is generally responsible for creating an east/west rainfall gradient across the area. During storm events the creeks and drainage lines experience high velocity flows, carrying large amounts of erosional materials down the steep escarpment slopes into the coastal creeks and lagoon downstream (WBM 2006). Riparian vegetation is limited and highly modified within the proposal area, providing minimal bank stability from erosion.

Fairy Lagoon is an Intermittently Closed and Open Lake or Lagoon (ICOLL) located downstream of the proposal. The entrance to Fairy Lagoon is usually closed, naturally discharging when catchment flows are sufficient to breach the sand berm at the entrance. Pollutants transported into Fairy Lagoon are likely to be retained for a longer time period compared to an open system or estuarine channel, which would receive greater tidal flushing.

Waterways and catchments

Two minor freshwater tributaries are located within the proposal area (see Figure 6-11). These include:

- A tributary of Cabbage Tree Creek to the north
- A tributary of Fairy Creek to the south.

The Fairy Creek and Cabbage Tree Creek catchment covers a combined area of 2,076 hectares (Wollongong City Council, 2010). The upper reaches of Fairy Creek and Cabbage Tree Creek are highly branched and primarily pass through residential areas with limited riparian vegetation. About one kilometre downstream of the proposal area, the creeks join to form Fairy Lagoon. The tidal
limit of Fairy Creek is 100 metres upstream of Flinders Street Bridge, while the tidal limit of Cabbage Tree Creek is 20 metres downstream from Montague Street Bridge.

**Key fish habitats**

The tributaries of Cabbage Tree Creek and Fairy Creek are not identified as key fish habitat based on mapping by DPI (2007). Site investigations carried out in November/December 2016 confirmed no key fish habitat to be present based on the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013). Both tributaries are impacted, minor first and second order streams, with limited water and instream aquatic habitat. No threatened or protected fish species are expected to occur.

**Sensitive receiving environments**

Sensitive receiving environments were identified using aquatic habitat as an indicator, which was assessed against the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) and *Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge, 2003). Sensitive receiving environments were identified based on the following considerations:

- Key fish habitat
- Groundwater and surface water dependent TSC listed vegetation communities, EPBC listed saltmarsh communities
- SEPP 14 and RAMSAR Wetlands
- Drinking water catchment
- Areas that contribute to aquaculture and commercial fishing.

No watercourses within the proposal area have been defined as a sensitive receiving environment.

Fairy Lagoon is the downstream receiving environment to the proposal area, and is situated about 1.4 km downstream from the nearest natural drainage channel in the proposal area (straight line distance; the stream bed distance via Cabbage Tree Creek and its tributary is about 2 km). Water quality within Fairy Lagoon is linked to the level of pollutants that are discharged and tidal flushing of the lagoon to dispose of these pollutants before they become problematic. Catchment runoff can result in elevated nutrient levels and subsequent algal blooms which are undesirable given the proximity to popular recreation areas surrounding Fairy Lagoon.

Fairy Lagoon is artificially opened in accordance with the Fairy Lagoon Entrance Management Policy (Cardno Lawson Treloar, 2007), which has a trigger level set at 1.6 m AHD. Seagrass beds (*Zostera Capricorni* and *Ruppia spp.*) occur in small scattered patches near the southern shore of Fairy Lagoon, and there are isolated wetlands surrounding Fairy Lagoon. Fairy Lagoon is defined as Type 2 – Moderately Sensitive Key Fish *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) due to the isolated patches of seagrass and the lagoon’s artificial opening by council.

**Environmental values**

Environmental values are values or uses of the environment that are important for a healthy ecosystem or for public benefit or health. Environmental values require protection from the effects of pollution and waste discharges (ANZECC/ARMCANZ, 2000). The NSW Office of Environment and Heritage (OEH) have nominated a number of environmental values for the Illawarra Catchment and relevant indicators and guideline levels which are used in protecting the environmental value (DECCW, 2006).
There are a number of recognised environmental values. Those relevant for this assessment include:

- Aquatic ecosystems
- Visual amenity
- Primary and secondary contact recreation.

**Aquatic ecosystems**

Aquatic ecosystems comprise the animals, plants and micro-organisms that live in water and the physical and chemical environment in which they interact. Aquatic ecosystems have historically been impacted by multiple pressures including changes in flow regime, modification and destruction of key habitats, development and poor water quality.

There are a number of naturally occurring physical and chemical stressors that can cause degradation of aquatic ecosystems. Stressors which have been considered in this assessment include:

**Nutrients** in aquatic environments promote the growth of algae and increase turbidity which reduces light and may affect plant growth. Nutrients consist of nitrogen (including total nitrogen, oxidised nitrogen and ammonia) and phosphorus (including total phosphorus and filterable reactive phosphorus (FRP)).

**pH** is a measure of the acidity or alkalinity of a waterbody. Changes in pH can impact the ability of aquatic organisms to maintain basic functions such as respiration. Potential sources of changes to pH include changes in the level of organic matter within the system, agricultural runoff from low pH soils (eg acid sulphate soils (ASS)) and changes in salinity.

**Turbidity** is a measure of the optical clarity of a water body which is important in characterising the health of a waterbody. Changes in the availability of light can affect the distribution of animals and potentially alter the chemical characteristics of the waterbody. Suspended solids from runoff or land disturbance can impact on aquatic ecosystems by increasing turbidity, reducing light penetration, modifying physical habitat and smothering biota.

**Dissolved oxygen** is a measure of the amount of oxygen dissolved in water. Dissolved oxygen is vital for estuarine biota including native fish, and for the functioning of healthy aquatic ecosystems.

**Metals** occur naturally at trace levels in the environment, and include arsenic, cadmium, copper, chromium, iron, lead, manganese, mercury, nickel, selenium and zinc. Organisms require metals for various biological functions. However, excessive levels can be toxic and can enter the food chain through bioaccumulation. Potential sources of metals include urban stormwater such as runoff from roads, industrial waste discharges and raw or treated effluent.

**Visual amenity**

Waters should be free from noticeable pollution, floating debris, oil, scum and other matter. Substances that produce objectionable colour, odour, taste or turbidity and substances and conditions that produce undesirable aquatic life should not be apparent (NHMRC, 2008). The key aesthetic indicators are transparency, odour and colour.

**Primary and secondary contact recreation**

There are two main categories of recreational water use; primary contact and secondary contact recreation. Primary contact recreation activities include swimming, diving and water skiing, where
there is potential for ingestion. Secondary contact recreation implies some direct contact with water such as boating, fishing and wading, where ingestion is unlikely.

**Existing water quality**

Water quality in Fairy Creek and Cabbage Tree Creek is largely influenced by urban development, and both are typically subjected to high velocity flows from the steep escarpment towards the coastal plains. The watercourses in the proposal area are classified as freshwater, but the downstream receiving environment is classified as estuarine.

Limited water quality data is available for the proposal area. The most recent relevant water quality data was collected by Wollongong City Council on a monthly basis from August 2002 to March 2006, at three locations in Fairy Creek.

- Immediately downstream of the proposal
- Upstream of the proposal
- Downstream in Fairy Creek Lagoon.

The 2002-2006 monitoring results are summarised in Table 6-32. Monitoring locations are shown in Figure 6-14.

Table 6-32 Median Wollongong City Council Monthly Water Quality Monitoring (2002-2006)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.72</td>
<td>7.94</td>
<td>6.5-8</td>
<td>7.61</td>
<td>7-8.5</td>
</tr>
<tr>
<td>Conductivity µs/cm</td>
<td>266.9</td>
<td>614</td>
<td>125-2200</td>
<td>21496</td>
<td>#</td>
</tr>
<tr>
<td>Dissolved Oxygen (% sat)</td>
<td>67.4</td>
<td>70.5</td>
<td>85-110</td>
<td>98</td>
<td>80-110</td>
</tr>
<tr>
<td>Suspended Solids (mg/L)</td>
<td>3</td>
<td>#</td>
<td>50</td>
<td>11</td>
<td>50</td>
</tr>
<tr>
<td>Total Phosphorus (mg/L)</td>
<td>0.03</td>
<td>0.065</td>
<td>0.025</td>
<td>0.0295</td>
<td>0.03</td>
</tr>
<tr>
<td>Total Nitrogen (mg/L)</td>
<td>0.4</td>
<td>0.42</td>
<td>0.35</td>
<td>0.38</td>
<td>0.3</td>
</tr>
<tr>
<td>Total Kjeldahl Nitrogen (TKN) (mg/L)</td>
<td>0.21</td>
<td>0.34</td>
<td>0.31</td>
<td>0.37</td>
<td>0.285</td>
</tr>
<tr>
<td>Ammonia* mg/L</td>
<td>0.02</td>
<td>0.03</td>
<td>0.015</td>
<td>0.04</td>
<td>0.015</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------</td>
<td>----------------------</td>
<td>---------------------------------------------</td>
<td>------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Copper (µg/L)</td>
<td>0.1</td>
<td>4</td>
<td>1.4</td>
<td>5</td>
<td>1.3</td>
</tr>
<tr>
<td>Zinc (µg/L)</td>
<td>7</td>
<td>19</td>
<td>8</td>
<td>14.5</td>
<td>15</td>
</tr>
<tr>
<td>Lead (µg/L)</td>
<td>1</td>
<td>1</td>
<td>3.4</td>
<td>1</td>
<td>4.4</td>
</tr>
<tr>
<td>Manganese (µg/L)</td>
<td>57</td>
<td>115</td>
<td>1900</td>
<td>91.5</td>
<td>#</td>
</tr>
<tr>
<td>Arsenic (µg/L)</td>
<td>0.5</td>
<td>1</td>
<td>13</td>
<td>1.5</td>
<td>#</td>
</tr>
<tr>
<td>Total Iron (µg/L)</td>
<td>271</td>
<td>177.25</td>
<td>#</td>
<td>125</td>
<td>#</td>
</tr>
<tr>
<td>Cadmium (µg/L)</td>
<td>0.05</td>
<td>#</td>
<td>0.2</td>
<td>0.1</td>
<td>5.5</td>
</tr>
<tr>
<td>Chromium** (µg/L)</td>
<td>0.5</td>
<td>#</td>
<td>1</td>
<td>0.5</td>
<td>1</td>
</tr>
<tr>
<td>Nickel (µg/L)</td>
<td>0.5</td>
<td>#</td>
<td>11</td>
<td>3</td>
<td>70</td>
</tr>
<tr>
<td>Mercury (µg/L)</td>
<td>0.05</td>
<td>#</td>
<td>0.6</td>
<td>0.05</td>
<td>0.4</td>
</tr>
<tr>
<td>Aluminium (µg/L)</td>
<td>30</td>
<td>#</td>
<td>55</td>
<td>35</td>
<td>na</td>
</tr>
</tbody>
</table>

Note: Bold text denotes exceedance of guidelines
* Ammonia is assumed to be NH₄
** More conservative ANZECC/ARMCANZ Guidelines for Chromium VI have been assumed.
# No data
Source: ‘An investigation into the utility of Wollongong City Council’s water quality monitoring program’ (WCC, 2007)
Figure 6-14 Water quality monitoring locations
Water quality within Fairy Creek was reflective of the urbanised catchment with high nutrient concentrations observed at both freshwater sites. The median total phosphorus, total nitrogen and ammonia concentrations were above the ANZECC/ARMCANZ (2000) recommended guidelines. Dissolved oxygen was below the recommended guideline downstream and upstream of the proposal. Metal concentrations were low upstream of the proposal, with all parameters within the recommended guidelines. Median concentrations of copper and zinc exceeded the recommended guidelines downstream of the proposal.

Nutrient concentrations remained high at Fairy Creek Lagoon, reflecting limited tidal flushing. Nitrogen (all forms) exceeded the recommended guidelines. Copper and zinc concentrations remained elevated, however only copper exceeded the more conservative estuarine guidelines.

Historic water quality in the proposal area indicates slightly eutrophic conditions with low oxygen and high nutrients, likely due to high nutrient and sediment inflows from the upstream catchment. Generally, the aquatic ecosystems are considered impacted due to the elevated nutrient concentrations. It is likely that water quality conditions have changed since monitoring was carried out in 2006, as catchment land uses have changed and urbanisation has continued within the proposal area.

**Groundwater**

**Groundwater bores**

A search of the PINEENA database (DPI Water, 2016) in 2017 was carried out as part of the Concept Design Geotechnical Interpretative Report (Jacobs, 2017). The search identified no registered groundwater bores located within the proposal area.

**Groundwater levels**

Geotechnical investigations for the proposal were carried out between February and April 2017. In general, groundwater seepage was not observed in any test pits or the augered (upper) part of boreholes.

Four standpipe piezometers were installed near the proposal during the geotechnical investigations to allow for groundwater level monitoring and sampling. The standpipe piezometers ranged in depth between 14.3 metres and 18.7 metres below ground level. A summary of standpipe groundwater level observations is provided in Table 6-33.
Table 6-33 Summary of standpipe groundwater level observations, 2017

<table>
<thead>
<tr>
<th>Borehole</th>
<th>Location</th>
<th>Surface RL (reduced level) (m A HD)</th>
<th>Observed groundwater level 15/03/17</th>
<th>Observed groundwater level 02/05/17</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Depth (m)</td>
<td>RL (m A HD)</td>
<td>Depth (m)</td>
</tr>
<tr>
<td>BH101</td>
<td>In vegetation land adjacent to Dumfries Avenue, west of Foothills Road</td>
<td>38.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>BH102</td>
<td>In vegetation land adjacent to Dumfries Avenue, south of Foothills Road</td>
<td>52.1</td>
<td>Dry</td>
<td>Dry</td>
</tr>
<tr>
<td>BH106</td>
<td>Near vegetated land, south of Mount Ousley Road</td>
<td>32.8</td>
<td>9.0</td>
<td>23.8</td>
</tr>
<tr>
<td>BH111</td>
<td>In vegetated land west of residences at Gowan Brae Avenue</td>
<td>31.0</td>
<td>9.6</td>
<td>21.4</td>
</tr>
</tbody>
</table>

Inferred groundwater levels near the proposal area have been included in the Concept Design Geotechnical Interpretative Report (Jacobs, 2017). In addition, the following hydrogeological conditions are observed:

Quaternary Alluvium: test pits were dug into the alluvium to depths of up to 3.1 m. Some seepage through the walls was observed. However, an alluvial water table was not encountered, which suggests that the creeks are not in connectivity with the groundwater in this area. This can change during periods of heavy rainfall. However, due to the efficient drainage of the area, any change to the prevailing baseline condition is expected to be short term.

Talus: test pits also intercepted the talus and did not encounter a groundwater table. Some shallow transient flows and perched water from rainfall would be expected in the talus.

Residual soils and bedrock: A bedrock water table was observed in three out of four standpipe piezometers at depths ranging from 8.8 to 10.4 m below ground level. The depth to groundwater demonstrates no direct connectivity with the overlying alluvium / talus and that the bedrock groundwater system is recharged directly by rainfall at areas of outcrop. Groundwater is expected to exist as the following:

- Transient downslope flows, water from rainfall within the residual soils and water charged bedrock strata or seepage or perched defects. These flows would be encountered as seepage into cuttings from bedrock defects, and in particular the coal bands/measures
- Deeper regional groundwater table within the bedrock.
Coal seams in the area are known to be aquifer pathways for high seepage and inflows to excavations, both below the water table and as perched groundwater.

Groundwater dependent ecosystems

6.6.3 Potential impacts

Construction

Surface water quality

The construction phase of the proposal has the potential to result in further degradation of downstream water quality if not carefully managed. The highest risk to water quality would occur due to the following activities:

- General construction activities upstream of the tributaries of Cabbage Tree Creek and Fairy Creek
- Construction of watercourse crossings traversing both tributaries of Cabbage Tree Creek and Fairy Creek. Watercourse crossings would be designed and constructed to minimise impacts on natural flow regimes and to not present any barriers (refer to 3 Description of the proposal)
- Disturbance and mobilisation of sediment associated with earthworks from activities such as vegetation removal, stripping of topsoil and filling, particularly where activities are located close to waterways. Loose fill also has the potential to be eroded by runoff during rainfall events. This has the potential to smother vegetation and change the soil surface characteristics and habitat of adjacent areas
- Vegetation clearing and subsequent rainfall and erosion in areas comprising of fine silt and clay. This has the potential to result in siltation of downstream watercourses and storages
- Dewatering activities have the potential to mobilise sediments and contaminants, and increase the turbidity of receiving environments
- Sediment-laden runoff from compound sites has the potential to be washed into stormwater systems and receiving environments
- The introduction of contaminants (such as oil or grease and disturb contaminated sediments) has the potential to have an adverse impact on water quality
- Relocation and protection of utilities including potential dewatering of potable water from watermains would require soil disturbance by trenching and underboring. The disturbance of soil by machinery could increase the potential for soil erosion. Potable water is chlorinated which has the potential to impact on downstream water quality. This has the potential to impact aquatic biodiversity
- Increased sediment loads and organic matter from exposed soil during site disturbance and movement of construction vehicles, particularly following rainfall events. This has the potential to result in elevated turbidity levels and increased levels of nutrients, metals and other pollutants in downstream waterways near construction activities. Increased sedimentation has the potential to smother aquatic life and affect the ecosystems of downstream waterways which would potentially impact on downstream users (such as commercial and recreational).

If appropriate safeguards and management measures are implemented during construction (refer to Section 6.6.4), the proposal would be unlikely to contribute significant amounts of sediment and organic matter to the immediate waterways. Potential impacts are likely to be localised and occur...
under high flow conditions. Impacts on the downstream environment would be negligible. Overall, potential impacts on surface water quality during construction are considered minor with the implementation of safeguards and management measures (refer to Section 6.6.4).

Water quality during construction would be managed through sediment basins and other safeguards and mitigation measures (refer to Section 6.6.4). Sediment basins have been designed in accordance with the Blue Book with key criteria considered including catchment area contributing to sediment basin, percentage of cut and fill in sub-catchment and whether the basin is located in a sensitive receiving environment. Chronic (day to day) impacts to water quality are expected to be minimal. Larger storm events could result in overtopping of basins and the potential deposition of sediment and associated pollutants into receiving waterways.

Risks of acute (one-off severe event) water quality impacts during construction would be primarily related to spills or leaks of fuel/oil from machinery due to accidents or negligence. The proposal includes three (temporary) sediment basins which are of an appropriate size to capture spills of this nature. As such, the likelihood of impacts to waterways is minimised. Additionally, onsite and offsite diversion drains, sediment fences, spill procedures, spill kits and erosion controls at the source would provide additional protection of waterways.

Groundwater

During construction, the proposal may reach the groundwater table. As a result, minor dewatering activities may be required during construction activities.

During construction activities there is a risk of introducing contaminants (through spills or sedimentation) into the aquifer. The likelihood of this occurring is minimised through the installation of appropriate erosion and sediment controls, and measures for managing spills and pollution in the CEMP that would be developed prior to construction.

Groundwater extracted in dewatering would be managed such that there would be minimal interaction with construction areas through the use of collection sumps, or dewatering via extraction outside the excavation. This would avoid contamination through entrainment of fine sediment, hydrocarbons (oil and grease) or other potential contaminants.

The proposal is not expected to require groundwater extraction at a rate of three megalitres per year or more, or at an instantaneous rate of greater than five litres per second, and therefore a dewatering licence would not be required. The expected rate and total dewatering would need to be calculated during detailed design, and a construction dewatering management plan submitted to DPI Water if required, to demonstrate that there is a plan to manage water take.

Given that the interaction of the proposal with the groundwater environment would be minimal and very localised, it is considered that any dewatering activities would not result in a propagation of groundwater drawdown to the nearby GDEs or watercourses.

Operation

Surface water quality

The operational phase of the proposal has the potential to result in surface runoff from increased impervious surfaces and concentration of runoff via drains and kerbs. Increased impervious surfaces and vehicle traffic can result in the build-up of contaminants on road surfaces, median areas, rest areas and roadside corridors in dry weather, which can be transported to surrounding watercourses or infiltrate into the groundwater system during rainfall events.
Important pollutants of concern relating to road runoff include:

- Sediments from the paved surface from pavement wear and atmospheric deposition
- Heavy metals attached to particles washed off the paved surface
- Oil and grease and other hydrocarbon products
- Litter from the road corridor
- Nutrients such as nitrogen and phosphorus (organic compounds) from biological matter and from natural atmospheric deposition of fine soil particles.

The proposal also has the potential to result in the accidental spillage of hazardous materials. Without a satisfactory means of containment, the spillage of contaminants would pass rapidly into the local drainage system and impact the downstream ecosystems. Accidental spills of chemicals or petrol in road accidents can cause severe damage to the ecology of waterways. Three locations near the proposal would require spill containment. These locations coincide with the locations where sediments basins would be required. Other safeguards and management measures which would be implemented to manage the impact of the proposal on water quality during operation phase are outlined in Section 6.6.4.

**Groundwater**

Operation of the proposal would not result in impacts to groundwater as there would not be any ongoing dewatering activities and any surface run-off would be captured within drainage infrastructure and managed in accordance with current practices.

### 6.6.4 Safeguards and management measures

Safeguards and management measures for potential impacts of the proposal on surface water and groundwater are listed in Table 6-34.

**Table 6-34 Safeguards and management measures for surface water and groundwater**

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard/additional safeguard</th>
</tr>
</thead>
</table>
| Surface water and groundwater | A Soil and Water Management Plan (SWMP) will be prepared and implemented as part of the CEMP. The SWMP will:  
- Identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks will be addressed during construction.  
- Specify the requirements for source controls  
- Identify that any water collected from the worksite during construction will be | Contractor       | Detailed design/pre-construction           | Core standard safeguard SW1  
Section 2.1 of QA G38  
Soil and Water Management |
<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard/additional safeguard</th>
</tr>
</thead>
</table>
• Specify the requirements for source controls (such as sediment fences and bunding of chemical storage areas). Where piling, concreting, earthworks, scour protection or other works are required within or adjacent to a waterway, a silt barrier such as a boom, bund or curtain will be installed either downstream of the work site and/or around the piles prior to the commencement of works. | Contractor | Detailed design/Pre-construction | Core standard safeguard SW2  
Section 2.2 of QA G38 *Soil and Water Management* |
<p>| Surface water and groundwater | A site specific Erosion and Sediment Control Plan/s (ESCP) will be prepared and implemented as part of the SWMP. The ESCP shall be approved by a registered soil conservationist. The ESCP will include arrangements for managing wet weather events, including monitoring of potential high risk events (such as storms) and specific controls and follow-up measures to be applied in the event of wet weather. | Contractor | During construction | Core standard safeguard SW3 |
| Surface water and groundwater | An Emergency Spill Plan will be developed and incorporated into the CEMP, which will include measures to avoid spillages of fuels, chemicals, and fluids into any waterways. The storage, | Contractor | During construction | Core standard safeguard SW3 |</p>
<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard/additional safeguard</th>
</tr>
</thead>
</table>
|                      | handling and use of the materials will be carried out in accordance with the *Occupational Health and Safety Act 2000* and SafeWork NSW’s Storage and Handling of Dangerous Goods Code of Practice (Workcover, 2005). Procedures will include:  
  - All fuels, chemicals, and liquids will be stored at least 50 metres away from any waterways or drainage lines and will be stored in an impervious bunded area within the compound site  
  - Bunded areas for refuelling and washdown  
  - Sediment basins with sufficient storage capacity to capture spills  
  - Spill kits  
  - Training of staff.                                                                                                                                  | Contractor      | Detailed design | Additional safeguard |
| Surface water and groundwater | Permanent water quality controls (spill containment basins and swales) will be incorporated into the design.                                                                                                            |                 |          |                                |
6.7 Topography, geology and soils

The potential impacts of the proposal on topography, geology and soils are presented in this section, together with safeguards and management measures to manage any negative impacts.

6.7.1 Methodology

A desktop review of the following resources was carried out to inform this assessment:

- Wollongong – Port Hacking 1:100 000 Geological Sheet 9029-9129 (Stroud et al., 1985).
- Soil Landscapes of the Wollongong-Port Hacking 1:100,000 Sheet (Hazelton and Tille, 1990)
- Australian Soil Resource Information System (compiled by the Commonwealth Scientific and Industrial Research Organisation; search carried out on 20 November 2014)
- The NSW Environment Protection Authority’s (EPA) Contaminated Land Public Record (search carried out on 20 November 2014)
- The EPA’s List of NSW contaminated sites notified to EPA (search carried out on 20 November 2014).

6.7.2 Existing environment

Topography

The landform covered by the proposal area generally comprises steeply sloping land associated with the lower slopes and foothills of the Illawarra Escarpment (comprising the western portion of the proposal area with gradients up to 10°), as well as areas of relatively flat coastal plain located at the base of the escarpment (comprising the south-eastern portion of the proposal area ie close to Wollongong TAFE with gradients of 1-3°). Slope gradients near to the proposal are shown in Figure 6-15.

Geology

The geology of the proposal area (as mapped by the Wollongong – Port Hacking 1:100,000 Geological Sheet 9029-9129; Stroud et al., 1985) is summarised as follows:

- The western region of the proposal area is underlain predominantly Pheasants Nest Formation with some areas of the Sydney SubGroup of the Illawarra Coal Measures
- The south-eastern region of the proposal area is underlain entirely by the Sydney Subgroup of the Illawarra Coal Measures.

A description of the lithology of these geological units is provided in Table 6-35.
Table 6-35 Geological units underlying the proposal area

<table>
<thead>
<tr>
<th>Geological unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney Subgroup of the Illawarra Coal Measures</td>
<td>Generally, comprises Permian aged interbedded quartz-lithic sandstone, grey siltstone and claystone, carbonaceous claystone, clay, laminate and coal</td>
</tr>
<tr>
<td>Pheasants Nest Formation</td>
<td>This geological unit forms part of the Cumberland Subgroup formation of the Illawarra Coal Measures and generally comprises Permian aged interbedded lithic sandstone, coal, carbonaceous claystone, siltstone and claystone</td>
</tr>
</tbody>
</table>

Source: *Wollongong – Port Hacking 1:100 000 Geological Sheet 9029-9129* (Stroud et al., 1985)
Figure 6-15 Slope gradients near the proposal
Soils and contamination

Mapping by the *Soil Landscapes of the Wollongong-Port Hacking 1:100,000 Sheet* (Hazelton and Tille, 1990) was used to determine the existing soil landscapes falling within the proposal area. Generally, the Disturbed Terrain Soil landscape is the dominant feature, although the western edge of the proposal area and the eastern part of Mount Ousley Road within the proposal area also fall partly within the Gwynneville soil landscape.

A description of key characteristics and limitations associated with these soil landscapes is provided in Table 6-36.

Table 6-36 Soil landscapes within the proposal area

<table>
<thead>
<tr>
<th>Soil landscape</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disturbed Terrain</td>
<td>Soils have been disturbed by human activity, with the original soil being removed, greatly disturbed or buried (Hazelton and Tille, 1990)</td>
</tr>
<tr>
<td>Gwynneville</td>
<td>Soils are shallow and are generally characterised by extreme erosion hazard, steep slopes, mass movement hazard and local flooding (Hazelton and Tille, 1990)</td>
</tr>
</tbody>
</table>

Acid Sulfate Soils (ASS) Risk Maps from the CSIRO Australian Soil Resource Information System (ASRIS) database were reviewed to ascertain the probability of ASS being present across the proposal area. Based on this information, the generalised ASS risk across the proposal area has been assessed as a low probability of occurrence.

**Potential contamination sources and contaminants of concern**

None of the registered contaminated sites on the EPA's database (*Contaminated Land Public Record* and the *List of NSW contaminated sites notified to EPA*) are located within the proposal area.

Notwithstanding the above, current and former land uses within the proposal area may have resulted in the contamination of soils and/or groundwater underlying the area. Potential contamination sources/environmental risks identified within the proposal area comprise the following:

- Spills from vehicles (contaminants of concern are total recoverable hydrocarbons (TRH), monocyclic aromatic hydrocarbons (BTEX), heavy metals).
- Unsealed areas adjacent to the proposal. There is the potential for localised point sources of contamination to exist along the road corridor, in nature strips and road verges. This could be associated with leaks and particulate deposition from vehicles (TRH, polycyclic aromatic hydrocarbons (PAH), heavy metals and asbestos).
- Fly tipped waste (typically general waste, building materials, and household products).
- Fill material and asphalt associated with road construction (heavy metals, TRH, BTEX and PAH).
Potential historical use of the proposal and surrounding areas as agricultural land. There is the potential for diffuse use of pesticides and herbicides (Organochlorine Pesticides (OCP), Organophosphorus Pesticides (OPP), TRH, heavy metals and herbicides), localised chemical storage (heavy metals, TRH, volatile organic compounds (VOC)) and waste disposal (heavy metals, TRH, BTEX, OCP, OPP, VOC and asbestos) associated with potential/unconfirmed historical use as agricultural land.

**Potential contamination migration pathways**
- Pathways by which the contamination sources discussed above could migrate towards potential receptors include:
- Direct human contact through dermal contact, ingestion and/or inhalation
- Vertical/ lateral migration via groundwater
- Vertical/lateral migration via vapour.

**Potential receptors of concern**
Potential receptors of contaminants of concern within the proposal could include:
- Personnel working at the site (during construction works)
- General public entering the site including future site users (during and post construction works)
- Flora and fauna habitats present surrounding the site (including local sensitive environments)
- Aquatic ecosystems within nearby local waterways
- Groundwater dependent ecosystems
- Nearby properties and residents
- Down gradient beneficial users of groundwater.

**6.7.3 Potential impacts**

**Construction**

**Topography**
As the western part of the proposal area is relatively steep, part of the existing land would need to be flattened out when undertaking the earthworks and construction of the retaining wall structures. Associated with this, soil erosion would be managed appropriately through measures identified in Table 6-37.

**Geology**
There is unlikely to be impacts to the geology of the proposal area.

**Soils and contamination**
During construction, there would be exposed soil during site preparation (including ancillary sites), vegetation removal, earthworks, excavation and other construction activities.
- Large areas of exposed soil, including stockpile sites, have the potential to be eroded by wind and water. The staged construction of the proposal would reduce the area of exposed soil. Potential impacts to soils and geology include but are not limited to:
- Increased sediment loading, including increased turbidity, and an increased potential for the transport of contaminants bound to sediment particles.
• Soil erosion as a result of exposure to wind and water runoff, removal of topsoil, exposure of buried structures and sedimentation.

• There is potential for contaminated land to be encountered during the construction of the proposal; however, this risk is considered to be of low probability.

Potential impacts in relation to contamination associated with the construction of the proposal include:

• Increasing waste amounts from improper practices such as poor fill management

• Contaminated or hazardous waste not being correctly disposed of

• Adverse effects on human health (construction personnel and the travelling public)

• Release of contaminants from construction plant and equipment into underlying soils and groundwater

• Movement of contaminated sediments into waterways (refer to Section 6.6)

• Adverse effects on flora and fauna (refer to Section 6.3).

The safeguards and management measures in Table 6-37 would be carried out to mitigate potential impacts to soils and contaminated land.

Operation

Topography

The proposal would not have an impact on the surrounding landform in the operational period.

Geology

The proposal would not have an impact on underlying geology in the operational period.

Soils and contamination

The main risks associated with the operation of the proposal include the mobilisation of unconsolidated materials if disturbed surfaces are not stabilised or successfully revegetated during construction.

In addition, there is potential for accidental spillage of hazardous materials during the operational stage of the proposal. Without satisfactory means of containment, the spillage of contaminants could pass rapidly into the soils. The likelihood of a potential spill of hazardous substances would be minimised as a result of the motorway upgrade and improved road design standards.
### 6.7.4 Safeguards and management measures

Safeguards and management measures for potential impacts of the proposal on topography, geology and soils are listed in Table 6-37.

**Table 6-37 Safeguards and management measures for topography, geology and soils**

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology and soils</td>
<td>The maintenance of established stockpile sites during construction is to be in accordance with the <em>Roads and Maritime Services Stockpile Site Management Guideline</em> (EMS-TG-10)</td>
<td>Contractor</td>
<td>Pre-construction/construction</td>
<td>Core standard safeguard</td>
</tr>
<tr>
<td>Geology and soils</td>
<td>Mulching will be excluded from areas likely to be inundated within the proposal area to reduce the risk of tannins pollution entering waterways.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Core standard safeguard</td>
</tr>
<tr>
<td>Geology and soils</td>
<td>Soil stabilisation will be carried out with materials such as rocks and erosion matting to reduce the risk of tannins pollution entering waterway.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Core standard safeguard</td>
</tr>
</tbody>
</table>
| Geology and soils              | Management measures for stockpile sites will be incorporated in the Soil and Water Management Plan (SWMP) and Erosion and Sedimentation Control Plans (ESCPs) and will include the following measures:  
  - Stockpile sites will be located away from overland flow paths and areas of high topography with minimal upstream catchment  
  - Stockpile sites will be maintained in accordance with Roads and Maritime’s Stockpile Site Management Procedures (Roads and Maritime Procedures) | Contractor     | Construction            | Core standard safeguard                       |
<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
</table>
| Maritime, 2001)        | • The number and size of stockpile sites will be minimised throughout the proposal  
                          • Indicate the stockpile management measures to be implemented if PASS are excavated during piling activities  
                          • Vehicle movements will be restricted to designated pathways, where feasible.                                                                                                           |                |                              |                                 |
| Geology and soils      | If contaminated areas are encountered during construction, a Contaminated Land Management Plan will be prepared in accordance with the *Guideline for the Management of Contamination* (Roads and Maritime, 2013) and implemented as part of the CEMP. All other works that may impact on the contaminated area will cease until the nature and extent of the contamination has been confirmed and any necessary site-specific controls or further actions identified in consultation with the Roads and Maritime Environment Manager and/or EPA. The CLMP will include, but not be limited to:  
                          • capture and management of any surface runoff contaminated by exposure to the contaminated land  
                          • further investigations required to determine the extent, concentration and type of contamination  
                          • management of the | Contractor       | Detailed design / Pre-construction | Core standard safeguard         |
<p>|                        |                                                                                                                                                                                                                                                |                |                              | Section 4.2 of QA G36 Environment Protection |</p>
<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>remediation and subsequent validation of the contaminated land, including any certification required • measures to ensure the safety of site personnel and local communities during construction.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geology and soils</td>
<td>A site specific emergency spill plan will be developed, and include spill management measures in accordance with the Roads and Maritime <em>Code of Practice for Water Management</em> (RTA, 1999) and relevant EPA guidelines. The plan will address measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities (including Roads and Maritime and EPA officers).</td>
<td>Contractor</td>
<td>Detailed design / Pre-construction</td>
<td>Core standard safeguard C3 Section 4.3 of QA G36 Environment Protection</td>
</tr>
<tr>
<td>Geology and soils</td>
<td>If potentially contaminated materials are suspected and/or encountered during construction, these will be managed by an unexpected finds protocol incorporated in the CEMP. Disposal of this material will be at an approved waste disposal facility.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Additional safeguard</td>
</tr>
</tbody>
</table>
6.8 Property, land use and socio-economic

Potential property, land use and socio-economic impacts of the proposal, both positive and negative, are presented in this section, together with safeguards and management measures to manage any negative impacts.

6.8.1 Methodology

The proposal area for the assessment is shown in Figure 6-16. It comprises Australian Bureau of Statistics (ABS) Statistical Area Level 1 (SA1) areas located closest to the proposal area boundary. It includes those communities that may experience impacts from the proposal's construction and/or operation, namely:

- Communities located along Dumfries Avenue and Mount Ousley Road, including:
  - Residential areas west of Dumfries Avenue (SA1 1114440)
  - Residential areas east of Dumfries Avenue (SA1 1114404)
  - Residential areas along Mount Ousley Road (SA1 1114441)
- Communities located near the TAFE NSW Wollongong Campus and University of Wollongong, including:
  - Residential areas near the TAFE NSW Wollongong Campus (SA1 1114403)
  - Residential areas west of Irvine Street (SA1 1114602)
  - Residential areas near the University of Wollongong and Wollongong Botanic Garden (SA1 1114618).

Population and demographic data for the SA1s of 1114440, 1114404 and 1114441 have been combined and are presented as 'Dumfries Avenue/Mount Ousley Road', while data for the SA1s of 1114403, 1114602 and 1114618 have been combined and are presented as 'TAFE/University campus'.

At a regional level, the proposal area includes the ABS Statistical Area Level 2 (SA2) geographies of:

- Figtree-Keiraville
- Balgownie-Fairy Meadow
- Wollongong-East
- Wollongong-West.

The methodology for this socio-economic assessment is guided by the Environmental Impact Assessment Practice Note: Socio-economic assessment (EIA-N05) (Roads and Maritime, 2013). Key steps in the assessment included:

- Scoping of the potential socio-economic impacts of the proposal and potentially affected communities, both locally and regionally
- Analysing existing socio-economic conditions and values, including population, social infrastructure (ie education, recreation and health services and facilities), and local businesses
- Identifying and assessing potential socio-economic impacts of the proposal’s construction and operation, including on local amenity, access and connectivity, social infrastructure and local community values.
• Identifying safeguards and management measures to mitigate or manage the identified impacts.

The description of the existing socio-economic environment principally draws on data and information from the ABS 2016 Census of Population and Housing. This is supplemented with data and information from:

• NSW Department of Planning and Environment, relating to population projections
• The Wollongong City Council website, as well as relevant Council plans and policies.
Figure 6-16 Land use zones and statistical areas
6.8.2 Socio-economic policy context

The proposal is located within the Wollongong Local Government Area (LGA) in south-eastern NSW. The *Wollongong 2022: Our Community Strategic Plan* (Community Strategic Plan) (Wollongong City Council, 2012) provides direction for the delivery of key projects and services, to help meet the needs of the community. The Plan outlines the vision of the LGA as *‘from the mountains to the sea, we value and protect our natural environment and we will be leaders in building an educated, creative and connected community’*. It identifies six community goals, with supporting objectives and strategies, to guide growth over the next 10 years. Those relevant to the proposal include:

- We have sustainable, affordable and accessible transport
- We are a healthy community in a liveable city.

An objective of the community goal relating to affordable and accessible transport is for Wollongong to be supported by an integrated transport system, including *‘effective and integrated regional transport, with a focus on road, bus, rail and freight movement (including the port of Port Kembla)’*. The proposal would provide for the growing freight task, including supporting the expanding port of Port Kembla, by improving the road network at this location, and improving accessibility to and from the M1 Princes Motorway and the Wollongong Central Business District (CBD).

An objective of the community goal *‘healthy community in a liveable city’* is for community safety to be improved. The proposal would improve safety for motorists, cyclists and pedestrians using the road network (refer to Section 6.1).

6.8.3 Existing land use and socio-economic environment

**Land use**

Key land uses near the proposal include:

- Major education facilities, including:
  - The University of Wollongong, located at the base of Mount Ousley, west of the M1 Princes Motorway
  - The TAFE NSW Wollongong Campus, located at the base of Mount Ousley, east of the M1 Princes Motorway
- Low density residential land uses near Dumfries Avenue and Mount Ousley Road
- Areas of native vegetation between the University of Wollongong and the M1 Princes Motorway, and between Mount Ousley Road and Dumfries Avenue
- Road infrastructure, including the M1 Princes Motorway and Mount Ousley Road.

**Property ownership**

All land within the proposal area is currently owned by Roads and Maritime, TAFE NSW Wollongong Campus, Wollongong City Council (such as footpaths) and the University of Wollongong.
Community profile

Population and growth

In 2016, the regional study area had an estimated resident population of 76,217 people (ABS, 2017). Between 2006 and 2016, the population of the regional study area grew by about 10,474 people, or an average of 1.5 per cent annually. This was above the rate of population growth recorded for NSW over the same period (at 1.4 per cent).

Information on population projections is available at a LGA level. The population of the Wollongong LGA is projected to increase to about 244,400 people by 2036 (NSW Department of Planning and Environment, 2016). This represents an average annual growth rate of 0.7 per cent from 2016, below the NSW average of 1.2 per cent. The M1 Princes Motorway connects and supports a number of key growth areas in the Wollongong LGA, including the port of Port Kembla, University of Wollongong and Shellharbour.

Demography

Socio-economic characteristics of the study area are shown in Table 6-38 characteristics and communities in the study area generally include:

- A relatively young population within communities located near the TAFE/University campus and older population in communities located along Dumfries Avenue/Mount Ousley Road compared to NSW. This is likely to reflect the high proportions of students within these communities and the proximity of the study area to the University and TAFE campuses
- A culturally diverse population at communities located near the TAFE/University campus, which demonstrated higher proportions of people born overseas and households where two or more languages are spoken compared to NSW. This is likely to reflect the attendance of international students at the University and TAFE campuses. Communities near Dumfries Avenue/Mount Ousley Road demonstrated lower proportions of people born overseas and households where two or more languages are spoken compared to NSW
- A high reliance on private vehicles as a mode of transport for communities located along Dumfries Avenue/Mount Ousley Road
- Higher household family incomes at communities located along Dumfries Avenue/Mount Ousley Road compared to NSW and lower household family incomes at communities at the TAFE/University campus and NSW
- High proportions of people attending university or tertiary education compared to the regional study area and NSW. Communities located near the TAFE/University campus demonstrated particularly high levels of people attending university or tertiary education. This is likely to reflect the proximity of the study area to the University and TAFE campus, as well as the presence of student accommodation such as the Graduate House, located at Irvine Street and Northfields Avenue and Kooloobong Village, located at Robsons Road.
Table 6-38 Key socio-economic characteristics for the study area, 2016 and 2011

<table>
<thead>
<tr>
<th>Socio-economic characteristics</th>
<th>Dumfries Avenue/Mount Ousley Road*</th>
<th>TAFE/University campus**</th>
<th>Regional study area</th>
<th>New South Wales</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2016 Census data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total population (2016)</td>
<td>1,231</td>
<td>1,383</td>
<td>72,945</td>
<td>7,480,228</td>
</tr>
<tr>
<td>Median age</td>
<td>41</td>
<td>25</td>
<td>36</td>
<td>38</td>
</tr>
<tr>
<td>0-14 years (per cent)</td>
<td>19.1</td>
<td>11.0</td>
<td>14.6</td>
<td>18.5</td>
</tr>
<tr>
<td>65+ years (per cent)</td>
<td>19.3</td>
<td>8.7</td>
<td>17.6</td>
<td>16.2</td>
</tr>
<tr>
<td>Aboriginal and Torres Strait Islander (per cent)</td>
<td>1.7</td>
<td>0.6</td>
<td>1.6</td>
<td>2.9</td>
</tr>
<tr>
<td>Born in Australia (per cent)</td>
<td>80.4</td>
<td>46.3</td>
<td>65.8</td>
<td>65.5</td>
</tr>
<tr>
<td>Households where two or more languages are spoken (per cent)</td>
<td>20.2</td>
<td>47.2</td>
<td>25.6</td>
<td>26.5</td>
</tr>
<tr>
<td>Households with no vehicle (per cent)</td>
<td>3.9</td>
<td>20.5</td>
<td>11.2</td>
<td>9.2</td>
</tr>
<tr>
<td>Households with two or more vehicles (per cent)</td>
<td>62.4</td>
<td>33.2</td>
<td>45.6</td>
<td>50.8</td>
</tr>
<tr>
<td>Median weekly household income</td>
<td>$1,804.33</td>
<td>$892.67</td>
<td>$1,303.75</td>
<td>$1,486.00</td>
</tr>
<tr>
<td>Attending university or tertiary education (per cent)</td>
<td>24.7</td>
<td>75.1</td>
<td>35.7</td>
<td>16.2</td>
</tr>
<tr>
<td><strong>2011 Census data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel to work by car (as driver or passenger) (per cent)</td>
<td>69.3</td>
<td>51.4</td>
<td>60.3</td>
<td>68.2</td>
</tr>
</tbody>
</table>
Travel to work by public transport (per cent)

<table>
<thead>
<tr>
<th>Socio-economic characteristics</th>
<th>Dumfries Avenue/Mount Ousley Road*</th>
<th>TAFE/University campus**</th>
<th>Regional study area</th>
<th>New South Wales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment rate (per cent)</td>
<td>7.3</td>
<td>14.6</td>
<td>10.9</td>
<td>7.1</td>
</tr>
</tbody>
</table>

| Unemployment rate (per cent)   | 4.5                               | 18.5                    | 11.2                | 7.6             |

Source: Based on 2016 ABS Census (ABS, 2017), based on 2011 ABS Census (ABS, 2013)

*Includes 1114440, 1114404, 1114441 SA1s

**Includes 1114403, 1114602, 1114618 SA1s

Workforce participation, employment and income

At the 2011 Census, unemployment rates varied within the study area, with communities located at Dumfries Avenue/Mount Ousley Road demonstrating relatively low levels of unemployment compared to the NSW average while those located near the TAFE/University campus demonstrated relatively high levels of unemployment. This is likely to reflect the high number of students attending tertiary education and low levels of workforce participation within this area.

Major industries of employment included tertiary education; school education; cafes, restaurants and takeaway food services; hospitals; and architectural, engineering and technical services.

Communities located along Dumfries Avenue/Mount Ousley Road demonstrated higher household family incomes compared to the NSW average, while communities located near the TAFE/University campus demonstrated lower household family incomes compared to the NSW average.

Access and connectivity

Households within the study area demonstrated varied levels of car ownership and dependence on private vehicles for travel to work. Those communities at Dumfries Avenue/Mount Ousley Road demonstrated higher levels of car ownership and travel to work by car compared to NSW, while those communities located near the TAFE/University campus demonstrated lower levels of car ownership and travel to work by car compared to NSW. This may be reflective of the low levels of workforce participation within communities located near the TAFE/University campus, the proximity of the study area to the University and TAFE campuses, and the higher proportion of students who are more likely to use public or active transport.

Major roads located near the proposal area include the M1 Princes Motorway, which connects Greater Sydney with Wollongong and the Illawarra region, and Mount Ousley Road, which provides an east-west link between the M1 Princes Motorway and the Princes Highway. Mount Ousley Road provides access to surrounding residential areas, as well as businesses located along the Princes Highway east of the proposal.

A number of local roads are located near the proposal. These roads provide access and connectivity to residential areas, as well as the University of Wollongong and TAFE NSW Wollongong Campus. Dumfries Avenue is located adjacent to Mount Ousley Road, and provides access to the surrounding local road network and residential properties along Mount Ousley Road.
A commuter car park is located on the northern side of Mount Ousley Road. The car park provides unrestricted parking space for about 34 vehicles and is accessible via dedicated turning lanes from both the eastbound and westbound carriageways of Mount Ousley Road. The car park is regularly used by commuters carpooling from Wollongong to Sydney, as well as other locations. The car park regularly has up to 45 vehicles parked as many vehicles park in unmarked parking areas.

Buses are the dominant mode of public transport within the study area. Bus routes operating near the proposal are listed in Section 6.1.2. North Wollongong Train Station is located about 750 metres east of the M1 Princes Motorway. Students travelling to the University via train generally walk or catch the University shuttle bus to the campus.

Formal pedestrian and cycle access is limited near the proposal. There are no existing pedestrian and cycleway infrastructure provided along the M1 Princes Motorway or Mount Ousley Road. Between the M1 Princes Motorway and Gaynor Avenue, Mount Ousley Road has narrow road shoulders, and no formal pedestrian or cycleway infrastructure. Between Gaynor Avenue and the Princes Highway, there is a pedestrian footpath on the northern side of Mount Ousley Road.

A formal shared path is located between the intersection of the Princes Highway/Mount Ousley Road to University Avenue, running adjacent to the TAFE NSW Wollongong Campus.

An unmarked cycle route is provided along Dumfries Avenue and Gaynor Avenue. The unmarked cycle route provides access at Helen Street to the formal shared path between the intersection of the Princes Highway/Mount Ousley Road and University Avenue, allowing access for cyclists from residential areas to the University of Wollongong and TAFE NSW Wollongong Campus, as well as businesses located along the Princes Highway.

**Social infrastructure**

A number of regional and state level community services and facilities are located within the Wollongong LGA which cater for communities in the study area as well as in the broader Illawarra region. These include:

- Tertiary education facilities, including the University of Wollongong and TAFE NSW Wollongong Campus
- Major hospitals, including Wollongong Hospital and Wollongong Private Hospital
- Regional and state sport and recreation facilities, including the WIN Stadium and WIN Entertainment Centre
- Major retail, commercial uses, cultural and community support facilities located in the Wollongong CBD.

The study area includes a range of community facilities and services that cater for both local and regional communities. The proposal would be located within land owned by the University of Wollongong. The University includes a number of social infrastructure uses and facilities, which would be located near the proposal. These include sporting and recreational, educational and child care facilities.

Social infrastructure located near the proposal is listed in Table 6-39.
<table>
<thead>
<tr>
<th>Facility type</th>
<th>Facility</th>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
</table>
| Educational facilities/sporting and recreation    | University of Wollongong        | Northfields Avenue, North     | The University of Wollongong offers tertiary education to domestic and international students. In 2016, the university had an equivalent full-time student load of 17,080 students at the campus (University of Wollongong, 2016). The university is targeting a growth in equivalent full-time student load of 3,230 students by 2036 (University of Wollongong, 2016). The University of Wollongong Recreation and Aquatic Centre (URAC) is the closest facility to the proposal. The URAC facilities include:  
  - Swimming pool  
  - Hockey field  
  - Tennis, basketball, badminton and squash courts  
  - Sport ovals  
  - Multi-purpose indoor sports stadium, which is also used during university examination periods, such as final exams held in February, June and November each year. The P5 Northern Carpark is located next to URAC. The P5 Northern Carpark is a permit bay, with ticketed parking after 4pm. The proposal would be located within the P5 Northern Car Park. The closest educational buildings to the proposal include Building 25 - Creative Arts (less than 50 metres from the proposal), Building 27 - Education Movement Laboratory (about 50 metres from the proposal) and Building 28 - Medicine (less than 50 metres from the proposal). These buildings are located south of the P5 Northern Carpark. Kids’ Uni is located on Northfields Avenue at the University of Wollongong campus. Kids’ Uni on campus provides child care and education for children aged six weeks to five years. Access to the University for motorists travelling south on the M1 Princes Motorway is via the southbound off-ramp to University Avenue from the M1 Princes Motorway. |
<p>| facilities                                        |                                 | Wollongong                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |</p>
<table>
<thead>
<tr>
<th>Facility type</th>
<th>Facility</th>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational facilities</td>
<td>TAFE NSW Wollongong Campus</td>
<td>Foley Lane, North Wollongong</td>
<td>TAFE NSW Wollongong Campus provides vocational education and training. Access to the TAFE NSW Wollongong Campus for motorists travelling south on the M1 Princes Motorway is via the left-turn bay into University Avenue.</td>
</tr>
<tr>
<td></td>
<td>Elonera Montessori School</td>
<td>Mount Ousley Road, Mount Ousley</td>
<td>The private school offers primary and secondary education to students in Kindergarten to Year 12. In 2016, there were 117 students enrolled in the school (My School, 2017a). The school also offers Parent Toddler Programs, day care, and pre-school facilities.</td>
</tr>
<tr>
<td></td>
<td>Keira High School</td>
<td>Lysaght Street, Fairy Meadow</td>
<td>The public school offers secondary education to students in Year 7 to Year 12. In 2016, there were 938 students enrolled at the school (My School, 2017b).</td>
</tr>
<tr>
<td></td>
<td>Wollongong High School of the Performing Arts</td>
<td>Lysaght Street, Fairy Meadow</td>
<td>The public school offers secondary education to students in Year 7 to Year 12. In 2016, there were 1,042 students enrolled at the school (My School, 2017c). The school has a wide catchment ranging from Engadine to Berry (Wollongong High School of the Performing Arts, undated).</td>
</tr>
<tr>
<td>Parks and open space</td>
<td>Park</td>
<td>Corner of Dumfries Avenue and Bass Street</td>
<td>An area of open space which includes children’s play equipment, seating and a picnic table.</td>
</tr>
</tbody>
</table>

**Community values**

Communities in the study area comprise permanent residents, as well as those that work or visit the area on a daily or intermittent basis.

Communities in Wollongong value the area for its ‘natural beauty, access to beaches and coastline, the escarpment backdrop and lifestyle and amenity’ as well as the area’s close proximity to other places like Sydney, friendly atmosphere and strong sense of community (Wollongong City Council, 2012). The Community Strategic Plan identifies a number of future challenges for the Wollongong LGA including infrastructure and the standard of assets, the need for infrastructure upgrades the need for revitalisation, employment, the need for improved public transport, preservation of the natural environment, and safety.
The M1 Princes Motorway and Mount Ousley Road are important access roads for residents within the study area, as well as important roads for access to Sydney and the Wollongong CBD. Road safety and efficient road networks are likely to be important, given the reliance of the community on private vehicle for travel.

Amenity in the study area is characterised by low density residential and major educational land uses and transport infrastructure. Areas of low density residential land uses are located along Dumfries Avenue, to the north of the proposal, near Mount Ousley Road, to the east of the proposal, and near Irvine Street and Falder Place, to the west of the proposal. The road corridor and associated infrastructure of the M1 Princes Motorway and Mount Ousley Road are likely to influence local amenity and character of areas near the proposal, with current amenity compromised by traffic, including heavy vehicles, along the M1 Princes Motorway. The M1 Princes Motorway presents a barrier for access between the University of Wollongong and residential areas at Mount Ousley and Fairy Meadow.

An area of native vegetation is located adjacent to residential properties along Dumfries Avenue. This provides a visual buffer from the M1 Princes Motorway for residents in this location. An area of native vegetation located to the south of the M1 Princes Motorway provides a buffer between the University of Wollongong and the road corridor.

A number of established trees are located on either side of the M1 Princes Motorway that also offer some landscaping and visual relief for road users.

**Local business and industry**

Port Kembla is located about five kilometres south of the proposal. Port Kembla is the largest motor vehicle import hub and grain export terminal in NSW, and the second largest coal export port in NSW (NSW Ports, undated). The port is a key infrastructure asset in the Illawarra region, supporting the employment of local people (Port Authority of NSW, undated). The M1 Princes Motorway provides for freight transport between Port Kembla and Sydney. Port Kembla is undergoing a three-stage expansion including the construction of a bulk berth and container berth, road and rail links, and the reclamation of about 42 hectares of land (NSW Department of Planning and Environment, 2015).

In June 2016, there were about 5,589 businesses operating within the regional study area (ABS, 2016). Local businesses located near the proposal area include:

- Retail businesses located along the Princes Highway at Fairy Meadow (east of the proposal), including Officeworks, Fergo’s Tackle World, Supercheap Auto, Trevor Jordan Motorcycles, Gateway Mitsubishi, and Gateway Holden
- Fast food businesses located along the Princes Highway at Fairy Meadow (east of the proposal), including KFC, Hungry Jack’s, Red Rooster, McDonald’s and Outback Steakhouse
- Businesses operating within the University of Wollongong
- Businesses operating within the TAFE NSW Wollongong Campus.
6.8.4 Potential impacts

Construction

Land use and property

The majority of construction activities would occur within the road corridor and on sites adjacent to the M1 Princes Motorway and Mount Ousley Road. The proposal would not require temporary or permanent acquisition of private property for construction.

A temporary compound site would be located west of Gowan Brae Avenue on vacant land owned by Roads and Maritime.

Access to private property would be unaffected during the construction phase of the proposal.

Access and connectivity

During construction, access would be maintained along the M1 Princes Motorway, although some temporary changes would be required.

Although the proposal would require temporary restriction of a secondary access to a property at Falder Place located on land owned by Roads and Maritime, primary access to the property would not be impacted.

The proposal would require the permanent closure of the southbound off-ramp from the M1 Princes Motorway to University Avenue. However, the exit would not be closed until after completion of the proposed southbound on ramp and service road and the proposed eastern roundabout on Mount Ousley Road, during Stage 1 of construction (see Section 3.3). Motorists that previously used this off-ramp would instead be required to exit the M1 Princes Motorway at Mount Ousley Road and access University Avenue via the southbound service road. This would remove a major congestion and potential traffic conflict point from the through lanes of the M1 Princes Motorway.

Consultation for the proposal in November 2016 identified concerns from some local residents about existing delays due to traffic congestion on the M1 Princes Motorway and local streets, particularly during school, TAFE and University semesters. Consultation also identified the need for potential impacts from construction activities on the road network to be managed to avoid further congestion. Potential impacts on traffic and transport during the construction phase of the proposal would be mitigated through the implementation of safeguards and management measures outlined in Section 6.1.4.

During construction, the proposal would have a minor impact on bus services, as there would be general delays due to implementation of temporary traffic switches and temporary speed reductions. The proposal would not impact bus stops or access to existing bus stops during construction.

The construction phase of the proposal would require temporary changes to pedestrian access within the proposal area for safety. This includes short-term closure of the existing shared path between Helen Street and the pedestrian overbridge at Northfields Avenue. During this time, pedestrian access would be diverted through the TAFE NSW Wollongong campus. Informal access through vacant land connecting the shared path at Helen Street and Mount Ousley Road would be closed due to the location of the temporary compound site. The pedestrian overbridge at Northfields Avenue would also be temporarily closed during construction. Pedestrian access across the M1 Princes Motorway would be maintained via the road bridge over University Avenue,
although would result in increased walking distances for some students accessing the University of Wollongong who currently use the pedestrian overbridge. Communities located near the TAFE/University campus demonstrated low levels of car ownership and high levels of attendance at tertiary education, suggesting that students may access educational facilities via walking.

Construction of the proposal would require the temporary closure of the existing commuter car park located on the northern side of Mount Ousley Road, removing the unrestricted parking spaces for about 34 vehicles. As indicated in Section 6.8.3, the commuter car park is regularly used by commuters carpooling from Wollongong to Sydney and elsewhere. Users of this facility would be required to find alternate parking during this time, which may require changes to daily commuter routes. Due to the short-term duration of this work, these impacts are considered to be minor.

Other potential impacts to access and connectivity during the construction phase would include:

- Temporary increase in construction traffic on roads within the study area, including heavy vehicles used to deliver materials and equipment, and construction worker vehicles, potentially impacting on perceptions of road safety for motorists, pedestrians and cyclists. The majority of construction vehicles would travel along the M1 Princes Motorway, with a small proportion travelling along Mount Ousley Road, Memorial Drive and Princes Highway (refer to Section 6.1). The use of local roads for construction access and increased construction traffic may impact on community perceptions of road safety

- Temporary changes to road conditions near construction activities, including reductions in speed limits, temporary traffic lane closures, and temporary diversions and access changes, resulting in delays and disruptions for motorists and other road users and potentially impacting on road safety.

**Community values**

Potential impacts on community values during construction may be experienced due to temporary adverse changes in local amenity for residents, businesses, facilities and natural areas near to construction due to noise, dust and traffic generated from construction activities (refer to Section 6.1 and 6.2).

Consultation carried out for the proposal in November 2016 indicated that local residents were concerned about construction noise near to local streets and educational facilities. Increased traffic noise and light spill may impact the night-time amenity for residents near the proposal, particularly where out-of-hours work is required or work would occur over extended periods. Management of noise impacts from out-of-hours work was identified by local residents as a concern during consultation. Safeguards and management measures to manage out-of-hours noise impacts are discussed in Section 6.2.4.

As noted previously, the proposal would require the use of a temporary construction compound site on vacant land near residential properties east of Gowan Brae Avenue. Construction vehicles would access the construction compound initially from the M1 Princes Motorway, and later (as construction progresses) from the proposed eastern roundabout via the southbound on ramp. During consultation for the proposal in November 2016, local residents expressed concern that construction vehicles and heavy machinery may use local streets to access construction compound sites. The compound site would require the removal of some native vegetation. The loss of this vegetation is likely to be a concern for some residents.

During construction, areas closest to the compound site may experience temporary adverse changes to local amenity due to increased noise and dust, changes in visual amenity,
infrastructure and vegetation removal, increased construction traffic and temporary changes to local access and connectivity. This may impact on the use and enjoyment of some homes, particularly outdoor areas. Impacts on night-time amenity may also be experienced should works need to be carried out outside of standard day-time hours.

Potential impacts on community values during the construction phase of the proposal would be mitigated through the implementation of safeguards and management measures outlined in Section 6.9.2.

**Social infrastructure**

Potential indirect impacts on amenity of social infrastructure located near construction activities may occur due to:

- Increased noise, dust and construction traffic, including heavy vehicles, impacting on amenity for users and workers of some community services and facilities
- Changes in local access and traffic disruptions and delays due to construction activities.

Facilities within the University of Wollongong campus located closest to the proposal include URAC, and Building 25 - Creative Arts, Building 27 - Education Movement Laboratory and Building 28 - Medicine. As indicated in Section 6.8.3, URAC includes a number of sports facilities, including a multi-purpose indoor sports stadium which is also used during examination periods, such as final exams held in February, June and November each year. Construction activities for the new Mount Ousley Road, commuter car park, and University access road, would be located in close proximity to these facilities. Construction of the University access road and shared path would also be located in close proximity to educational buildings. Construction activities at this location have the potential to result in construction noise and dust, impacting on amenity for students and staff and the enjoyment of outdoor spaces. Potential noise and vibration during the construction phase of the proposal would be mitigated through the implementation of safeguards and management measures outlined in Section 6.2.4.

Elonera Montessori School is located at Mount Ousley Road, near to construction activities required for the construction of Mount Ousley Road, the eastern roundabout, and the heavy vehicle off-ramp. Kids’ Uni is located on Northfields Avenue at the University of Wollongong campus, near to construction activities required for the Northfields Avenue on-ramp northbound. Without mitigation, potential impacts may relate to noise and dust from construction activities, as well as the haulage of spoil, materials and equipment on Mount Ousley Road. Increased construction traffic and heavy vehicles using Mount Ousley Road may also result in perceptions of increased safety risks for children attending Elonera Montessori School, particularly during drop-off and pick-up times. Ongoing consultation and communication with both the Elonera Montessori School and Kids’ Uni, including students, parents and teachers, about haulage and construction activities and potential safety risks would assist in managing potential impacts.

A local park is located at the corner of Dumfries Avenue and Bass Street, Mount Ousley. The park includes an area of open space which includes children’s play equipment, seating and a picnic table. The park would be located near construction of the eastern roundabout and heavy vehicle off-ramp along Mount Ousley Road. Access to the park would be maintained during construction, although temporary impacts may be experienced by some park users due to changes in amenity and increased construction traffic.

Other social infrastructure, such as the TAFE NSW Wollongong Campus may experience increased noise and dust and increased construction traffic, including heavy vehicles, and changes
to access during the construction phase of the proposal. Elements of the proposal located near the TAFE NSW Wollongong Campus includes construction activities along the M1 Princes Motorway, and construction of the southbound service road, Mount Ousley Road on-ramp southbound, and pedestrian bridge extension over the M1 Princes Motorway. This may impact on amenity, as well as traffic disruptions and delays, for students and staff.

Potential indirect impacts to the social infrastructure during the construction phase of the proposal would be mitigated through the implementation of safeguards and management measures outlined in Section 6.8.5.

**Local business**

The proposal would not have a direct impact on local businesses during the construction phase. Access to businesses near the proposal would be unaffected during construction.

Construction of the proposal may also have a positive effect for some local businesses through increased demand for local goods and services. This includes local shops and food outlets near construction activities that may benefit from increased business in response to day-to-day needs of construction workers. Businesses supplying goods and services to construction may also experience benefits from increased construction activities locally.

**Operation**

**Land use and property**

Property acquisition required by the proposal is outlined in Section 3.6 and would include partial acquisition of land owned by the University of Wollongong and TAFE NSW Wollongong campus. The proposal would not result in the permanent acquisition of any private residential property however the relocation of noise walls would reduce the effective size of some properties which are currently utilising the road reserve.

The proposal is predominantly located on land used for transport infrastructure or as a buffer between residential and educational areas and the road corridor. Although the proposal would result in a change of land use from educational uses to road infrastructure in some locations (such as at the University of Wollongong and TAFE NSW Wollongong Campus), the proposal would not impact on the ongoing wider educational use of the land.

**Access and connectivity**

The proposal would result in benefits for access and connectivity within the study area, regional study area and wider Illawarra region (refer to Section 2).

Access to private property near the proposal would be maintained during operation.

In terms of impacts to buses and heavy vehicles, there would be a small increase in travel distance for these vehicles that currently use the existing University Avenue off-ramp of up to 1.5 kilometres.

The proposal would include a new shared path between Dumfries Avenue (north of the M1 Princes Motorway) to University of Wollongong (south of the M1 Princes Motorway), a new pedestrian bridge over Mount Ousley Road to the east of M1 Princes Motorway, and a shared path along the proposed extension of Mount Ousley Road across the M1 Princes Motorway. This would support improves access and safety for pedestrians and cyclists along Mount Ousley Road and for staff, students and visitors to the University of Wollongong. This may encourage some visitors to the university to use alternate transport.
The commuter car park on the northern side of Mount Ousley Road would be relocated to the western side of the M1 Princes Motorway. This would result in minor changes to access of the car park for commuters. It is expected that the car park would include a similar number of parking spaces as the existing car park.

**Community values**

As indicated in Section 6.8.3, native vegetation within the road reserve offers a buffer between residential areas and the M1 Princes Motorway and Mount Ousley Road. The proposal would result in the removal of about 7.5 hectares of native vegetation, about 4.8 hectares of roadside and urban plantings, and about one hectare of weed dominated vegetation to allow for new road infrastructure. This is likely to reduce the visual screening of the motorway in these locations, impacting on visual amenity and increasing visibility of motorway traffic from these properties until such time as proposed landscaping matures. This may increase community perceptions about impacts of traffic noise. Tree planting areas are proposed for screening which would take between five and ten years to establish, therefore this impact would be temporary. Consultation carried out for the project in November 2016 indicated that the local community were concerned about the visual impacts of the proposal. Landscape character and visual impacts of the proposal are discussed further in Section 6.4.

Operation of the proposal would result in the road corridor being located closer to residential properties at some locations, such as at Dumfries Avenue and Gowan Brae Avenue. This has the potential to result in perceived impacts to amenity at these locations.

As indicated in Section 6.8.3, safety was identified in the Community Strategic Plan as being important to the local community. The proposal would provide improvements to road safety for motorists, cyclists and pedestrians (refer to Section 6.1). This includes improved safety for vehicles travelling along the M1 Princes Motorway due removal of the priority right turn from Mount Ousley and southbound queueing at the University Avenue southbound off-ramp, provision of two new safety ramps, provision of bridges over the M1 Princes Motorway and Mount Ousley Road catering for pedestrians and cyclists, provision of a heavy vehicle bypass and service lane to reduce weave movements between heavy vehicles and traffic exiting at Mount Ousley Road and travelling to University Avenue on the M1 Princes Motorway, and implementation of Smart Motorway infrastructure (refer to Section 3.2).

**Social infrastructure**

The proposal would support access to local and regional social infrastructure, such as the University of Wollongong and TAFE NSW Wollongong Campus, through improved access and connectivity, and improved safety for motorists, pedestrians and cyclists travelling along the M1 Princes Motorway at this location.

The proposal would require the permanent acquisition of 3.0 hectares of land owned by the University of Wollongong to allow for the new Mount Ousley Road, western roundabout, University access road and shared path. As this land is currently unused, there would not be an impact on the operations of the University of Wollongong. The proposal would also require the permanent acquisition of a narrow strip comprising 0.6 hectares of land TAFE NSW Wollongong campus.

The P5 Northern Carpark is located to the west of URAC at the University of Wollongong. The P5 Northern Carpark is a permit bay, with ticketed parking after 4pm. Students are advised to ‘anticipate high demand for parking spaces at peak times, especially in the early weeks of session’ (University of Wollongong, 2017). The proposed interchange is considered as part of the
University of Wollongong Campus Masterplan and forward planning for car parking at the campus. There is the potential for the removal of up to 50 existing off-street parking spaces at the University of Wollongong northern carpark. Replacement of these parking spaces would be undertaken in consultation with the University of Wollongong in consideration of the University of Wollongong Masterplan.

Operation of the proposal would result in road infrastructure (such as the commuter car park, Mount Ousley Road, and western roadabout, located closer to the University of Wollongong, particularly URAC and other sporting facilities. Road infrastructure would also be located closer to educational buildings. For example, the University access road would be located closer to Building 25 - Creative Arts, Building 27 - Education Movement Laboratory and Building 28 - Medicine. This may have an indirect impact on amenity for students and staff at the University due to increased operational noise.

**Local business**

At a regional level, the proposal would have long-term beneficial impacts on business and industry through improved access and connectivity between the Illawarra region and Sydney, including improved access for freight accessing Port Kembla. The proposal would also enhance accessibility to and from the M1 Princes Motorway and the Wollongong CBD and the University of Wollongong.

Locally, the proposal would improve road safety and accessibility, supporting general improvements to local business and industry in the study area.

**6.8.5 Safeguards and management measures**

The proposed safeguards and management measures for property, land use and socio-economic impacts are listed in Table 6-40. Other safeguards and management measures that would address these impacts are identified in:

- Section 6.1 Traffic and transport
- Section 6.2 Noise and vibration
- Section 6.3 Biodiversity
- Section 6.4 Landscape character and visual impacts
- Section 6.11 Air quality.

Table 6-40 Safeguards and management measures for property, land use and socio-economic factors

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard/additional safeguard</th>
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<tbody>
<tr>
<td>Socio-economic</td>
<td>All property acquisition will be carried out in accordance with the <em>Land Acquisition Information Guide</em> (Roads and Maritime, 2012) and the <em>Land Acquisition (Just Terms Compensation) Act 1991.</em></td>
<td>Roads and Maritime project manager</td>
<td>Pre-construction and construction</td>
<td>Core standard safeguard PL1</td>
</tr>
</tbody>
</table>
A Community and Stakeholder Engagement Plan (CSEP) will be prepared in accordance with the Community Involvement and Communications Resource Manual (RTA, 2008), and implemented as part of the CEMP to help provide timely and accurate information to the community during construction. The CSEP will include (as a minimum):

- Mechanisms to provide details and timing of proposed activities to affected residents, including changed traffic and access conditions.
- Contact name and number for complaints.
- Consultation with potentially affected residents prior to commencement of and during work in accordance with Roads and Maritime’s Community Involvement and Communications Resource Manual. Consultation will include but is not limited to door knocks, newsletters or letterbox drops providing information on the proposed work, working hours and a contact name and number for more information or to register complaints.
- Consultation would be undertaken to advise of alternative routes to take during construction.
- Consultation with emergency services to ensure adequate emergency vehicle access is provided and maintained at all times.

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<th>Impact</th>
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<th>Timing</th>
<th>Standard/additional safeguard</th>
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</table>
| Socio-economic | A Community and Stakeholder Engagement Plan (CSEP) will be prepared in accordance with the Community Involvement and Communications Resource Manual (RTA, 2008), and implemented as part of the CEMP to help provide timely and accurate information to the community during construction. The CSEP will include (as a minimum):
- Mechanisms to provide details and timing of proposed activities to affected residents, including changed traffic and access conditions.
- Contact name and number for complaints.
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- Consultation would be undertaken to advise of alternative routes to take during construction.
- Consultation with emergency services to ensure adequate emergency vehicle access is provided and maintained at all times. | Contactor       | Pre-construction | Core standard safeguard SE1 |
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<th>Impact</th>
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<th>Timing</th>
<th>Standard/ additional safeguard</th>
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<td></td>
<td>times for the duration of construction.</td>
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<tr>
<td></td>
<td>• Consultation with the community and relevant stakeholders will be undertaken to establish the preferred design for new noise walls.</td>
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</tr>
<tr>
<td>Socio-economic</td>
<td>Heavy vehicle access will be limited near schools and child care centres during drop-off and pick-up times.</td>
<td>Contactor</td>
<td>During construction</td>
<td>Core standard safeguard</td>
</tr>
</tbody>
</table>
6.9 Aboriginal heritage

The potential impacts of the proposal on Aboriginal heritage are presented in this section, together with safeguards and management measures to manage any negative impacts.

6.9.1 Methodology

Preliminary investigations carried out by Roads and Maritime comprised an extensive search of the NSW Office of Environment and Heritage’s (OEH) Aboriginal Heritage Information Management System (AHIMS) and a site walkover carried out on 5 September 2014. The site walkover was completed in accordance with Stage 1 of Roads and Maritime’s Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI) and involved Roads and Maritime personnel and a representative from the Illawarra Local Aboriginal Land Council.

6.9.2 Existing environment

Historical background

Aboriginal groups inhabiting the Illawarra region belong to the Wodi Wodi group of the Dharawal language group (Kass, 2010). Evidence of Aboriginal occupation within the Illawarra region dates back at least 30,000 years; although evidence of earlier occupation is thought to have been disturbed by sea level rises (Kass, 2010). It has been suggested that the Wodi Wodi people would move to the coast during the spring, summer and autumn months to exploit abundant coastal food resources before becoming more dispersed during winter (Kass, 2010).

Registered Aboriginal heritage sites

A search of the AHIMS register indicated that there are no known registered Aboriginal heritage sites or sensitive landforms located within the proposal area.

Similarly, no previously unrecorded Aboriginal heritage sites or sensitive landforms were identified during the site walkover. Observations made during the site walkover confirmed that the proposal area does not contain landscape features that indicate the presence of Aboriginal objects, based on OEH's Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW (DECCW, 2010) and Roads and Maritime’s PACHCI.

A PACHCI clearance letter was obtained for the study area from the Roads and Maritime Aboriginal cultural heritage advisor. The clearance letter describes the proposal as unlikely to have an impact on Aboriginal cultural heritage based on the following:

- The proposal is unlikely to harm known Aboriginal objects or places
- The AHIMS search did not indicate any known Aboriginal objects or places in the proposal area
- The proposal area does not contain landscape features that indicate the presence of Aboriginal objects, based on the Office of Environment and Heritage’s Due Diligence Code of Practice for the Protection of Aboriginal objects in NSW and the Roads and Maritime Services’ procedure
- The Aboriginal cultural heritage potential of the proposal area appears to be severely reduced due to past disturbance
- There is an absence of sandstone rock outcrops likely to contain Aboriginal art.
Archaeological potential
The proposal area is located within an urban area that has experienced a substantial degree of ground disturbance associated with past and present land use activities. The archaeological potential of the proposal area is considered to be low. No further Aboriginal archaeological investigation is required for the proposed works.

6.9.3 Potential impacts

Construction
Any potential for impacts on Aboriginal heritage would be related to unexpected finds of Aboriginal heritage items (or suspected items) during the construction phase. The proposal area is considered unlikely to contain and therefore impact any items of Aboriginal heritage or Aboriginal archaeological remains.

Risks associated with potential impacts to unexpected Aboriginal objects, historical archaeological relics, historic work, structures, buildings or movable objects, or human skeletal remains, should such items be uncovered within the proposal area, would be readily manageable through Roads and Maritime’s (2015) Standard Management Procedure: Unexpected Archaeological Finds Procedure (refer to Table 6-41). If Aboriginal heritage items (including skeletal remains) are uncovered during the proposal, all works in the vicinity of the find will cease and the Roads and Maritime Aboriginal Cultural Heritage Officer and Environment representative contacted immediately.

Operation
As no Aboriginal heritage sites or sensitive landforms have been identified within the proposal area, no impacts are anticipated during operation of the proposal.
### 6.9.4 Safeguards and management measures

Safeguards and management measures for potential impacts of the proposal on Aboriginal heritage are listed in Table 6-41.

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<thead>
<tr>
<th>Impact</th>
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<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aboriginal heritage</td>
<td>The <em>Standard Management Procedure - Unexpected Heritage Items</em> (Roads and Maritime, 2015) will be followed in the event that an unknown or potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Roads and Maritime does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place. Work will only re-commence once the requirements of that Procedure have been satisfied.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Core standard safeguard AH2 Section 4.9 of QA G36 Environment Protection</td>
</tr>
</tbody>
</table>

### 6.10 Non-Aboriginal heritage

The potential impacts of the proposal on non-aboriginal heritage are presented in this section, together with safeguards and management measures to manage any negative impacts.

#### 6.10.1 Methodology

A desktop review of the following non-aboriginal heritage registers and resources was carried out to inform this assessment:

- NSW State Heritage Register
- Roads and Maritime’s Section 170 Heritage and Conservation Register
- Wollongong Local Environmental Plan 2009
- Commonwealth Heritage List
- National Heritage List
- World Heritage List
- Register of the National Estate
- A Thematic History of the City of Wollongong (Kass, 2010)
- Publicly available information from the Wollongong City Council website.
6.10.2 Existing environment

**Historical background**

The first land grants in Wollongong were issued in 1817 (Wollongong City Council, 2013; Kass, 2010). Timber harvesting and land clearing for agriculture were the primary forms of employment in the region during the early stages of European settlement, with surplus produce from the region being shipped up to Sydney (Wollongong City Council, 2013).

The first coal mine in the Illawarra was opened at Mount Keira in 1849, which had a considerable effect on both the primary form of employment in the region and the port at Wollongong Harbour, which was expanded in 1868 to accommodate the growing volume of coal being exported from the region via the sea (Wollongong City Council, 2013).

In 1930, steel production in the Illawarra region commenced following the opening of the first blast furnace at Port Kembla (Wollongong City Council, 2014). Steel production at Port Kembla increased following BHP’s acquisition of Australian Iron and Steel Limited in 1936 (Wollongong City Council, 2013), resulting in a large influx of migrant workers seeking employment in the steelworks and other manufacturing industries, driving urban expansion within the Illawarra region (Department of Planning, 2007). Employment in the Illawarra region has since diversified, with tourism, information technology, hospitality and health services now forming key areas of growth within the area (Wollongong City Council, 2014).

Access and transportation into the Illawarra region during the preliminary stages of European settlement was primarily via the sea, due to the difficulty in finding an easily navigable land access route down the Illawarra Escarpment (Kass, 2010). The earliest reliable road crossings of the Illawarra Escarpment opened in 1843 to 1868 and included a crossing between Dapto and Berrima, as well as Bulli Pass (Kass, 2010).

Road construction in the region intensified during World War Two, with a number strategic road linkages established during this period (Kass, 2010). Mount Ousley Road was built in 1942 for the purposes of providing vehicles with an alternative access route into the Illawarra from the north, which up until this time was only provided via Bulli Pass and the Princes Highway (Kass, 2010). The Mount Ousley Road crossing of the Illawarra Escarpment (now referred to as the M1 Princes Motorway) continues to provide the primary access route for vehicles travelling between Sydney and the Illawarra region.

**Heritage items within the proposal area**

**Commonwealth heritage items**

There are no world heritage properties or national heritage places located within the proposal area.

**State heritage items**

There are no registered State heritage items or areas of archaeological significance located within the proposal area.

**Local heritage items**

There are no registered heritage items or registered heritage conservation areas located within the proposal area.

The potential for previously unrecorded heritage items or archaeological relics to be present within the proposal area is considered to be low.
**Archaeological potential**

Non-Aboriginal archaeological potential is defined as the potential of a site to contain historical relics, as classified under the NSW *Heritage Act 1977*. Non-Aboriginal archaeological potential is assessed by identifying former land uses and associated features through historical research, and evaluating whether subsequent actions (natural or human) may have impacted on evidence for these former land uses.

The proposal area has undergone major disturbance throughout the period of European settlement, most of which is associated with clearing, excavation and earthworks for Mount Ousley Road and the M1 Princes Motorway. Over time the corridor has been widened, the road reconstructed and gradients altered, such that any archaeological potential would have been erased. The archaeological potential of the proposal area (State or local heritage significance) is therefore considered to be low.

**Listed heritage items near the proposal area**

Illawarra Escarpment Landscape Area is located more than 300 metres to the west of the proposal area. Houses in Mount Ousley at 3 Sansey Avenue, 18 Strone Avenue and 31 Burling Avenue are all about 150 metres from the proposal area. These are shown in Figure 6-17.

These heritage items have not been included in the assessment given their location away from the M1 Princes Motorway and Mount Ousley Road.
Figure 6-17 Listed heritage items located near to the proposal area
6.10.3 Potential impacts

Construction

There is potential for previously unrecorded heritage items or archaeological relics to be unearthed during the construction period, although this potential is considered to be of low risk.

If unexpected archaeological remains are uncovered during the proposal, all works will cease in the vicinity of the material/find and the steps in the Roads and Maritime’s *Standard Management Procedure: Unexpected Heritage Items* (Roads and Maritime, 2015) will be followed. Roads and Maritime Senior Environment Specialist (Heritage) will be contacted immediately.

If any items defined as relics under the *NSW Heritage Act 1977* are uncovered during the proposal, all works will cease in the vicinity of the find and the Roads and Maritime Senior Environment Specialist (Heritage) contacted immediately.

Operation

As no heritage items have been identified within the proposal area, no impacts are associated with the operational period.

6.10.4 Safeguards and management measures

Safeguards and management measures for potential impacts of the proposal on non-Aboriginal heritage are listed in Table 6-42.

Table 6-42 Safeguards and management measures for non-Aboriginal heritage

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Aboriginal heritage</td>
<td>The Standard Management Procedure - Unexpected Heritage Items (Roads and Maritime, 2015) will be followed in the event that any unexpected heritage items, archaeological remains or potential relics of Non-Aboriginal origin are encountered. Work will only re-commence once the requirements of that Procedure have been satisfied.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Core standard safeguard H2 Section 4.10 of QA G36 Environment Protection</td>
</tr>
</tbody>
</table>

6.11 Air quality

The potential impacts of the proposal on air quality are presented in this section, together with safeguards and management measures to manage any negative impacts.

6.11.1 Methodology

Identification of key risks

During construction, air quality issues may arise from temporary increases in local dust (including total deposited dust, total suspended solids and fine particulate matter) emissions associated with vegetation clearing, excavation and demolition works and the handling, storage and disturbance of soils and materials; and other emissions such as exhaust fumes associated with the operation of construction machinery.

The Approved Methods for the Modelling and assessment of Air pollutants in New South Wales (Approved Methods), (NSW Environment Protection Agency, 2016) lists the following ‘impact assessment criteria’ (refer to Table 6-43) for the purpose of evaluating emissions of dust and particulate matter.

Table 6-43 NSW EPA impact assessment criteria most relevant to typical emissions during construction

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging period</th>
<th>Concentration (µg/m³) unless stated</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total suspended solids (TSP)</td>
<td>Annual</td>
<td>90</td>
<td>NHMRC, 1996</td>
</tr>
<tr>
<td>Deposited dust (DD)</td>
<td>Annual</td>
<td>4 g/m²/month</td>
<td>NERDDC, 1988</td>
</tr>
<tr>
<td></td>
<td>Maximum increase</td>
<td>2 g/m²/month</td>
<td>NERDDC, 1988</td>
</tr>
<tr>
<td>Particulate matter with an aerodynamic diameter less than 10 microns (PM₁₀)</td>
<td>24 hours</td>
<td>50</td>
<td>DoE, 2016</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>25</td>
<td>DoE, 2016</td>
</tr>
<tr>
<td>Particulate matter with an aerodynamic diameter less than 2.5 microns (PM₂.₅)</td>
<td>24 hours</td>
<td>25</td>
<td>DoE, 2016</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>8</td>
<td>DoE, 2016</td>
</tr>
</tbody>
</table>

* µg/m³: micrograms per cubic metre

The primary risk to air quality during operations is emissions resulting from the combustion of fossil fuels in motor vehicles. The Australia State of the Environment 2016: Atmosphere (SoE 2016) report (Department of the Environment and Energy, 2017) lists carbon monoxide (CO), oxides of nitrogen (NOₓ) including nitrogen dioxide (NO₂) and particulate matter (PM₁₀ and PM₂.₅) as the primary pollutants associated with motor vehicle emissions. Volatile organic compounds (VOCs) are also noted to be a key species of pollutants associated with motor vehicle exhaust emissions.
Applicable criteria for these pollutants from the Approved Methods have been reproduced in Table 6-44.

Table 6-44 NSW EPA impact assessment criteria most relevant to primary emissions associated with operations

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging period</th>
<th>Concentration (µg/m³) unless stated</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate matter with an aerodynamic diameter less than 10 microns (PM₁₀)</td>
<td>24 hours</td>
<td>50</td>
<td>DoE, 2016</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>25</td>
<td>DoE, 2016</td>
</tr>
<tr>
<td>Particulate matter with an aerodynamic diameter less than 2.5 microns (PM₂.₅)</td>
<td>24 hours</td>
<td>25</td>
<td>DoE, 2016</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>8</td>
<td>DoE, 2016</td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>15 minutes</td>
<td>100 mg/m³</td>
<td>WHO, 2000</td>
</tr>
<tr>
<td></td>
<td>1 hour</td>
<td>30 mg/m³</td>
<td>WHO, 2000</td>
</tr>
<tr>
<td></td>
<td>8 hours</td>
<td>10 mg/m³</td>
<td>NEPC, 1998</td>
</tr>
<tr>
<td>Nitrogen dioxide (NO₂)</td>
<td>1 hour</td>
<td>246</td>
<td>NEPC, 1998</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td>62</td>
<td>NEPC, 1998</td>
</tr>
<tr>
<td>Volatile organic compounds (VOCs) as benzene</td>
<td>1 hour</td>
<td>29</td>
<td>VGG, 2001</td>
</tr>
</tbody>
</table>

* µg/m³: micrograms per cubic metre

**Risk-based assessment of potential impacts**

To evaluate the potential for air quality impacts during both phases of the proposal, a risk-based qualitative assessment method was applied. The likelihood (probability) and consequence (severity) of activities with the potential to result in air quality impacts were evaluated to develop initial risk ratings. This was completed using metrics developed based on guidance from AS/NZS ISO 31000: 2009 Risk Management – Principles and Guidelines shown in Table 6-45 and 6-46.
Table 6-45 Environmental risk evaluation matrix (based on guidance from AS/NZS ISO 31000:2009)

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Likelihood</th>
<th>Very unlikely</th>
<th>Unlikely</th>
<th>Possible</th>
<th>Likely</th>
<th>Almost certain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catastrophic</td>
<td></td>
<td>15</td>
<td>19</td>
<td>22</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>Major</td>
<td></td>
<td>10</td>
<td>14</td>
<td>18</td>
<td>21</td>
<td>23</td>
</tr>
<tr>
<td>Moderate</td>
<td></td>
<td>6</td>
<td>9</td>
<td>13</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>Minor</td>
<td></td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>Insignificant</td>
<td></td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 6-46 Method for evaluating the significance of calculated risks, (based on guidance from AS/NZS ISO 31000: 2009)

<table>
<thead>
<tr>
<th>Risk rating</th>
<th>Risk category</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 7</td>
<td>Low</td>
<td>Negligible effect or implication on the environment. No injury, insignificant financial loss (i.e. less than $5,000), minimal environmental damage, no complaints. Environmental impact that would not be of concern to a reasonable person.</td>
</tr>
<tr>
<td>8 to 12</td>
<td>Medium</td>
<td>Minor effect or implication on the environment. First-aid required, on site damage immediately contained with no long-term impacts, minor financial loss (greater than $5,000 but less than $50,000), occasional complaints, possible media interest. Localised and reversible damage to the environment.</td>
</tr>
<tr>
<td>13 to 18</td>
<td>High</td>
<td>Moderate, medium-term effect or implication on the environment. Medical treatment required, containable localised damage on-site, moderate financial loss (greater than $50,000 but less than $5,000,000), low likelihood of prosecution, minimal fines, occasional complains and possible media interest. Extensive and reversible or localised and irreversible environmental damage.</td>
</tr>
<tr>
<td>Risk rating</td>
<td>Risk category</td>
<td>Comments</td>
</tr>
<tr>
<td>------------</td>
<td>---------------</td>
<td>----------</td>
</tr>
<tr>
<td>19 to 22</td>
<td>Very High</td>
<td>Long-term effect or implication on the environment. Extensive injuries, project suspensions for a period of days, major financial loss (greater than $5,000,000 but less than $100,000,000), significant on-site environmental damage, very bad media coverage, community discontent, possible prosecution. Extensive and reversible or localised and irreversible environmental damage.</td>
</tr>
<tr>
<td>23 to 25</td>
<td>Extreme</td>
<td>Irreversible, extensive implications on the environment. Death, project suspensions for a period of weeks, massive financial loss (greater than $100,000,000), significant off-site environmental damage, sustained bad media coverage, sustained complaints and community discontent, probable prosecution.</td>
</tr>
</tbody>
</table>

6.11.2 Existing environment

Surrounding receivers

The proposal area is set within an urbanised environment. The University of Wollongong, TAFE NSW Wollongong campus and residential properties close to the proposal area all are the main receptors that need to be taken into consideration for the air quality assessment.

Local climate and meteorological conditions

Meteorological conditions are important for determining the direction and rate at which emissions from a source will disperse. The nearest weather station with long-term historical records operated by the BoM is the Bellambi automatic weather station (AWS) (Station number 068228). This station is located approximately 5.6 km to the north east of the proposal.

Table 6-47 displays long-term temperature and rainfall averages recorded at this station from its date of commission in 1997 to May 2017.

Table 6-47 Long-term temperature and rainfall data from BoM Bellambi AWS, (BoM, 2017)

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean maximum temperature (°C)</th>
<th>Mean minimum temperature (°C)</th>
<th>Mean rainfall (mm)</th>
<th>Mean number of rain days (&gt; 1 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>24.9</td>
<td>19.1</td>
<td>81.4</td>
<td>8.3</td>
</tr>
<tr>
<td>February</td>
<td>24.8</td>
<td>19.2</td>
<td>137.0</td>
<td>9.3</td>
</tr>
<tr>
<td>March</td>
<td>24.0</td>
<td>18.2</td>
<td>123.7</td>
<td>9.7</td>
</tr>
<tr>
<td>April</td>
<td>22.2</td>
<td>15.6</td>
<td>101.1</td>
<td>8.7</td>
</tr>
<tr>
<td>May</td>
<td>19.8</td>
<td>13.1</td>
<td>84.1</td>
<td>6.3</td>
</tr>
</tbody>
</table>
### Month-wise Mean Climate Data

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean maximum temperature (°C)</th>
<th>Mean minimum temperature (°C)</th>
<th>Mean rainfall (mm)</th>
<th>Mean number of rain days (&gt; 1 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>17.6</td>
<td>11.2</td>
<td>129.8</td>
<td>7.8</td>
</tr>
<tr>
<td>July</td>
<td>16.9</td>
<td>10.1</td>
<td>80.4</td>
<td>6.2</td>
</tr>
<tr>
<td>August</td>
<td>18.0</td>
<td>10.6</td>
<td>97.3</td>
<td>5.6</td>
</tr>
<tr>
<td>September</td>
<td>20.1</td>
<td>12.5</td>
<td>57.1</td>
<td>6.3</td>
</tr>
<tr>
<td>October</td>
<td>21.7</td>
<td>14.0</td>
<td>71.7</td>
<td>7.3</td>
</tr>
<tr>
<td>November</td>
<td>22.3</td>
<td>15.8</td>
<td>97.9</td>
<td>9.4</td>
</tr>
<tr>
<td>December</td>
<td>23.9</td>
<td>17.5</td>
<td>74.3</td>
<td>8.4</td>
</tr>
<tr>
<td><strong>Annual</strong></td>
<td><strong>21.3</strong></td>
<td><strong>14.7</strong></td>
<td><strong>1123.8</strong></td>
<td><strong>93.3</strong></td>
</tr>
</tbody>
</table>

The data indicates that the locality around the proposal experiences warm summers with mean daily maximum temperatures of around 24.5 degrees Celsius. The winter months through the end of July are the coldest of the year with average maximum temperatures of around 17 to 18 degrees Celsius. The wettest months on average are between later summer and mid-winter, with the driest months occurring through early spring.

To determine prevailing wind conditions around the proposal area, annual and seasonal wind data were reviewed for the years 2013, 2014 and 2015 at the Bellambi AWS. Annual and seasonal trends are generally consistent over the three years, with winds blowing commonly from the north east and south in spring and summer and from the south west and west in autumn and winter. Calm conditions (i.e. wind speeds less than 0.5 metres per second) were most common in summer; occurring between 2.7 and 5.2 per cent of the time during this season.

### Background air quality

The NSW OEH operates a state wide air quality monitoring network which provides information on current and historical air quality. The network includes three air quality stations in the Illawarra region. The nearest station in relation to the proposal is located at the Australian Army Depot on Gipps St, Wollongong (around 2 km to the south of the proposal area). Data from this station has been used to characterise ambient air quality conditions around the proposal area.

#### Air quality index

NSW OEH developed a metric known as the ‘air quality index’ (AQI) to provide an indication of the overall air quality. The metric considers pollutant data measurements for ozone (O3), nitrogen dioxide (NO2), carbon monoxide (CO), sulphur dioxide (SO2) and PM10, as well as visibility against criteria presented in the Variation to the National Environment Protection (Ambient Air Quality) Measure and OEH standard for visibility.

Statistics generated from daily AQI values calculated at the OEH Wollongong air quality monitoring station indicate that daily AQI values are generally ‘good’ with occasional days of ‘fair’ to ‘poor’ air quality.
quality or worse, usually driven by particulate matter concentrations. An annual daily maximum AQI in 2013 was a result of severe bushfires.

**Background concentrations**

A summary of the ambient concentrations of PM$_{10}$, PM$_{2.5}$, NO$_2$, SO$_2$ and CO measured at this station from 2013 to 2016 is shown below in Table 6-48. It is noted that the bracketed values are 95th percentile values, or concentrations not exceeded 95 percent of the time except during more extreme conditions.

Table 6-48 Summary of ambient pollutant concentrations measured from 2013 to 2016 at Wollongong

<table>
<thead>
<tr>
<th>Year</th>
<th>Wollongong</th>
<th>Impact assessment criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum 24 hour averaged PM$_{10}$ in µg/m$^3$</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>94 (37)</td>
<td>50</td>
</tr>
<tr>
<td>2014</td>
<td>45 (35)</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>46 (32)</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>53 (36)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annually averaged PM$_{10}$ in µg/m$^3$</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>2014</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maximum 24 hour averaged PM$_{2.5}$ in µg/m$^3$</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>88 (15)</td>
<td>25</td>
</tr>
<tr>
<td>2014</td>
<td>17 (13)</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>32 (14)</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>34 (15)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annually averaged PM$_{2.5}$ in µg/m$^3$</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>7.8</td>
<td>8</td>
</tr>
<tr>
<td>Year</td>
<td>Wollongong</td>
<td>Impact assessment criteria</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>2014</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>7.6</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>7.5</td>
<td></td>
</tr>
</tbody>
</table>

| Maximum 1 hour averaged NO\(_2\) in \(\mu\text{g/m}^3\) |
|-----------------|-----------------|
| 2013            | 94              |
| 2014            | 71              | 246                      |
| 2015            | 113             |
| 2016            | 81              |

| Annually averaged NO\(_2\) in \(\mu\text{g/m}^3\) |
|-----------------|-----------------|
| 2013            | 15              |
| 2014            | 15              | 62                       |
| 2015            | 15              |
| 2016            | 11              |

<table>
<thead>
<tr>
<th>Maximum 8 hour averaged CO in mg/m(^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
</tr>
<tr>
<td>2014</td>
</tr>
<tr>
<td>2015</td>
</tr>
<tr>
<td>2016</td>
</tr>
</tbody>
</table>

From this information, the following observations were made:

- **Particulate matter (PM\(_{10}\) and PM\(_{2.5}\))** – Annual concentrations were measured below the relevant impact assessment criteria. 24 hour averaged maximum concentrations generally exceeded the relevant criteria with 95\(^{th}\) percentile values calculated to be below these criteria.

- **Nitrogen dioxide (NO\(_2\)) and carbon monoxide (CO)** – Recorded values for both pollutants were well below the respective criteria for each averaging period of interest.
VOCs are not monitored at the nearest OEH air quality monitoring station. In the study, Ambient Air Quality Monitoring and Fuel Quality Testing Project (AAQMFQTP) completed by the NSW Environment Protection Authority between October 2008 and October 2009 an annual concentration of benzene was measured of 0.6 parts per billion. This equates to an annual average concentration of around 1.2 µg/m³.

6.11.3 Potential impacts

Construction

The phases of construction considered as part of this assessment included:

- Pre-construction activities including establishment of temporary construction compound areas, equipment laydown areas and stockpiling locations; installation of construction fencing and screening; and transport of plant and equipment to the site
- General site activities including establishment and removal of safety, amenity and traffic controls during the works
- Road upgrade works which will involve the relocation of existing utilities and stormwater; construction of new drainage connections; road pavement widening works; installation of road furniture and signage; and landscaping
- Transport of stockpiled wastes to a licenced disposal facility; decommissioning of temporary compound, laydown and stockpiling areas; removal of plant, equipment and environmental controls from the site; and reinstate all property accesses.

Of these, it was identified that the following works have the greatest potential to generate dust:

- Excavation activities
- Materials handling and storage operations
- Demolition works
- Compound, laydown and storage area operations.

Owing to the highly urbanised nature of the setting, there is also the potential that materials may be excavated which exhibit other risks to air quality such as odour. These types of materials are most likely to be uncovered during excavation works, including utility and drainage relocation activities.

Operation

Exhaust emissions resulting from the combustion of fossil fuels present the greatest risk in the operational period, particularly at locations where traffic is being moved closer to receiver areas.

The outcomes of the risk assessment for the construction and operational periods are summarised in Table 6-49.

Table 6-49 Air quality risk assessment

<table>
<thead>
<tr>
<th>Activity</th>
<th>Phase</th>
<th>Impact</th>
<th>Pre-mitigated level of risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-construction – site establishment</td>
<td>Construction</td>
<td>• Emissions to air including dust and products of combustion (from equipment operations).</td>
<td>Low</td>
</tr>
<tr>
<td>Activity</td>
<td>Phase</td>
<td>Impact</td>
<td>Pre-mitigated level of risk</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>General activities – safety, traffic and amenity controls</td>
<td>Construction</td>
<td>• Emissions to air including dust and products of combustion (from equipment operations).</td>
<td>Low</td>
</tr>
<tr>
<td>Road upgrade works – excavations</td>
<td>Construction</td>
<td>• Emissions to air including dust and products of combustion (from equipment operations).</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Windborne dust emanating from disturbed/exposed surfaces.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Odours and emissions arising from uncovered contaminated and/or hazardous materials.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Dust and debris arising from haulage of materials.</td>
<td></td>
</tr>
<tr>
<td>Road upgrade works – demolitions</td>
<td>Construction</td>
<td>• Emissions to air including dust and products of combustion (from equipment operations).</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Impacts associated with hazardous materials contained within demolition wastes</td>
<td></td>
</tr>
<tr>
<td>Road upgrade works – construction of road pavement</td>
<td>Construction</td>
<td>• Emissions to air including dust and products of combustion (from equipment operations).</td>
<td>Low</td>
</tr>
<tr>
<td>Storage and management of materials</td>
<td>Construction</td>
<td>• Emissions to air including dust and products of combustion (from equipment operations).</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Windborne dust emanating from disturbed/exposed surfaces.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Dust and debris arising from haulage of materials.</td>
<td></td>
</tr>
<tr>
<td>Operation of temporary compound and laydown areas</td>
<td>Construction</td>
<td>• Emissions to air including dust and products of combustion (from equipment operations).</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Windborne dust emanating from disturbed/exposed surfaces.</td>
<td></td>
</tr>
</tbody>
</table>
### 6.11.4 Safeguards and management measures

Safeguards and management measures for potential impacts of the proposal on air quality are listed in Table 6-50.

**Table 6-50 Safeguards and management measures for air quality**

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
</table>
| Air quality       | An Air Quality Management Plan (AQMP) will be prepared and implemented as part of the CEMP. The AQMP will include, but not be limited to:  
- Potential sources of air pollution  
- Air quality management objectives consistent with any relevant published EPA and/or OEH guidelines  
- Mitigation and suppression measures to be implemented  
- Methods to manage work during strong winds or other adverse weather conditions  
- Methods for management of stored materials and excavated materials which are hazardous and/or exhibit odour  
- A progressive rehabilitation strategy for exposed surfaces. | Contractor      | Detailed design / pre-construction          | Core standard safeguard AQ1  
Section 4.4 of QA G36 Environment Protection |
With the implementation of the safeguard and management measures above it is expected that the initial risk rating above would be able to be reduced to a level of ‘medium’ or lower.

6.12 Sustainability and climate change

The potential impacts of the proposal on sustainability and climate change is presented in this section, together with safeguards and management measures to manage any negative impacts.

6.12.1 Methodology

The following sources of information have been used to inform this assessment:

- NSW Office of Environment and Heritage’s (OEH) *NSW Climate Impact Profile* (DECCW, 2010)
- The Intergovernmental Panel on Climate Change’s (IPCC) *Fifth Assessment Report* (IPCC, 2013)
- OEH’s NSW Sea Level Rise Policy Statement (DECCW, 2009)
- Wollongong City Council’s (2010) *Coastal Zone Management Plan*.

6.12.2 Existing environment

Sustainability refers to maintenance of natural resources, and the aim of the Roads and Maritime Environmental Sustainability Strategy 2015 to 2019 (Roads and Maritime, 2016) is to conserve and enhance air, environmental resources required for biodiversity and our communities.

Climate change refers to the projected long-term changes to global climatic patterns as a result of increases in the concentration of greenhouse gases in the atmosphere. Greenhouse gases, such as carbon dioxide, methane and sulphur hexafluoride, have heat absorbing capacity (also referred to as global warming potential), meaning that they absorb heat that is reflected from the earth, which results in warming of the air. There is a need to understand the projected changes to future climatic conditions and the effect they could have on existing and future land use developments and infrastructure projects. Moreover, it is important to understand how the proposal might influence these changes.

In addition to the effects that climate change are forecast to have on global climatic patterns, the predicted warming of the earth’s atmosphere is also considered likely to have an effect on global sea levels (Intergovernmental Panel on Climate Change (IPCC), 2013). The IPCC’s (2013) *Fifth Assessment Report* outlines that global sea levels have risen by about 0.19 metres between the years 1901 and 2010. Sea levels are predicted to continue to rise during the 21st century, which has the potential to impact on coastal communities, infrastructure and environments (IPCC, 2013).

**Climate change forecasts for the Illawarra region**

**Projected regional climatic changes**

The former NSW Department of Environment, Climate Change and Water NSW (DECCW; now the NSW Office of Environment and Heritage), in partnership with the Climate Change Research Centre at the University of New South Wales, has developed regional climate projections for NSW based on preliminary analyses of global modelling data. These projections are documented in the NSW Climate Impact Profile (DECCW, 2010).
Table 6-51 provides a summary of the climate change forecasts (projected to the year 2050) for the Illawarra region, which have been adapted from the NSW Climate Impact Profile (DECCW, 2010).

Table 6-51 Climate change forecasts – Illawarra region

<table>
<thead>
<tr>
<th>Season</th>
<th>Seasonal rainfall</th>
<th>Temperature</th>
<th>Evaporation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Spring</td>
<td>10-20% increase</td>
<td>2.0 to 3.0°C</td>
<td>2.0 to 3.0°C</td>
</tr>
<tr>
<td>Summer</td>
<td>20-50% increase</td>
<td>2.0 to 3.0°C</td>
<td>1.5 to 2.0°C</td>
</tr>
<tr>
<td>Autumn</td>
<td>10-20% increase</td>
<td>2.0 to 3.0°C</td>
<td>2.0 to 3.0°C</td>
</tr>
<tr>
<td>Winter</td>
<td>No change</td>
<td>2.0 to 3.0°C</td>
<td>2.0 to 3.0°C</td>
</tr>
</tbody>
</table>

Source: Adapted from the NSW Climate Change Impact Profile (DECCW, 2010).

Expected regional climatic changes for the Illawarra region, as defined in the NSW Climate Change Impact Profile (DECCW, 2010), are as follows:

- Increase in average daily minimum and maximum temperatures
- Shifts in current patterns of climate variability, including increased rainfall in summer and decreased rainfall in winter
- Increased intensity of extreme events (e.g. droughts, floods, severe storm events)
- Changes in seasonality and amount of precipitation (the direction and magnitude of changes will vary between geographic locations).

By 2050, the Illawarra region of NSW is expected to experience a hotter climate, with both minimum and maximum temperatures projected to increase by between 1.5°C and 3°C throughout the year. Rainfall is projected to increase, particularly in summer. Evaporation in spring and summer will increase, with no clear change in evaporation patterns in autumn and winter.

**Project sea level rise**

The IPCC’s (2013) *Fifth Assessment Report* predicts that, if global warming was able to be contained below two degrees above pre-industrial temperatures (through a significant reduction in greenhouse gas emissions), future sea levels would rise by about 0.28 metres to 0.61 metres by 2100. However, under a high greenhouse gas emission scenario (where little effort is made to reduce emissions), the IPCC (2013) predicts that future sea levels would rise by about 0.52 metres to 0.98 metres by 2100. Global sea levels are predicted to continue to rise beyond 2100 (IPCC, 2013).

The NSW Government’s *NSW Sea Level Rise Policy Statement* (DECCW, 2009) outlines the NSW Government’s response to the risks associated with the forecasted increase in global sea levels, and the support that the Government will provide to assist local communities and councils prepare and adapt to rising sea levels.

The NSW Government has adopted the following sea level rise planning benchmarks (as part of the *NSW Sea Level Rise Policy Statement; DECCW, 2009*) to provide a consistent approach to managing sea level rise throughout NSW:
• An increase in average sea levels of 0.4 metres by the year 2050
• An increase in average sea levels of 0.9 metres by the year 2100.

These sea level rise planning benchmarks represent the current national and international projections of sea level rise along the NSW coast (DECCW, 2009).

Under *NSW Sea Level Rise Policy Statement* (DECCW, 2009), councils have the flexibility to determine their own sea level risk projections to suit their local conditions. Relevant to the proposal area, Wollongong City Council is currently preparing a Coastal Zone Management Plan for Wollongong, which will be completed in two stages.

Stage 1 of the Coastal Zone Management Plan for Wollongong comprised the completion of the *Wollongong City Council Coastal Zone Study* (Wollongong City Council 2010) which identified and mapped areas within the Wollongong CBD that are considered to be at risk from coastal processes, climate change and sea level rise. The hazards considered included coastal erosion and recession, ocean inundation and geotechnical instability (in the event of a 1 in 100 year ocean conditions) and sea level rises (of 40 centimetres to 2050 and 90 centimetres to 2100 above the 1990 average sea level).

Land situated within the proposal area is not mapped as being at risk from coastal processes, climate change or sea level rise under the *Wollongong City Council Coastal Zone Study* (Wollongong City Council, 2010), therefore this has not been assessed further.

### 6.12.3 Potential impacts

**Construction**

Climate change risks during the construction of the proposal would primarily be associated with the occurrence of severe weather events; for example, the increased frequency and severity of rainfall events placing increased pressure on erosion and sediment control measures and/or flooding of the work site.

The extent to which climate change risks could alter the pattern of existing hydrology and flooding constraints within the proposal area is likely to be minor given that the construction period would be temporary, over a period around 2.5 years. Therefore it is not expected that climate change risks would cause a discernible impact to construction activities. Hydrology and flooding constraints within the proposal area are discussed further in Section 6.5.

Potential impacts on climate change from construction activities would be readily manageable through the application of standard mitigation measures.

**Operation**

Climate change risks during the operation of the proposal would primarily be associated with:

Increases in average temperatures and heatwaves which may affect the integrity of pavement and other construction materials. Direct impacts could include more rapid deterioration of infrastructure, which may result in higher operational and maintenance costs. Indirectly, evaporative changes can result in changes to soil moisture content and soil instability, which may impact on slope stability (increasing the potential for landslips), the foundations of structures, as well as cause cracking and/or softening of pavements and road rutting.

The increased frequency and severity of rainfall events, which may place increased pressure on drainage infrastructure and/or result in flooding of the proposal area.
Overall, the above climate change risks are considered to be readily manageable through the adoption of standard practices that are currently being applied elsewhere for similar infrastructure projects. Such measures include designing infrastructure in accordance with relevant standards and guidelines and ensuring that stormwater drainage is designed with sufficient capacity to account for the projected effects of climate change on the Illawarra region.

In addition, road infrastructure established as part of the proposal is unlikely to be any more susceptible to climate change risks than that of the existing road network. Therefore, the above climate change risks are unlikely to be significant constraints for the proposal.

6.12.4 Safeguards and management measures

Safeguards and management measures for potential impacts of the proposal on sustainability and climate change are listed in Table 6-52.

Table 6-52 Safeguards and management measures for sustainability and climate change

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
</table>
| Sustainability and climate change | During detailed design and construction, the following measures will be considered and implemented where possible:  
• Use of LED and low energy equipment for traffic lights and signage  
• Plant and equipment will be switched off when not in use  
• Vehicles, plant and construction equipment will be appropriately sized for the task and properly maintained so as to achieve optimum fuel efficiency  
• The use of alternative fuels and power sources for construction plant and equipment will be investigated and implemented, where appropriate.  
• Energy efficiency and related carbon emissions will be considered when selecting vehicles and equipment  
• Vegetation clearing will be reduced as much as feasible, and re-established in suitable | Contractor       | Construction | Additional safeguard           |
### 6.13 Waste and resource use

The potential impacts of the proposal on waste and resource management are presented in this section, together with safeguards and management measures to manage any negative impacts.

#### 6.13.1 Policy setting

The Protection of the Environment Operations Act 1997 (POEO Act), the POEO (Waste) Regulation 2005 and the hierarchy prescribed in the Waste Avoidance and Resource Recovery Act 2001 (WARR Act) are the key pieces of legislation that regulate waste in New South Wales. They contain the requirements for managing, storing, transporting, processing, recovering and disposing of waste.

The NSW Government released the NSW WARR Strategy 2014-21 to minimise waste generated across all government sectors and improve the efficient use of resources. This reflects the community's view that waste should be treated as a resource. The WARR Strategy identifies the following waste avoidance and resource recovery goals and targets:

- Avoid and reduce waste reduction
- Increase recycling
- Divert more waste from landfill
- Manage problem wastes better
- Reduce litter
- Reduce illegal dumping.


#### 6.13.2 Existing environment

The road network in the proposal area currently generates minimal waste. Waste sources are limited to roadside litter, some waste material from clearing roadside drainage, and green waste associated with the maintenance of roadside vegetation.

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**Table: Impact of Waste and Resource Use**

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
</table>
|        | areas when construction is completed  
- Waste will be reduced and recycled as a preference before disposing to landfill. |                |        |                                |
6.13.3 Potential impacts

Construction

Waste

Construction of the proposal involving earthworks, structures, pavements, drainage, utilities placement and protection, establishment of ancillary sites, installation of lighting and fencing, would generate waste streams typical of road construction, including:

- Green waste from cleared vegetation
- Road infrastructure materials to be removed and/or replaced
- Oil, grease and other liquid wastes from the maintenance of construction plant and equipment
- General wastes and sewage from site compound offices
- Packaging materials from items delivered to site, such as pallets, crates, cartons, plastics and wrapping materials
- Potential contaminated material unearthed during construction (refer to Section 6.7).

At this stage of concept design, it is anticipated that cut and fill earthworks would result in a surplus of fill material, in the order of about 22,000 cubic metres of excess cut material that would not have suitable engineering properties to be used as 'select' fill (refer Section 3.3.4). This material would therefore need to be disposed of at a suitable landfill or other facility. During detailed design, the quantity of waste streams would be estimated, taking into account the suitability (or otherwise) of cut material for reuse.

Volumes of waste generated by the proposal would be managed through the application of standard mitigation measures shown in Table 6-53.

Resource use

Construction of the proposal would require the use of various construction materials, including:

- Earthworks materials, such as topsoil and general fill material
- Aggregates for drainage construction, concrete and asphalt production and spray seals
- Sand for drainage construction, and concrete and asphalt production
- Concrete for drainage and pavement construction, bridgeworks and miscellaneous works
- Bitumen for spray seals and asphalt production
- Cement and fly ash for concrete production
- Road base for the construction of flexible pavements
- Precast concrete elements for drainage construction and miscellaneous works
- Steel for barrier railings and reinforcement in concrete
- Super-T bridge beams.

The proposal would not create any significant demand on these resources, such that they would become in short supply.

Operation

Operation of the proposal would not increase the amount or change the type of waste generated within the proposal area.
6.13.4 Safeguards and management measures

Safeguards and management measures for potential impacts of the proposal on waste and resource management are listed in Table 6-53.

Table 6-53 Safeguards and management measures for waste and resource management

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste management</td>
<td>A Resource and Waste Management Plan (RWMP) will be prepared and implemented as part of the CEMP. The RWMP will include the following (as a minimum):</td>
<td>Construction contractor</td>
<td>Construction</td>
<td>Core standard safeguard WM1</td>
</tr>
<tr>
<td></td>
<td>• The type, classification and volume of all materials to be generated and used on site including identification of recyclable and non-recyclable waste in accordance with EPA Waste Classification Guidelines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Quantity and classification of excavated material generated as a result of the proposal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Interface strategies for cut and fill on site to ensure reuse where possible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Strategies to ‘avoid’, ‘reduce’, ‘reuse’ and ‘recycle’ materials.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Classification and disposal strategies for each type of material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Destinations for each resource/waste type either for on-site reuse or recycling, offsite reuse or recycling, or disposal at a licensed waste facility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Details of how material will be stored and treated on-site.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Identification of available recycling facilities on and off site</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Identification of suitable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Environmental safeguards</td>
<td>Responsibility</td>
<td>Timing</td>
<td>Standard / additional safeguard</td>
</tr>
<tr>
<td>------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------</td>
<td>-----------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Waste management</td>
<td>The following resource management hierarchy principles will be followed through the project life cycle:</td>
<td>Construction contractor</td>
<td>Detailed design, pre-construction, construction</td>
<td>Core standard safeguard WM12</td>
</tr>
<tr>
<td></td>
<td>• Unnecessary resource consumption will be avoided as a priority</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Where avoidance is not possible, waste will be processed for resource recovery (including reuse of materials, reprocessing, recycling and energy recovery)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Where resource recovery is not possible, waste will be disposed as a last resort at an appropriately licensed waste facility – in accordance with the Waste Avoidance and Resource Recovery Act 2001 and the EPA waste classification guidelines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Procurement will endeavour to use materials and products with a recycled content, provided that material or product is cost-effective and methods and routes to transport waste.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Procedures and disposal arrangements for unsuitable excavated material or contaminated material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Site clean-up for each construction stage.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Provision of appropriate garbage and recycling receptacles. Waste which cannot be recycled or reused will be disposed regularly at a licensed waste facility.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>Environmental safeguards</td>
<td>Responsibility</td>
<td>Timing</td>
<td>Standard / additional safeguard</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>-------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Waste management</td>
<td>All waste will be classified according to the Waste Classification Guidelines Part 1: Classifying Waste (EPA, 2014).</td>
<td>Construction contractor</td>
<td>Construction</td>
<td>Core standard safeguard WM3</td>
</tr>
</tbody>
</table>

### 6.14 Cumulative impacts

#### 6.14.1 Proposal area

The proposal area used for the assessment of cumulative impacts has been defined by identifying other developments or activities that are under way now, or are likely to commence during the proposal’s scheduled construction timeframe. While no timing or funding has been committed for construction at this stage, construction of the proposal could begin in 2020 and is estimated to take about 2.5 years to complete.

The study area has considered the suburbs within and adjacent to the proposal area, including Mount Ousley, North Wollongong, Gwynneville, Keiraville, Mount Pleasant and Fairy Meadow. This covers an area of approximately 1 km in all directions from the proposal area.

#### 6.14.2 Other projects and developments

Given that the construction period for the proposal is likely to start in 2020, the list of other projects and developments within the study area could change after the publication of this REF. An initial list of other projects and developments is considered below.

**Improvements between Picton Road and Bulli Tops**

The M1 Princes Motorway improvements between Picton Road and Bulli Tops is a proposal to improve safety, capacity and travel times on this section of the motorway. This proposal is located about 7 km north of the M1 Princes Motorway Mount Ousley Interchange proposal. There is potential for the construction periods of the two proposals to overlap, which may result in some additional delays for vehicles travelling along this route. Traffic management of both proposals would be considered to minimise delays.

**University of Wollongong**

The University of Wollongong, adjacent to the proposal area has a campus masterplan (2016-2036) which creates a vision and framework to guide the physical development of the Wollongong campus over the next 20 years. This has been developed through University of Wollongong Strategic Plan (2016-2020), where the university recognised that a new masterplan was needed to support regional strategic planning initiatives for the campus. While details of new construction projects under the campus masterplan are under development, it is understood that the campus northern car park, which may be directly impacted under this proposal by the proposed new northern access road, may be complete or under construction at the same time as the proposal is under construction. Roads and Maritime will continue to engage with the University of Wollongong to manage any potential cumulative impacts.
Local developments

According to the Wollongong City Council website, a search of the current applications currently on exhibition found several local development applications in the suburbs within the proposal area. These included mainly demolition, alterations and additions to residential properties in Kairaville, and Gwynneville. A proposal to demolish an existing industrial facility in North Wollongong is currently being considered by Wollongong City Council.

6.14.3 Potential impacts

University of Wollongong

Depending on the program for development of the masterplan at the University of Wollongong campus, there is potential for cumulative impacts to occur with the proposal at Mount Ousley Interchange. This could include the in-combination impact of construction traffic on the local road network, and related noise and air quality impacts on nearby receptors.

The University of Wollongong masterplan and the proposal would improve the visual landscape, help to enhance local biodiversity and enhance connectivity and public access for the town of Wollongong in the operation of the proposal.

The likely cumulative impacts of the proposal with the proposed University of Wollongong campus masterplan during construction and operation are summarised in Table 6-54.

Local developments

In terms of the local residential and industrial developments proposed in the surrounding area to the proposal, as these are small to medium scale and not located adjacent to the proposal area, cumulative effects in construction and operation of the proposal are likely to be negligible.

Table 6-54 Potential cumulative impacts

<table>
<thead>
<tr>
<th>Environmental factor</th>
<th>Construction</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic and Transport, Air quality and noise and vibration</td>
<td>Likely to be a slight increase in construction traffic on the local network, as well as the related noise and air quality impacts for nearby sensitive receivers. These impacts are considered to be low.</td>
<td>The proposal will lead to improvements to traffic flows and safety on its own, but in combination with the University of Wollongong campus masterplan, there would not be further discernible impacts.</td>
</tr>
<tr>
<td>Landscape and visual, biodiversity and public access</td>
<td>No discernible impacts expected in the construction of the two projects.</td>
<td>Beneficial impacts to the visual landscape, local biodiversity and public access will take hold which would improve the liveability of the city of Wollongong.</td>
</tr>
</tbody>
</table>

6.14.4 Safeguards and management measures

The potential of negative cumulative impacts is most effectively addressed by the application of individual safeguards recommended throughout Chapter 6 of this REF and summarised in Section 7. Additional safeguards are listed in Table 6-55.
Table 6-55 Safeguards and management measures for cumulative impacts

<table>
<thead>
<tr>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative impacts</td>
<td>The CEMP will be updated as required to address cumulative impacts as other projects/activities begin. This will include a process to review and update mitigation measures as new work begins or if complaints are received.</td>
<td>Contractor</td>
<td>Pre-construction / Construction</td>
<td>Additional safeguard</td>
</tr>
</tbody>
</table>
7 Environmental management

This chapter describes how the proposal will be managed to reduce potential environmental impacts throughout detailed design, construction and operation. A framework for managing the potential impacts is provided. A summary of site-specific environmental safeguards is provided and the licence and/or approval requirements required prior to construction are also listed.

7.1 Environmental management plans (or system)

A number of safeguards and management measures have been identified in the REF in order to minimise adverse environmental impacts, including social impacts, which could potentially arise as a result of the proposal. Should the proposal proceed, these safeguards and management measures would be incorporated into the detailed design and applied during the construction and operation of the proposal.

A Project Environmental Management Plan (PEMP) and a CEMP will be prepared to describe the safeguards and management measures identified. The PEMP and CEMP will provide a framework for establishing how these measures will be implemented and who would be responsible for their implementation.

The PEMP and CEMP will be prepared prior to construction of the proposal and must be reviewed and certified by the Roads and Maritime Environment Officer, Southern Region, prior to the commencement of any on-site works. The CEMP and PEMP will be a working document, subject to ongoing change and updated as necessary to respond to specific requirements. The CEMP and PEMP would be developed in accordance with the specifications set out in the QA Specification G36 – Environmental Protection (Management System), QA Specification G38 – Soil and Water Management (Soil and Water Plan), QA Specification G40 – Clearing and Grubbing, QA Specification G10 - Traffic Management. These are described in more detail below:

- QA Specification G36 – Environmental Protection (Management System) describes an environmental protection management process which must be implemented as a minimum, to provide environmental protection during execution of the work.
- QA Specification G38 – Soil and Water Management (Soil and Water Plan) sets out the requirements for preventing water pollution, minimising soil erosion and controlling sedimentation on work sites.
- QA Specification G40 – Clearing and Grubbing consists of the clearing of vegetation, both living and dead, all minor built structures (such as fences and livestock yards), all rubbish and other materials which are unsuitable for use, and the grubbing of trees and stumps from the area to be cleared.
- QA Specification G10 - Traffic Management sets out the requirements for the management of traffic passing through and/or adjacent to the site.
7.2 Summary of safeguards and management measures

Environmental safeguards and management measures outlined in this REF will be incorporated into the detailed design phase of the proposal and during construction and operation of the proposal, should it proceed. These safeguards and management measures will minimise any potential adverse impacts arising from the proposed works on the surrounding environment. The safeguards and management measures are summarised in Table 7-1.

Table 7-1 Summary of safeguards and management measures

<table>
<thead>
<tr>
<th>No.</th>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
</table>
| GEN1| General - minimise environmental impacts during construction | A CEMP will be prepared and submitted for review and endorsement of the Roads and Maritime Environment Manager prior to commencement of the activity. As a minimum, the CEMP will address the following:  
  • any requirements associated with statutory approvals  
  • details of how the project will implement the identified safeguards outlined in the REF  
  • issue-specific environmental management plans  
  • roles and responsibilities  
  • communication requirements  
  • induction and training requirements  
  • procedures for monitoring and evaluating environmental performance, and for corrective action  
  • reporting requirements and record-keeping  
  • procedures for emergency and incident management  
  • procedures for audit and review.  
  The endorsed CEMP will be implemented during the undertaking of the activity. | Contractor / Roads and Maritime project manager | Pre-construction / detailed design | Core standard safeguard GEN1   |
<table>
<thead>
<tr>
<th>No.</th>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEN2</td>
<td>General - notification</td>
<td>All businesses, residential properties and other key stakeholders (e.g., schools, local councils) affected by the activity will be notified at least five days prior to commencement of the activity.</td>
<td>Contractor / Roads and Maritime project manager</td>
<td>Pre-construction</td>
<td>Core standard safeguard GEN2</td>
</tr>
</tbody>
</table>
| GEN3 | General – environmental awareness | All personnel working on site will receive training to ensure awareness of environment protection requirements to be implemented during the project. This will include up-front site induction and regular "toolbox" style briefings. Site-specific training will be provided to personnel engaged in activities or areas of higher risk. These include:  
  - threatened species habitat  
  - adjoining residential areas requiring particular noise management measures  
  - traffic management  
  - soil and water management  
  - community interaction.  
  Records of training will be maintained by the contractor, including details of staff attending, dates, nature of training provided, and training provider(s) used. | Contractor / Roads and Maritime project manager | Pre-construction / detailed design      | Core standard safeguard GEN3 |
| GEN4 | General – environmental awareness | Standard construction hours:  
  - Monday to Friday 7.00 am to 6.00 pm  
  - Saturdays 8.00 am to 1.00 pm  
  - No construction on Sundays or Public Holidays. | Contractor | Construction | Additional safeguard         |
<table>
<thead>
<tr>
<th>No.</th>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Works outside standard construction hours (including those detailed within this REF) will be undertaken in accordance with the management and mitigation measures detailed within the Noise and Vibration Management Plan.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEN5</td>
<td>General – environmental awareness</td>
<td>The final locations and configurations of ancillary facilities will be determined by the contractor in consultation with the Roads and Maritime Environmental representative to confirm the suitability of the locations and whether any additional environmental assessment is required. Stockpile and compound sites will be located and managed in accordance with the <em>Roads and Maritime Services Stockpile Site Management Guideline</em> (EMS-TG-10):</td>
<td>Contractor / Roads and Maritime project manager</td>
<td>Pre-construction / detailed design</td>
<td>Additional safeguard</td>
</tr>
</tbody>
</table>
| TT1 | Traffic and transport | A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the Roads and Maritime *Traffic Control at Work Sites Manual* (RTA, 2010) and QA Specification G10 Control of Traffic (Roads and Maritime, 2008). The TMP will (but is not limited to):  
  - Include individual traffic management requirements at each phase of construction  
  - Outline the general principles and procedures for the development of specific construction Traffic Management Plans (CTMPs)  
  - Ensure safe and continuous traffic movement for construction workers and the general public  
  - Maintain the capacity of existing roads where possible  
  - Identify the requirements for temporary speed restrictions where traffic | Contractor | Detailed design / Pre-construction | Core standard safeguard TT1  
  Section 4.8 of QA G36 Environment Protection |
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<td>may pose a safety risk to workers</td>
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<td>• Maintain continuity of access to local roads and properties, particularly along Mount Ousley Road and University Avenue (may require temporary u-turn facilities)</td>
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<td>• Provide temporary traffic control where necessary</td>
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<td>• Identify requirements and placement of traffic barriers</td>
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<td>• Provide appropriate warning and signage for traffic in the vicinity of work areas</td>
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<td>• Include methods to minimise road user delays such as undertaking works around live traffic including tie-in and bridge work outside of peak periods</td>
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<td>• Undertake construction activities off-line where possible to minimise the requirement to operate temporary traffic control and reduced speed zones</td>
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<td>• Develop a communication plan to advise local residents and businesses of any changes to traffic conditions during construction.</td>
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<tr>
<td>TT2</td>
<td>Traffic and transport</td>
<td>Requirements for any changes to local traffic and access arrangements will be confirmed during detailed design in consultation with Roads and Maritime, Wollongong City Council and any affected landowners, including any temporary alternative access arrangements as required.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
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<tr>
<td>TT3</td>
<td>Traffic and transport</td>
<td>Pedestrian and cyclist access will be maintained throughout construction in its current location where feasible. Where this is not feasible, temporary alternative access arrangements will be provided.</td>
<td>Contractor</td>
<td>Pre-construction</td>
<td>Additional safeguard</td>
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<tr>
<td>TT4</td>
<td>Traffic and transport</td>
<td>Access for public transport services will be maintained. The requirements for any temporary changes will be confirmed following consultation with local bus operators and the community.</td>
<td>Contractor</td>
<td>Pre-construction</td>
<td>Additional safeguard</td>
</tr>
</tbody>
</table>
| NV1 | Noise and vibration     | A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the CEMP. The NVMP will generally follow the approach in the *Interim Construction Noise Guideline* (ICNG) (DECC, 2009) and identify:  
• All potential significant noise and vibration generating activities associated with the activity  
• Feasible and reasonable mitigation measures to be implemented, taking into account *Beyond the Pavement: urban design policy, process and principles* (Roads and Maritime, 2014).  
• A monitoring program to assess performance against relevant noise and vibration criteria  
• Arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures  
• Contingency measures to be implemented in the event of non-compliance with noise and vibration criteria.  
In addition to the above, the NVMP will also consider:  
• Place as much distance as possible between the plant or equipment and residences and other sensitive land uses, particularly at site compounds.  
• Use of temporary site buildings and materials stockpiles as noise barriers where possible (e.g. on site compounds).  
• Scheduling construction of any permanent walls so that they can be | Contractor     | Detailed design / pre-construction | Core standard safeguard NV1  
Section 4.6 of QA G36 Environment Protection |
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<td>used as early as possible as noise barriers where possible.</td>
<td>• Where practical, scheduling the use of vibration intensive equipment for less sensitive times of the day.</td>
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<td>• Avoid multiple vibration intensive activities occurring at the same time where possible.</td>
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<td>• Selection of ancillary sites location shall consider the proximity of the sites to sensitive receivers. Where compounds are close to residences, additional care shall be taken in layout and utilising structures and stockpiles as noise screens.</td>
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<td>• Where possible, works outside of standard construction hours will be planned so that noisier works are carried out in the earlier part of the evening or night time.</td>
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<td>• Examining different types of machines that perform the same function and compare the noise level data to select the least noisy machine. For example, rubber wheeled tractors can be less noisy than steel tracked tractors.</td>
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<td>• Selecting appropriately sized equipment for the task rather than using large equipment when not necessary.</td>
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<td>• Reducing throttle setting and turn off equipment when not being used.</td>
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<td></td>
<td>• Regularly inspecting and maintaining equipment to ensure it is in good working order. Also check the condition of mufflers.</td>
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<td>• Where acceptable from a work health and safety perspective, quieter alternatives to reversing alarms (such as spotters, closed circuit television monitors and ‘smart’ reversing alarms) will be used particularly during out of hours activities.</td>
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<td>• Noise monitoring will be undertaken to assess compliance with noise management levels (NMLs) and assess the effectiveness of noise monitoring.</td>
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<td>mitigation.</td>
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<td>• All noise complaints will be investigated and appropriate mitigation measures implemented where practicable to minimise further impacts.</td>
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<tr>
<td>NV2</td>
<td>Noise and vibration</td>
<td>All sensitive receivers (e.g. schools, local residents) likely to be affected will be notified at least five days prior to commencement of any works associated with the activity that may have an adverse noise or vibration impact. The notification will provide details of: • The project • The construction period and construction hours • Contact information for project management staff • Complaint and incident reporting and how to obtain further information.</td>
<td>Contractor</td>
<td>Detailed design / pre-construction</td>
<td>Core standard safeguard NV2</td>
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<tr>
<td>NV3</td>
<td>Noise and vibration</td>
<td>Further assessment of reasonable and feasible operational noise mitigation in the form of noise barriers and at-property treatments will be assessed and determined during detailed design. At-property treatments will be determined and implemented in consultation with impacted property owners.</td>
<td>Roads and Maritime Services</td>
<td>Detailed design / pre-construction</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>NV4</td>
<td>Noise and vibration</td>
<td>Where works are required outside standard construction hours, an out of hours work procedure will be developed in accordance with the Roads and Maritime Construction Noise and Vibration Guideline as an appendix to the NVMP. Construction programming will be developed in consultation with Roads and Maritime to minimise noise impacts – this may include agreement on completing construction in as short a time as possible or implementing time and duration restrictions and respite periods subject to community consultation.</td>
<td>Contractor</td>
<td>Pre-construction</td>
<td>Additional safeguard</td>
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| B1  | Biodiversity | A Flora and Fauna Management Plan (FFMP) will be prepared and implemented as part of the CEMP. The FFMP will include the following:  
• Native vegetation removal will be minimised where reasonably practicable through detailed design.  
• Pre-clearing surveys will be carried out in accordance with Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).  
• Vegetation removal will be carried out in accordance with Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).  
• Habitat will be replaced or re-instated in accordance with Guide 5: Re-use of woody debris and bushrock and Guide 8: Nest boxes of the Biodiversity  
• Native vegetation will be re-established in accordance with Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).  
• The unexpected species find procedure will be followed under Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) if threatened ecological communities that have not been assessed in the biodiversity assessment, are identified in the proposal area. | Contractor     | Detailed design/prior to construction | Core standard safeguard B1             |
<p>| B2  | Biodiversity | Exclusion zones will be set up at the limit of clearing in accordance with Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).                                                                                                                                                                                                                                   | Contractor     | During construction / prior to construction | Additional safeguard                     |</p>
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<td></td>
<td>Biodiversity</td>
<td>The unexpected species find procedure is to be followed under <em>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</em> (RTA 2011) if threatened flora species that have not been assessed in the biodiversity assessment, are identified in the proposal area. This procedure is important to identify any threatened species that may germinate in disturbed areas during and after construction. <em>Senna acclinis</em> and <em>Solanum celatum</em> may be present as seed in the soil seed bank and as these species are disturbance specialists, the work areas must be monitored to check whether these species germinate in areas of disturbed soil or topsoil stockpiles. An option that can be considered during the detailed design to reduce the impact to the <em>Syzygium paniculatum</em> plants within the proposal area may be to implement a salvage program. Seed could be harvested from the plants to be removed, grown off site in a nursery, and reused in landscaping required for the proposal. This will retain the genetics of these plants in the habitat and will lead to an overall increase in the size of the local population.</td>
<td>Contractor</td>
<td>During construction</td>
<td>Additional safeguard</td>
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<tr>
<td>B3</td>
<td>Aquatic</td>
<td>Aquatic habitat will be protected in accordance with <em>Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</em> (RTA 2011) and Section 3.35.2 <em>Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management Update 2013</em> (DPI (Fisheries NSW, 2013).</td>
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<td>B4</td>
<td>Biodiversity</td>
<td>Interruptions to water flows associated with groundwater dependent ecosystems will be minimised through detailed design where possible.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>B5</td>
<td>Biodiversity</td>
<td>Changes to existing surface water flows will be minimised through detailed design where possible.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>B6</td>
<td>Biodiversity</td>
<td>Fauna will be managed in accordance with Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011).</td>
<td>Contractor</td>
<td>During construction</td>
<td>Additional safeguard</td>
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<tr>
<td>B7</td>
<td>Biodiversity</td>
<td>Weed species will be managed in accordance with Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011).</td>
<td>Contractor</td>
<td>During construction</td>
<td>Additional safeguard</td>
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<tr>
<td>B8</td>
<td>Biodiversity</td>
<td>Design of roadside edges shall be done in a manner that reduces potential foraging opportunities for deer (ie limit the amount of grassed areas adjacent to the road). Roads and Maritime will work with the South East Local Land Services Northern Illawarra Wild Deer Management program to determine if the proposal area is suitable for pre-clearing deer control.</td>
<td>Contractor</td>
<td>Detailed design / During construction</td>
<td>Additional safeguard</td>
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<tr>
<td>B9</td>
<td>Biodiversity</td>
<td>Pathogens will be managed in accordance with Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011).</td>
<td>Contractor</td>
<td>During construction</td>
<td>Additional safeguard</td>
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<tr>
<td>UD1</td>
<td>Landscape character and visual impact</td>
<td>A UDP will be prepared to support the final detailed project design and implemented as part of the CEMP. The UDP will present an integrated urban design for the project, providing</td>
<td>Contractor</td>
<td>Detailed design / pre-construction</td>
<td>Core standard safeguard UD1</td>
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<td>practical detail on the application of design principles and objectives identified in the environmental assessment. The Plan will include design treatments for:</td>
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<td>- Location and identification of existing vegetation and proposed landscaped areas, including species to be used</td>
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<td>- Built elements including retaining walls, bridges and noise walls</td>
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<td>- Pedestrian and cyclist elements including footpath location, paving types and pedestrian crossings</td>
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<td>- Fixtures such as seating, lighting, fencing and signs</td>
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<td>- Details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage</td>
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<td>- Procedures for monitoring and maintaining landscaped or rehabilitated areas.</td>
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<td>The UDP will be prepared in accordance with relevant guidelines, including:</td>
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<td>- Beyond the Pavement urban design policy, process and principles (Roads and Maritime, 2014)</td>
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<td>- Landscape Guideline (RTA, 2008)</td>
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<td>- Bridge Aesthetics (Roads and Maritime 2012)</td>
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<tr>
<td>UD2</td>
<td>Landscape character and visual impact</td>
<td>The UDP is to provide details on tree planting with an emphasis on reinstating vegetation character, framing views and providing amenity in public open space.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
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<tr>
<td>UD3</td>
<td>Landscape character and visual impact</td>
<td>Bridge design is to include throw screens, transparent fences and safety barriers. Opportunities for views from the bridge along the M1 Princes Motorway and toward the Illawarra Escarpment will be maximised.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>UD4</td>
<td>Landscape character and visual impact</td>
<td>Detailed design solutions to minimise the visual impacts of noise walls will be developed in accordance with the RTA Noise wall design guideline.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
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<tr>
<td>UD5</td>
<td>Landscape character and visual impact</td>
<td>A consistent design for retaining walls, including surface treatment, colour and detailing will be developed.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
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<tr>
<td>UD6</td>
<td>Landscape character and visual impact</td>
<td>Project work sites, including construction areas and supporting facilities (such as storage compounds and offices) will be managed to minimise visual impacts, including appropriate fencing or screening (eg use of shade cloth), storage of equipment, parking, stockpile screening and arrangements for the storage and removal of rubbish and waste materials.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Additional safeguard</td>
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<tr>
<td>UD7</td>
<td>Landscape character and visual impact</td>
<td>Compound and ancillary facilities will be decommissioned and the sites rehabilitated to their existing condition or as otherwise agreed with the landowner on completion of works.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Additional safeguard</td>
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<tr>
<td>UD8</td>
<td>Landscape character and visual impact</td>
<td>Temporary lighting will be sited and designed to avoid light spill into residential properties and identified sensitive receptors.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Additional safeguard</td>
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<tr>
<td>UD9</td>
<td>Landscape character and visual impact</td>
<td>Lighting will be designed to minimise light spill into residential properties and sensitive receptors.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
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</table>
| UD10| Landscape character and visual impact                                  | • All reasonable measures shall be taken to minimise the loss of vegetation at and surrounding the interchange, including rationalisation of the requirements for maintenance access  
• At locations where higher visual impacts have been identified, the specification and planting of more mature sized shrubs and trees shall be adopted to help reduce the visual impact at opening of the road. Further, early planting shall be considered in relation to construction staging to achieve a greater maturity of plants at opening  
• Management of the natural environment will include rehabilitation of any affected areas of important native habitat and creek embankments; use of endemic vegetation in these and other areas where habitat values are important; during the detailed design phase identify and retain as many mature trees as possible; rehabilitate and replace any lost public uses. | Contractor     | Construction                  | Additional safeguard |
<p>| UD11| Landscape character and visual impact                                  | The number and location of signage and gantries shall be rationalised to avoid visual clutter and ensure that strategic views are not blocked.                                                                                            | Contractor     | Detailed design                  | Additional safeguard |
|     |                                                                        | The location of light posts shall be rationalised to ensure integration with other structures such as retaining walls, noise walls, bridges and pedestrian lighting.                                                                       |                |        |                                 |</p>
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<tr>
<td>UD12</td>
<td>Landscape character and visual impact</td>
<td>The design development of spill containment basins shall aim to achieve a naturalised form and detailing.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
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<tr>
<td>HF1</td>
<td>Hydrology and flooding</td>
<td>Prior to construction commencing, final flood and hydrology assessments will be undertaken to inform detail design measures to minimise risks to the environment, properties and the project.</td>
<td>Contractor</td>
<td>Pre-construction</td>
<td>Additional safeguard</td>
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<td>HF2</td>
<td>Hydrology and flooding</td>
<td>Further flood modelling shall be undertaken at detailed design. Floor level surveys shall be conducted at dwellings subject to increased flood levels during the 1% AEP storm event. This will determine if there is any increase in above floor flooding. No new property floor levels will be subject to inundation in the 1% event as a result of the proposal.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>HF3</td>
<td>Hydrology and flooding</td>
<td>Debris control structures are to be designed for inclusion at culvert inlets, to minimise blockages and ensure that drainage structures function effectively</td>
<td>Contractor</td>
<td>Detailed design and Construction</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>HF4</td>
<td>Hydrology and flooding</td>
<td>Scour protection measures shall be considered to protect culvert outlets; and at the base of the retaining wall adjacent to the Dallas Street Branch creek.</td>
<td>Contractor</td>
<td>Detailed design and Construction</td>
<td>Additional safeguard</td>
</tr>
</tbody>
</table>
| SGW1 | Surface water and groundwater              | A Soil and Water Management Plan (SWMP) will be prepared and implemented as part of the CEMP. The SWMP will:  
  - Identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks will be addressed during …                                                                                                                                                                                                                           | Contractor      | Detailed design/pre-construction | Core standard safeguard SW1    |

M1 Princes Motorway, Mount Ousley Interchange
Review of Environmental Factors
<table>
<thead>
<tr>
<th>No.</th>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
</tr>
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</table>
|     |                               | • Specify the requirements for source controls  
• Identify that any water collected from the worksite during construction will be treated and discharged in accordance with *The Blue Book – Managing Urban Stormwater* (Landcom, 2004) and the Roads and Maritime (2011) *Technical Guideline – Environmental Management of Construction Site Dewatering*  
• Specify the requirements for source controls (such as sediment fences and bunding of chemical storage areas). Where piling, concreting, earthworks, scour protection or other works are required within or adjacent to a waterway, a silt barrier such as a boom, bund or curtain will be installed either downstream of the work site and/or around the piles prior to the commencement of works. |               |                          | Section 2.1 of QA G38 Soil and Water Management                        |
<p>| SGW2 | Surface water and groundwater | A site specific Erosion and Sediment Control Plan/s (ESCP) will be prepared and implemented as part of the SWMP. The ESCP shall be approved by a registered soil conservationist. The ESCP will include arrangements for managing wet weather events, including monitoring of potential high risk events (such as storms) and specific controls and follow-up measures to be applied in the event of wet weather. | Contractor     | Detailed design/Pre-construction                                    | Core standard safeguard SW2                                            |
|     |                               |                                                                                                                                                                                                                                                                                                                                              |               |                        | Section 2.2 of QA G38 Soil and Water Management                        |
| SGW3 | Surface water and groundwater | An Emergency Spill Plan will be developed and incorporated into the CEMP, which will include measures to avoid spillages of fuels, chemicals, and fluids into any waterways. The storage, handling and use of the materials will be carried out in accordance with the <em>Occupational Health and Safety Act 2000</em> and SafeWork NSW’s Storage and Handling of | Contractor     | During construction    | Core standard safeguard SW3                                            |</p>
<table>
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<tr>
<th>No.</th>
<th>Impact</th>
<th>Environmental safeguards</th>
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<th>Standard / additional safeguard</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Dangerous Goods Code of Practice (Workcover, 2005). Procedures will include:</td>
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<td>• All fuels, chemicals, and liquids will be stored at least 50 metres away from any waterways or drainage lines and will be stored in an impervious bunded area within the compound site</td>
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<td></td>
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<td>• Bunded areas for refuelling and washdown</td>
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<td></td>
<td>• Sediment basins with sufficient storage capacity to capture spills</td>
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<td></td>
<td>• Spill kits</td>
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<td></td>
<td></td>
<td>• Training of staff.</td>
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<tr>
<td>SGW4</td>
<td>Surface water and groundwater</td>
<td>Permanent water quality controls (spill containment basins and swales) will be incorporated into the design.</td>
<td>Contractor</td>
<td>Detailed design</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>GS1</td>
<td>Geology and soils</td>
<td>The maintenance of established stockpile sites during construction is to be in accordance with the Roads and Maritime Services Stockpile Site Management Guideline (EMS-TG-10)</td>
<td>Contractor</td>
<td>Pre-construction/construction</td>
<td>Core standard safeguard</td>
</tr>
<tr>
<td>GS2</td>
<td>Geology and soils</td>
<td>Mulching will be excluded from areas likely to be inundated within the proposal area to reduce the risk of tannins pollution entering waterways.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Core standard safeguard</td>
</tr>
<tr>
<td>GS3</td>
<td>Geology and soils</td>
<td>Soil stabilisation will be carried out with materials such as rocks and erosion matting to reduce the risk of tannins pollution entering waterway.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Core standard safeguard</td>
</tr>
<tr>
<td>GS4</td>
<td>Geology and soils</td>
<td>Management measures for stockpile sites will be incorporated in the Soil and Water Management Plan (SWMP) and Erosion and Sedimentation Control Plans (ESCPs) and will include the following measures:</td>
<td>Contractor</td>
<td>Construction</td>
<td>Core standard safeguard</td>
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<tr>
<td></td>
<td></td>
<td>• Stockpile sites will be located away from overland flow paths and areas</td>
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</tbody>
</table>
| 281 |        | of high topography with minimal upstream catchment  
- Stockpile sites will be maintained in accordance with Roads and Maritime’s Stockpile Site Management Procedures (Roads and Maritime, 2001)  
- The number and size of stockpile sites will be minimised throughout the proposal  
- Indicate the stockpile management measures to be implemented if PASS are excavated during piling activities  
- Vehicle movements will be restricted to designated pathways, where feasible. |                |                                                                             |                                  |
|     | GS5    | Geology and soils  
If contaminated areas are encountered during construction, a Contaminated Land Management Plan will be prepared in accordance with the *Guideline for the Management of Contamination* (Roads and Maritime, 2013) and implemented as part of the CEMP. All other works that may impact on the contaminated area will cease until the nature and extent of the contamination has been confirmed and any necessary site-specific controls or further actions identified in consultation with the Roads and Maritime Environment Manager and/or EPA. The CLMP will include, but not be limited to:  
- capture and management of any surface runoff contaminated by exposure to the contaminated land  
- further investigations required to determine the extent, concentration and type of contamination  
- management of the remediation and subsequent validation of the contaminated land, including any certification required  
- measures to ensure the safety of site personnel and local communities during construction. | Contractor       | Detailed design / Pre-construction                                                                 | Core standard safeguard  
Section 4.2 of QA G36 Environment Protection |
<table>
<thead>
<tr>
<th>No.</th>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
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</thead>
<tbody>
<tr>
<td>GS6</td>
<td>Geology and soils</td>
<td>A site specific emergency spill plan will be developed, and include spill management measures in accordance with the Roads and Maritime <em>Code of Practice for Water Management</em> (RTA, 1999) and relevant EPA guidelines. The plan will address measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities (including Roads and Maritime and EPA officers).</td>
<td>Contractor</td>
<td>Detailed design / Pre-construction</td>
<td>Core standard safeguard C3 Section 4.3 of QA G36 Environment Protection</td>
</tr>
<tr>
<td>GS7</td>
<td>Geology and soils</td>
<td>If potentially contaminated materials are suspected and/or encountered during construction, these will be managed by an unexpected finds protocol incorporated in the CEMP. Disposal of this material will be at an approved waste disposal facility.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Additional safeguard</td>
</tr>
<tr>
<td>SE1</td>
<td>Socio-economic</td>
<td>All property acquisition will be carried out in accordance with the <em>Land Acquisition Information Guide</em> (Roads and Maritime, 2012) and the <em>Land Acquisition (Just Terms Compensation) Act 1991</em>.</td>
<td>Roads and Maritime project manager</td>
<td>Pre-construction and construction</td>
<td>Core standard safeguard PL1</td>
</tr>
</tbody>
</table>
| SE2 | Socio-economic          | A Community and Stakeholder Engagement Plan (CSEP) will be prepared in accordance with the *Community Involvement and Communications Resource Manual* (RTA, 2008), and implemented as part of the CEMP to help provide timely and accurate information to the community during construction. The CSEP will include (as a minimum):  
  • Mechanisms to provide details and timing of proposed activities to affected residents, including changed traffic and access conditions  
  • Contact name and number for complaints.  
  • Consultation with potentially affected residents prior to commencement of and during work in accordance with Roads and Maritime’s | Contactor               | Pre-construction              | Core standard safeguard SE1    |
<table>
<thead>
<tr>
<th>No.</th>
<th>Impact</th>
<th>Environmental safeguards</th>
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<th>Standard / additional safeguard</th>
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<td></td>
<td>Community Involvement and Communications Resource Manual. Consultation will include but is not limited to door knocks, newsletters or letterbox drops providing information on the proposed work, working hours and a contact name and number for more information or to register complaints.</td>
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<td>• Consultation would be undertaken to advise of alternative routes to take during construction.</td>
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<td></td>
<td>• Consultation with emergency services to ensure adequate emergency vehicle access is provided and maintained at all times for the duration of construction.</td>
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<td></td>
<td></td>
<td>• Consultation with the community and relevant stakeholders will be undertaken to establish the preferred design for new noise walls.</td>
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</tr>
<tr>
<td>SE3</td>
<td>Socio-economic</td>
<td>Heavy vehicle access will be limited near schools and child care centres during drop-off and pick-up times.</td>
<td>Contactor</td>
<td>During construction</td>
<td>Core standard safeguard</td>
</tr>
<tr>
<td>A1</td>
<td>Aboriginal heritage</td>
<td>The <em>Standard Management Procedure - Unexpected Heritage Items</em> (Roads and Maritime, 2015) will be followed in the event that an unknown or potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Roads and Maritime does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place. Work will only re-commence once the requirements of that Procedure have been satisfied.</td>
<td>Contractor</td>
<td>Construction</td>
<td>Core standard safeguard AH2 Section 4.9 of QA G36 Environment Protection</td>
</tr>
<tr>
<td>H1</td>
<td>Non-Aboriginal heritage</td>
<td>The <em>Standard Management Procedure - Unexpected Heritage Items</em> (Roads and Maritime, 2015) will be followed in the event that any unexpected heritage items, archaeological remains or potential relics of</td>
<td>Contractor</td>
<td>Construction</td>
<td>Core standard safeguard H2 Section 4.10</td>
</tr>
<tr>
<td>No.</td>
<td>Impact</td>
<td>Environmental safeguards</td>
<td>Responsibility</td>
<td>Timing</td>
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<td></td>
<td>Non-Aboriginal origin are encountered. Work will only re-commence once the requirements of that Procedure have been satisfied.</td>
<td></td>
<td></td>
<td></td>
<td>of QA G36 Environment Protection</td>
</tr>
</tbody>
</table>
| AQ1 | Air quality                        | An Air Quality Management Plan (AQMP) will be prepared and implemented as part of the CEMP. The AQMP will include, but not be limited to:  
• Potential sources of air pollution  
• Air quality management objectives consistent with any relevant Published EPA and/or OEH guidelines  
• Mitigation and suppression measures to be implemented  
• Methods to manage work during strong winds or other adverse weather conditions  
• Methods for management of stored materials and excavated materials which are hazardous and/or exhibit odour  
• A progressive rehabilitation strategy for exposed surfaces. | Contractor      | Detailed design / pre-construction          | Core standard safeguard AQ1  
Section 4.4 of QA G36 Environment Protection |
| CC1 | Sustainability and climate change  | During detailed design and construction, the following measures will be considered and implemented where possible:  
• Use of LED and low energy equipment for traffic lights and signage  
• Plant and equipment will be switched off when not in use  
• Vehicles, plant and construction equipment will be appropriately sized for the task and properly maintained so as to achieve optimum fuel efficiency  
• The use of alternative fuels and power sources for construction plant and equipment will be investigated and implemented, where appropriate. | Contractor      | Construction                               | Additional safeguard                                      |
<table>
<thead>
<tr>
<th>No.</th>
<th>Impact</th>
<th>Environmental safeguards</th>
<th>Responsibility</th>
<th>Timing</th>
<th>Standard / additional safeguard</th>
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<tr>
<td></td>
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<td>• Energy efficiency and related carbon emissions will be considered when selecting vehicles and equipment</td>
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<td>• Vegetation clearing will be reduced as much as feasible, and re-established in suitable areas when construction is completed</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Waste will be reduced and recycled as a preference before disposing to landfill.</td>
<td></td>
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<tr>
<td></td>
<td>Waste management</td>
<td>A Resource and Waste Management Plan (RWMP) will be prepared and implemented as part of the CEMP. The RWMP will include the following (as a minimum):</td>
<td>Construction contractor</td>
<td>Construction</td>
<td>Core standard safeguard WM1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The type, classification and volume of all materials to be generated and used on site including identification of recyclable and non-recyclable waste in accordance with EPA Waste Classification Guidelines</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Quantity and classification of excavated material generated as a result of the proposal</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Interface strategies for cut and fill on site to ensure re-use where possible</td>
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<tr>
<td></td>
<td></td>
<td>• Strategies to ‘avoid’, ‘reduce’, ‘reuse’ and ‘recycle’ materials.</td>
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<tr>
<td></td>
<td></td>
<td>• Classification and disposal strategies for each type of material</td>
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<tr>
<td></td>
<td></td>
<td>• Destinations for each resource/waste type either for on-site reuse or recycling, offsite reuse or recycling, or disposal at a licensed waste facility</td>
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<tr>
<td></td>
<td></td>
<td>• Details of how material will be stored and treated on-site.</td>
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<td></td>
<td></td>
<td>• Identification of available recycling facilities on and off site</td>
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<td></td>
<td></td>
<td>• Identification of suitable methods and routes to transport waste.</td>
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<td></td>
<td>• Procedures and disposal arrangements for unsuitable excavated material or contaminated material</td>
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<td></td>
<td>• Site clean-up for each construction stage.</td>
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<tr>
<td>No.</td>
<td>Impact</td>
<td>Environmental safeguards</td>
<td>Responsibility</td>
<td>Timing</td>
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<tr>
<td></td>
<td></td>
<td>• Provision of appropriate garbage and recycling receptacles. Waste which cannot be recycled or reused will be disposed regularly at a licensed waste facility.</td>
<td></td>
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</tr>
<tr>
<td>WM2</td>
<td>Waste management</td>
<td>The following resource management hierarchy principles will be followed through the project life cycle:</td>
<td>Construction contractor</td>
<td>Detailed design, pre-construction, construction</td>
<td>Core standard safeguard WM12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Unnecessary resource consumption will be avoided as a priority</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Where avoidance is not possible, waste will be processed for resource recovery (including reuse of materials, reprocessing, recycling and energy recovery)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Where resource recovery is not possible, waste will be disposed as a last resort at an appropriately licensed waste facility – in accordance with the Waste Avoidance and Resource Recovery Act 2001 and the EPA waste classification guidelines</td>
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<td></td>
<td></td>
<td>• Procurement will endeavour to use materials and products with a recycled content, provided that material or product is cost-effective and performance-effective.</td>
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<tr>
<td>WM3</td>
<td>Waste management</td>
<td>All waste will be classified according to the Waste Classification Guidelines Part 1: Classifying Waste (EPA, 2014).</td>
<td>Construction contractor</td>
<td>Construction</td>
<td>Core standard safeguard WM3</td>
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<tr>
<td>CI1</td>
<td>Cumulative impacts</td>
<td>The CEMP will be updated as required to address cumulative impacts as other projects/activities begin. This will include a process to review and update mitigation measures as new work begins or if complaints are received.</td>
<td>Contractor</td>
<td>Pre-construction / Construction</td>
<td>Additional safeguard</td>
</tr>
</tbody>
</table>
### 7.3 Licensing and approvals

Table 7-2 Summary of licensing and approvals required

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Requirement</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Protection of the Environment Operations Act 1997 (s43)</em></td>
<td>Environment protection licence (EPL) for scheduled activities (road construction) from the EPA.</td>
<td>Prior to start of the activity.</td>
</tr>
</tbody>
</table>
8 Conclusion

This chapter provides the justification for the proposal taking into account its biophysical, social and economic impacts, the suitability of the site and whether or not the proposal is in the public interest. The proposal is also considered in the context of the objectives of the EP&A Act, including the principles of ecologically sustainable development as defined in Schedule 2 of the Environmental Planning and Assessment Regulation 2000.

8.1 Justification

8.1.1 The need for the proposal

The M1 Princes Motorway is a major transport route connecting Sydney to the Wollongong CBD and the broader Illawarra region, providing a vital road link for freight, commerce, commuters and tourists. The motorway forms part of the National Land Transport Network – an integrated network of national and inter-regional transport corridors that are of strategic importance in terms of their role in supporting national and regional economic growth and connectivity.

The M1 Princes Motorway and Mount Ousley Road are strategically important as the only approved B-double route into Wollongong from the north, providing freight access between Port Kembla, Sydney and the northern Illawarra collieries. There are also a large number of significant trip generating and attracting land uses within or adjacent to the proposal area. These land uses include Wollongong CBD, the University of Wollongong, TAFE NSW Wollongong campus, Port Kembla, general residential development and a number of high schools and commercial precincts.

More than 50,000 vehicles use the link between Sydney and the Illawarra on approach to Wollongong every day, of which around 15 per cent are heavy vehicles. The M1 Princes Motorway and Mount Ousley Road currently experience heavy traffic congestion particularly during weekday, weekend and holiday peaks. The section of motorway under investigation is steep, with grades exceeding eight per cent for a large proportion of the length and up to 10 per cent at some parts.

In the southbound motorway carriageway, the speed differential between heavy vehicles (40 km/h) and light vehicles (80 km/h) is a source of potential conflict as faster moving light vehicles weave and merge across the path of slower moving heavy vehicles to exit the M1 Princes Motorway at Mount Ousley Road. This presents safety concerns and impedes smooth flow of traffic.

The M1 Princes Motorway/Mount Ousley Road intersection is the only location on the motorway between Heathcote and Albion Park Rail where vehicles are required to make an at-grade right turn to access the motorway. Between July 2011 and June 2016, 56 crashes were reported near the intersection. These included one fatal crash, 23 injury crashes, and 32 non-injury crashes.

Freight movements are increasing on the M1 Princes Motorway. Many of the heavy vehicles continue on the M1 Princes Motorway to Port Kembla, which is one of the largest mixed commodity ports on the east coast. Further, general traffic volumes are increasing, with the motorway intersections with Mount Ousley Road and University Avenue (southbound) already operating at capacity during peak periods, with substantial delays.

In its current configuration, the M1 Princes Motorway/Mount Ousley Road intersection has insufficient capacity to accommodate forecast future volumes of traffic that will travel through the intersection. Without the proposal, the level of service at the Mount Ousley Road entry to the M1
Princes Motorway and the southbound motorway exit to University Avenue, will further decline and congestion will continue to worsen.

Roads and Maritime has identified the M1 Princes Motorway/Mount Ousley Road intersection as needing to be upgraded to improve road safety, improve travel time and traffic efficiency, provide for the growing freight task, and enhance accessibility to and from the motorway, the Wollongong CBD and surrounding suburbs, the University of Wollongong and Port Kembla.

### 8.1.2 Benefits of the proposal

The upgrade of the intersection of the M1 Princes Motorway and Mount Ousley Road, Mount Ousley would deliver a number of major traffic, transport and safety improvements. In particular, it would:

- Separate heavy vehicles from other motorway traffic moving through the upgraded interchange and eliminating unsafe weave movements
- Achieve grade separation of the right turn from Mount Ousley Road onto the M1 Princes Motorway, improving safety and removing a traffic bottleneck
- Separate southbound university-bound traffic from through traffic on the M1 Princes Motorway, by directing the majority of this traffic off the motorway at Mount Ousley Road
- Provide traffic capacity for future growth and development, and improve the critical link between Wollongong and Sydney
- Provide a new access road into the northern side of the University of Wollongong campus, spreading the traffic load and creating new opportunities for additional public transport connections
- Improve heavy vehicle safety with the addition of a second safety ramp at the base of Mount Ousley
- Improve and extend the coverage of noise barriers
- Improve pedestrian and cycle connectivity from suburbs to the north with provision of a new shared path connection via bridges over Mount Ousley Road and the M1 Princes Motorway, with direct connection to the existing shared path network
- Replace the existing commuter car park with a larger, safer and more accessible car park

While the proposal would result in some environmental impacts, they have been avoided or minimised wherever possible through the design and site-specific safeguards summarised in Chapter 7. The beneficial effects are considered to outweigh the adverse impacts associated with the proposal.

Given these improvements, the proposal is considered to be justified.

### 8.1.3 Social factors

As documented in Section 6.9, the proposal would have some minor short-term negative social impacts as a result of the disturbance and change that would occur during construction. The combined effect of construction noise, dust, and general disturbance caused by construction activity, construction traffic and machinery movements would result in a short term, temporary loss of amenity for residents, motorists, workers and others who live near the proposal area and those who visit the proposal area on a regular basis. Safeguards have been proposed to minimise these impacts.
However, the long-term effect would be an overall social benefit, through improvements to the transport network in and around the proposal area. The proposal would not only provide improved conditions for motorists, it would improve pedestrian and cycle connectivity, improve safety for all road users, and reduce the impacts of traffic noise for some receivers. The proposal would achieve this benefit without any acquisition of private property, and without any impact on local heritage.

### 8.1.4 Biophysical factors

The proposal involves works in an existing main road corridor, but would result in disturbance through clearing and earthworks in vegetated areas north and south of the existing M1 Princes Motorway. The proposal requires extensive clearing for its construction, and major new drainage infrastructure in order to manage stormwater and maintain natural drainage lines across the motorway corridor.

The proposal would involve clearing of nationally listed threatened species habitat (ie habitat for *Syzygium paniculatum* and Grey-headed Flying-fox). As more than one hectare of habitat in moderate to good condition would be cleared, a biodiversity offset strategy would be prepared to address how offsets would be met. In addition, the proposal area would be rehabilitated and landscaped following construction with native vegetation endemic to the lower Illawarra escarpment and coastal plain.

The proposal would cross two main natural drainage channels, and would impact on the flood behaviour of a third, as documented in Section 6.5. As a result of the increased impervious area, the proposal would result in minor increases in flooding on the motorway carriageways themselves, and some downstream areas, during extreme rain events. During these events, some upstream areas would also experience increases in flood levels, but these would be mostly contained within the existing channels. Some areas downstream from the proposal would experience reductions in flood levels as a result of the proposal. Further flood modelling would be undertaken during detailed design. Floor level surveys would be conducted at dwellings subject to increased flood levels during the 1% AEP storm event. This would determine if there is any increase in above floor flooding. The drainage design would be further developed during detailed design to ensure no new property floor levels will be subject to inundation in the 1% event as a result of the proposal.

Existing creeks and watercourses downstream of the proposal have been heavily modified by urban development and intrusion of weeds and pathogens. The proposal would result in no major change to water quality in downstream receiving environments, and would not impact on any sensitive aquatic ecosystems or key fish habitat. The proposal would not have any impacts on groundwater flows or quality.

### 8.1.5 Economic factors

The proposal would be constructed largely within the existing road corridor, with minimal land acquisition required and no acquisition of private property. The upgrade of an existing road corridor would minimise long-term disruption and economic impacts on residents, landowners and motorists.

The proposal has been designed so that construction can be staged to avoid the need for any road closures or diversions, thereby keeping a critical transport link open throughout the construction duration.

In the longer term, the proposal would deliver road transport improvements through improved safety, reduced congestion and better overall efficiency for traffic movements through the M1.
Princes Motorway/Mount Ousley Road interchange. The reduced costs of congestion and delays for freight and other traffic would constitute a real economic benefit to the proposal.

The proposal would also create opportunities for new public transport services into the University of Wollongong via the proposed Northern Access Road, adding to its overall value.

The proposal would deliver long-term economic benefits to Wollongong and the Illawarra region on its own, and as part of the current program of investment in upgrades to the Princes Highway between Wollongong and Nowra. It would improve traffic conditions and reduce travel times while improving accessibility to and from Wollongong, Sydney, Port Kembla, the Illawarra coalfields and the NSW South Coast.

8.1.6 Public interest

The public interest is best served through the equitable distribution of resources, and investment in public infrastructure that fulfils the needs of the majority. The proposal represents a cost-efficient investment in public infrastructure that would maximise the long-term social and economic benefits, while minimising the long-term negative impacts on communities and the environment. By improving local and regional transport facilities, the proposal would better enable the movement of people, goods and services.

The proposed separation of light and heavy vehicles, and the grade separation of the M1 Princes Motorway/Mount Ousley Road intersection, would provide a social as well as an economic benefit through improved road safety and transport efficiency, while the new shared path would improve equity through increasing the reach of the local shared path network.

Upgrading the M1 Princes Motorway/Mount Ousley Road intersection provides an opportunity to make an urban design statement through creating a gateway to Wollongong and the Illawarra region. This would improve the legibility of the interchange, giving motorists a stronger sense of arrival at the City of Wollongong as they descend the escarpment.

Although the proposal would result in some short-term impacts on amenity during the construction phase, these impacts would be outweighed by the long-term benefits once the proposal is operational.

8.2 Objects of the EP&A Act

<table>
<thead>
<tr>
<th>Object</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>5(a)(i) To encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment.</td>
<td>Although the proposal would involve extensive vegetation clearing, it would minimise impacts on the environment through the use of an existing transport corridor, with minimal land acquisition required. The proposal would promote social and economic welfare by improving connectivity to the major land uses in the City of Wollongong, and helping to facilitate growth. It would also provide amenity and safety benefits for local communities and road users including pedestrians and cyclists, through road and</td>
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<td>Object</td>
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<td>intersection upgrades, and a new shared path. A number of mitigation measures would be implemented to minimise any environmental impacts associated with the proposal. This includes a landscape strategy to revegetate land cleared for construction that is not required for road and biodiversity offsets will be provided to offset the impact of the vegetation to be cleared.</td>
<td></td>
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<tr>
<td>5(a)(ii) To encourage the promotion and co-ordination of the orderly economic use and development of land.</td>
<td>The proposal is needed to address current and future traffic congestion issues, road safety and freight transport efficiency. In meeting these needs, the proposal would help to promote development and growth in Wollongong and the wider Illawarra region. It would also make use of an existing transport corridor, and therefore avoid the need for any realignment that would impact directly on the economic development of surrounding land.</td>
</tr>
<tr>
<td>5(a)(iii) To encourage the protection, provision and co-ordination of communication and utility services.</td>
<td>Some utilities would need to be relocated or protected during construction. However, the proposal would incorporate reinstatement of any utilities that are disturbed, and upgrading of communication and utility services through the installation of new services wherever their disturbance or relocation is required.</td>
</tr>
<tr>
<td>5(a)(iv) To encourage the provision of land for public purposes.</td>
<td>The proposal involves work to upgrade a public road to provide a public benefit. It would involve acquisition of small strips of land that is currently used for educational purposes, but no impact on actual education facilities. Additional land within the existing road corridor that would be taken up for development of the proposal has not been recognised as having a specific existing public purpose other than for a road. By limiting the proposal footprint mostly to an existing road corridor, the proposal ensures that surrounding land can be provided for other public purposes.</td>
</tr>
<tr>
<td>5(a)(v) To encourage the provision and co-ordination of community services and facilities.</td>
<td>The proposal involves work for the purpose of a road and would not impact on any community services or facilities.</td>
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<td>Object</td>
<td>Comment</td>
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<tr>
<td>5(a)(vi) To encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats.</td>
<td>The proposal would involve clearing of nationally listed threatened species habitat, and would therefore require vegetation offsets or other supplementary measures to mitigate this impact. Following construction, the proposal area would be rehabilitated and landscaped with native vegetation endemic to the lower Illawarra escarpment and coastal plain.</td>
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<tr>
<td>5(a)(vii) To encourage ecologically sustainable development.</td>
<td>Ecologically sustainable development is considered in Sections 8.2.1 to 8.2.4 below.</td>
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<tr>
<td>5(a)(viii) To encourage the provision and maintenance of affordable housing.</td>
<td>Not relevant to the proposal.</td>
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<tr>
<td>5(b) To promote the sharing of the responsibility for environmental planning between different levels of government in the State.</td>
<td>Not relevant to the proposal.</td>
</tr>
<tr>
<td>5(c) To provide increased opportunity for public involvement and participation in environmental planning and assessment.</td>
<td>Consultation with the community and relevant government agencies was undertaken during the development of the proposal. There will be further opportunities for the public to comment on the proposal during the exhibition of the REF. Details of this consultation can be found in Chapter 5.</td>
</tr>
</tbody>
</table>

### 8.2.1 The precautionary principle

This principle states: “if there are threats of serious or irreversible damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation”.

Evaluation and assessment of alternatives and options have aimed to reduce the risk of serious and irreversible impacts on the environment. Stakeholder consultation considered issues raised by stakeholders and a range of specialist studies were undertaken for key issues to provide accurate and impartial information to assist in the evaluation of options.

The concept design has sought to minimise impacts on the amenity of the proposal area while maintaining engineering feasibility and safety for all road users. A number of safeguards are proposed to minimise potential impacts. These safeguards would be implemented during construction and operation of the proposal. No safeguards have been postponed out of any lack of scientific certainty.
A CEMP would be prepared before construction starts. This requirement would ensure the proposal achieves a high level of environmental performance. No mitigation measures or management mechanisms would be postponed because of a lack of information.

8.2.2 Intergenerational equity
The principle states: “the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations”.

The proposal would not result in any impacts that are likely to adversely impact on the health, diversity or productivity of the environment for future generations.

The proposal – together with other road improvements in the Illawarra region, would cater for future population and traffic growth in the region. The proposal would benefit future generations by addressing the future increases in traffic volumes and traffic congestion associated with movement of traffic, including road freight, between Sydney, Wollongong, the Illawarra region and the NSW South Coast. While the proposal would have some adverse impacts, they are not considered to be of a nature or extent that would result in disadvantage to any specific section of the community or to future generations.

Should the proposal not proceed, the principle of intergenerational equity may be compromised, as future generations would inherit a lower level of service associated with the performance of the existing intersection of the M1 Princes Motorway and Mount Ousley Road and the University Avenue interchange.

8.2.3 Conservation of biological diversity and ecological integrity
This principle states: “the diversity of genes, species, populations and communities, as well as the ecosystems and habitats to which they belong, must be maintained and improved to ensure their survival”.

The environment in which the proposal would be undertaken is a modified urban environment at the base of the heavily forested Illawarra escarpment. A thorough assessment of the existing local environment was undertaken to identify and manage any potential impacts of the proposal on local biodiversity. The proposal would result in the clearing of about 7.5 hectares of vegetation comprising two native plant community types, about 4.8 hectares of roadside and urban plantings, and about 1 hectare of weed dominated vegetation.

The concept design has been developed to minimise, wherever possible, direct impacts on biodiversity. Opportunities to further minimise these impacts would be explored during detailed design, including biodiversity offsets (for listed threatened species) and revegetation.

With implementation of the recommended management measures and safeguards, which include offsetting the loss of native vegetation, the proposal would not have a significant impact on biological diversity and ecological integrity. A biodiversity assessment and appropriate site-specific safeguards are provided in Section 6.3.

8.2.4 Improved valuation, pricing and incentive mechanisms
This principle is defined as:

“improved valuation, pricing and incentive mechanisms, namely, that environmental factors should be included in the valuation of assets and services, such as:
polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,

the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,

environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems."

This REF has examined the environmental consequences of the proposal and identified mitigation measures to manage the potential for adverse impacts. The requirement to implement these mitigation measures would result in an economic cost to Roads and Maritime, and would increase the capital and operating costs of the proposal. The costs of the generation and management of waste and pollution would be captured in any waste disposal charges, and the cost of obtaining an Environment Protection Licence for construction activities. This signifies that environmental resources have been given appropriate valuation.

The concept design has been developed with an objective of minimising potential impacts on the surrounding environment. This indicates that the proposal is being developed with an environmental objective in mind.

### 8.3 Conclusion

The proposed upgrade of the M1 Princes Motorway intersection with Mount Ousley Road, Mount Ousley, is subject to assessment under Part 5 of the EP&A Act. The REF has examined and taken into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity.

This has included consideration (where relevant) of conservation agreements and plans of management under the NPW Act, joint management and biobanking agreements under the TSC Act, regulations set out in the *Biodiversity Conservation Act 2016*, wilderness areas, critical habitat, impacts on threatened species, populations and ecological communities and their habitats and other protected fauna and native plants. It has also considered potential impacts to matters of national environmental significance listed under the Federal EPBC Act.

A number of potential environmental impacts from the proposal have been avoided or reduced during the concept design development and options assessment. The proposal as described in the REF best meets the project objectives but would still result in some impacts on biodiversity, minor changes to flooding behaviour, and visual impacts. Safeguards and management measures as detailed in this REF would mitigate or minimise these expected impacts. The proposal would also result in positive impacts in terms of improved road safety, improved driving conditions and transport efficiency, and reduced travel times.

On balance the proposal is considered justified and the following conclusions are made.

**Significance of impact under NSW legislation**

The proposal would be unlikely to cause a significant impact on the environment. Therefore it is not necessary for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning under Part 5.1 of the EP&A Act. A Species Impact Statement is not
required. The proposal is subject to assessment under Part 5 of the EP&A Act. Consent from Council is not required.

**Significance of impact under Australian legislation**

The proposal is not likely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*. A referral to the Australian Department of the Environment is not required.
9 Certification

This review of environmental factors provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposal.

Tim Colman
Environment Lead
Jacobs
Date: 13 November 2017

I have examined this review of environmental factors and accept it on behalf of Roads and Maritime Services.

Tim Webster
Project Development Manager
Roads and Maritime Regional Project Office, South
Date: 13 November 2017
References


Department of Environment, Climate Change and Water (DECCW) 2010, Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW, September 2010


NSW Department of Planning and Environment (2015) Illawarra Shoalhaven Regional Plan, available online: http://www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/~media/3316E0D25C04474AB7E4D3D6648C6B97.ashx

Port Authority of NSW (undated), *Port Kembla*, available online: https://www.portauthoritynsw.com.au/port-kembla/

Roads and Maritime Services (2013) *Environmental Impact Assessment Practice Note: Socio-economic assessment* (EIA-N05)


Roads and Maritime (2013) *Guideline for the Management of Contamination*

Roads and Traffic Authority (1999) *Code of Practice for Water Management*


Wollongong High School of the Performing Arts (undated), *Our school*, available online: http://www.wollongong-h.schools.nsw.edu.au/our-school


### Terms and acronyms used in this REF

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<thead>
<tr>
<th>Term/Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>AAQMFQTP</td>
<td>Ambient Air Quality Monitoring and Fuel Quality Testing Project</td>
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<td>ABS</td>
<td>Australian Bureau of Statistics</td>
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<tr>
<td>ADT</td>
<td>Average Daily Traffic</td>
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<tr>
<td>AEP</td>
<td>Annual Exceedance Probability – refers to the probability of a flood event occurring in any year. The probability is expressed as a percentage. For example, a large flood which may be calculated to have a 1% chance of occurring in any one year, is described as 1%AEP.</td>
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<tr>
<td>AHD</td>
<td>Australian Height Datum</td>
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<td>AHIMS</td>
<td>Aboriginal Heritage Information Management System</td>
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<td>AHIP</td>
<td>Aboriginal Heritage Impact Permit</td>
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<td>ANZECC</td>
<td>Australian and New Zealand Environment Conservation Council</td>
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<td>AQI</td>
<td>Air Quality Index</td>
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<td>AQMP</td>
<td>Air Quality Management Plan</td>
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<td>ARI</td>
<td>Average Recurrence Interval</td>
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<td>ARMCANZ</td>
<td>Agriculture and Resources Management Council of Australia and New Zealand</td>
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<td>ASRIS</td>
<td>Australian Soil Resource Information System</td>
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<td>ASS</td>
<td>Acid Sulfate Soils</td>
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<td>ATC</td>
<td>Australian Transport Council</td>
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<td>AWS</td>
<td>Automatic Weather Station</td>
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<td>BCR</td>
<td>Benefit Cost Ratio</td>
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<td>BOS</td>
<td>Biodiversity Offset Strategy</td>
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<td>BSI</td>
<td>British Standard</td>
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<td>BTEX</td>
<td>Monocyclic Aromatic Hydrocarbons</td>
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<td>Term/Acronym</td>
<td>Description</td>
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<tr>
<td>CBD</td>
<td>Central Business District</td>
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<td>CEMP</td>
<td>Construction Environmental Management Plan</td>
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<td>CLM Act</td>
<td><em>Contaminated Land Management Act 1997</em></td>
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<td>CNVG</td>
<td><em>Construction Noise and Vibration Guideline</em></td>
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<td>CSEP</td>
<td>Community and Stakeholder Engagement Plan</td>
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<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
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<tr>
<td>DBYD</td>
<td>Dial Before You Dig</td>
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<tr>
<td>DECC</td>
<td>Department of Environment and Climate Change</td>
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<td>DECCW</td>
<td>Department of Environment, Climate Change and Water NSW, now the NSW Office of Environment and Heritage</td>
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<td>DIN</td>
<td>Deutsches Institute fur Normung</td>
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<td>DPI</td>
<td>NSW Department of Primary Industries</td>
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<td>DUAP</td>
<td>New South Wales Department of Urban Affairs and Planning</td>
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<td>Environmental impact assessment</td>
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<td>Environmental management system</td>
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<td><em>Environmental Planning and Assessment Act 1979</em></td>
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<td><em>Environment Protection and Biodiversity Conservation Act 1999</em></td>
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<td>Environment protection licence</td>
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<td>ESCP</td>
<td>Erosion and Sediment Control Plan</td>
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<td>ESD</td>
<td>Ecologically sustainable development</td>
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<td>FBA</td>
<td>Framework for Biodiversity Assessment</td>
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<tr>
<td>FRP</td>
<td>Filterable reactive phosphorus</td>
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<td>GDE</td>
<td>Groundwater dependent ecosystem</td>
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<td>HPV</td>
<td>Higher productivity vehicles</td>
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<td>Hazard and Risk Management Plan</td>
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<td>IBUG</td>
<td>Illawarra Bicycle User Group</td>
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<td>ICNG</td>
<td>Interim Construction Noise Guideline</td>
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<td>ICOLL</td>
<td>Intermittently Closed and Open Lake or Lagoon</td>
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<td>IEC</td>
<td>International Electrotechnical Commission</td>
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<td>Industrial Noise Policy</td>
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<td>ISEPP</td>
<td>Infrastructure State Environment Planning Policy</td>
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<td>ISO</td>
<td>International Organization for Standardization</td>
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<td>Local Aboriginal Land Council</td>
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<td>LEA</td>
<td>Lead Environment Adviser</td>
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<td>LED</td>
<td>Light-emitting diode</td>
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<td>LPI</td>
<td>NSW Land and Property Information database</td>
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<td>Long Term Transport Master Plan</td>
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<td>NATA</td>
<td>National Association of Testing Authorities</td>
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<td>Out of hours work</td>
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<td>PACHCI</td>
<td>Procedure for Aboriginal Cultural Heritage Consultation and Investigation</td>
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<td>Transport Management Centre</td>
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<td>Total recoverable hydrocarbons</td>
</tr>
<tr>
<td>TSC Act</td>
<td><em>Threatened Species Conservation Act 1995</em></td>
</tr>
<tr>
<td>TSP</td>
<td>Total suspended solids</td>
</tr>
<tr>
<td>URAC</td>
<td>University of Wollongong Recreation and Aquatic Centre</td>
</tr>
<tr>
<td>VHT</td>
<td>Vehicle hours travelled</td>
</tr>
<tr>
<td>VIS</td>
<td>Vegetation Information System</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile organic compounds</td>
</tr>
<tr>
<td>WARR</td>
<td><em>Waste Avoidance and Resource Recovery (WARR) Act 2001</em></td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>Term/Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>WHS</td>
<td>Work health and safety</td>
</tr>
<tr>
<td>WMP</td>
<td>Waste Management Plan</td>
</tr>
</tbody>
</table>
Appendix A

Consideration of clause 228(2) factors and matters of national significance
Clause 228(2) Checklist

In addition to the requirements of the *Is an EIS required?* guideline (DUAP 1995/1996) and the *Roads and Related Facilities EIS Guideline* (DUAP 1996) as detailed in the REF, the following factors, listed in clause 228(2) of the *Environmental Planning and Assessment Regulation 2000*, have also been considered to assess the likely impacts of the proposal on the natural and built environment.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Any environmental impact on a community?</td>
<td></td>
</tr>
<tr>
<td>The proposal involves some impact on a community during construction including noise and vibration impacts, generation of airborne dust, temporary changes to traffic and access, and visual amenity impacts. During construction, sites would be used for ancillary purposes such as construction compounds, material and plant storage, or material stockpiles.</td>
<td>Short term - negative</td>
</tr>
<tr>
<td>In the long term the proposal would result in improvements to traffic efficiency and road safety as well as improved facilities for pedestrians, cyclists and public transport.</td>
<td>Long term – positive</td>
</tr>
<tr>
<td>The proposal would also result in permanent changes to the visual environment and the overall landscape within the proposal area. Construction of a new bridge over the M1 Princess Motorway, and the introduction of noise barriers along M1 Princess Motorway and Mount Ousley Road, would impact on local views and visual amenity for some receptors. The final detailed design for the proposal would incorporate an integrated urban design and landscape concept plan, to mitigate visual impacts and to improve the proposal’s landscape setting.</td>
<td>Long term – neutral</td>
</tr>
<tr>
<td>Chapter 6 of this REF describes the likely temporary and permanent impacts of the proposal, and lists recommended measures to mitigate impacts during construction and operation. The construction contractor’s Construction Environmental Management Plan would incorporate all of the proposed safeguards for implementation throughout the proposal’s construction phase.</td>
<td></td>
</tr>
</tbody>
</table>
### b. Any transformation of a locality?

The proposal area would undergo temporary transformation during construction due to clearing of vegetation and earthworks required to widen the road corridor and the construction of noise barriers and a new bridge across the M1 Princess Motorway.

The proposal will introduce a number of changes in the locality including road widening, acquisition of land currently used for educational purposes, the removal of vegetation, the introduction of new road infrastructure including a new bridge and new pedestrian overpass, the introduction of noise and retaining walls, and a new commuter car park. The urban design would introduce revegetated areas and screening to improve the visual amenity of the proposal area.

<table>
<thead>
<tr>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short term – negative</td>
</tr>
<tr>
<td>Long term – neutral</td>
</tr>
</tbody>
</table>

### c. Any environmental impact on the ecosystems of the locality?

The proposal would result in clearing of about 7.5 hectares of two Plant Community Types including:

- 6.6 hectares of Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (PCT 694)
- 0.8 hectares of Sydney Blue Gum x Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion (PCT 1245).

The recommended offset strategy is documented in Section 6.3 of this REF.

The proposal would have no long term impacts on any aquatic ecosystems, habitats or species.

<table>
<thead>
<tr>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short term – neutral</td>
</tr>
</tbody>
</table>

### d. Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?

The proposal would involve clearing of substantial areas of existing regrowth vegetation which would transform the landscape character and the aesthetics of the locality. The urban design would introduce revegetated areas and screening to improve the visual amenity of the proposal area.

<table>
<thead>
<tr>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short term – negative</td>
</tr>
<tr>
<td>Long term - neutral</td>
</tr>
<tr>
<td>Factor</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>e. Any effect on a locality, place or building having aesthetic,</td>
</tr>
<tr>
<td>anthropological, archaeological, architectural, cultural, historical,</td>
</tr>
<tr>
<td>scientific or social significance or other special value for present</td>
</tr>
<tr>
<td>or future generations?</td>
</tr>
<tr>
<td>The proposal is not expected to have an impact on any locality, place</td>
</tr>
<tr>
<td>or building having aesthetic, anthropological, architectural, cultural,</td>
</tr>
<tr>
<td>historical, scientific or social significance or other special value</td>
</tr>
<tr>
<td>for present or future generations.</td>
</tr>
<tr>
<td>f. Any impact on the habitat of protected fauna (within the meaning</td>
</tr>
<tr>
<td>of the National Parks and Wildlife Act 1974)?</td>
</tr>
<tr>
<td>The proposal would not impact on the habitat of protected fauna (within</td>
</tr>
<tr>
<td>meaning of the National Parks and Wildlife Act 1974)</td>
</tr>
<tr>
<td>g. Any endangering of any species of animal, plant or other form of</td>
</tr>
<tr>
<td>life, whether living on land, in water or in the air?</td>
</tr>
<tr>
<td>The assessment of the proposal's impact on nationally listed</td>
</tr>
<tr>
<td>threatened species, populations, endangered ecological communities</td>
</tr>
<tr>
<td>and migratory species found that there is unlikely to be a significant</td>
</tr>
<tr>
<td>impact on relevant matters of national environmental significance.</td>
</tr>
<tr>
<td>h. Any long-term effects on the environment?</td>
</tr>
<tr>
<td>Long-term negative effects on the environment are not expected.</td>
</tr>
<tr>
<td>Benefits would be realised in terms of reduced congestion and</td>
</tr>
<tr>
<td>improvements in road safety.</td>
</tr>
<tr>
<td>i. Any degradation of the quality of the environment?</td>
</tr>
<tr>
<td>Construction would have the potential to result in visual, noise</td>
</tr>
<tr>
<td>and air quality impacts. These potential impacts would be managed</td>
</tr>
<tr>
<td>by the implementation of safeguards listed in Section 7 of this REF.</td>
</tr>
<tr>
<td>j. Any risk to the safety of the environment?</td>
</tr>
<tr>
<td>Traffic management safeguards including the preparation of a traffic</td>
</tr>
<tr>
<td>management plan, would address safety risks during construction.</td>
</tr>
<tr>
<td>The proposal would improve safety for road users during operation by</td>
</tr>
<tr>
<td>reducing congestion and by removing existing points of potential</td>
</tr>
<tr>
<td>traffic conflict. The proposal would also improve intersection</td>
</tr>
<tr>
<td>performance and pedestrian/cyclist facilities.</td>
</tr>
<tr>
<td>Factor</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>k. Any reduction in the range of beneficial uses of the environment?</td>
</tr>
<tr>
<td>The proposal would not reduce the range of beneficial uses of the environment.</td>
</tr>
<tr>
<td>l. Any pollution of the environment?</td>
</tr>
<tr>
<td>There is potential for accidental spills of chemicals during construction which could affect the surrounding land, surface water and groundwater. Management of impacts on surface water and groundwater is addressed in Section 6.6 of this REF.</td>
</tr>
<tr>
<td>m. Any environmental problems associated with the disposal of waste?</td>
</tr>
<tr>
<td>Waste streams generated during construction are common and would pose no difficulty in their disposal. Waste would be recycled wherever possible.</td>
</tr>
<tr>
<td>n. Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply?</td>
</tr>
<tr>
<td>All resources required for the proposal are readily available and are not in short supply.</td>
</tr>
<tr>
<td>o. Any cumulative environmental effect with other existing or likely future activities?</td>
</tr>
<tr>
<td>There is potential for the construction period for the proposal to overlap with the construction period for the M1 Princes Motorway improvements between Picton Road and Bulli Tops (located 7 km to the north of the proposal). Traffic management of both proposals would be considered to minimise potential delays.</td>
</tr>
<tr>
<td>There is the potential for the proposal to result in a cumulative impact with works being carried out or proposed under the current University of Wollongong campus masterplan. Depending on the program of development for the masterplan, this could include the in-combination impact of construction traffic on the local road network, and related noise and air quality impacts on nearby receptors. The University of Wollongong masterplan and the proposal would improve the visual landscape, help to enhance local biodiversity and enhance connectivity and public access for the town of Wollongong in the operation of the proposal.</td>
</tr>
<tr>
<td>Cumulative impacts of the proposal are discussed in Section 6.14 of this REF.</td>
</tr>
<tr>
<td>Factor</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
</tr>
<tr>
<td>p. Any impact on coastal processes and coastal hazards, including those under projected climate change conditions?</td>
</tr>
<tr>
<td>The proposal would not result in any impact on coastal processes and coastal hazards.</td>
</tr>
</tbody>
</table>
Matters of National Environmental Significance

Under the environmental assessment provisions of the *Environment Protection and Biodiversity Conservation Act 1999*, the following matters of national environmental significance and impacts on Commonwealth land are required to be considered to assist in determining whether the proposal should be referred to the Australian Government Department of the Environment.

A referral is not required for proposed actions that may affect nationally listed threatened species, populations, endangered ecological communities and migratory species. Impacts on these matters are still assessed as part of the REF in accordance with Australian Government significant impact criteria and taking into account relevant guidelines and policies.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Any impact on a World Heritage property?</td>
<td>Nil</td>
</tr>
<tr>
<td>b. Any impact on a National Heritage place?</td>
<td>Nil</td>
</tr>
<tr>
<td>c. Any impact on a wetland of international importance?</td>
<td>Nil</td>
</tr>
<tr>
<td>d. Any impact on a listed threatened species or communities?</td>
<td>Nil</td>
</tr>
<tr>
<td>The proposal is not likely to significantly impact threatened species, populations, ecological communities or migratory species, within the meaning of the EPBC Act</td>
<td></td>
</tr>
<tr>
<td>e. Any impacts on listed migratory species?</td>
<td>Nil</td>
</tr>
<tr>
<td>Three migratory species listed under the EPBC Act may potentially occur within the investigation area. Of these, the White-throated Needletail has a moderate potential of occurring in the investigation area. This species may fly over the proposal area on occasion during seasonal migration but is unlikely to land in the proposal area to utilise the habitats.</td>
<td></td>
</tr>
<tr>
<td>f. Any impact on a Commonwealth marine area?</td>
<td>Nil</td>
</tr>
<tr>
<td>g. Does the proposal involve a nuclear action (including uranium mining)?</td>
<td>Nil</td>
</tr>
<tr>
<td>Additionally, any impact (direct or indirect) on Commonwealth land?</td>
<td>Nil</td>
</tr>
</tbody>
</table>
Appendix B

Proposed concept design
TYPICAL SECTION AT CH 120 (MCP1) UNIVERSITY ACCESS ROAD
Appendix C

Statutory consultation checklists
## Infrastructure SEPP

### Council related infrastructure or services

<table>
<thead>
<tr>
<th>Issue</th>
<th>Potential impact</th>
<th>Yes / No</th>
<th>If ‘yes’ consult with</th>
<th>ISEPP clause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stormwater</td>
<td>Are the works likely to have a <em>substantial</em> impact on the stormwater management services which are provided by council?</td>
<td>No</td>
<td></td>
<td>ISEPP cl.13(1)(a)</td>
</tr>
<tr>
<td>Traffic</td>
<td>Are the works likely to generate traffic to an extent that will <em>strain</em> the existing road system in a local government area?</td>
<td>No</td>
<td></td>
<td>ISEPP cl.13(1)(b)</td>
</tr>
<tr>
<td>Sewerage system</td>
<td>Will the works involve connection to a council owned sewerage system? If so, will this connection have a <em>substantial</em> impact on the capacity of any part of the system?</td>
<td>No</td>
<td></td>
<td>ISEPP cl.13(1)(c)</td>
</tr>
<tr>
<td>Water usage</td>
<td>Will the works involve connection to a council owned water supply system? If so, will this require the use of a <em>substantial</em> volume of water?</td>
<td>No</td>
<td></td>
<td>ISEPP cl.13(1)(d)</td>
</tr>
<tr>
<td>Temporary structures</td>
<td>Will the works involve the installation of a temporary structure on, or the enclosing of, a public place which is under local council management or control? If so, will this cause more than a <em>minor or inconsequential</em> disruption to pedestrian or vehicular flow?</td>
<td>No</td>
<td></td>
<td>ISEPP cl.13(1)(e)</td>
</tr>
<tr>
<td>Road &amp; footpath excavation</td>
<td>Will the works involve more than <em>minor or inconsequential</em> excavation of a road or adjacent footpath for which council is the roads authority and responsible for maintenance?</td>
<td>Yes</td>
<td>Wollongong City Council</td>
<td>ISEPP cl.13(1)(f)</td>
</tr>
</tbody>
</table>
## Local heritage items

<table>
<thead>
<tr>
<th>Issue</th>
<th>Potential impact</th>
<th>Yes / No</th>
<th>If ‘yes’ consult with</th>
<th>ISEPP clause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local heritage</td>
<td>Is there a local heritage item (that is not also a State heritage item) or a heritage conservation area in the study area for the works? If yes, does a heritage assessment indicate that the potential impacts to the item/area are more than <em>minor</em> or <em>inconsequential</em>?</td>
<td>No</td>
<td></td>
<td>ISEPP cl.14</td>
</tr>
</tbody>
</table>

## Flood liable land

<table>
<thead>
<tr>
<th>Issue</th>
<th>Potential impact</th>
<th>Yes / No</th>
<th>If ‘yes’ consult with</th>
<th>ISEPP clause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood liable land</td>
<td>Are the works located on flood liable land? If so, will the works change flood patterns to more than a <em>minor</em> extent?</td>
<td>No</td>
<td></td>
<td>ISEPP cl.15</td>
</tr>
</tbody>
</table>

## Public authorities other than councils

<table>
<thead>
<tr>
<th>Issue</th>
<th>Potential impact</th>
<th>Yes / No</th>
<th>If ‘yes’ consult with</th>
<th>ISEPP clause</th>
</tr>
</thead>
<tbody>
<tr>
<td>National parks and reserves</td>
<td>Are the works adjacent to a national park or nature reserve, or other area reserved under the <em>National Parks and Wildlife Act 1974</em>?</td>
<td>No</td>
<td></td>
<td>ISEPP cl.16(2)(a)</td>
</tr>
<tr>
<td>Marine parks</td>
<td>Are the works adjacent to a declared marine park under the <em>Marine Parks Act 1997</em>?</td>
<td>No</td>
<td></td>
<td>ISEPP cl.16(2)(b)</td>
</tr>
<tr>
<td>Aquatic reserves</td>
<td>Are the works adjacent to a declared aquatic reserve under the <em>Fisheries Management Act 1994</em>?</td>
<td>No</td>
<td></td>
<td>ISEPP cl.16(2)(c)</td>
</tr>
<tr>
<td>Sydney Harbour foreshore</td>
<td>Are the works in the Sydney Harbour Foreshore Area as defined by the <em>Sydney Harbour Foreshore Authority Act 1998</em>?</td>
<td>No</td>
<td></td>
<td>ISEPP cl.16(2)(d)</td>
</tr>
<tr>
<td>Issue</td>
<td>Potential impact</td>
<td>Yes / No</td>
<td>If ‘yes’ consult with</td>
<td>ISEPP clause</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----------</td>
<td>-----------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Bush fire prone land</td>
<td>Are the works for the purpose of residential development, an educational establishment, a health services facility, a correctional centre or group home in bush fire prone land?</td>
<td>No</td>
<td></td>
<td>ISEPP cl.16(2)(f)</td>
</tr>
</tbody>
</table>