

HW1 Island Point Road Roundabout Installation

Review of Environmental Factors

Roads and Maritime Services | August 2019



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Prepared by Cardno (NSW/ACT) Pty Ltd and Roads and Maritime Services

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Executive summary

The proposal

Roads and Maritime Services proposes to install a roundabout at the Princes Highway and Island Point Road intersection, Tomerong, within the Shoalhaven Local Government Area (LGA). The features of the roundabout include:

- Two southbound lanes entering and exiting the roundabout on Princes Highway
- Two lanes entering the roundabout from Island Point Road
- One northbound lane entering the roundabout and one northbound slip lane on Princes Highway
- Relocation of the existing street lights at the intersection
- A cyclist crossing point for crossing Princes Highway on southern side of roundabout.



Need for the proposal

Tomerong is in the South Coast Region of NSW, around 20 kilometres south of Nowra. At the intersection of the Princes Highway and Island Point Road in Tomerong, a total of 36 vehicle crashes were recorded between 1 July 2011 and 30 September 2016. These crashes resulted in 45 casualties, including 11 serious injuries.

As part of the NSW Road Safety Strategy, the NSW Government established the Safer Roads Program aiming to reduce crashes on the NSW road network. As part of the program, a project for a new roundabout at Island Point Road was developed to improve safety at this intersection.

Proposal objectives and development criteria

The objectives of the proposal include:

- Improve road safety and reduce the occurrence of crashes at the intersection of Princes Highway and Island Point Road, targeting the dominant crash types that have been recorded at the intersection (majority involve vehicles crossing the highway in to or out of Island Point Road)
- Improve traffic efficiency and intersection performance as traffic modelling found that the current intersection would fail service requirements in 2020.

Options considered

The options considered as part of the proposal development were:

1. Install a roundabout:
 - a. With a free flowing northbound lane
 - b. With the northbound lane passing through the roundabout
2. Install traffic signals on the existing intersection arrangement
3. Reconfigure the intersection to a channelised right turn (CHR) arrangement:
 - a. With a realigned left turn lane into Island Point Road
 - b. With the left turn into Island Point Road removed and a new access provided at Grange Road
 - c. With the right turn out of Island Point Road banned and a turn-around facility located to the south
 - d. With the right turn out of Island Point Road banned and relocated to a new location
4. Grade separated interchange
5. Do nothing – no change to existing arrangement.

Option 1a has been selected as the preferred option, as it meets both objectives in improving road safety and traffic efficiency. It also has a smaller environmental impact and provides good value for money.

Statutory and planning framework

The proposed roundabout needs to be approved and built in accordance with the *Environmental Planning and Assessment Act 1979* (EP&A Act). Roads and Maritime is able to build roads consistent with the requirements of Clause 94 of the *State Environmental Planning Policy (Infrastructure) 2007* providing it meets the obligations under part 5 of the EP&A Act. This requires Roads and Maritime to “examine and take into account to the fullest extent possible all matters affecting, or likely to affect, the environment by reason of that activity” before determining if the proposed roundabout is to be built. Roads and Maritime is also required to decide if any other legal requirements are identified that would require the proposed roundabout to either be approved by a third-party under development consent or whether any additional information is needed.

This Review of Environmental Factors (REF) has been prepared to assist Roads and Maritime to review legislative requirements and to document related environmental assessment, community and stakeholder consultation obligations for the proposal.

Community and stakeholder consultation

Roads and Maritime carried out community consultation in March and April 2017 to determine how the intersection is used and what difficulties are experienced while using the intersection. Over 300 responses were received, showing a high level of community interest in an upgrade to the intersection. The main concerns with the current intersection were:

- Driver behaviour (impatient drivers and risk-taking behaviour)
- Speed of through traffic on the Princes Highway
- Visibility/geometry of the intersection
- Turning movements at the intersection, particularly turning right out of Island Point Road

Several upgrade options were identified and considered, including the installation of traffic lights, a roundabout, a grade-separated interchange (fly-over), and reconfiguring the current intersection. An extensive option selection process which included consideration of road safety benefits, traffic modelling, cost analysis and community feedback was then undertaken, which identified a roundabout with a free-flowing northbound lane as the preferred option. A community update summarising the feedback received,

the selected treatment option and the next steps in project development was distributed in November 2018, along with the creation of a project webpage and phone number.

Environmental impacts

The key potential environmental impacts of the proposed roundabout identified in this assessment are:

- Minor biodiversity impacts due to the removal of 0.95 ha of vegetation for construction. No threatened species or endangered ecological communities are likely to be significantly affected by the proposal.
- Night works would be required to construct the proposal, which has the potential to temporarily impact a number of isolated residents adjacent to the construction footprint. Stage three of the construction program is likely to have the largest impact, as an excavator with a hammer would be required for approximately 4-6 weeks.
- Construction activities have the potential for minor erosion and sedimentation that requires management to not impact drainage lines Temporary closure of Island Point Road between Grange Road and the Princes Highway for up to two weeks and lane road closures on the Princes Highway. Closures would require detours which would increase traffic and vehicle movements on Hawken Road and The Wool Road during construction
- Minor disruption to businesses and the local community at the intersection of Island Point Road and the Princes Highway during construction.

Justification and conclusion

The proposed roundabout at Island Point Road and the Princes Highway 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 where the proposed activity would occur. This includes the 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. Through design refinements, a number of environmental impacts have been reduced or avoided, however it still would result in impacts to biodiversity, soils, traffic and transport. Vegetation removal required for the work is unavoidable and would likely only have a minor impact to the environment.

The proposal would have a positive impact on the community of the Shoalhaven LGA due the improved safety and accessibility to Island Point Road from the Princes Highway. The environmental impacts associated with the construction and operational phases of works would be managed through effectively applying the safeguards and mitigation measures outlined in this REF.

Contents

| | |
|---|-----------|
| Executive summary | i |
| Contents | iv |
| 1. Introduction | 1 |
| 1.1 Proposal identification..... | 1 |
| 1.2 Purpose of the report..... | 4 |
| 2. Need and options considered | 5 |
| 2.1 Strategic need for the proposal..... | 5 |
| 2.2 Existing infrastructure..... | 5 |
| 2.3 Proposal objectives..... | 5 |
| 2.4 Alternatives and options considered..... | 6 |
| 2.5 Preferred option..... | 8 |
| 2.6 Design refinements..... | 9 |
| 3. Description of the proposal | 10 |
| 3.1 The proposal..... | 10 |
| 3.2 Design..... | 12 |
| 3.3 Construction activities..... | 14 |
| 4. Statutory and planning framework | 18 |
| 4.1 Environmental Planning and Assessment Act 1979..... | 18 |
| 4.2 Other relevant NSW legislation..... | 21 |
| 4.3 Commonwealth legislation..... | 22 |
| 4.4 Confirmation of statutory position..... | 23 |
| 5. Consultation | 24 |
| 5.1 Consultation strategy..... | 24 |
| 5.2 Community involvement..... | 24 |
| 5.3 Aboriginal community involvement..... | 25 |
| 5.4 ISEPP consultation..... | 26 |
| 5.5 Ongoing or future consultation..... | 26 |
| 6. Environmental assessment | 27 |
| 6.1 Biodiversity..... | 27 |
| 6.2 Surface water, hydrology and flooding..... | 40 |
| 6.3 Soils..... | 44 |
| 6.4 Traffic and transport..... | 46 |
| 6.5 Noise and vibration..... | 51 |
| 6.6 Aboriginal cultural heritage..... | 57 |
| 6.7 Non-Aboriginal heritage..... | 62 |
| 6.8 Landscape character and visual impacts..... | 63 |
| 6.9 Property and land use..... | 65 |
| 6.10 Socio-economic..... | 66 |
| 6.11 Other impacts..... | 69 |
| 6.12 Cumulative impacts..... | 73 |
| 7. Environmental management | 75 |

| | | |
|------------|--|-----------|
| 7.1 | Environmental management plans..... | 75 |
| 7.2 | Summary of safeguards and management measures..... | 76 |
| 7.3 | Licensing and approvals..... | 92 |
| 8. | Conclusion..... | 93 |
| 8.1 | Justification..... | 93 |
| 8.2 | Objects of the EP&A Act..... | 94 |
| 8.3 | Conclusion..... | 96 |
| 9. | Certification..... | 97 |
| 10. | References..... | 98 |
| | Terms and acronyms used in this REF..... | 99 |

Tables

| | |
|--|----|
| Table 5-1: Summary of issues raised by the community | 24 |
| Table 5-2: Summary of Roads and Maritime Procedure for Aboriginal Cultural Heritage Consultation and Investigation | 25 |
| Table 5-3: Issues raised through Aboriginal community consultation | 25 |
| Table 5-4: Issues raised through ISEPP consultation | 26 |
| Table 6-1: Plant Community Types (PCT) | 29 |
| Table 6-2: Impacts on native vegetation | 31 |
| Table 6-3: Impacts on threatened flora | 32 |
| Table 6-4: Shoalhaven LGA climate data | 40 |
| Table 6-5: Construction Stage Traffic Impact Summary | 47 |
| Table 6-6: INCG Noise Management levels for residential receivers | 53 |
| Table 6-7: Noise and vibration impact..... | 54 |
| Table 7-1: Summary of safeguards and management measures..... | 76 |
| Table 7-2: Summary of licensing and approvals required | 92 |

Figures

| | |
|--|----|
| Figure 1-1: Site Locality..... | 2 |
| Figure 1-2: Proposed location..... | 3 |
| Figure 3-1: Key features of the proposal..... | 11 |
| Figure 3-2: Typical cross section | 13 |
| Figure 4-1: Zoning Plan | 20 |
| Figure 6-1: Extent of impacts | 35 |
| Figure 6-2: Hydrology | 41 |
| Figure 6-3: Detour route map..... | 48 |
| Figure 6-4: Sensitive receivers | 52 |
| Figure 6-5: Cleared dirt track | 58 |
| Figure 6-6: Vegetation within study area..... | 59 |
| Figure 6-7: Aboriginal artefact..... | 59 |
| Figure 6-8: Raised concrete medians | 63 |
| Figure 6-9: Compound site surrounding landscape..... | 64 |

Appendices

| | |
|------------|---|
| Appendix A | Consideration of clause 228(2) factors and matters of national environmental significance and Commonwealth land |
| Appendix B | Statutory consultation checklists |
| Appendix C | Biodiversity assessment report |
| Appendix D | Heritage assessment report |
| Appendix E | ISEPP consultation |

1. Introduction

This chapter introduces the proposal and provides the context of the environmental assessment. In introducing the proposal, the objectives and project development history are detailed and the purpose of the report provided.

1.1 Proposal identification

Roads and Maritime Services propose to construct a roundabout at the intersection of the Princes Highway and Island Point Road, Tomerong, within the Shoalhaven City Council Local Government Area (LGA). This section of Princes Highway connects Nowra in the north to southern coastal towns such as Ulladulla and Batemans Bay. Island Point Road provides access to St Georges Basin, Sanctuary Point and the surrounding villages. It is also one of two main access routes to the Booderee National Park, a popular tourist destination in the Jervis Bay Territory.

Key features of the proposal would include:

- Two southbound lanes entering and exiting the roundabout on Princes Highway
- Two lanes entering the roundabout from Island Point Road
- One northbound lane entering the roundabout and one northbound slip lane on Princes Highway
- Relocation of the existing street lights at the intersection
- A cyclist crossing point for crossing Princes Highway on southern side of roundabout.

The location of the proposal is shown in Figure 1-1 and an overview of the proposal is provided in Figure 1-2. Chapter 3 describes the proposal in more detail.

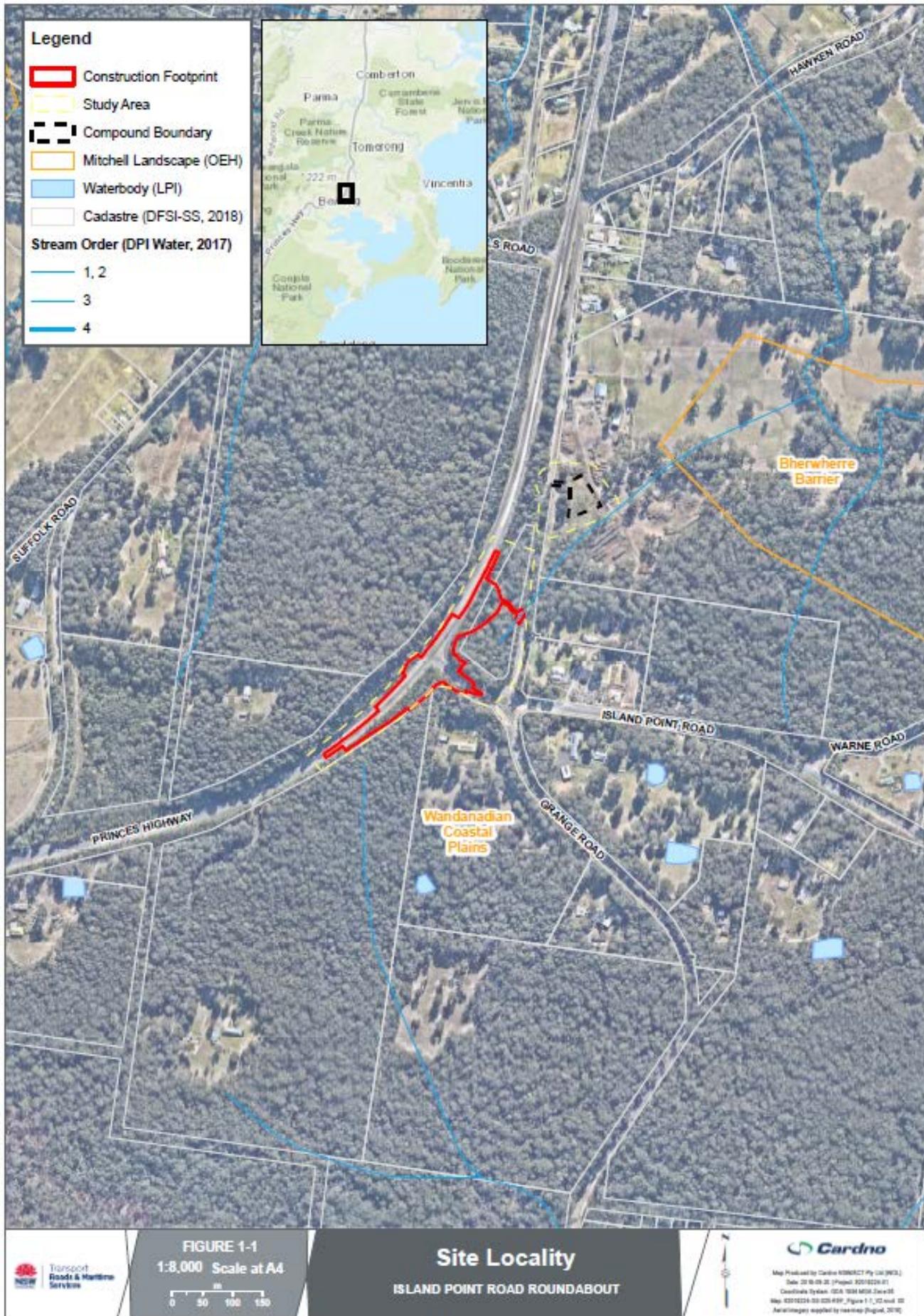


Figure 1-1: Site Locality

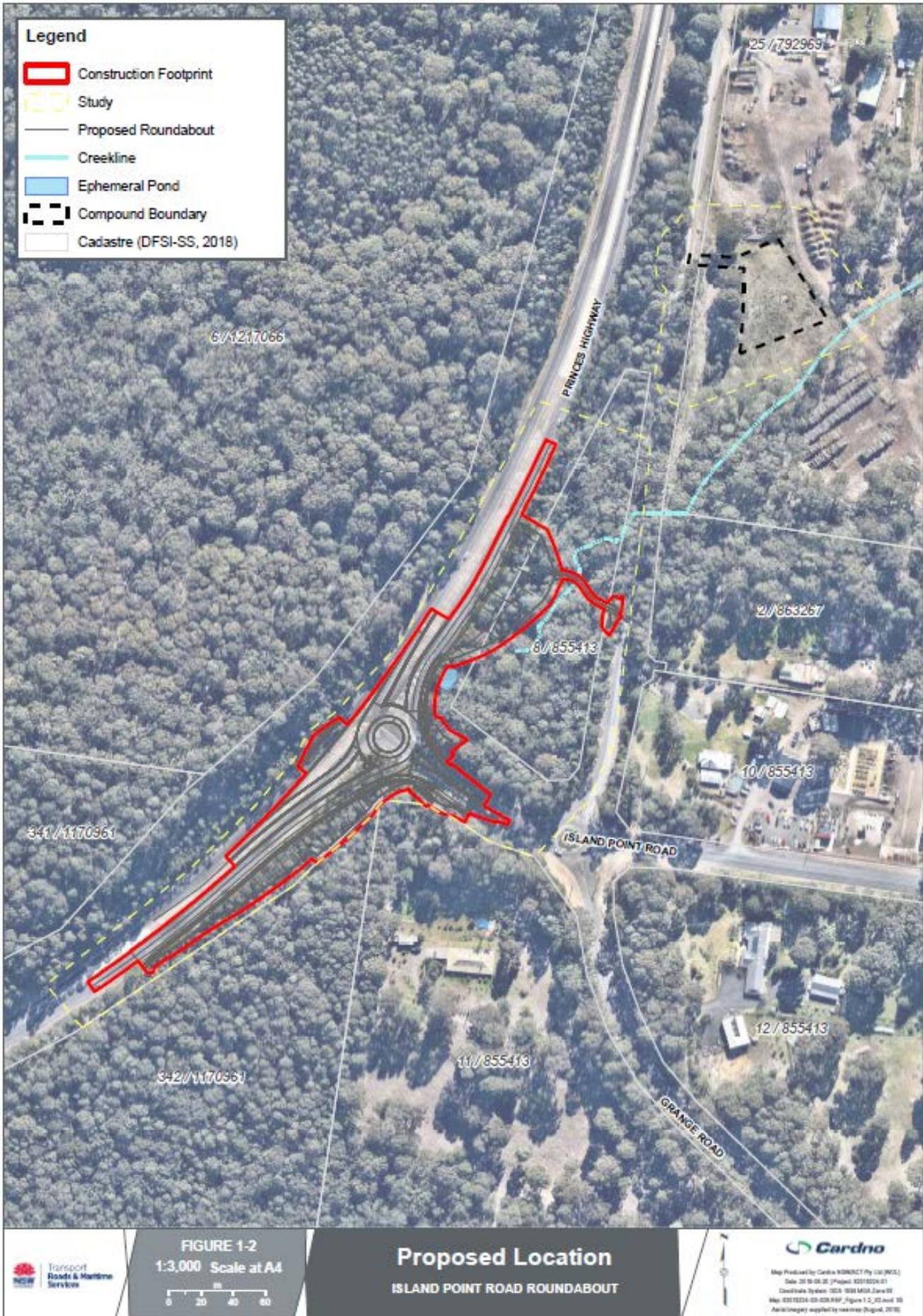


Figure 1-2: Proposed location

1.2 Purpose of the report

This Review of Environmental Factors (REF) has been prepared by Cardno (NSW/ACT) Pty Ltd on behalf of Roads and Maritime. For the purposes of these works, Roads and Maritime is the proponent and the determining authority under Division 5.1 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 mitigation and management measures to be implemented.

The description of the proposed work and assessment of associated environmental impacts has been undertaken in the context of clause 228 of the Environmental Planning and Assessment Regulation 2000, the factors in the *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), *Roads and Related Facilities EIS Guideline* (DUAP 1996), the *Biodiversity Conservation Act 2016* (BC 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 5.5 of the EP&A Act including that Roads and Maritime 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 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 Division 5.2 of the EP&A Act
- The significance of any impact on threatened species as defined by the BC Act and/or FM Act, in section 1.7 of the EP&A Act and therefore the requirement for a Species Impact Statement or a Biodiversity Development Assessment Report
- The significance of any impact on nationally listed biodiversity matters under the EPBC Act, including whether there is a real possibility that the activity may threaten long-term survival of these matters, 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, subject to the EPBC Act strategic assessment approval, to make a referral to the Australian Government Department of the Environment 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

This chapter describes the need for the proposal in terms of its strategic setting and operational need. It identifies the various options considered and the selection of the preferred option for the proposal.

2.1 Strategic need for the proposal

The proposal is funded under the NSW Government's Safer Roads Program, a key initiative of the NSW Road Safety Strategy, which aims to make NSW roads safer and reduce crashes on the road network. This program provides treatments where there are clusters of casualty crashes on local and regional roads. At the intersection of Princes Highway and Island Point Road, between 1 July 2011 and 30 September 2016, there were 36 recorded crashes resulting in 45 casualties, including 11 serious injury crashes.

In addition to the road safety benefits, traffic modelling has shown that a roundabout would provide a higher level of intersection performance, reduced queue lengths and improved traffic efficiency.

2.2 Existing infrastructure

The existing intersection consists of a T-junction without traffic lights, raised concrete median islands and north and southbound through lanes on the Princes Highway. A southbound overtaking lane begins approximately 100 meters south of the intersection. The posted speed limit is 80 km/h in the southbound direction and 100 km/h in the northbound direction on Princes Highway, and 80 km/h on Island Point Road. There is a small, single lane roundabout at the intersection of Island Point Road and Grange Road, about 120 meters east of the Princes Highway.

Street lights exist within the proposed site on the Princes Highway and Island Point Road in addition to associated underground low voltage electrical service lines. Stormwater drainage exists along the median and under the northbound kerb on the Princes Highway; and crosses the highway north and south of the intersection. Another crossing exists on Island Point Road, between the Highway and Grange Road. All other underground utilities are located near the Grange Road roundabout, outside of the proposed works site.

2.3 Proposal objectives

The objectives of the proposal include:

- Improve road safety and reduce the occurrence of crashes at the intersection of Princes Highway and Island Point Road, targeting the dominant crash types that have been recorded at the intersection (majority involve vehicles crossing the highway in to or out of Island Point Road)
- Improve traffic efficiency and intersection performance as traffic modelling found that the current intersection would fail service requirements in 2020.

2.4 Alternatives and options considered

This section describes the alternatives and options to deliver the proposed roundabout.

2.4.1 Methodology for selection of preferred option

A detailed investigation and review of the intersection was undertaken to identify treatment options and develop strategic designs and cost estimates. The investigation and review included:

- Researching previous improvements and alterations to the intersection
- Collecting and examining crash history data
- The installation of a 'crash camera' for a period of about six months
- Obtaining and reviewing survey information
- A road safety audit of the existing road environment
- Community consultation
- Research and determination of potential treatment options
- Developing strategic designs
- Assessing strategic estimates
- Safety Benefit to Cost Ratio (BCR) analysis
- Traffic modelling
- Options assessment.

Once treatment options had been identified, they were assessed by comparing the road safety benefit, expected traffic efficiency and estimated project cost. Potential treatment options that would increase the existing road safety risk or would introduce new road safety risks were removed from further consideration. Each remaining option was graded based on its assessed performance, to determine the preferred treatment for implementation.

2.4.2 Identified options

The following treatment options were investigated:

1. Install a roundabout:
 - a. With a free flowing northbound lane
 - b. With the northbound lane passing through the roundabout
2. Install traffic signals on the existing intersection arrangement
3. Reconfigure the intersection to a channelised right turn (CHR) arrangement:
 - a. With a realigned left turn lane into Island Point Road
 - b. With the left turn into Island Point Road removed and a new access provided at Grange Road
 - c. With the right turn out of Island Point Road banned and a turn-around facility located to the south
 - d. With the right turn out of Island Point Road banned and relocated to a new location
4. Grade separated interchange
5. Do nothing – no change to existing arrangement.

2.4.3 Analysis of options

Option 1a – Install a roundabout with free flowing northbound lane

This option would treat the severity and frequency of crash types that were most common in the last five years, reducing the number of conflict points between traffic travelling in different directions. It is in line with the safe systems approach to road safety, as a crash resulting from driver error would occur at low speeds. In addition, cyclists would be accounted for with a staged crossing of Princes Highway. Traffic modelling ranked this as the most efficient option. This option would meet both project objectives of improving road safety and improving traffic efficiency.

Option 1b – Install a roundabout with the northbound lane passing through the roundabout

This option has similar road safety benefits to option 1a, however traffic efficiency is lower as northbound vehicles on the Princes Highway would have to slow and navigate through the intersection as opposed to driving past it without needing to slow down. As such, this was ranked as the second most efficient treatment option. This option would also cost more than option 1a as it would require additional works to realign the northbound lane on Princes Highway.

Option 2 – Traffic signals on the existing intersection arrangement

This option would increase the road safety risk as it does not reduce the number of conflict points and introduces a new hazard in the form of traffic signal posts. This option is not in line with the safe systems approach as there is potential for non-compliance at the red light and, in the instance of driver error, a crash would be at high speed. Furthermore, Austroads' *Guide to Road Design Part 3* and *Guide to Traffic Management Part 3* recommend that traffic signals are not used at an isolated, high speed location; "In instances where traffic signal devices are unexpected, road users may take additional time to interpret the road environment and as a result, reaction times are extended and compromised." In terms of traffic efficiency, traffic modelling ranked this option as the third most efficient, as it would have longer right turning queues compared to a roundabout. This option was removed from consideration due to significant road safety concerns.

Option 3a – Reconfigure the intersection to a channelised right turn (CHR) with a realigned left turn into Island Point Road

This option would slightly improve road safety as it would improve sight distance to the north for vehicles turning right out of Island Point Road and would reduce confusion caused by left turning vehicles. However, the number of conflict points would not be reduced and cyclists would not be catered for. This option would have minimal improvement to traffic efficiency compared with the existing intersection.

Option 3b – Reconfigure the intersection to a CHR with the left turn into Island Point Road removed and new access provided north of the intersection with Grange Road

This option would require southbound vehicles to turn left at a new intersection located to the north of the existing intersection. As with option 3a, this option would improve sight distance to the north for vehicles turning out of Island Point Road. However, it would increase the number of conflict points due to an additional intersection. Southbound vehicles would still be able to turn left into Island Point Road and motorists may attempt to turn right onto Princes Highway at the new intersection. Both of these movements would result in a significantly higher safety risk than the existing arrangement. This option would have minimal improvement to traffic efficiency compared with the existing intersection and would not cater for cyclists.

Option 3c – Reconfigure the intersection to a CHR with the right turn out of Island Point Road banned, and provide a U-turn area to the south

This option would require motorists from Island Point Road to head south on the Princes Highway and use a U-turn facility to travel north. This option would slow northbound vehicles turning right into Island Point Road and remove the conflict of vehicles turning right at the intersection; however, it would introduce major sight distance issues for northbound traffic. As such, this option was removed from consideration due to significant road safety concerns.

Option 3d – Reconfigure the intersection to a CHR with the right turn out of Island Point Road banned, and provide a new right turn further to the north

This option would require northbound motorists from Island Point Road to head north along Grange Road to turn right onto the Princes Highway at a new intersection. This option does not reduce the number of conflict points overall as it is relocating the same turning movement to another location. It would also introduce potential weaving issues for motorists wanting to turn left onto Kells Road from the new intersection. As such, this option was removed from consideration due to significant road safety concerns.

Option 4 – Grade separated interchange

This option would treat the severity and frequency of crash types that have been most common in the last five years through removal of conflict points; however the estimated cost of this treatment is nine times higher than option 1a. An interchange would also require a larger environmental impact from the increased footprint required. As such, this option was removed from consideration due to reasonable funding constraints/availability and environmental impact.

Option 5 – Do nothing

This option would not alter the existing road environment, therefore not reducing the road safety risks associated with the current intersection layout. As such, this option would not meet the project objectives.

2.5 Preferred option

Option 1a was selected as the preferred treatment, as it meets the project objectives of improving road safety and traffic efficiency within the funding available. Of the lower cost options, it was rated as providing the greatest improvement to traffic efficiency compared to the existing layout. In terms of road safety improvements, a roundabout and grade separated interchange have similar outcomes as they would both eliminate conflict points; however, a roundabout has a significantly smaller environmental impact and would cost significantly less to construct and maintain.

2.6 Design refinements

2.6.1 Compound Sites

Roads and Maritime identified four potential locations for the compound site. The site chosen would be located on Lot 25 DP 792969, which is highly disturbed from its current land use consisting of an operational timber yard (Figure 1 2). This site was chosen due to its position in relation to the construction boundary and access points from Grange Road avoiding key environmental constraints such as native vegetation, heritage sites and waterways.

2.6.2 Access Road Alignment

To construct the western batter of the proposal, an access track is required on Lot 8 DP 855413 to allow construction vehicles to access the area. The design of the access road from Grange Road has been aligned to reduce the environmental impact to Lot 8 DP 855413, by limiting the number of trees and amount of vegetation to be removed. This would enable vehicles to access the embankment for vegetation clearing during the construction phase of the proposed roundabout.

2.6.3 Embankment Fill Profile

The embankment fill profile adjacent to Lot 8 DP 855413 has been redesigned to reduce the impact on the ephemeral pond, vegetation removal and the amount of offsite material disposal, from 2,500m³ to less than 1,000m³. This would reduce the amount of offsite vehicle movements required, reduce project costs, and reduce offsite environmental impacts.

3. Description of the proposal

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

3.1 The proposal

Roads and Maritime propose to construct a roundabout at the intersection of the Princes Highway and Island Point Road, Tomerong, within the Shoalhaven City Council LGA. The proposal is shown in Figure 1-2 and Figure 3-1.

Key features of the proposal would include:

- Two southbound lanes from Island Point Road
- Two lanes entering the roundabout from Island Point Road
- One northbound lane entering the roundabout and one northbound slip lane on Princes Highway
- Relocation of the existing street lights at the intersection
- A cyclist crossing point for crossing the Princes Highway on the southern side of the roundabout
- Posted speed limit would remain at 80 km/h in the southbound direction and would be reduced to 80 km/h in the northbound direction on Princes Highway.

The existing intersection consists of a T-junction without traffic lights, raised concrete median islands and north and southbound through lanes on the Princes Highway. A southbound overtaking lane begins approximately 100 meters south of the intersection. The posted speed limit is 80 km/h in the southbound direction and 100 km/h in the northbound direction on Princes Highway, and 80 km/h on Island Point Road. There is a small, single lane roundabout at the intersection of Island Point Road and Grange Road, about 120 meters east of the Princes Highway.

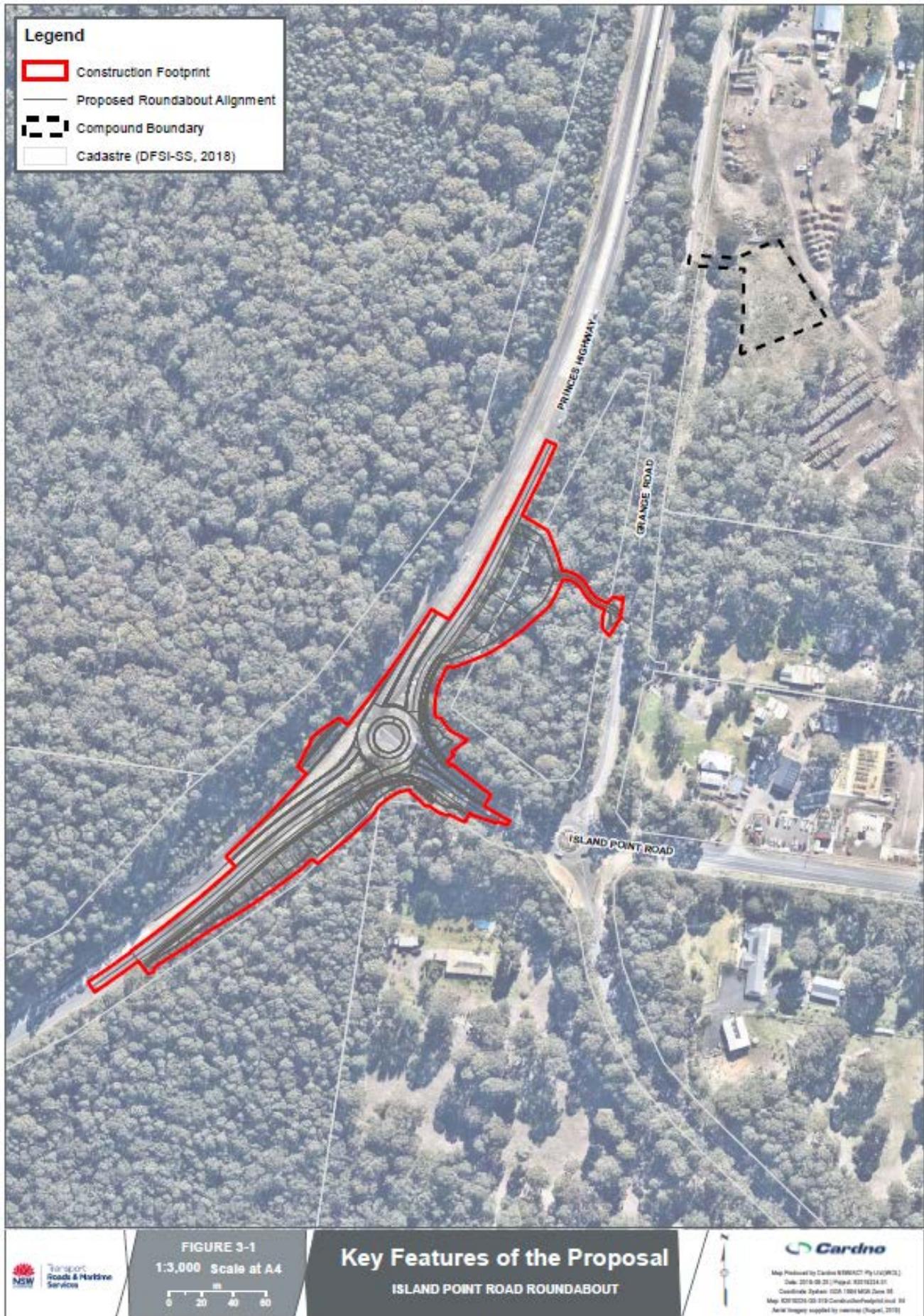


Figure 3-1: Key features of the proposal

3.2 Design

3.2.1 Design criteria

The concept design for the proposal is based on the following design criteria:

- Provide a two-lane roundabout
- Maintain the existing free-flow northbound lane on the Princes Highway
- Maintain existing lane widths
- Target southbound shoulder width of 3 m

A typical cross section is shown in Figure 3-2 below.

3.2.2 Engineering constraints

The following engineering constraints would need to be addressed

- Minimise changes to existing vertical alignments of Princes Highway and Island Point Road to assist constructability
- Minimise changes to free-flow northbound lane on Princes Highway
- Minimise impacts on the existing approach length of Island Point Road to the proposed roundabout
- Avoid impact to existing roundabout at Island Point Road and Grange Road.

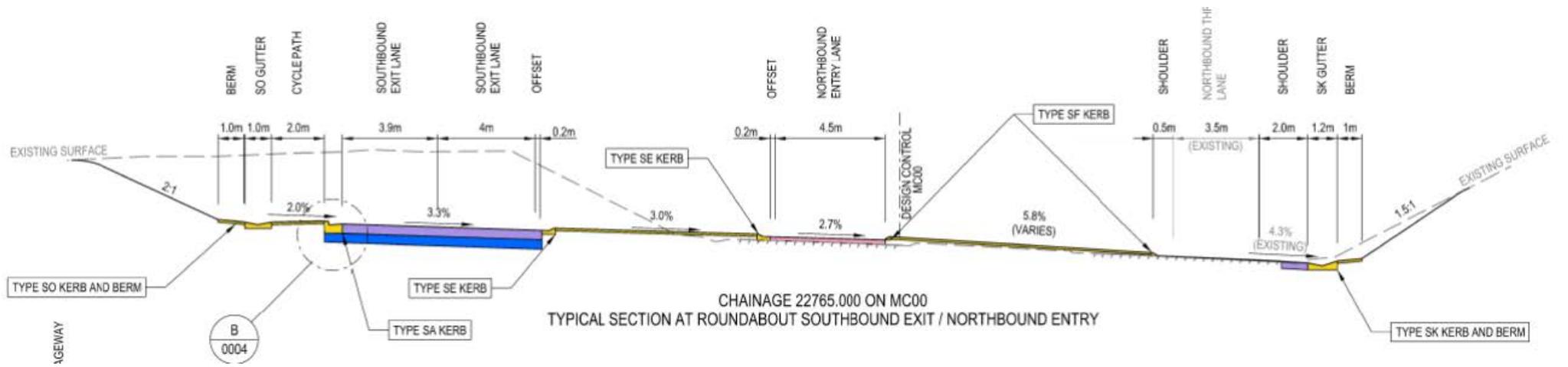


Figure 3-2: Typical cross section

3.3 Construction activities

3.3.1 Work methodology

It is expected that construction of the roundabout would take place in the following stages:

Stage 1 – Site establishment and vegetation clearing (4-6 weeks)

This stage is to be completed under traffic control during standard working hours, and is expected to occur in late 2019. It is proposed that the removed vegetation would be mulched and stockpiled for later use during the rehabilitation of disturbed areas.

Stage 2 – Offline works earthworks and pavement construction (12-16 weeks)

This stage would commence in early 2020 and would include all earthworks and pavement construction for the sections outside of the existing road pavement, including the cutting on the southern side of the intersection and the fill embankment on the northern side of the intersection. The material from the cutting would be transported to construct the fill batter, however there would be up to 1,000m³ of material that requires offsite disposal. Traffic control for this stage would involve closing the southbound left-turn lane on the Princes Highway and the eastbound lane on Island Point Road between the highway and Grange Road. Access to Basin View from the Princes Highway for southbound vehicles would be via Hawken Road (additional 0.5 kilometres and 2 minutes of travel), and via The Wool Road for northbound vehicles (additional 1.8 kilometres and 3 minutes of travel). The westbound lane on Island Point Road would remain open, however short stoppages would occur to allow construction vehicles to cross the road between the cut and fill sites. Work during this stage would be undertaken during standard working hours. The street lighting would be decommissioned at the start of this stage to remove the safety risk of striking a live underground electrical cable. Temporary street lights would be used to ensure sufficient lighting of the intersection throughout the works.

Stage 3 – Pavement construction and stormwater drainage works under the existing concrete islands on Princes Highway (4-6 weeks)

This stage includes removing the existing concrete medians, relocating stormwater drainage assets and constructing new road pavement on the Princes Highway. To ensure worker safety, Island Point Road between the highway and Grange Road would be closed (eliminating turning movements through the worksite). As such, the work would be undertaken at night to reduce the impact to motorists. Island Point Road would be reopened each day.

Stage 4 – Pavement construction under the new roundabout (3-4 weeks)

This stage would involve constructing pavement under the new roundabout location and would be undertaken in two parts (Stage 4a and 4b) to allow for continued through movements on the Princes Highway. Stage 4a would require the closure of Island Point Road between the highway and Grange Road for up to two weeks to allow for the pavement to be rebuilt on the eastern side of Princes Highway and on Island Point Road. One lane in each direction would be maintained on Princes Highway, while access from the Basin View area to the highway would be via Hawken Road and The Wool Road. Stage 4b would involve the pavement to be rebuilt between the southbound lanes and the northbound through-lane on Princes Highway and would require banning the right-turn-in and right-turn-out of Island Point Road. Works during Stage 4 would be undertaken during both the day and night to reduce the impact to motorists.

Stage 5 – Construction of new roundabout and concrete medians, and final road surfacing (4-6 weeks)

This stage would involve constructing the new roundabout as well as new concrete medians on Princes Highway and Island Point Road, followed by installing the final road surface. Due to impacts to traffic, this stage would be undertaken at night and would require banning the right-turn-in and right-turn-out of Island Point Road during night time working hours. Island Point Road would be reopened each day with the intersection operating in the new roundabout layout.

Stage 6 – Kerb adjustment on Princes Highway, installation of street lights and disestablishment from site (2-3 weeks)

This stage involves kerb adjustment work adjacent to the northbound through-lane on the Princes Highway. This would require all northbound traffic to travel through the roundabout and would be undertaken at night to reduce impacts to traffic. The new roundabout layout would be in full operation during the day.

Street light installation would be completed at night to reduce impacts to traffic on the highway, and would be done under ordinary traffic control arrangements. The removal of site amenities would be undertaken during standard working hours.

3.3.2 Construction hours and duration

Preliminary site work is anticipated to begin in November 2019 with the project completion date expected in late-2020, weather permitting. Day work would take place during the hours detailed below:

- Monday – Friday: 8:00am to 6:00pm
- Saturday: 8:00am to 5:00pm
- Sunday and Public Holidays: No work.

Night work would be required throughout multiple stages of the project to reduce disruptions to traffic, reduce disruptions to residents and to ensure the safety of workers. Night work would take place during the hours detailed below:

- Sunday – Friday: 7:00pm to 5:00am
- Saturday and Public Holidays: No work

The night works would be confirmed upon Roads and Maritime obtaining a Road Occupancy Licence. Work may be undertaken outside of the working hours mentioned above on weekends or nights to minimise traffic impacts on the community. If it is determined that work outside the nominated hours is required, assessment would be undertaken in accordance with the standard actions for noise minimisation identified in the Roads and Maritime Construction Noise and Vibration Guideline

3.3.3 Plant and equipment

An indicative list of plant and equipment that would typically be required is provided below. Additional equipment that is likely to be used would be identified during detailed design by the construction contractor.

- Chainsaws
- Large excavators
- Bulldozers
- Tipper trucks, dump trucks and truck and dog combinations
- Concrete trucks and pumps
- Rotor mill

- Vibratory rollers
- Water carts
- Graders
- Asphalt paver

3.3.4 Earthworks

The proposal would involve earthworks, with the overall aim of maximising the re-use of material. Earthworks would include:

- Cutting on the southern side of the intersection (stage 2)
- Fill embankment on the northern side of the intersection
- Widening of fill embankments and at culvert locations.

The estimated amount of excavated (cut) material is approximately 5,700 m³. It is expected there would be up to 1,000 m³ of cut material that would need to be disposed of offsite, with the remaining 4,800 m³ to be used as fill material for the proposal. The estimates may change depending on the actual quality of the material and the suitability for reuse in construction.

3.3.5 Traffic management and access

Traffic management controls would be applied throughout each construction stage, and would involve:

- Stage 2 construction stage:
 - Closure of the southbound left-turn lane on the Princes Highway and eastbound lane on Island Point Road during stage 2 of the construction phase
 - Westbound lane would remain open with short stoppages occurring during construction hours to allow for movement of construction vehicles to cross the road during stage 2 of the construction phase
 - Access to Basin View from the Princes Highway for southbound vehicles would be via Hawken Road (additional 0.5 kilometres or approximately 2 minutes' additional travel time) and for southbound vehicles via The Wool Road (1.8 kilometres or approximately 3 minutes' additional travel time)
- Stage 3 construction stage:
 - Night works and road closure - Island Point Road closure between Grange Road and the Princes Highway. Island Point Road would be reopened each day
- Stage 4 construction stage:
 - Closure of Island Point Road between Grange Road and the Princes Highway, with one lane in each direction on the Princes Highway being maintained
 - Access to Basin View would be via Hawken Road
 - Closure of the right-turn-in and right-turn-out of Island Point Road
 - Night works on Island Point Road and the Princes Highway
- Stage 5 construction stage:
 - Night works and closure of the right-turn-in and right-turn-out of Island Point Road. The road would be reopened each day
- Stage 6 construction stage:
 - Night works on the Princes Highway
- Temporary lights and stop-go signs on the Princes Highway, Island Point Road and Grange Road.

3.3.6 Ancillary facilities

The site compound would be located at Lot 25 DP 792969 (Figure 1-2), which is slightly to the north of the proposal, and would consist of:

- Site offices
- Toilets
- Light and heavy vehicle parking and storage
- Lay down of materials
- Temporary stockpile area for non-erodible material
- Plant storage and parking.

Temporary stockpiling of topsoil, pavement aggregates, unsuitable fill and mulch would occur within the assessed project footprint area. Stockpiles would be managed in accordance with the Roads and Maritime *Stockpile Management Procedure and the QA Specification R44 – Earthworks*.

A new access track would be constructed on Roads and Maritime owned land at Lot 8 DP 855413, the access track has been designed to create minimal disturbance for the surrounding environmental and would primarily be used for the safe passage of trucks and other construction equipment during the construction of the proposed roundabout.

3.3.7 Public utility adjustment

Lights along the Princes Highway and Island Point Road would be turned off at the commencement of stage 2 works. Offline works will consist of earthworks and pavement construction (12-16 weeks) in early 2020 to remove the risk of striking a live underground electrical cable. Temporary lighting would be used during this time whilst the lights are switched off to ensure there is sufficient lighting during the night works. New lights would be installed at the end of the construction period. There would be no other adjustments or changes of other public utilities during the construction period.

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

Road infrastructure delivered is typically self-determined under the Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) or is approved by DP&E under part 5.1 of the above Act or its predecessor Part 3A. The proposed roundabout is defined as an 'activity' for the purposes of Part 5 of the (EP&A Act) and is subject to an environmental impact assessment (this REF).

4.1.1 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. In this clause (94 (2)) and clause 96, a reference to development for the purpose of road infrastructure facilities includes a reference to development for any of the following purposes if the development is in connection with a road or road infrastructure facilities:

- a) construction works (whether or not in a heritage conservation area), including:
 - i. temporary buildings or facilities for the management of construction, if they are in or adjacent to a road corridor, and
 - ii. creation of embankments, and
 - iii. extraction of extractive materials and stockpiling of those materials, if:
 - a. the extraction and stockpiling are ancillary to road construction, or
 - b. the materials are used solely for road construction and the extraction and stockpiling take place in or adjacent to a road corridor, and
 - iv. temporary crushing or concrete batching plants, if they are used solely for road construction and are on or adjacent to a road corridor, and
 - v. temporary roads that are used solely during road construction,
- b) emergency works, or routine maintenance works, carried out on an existing public road or on land that is adjacent to such a road (including on land to which State Environmental Planning Policy No 14—Coastal Wetlands or State Environmental Planning Policy No 26—Littoral Rainforests applies but, if they are on such land, only if any adverse effect on the land is restricted to the minimum possible to allow the works to be carried out),
- c) alterations or additions to an existing road (such as widening, duplication or reconstruction of lanes, changing the alignment or strengthening of the road), environmental management works, if the works are in or adjacent to a road corridor.

As the proposal is for a HW1 roundabout installation is to be carried out by Roads and Maritime it can be assessed under Division 5.1 of the *Environmental Planning and Assessment Act 1979*. Development consent from council is not required.

The proposal is not located on land reserved under the *National Parks and Wildlife Act 1974* and does not require development consent or approval under *State Environmental Planning Policy (Coastal*

Management) 2018, State Environmental Planning Policy (State and Regional Development) 2011 or State Environmental Planning Policy (State Significant Precincts) 2005.

This means the proposed roundabout can proceed with the provisions of the ISEPP prevailing over other State and local policy. However, this does not remove the need to assess the significance of any environmental impacts if the proposed roundabout progresses under Part 5 of the EP&A Act as described in Section 4.1.

Part 2 of 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, including consultation as required by ISEPP (where applicable), is discussed in chapter 5 of this REF.

4.1.2 Local Environmental Plans

Shoalhaven Local Environment Plans

The proposed roundabout is located within the Shoalhaven LGA. There is one local environmental planning instrument that applies to the Shoalhaven LGA – Shoalhaven Local Environment Plan (LEP) 2014. The proposed roundabout comprises of the following zoning:

- SP2 – Infrastructure

The *SP2 – Infrastructure zone* includes the following objectives pursuant to the LEP:

- To provide for infrastructure and related uses;
- To prevent development that is not compatible with or that may detract from the provision of infrastructure.

Lot 8 DP 855413 is mapped as a biodiversity habitat corridor and is identified as terrestrial biodiversity as defined in Part 7.5 of the LEP and has the following objectives:

- Protecting native flora and fauna
- Protecting the ecological processes necessary for their continued existence
- Encouraging the conservation and recovery of native fauna and flora and their habitats.

The proposed roundabout is consistent with the zone and corridor objectives as it is targeted towards providing infrastructure whilst limiting impact to native flora and faunal habitat. It would not hinder the achievement of the above objectives in the context of the LEP, as shown Figure 4-1.

The primary site compound is situated in land zoned as RU2 – Rural Landscape. Roads and Maritime have reached a lease agreement with the land owner for the temporary use of part of the land as the primary compound site.

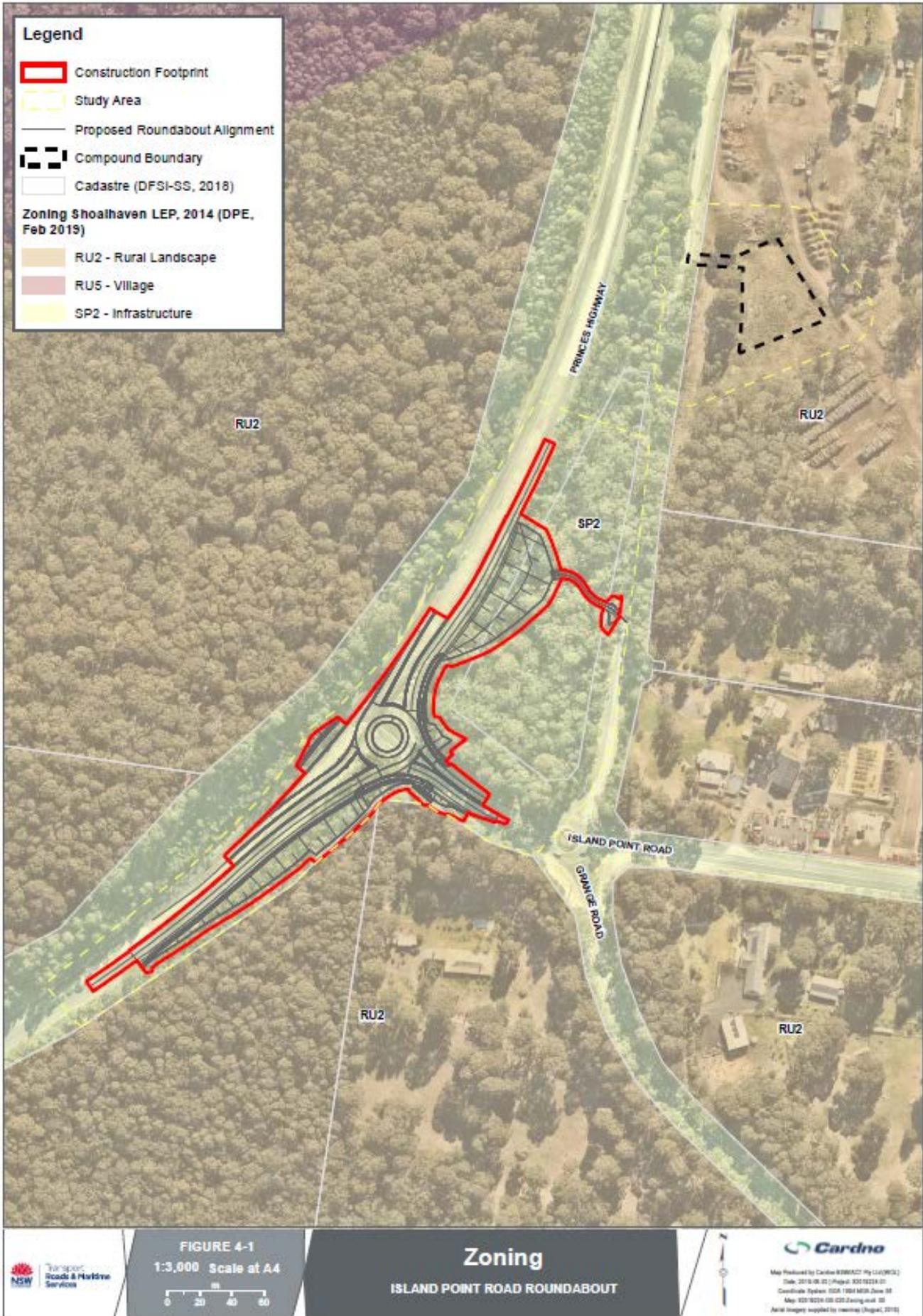


Figure 4-1: Zoning Plan

4.2 Other relevant NSW legislation

Heritage Act 1977

The Act provides for the protection of conservation of buildings, works, archaeological relics and places of heritage value through their listing on various state local registers. Matters protected under the Act include items subject to an Interim Heritage Order and items listed on the State Heritage Register, the heritage schedules of local council LEPs, and the heritage and conservation registers established under section 170 of the Act by NSW Government agencies. The Act also provides for the protection of archaeological 'relics', being any deposit, object or material evidence that relates to the non-Aboriginal settlement of NSW and is of State or local heritage significance, it is an offence to harm any non-Aboriginal heritage values without permission.

This section of the Princes Highway and Island Point Road is not listed in the Roads and Maritime's section 170 Heritage and Conservation Area and is not of heritage significance.

Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) commenced on 25 August 2017 repealing *the Threatened Species Conservation Act 1995*. The BC Act seeks to conserve biological diversity and promote Ecologically Sustainable Development (ESD); to prevent extinction and promote recovery of threatened species, populations and ecological communities; and to protect areas of outstanding biodiversity value. The BC Act provides a listing of threatened species, populations and ecological communities, areas of outstanding biodiversity value, and key threatening processes.

The proposal would not result in a significant impact on critical flora and fauna habitats or aquatic threatened species, removing the need to prepare a Species Impact Statement (SIS) as identified in Section 6.1 of this report and in the Biodiversity Assessment (Appendix D).

Roads Act 1993

The Roads Act governs the use and access to public roads, manage opening and closing of public roads as well as providing classification of roads and identifying the functions of road authorities. Under the Act Roads and Maritime provides construction and maintenance functions of public roads. Roads and Maritime may construct a road to connect with, or to pass over or under, a freeway, transitway or controlled access road.

The proposed works would be undertaken on a number of public roads in the local area, these are:

- Princes Highway
- Island Point Road
- Grange Road.

The construction of the proposed roundabout is likely to impact on the traffic during the construction period, Roads and Maritime would obtain a Road Occupancy Licence (ROL) from the Traffic Management Centre to work on the Princes Highway, Island Point Road and Grange Road.

Protection of the Environment Operations Act 1997

The Act focuses on environmental protection and provisions for the reduction of water, noise and air pollution and the storage, treatment and disposal of waste. No Protection of the Environment Policies (PEPs) are relevant to the proposal. Licenses would be required pursuant to the *Protection of the Environment Operations Act 1997* if Scheduled Activities listed under the Act are undertaken (also refer to Section 7.3 of this report). The Roads and Maritime staff and/or contractors working on behalf of the Roads and Maritime are required to notify the EPA when a 'pollution incident' occurs that is likely to impact upon

the environment as per section 148 of the Act. An incident management plan would be included the Construction Environmental Management Plan (CEMP).

Fisheries Management Act 1994

The Act provides for the protection of fishery resources and values for current and future generations. The Act makes it an offence to harm fisheries and resources without an appropriate assessment, inclusion of safeguards and/or the appropriate permissions to carry out certain work. The proposal would not result in a significant impact on critical flora and fauna habitats or aquatic threatened species, removing the need to prepare an SIS as per section 221 of the Act as identified in Section 6.1 of this report and in the Biodiversity Assessment (Appendix D).

No specific permissions and safeguards are needed in response to the provisions of the above Act. However, safeguards are needed to prevent any indirect impact on the wider catchment values associated with nearby creeklines and waterbodies.

4.3 Commonwealth legislation

4.3.1 Environment Protection and Biodiversity Conservation Act 1999

A referral under the *Environmental Protection and Biodiversity Conservation Act 1997* (EPBC Act) is not required for proposed road activities that may affect nationally listed threatened species, 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 as part of chapter 6 of the REF and Appendix C.

Findings – matters of national environmental significance

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 Australian Government Department of the Environment under the EPBC Act.

Findings – nationally listed biodiversity matters (where the strategic assessment applies)

The assessment of the proposal's impact on nationally listed threatened species, endangered ecological communities and migratory species found that there is unlikely to be a significant impact on relevant matters of national environmental significance. Chapter 6 of the REF describes the safeguards and management measures to be applied.

4.4 Confirmation of statutory position

The proposal is categorised as development for the purpose of a road and/or road infrastructure facilities and is being carried out by or on behalf of a public authority. Under clause 94 of ISEPP the proposal is permissible without consent. The proposal is not State significant infrastructure or State significant development. The proposal can be assessed under Division 5.1 of the EP&A Act.

Roads and Maritime is the determining authority for the proposal. This REF fulfils Roads and Maritime's obligation under section 5.5 of the EP&A Act including 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.

5. Consultation

This chapter discusses the consultation undertaken to date for the proposal and the consultation proposed for the future.

5.1 Consultation strategy

During the proposal, consultation with the community and government agencies would be undertaken. The engagement objectives are to:

- Provide clear information on when Roads and Maritime are seeking feedback for the proposal
- Provide stakeholders and the community with targeted information to build awareness and knowledge of the proposal
- Encourage participation from the community and stakeholders in the engagement process to help identify a preferred option for the proposed upgrade
- Ensure community and stakeholder feedback is considered at all stages of the Proposal
- Identify and mitigate stakeholder and community issues early to avoid delays to the overall program.

5.2 Community involvement

The community was engaged by letter that was distributed in April 2017, seeking feedback via online survey, email or post to answer the following questions:

- How frequently do you use this intersection?
- Have you experienced any difficulties using the intersection?
- Are there particular movements that are an issue?

A total of 327 responses were received, showing a high level of community interest. A summary of the key issues raised by the community is shown in Table 5-1.

Table 5-1: Summary of issues raised by the community

| Group | Issue raised | Response / where addressed in REF |
|--------------------------------|---|---|
| Residents and local businesses | <ul style="list-style-type: none"> • Driver behaviour and speed (Impatient drivers and risk-taking behaviour) | <ul style="list-style-type: none"> • Section 3 – Description of the proposal |
| Residents and local businesses | <ul style="list-style-type: none"> • Speed of through traffic on the Princes Highway | <ul style="list-style-type: none"> • Section 3.2 – Design • Section 6.4 – Traffic and Transport |
| Residents and local businesses | <ul style="list-style-type: none"> • Visibility / geometry of the intersection | <ul style="list-style-type: none"> • Section 6.4 – Traffic and Transport |
| Residents and local businesses | <ul style="list-style-type: none"> • Turning movements at the intersection, particularly turning right out of Island Point Road. | <ul style="list-style-type: none"> • Section 6.4 – Traffic and Transport |

5.3 Aboriginal community involvement

Consultation with the Aboriginal community for this project involved two stages. Roads and Maritime are committed to effective consultation with Aboriginal communities regarding Roads and Maritime activities and their potential for impact on Aboriginal cultural heritage. Consultation has been undertaken for the proposal with the Aboriginal community in accordance with the Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI) (Roads and Maritime Services, 2011). Table 5-2 provides a summary of the stages undertaken to date. Table 5-3 provides a summary of the issues raised through consultation with the Aboriginal community and where these issues are addressed in the REF.

Table 5-2: Summary of Roads and Maritime Procedure for Aboriginal Cultural Heritage Consultation and Investigation

| Stage | Description |
|---------|--|
| Stage 1 | <p>Initial Roads and Maritime assessment</p> <p>The first stage consisted an initial Roads and Maritime desktop assessment to determine whether a Roads and Maritime proposal is likely to harm Aboriginal cultural heritage, and whether further assessment or investigation is required.</p> |
| Stage 2 | <p>Site survey and further assessment</p> <p>The second stage of the PACHCI assessment required the engagement of a specialist sub-consultant to conduct a site survey and further assessment to determine whether any features of Aboriginal cultural significance occur within the study area, and if they it would be affected by the project. A summary of the assessment can be found in Section 6.6 with the full assessment located in Appendix D.</p> |

Table 5-3: Issues raised through Aboriginal community consultation

| Group | Issue | Response / where addressed in REF |
|------------|---|--|
| Nowra LALC | <ul style="list-style-type: none"> Members of the public utilising the area for public leisure | <ul style="list-style-type: none"> The area would be made available to aboriginal communities to access the area for public leisure upon completion of construction of the proposal |
| Nowra LALC | <ul style="list-style-type: none"> A flake was found within a pile of dirt, the original location is unknown due to bike track being built | <ul style="list-style-type: none"> Section 6.7: Aboriginal and Cultural Heritage Assessment |
| Nowra LALC | <ul style="list-style-type: none"> Aboriginal people would have used this area for food resource and bush medicine, as well as resources for tools (spears, coolamans, etc.) | <ul style="list-style-type: none"> Section 6.7: Aboriginal and Cultural Heritage Assessment |

5.4 ISEPP consultation

Roads and Maritime has recently submitted detailed design plans to Shoalhaven Council with regards to the proposal as per the requirements of clause 13 of the ISEPP. Appendix E contains an ISEPP consultation checklist that documents how ISEPP consultation requirements have been considered.

Issues raised as a result of this consultation are outlined below in Table 5-4.

Table 5-4: Issues raised through ISEPP consultation

| Agency | Issue raised | Response / where addressed in REF |
|--------------------|---|---|
| Shoalhaven Council | <ul style="list-style-type: none"> The central island is not desirable from a visual amenity/environmental/safety perspective | <ul style="list-style-type: none"> Section 6.8: Landscape character and visual impacts |
| Shoalhaven Council | <ul style="list-style-type: none"> Inadequate provision for cyclists travelling north on the Princes Highway and turning right on to Island Point road | <ul style="list-style-type: none"> Section 3.2: Design Section 6.4: Traffic and Transport |
| Shoalhaven Council | <ul style="list-style-type: none"> Lack of sight lines due to vegetation on north-east corner of the intersection | <ul style="list-style-type: none"> Section 6.1: Biodiversity Section 6.4: Traffic and transport |

5.5 Ongoing or future consultation

This REF would be placed on public exhibition for stakeholder and community comment. All submissions would be formerly considered and acknowledged and responses would be provided in a submissions report that would be made available to the public. Roads and Maritime would continue liaise with Shoalhaven Council with regard to any potential future design revisions and would continue consultation with the land owner for the compound site throughout the undertaking of the works.

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 Biodiversity

A Biodiversity Assessment report was produced to provide detail of the potential impacts to biodiversity within the study area, and is provided in Appendix C.

6.1.1 Methodology

The biodiversity assessment process consisted of the following steps:

- Background research was conducted for the study area and, where relevant, a wider 10 kilometres locality (study locality), the following database searches were completed in May 2019:
 - NSW Office of Environment and Heritage (OEH):
 - Illawarra Vegetation Integration (SCIVI) mapping
 - BioNet database
 - Threatened Species Profile Database
 - Critical Habitat Register
 - Vegetation Information System (VIS) database
 - NSW Department of Primary Industries (DPI):
 - Fisheries Spatial Data Portal - Fish Freshwater Threatened Species
 - Aquatic Threatened Species and Ecological Communities database
 - Federal Department of Environment and Energy (DoEE)
 - Protected Matters Search Tool (PMST)
 - Register of Critical Habitat
 - Directory of important wetlands
 - Federal Bureau of Meteorology's (BOM) Atlas of Groundwater Dependent Ecosystems (GDE)
 - NSW Department of Planning and Environment (DPE) State Environmental Planning Policy (Coastal Management) 2018 spatial data
- Habitat assessment to populate all threatened species, populations and Threatened Ecological Communities (TECs) known or considered to have potential to occur within the study locality based on the database search

Ecological surveys were conducted on 06 and 07 May 2019 and covered the entire footprint area within the road reserves and Lot 8 DP 855413 as well as the wider study area. The wider study area was defined to consider the potential ecological impacts of the proposal on neighbouring vegetated areas. Flora surveys consisted of complete meander surveys of the study area that identified three vegetation zones. A vegetation assessment plot was conducted in vegetation zone. The vegetation assessment consisted of visual observation from the nearest road reserve and a review of high resolution imagery for the area.

Based on background research, threatened fauna surveys targeted the following fauna groups and techniques:

- Amphibians and reptiles. Diurnal and nocturnal habitat searches and call playback
- Diurnal birds. Point area surveys and opportunistic recordings
- Microbats. Diurnal potential roost searches, echolocation detector surveys (Anabat Express)
- Nocturnal birds. Spotlighting and call playback
- Nocturnal mammals. Spotlighting and call playback.

A detailed methodology for the Biodiversity Assessment is provided in Appendix C.

6.1.2 Existing environment

Flora

The study area is located on the Wandandian Plain with the topography of the study area characterised by flat to gently sloping with an overall north-easterly aspect. The study area is located within the Jervis subregion of the Sydney Basin Interim Biogeographic Regionalisation for Australia (IBRA) bioregion and within the Wandandian Coastal Plains NSW Landscape (formally Mitchell Landscapes). The nearest National Park Wildlife Service (NPWS) estate is the Corramy Regional Park, located approximately 2 kilometres to the south-west of the study area. The areas adjoining to the study area contains the Conjola National Park, Jerrawangala National Park, Jervis Bay National Park, Parma Creek Nature Reserve and Woollamia Nature Reserve. The study area is not located within any National Parks.

The study area is not within or located near to any areas mapped as critical habitat areas under the BC Act. The nearest declared critical habitat area is the Endangered population of Little Penguins at Manly, located over 150 kilometres to the north-east of the study area.

The survey identified the native vegetation of the study area consisted of two Plant Community Types (PCT):

- Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (PCT 1206)
- Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (694).

The Spotted Gum PCT occurred as two separate zones (zone 1 and zone 2) due to observable differences in condition due to zone 2 showing a greater degree of disturbance than zone 1. The PCTs identified in the study area, condition and legislative status, and area present within the study is described in Table 6-1 below.

Table 6-1: Plant Community Types (PCT)

| Plant community type (PCT) | Condition class | Threatened ecological community? | Area (ha) in construction footprint area | Area (ha) in compound site area | Area (ha) in total Proposal Area | Area (ha) in study area |
|---|-------------------------|----------------------------------|--|---------------------------------|----------------------------------|-------------------------|
| Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (1206) | Zone 1 – Moderate/ Good | No | 0.31 | 0.24 | 0.55 | 1.93 |
| | Zone 2 – Moderate/ Good | No | 0.55 | 0.00 | 0.55 | 0.78 |
| Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (694) | Moderate/ Good | No | 0.06 | 0.00 | 0.06 | 0.48 |
| Total | | | 0.92 | 0.24 | 1.16 | 3.19 |

The PCT's mentioned in Table 6-1 are not assessed as conforming to any Threatened Ecological Communities within the study area as listed under the BC Act or EPBC Act.

The study area contained several important habitat features comprising seven habitat trees, a small waterbody, an ephemeral creek line and two large stormwater culverts providing potential roosting resources for threatened structure-roosting microbats. The native vegetation communities present also provided foraging, roosting and refuge habitat for native fauna. The following threatened species were detected during surveys within the study area:

- Biconvex Paperbark (*Melaleuca biconvexa*)
- Magenta Lilly Pilly (*Syzygium paniculatum*).

A population of about 284 Biconvex Paperbark were detected within the study area, located predominantly within and adjacent to the ephemeral creek line. Two Magenta Lilly Pilly were detected within the east of the construction footprint.

Fauna

The following additional threatened species were also considered likely to occur within the study area, based on the presence of suitable habitat and recent occurrence records from the study locality:

- Barking Owl (*Ninox connivens*)
- Gang Gang Cockatoo (*Callocephalon fimbriatum*)

- Greater Broad-nosed Bat (*Scoteanax rueppellii*)
- Greater Glider (*Petauroides volans*)
- Green and Golden Bell Frog (*Litoria aurea*)
- Eastern Pygmy Possum (*Cercartetus nanus*)
- Little Lorikeet (*Glossopsitta pusilla*)
- Masked Owl (*Tyto novaehollandiae*)
- Powerful Owl (*Ninox strenua*)
- Sooty Owl (*Tyto tenebricosa*)
- Spotted-tailed Quoll (*Dasyurus maculatus*)
- Yellow-bellied Glider (*Petaurus australis*)
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*).

The following threatened microbat species were detected within the study area by analysis of the Anabat express data:

- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)
- Eastern Freetail Bat (*Mormopterus norfolkensis*).

Waterways

An ephemeral waterway was observed in the construction footprint area. The ephemeral water was identified as having a good overall condition. However, due to a lack of permanent water and important key fish habitat resources (deep pools, gravel beds, snags and aquatic vegetation) the stream was assessed as class 4 unlikely fish habitat and type 3 minimally sensitive fish habitat. The stream is not considered likely to provide habitat for any threatened fish species listed under the FM Act.

Groundwater dependant ecosystems

One terrestrial Groundwater Dependant Ecosystem (GDE) was identified as occurring within the study area. The GDE corresponds to the PCT identified in Table 6-1 as Spotted Gum. This occurrence is described as a moderate potential GDE from regional studies as described in Appendix C. No aquatic GDEs were mapped as occurring within the study area, with the nearest mapped being St Georges Basin, located approximately 1.7 kilometres to the south-east of the study area.

LEP habitat corridor

The access track along Grange Road (Lot 8 855413) is mapped as Biodiversity – habitat corridor under the LEP. The vegetation within this lot provides a portion of a vegetation corridor along and across the Princes Highway road reserve with lots to the east and west also forming parts of the mapped habitat corridor (Lot 25 DP 792969 and Lot 6 DP 1217066). The compound site in lot 25 DP 792969 does not include lands mapped as habitat corridors under this instrument.

6.1.3 Potential impacts

Construction

The proposed roundabout would require clearing of native woody vegetation and exotic grasslands for the construction footprint and site compound. Table 6-2 below details the predicted extent of direct impacts on native vegetation within the study area as a result of the proposed roundabout.

Table 6-2: Impacts on native vegetation

| Plant Community Type (PCT) | Status | | Total Clearing of Proposal Area (ha) | Percent cleared in Catchment Management Area (CMA) |
|---|------------|------------|--|--|
| | TSC Act | EPBC Act | | |
| Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (PCT 1206) | Not listed | Not listed | 0.89 (0.86 ha within construction footprint and 0.03 ha within compound site) | 0.15 |
| Spotted Gum - Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (PCT 694) | Not listed | Not listed | 0.06 (construction footprint only) | 0.5 |
| Total | | | 0.95 | |

The proposal requires the removal of 0.95 hectares of native PCTs to construct the proposed roundabout. The removal of the PCTs is required for the proposed Princes Highway southbound lanes, Island Point Road upgrades, associated earthworks (batters) and for widening of the existing access track and turning circle. Disturbance to associated native grasslands of this PCT within the site compound proposal area would be restricted to vehicle access through these grasslands and passive materials (stormwater infrastructure) storage, vehicle movements would disturb soils and promote ongoing erosion. Roads and Maritime would remove the topsoil, import road base and compact it during the construction of the proposal. Topsoil would be reinstated during the rehabilitation of the compound. The above calculations include the vehicle access corridor but exclude the storage area in the total clearing area impact. Use of the site compound would temporarily impact on the exotic grassland vegetation present. However, no clearing of PCT 1206 woody vegetation would be required at the compound site.

The proposal is estimated to have the following level of impact on these PCTs within the study locality:

- PCT 1206 – A loss of 0.89 hectares from a mapped occurrence of 9981.64 ha, or 0.009 percent
- PCT 694 – A loss of 0.06 hectares from a mapped occurrence of 1515.15 ha, or 0.004 percent.

The proposal is not considered to represent a significant reduction of any PCT present in the study area within the study locality as shown in Figure 6-1. The proposal would require the removal of a portion of the Biconvex Paperbark population west of the ephemeral creek line to allow for the widening of an existing access track to provide access from Grange Road to the base of a new batter north of the intersection. The two Magenta Lilly Pilly individuals recorded within the study area are located in the east of Lot 8 DP 855413. Table 6-3 below details the predicted extent of the impacts of threatened flora during the construction of the proposal. No direct disturbance to these individuals or their surrounding environment would occur as a result of the proposal.

Table 6-3: Impacts on threatened flora

| Threatened species | Status* | | Habitat or individuals to be impacted | Habitat or individuals in the study area |
|---|---------|----------|---------------------------------------|--|
| | BC Act | EPBC Act | | |
| Biconvex Paperbark (<i>Melaleuca biconvexa</i>) | V | V | 42 individuals 0.95 ha habitat | 284 individuals 3.19 ha habitat |
| Magenta Lilly Pilly (<i>Syzygium paniculatum</i>) | E | V | 0 individuals 0.95 ha habitat | 2 individuals 3.19 ha habitat |

The compound site would not require the removal of PCT 1206 woody vegetation with access through this vegetation occurring within cleared lands dominated by native grasses.

The proposal would remove foraging and/or sheltering and/or roosting habitat. However, this habitat is not limited in the study locality and represents general resources for these species and not associated with crucial life stages (breeding). None of the faunal species identified are considered dependent on the foraging and refuge habitat provided by the native vegetation present within the study area.

No high value threatened fauna habitat would be removed by the proposal, with all identified habitat-bearing trees and the small waterbody to be retained. The two large culverts would also not be removed or modified by the proposal. The proposal has considered the ecological values present within the study area and the proposal has been designed to avoid many of the high value ecological features present (habitat-bearing trees, culverts and the small waterbody).

Operation

Wildlife connectivity and habitat fragmentation

The proposal would require removal of 0.95 hectares of native vegetation from the western edge of Lot 8 DP 855413 for the widening of the Princes Highway (refer to Appendix C). However, the proposal would not isolate any portion of the native vegetation present. Clearing would occur along the eastern edge of the existing roadway and north-south connectivity within this lot would be retained through the vegetation in the east of the lot. The proposal would create new borders through clearing of native vegetation along the east side of the Princes Highway and the north and south sides of Island Point Road. This would result in areas of exposed soil upslope of retained vegetation, creating potential for the movement of unconsolidated sediments and associated contaminants into retained vegetation.

The required clearing is not considered likely to significantly reduce fauna dispersion capability across the Princes Highway through mapped habitat corridor lands. The movement corridor and patterns for mammals traversing across the Princes Highway and Island Point Road would not likely be interrupted by the proposal. The approved NSW Recovery Plan for the Yellow-bellied Glider states gliding distances of up to 140 m have been recorded for this species. However, this distance is strongly related to the vegetation present (height) with gaps as narrow as 50 m identified as dispersal barriers in some vegetation types. The extent of works is limited (380 m along the Princes Highway) and existing connectivity to the north and south of the works extent would not be significantly altered by the required upgrades of Island Point Road.

Edge effects on adjacent native vegetation and habitat

The vegetation of Princes Highway road reserve and within Lot 8 DP 855413 is located adjacent to existing road networks and consequently, edge effects already impacted along the road/bushland interface throughout much of the study area. Evidence of edge effects are apparent along this boundary with the primary weed populations present within cleared lands adjacent to the sealed road surface.

Exposure of new areas of unconsolidated soil and the construction of new batters adjacent to retained vegetation would potentially create new sources of sediment and consolidated contaminants (fuel, lubricants from plant and other vehicles) which could migrate into retained vegetation during rain events. This effect is already present from the adjacent road networks; however, the proposal would exacerbate these impacts particularly through the creation of large areas of new exposed soil. This impact would be largely limited to the construction phase and would the impact would recede as the exposed area is consolidated by recovering vegetation.

Clearing of vegetation next to the high value fauna habitat features identified in the construction footprint area (habitat-bearing trees) may decrease the utility of these items for native fauna, including threatened species. These features are currently located next to established road infrastructure and artificial road lighting.

Invasion and spread of pests, pathogens and disease

The proposal is not considered likely to lead to the proliferation of existing or the importation of large exotic mammal pest species such as feral cats, foxes or wild dogs. The proposal would not involve the translocation, keeping or breeding of any pest species. The site compound may attract resident feral animals (such as foxes) through the provision of additional foraging resources (food waste) and through providing additional sheltering resources (under new structures). However, any such impact would be limited to the construction phase and is considered unlikely to lead to a significant increase in the local population of any pest species in the long-term.

Pathogens and diseases affecting native species can be introduced through the transport of contaminated media or in infected host fauna (either deliberately or incidentally translocated). Several pathogens and diseases are recognised as KTPs. Such pathogens and disease that may affect the proposed roundabout are:

- Infection by *Psittacine circoviral* (beak and feather) disease affecting endangered psittacine species.
- Infection of frogs by amphibian chytrid causing the disease *chytridiomycosis*.
- Infection of native plants by *Phytophthora cinnamomi*.
- Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae

Phytophthora cinnamomi and Exotic Rust Fungi could have an adverse impact on native flora species within the study area, including of the two threatened flora species identified (both members of the family Myrtaceae). Both of these diseases can be introduced in contaminated soil used for work or on uncleaned plant and other machinery. These diseases can also be introduced through contaminated water used for dust suppression or otherwise discharged into an area.

Chytridiomycosis is a significant fungal infection affecting amphibian populations worldwide. It is spread by physical contact between infected host amphibians and through spores in contaminated water (Commonwealth of Australia, 2016). The proposal may introduce this disease through the incidental translocation of infected host amphibians in tubestock used for revegetation work or through discharge of contaminated water used on site. This risk can be managed through local sourcing of landscaping tubestock and use of treated water onsite and is not considered a high risk for the proposal.

Psittacine circoviral (beak and feather) disease is primarily transmitted by contamination of nesting hollows with spores from infected birds (Australian Government Department of Environment and Heritage, 2005). The proposal is not considered likely to lead to the introduction of this disease into the study area. The proposal does not include likely transmission vectors such as the introduction of potentially infected host fauna.

Groundwater dependant ecosystems (GDE)

The proposal would include direct clearing of portions this terrestrial GDE as well as minor local alterations to surface water flow patterns and surface water recharge of local aquifers. The risk assessment guidelines for groundwater dependent ecosystems provides a method for determining the risk of an activity to the ecological value of an aquifer and associated GDEs.

Based on the assessment in Appendix C, the proposal is considered unlikely to significantly impact the identified GDE. The proposal would involve the clearing of terrestrial vegetation GDE and minor alterations to surface hydrology through an increase in hardstands and modifications to the existing road network stormwater infrastructure. However, the proposal is not considered likely to substantially alter the groundwater expression and surface recharge of the underlying aquifer supporting the terrestrial GDE. The proposal would not involve excavation into the watertable, fracturing of underlying bedrock or groundwater extraction.

Conclusion

Based on the Biodiversity assessment included in Appendix C, the proposed roundabout is not likely to have significant impacts to threatened species, ecological communities or their habitats within the meaning of the BC Act or FM Act. The assessment concluded the proposal is not likely to have a significant impact on any BC Act listed entities, and further assessment through a Biodiversity Development Assessment Report (BDAR) is not considered necessary. The proposal is not likely to significantly impact threatened species, ecological communities or migratory species, within the meaning of the EPBC Act.

Road and Maritime provides assessment guidelines which help determine whether an action or impact requires the development of a Biodiversity Offset Strategy (BOS). An assessment was undertaken to determine if offsets for the proposed roundabout are required for any residual impacts following the implementation of environmental safeguards in Section 6.1.4. Based on the Roads and Maritime assessment BOS guidelines, it was determined the proposed roundabout does not require offsetting for residual impacts on biodiversity values.

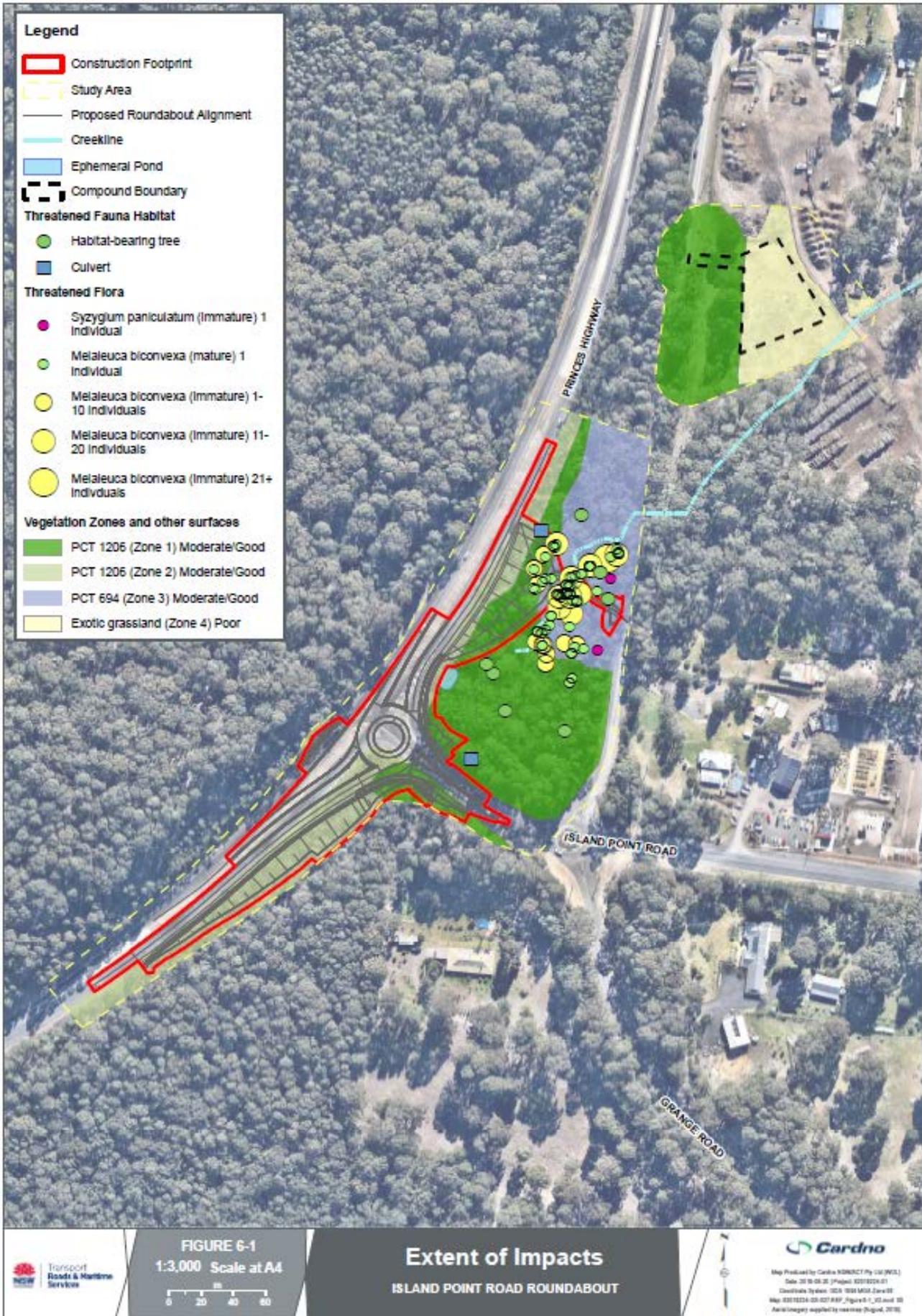


Figure 6-1: Extent of impacts

6.1.4 Safeguards and management measures

| Impact | Environmental safeguards | Responsibility | Timing |
|-------------------------------------|---|----------------|--|
| BD01 - Biodiversity | <p>An Environmental Work Method Statement (EWMS) for Clearing and Grubbing must be prepared and implemented. The EWMS must conform to Roads and Maritime Biodiversity Guidelines;</p> <ul style="list-style-type: none"> Pre-clearing surveys will be undertaken in accordance with <i>Guide 1: Pre-clearing process</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011). Vegetation removal and habitat will be undertaken in accordance with <i>Guide 4: Clearing of vegetation and removal of bushrock</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011) and <i>Guide 5: Re-use of woody debris and bushrock</i>. Exclusion zones identified and demarcated in accordance with the <i>Roads and Maritime's Biodiversity Guidelines (Guide 2: Exclusion zones)</i> (RTA 2011). The unexpected species find procedure is to be followed under <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011) if threatened ecological communities, not assessed in the biodiversity assessment, are identified in the proposal area. Roads and Maritime QA Specification G40 <p>The EWMS must at least include following:</p> <ul style="list-style-type: none"> A description of the work activity, including the sequence of tasks, any plant and equipment to be used Identification of any environmentally sensitive areas A detailed site diagram showing all work areas, controls, sensitive areas, and no-go-zones. The control measures to be implemented based on the REF Safeguards and management measures | Contractor | <p>Prior to construction</p> <p>During construction</p> <p>Post construction</p> |
| BD02 – Removal of native vegetation | Exclusion zones are to be identified and demarcated as per the boundary limit on the design | Contractor | Prior to construction |
| BD03 – Groundwater | Prior to construction, implement risk management actions for identified risk | Contractor | Prior to construction |

| Impact | Environmental safeguards | Responsibility | Timing |
|--------------------------------------|---|----------------|---|
| dependant ecosystems | <p>matrix level (A) as per the DPI Risk assessment guidelines for groundwater dependent ecosystems Including:</p> <ul style="list-style-type: none"> Establish exclusion zones at the GDE boundary limit as per on the design and erect environmental exclusion zone signage Implement erosion and sediment control plan Monitor terrestrial GDE on Lot 8 DP 855413 for one occasion at the completion of works, to compare against the Biodiversity Assessment (baseline data). <p>Monitoring is to comprise vegetation plot (species richness and percent cover) and qualitative health assessment of threatened flora populations and is to be stipulated in the CEMP. Two vegetation plots are to be located within the two vegetation zones comprising the GDE vegetation (PCT 1206). Qualitative health assessment of the two threatened flora species present, <i>Melaleuca biconvexa</i> and <i>Syzygium paniculatum</i>, will comprise descriptions of evidence of die-back, physical damage, stress (yellowing) and signs of infection by flora pathogens (<i>Phytophthora cinnamomi</i> and Myrtle Rust).</p> | | <p>During construction</p> <p>Post construction</p> |
| BD04 – Injury and mortality of fauna | Fauna will be managed in accordance with <i>Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011). | Contractor | During construction |
| BD05 – Injury and mortality of fauna | <p>Timing of works to avoid large forest owl breeding and microbat torpor periods (autumn/winter).</p> <p>If works are required to occur within the autumn/winter period, additional survey by a suitably qualified ecologist are to be undertaken for evidence of large forest owl nest presence prior to the commencement of clearing. If evidence of nest presence is determined, expert advice is to be sought to manage nest presence.</p> | Contractor | Detailed design |
| BD06 – | A microbat management plan must be | Contractor | During construction |

| Impact | Environmental safeguards | Responsibility | Timing |
|---|--|----------------|---------------------|
| Injury and mortality of fauna | implemented as part of the CEMP. It will include tool boxing microbat identification, inspecting of potential habitual prior to any disturbance and erect exclusion fencing if required. | | |
| BD07 – Invasion and spread of weeds | <p>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).</p> <p>Due to the low density of priority weed species within the Study Area, recommended weed control measures are to comprise physical removal of <i>Lantana camara</i> (Lantana) and <i>Rubus fruticosus</i> agg. (Blackberry) prior to the commencement of clearing. Removed weed material is to be transported off-site following removal for appropriate disposal and is not to be stockpiled on site.</p> <p>Weed management requirements to be documented in the CEMP.</p> | Contractor | During construction |
| BD08 – Invasion and spread of pathogens and disease | <p>The risk of pathogen contamination will be managed in accordance with <i>Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).</p> <p>The Project may introduce the flora pathogens <i>Phytophthora cinnamomi</i> and exotic Rust Fungi as well as the amphibian chytrid fungus through media such as unclean fill, untreated water and contaminated plants or soil media from imported plants used for any revegetation works.</p> <p>Specific measures to minimise the risk of pathogen infection comprise (with reference to best practice guidelines in Table 7.1 of <i>Guide 7: Pathogen management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011)).</p> <ul style="list-style-type: none"> • Restrict personnel to designated tracks and trails • Use of onsite fill where possible • Offsite cleaning of soil and plant material from contaminated plant and equipment | Contractor | During construction |

| Impact | Environmental safeguards | Responsibility | Timing |
|--------|--|----------------|--------|
| | <p>prior to use on site</p> <ul style="list-style-type: none"> • Restrict vehicles to designated tracks, trails and parking areas • Use of treated water for dust suppression and other site requirements • Use a certified supply of plants and soil that is disease-free. <p>Pathogen management requirements are to be documented in the CEMP.</p> | | |

Other safeguards and management measures that would address biodiversity impacts are identified in Sections 6.2 and 6.3.

6.2 Surface water, hydrology and flooding

6.2.1 Existing environment

Stormwater drainage exists along the road median strip and under the northbound kerb on Princes Highway, with crossings north and south of the intersection, as well as one crossing on Island Point Road between the Highway and Grange Road. An unnamed tributary of Suffolk Creek is located in the south-west of the main body of study area, discharging from the north-east under a culvert under Grange Road. This waterway is classified as a first order stream under the Strahler stream order method. A small ephemeral pond is located in the south-west corner of the main body of the study area, presumed to have been constructed as part of the stormwater management infrastructure for the Princes Highway/Island Point Road junction as shown in Figure 6-2.

Climate data from the Nowra Air Station, approximately 15 kilometres from the proposed roundabout location provides average monthly temperatures and rainfall, as displayed in Table 6-4.

Table 6-4: Shoalhaven LGA climate data

| Month | Mean daily max. temp (°C) | Mean daily min. temp (°C) | Mean monthly rainfall (mm) |
|-----------|---------------------------|---------------------------|----------------------------|
| January | 25.8 | 15.9 | 90.4 |
| February | 25.8 | 16.3 | 120.0 |
| March | 24.5 | 14.8 | 124.4 |
| April | 22.1 | 12.1 | 97.1 |
| May | 19.0 | 9.7 | 90.5 |
| June | 16.4 | 7.6 | 104.8 |
| July | 15.8 | 6.2 | 56.5 |
| August | 17.1 | 6.7 | 75.8 |
| September | 19.3 | 8.3 | 65.6 |
| October | 21.5 | 10.7 | 107.5 |
| November | 23.1 | 12.6 | 98.1 |
| December | 24.8 | 14.4 | 80.5 |

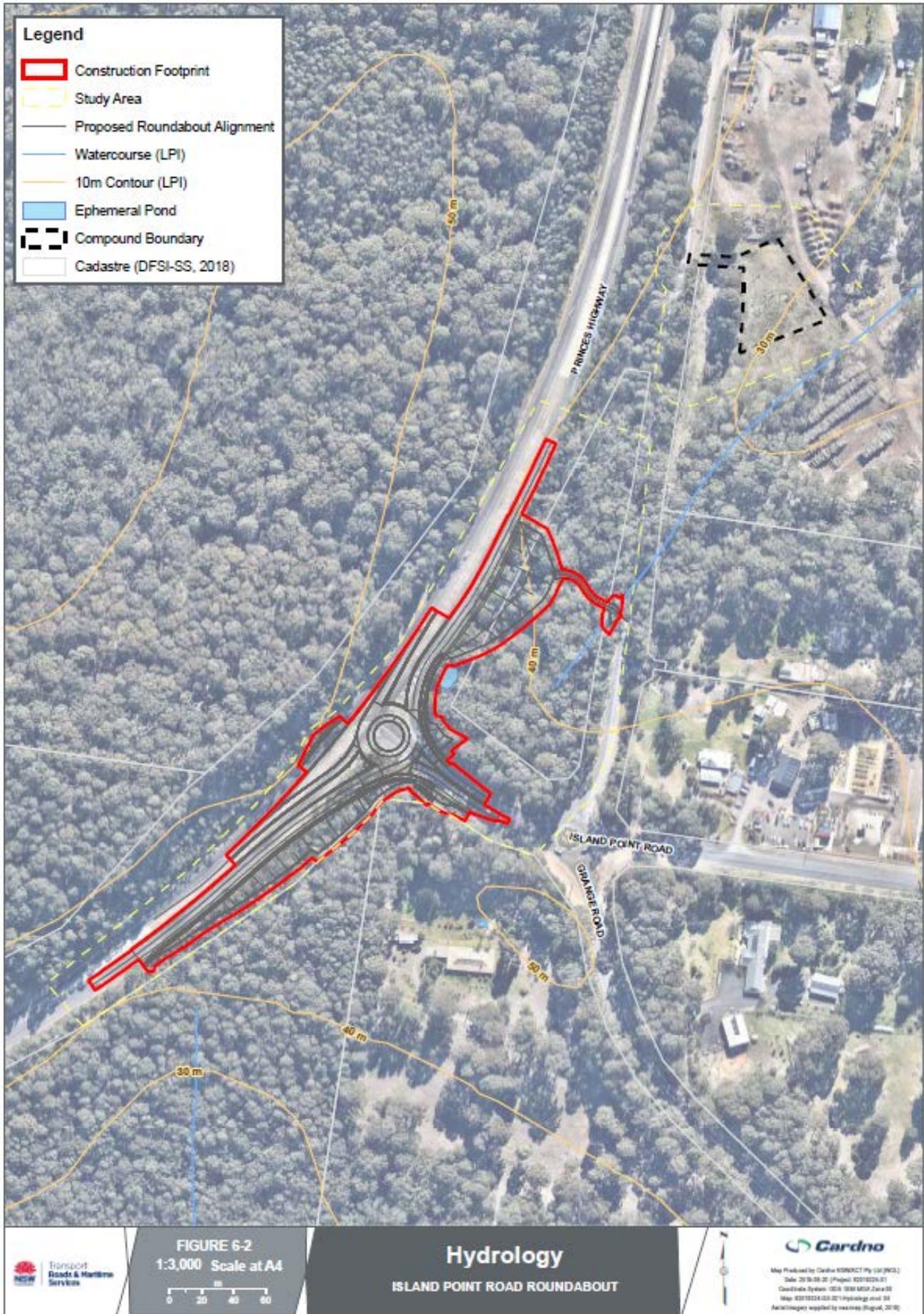


Figure 6-2: Hydrology

6.2.2 Potential impacts

Construction

Construction of the proposal may degrade water quality if management measures are not implemented, monitored and maintained throughout the construction phase. The removal of vegetation, stripping of topsoil and filling and mobilisation of sediment associated with general earth work can impact on water quality during the construction phase if runoff is allowed to mobilise exposed soils. The potential impacts to surface water, hydrology and flooding that could arise from the proposal are:

- Erosion and sedimentation that may affect ephemeral drainage lines that flow into the ephemeral pond
- Pollution of water from construction activities, construction materials and spills. During construction the use of various liquids may be used such as diesel, machinery oils and unleaded petrol. Due to the nature of these liquids any contact with waters may have an adverse effect on the quality of surface water within the project footprint boundary
- Minor change in the hydrology of the ephemeral drainage lines during the clearing of vegetation for the development of the access track.

The release of potentially harmful chemicals and other substances accidentally during construction as a result of inappropriate storage and handling has the potential to impact on water quality of downstream receiving waters. These contaminants could include acids and chemicals from washing down of vehicles, construction fuels, oils, lubricants, hydraulic fluids and other chemicals. The implementation of the safeguards and mitigation measures below would reduce the potential impacts during the construction phase.

Operation

During the operation of the proposed roundabout, the potential impacts on water quality could be from the spill of vehicle oils, lubricants and hydraulic fluids and other accidental spills including leakage of chemicals in transit. It should be noted that such events could occur in current highway conditions.

There is a period of time following the completion of construction where recently disturbed soils are susceptible to scour and erosion from stormwater runoff, particularly as there is a small increase in impervious areas. The potential for sediment transport is dependent on status of rehabilitation, severity of rainfall events, and the slope and scale of the disturbed area. The implementation of the safeguards and mitigation measures below would reduce the potential impacts during the operational phase.

6.2.3 Safeguards and management measures

| Impact | Environmental safeguards | Responsibility | Timing | Reference |
|-----------------------------|--|----------------|------------------------------------|--|
| SW01 – Surface Water | 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. | Contractor | Detailed design / Pre-construction | Section 2.1 of QA G38 <i>Soil and Water Management</i> |
| SW02 – Erosion and Sediment | A site specific Erosion and Sediment Control Plan/s will be prepared and implemented as part of the CEMP. | Contractor | Detailed design / Pre-construction | Section 2.2 of QA G38 <i>Soil and Water</i> |

| Impact | Environmental safeguards | Responsibility | Timing | Reference |
|-------------------------------|--|-----------------------------|---------------------------------|-------------------|
| | The Plan 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. | | | <i>Management</i> |
| SW03 – Spill Response | If a spill occurs, the Roads and Maritime’s Environmental Incident Classification and Management Procedure must be followed and the Roads and Maritime Project Manager notified as soon as practicable. | Project Manager, Contractor | Pre-construction / construction | |
| SW04– Spills and leaks | An emergency spill kit will be kept on site at all times. All staff will be made aware of the location of the spill kit and trained in its use. | Contractor | During Construction | |
| SW05 – Liquid storage | All fuels, chemicals, and liquids will be stored at least 50 m away from waterways (including existing stormwater drainage system) and will be stored in an impervious bunded area within the compound site. Only materials required onsite must be stored in the dedicated area | Project Manager, Contractor | Pre-construction / construction | |
| SW06 – Contamination of water | The refuelling of plant and maintenance of machinery will be undertaken in impervious bunded areas | Contractor | During construction | |

6.3 Soils

6.3.1 Existing environment

The study area is defined by gently undulating lowland, consisting of low rises, gentle slopes, and various watercourses which are surrounded by plateaus and spurs. Tomerong is at the edge of the Nowra sandstone, which lies to the west of the study area, and the Wandrawandian siltstone of the Permian age, which underlies the study area and continues to the east. Typical soil of Wandrawandian siltstone is sandy clay loam, which overlies a light clay sub-soil.

The study area is classified as the Wandandian Coastal Plains soil landscape, which is defined by undulating slopes and wide flat valleys with dendritic drainage. The topsoil consists of a friable brown sandy clay loam, which has been mixed via machine disturbance (dirt road track) with underlying light brown clay deposits in the north of the study area, and only silty loam (presumably topsoil removed from the westerly adjacent Princes Highway) in the south of the study area. These soil types align with that typical of Wandrawandian siltstone. The soil horizon is shallow, and topsoil has been removed and/or displaced in the majority of the northern half of the study area, while imported soil in the southern half makes the original soil unobservable.

6.3.2 Potential impacts

Construction

Potential impacts to soils may occur during the construction phase of the proposed roundabout and the establishment of the access track and site compound. The proposed vegetation clearance, tree removal, ground profiling and earthwork would expose natural soils.

Excavation would result in temporary stockpiles of top soil and sub soil at its point of excavation and at the site compound. The result of these activities can lead to the following potential impacts during the construction phase:

- Erosion and sediment resulting from exposed soils
- Erosion, leaching and dust generation from stockpiled materials
- Loss of soil quality impacts through any accidental spills cause by traffic accidents (including loading and unloading risks), leaks and drips from poor maintenance of vehicles used during the construction phase and the temporary of storage and management of spoil and waste leading to leachate generation.

The mitigation measures proposed in Section 6.3.3 have been designed to mitigate and reduce these potential impacts.

Operation

During the operation of the proposed roundabout there is a risk of ongoing erosion upstream and downstream of the roundabout if inappropriate cross drainage is installed during the construction phase. Consequently the design of the highways drainage would include adequate drainage as described in Section 3.

6.3.3 Safeguards and management measures

| Impact | Environmental safeguards | Responsibility | Timing |
|-------------------------------|---|----------------|--|
| S01 - General Soil Management | All stockpiles will be designed, established, operated and decommissioned in accordance with the Stockpile Site Management Procedure | Contractor | Pre-construction / During construction |
| S02 - General Soil Management | Rehabilitation works of disturbed areas are to commence as soon as practicable after works are completed in any area. Where feasible, work should be stage to reduce soil exposure duration | Contractor | During construction |

6.4 Traffic and transport

6.4.1 Methodology

Traffic modelling was undertaken to assess the existing traffic performance (Cardno, 2017). The modelling included:

- Evaluation of current intersection performance of Princes Highway / Island Point Road and Island Point Road/ Grange Road
- Evaluation of proposed intersection upgrade performances using SIDRA 7
- Performing a sensitivity test where intersection fails before 2047; and
- Identifying preferred intersection upgrade based on intersection performance.

The results of the traffic modelling guided the selection of the free flowing northbound lane roundabout which is proposed in this assessment.

The proposed activities during the construction of the roundabout have also been considered along with the construction methodology and expected vehicle movements that would impact all modes of public, private and active transport as well as public road and private property access required.

6.4.2 Existing environment

The existing intersection is an un-signalised, seagull T-junction with north and southbound through lanes on the Princes Highway, and raised concrete medians and triangular islands. A southbound overtaking lane develops about 100 m south of the intersection. The posted speed limit is 80 km/h in the southbound direction and 100 km/h in the northbound direction on Princes Highway, and 80 km/h on Island Point Road. There is a small, single lane roundabout at the intersection of Island Point Road and Grange Road, about 120 m east of Princes Highway. Traffic modelling identified that the existing intersection currently performs at a Level of Service (LoS) of D and would fail by 2020 (Cardno, 2017).

A bus stop is located slightly to the north of the single lane roundabout on Grange Road that is utilised by commuters to access the area of Tomerong.

There are no private driveways within the proposed construction footprint or the compound boundary. Access to the site on which the compound is proposed is currently located north of the proposed new access point for the site compound.

6.4.3 Potential impacts

Construction

The works would result in temporary traffic delays during throughout the duration of the construction of the proposed roundabout. Potential delays during the construction would be maintained through a Traffic Management Plan (TMP) that would be implemented as part of the CEMP. Traffic delays may be experienced by businesses and residents on Grange Road as a result of the location of the site compound and access track that would see the movement of 12.5 tonne vehicles, site personnel and other vehicles as part of the construction of the roundabout. A new access way to the compound site would be created from the Grange Road to prevent limitations to vehicles requiring access to the private site which surrounds the compound.

An increase in traffic and vehicle movements may be experienced on the proposed detour roads during each stage of construction as stated in Section 3.3.5. The detour roads that may impacted from the Island Point Road and Princes Highway closures are:

- Hawken Road
- The Wool Road.

Each stage of construction of the proposed roundabout would experience impacts to traffic and vehicle movements, a detour map for alternate routes is displayed Figure 6-3. A summary of impacts is shown in Table 6-5 below:

Table 6-5: Construction Stage Traffic Impact Summary

| Construction Stage | Impact to Traffic and Transport |
|--------------------|---|
| Stage 2 | <ul style="list-style-type: none"> • Southbound lane road closure on the Princes Highway and eastbound lane on Island Point Road • Short stoppages during construction hours on westbound lane on Island Point Road to allow for the movement of construction vehicles and equipment • Hawken Road and The Wool Road detour roads may have increased traffic movements as a result of the lane closures. |
| Stage 3 | <ul style="list-style-type: none"> • Road closures of Island Point Road between Grange Road and the Princes Highway during night works construction hours would result in vehicles not being able to access the Princes Highway from Island Point Road. |
| Stage 4 | <ul style="list-style-type: none"> • Closure of Island Point Road between Grange Road and the Princes Highway for up to two weeks to allow for the pavement to be rebuilt on the eastern side of the Princes Highway, this would be constructed during day time and night time construction hours and would result in vehicles and road users not being to access the Princes Highway from Grange Road and would use the detour roads of Hawken Road and The Wool Road. • Potential increase in traffic and vehicle movements on detour roads during this period. |
| Stage 5 | <ul style="list-style-type: none"> • Night works and the closure of the right-turn-in and right-turn-out of Island Point Road for the installation of concrete medians. Island Point Road would be reopened during the day. |
| Stage 6 | <ul style="list-style-type: none"> • Night works for the kerb adjustment and installation of street lights, night works would reduce the impact to traffic as the roundabout layout would be in full operation during the day. • There would no further road closures for this stage of construction. |



NOTE
 DIVERSION 1
 - DISTANCE: 8.1 km
 - APPROX. TRAVEL TIME: 6 min

DIVERSION 2
 - DISTANCE: 4.6 km
 - APPROX. TRAVEL TIME: 4 min

NOTE
 1. IMAGE SOURCED FROM NEARMAP (FEB. 2018)

LEGEND
 - - - - - DIVERSION 1 - PRIMARY NORTHBOUND
 - - - - - DIVERSION 2 - PRIMARY SOUTHBOUND

FIGURE 6-3: Detour Route Map
 SCALE 1:25,000

Figure 6-3: Detour route map

The utilisation of the bus stop on Grange Road would have minor disruptions to public transport during the construction period. Bus routes may be potentially delayed as a result of increased vehicles, plant and equipment during the proposed roundabout construction.

Cyclists using the Princes Highway, Island Point Road and Grange Road would be impacted during the construction period, as access to utilise these roads would be reduced and pose a safety risk due to the increased volumes and movements of vehicles, plant and equipment. The TMP for the site would consider cyclists during construction and would ensure adequate measures to allow safe passage during the construction phase. Traffic management to allow for the construction of the roundabout would be required in accordance with the approved TMP, that would include appropriate stakeholder and public notice to minimise socio-economic impacts (Section 6.10). The TMP would include management of potential impacts to residents and businesses on Grange Road.

Construction is anticipated to begin in November 2019 with an approximate completion date expected in late-2020. There would be increased presence of vehicle movements each day would occur during the construction phase of the roundabout. Construction of the roundabout would be shut down over the Christmas period to reduce the impact of increased vehicles using the Princes Highway during this period, as stated in the Work methodology (Section 3.3.1).

Material haulage would result in trucks moving through the project footprint throughout the duration of the project to dispose of excavated material. It is noted that that opportunities to reduce the volume of excavated material and reduce the amount of truck trips would continue to be explored during the detailed design phase. The increase in heavy vehicle movements has associated safety risks and impacts to travel time, it is considered that these risks can be managed in the TMP.

Operation

Impacts during the operation of the proposed roundabout installation would be positive and would include improved safety for road users, higher level of intersection performance, reduced queue lengths and improved traffic efficiency. Traffic modelling identified a LoS of B could be achieved through to 2047 with the proposed works.

The vegetation clearing as described in Section 6.1 would increase the safety of vehicles and other transport as there would be increased visibility of vehicle movement on to Island Point Road from the Princes Highway. This would improve the existing views which are currently blocked by dense vegetation.

Buses and public transport would benefit from the proposed roundabout during construction due to the safety benefits the roundabout would provide. The selected option for the treatment of the intersection would provide an increase in safety for cyclists due to the installation of a staged crossing to allow for the safe passage of cyclists crossing the Princes Highway or on Island Point Road.

6.4.4 Safeguards and management measures

| Impact | Environmental safeguards | Responsibility | Timing |
|------------------------------|--|----------------|------------------------------------|
| TT01 – Traffic and Transport | <p>A TMP will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the <i>Roads and Maritime Traffic Control at Work Sites Manual</i> (RTA, 2010) and <i>QA Specification G10 Control of Traffic</i> (Roads and Maritime, 2008). The TMP will include:</p> <ul style="list-style-type: none"> • confirmation of haulage routes • measures to maintain access to local roads and properties • site specific traffic control measures (including signage) to manage and regulate traffic movement • measures to maintain pedestrian and cyclist access • requirements and methods to consult and inform the local community of impacts on the local road network • access to construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads. • a response plan for any construction traffic incident • consideration of other developments that may be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic • monitoring, review and amendment mechanisms. | Contractor | Detailed design / Pre-construction |
| TT02 – Traffic and Transport | Local residents would be notified at least five days of any potential delays and detours regarding access and traffic flows during prior to and during construction | Contractor | During construction |

| Impact | Environmental safeguards | Responsibility | Timing |
|------------------------------|--|----------------|---------------------|
| TT03 – Traffic and Transport | Consultation would be undertaken at least five days prior to construction with bus companies traveling through and/or stop on Island Point Road. | Contractor | Pre-construction |
| TT04 – Traffic and Transport | Partial road closures (or any short-term full road closures) will be timed to avoid peak periods such as holiday periods when vehicle traffic is high along the highway | Contractor | During construction |
| TT05 – Cyclist Impact | Cyclist connectivity across the site would be maintained during construction. The community would be notified at least five days before any access changes including alternative routes. | Contractor | During construction |

6.5 Noise and vibration

6.5.1 Methodology

The Roads and Maritime Maintenance Noise Estimator Tool was used to provide a noise and vibration assessment for each stage of construction for the proposed roundabout. The noise and vibration impact assessment investigated the potential noise and vibration impacts in order to identify an appropriate background noise levels and the recommend noise mitigation for each stage of the works. Multiple assessments were performed for each stage, as the noise associated with each stage would differ due to the equipment and duration required.

6.5.2 Existing environment

The proposed roundabout is to be constructed on established road Infrastructure. Existing vehicle traffic travelling through the Princes Highway and Island Point Road is typical with major road infrastructure and dominates the acoustic environment of the study area. The nearest sensitive receiver has been identified to be a residential property approximately 100m south-east from the study area (sensitive receiver 1). The surrounding area has mix use of rural residential land and local businesses as displayed in Figure 6-4.

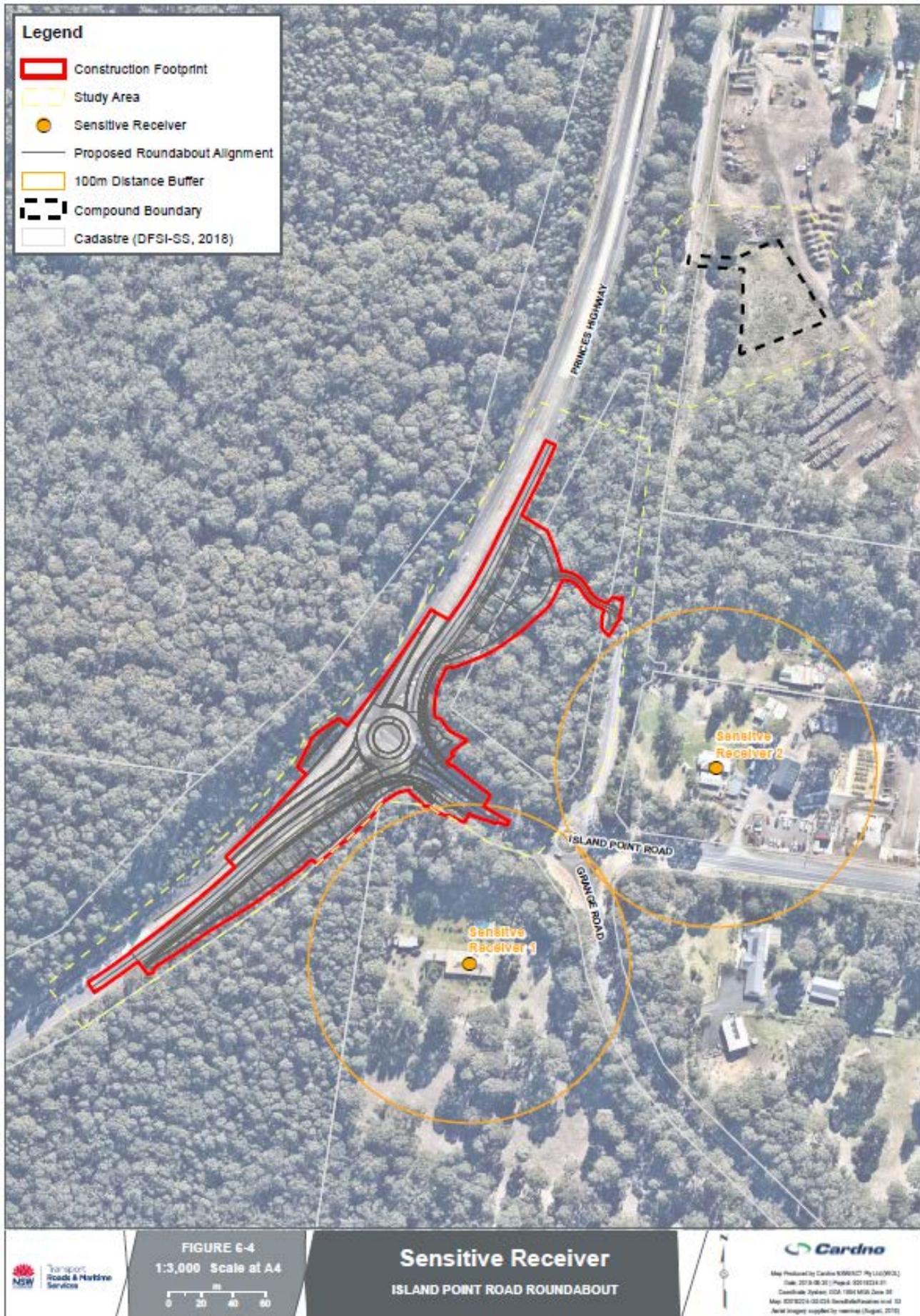


Figure 6-4: Sensitive receivers

6.5.3 Criteria

The Interim Noise Construction Guideline (INCG) (DECC,2009) recommends noise management levels (NML) to reduce the likelihood of noise impacts arising from construction activities. The ICNG NML for residential receivers are shown in Table 6-6 below:

Table 6-6: INCG Noise Management levels for residential receivers

| Time of Day | Management Level (L _{Aeq} 15 min)* | How to Apply |
|--|---|---|
| <p>Recommended standard hours:</p> <p>Monday to Friday 7am to 6pm</p> <p>Saturday 8am to 1pm</p> <p>No work on Sundays or public holidays</p> | <p>Noise affected RBL + 10 dB</p> | <p>The noise affected level represents the point above which there may be some community reaction to noise.</p> <ul style="list-style-type: none"> Where the predicted or measured L_{Aeq} (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details. |
| <p>Noise and vibration</p> | <p>Highly noise affected 75 dB(A)</p> | <p>The highly noise affected level represents the point above which there may be strong community reaction to noise.</p> <ul style="list-style-type: none"> Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: <ol style="list-style-type: none"> Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times. |
| <p>Outside Recommended Standard Hours</p> | <p>Noise affected RBL + 5 dB</p> | <ul style="list-style-type: none"> A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community |

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Indicative background noise levels for various environments are provided in the Construction Noise and Vibration Guideline (Roads and Maritime, 2016). The environment surrounding the proposed roundabout is best described as “Urban” – “Areas with medium density transportation or some commerce or industry. Typically traffic is moving from one area to another (light & heavy vehicles) with heavy peak hour traffic movement. May be on or close to bus route/ light rail.” The estimated background noise levels (LA90) for urban area types are:

- Day (7.00am-6.00pm Monday to Saturday and 9.00am-6.00pm Sunday) – 50 dBA
- Evening (6.00pm-10.00pm Monday to Sunday) – 45 dBA
- Night (10.00pm-7.00am Monday to Saturday and 10.00pm-9.00am Sunday) – 40 dBA.

6.5.4 Potential impacts

Construction

The proposed roundabout is to be constructed on the Princes Highway which traverses through heavily vegetated areas. The topography of the study is generally flat with no sudden change in elevation that could result in the propagation of noise from construction activities to surrounding residents and local businesses. Construction generated traffic would be limited to workers’ vehicles and material transport.

An increase in the amount noise generated could occur along detour roads as there could be increased traffic travelling these roads during the proposed road closures detail in Section 3.3.1.. The use of temporary detours has the potential to change the background noise levels due to the temporary change in traffic volumes. To assess noise from construction traffic and the temporary detour, a noise assessment using the estimator for traffic was performed. The result found change in noise level would be less than 2.0 dBA and therefore no additional mitigation measures are included.

The noise and vibration assessment (Appendix F) indicates the potential for construction noise levels to exceed the NML criteria identified in Section 6.5.3 during the construction of the proposed roundabout. Table 6-7 provides a summary of the estimated noise impacts for each stage of construction.

Table 6-7: Noise and vibration impact

| Construction Stage | Proposed Construction Period | Noise and vibration Impact |
|--------------------|---|---|
| Stage 1 | Day (7.00am-6.00pm Monday to Saturday and 9.00am-6.00pm Sunday) | <ul style="list-style-type: none"> • Sensitive receivers would experience clearly audible noise levels during the clearing of vegetation with moderately intrusive noise levels. |
| Stage 2 | Day (7.00am-6.00pm Monday to Saturday and 9.00am-6.00pm Sunday) | <ul style="list-style-type: none"> • Sensitive receivers would experience moderately intrusive noise levels about the NML |
| Stage 3 | Evening (6.00pm- | <ul style="list-style-type: none"> • Construction works during this stage would result in noise levels |

| Construction Stage | Proposed Construction Period | Noise and vibration Impact |
|--------------------|---|--|
| | 10.00pm Monday to Sunday) and Night (10.00pm-7.00am Monday to Saturday and 10.00pm-9.00am Sunday) | <p>that would exceed the NML. This is due the use of an excavator with a hammer that would result in in the nearest sensitive receivers experiencing moderately intrusive noise levels above background noise levels (55-65 dBA)</p> <ul style="list-style-type: none"> • Sleep disturbance during this stage of construction could impact sensitive receivers within 260 m of the construction footprint area. |
| Stage 4,5, 6 | Evening (6.00pm-10.00pm Monday to Sunday) and Night (10.00pm-7.00am Monday to Saturday and 10.00pm-9.00am Sunday) | <ul style="list-style-type: none"> • Noise levels during this stage of construction would experience low amounts of clearly audible noise above the noise level background for sensitive receivers • There would be no impact to sleep disturbance during this stage as the affected distance is estimated to be 60 m. |

As described in Section 3.3.2, night works are required to successfully complete the project whilst limiting significant traffic impacts on the Princes Highway and to reduce the duration of construction disturbance. The night works would be based the durations describe in Section 3.3.2, which have been assessed accordingly in Appendix F to ensure suitable mitigation is applied to sensitive receivers within the affected distance. All feasible and reasonable work practices have been considered to attempt to reduce the impacts to sensitive receivers. This includes scheduling noisy works to occur in standard day hours or before 11pm where feasible.

Where sensitive receivers are within the affected distance for sleep disturbance and or where the assessment indicates a noise level above background level, consultation would be undertaken with all affected receivers to discuss the project and potential mitigation measures. These meetings could assist in scheduling works to minimise impacts on the community or discussing other mitigation measures required such as respite offers. In instances where the resident cannot be contacted directly, a letter may be hand delivered to their door outlining the works details with contact information should they have any questions.

Operation

The operation of the proposed roundabout is unlikely to alter the existing background noise level of the intersection for sensitive receivers. The proposal would not be altering the level of the existing carriageway, removing obstacles that provide shielding, changing the type of pavement or increasing traffic speeds by more than 10km/hr. Traffic volumes and heavy vehicles movements would also remain at current levels.

Vibration

Due to the distance of the nearest sensitive receivers, it is unlikely that vibration criteria would be exceeded by the works. No blasting is anticipated during the construction phase of the proposal. If blasting is required, further detailed assessment would be required and a blast management plan prepared.

6.5.5 Safeguards and management measures

| Impact | Environmental safeguards | Responsibility | Timing |
|-------------------------------------|--|--------------------|--|
| NV01 – Noise and Vibration | <p>A Noise Management Plan (NMP) will be prepared and implemented as part of the CEMP. The NMP will follow the approach in the Roads and Maritime Construction Noise and Vibration Guideline and include:</p> <ul style="list-style-type: none"> feasible and reasonable mitigation measures to be implemented as per the results for each stage of the Roads and Maritime Maintenance Noise Estimator Tool (Appendix F) arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures. | Contactor | Detailed design / pre-construction / During construction |
| NV02 – Noise and Vibration | <p>All sensitive receivers (e.g. schools, local residents) likely to be affected will be notified at least 5 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:</p> <ul style="list-style-type: none"> the project the construction period and construction hours contact information for project management staff complaint and incident reporting how to obtain further information. | Contactor | Detailed design / pre-construction |
| NV03 – Affected sensitive receivers | Roads and Maritime will seek to meet with sensitive receivers within the affected distance, to discuss mitigation options during night works and a duration respite, as per the Roads and Maritime Noise Mitigation Guideline | Roads and Maritime | Pre –construction / construction |
| NV04 – Affected sensitive | Noisy works would be scheduled to occur in standard day hours or | Contactor | During construction |

| Impact | Environmental safeguards | Responsibility | Timing |
|-----------|-----------------------------|----------------|--------|
| receivers | before 11pm where feasible. | | |

6.6 Aboriginal cultural heritage

6.6.1 Methodology

A Stage 2 PACHCI investigation of the study area was undertaken in May 2019 (Appendix D) to inform this assessment. The Stage 2 Aboriginal archaeological survey report was prepared in accordance with the OEH Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales 2010 and Stage 2 of the Roads and Maritime PACHCI. The Stage 2 PACHCI assessment consisted of:

- Stage 1 – Desktop investigation to determine whether a Roads and Maritime proposal is likely to harm Aboriginal cultural heritage, and whether further assessment or investigation is required
- Stage 2 - The second stage of the PACHCI assessment required the engagement of a specialist sub-consultant to conduct a site survey and further assessment to determine whether any features of Aboriginal cultural significance occur within the study area, and if they it would be affected by the project. The site inspection was undertaken on 20 May 2019, with an Aboriginal site officer from the Nowra Aboriginal Land Council (LALC).

The field inspection of the study area paid close attention to areas of favourable landform condition, of which none were present or identifiable. The key survey variables of ground visibility, which considers the amount of ground surface which is visible and not covered by any vegetation; and exposure, which defines areas where dispersed surface soils and vegetative matter afford a clear assessment of the ground, were assessed across the study area and within each landform element. Overall survey coverage and calculated survey effectiveness was recorded. Note that the effectiveness of the field survey was largely dependent on the degree of ground surface visibility.

6.6.2 Existing environment

The study area is thought to lie within the boundary of the Wandandian people, The Wandandian are Dhurga speakers whose territory is believed to have extended south from the Shoalhaven River and Jervis Bay to Ulladulla, and west to the Shoalhaven River north of Braidwood. The Wandandian were part of a larger inter-tribal group known as the Murring; whose territory extended from Shoalhaven down south to Double Bay.

Population estimates at the time of contact are notoriously problematic as Aboriginal groups avoided the early settlers and were highly mobile. Several settlers and explorers recorded observations from 1770 onward. The initial contact period offers descriptions of local populations as ‘numerous’, while post-1800 the population in the region declined rapidly due to the spread of disease from Europeans with permanent European Settlement of Jervis Bay beginning in 1828.

The natural environment of an area influences not only the availability of local resources, such as food and raw materials for artefacts, but also determines the likely presence and/or absence of various archaeological site types which may be encountered during a field investigation.

An archaeological survey of the study areas was undertaken on 20 May 2019. The study area consisted of approximately 68,000 m² of flat, undulating (0% - 5%) terrain. The majority of the study area was disturbed

by modern activity. The effective survey coverage in the exposed disturbed portion was high at 60%, as shown in Figure 6-5 and 6-6 below. The remaining 40% was mostly covered in leaf fall with poor visibility. The land in the study area has been cleared of vegetation and re-populated by trees within the last century, evident in the lack of old growth. It is likely land was used for ploughing or cattle at some point, as it lies adjacent to several plot used as farms. Piling of topsoil, likely removed during construction of the current Princes Highway, is present in the south of the study area.

One flake was observed in a spoil heap in the northern portion of the study area next to the dirt track, the soil heap was approximately 600 mm and has been removed from its original location to the side of the dirt track to create a turning platform as shown in Figure 6-7. This location was located outside of both the construction and study areas for this proposal.

No other Aboriginal heritage objects or places were observed during the field survey. No areas of archaeological sensitivity were observed. Any potential remaining archaeological deposits present in the study area would likely represent a low-density background scatter of stone artefacts, evidence of people moving rather than of long-term occupation sites. Archaeological deposits of this nature would consist of isolated stone artefacts or small scatters. These sites would likely be low in scientific significance, and low in research potential, but may have some cultural value for Aboriginal people.



Figure 6-5: Cleared dirt track



Figure 6-6: Vegetation within study area



Figure 6-7: Aboriginal artefact

6.6.3 Potential impacts

Construction

Based on the low potential of the study area to contain further Aboriginal heritage sites, the Heritage Assessment (Appendix D) concluded the predicted impact of the proposed works has low potential of impacting on further Aboriginal cultural material with some loss of minor Aboriginal heritage values of the adjacent area.

Construction of the proposal could potentially result in the accidental disturbance and movement of the lithic flake as identified in Figure 6-5. However, to ensure that impact to the site does not occur, a 10 metre exclusion zone would be established around AHIMS site 58-2-0478 during construction works. An Aboriginal Heritage Impact permit is not required as per section 90 of the *National Parks and Wildlife Act 1974*.

Operation

During the operation of the proposed roundabout, it is unlikely that further damage to Aboriginal heritage would occur. The access track would continue to be used by Roads and Maritime for inspections and maintenance only and access would be limited to the existing track.

6.6.4 Safeguards and management measures

| Impact | Environmental safeguards | Responsibility | Timing | Reference |
|--|---|----------------|------------------------------------|---|
| AH01 - Impact to known Aboriginal Heritage | AHIMS site 58-2-0478 is located outside of the area of construction impact. To ensure that impact to the site does not occur, a 10 metre exclusion zone must be established around the AHIMS site 58-2-0478 site during construction works. | Contactor | Construction | |
| AH02 – Unexpected finds | <p>Unexpected Heritage Items (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.</p> <ul style="list-style-type: none"> Work will only recommence once the requirements of that | Contactor | Detailed design / pre-construction | Section 4.9 of QA G36 <i>Environment Protection</i> |

| Impact | Environmental safeguards | Responsibility | Timing | Reference |
|-------------------------------|---|-----------------|------------------|-----------|
| | Procedure have been satisfied. | | | |
| AH03 – Aboriginal constraints | If any changes to the proposed project design a re-analysis of Aboriginal Heritage constraints should be undertaken by suitably qualified personnel | Project Manager | Detailed Design | |
| AH04 – Earthworks | All contractors undertaking earthworks in the study area should undergo an induction on identifying Aboriginal heritage objects and the penalties for damage to these items | Contractor | Pre-construction | |

6.7 Non-Aboriginal heritage

6.7.1 Methodology

The Non-Aboriginal heritage assessment included a desktop review of published records and data, in the form of local, State, national and world heritage registers, to confirm the likely presence of non-Aboriginal heritage values in the local area. A search of all available non-Aboriginal heritage registers was carried out on in July 2019. A wider area than the proposed road's study area was searched to demonstrate the heritage context of, and to include those items that may be impacted visually by the proposal. The register search included:

- NSW Heritage Database (Appendix D)
- Shoalhaven Local Environment Plan 2014
- Australian Heritage Database (Appendix D).

6.7.2 Existing environment

The desktop searches indicated no potential items of heritage significance in close proximity to the study area.

6.7.3 Potential impacts

Potential damage to non-Aboriginal artefacts could result if such items are undiscovered within the study area. The likelihood of any damage to non-Aboriginal artefacts within the study area are considered low due the location of the study area and the land disturbance as a result from existing road infrastructure.

6.7.4 Safeguards and management measures

| Impact | Environmental safeguards | Responsibility | Timing |
|-----------------------|---|----------------|------------------------------------|
| NA01 – Non-Aboriginal | <p>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.</p> <p>Work will only re-commence once the requirements of that Procedure have been satisfied.</p> | Contactor | Detailed design / pre-construction |

6.8 Landscape character and visual impacts

6.8.1 Existing environment

The proposed roundabout is to be constructed on existing road infrastructure and traverses heavily vegetated areas along with commercial and residential areas. The existing road infrastructure on the Princes Highway consists of raised concrete median islands as shown in Figure 6-8.



Figure 6-8: Raised concrete medians

The general locality of the proposed roundabout is of low visual amenity due to existing road infrastructure. The Princes Highway is obscured by trees that split the Highway from commercial businesses, residents and other sensitive receivers

The compound site would be located in a timber yard property (Lot 25 DP 792969) along Grange Road. The compound site would be concealed by trees to reduce the visual exposure of the compound to vehicles travelling Grange Road.

6.8.2 Potential impacts

Construction

The construction phase of the proposed roundabout would result in a minor visual impact, as the majority of the works would be undertaken on existing road infrastructure. The surrounding vegetation would provide a screen from surrounding businesses and residents on Grange Road and Island Point Road, this is provided in Figure 6-9.



Figure 6-9: Compound site surrounding landscape

Operation

The operational impact would result in minimal impact to the visual landscape of the area. The removal of trees would cause some minor visual impact to road users due to the area representing a small portion of the total amount of existing trees, refer to Section 6.1 for further information.

A landscaping plan would be developed to assist in limiting potential visual impacts on the landscape from the roundabout and to assist with integrating the proposal into the setting. The landscape design would follow the *Roads and Maritime Landscape design guideline - Design guideline to improve the quality, safety and cost effectiveness of green infrastructure in road corridors (2018)*. The final design would feature a roundabout with a concrete border wide enough for a maintenance truck and a densely planted centre of clumping grasses up to 500mm high, such as lomandra. This design was selected to maintain sight distances, not introduce hazards, and requires minimal maintenance and lane closures. The approach medians design would remain the existing concrete surface, due to safety concerns if maintenance is required. The faces of the cut and fill batters would be stabilised by topsoiling and applying spray grass or a similar treatment.

6.8.3 Safeguards and management measures

| Impact | Environmental safeguards | Responsibility | Timing |
|----------------------|--|----------------|------------------------------------|
| LC01 – Visual Impact | <p>A landscape Plan will be prepared and implemented as part of the CEMP.</p> <p>The Plan will include design treatments for:</p> <ul style="list-style-type: none"> proposed landscaped areas, including species to be used cyclist elements including footpath location and paving | Contactor | Detailed design / pre-construction |

| Impact | Environmental safeguards | Responsibility | Timing |
|--------|--|----------------|--------|
| | <p>types</p> <p>The Plan will be prepared in accordance with relevant guidelines, including:</p> <ul style="list-style-type: none"> • Landscape Guideline (RTA, 2018) • • Roads and Maritime Guideline for landscape character and visual impact assessment (2018) • Roads and Maritime specification R178 & R179 | | |

6.9 Property and land use

6.9.1 Existing environment

The existing land uses in the area, which are reflected in the current zoning policies and development control provisions described in Section 4.1.2, include:

- Transport infrastructure in the form of several major and local roads (Princes Highway, Island Point Road and Grange Road)
- Residential areas south-east of the area
- Commercial business adjacent to Grange Road
- Undeveloped land to the west of the study area.

The study area of the proposed roundabout covers Lot 8 DP 855413, Lot 342 DP 1170961 and the compound site on Lot 25 DP 792969. Lot 8 DP 855413 and Lot 342 DP 1170961 is owned by Roads and Maritime. Lot 25 DP 792969 is privately owned land that would be leased to Roads and Maritime for the duration of the construction of the proposed roundabout. Construction of the roundabout will occur on the road corridor and Lot 8 DP 866413.

6.9.2 Potential impacts

As discussed in Section 3.3.6, the proposal would require the lease on private property in Lot 25 DP 792969. Lease agreements of the required land would be negotiated between the land owner and Roads and Maritime. The land total land required for the site compound is approximately 0.53 hectares. The site compound would accommodate a site office, meal room, ablutions block, storage area for concrete pipes and pits, temporary stockpile area for non-erodible material, light and heavy vehicle parking, and a storage shed for small tools and equipment.

There is an existing access track from Grange Road into the Roads and Maritime owned land of Lot 8 DP 855413. This track would require some vegetation removal and groundworks to create an all-weather track,

giving access to the fill embankment site on the northern end of the works. The track would be gated and locked outside of working hours, and would be retained for future maintenance and inspection access.

6.9.3 Safeguards and management measures

| Impact | Environmental safeguards | Responsibility | Timing |
|-----------------|---|------------------------------------|-------------------|
| PL01 – Property | Following completion of the construction works the compound site will be disassembled and returned to near original conditions. | Roads and Maritime project manager | Post construction |

6.10 Socio-economic

6.10.1 Methodology

This Socio-economic assessment has considered the local community, business and industry impacts and benefits from the construction and operation of the roundabout. The stakeholder impacts considered include:

- Local and regional business within Tomerong, and the greater Shoalhaven LGA
- The local community and its endorsement or opposition to the construction of the roundabout
- Community values – amenity, health and safety, character, environmental and sense of place
- Social amenity and existing infrastructure.
- Temporary impacts on the community from the construction.

This involved reviewing the community and stakeholder feedback (refer to Section 5), and the output from other REF assessments containing relevant socio-economic themes, these include:

- Traffic and access
- Noise and vibration
- Landscape character and visual impacts
- Air quality
- Land use and property.

6.10.2 Existing environment

The Princes Highway is an important strategic Highway that connects the Shoalhaven LGA to other coastal regions of Southern NSW. The socio-economic value of the Princes Highway can be rated as high due to the connectivity it provides to the Shoalhaven LGA and other areas of the south coast of NSW. There is an estimated 1,065 people living in Tomerong, NSW, of which approximately 70% use a car to travel to work as the most common method of travel based on the 2016 census data. The nearest residential property is located approximately 100 m from the study area. Local businesses located within 200 m to the study area include:

- Landscape and garden supply store
- Local café
- Firewood supplier.

6.10.3 Potential impacts

Construction

Construction is likely to result in temporary changes in local amenity for residents and community Due to increased noise and dust from construction activities and increased traffic, including heavy vehicles. The construction of the proposed roundabout may impose a number potential negative socio-economic during construction including:

- Disruptions to local residences that regularly use the Princes Highway and Island Point Road intersection
- Increased traffic and vehicular movements on the proposed detour roads
- Disruption to businesses and the local community at the intersection of Island Point Road and the Princes Highway during construction
- Disruption to sensitive receivers during night work construction hours
- Residents journeys may be delayed during the construction period
- Drivers may experience frustration and amenity loss when travelling through the study area
- Residents may suffer from amenity issues during construction

The impact associated with the temporary lease of land on Lot 25 DP 792969 would be short-term and are not expected to be significant. Following construction, land occupied by construction work but not required for the ongoing operation of the proposal would be reinstated to its pre-construction use.. Access to the property near to the construction work for the proposal would be maintained during construction. Where changes are required, suitable access arrangements would be implemented in consultation with affected property owners.

Operation

The operation is not expected to change the access arrangements for local businesses and residents within the study area, the reduction in speed from 100 km/h to 80 km/h would have negligible impacts on travel times. The proposed roundabout would have long term beneficial impact on businesses through improved access and connectivity within the Shoalhaven LGA, helping to improve the travel times and safety through the intersection. The proposed roundabout would have the following positive impacts:

- Improved transport, connectivity and access to the road, improving the locations liveability
- Improved road safety by building and designing the road to current Austroad standards.

6.10.4 Safeguards and management measures

| Impact | Environmental safeguards | Responsibility | Timing |
|-----------------------|---|----------------|------------------------------------|
| SE01 – Socio-economic | <p>A Communication Plan (CP) will be prepared and implemented as part of the CEMP to help provide timely and accurate information to the community during construction. The CP will include (as a minimum):</p> <ul style="list-style-type: none"> • mechanisms to provide details and timing of proposed activities to affected residents, including changed traffic and access conditions • contact name and number for | Contractor | Detailed design / pre-construction |

| Impact | Environmental safeguards | Responsibility | Timing |
|------------------------|---|----------------|--|
| | <p>complaints.</p> <p>The CP will be prepared in accordance with the <i>Community Involvement and Communications Resource Manual</i> (RTA, 2008).</p> | | |
| SE02 – Traffic Closure | Any traffic closure and delays of the Princes Highway and Island Point Road would be design to minimise impacts on the local community, freight, businesses and commercial operators using the roads. | Contractor | Pre-construction and during construction |

6.11 Other impacts

6.11.1 Existing environment and potential impacts

| Environmental factor | Existing environment | Potential impacts |
|--|---|--|
| Traffic Hazard and Risk Management | The proposed roundabout would be built on existing road infrastructure, with existing traffic and transport using the Princes Highway, Island Point Road and Grange Road | Accidents and interaction with construction equipment and vehicles moving through the project boundary during construction may occur. |
| Climate Change / Air Quality Emissions | The proposed roundabout is surrounded by natural vegetation, with emissions generated from existing environment from vehicle movements along the Princes Highway, Island Point Road and Grange Road, and activities of commercial businesses and local residents. | The proposed roundabout would contribute to carbon emissions and climate change to a minor extent via the emissions by construction equipment and traffic as well as the consumption of materials requiring emissions during the undertaking of construction works. There is a potential for temporary minor air quality impacts from vehicle emissions during construction |
| Waste | The main types of waste currently associated with the site are municipal solid waste which may have been left by road users travelling on the Princes Highway, Island Point Road or Grange Road. | <p>Construction would generate waste streams typical of road construction, including:</p> <ul style="list-style-type: none"> • Green waste from cleared vegetation • Roadside materials (ie. guide posts, guard rails, traffic signage) • Road construction materials from construction of the roundabout • Excess fill material from any excavation of soils and fill embankments during construction • Oil, grease and other liquid wastes from the maintenance of construction plant and equipment • General wastes and sewage from site compounds and offices. <p>Any remaining excess spoil and materials would be taken to a licenced facility to be lawfully disposed. Concrete medians would be taken to a facility for crushing and recycling as they cannot be reused due to construction staging.</p> |

6.11.2 Safeguards and management measures

This section describes the existing environment, potential impact of the proposal and proposed safeguards and management measures in relation to the following environmental factors:

- Air quality
- Hazards and risk management
- Waste

| Impact | Environmental safeguards | Responsibility | Timing | |
|--------------------|---|----------------|------------------------------------|--|
| AQ01 – Air quality | Air Quality Management Plan (AQMP) will be prepared and implemented as directly into the CEMP. The AQMP will include, but not be limited to: <ul style="list-style-type: none"> • 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 • a progressive rehabilitation strategy for exposed surfaces. | Contractor | Detailed design / pre-construction | |

| Impact | Environmental safeguards | Responsibility | Timing | |
|------------------------------------|---|----------------|------------------------------------|--|
| HR01 – Hazards and risk management | <p>A Hazard and Risk Management Plan (HRMP) will be prepared and implemented directly into the CEMP. The HRMP will include, but not be limited to:</p> <ul style="list-style-type: none"> • details of hazards and risks associated with the activity • measures to be implemented during construction to minimise these risks • record keeping arrangements, including information on the materials present on the site, material safety data sheets, and personnel trained and authorised to use such materials • a monitoring program to assess performance in managing the identified risks • contingency measures to be implemented in the event of unexpected hazards or risks arising, including emergency situations. <p>The HRMP will be prepared in accordance with relevant guidelines and standards, including relevant Safe Work Australia Codes of Practice, and EPA or Office of Environment and Heritage publications.</p> | Contractor | Detailed design / pre-construction | |
| WM01 – Waste | <p>A Waste Management Plan (WMP) will be prepared and implemented as part of the CEMP. The WMP will include but not be limited to:</p> <ul style="list-style-type: none"> • Measures to avoid and minimise waste associated with the project • Classification of wastes and management options (re-use, recycle, stockpile, disposal) • Statutory approvals required for managing both on and off-site waste, or application of any relevant resource recovery exemptions • Procedures for storage, transport and disposal • Monitoring, record keeping and reporting. <p>The WMP will be prepared taking into account the Environmental Procedure - Management of Wastes on Roads and Maritime Services Land (Roads and Maritime, 2014) and relevant Roads and Maritime Waste Fact Sheets.</p> | Contractor | Detailed design / pre-construction | |

| Impact | Environmental safeguards | Responsibility | Timing | |
|--------------|--|----------------|--|--|
| WM02 – Waste | Bulk project waste (e.g. fill) sent to a site not owned by the Roads and Maritime (excluding EPA licensed landfills and resource recovery facilities) is to have prior formal written approval from the landowner, in accordance with Environmental Direction No.20 – Legal Off-site Disposal of Roads and Maritime Services Waste. This includes waste transported for reuse, recycling, disposal or stockpiling. | Contractor | Detailed design / pre-construction/ construction | |

6.12 Cumulative impacts

6.12.1 Study area

This cumulative impact assessment considers the works to construct the roundabout on existing road infrastructure at the intersection of Island Point Road and the Princes Highway, as well as other projects undertaken within the Shoalhaven LGA that may impact the construction of the proposed roundabout.

6.12.2 Broader program of work

The proposed roundabout is not part of a broader works program for the intersection, the proposed roundabout is funded under the NSW Government's Safer Roads program which is an initiative of the NSW Road Safety Strategy to reduce crashes and make roads safer.

6.12.3 Potential impacts

The proposal has the potential to add a number of cumulative impacts including removal of 0.95 hectares of vegetation from the study area, resource consumption, disruption to traffic and transport movements and increased activity on Island Point Road, Grange Road and the Princes Highway. The mitigation summarised in Section 7.2 aims to minimise the extent to which the proposal contributes to any cumulative adverse environmental impacts.

6.12.4 Other projects and developments

A general search was undertaken to determine if there are any other projects or developments within proximity of the proposed roundabout that may affect the construction and operation.

| Project | Construction impacts | Operational impacts |
|---|--|--|
| <p>Nowra Bridge Upgrade: Roads and Maritime is planning for a new 4 lane bridge over the Shoalhaven River, upgraded intersections and additional lanes on the Princes Highway. The project would improve traffic flow and ease congestion on a major section of the Princes Highway and deliver faster and more reliable journeys within the Nowra-Bomaderry area.</p> <p>The REF and concept design was made for public display in August 2018, a submissions reported was provided.</p> <p>Roads and Maritime will soon issue</p> | <p>Due to the timing of the bridge upgrade it is not expected that there will be any construction impacts to the proposed roundabout</p> | <p>The operational impact of the bridge will ease congestion on the Princes Highway and deliver safer and reliable travel to the Shoalhaven LGA.</p> |

| Project | Construction impacts | Operational impacts |
|--|---|--|
| <p>a Request for Tenders for the detailed design and construction of the project. It is expected that the successful contractor will be announced in the first half of 2020.</p> | | |
| <p>Princes Highway Upgrade: The NSW government has committed to upgrade the Princes Highway that includes duplicating sections of the Princes Highway from Jervis Bay Road to Sussex Inlet Road.</p> | <p>Due to the timing of the road duplication it is not expected that there will be any construction impacts to the proposed project area.</p> | <p>The operational impact of the road duplication will improve the safety and connectivity south the South Coast region.</p> |

7. Environmental management

This chapter describes how the proposal would 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

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 Construction Environmental Management Plan (CEMP) would be prepared to describe the safeguards and management measures identified. The CEMP would provide a framework for establishing how these measures would be implemented and who would be responsible for their implementation.

The CEMP would be prepared prior to construction of the proposal and must be reviewed and certified by the Roads and Maritime Environment Officer, Southern NSW, prior to the commencement of any on-site works. The CEMP would be a working document, subject to ongoing change and updated as necessary to respond to specific requirements. The CEMP 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.

7.2 Summary of safeguards and management measures

Environmental safeguards and management measures outlined in this REF would 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

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|--|--|---|------------------------------------|-----------|
| GEN1 | General - minimise environmental impacts during construction | <p>A CEMP will be prepared and submitted for review and endorsement of the Roads and Maritime Environment Manager prior to commencement of the activity.</p> <p>As a minimum, the CEMP will address the following:</p> <ul style="list-style-type: none"> • 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 | Contractor / Roads and Maritime project manager | Pre-construction / detailed design | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|-----------------------------------|---|---|--|-----------|
| | | <ul style="list-style-type: none"> procedures for emergency and incident management procedures for audit and review. <p>The endorsed CEMP will be implemented during the undertaking of the activity.</p> | | | |
| GEN2 | General - notification | All businesses, residential properties and other key stakeholders (eg schools, local councils) affected by the activity will be notified at least five days prior to commencement of the activity. | Contractor / Roads and Maritime project manager | Pre-construction | |
| GEN3 | General – environmental awareness | <p>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.</p> <p>Site-specific training will be provided to personnel engaged in activities or areas of higher risk. These include:</p> <ul style="list-style-type: none"> areas of Aboriginal heritage sensitivity areas of environmental sensitivity and private property boundaries threatened species habitat adjoining residential areas requiring particular noise management measures | Contractor / Roads and Maritime project manager | Pre-construction / detailed design | |
| BD01 | Biodiversity | An Environmental Work Method Statement (EWMS) for Clearing and Grubbing must be prepared and implemented. The EWMS must conform to Roads and Maritime Biodiversity Guidelines; | Contractor | <p>Prior to construction</p> <p>During construction</p> <p>Post construction</p> | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|-----|--------|---|----------------|--------|-----------|
| | | <ul style="list-style-type: none"> • Pre-clearing surveys will be undertaken in accordance with <i>Guide 1: Pre-clearing process</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011). • Vegetation removal and habitat will be undertaken in accordance with <i>Guide 4: Clearing of vegetation and removal of bushrock</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011) and <i>Guide 5: Re-use of woody debris and bushrock</i>. Exclusion zones identified and demarcated in accordance with the <i>Roads and Maritime's Biodiversity Guidelines (Guide 2: Exclusion zones)</i> (RTA 2011). • The unexpected species find procedure is to be followed under <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011) if threatened ecological communities, not assessed in the biodiversity assessment, are identified in the proposal area. • Roads and Maritime QA Specification G40 <p>The EWMS must at least include following:</p> <ul style="list-style-type: none"> • A description of the work activity, including the sequence of tasks, any plant and equipment to be used • Identification of any environmentally sensitive areas • A detailed site diagram showing all work areas, controls, sensitive areas, and no-go-zones. | | | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|----------------------------------|---|----------------|--|-----------|
| | | <ul style="list-style-type: none"> The control measures to be implemented based on the REF Safeguards and management measures | | | |
| BD02 | Removal of native vegetation | Exclusion zones are to be identified and demarcated as per the boundary limit on the design. | Contractor | Detailed design | |
| BD03 | Groundwater dependant ecosystems | <p>Prior to construction, implement risk management actions for identified risk matrix level (A) as per the DPI Risk assessment guidelines for groundwater dependent ecosystems Including:</p> <ul style="list-style-type: none"> Establish exclusion zones at the GDE boundary limit as per on the design and erect environmental exclusion zone signage Implement erosion and sediment control plan Monitor terrestrial GDE on Lot 8 DP 855413 for one occasion at the completion of works, to compare against the Biodiversity Assessment (baseline data). <p>Monitoring is to comprise vegetation plot (species richness and percent cover) and qualitative health assessment of threatened flora populations and is to be stipulated in the CEMP. Two vegetation plots are to be located within the two vegetation zones comprising the GDE vegetation (PCT 1206). Qualitative health assessment of the two threatened flora species present, <i>Melaleuca biconvexa</i> and <i>Syzygium paniculatum</i>, will comprise descriptions of</p> | Contractor | <p>Prior to construction</p> <p>During construction</p> <p>Post construction</p> | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|-------------------------------|--|----------------|---------------------|-----------|
| | | evidence of die-back, physical damage, stress (yellowing) and signs of infection by flora pathogens (<i>Phytophthora cinnamomi</i> and Myrtle Rust). | | | |
| BD04 | Injury and mortality of fauna | Fauna will be managed in accordance with <i>Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011). | Contractor | During construction | |
| BD05 | Injury and mortality of fauna | Timing of works to avoid large forest owl breeding and microbat torpor periods (autumn/winter). If works are required to occur within the autumn/winter period, additional survey by a suitably qualified ecologist are to be undertaken for evidence of large forest owl nest presence prior to the commencement of clearing. If evidence of nest presence is determined, expert advice is to be sought to manage nest presence. | Contractor | During construction | |
| BD06 | Injury and mortality of fauna | A microbat management plan must be implemented as part of the CEMP. It will include tool boxing microbat identification, inspecting of potential habitual prior to any disturbance and erect exclusion fencing if required. | Contractor | During construction | |
| BD07 | Invasion and spread of weeds | Weed species will be managed in accordance with <i>Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011). | Contractor | During construction | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|------------------------------|---|----------------|---------------------|-----------|
| | | <p>Due to the low density of priority weed species within the Study Area, recommended weed control measures are to comprise physical removal of <i>Lantana camara</i> (Lantana) and <i>Rubus fruticosus</i> agg. (Blackberry) prior to the commencement of clearing. Removed weed material is to be transported off-site following removal for appropriate disposal and is not to be stockpiled on site.</p> <p>Weed management requirements to be documented in the CEMP.</p> | | | |
| BD08 | Invasion and spread of pests | <p>risk of pathogen contamination will be managed in accordance with <i>Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).</p> <p>The Project may introduce the flora pathogens <i>Phytophthora cinnamomi</i> and exotic Rust Fungi as well as the amphibian chytrid fungus through media such as unclean fill, untreated water and contaminated plants or soil media from imported plants used for any revegetation works.</p> <p>Specific measures to minimise the risk of pathogen infection comprise (with reference to best practice guidelines in Table 7.1 of <i>Guide 7: Pathogen management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).</p> <ul style="list-style-type: none"> Restrict personnel to designated tracks and trails | Contractor | During construction | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|---------------------------------------|---|-----------------------------|------------------------------------|---|
| | | <ul style="list-style-type: none"> • Use of onsite fill where possible • Offsite cleaning of soil and plant material from contaminated plant and equipment prior to use on site • Restrict vehicles to designated tracks, trails and parking areas • Use of treated water for dust suppression and other site requirements • Use a certified supply of plants and soil that is disease-free. <p>Pathogen management requirements are to be documented in the CEMP.</p> | | | |
| SW01 | Surface Water, hydrology and flooding | 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. | Contractor | Detailed design / Pre-construction | Section 2.1 of QA G38 Soil and Water Management |
| SW02 | Erosion and Sediment | <p>A site specific Erosion and Sediment Control Plan/s will be prepared and implemented as part of the CEMP.</p> <p>The Plan 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.</p> | Contractor | Detailed design / Pre-construction | Section 2.2 of QA G38 Soil and Water Management |
| SW03 | Spill Response | If a spill occurs, the Roads and Maritime's Environmental Incident Classification and Management Procedure must be followed and the Roads and Maritime Project Manager notified as | Project Manager, Contractor | Pre-construction / construction | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|-------------------------|--|-----------------------------|--|-----------|
| | | soon as practicable. | | | |
| SW04 | Spills and leaks | An emergency spill kit will be kept on site at all times. All staff will be made aware of the location of the spill kit and trained in its use. | Contractor | During Construction | |
| SW05 | Liquid storage | All fuels, chemicals, and liquids will be stored at least 50 m away from waterways (including existing stormwater drainage system) and will be stored in an impervious bunded area within the compound site. Only materials required onsite must be stored in the dedicated area. | Project Manager, Contractor | Pre-construction / construction | |
| SW06 | Contamination of water | The refuelling of plant and maintenance of machinery will be undertaken in impervious bunded areas. | Contractor | During construction | |
| S01 | General soil management | All stockpiles will be designed, established, operated and decommissioned in accordance with the Stockpile Site Management Procedure. | Contractor | Pre-construction / During construction | |
| S02 | General soil management | Rehabilitation works of disturbed areas are to commence as soon as practicable after works are completed in any area. Where feasible, work should be stage to reduce soil exposure duration | Contractor | During construction | |
| TT01 | Traffic and Transport | A TMP will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the <i>Roads and Maritime Traffic Control at Work Sites Manual</i> (RTA, 2010) and <i>QA Specification G10 Control of Traffic</i> (Roads and Maritime, 2008). The TMP will include: <ul style="list-style-type: none"> • confirmation of haulage routes • measures to maintain access to local | Contractor | Detailed design / Pre-construction | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|-----------------------|--|----------------|---------------------|-----------|
| | | <p>roads and properties</p> <ul style="list-style-type: none"> • site specific traffic control measures (including signage) to manage and regulate traffic movement • measures to maintain pedestrian and cyclist access • requirements and methods to consult and inform the local community of impacts on the local road network • access to construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads. • a response plan for any construction traffic incident • consideration of other developments that may be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic • monitoring, review and amendment mechanisms. | | | |
| TT02 | Traffic and Transport | Local residents would be notified at least five days of any potential delays and detours regarding access and traffic flows during prior to and during construction | Contractor | During construction | |
| TT03 | Traffic and Transport | Consultation would be undertaken at least five days prior to construction with bus companies traveling through and/or stop on Island Point | Contractor | Pre-construction | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|-----------------------|--|----------------|--|-----------|
| | | Road. | | | |
| TT04 | Traffic and Transport | Partial road closures (or any short-term full road closures) will be timed to avoid peak periods such as holiday periods when vehicle traffic is high along the highway | Contractor | During construction | |
| TT05 | Traffic and Transport | Cyclist connectivity across the site would be maintained during construction. The community would be notified at least five days before any access changes including alternative routes. | Contractor | During construction | |
| NV01 | Noise and Vibration | <p>A Noise Management Plan (NMP) will be prepared and implemented as part of the CEMP. The NMP will follow the approach in the Roads and Maritime Construction Noise and Vibration Guideline and include:</p> <ul style="list-style-type: none"> feasible and reasonable mitigation measures to be implemented as per the results for each stage of the Roads and Maritime Maintenance Noise Estimator Tool (Appendix F), arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures | Contractor | Detailed design / pre-construction / During construction | |
| NV02 | Noise and Vibration | <p>All sensitive receivers (e.g. schools, local residents) likely to be affected will be notified at least 5 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:</p> <ul style="list-style-type: none"> the project | Contractor | Detailed design / pre-construction | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|-------------------------------------|--|--------------------|------------------------------------|---|
| | | <ul style="list-style-type: none"> the construction period and construction hours contact information for project management staff complaint and incident reporting how to obtain further information. | | | |
| NV03 | Noise and Vibration | Roads and Maritime will seek to meet with sensitive receivers within the affected distance, to discuss mitigation options during night works and a duration respite, as per the Roads and Maritime Noise Mitigation Guideline | Roads and Maritime | Pre –construction / construction | |
| NV04 | Noise and Vibration | Noisy works would be scheduled to occur in standard day hours or before 11pm where feasible. | Contactor | During construction | |
| AH01 | Impact to known Aboriginal Heritage | AHIMS site 58-2-0478 is located outside of the area of construction impact. To ensure that impact to the site does not occur, a 10 metre exclusion zone must be established around the AHIMS site 58-2-0478 site during construction works. | Contactor | Construction | |
| AH02 | Unexpected finds | An Aboriginal Heritage Management Plan (AHMP) will be prepared in accordance with the <i>Procedure for Aboriginal cultural heritage consultation and investigation</i> (Roads and Maritime, 2012) and <i>Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015) and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented for managing impacts on Aboriginal heritage. The | Contactor | Detailed design / pre-construction | Section 4.9 of QA G36 <i>Environment Protection</i> |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|-------------------------|--|-----------------|------------------------------------|-----------|
| | | AHMP will be prepared in consultation with all relevant Aboriginal groups. | | | |
| AH03 | Aboriginal constraints | If any changes to the proposed project design a re-analysis of Aboriginal Heritage constraints should be undertaken by suitably qualified personnel | Project Manager | Detailed Design | |
| AH04 | Earthworks | All contractors undertaking earthworks in the study area should undergo an induction on identifying Aboriginal heritage objects and the penalties for damage to these items | Contractor | Pre-construction | |
| NA01 | Non-Aboriginal Heritage | A Non-Aboriginal Heritage Management Plan (NAHMP) will be prepared and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented to avoid and mitigate impacts to Non-Aboriginal heritage. [The NAHMP will be prepared in consultation with the Office of Environment and Heritage] <i>[delete if consultation not required]</i> . | Contacto | Detailed design / pre-construction | |
| NA02 | Non-Aboriginal Heritage | 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. | Contacto | Detailed design / pre-construction | |
| LC01 | Visual Impact | A landscape Plan will be prepared and implemented as part of the CEMP. | Contacto | Detailed design / pre-construction | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|-----------------------|--|------------------------------------|------------------------------------|-----------|
| | | <p>The Plan will include design treatments for:</p> <ul style="list-style-type: none"> • proposed landscaped areas, including species to be used • cyclist elements including footpath location and paving types <p>The Plan will be prepared in accordance with relevant guidelines, including:</p> <ul style="list-style-type: none"> • Landscape Guideline (RTA, 2018) • Roads and Maritime Guideline for landscape character and visual impact assessment (2018) • Roads and Maritime specification R178 & R179 | | | |
| PL01 | Property and land use | Following completion of the construction works the compound site will be disassembled and returned to near original conditions. | Roads and Maritime project manager | Post construction | |
| SE01 | Socio-economic | <p>A Communication Plan (CP) will be prepared and implemented as part of the CEMP to help provide timely and accurate information to the community during construction. The CP will include (as a minimum):</p> <ul style="list-style-type: none"> • mechanisms to provide details and timing of proposed activities to affected residents, including changed traffic and access conditions • contact name and number for complaints. <p>The CP will be prepared in accordance with the <i>Community Involvement and Communications</i></p> | Contactor | Detailed design / pre-construction | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|-----------------|--|----------------|--|-----------|
| | | <i>Resource Manual</i> (RTA, 2008). | | | |
| SE02 | Socio-economic | <p>A Communication Plan (CP) will be prepared and implemented as part of the CEMP to help provide timely and accurate information to the community during construction. The CP will include (as a minimum):</p> <ul style="list-style-type: none"> mechanisms to provide details and timing of proposed activities to affected residents, including changed traffic and access conditions contact name and number for complaints. <p>The CP will be prepared in accordance with the <i>Community Involvement and Communications Resource Manual</i> (RTA, 2008).</p> | Contractor | Detailed design / pre-construction | |
| SE03 | Traffic closure | Any traffic closure and delays of the Princes Highway and Island Point Road would be design to minimise impacts on the local community, freight, businesses and commercial operators using the roads. | Contractor | Pre-construction and during construction | |
| AQ01 | Air quality | <p>Air Quality Management Plan (AQMP) will be prepared and implemented as directly into the CEMP. The AQMP will include, but not be limited to:</p> <ul style="list-style-type: none"> 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 | Contractor | Detailed design / pre-construction | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|----------------------------|---|----------------|------------------------------------|-----------|
| | | <ul style="list-style-type: none"> • methods to manage work during strong winds or other adverse weather conditions • a progressive rehabilitation strategy for exposed surfaces. | | | |
| HR01 | Hazard and risk management | <p>A Hazard and Risk Management Plan (HRMP) will be prepared and implemented directly into the CEMP. The HRMP will include, but not be limited to:</p> <ul style="list-style-type: none"> • details of hazards and risks associated with the activity • measures to be implemented during construction to minimise these risks • record keeping arrangements, including information on the materials present on the site, material safety data sheets, and personnel trained and authorised to use such materials • a monitoring program to assess performance in managing the identified risks • contingency measures to be implemented in the event of unexpected hazards or risks arising, including emergency situations. <p>The HRMP will be prepared in accordance with relevant guidelines and standards, including relevant Safe Work Australia Codes of Practice, and EPA or Office of Environment and Heritage publications.</p> | Contractor | Detailed design / pre-construction | |

| No. | Impact | Environmental safeguards | Responsibility | Timing | Reference |
|------|--------|--|----------------|--|-----------|
| WM01 | Waste | <p>A Waste Management Plan (WMP) will be prepared and implemented as part of the CEMP. The WMP will include but not be limited to:</p> <ul style="list-style-type: none"> • Measures to avoid and minimise waste associated with the project • Classification of wastes and management options (re-use, recycle, stockpile, disposal) • Statutory approvals required for managing both on and off-site waste, or application of any relevant resource recovery exemptions • Procedures for storage, transport and disposal • Monitoring, record keeping and reporting. <p>The WMP will be prepared taking into account the Environmental Procedure - Management of Wastes on Roads and Maritime Services Land (Roads and Maritime, 2014) and relevant Roads and Maritime Waste Fact Sheets.</p> | Contactor | Detailed design / pre-construction | |
| WM02 | Waste | <p>Bulk project waste (e.g. fill) sent to a site not owned by the Roads and Maritime Services (excluding EPA licensed landfills and resource recovery facilities) is to have prior formal written approval from the landowner, in accordance with Environmental Direction No.20 – Legal Off-site Disposal of Roads and Maritime Services Waste. This includes waste transported for reuse, recycling, disposal or stockpiling.</p> | Contactor | Detailed design / pre-construction/ construction | |

7.3 Licensing and approvals

Table 7-2 lists the license approval requirements that would need obtaining to cover various activities that would be undertaken in the building proposal. They relate to the planning statutory and planning framework presented in Chapter 4.

Table 7-2: Summary of licensing and approvals required

| Instrument | Requirement | Timing |
|-----------------------|--|--------------------------------|
| <i>Roads Act 1993</i> | A Road Occupancy Licence would need to be obtained prior to construction commencing. | Prior to start of the activity |

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

The construction of the roundabout at Island Point Road and the Princes Highway is required to meet the objectives of the NSW Government Road Safety Strategy. The roundabout would aim to achieve

- Improve road safety and reduce the occurrence of crashes at the intersection of Princes Highway and Island Point Road, targeting the dominant crash types that have been recorded at the intersection (majority involve vehicles crossing the highway in to or out of Island Point Road)
- Improve traffic efficiency and intersection performance as traffic modelling found that the current intersection would fail service requirements in 2020.

The environmental impacts associated with undertaking the constructions would be managed through effective implementation of the safeguards and mitigation measures of this REF.

8.1.1 Biophysical factors

The construction of the proposed roundabout would be primarily built over existing road infrastructure. It would result in the loss of 0.95 hectares of vegetation. Measures have been applied to minimise such impacts. The safeguards are designed reduce the environmental footprint of the work required to construct the roundabout. As a result, the proposed roundabout would not substantially impact on the biophysical values of Tomerong or the wider Shoalhaven LGA. The vegetation removal required for the works are unavoidable yet not substantial and would only have a minor impact to the environment.

8.1.2 Economic factors

The proposed roundabout would deliver wider socio-economic benefit to the region of Tomerong and the greater Shoalhaven LGA. There would be some socio-economic impacts, as identified in Section 6.10 however they are considered minor. The socio-economic and public interest factors would have a positive impact to the Shoalhaven LGA due the improved safety and accessibility to Island Point Road from the Princes Highway.

8.1.3 Public interest

The proposed roundabout would support the NSW Safer Roads Program by minimising the risk of traffic accidents. The proposed roundabout has been design to reduce the impact to the environment and ensure the objectives and the needs for the roundabout are met.

8.2 Objects of the EP&A Act

The table below provides consideration of the proposed roundabout in accordance with the EP&A Act.

| Object | Comment |
|---|--|
| 1.3(a) To promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources. | The proposed roundabout has been designed to maximise material reuse and, minimise adverse environmental impacts and the amount of vegetation clearing required for construction and operation |
| 1.3(b) To facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment. | All matters and potential impacts have been considered for the proposed roundabout and site compound. Mitigation measures have been detailed to ensure these impacts are controlled. |
| 1.3(c) To promote the orderly and economic use and development of land. | The proposed roundabout would not adversely impact the development of land. The roundabout would improve the safety of the intersection and reduce crashes. |
| 1.3(d) To promote the delivery and maintenance of affordable housing. | Not relevant to the project. |
| 1.3(e) To protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats. | The best practice design, construction methodologies and mitigation measures will ensure environmental impacts are controlled. |
| 1.3(f) To promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage). | All Aboriginal impacts have mitigation measures to minimise damage to Aboriginal heritage within the footprint during construction and operation. |
| 1.3(g) To promote good design and amenity of the built environment. | The detailed design of the proposed roundabout aims to reduce the environmental footprint of the area. |
| 1.3(h) To promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants. | Not relevant to the project. |
| 1.3(i) To promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State. | Not relevant to the project. |
| 1.3(j) To provide increased opportunity for community participation in environmental planning and assessment. | The proposed roundabout underwent a community and stakeholder holder consultation process in accordance with the provisions of the EP&A Act. |

8.2.1 The precautionary principle

The precautionary principle has been applied in Section 6 – Environmental Assessment for the proposed roundabout.

8.2.2 Intergenerational equity

The proposal would not significantly affect the viability of local or threatened species, or any EECs. Therefore, local biodiversity values would not be substantially adversely affected by the proposal and would be maintained for future generations. Without the works proceeding, traffic safety and efficiency would remain inadequate. Overall, the socio-economic, safety and environmental safety benefits of the proposal would occur only at limited minimal potential environmental expense.

8.2.3 Conservation of biological diversity and ecological integrity

The proposed works would result in the following vegetation clearance:

- PCT 1206. A loss of 0.89 hectares from a mapped occurrence of 9981.64 ha, or 0.009 percent
- PCT 694. A loss of 0.06 hectares from a mapped occurrence of 1515.15 ha, or 0.004 percent.

The impacts to ecological integrity and conservation of biological diversity at the site have been thoroughly assessed as part of this REF. No threatened species, endangered populations or EECs are likely to be significantly affected by the proposal. No populations or native species are likely to be made locally rare or unviable as a result of the proposal. Consequently, the ecological integrity and biological diversity would be maintained at the site.

8.2.4 Improved valuation, pricing and incentive mechanisms

The pricing of environmental resources involves placing a monetary value on natural assets and services. The principle suggests that Roads and Maritime should:

- Bear reasonable costs to avoid pollution risks (the 'polluter pays principle') and implement controls to contain or reduce pollution should it occur.
- Consider the lifecycle environmental, social and economic costs of building, operating and maintaining the proposal
- Implement the proposal's environmental goals by enabling specialists to identify the most cost effective safeguards and management measures to respond to its predicted environmental impact.

Roads and Maritime has committed to safeguards and management measures that would reduce the likelihood of routine pollution occurring while the proposal is being built, Roads and Maritime has also committed to safe working methods to reduce the likelihood of an accidental spillage or pollution event, while providing further precaution by implementing management measures to contain or reduce pollution in the unlikely event that it should occur.

8.3 Conclusion

The proposed roundabout installation at the intersection of Island Point Road and the Princes Highway Tomerong NSW, is subject to assessment under Division 5.1 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, biodiversity stewardship sites under the BC Act, wilderness areas, areas of outstanding value, impacts on threatened species 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. Safeguards and management measures as detailed in this REF would ameliorate or minimise these expected impacts. The proposal would also improve safety and reduce travel times for commuters. 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 Division 5.2 of the EP&A Act. A Biodiversity Development Assessment Report or Species Impact Statement is not required. The proposal is subject to assessment under Division 5.1 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 EPBC Act. 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.



Cassy Baxter

Senior Environmental Scientist

Cardno (NSW/ACT) Pty Ltd

Date: 26/08/19

I have examined this review of environmental factors and accept it on behalf of Roads and Maritime Services.

Benjamin Beattie

Project/Contract Manager

Roads and Maritime Services, Regional Maintenance

Date:

10. References

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Terms and acronyms used in this REF

| Term / Acronym | Description |
|--------------------|---|
| AusLink | Mechanism to facilitate cooperative transport planning and funding by Commonwealth and state and territory jurisdictions |
| BC Act | <i>Biodiversity Conservation Act 2016 (NSW).</i> |
| BCR | Benefit Cost Ratio |
| BDAR | Biodiversity Development Assessment Report |
| BOS | Biodiversity Offset Strategy |
| CEMP | Construction environmental management plan |
| EEC | Endangered Ecological Community |
| EIA | Environmental Impact Assessment |
| EP&A Act | <i>Environmental Planning and Assessment Act 1979 (NSW).</i> Provides the legislative framework for land use planning and development assessment in NSW |
| EPBC Act | <i>Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth).</i> Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process. |
| ESD | Ecologically sustainable development. Development which uses, conserves and enhances the resources of the community so that ecological processes on which life depends, are maintained and the total quality of life, now and in the future, can be increased |
| FM Act | <i>Fisheries Management Act 1994 (NSW)</i> |
| GDE | Groundwater Dependent Ecosystems |
| Heritage Act | <i>Heritage Act 1977 (NSW)</i> |
| ISEPP | State Environmental Planning Policy (Infrastructure) 2007 |
| LALC | Local Aboriginal Land Council |
| LEP | Local Environmental Plan. A type of planning instrument made under Part 3 of the EP&A Act. |
| LGA | Local Government Area |
| LoS | Level of Service. A qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers. |
| MNES | Matters of national environmental significance under the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999.</i> |
| NPW Act | <i>National Parks and Wildlife Act 1974 (NSW)</i> |
| REF | Review of Environmental Factors |
| Roads and Maritime | NSW Roads and Maritime Services |
| ROL | Road Occupancy Licence |

| Term / Acronym | Description |
|-------------------|--|
| SEPP | State Environmental Planning Policy. A type of planning instrument made under Part 3 of the EP&A Act. |
| CM SEPP | State Environmental Planning Policy (Coastal Management) 2018 |
| QA Specifications | Specifications developed by Roads and Maritime Services for use with road work and bridge work contracts let by Roads and Maritime Services. |

Appendix A

Consideration of clause 228(2) factors and matters of national environmental significance and Commonwealth land

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.

| Factor | Impact |
|---|--|
| <p>a) Any environmental impact on a community?</p> <p>The community would not be affected through declines in the local environment as a result of the proposal. Extensive safeguards and management measures have been designed to reduce environmental impacts on the community to acceptable levels (refer to Section 6)</p> | <p>Minor short term construction impacts</p> |
| <p>b) Any transformation of a locality?</p> <p>Temporary transformations comprise of:</p> <ul style="list-style-type: none"> • Construction and operation of a site compound • General construction works <p>After the completion of the works, permanent transformations comprise of:</p> <ul style="list-style-type: none"> • New road infrastructure | <p>Minor short term negative impact</p> <p>Positive long term impacts with regards to road safety and travel time improvements</p> |
| <p>c) Any environmental impact on the ecosystems of the locality?</p> <p>The proposal would not result in a significant impact on any EECs or threatened species, or the local ecosystems of the area. Effective implementation of the mitigation measures determined in Section 6 would ensure all environmental impacts associated with the proposal are not likely to be significant.</p> | <p>Minor long term negative impact</p> |
| <p>d) Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?</p> <p>It is not likely that the scientific quality of the locality would be significantly affected by the proposal. The character of the general area would largely be the same post construction and no significant visual impact from external viewpoints is expected. No reduction in the quality of the environment associated with noise, water, soil and air quality or significant decreases in biodiversity are likely to occur due to the design of the works methodology and the mitigation measures provided in Section 6 of this REF</p> | <p>Minor negative short-term. Positive long-term impacts with regards to the improving road safety.</p> |
| <p>e) Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations?</p> <p>The proposal is located at the intersection of the Princes Highway and Island Point road; known sites and object of value have been avoided by the proposed works so it would not have significant impact.</p> | <p>Potential for minor negative short-term.</p> |
| <p>f) Any impact on the habitat of protected fauna (within the meaning of the <i>National Parks and Wildlife Act 1974</i>)?</p> <p>Potential impacts on native fauna would be minor. With effective implementation of the safeguards provided in Section 6 of this REF, the proposal is not considered likely to have a significant negative impact on the habitat of any protected fauna.</p> | <p>Potential Minor negative short-term.</p> |

| Factor | Impact |
|--|--|
| <p>g) Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air?</p> <p>With effective implementation of the safeguards provided in Section 6, the proposal is not considered likely to impact any species of animal, plant or other form of life.</p> | <p>Potential Minor negative short-term.</p> |
| <p>h) Any long-term effects on the environment?</p> <p>No significant negative long-term environmental impacts are considered likely with effective implementation of the proposed mitigation measures in Section 6 of this REF</p> | <p>Nil</p> |
| <p>i) Any degradation of the quality of the environment?</p> <p>No significant degradation of the quality of the environment is expected with effective implementation of the safeguards in Section 6 of this REF.</p> | <p>Minor negative short-term. Positive long-term impacts with regards road safety.</p> |
| <p>j) Any risk to the safety of the environment?</p> <p>The proposal is unlikely to pose any significant risk to the safety of the environmental attributes outlined in Section 6. Any possible impacts would be minimised with the implementation of the safeguards in Section 6 of this REF.</p> | <p>Minor negative short-term. Positive long-term impacts with regards road safety</p> |
| <p>k) Any reduction in the range of beneficial uses of the environment?</p> <p>The proposal is not likely to result in any reduction in the range of beneficial uses of the environment.</p> | <p>Nil.</p> |
| <p>l) Any pollution of the environment?</p> <p>Waste materials, fuel spills and sediment have the potential to cause pollution to the environment. However, given the proposed safeguards detailed in Section 6 of this REF and the nature and methodology proposed for the works, pollution to the environment is unlikely to occur</p> | <p>Potential Minor negative short-term.. Safeguards available to reduce the risk of pollution.</p> |
| <p>m) Any environmental problems associated with the disposal of waste?</p> <p>All waste generated by the proposal would be disposed of in a manner which would not damage or disturb any native flora or fauna or the physical environment. During operation, waste generation is expected to be minimal and consistent with the current use</p> | <p>Potential minor negative</p> |
| <p>n) Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply?</p> <p>The proposal does not create any demand for resources that are in short supply nor is it likely to result in an increased demand on any natural resources that are likely to become in short supply. Roads and Maritime would attempt to draw supplies and resources from established suppliers having appropriate environmental approvals and standards.</p> | <p>Nil.</p> |
| <p>o) Any cumulative environmental effect with other existing or likely future activities?</p> <p>The proposal is unlikely to significantly contribute to any cumulative impacts</p> | <p>Nil.</p> |

| Factor | Impact |
|--|--------|
| p) Any impact on coastal processes and coastal hazards, including those under projected climate change conditions? None, as the proposal is located outside of coastal areas. | Nil. |

Matters of National Environmental Significance and Commonwealth land

Under the environmental assessment provisions of the EPBC 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 and Energy.

A referral is not required for proposed actions that may affect nationally listed threatened species, 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.

| Factor | Impact |
|---|--------|
| a) Any impact on a World Heritage property? | Nil |
| b) Any impact on a National Heritage place? | Nil |
| c) Any impact on a wetland of international importance? | Nil |
| d) Any impact on a listed threatened species or communities? | Nil |
| e) Any impacts on listed migratory species? | Nil |
| f) Any impact on a Commonwealth marine area? | Nil |
| g) Does the proposal involve a nuclear action (including uranium mining)? | Nil |
| h) Additionally, any impact (direct or indirect) on the environment of Commonwealth land? | Nil |

Appendix B

Statutory consultation checklists

Infrastructure SEPP

Certain development types

| Development type | Description | Yes / No | If 'yes' consult with | ISEPP clause |
|--|--|----------|-----------------------|---------------|
| Car Park | Does the project include a car park intended for the use by commuters using regular bus services? | No | | ISEPP cl. 95A |
| Bus Depots | Does the project propose a bus depot? | No | | ISEPP cl. 95A |
| Permanent road maintenance depot and associated infrastructure | Does the project propose a permanent road maintenance depot or associated infrastructure such as garages, sheds, tool houses, storage yards, training facilities and workers' amenities? | No | | ISEPP cl. 95A |

Development within the Coastal Zone

| Issue | Description | Yes / No / NA | If 'yes' consult with | ISEPP clause |
|--|--|---------------|-----------------------|---------------|
| Development with impacts on certain land within the coastal zone | Is the proposal within a coastal vulnerability area and is inconsistent with a certified coastal management program applying to that land? | No | | ISEPP cl. 15A |

Council related infrastructure or services

| Issue | Potential impact | Yes / No | If 'yes' consult with | ISEPP clause |
|-----------------|---|----------|-----------------------|-------------------|
| Stormwater | Are the works likely to have a <i>substantial</i> impact on the stormwater management services which are provided by council? | No | | ISEPP cl.13(1)(a) |
| Traffic | Are the works likely to generate traffic to an extent that will <i>strain</i> the capacity of the existing road system in a local government area? | Yes | Shoalhaven Council | ISEPP cl.13(1)(b) |
| Sewerage system | Will the works involve connection to a council owned sewerage system? If so, will this connection have a <i>substantial</i> impact on the capacity of any part of the system? | No | | ISEPP cl.13(1)(c) |
| Water usage | Will the works involve connection to a council owned water supply system? If so, will this require the use of a <i>substantial</i> volume of water? | No | | ISEPP cl.13(1)(d) |

| Issue | Potential impact | Yes / No | If 'yes' consult with | ISEPP clause |
|----------------------------|--|----------|-----------------------|-------------------|
| Temporary structures | 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 <i>minor</i> or <i>inconsequential</i> disruption to pedestrian or vehicular flow? | No | | ISEPP cl.13(1)(e) |
| Road & footpath excavation | Will the works involve more than <i>minor</i> or <i>inconsequential</i> excavation of a road or adjacent footpath for which council is the roads authority and responsible for maintenance? | No | | ISEPP cl.13(1)(f) |

Local heritage items

| Issue | Potential impact | Yes / No | If 'yes' consult with | ISEPP clause |
|----------------|---|----------|-----------------------|--------------|
| Local heritage | Is there is a local heritage item (that is not also a State heritage item) or a heritage conservation area in the study area for the works? | No | | ISEPP cl.14 |

Flood liable land

| Issue | Potential impact | Yes / No | If 'yes' consult with | ISEPP clause |
|-------------------|---|----------|-----------------------|---------------|
| Flood liable land | Are the works located on flood liable land? If so, will the works change flood patterns to more than a <i>minor</i> extent? | No | | ISEPP cl.15 |
| Flood liable land | Are the works located on flood liable land? (to any extent). If so, do the works comprise more than minor alterations or additions to, or the demolition of, a building, emergency works or routine maintenance | No | | ISEPP cl.15AA |

Note: Flood liable land means land that is susceptible to flooding by the probable maximum flood event, identified in accordance with the principles set out in the manual entitled *Floodplain Development Manual: the management of flood liable land* published by the New South Wales Government.

Public authorities other than councils

| Issue | Potential impact | Yes / No | If 'yes' consult with | ISEPP clause |
|-----------------------------|--|----------|-----------------------|-------------------|
| National parks and reserves | Are the works adjacent to a national park or nature reserve, or other area reserved under the <i>National Parks and Wildlife Act</i> | No | | ISEPP cl.16(2)(a) |

| Issue | Potential impact | Yes / No | If 'yes' consult with | ISEPP clause |
|------------------------------------|---|----------|-----------------------|--------------------|
| | 1974, or on land acquired under that Act? | | | |
| National parks and reserves | Are the works on land in Zone E1 National Parks and Nature Reserves or in a land use zone equivalent to that zone? | No | | ISEPP cl. 16(2)(b) |
| Aquatic reserves | Are the works adjacent to an aquatic reserve or a marine park declared under the <i>Marine Estate Management Act 2014</i> ? | No | | ISEPP cl.16(2)(c) |
| Sydney Harbour foreshore | Are the works in the Sydney Harbour Foreshore Area as defined by the <i>Sydney Harbour Foreshore Authority Act 1998</i> ? | No | | ISEPP cl.16(2)(d) |
| Bush fire prone land | 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? | No | | ISEPP cl.16(2)(f) |
| Artificial light | Would the works increase the amount of artificial light in the night sky and that is on land within the dark sky region as identified on the dark sky region map? (Note: the dark sky region is within 200 kilometres of the Siding Spring Observatory) | No | | ISEPP cl.16(2)(g) |
| Defence communications buffer land | Are the works on buffer land around the defence communications facility near Morundah? (Note: refer to Defence Communications Facility Buffer Map referred to in clause 5.15 of Lockhardt LEP 2012, Narrandera LEP 2013 and Urana LEP 2011. | No | | ISEPP cl. 16(2)(h) |
| Mine subsidence land | Are the works on land in a mine subsidence district within the meaning of the <i>Mine Subsidence Compensation Act 1961</i> ? | No | | ISEPP cl. 16(2)(i) |

Growth Centres SEPP

| Issue | Potential impact | Yes / No | If 'yes' consult with | ISEPP clause |
|----------------------------|---|----------|-----------------------|--------------|
| Clearing native vegetation | Do the works involve clearing native vegetation (as defined in the <i>Local Land Services Act 2013</i>) on land that is not subject land (as defined in cl 17 of schedule 7 of the <i>Threatened Species Conservation Act 1995</i>)? | No | | |

Appendix C

Biodiversity Assessment Report

Island Point Road Roundabout Installation Biodiversity Assessment

August 2019



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Island Point Road Roundabout Installation Biodiversity Assessment

August 2019

Prepared by Cardno (NSW/ACT) Pty Ltd

| Document status | Date | Prepared by | Reviewed by |
|-----------------|------------|---------------------------|---------------|
| Draft 1 | 09/07/2019 | Bo Davidson | Kevin Roberts |
| Draft 2 | 23/07/2019 | Bo Davidson | Cassy Baxter |
| Draft 3 | 20/08/2019 | Bo Davidson | Cassy Baxter |
| Final | 26/08/2019 | Bo Davidson/ Andrew Smith | Cassy Baxter |

Executive summary

This Biodiversity Assessment (BA) was conducted as part of a Review of Environmental Factors (REF) for the proposed upgrade of the Princes Highway/Island Point Road intersection at Tomerong (The proposal). The proposal construction footprint would be located within the existing Princes Highway and Island Point Road road reserves and Roads and Maritime Services (Roads and Maritime) lands in lot 8 DP 855413. The construction footprint would also include the widening of an existing track for site access and maintenance purposes. A compound site to support site offices and vehicle laydown would be located within private lands in lot 25 DP 792969. A wider area of accessible lands was also assessed, referred to as the construction footprint study area and compound site study area, respectively.

Surveys consisted of meander and plot based flora surveys and general and targeted fauna surveys. For species where surveys could not be conducted during appropriate conditions or seasons or where an appropriate level of survey (in line with relevant state and federal guidelines) was not conducted, the species have been assumed present and assessments of significance conducted to consider all impacts.

Survey identified the native vegetation of the study area consisted of two Plant Community Types (PCTs).

- Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (PCT 1206)
- Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (PCT 694).

PCT 1206 was identified as comprising two distinct zones due to observable differences in vegetation maturity and disturbance history. The compound study area also contained cleared exotic grasslands. Neither of the above PCTs are known to be associated with Threatened Ecological Communities (TECs) listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The construction footprint study area contained several important habitat features comprising seven habitat trees, a small waterbody, an ephemeral creek line and two large stormwater culverts providing potential roosting resources for threatened structure-roosting microbats. The native vegetation communities present also provided foraging, roosting and refuge habitat for native fauna.

The following threatened species were detected during surveys.

- Biconvex Paperbark (*Melaleuca biconvexa*) – listed as vulnerable under the BC Act and EPBC Act
- Magenta Lilly Pilly (*Syzygium paniculatum*) – listed as endangered under the BC Act and vulnerable under the EPBC Act
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) – listed as vulnerable under the BC Act
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) – listed as vulnerable under the BC Act
- Eastern Freetail Bat (*Mormopterus norfolkensis*) – listed as vulnerable under the BC Act.

A population of about 284 Biconvex Paperbark were detected within the construction footprint, located predominantly within and next to the ephemeral creek line. Two Magenta Lilly Pilly were detected within the east of the construction footprint. The three threatened microbat species were detected from analysis of the Anabat Express data.

The following additional threatened species were considered likely to occur within the study area.

- Barking Owl (*Ninox connivens*) – listed as vulnerable under the BC Act
- Gang Gang Cockatoo (*Callocephalon fimbriatum*) – listed as vulnerable under the BC Act
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) – listed as vulnerable under the BC Act
- Greater Glider (*Petauroides volans*) – listed as vulnerable under the EPBC Act
- Green and Golden Bell Frog (*Litoria aurea*) – listed as endangered under the BC Act and vulnerable under the EPBC Act
- Eastern Pygmy Possum (*Cercartetus nanus*) – listed as vulnerable under the BC Act
- Little Lorikeet (*Glossopsitta pusilla*) – listed as vulnerable under the BC Act
- Masked Owl (*Tyto novaehollandiae*) – listed as vulnerable under the BC Act
- Powerful Owl (*Ninox strenua*) – listed as vulnerable under the BC Act
- Sooty Owl (*Tyto tenebricosa*) – listed as vulnerable under the BC Act
- Spotted-tailed Quoll (*Dasyurus maculatus*) – listed as vulnerable under the BC Act and endangered under the EPBC Act
- Yellow-bellied Glider (*Petaurus australis*) – listed as vulnerable under the BC Act
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*) – listed as vulnerable under the BC Act.

The proposal would result in the removal of portions of both native PCTs from the construction footprint. This would also require the removal of a portion of the Biconvex Paperbark population. Neither Magenta Lilly Pilly individual would be removed. The compound site would not require the removal of PCT 1206 woody vegetation with access through this vegetation occurring within cleared lands dominated by native grasses. The portion of the compound site for structures and vehicle laydown is dominated by exotic grasslands. No high value threatened fauna habitat would be removed by the proposal, with all identified habitat-bearing trees, large culverts and the small waterbody to be retained.

Five-part tests and assessments of significance under the BC Act and/or EPBC Act concluded there would not be a significant impact on the above species as a result of the proposal. The proposal would not result in the local (within the study area) extinction of the two threatened flora species recorded or remove high value fauna habitat features. The proposal would not result in the fragmentation or isolation of any area of native vegetation or threatened species habitat. Based on the results of these tests, further assessment through a SIS is not considered necessary.

The construction footprint would largely be located within less mature native vegetation abutting the existing road network. Use of the compound site would not require the removal of woody vegetation and impact to associated native grasslands would be limited to passive materials storage. The construction of hardstands and clearing of vegetation would be located within portions of this area dominated by exotic grasslands.

The proposal will implement standard mitigation measures in accordance with the Roads and Maritime biodiversity management guidelines. Key mitigation measures to be enacted for the proposal comprise.

- Timing of work to avoid large forest owl breeding and microbat torpor periods (autumn/winter)
- Avoid entry into potential microbat roost structures. Erect exclusion fencing
- Include flora and fauna management measures within the Construction Environment Management plan to manage the ecological values present in the study area.

Based on this assessment, the proposal would not trigger the requirement for the development of a Biodiversity Offset Strategy (BOS).

Contents

| | |
|---|------------|
| Executive summary | 5 |
| Contents | 8 |
| 1 Introduction | 11 |
| 1.1 Background | 11 |
| 1.2 The proposal..... | 13 |
| 1.3 Legislative context | 16 |
| 2 Methods | 17 |
| 2.1 Personnel | 17 |
| 2.2 Background research | 17 |
| 2.3 Habitat assessment | 19 |
| 2.4 Field survey | 19 |
| 2.5 Limitations | 37 |
| 3 Existing environment | 38 |
| 3.1 Plant community types | 39 |
| 3.2 Threatened ecological communities | 49 |
| 3.3 Groundwater dependent ecosystems..... | 49 |
| 3.5 Threatened species and populations..... | 57 |
| 3.6 Critical habitat (where applicable) | 65 |
| 3.7 Wildlife connectivity corridors | 65 |
| 3.8 SEPPs (where applicable)..... | 65 |
| 3.9 Matters of National Environmental Significance | 65 |
| 4 Impact assessment | 68 |
| 4.1 Construction impacts | 68 |
| 4.2 Indirect/operational impacts..... | 72 |
| 4.3 Cumulative impacts | 82 |
| 4.4 Assessments of significance | 83 |
| 4.5 Impact summary | 86 |
| 5 Avoid, minimise and mitigate impacts | 93 |
| 5.1 Avoidance and minimisation..... | 93 |
| 5.2 Mitigation measures | 95 |
| 6 Offset strategy | 100 |
| 6.1 Quantification of impacts | 100 |
| 7 Conclusion | 103 |
| 8 References | 106 |
| Appendix A – Species recorded | 109 |
| Appendix B – Habitat assessment table | 113 |
| Appendix C – Five-part tests and assessments of significance (BC Act and EPBC Act) | 146 |

Glossary of terms

Definitions

| | |
|---------------------------------|--|
| Cumulative impact | The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Refer to Clause 228(2) of the EP&A Regulation 2000 for cumulative impact assessment requirements. |
| Direct impact | Where a primary action is a substantial cause of a secondary event or circumstance which has an impact on a protected matter (ref http://www.environment.gov.au/system/files/resources/0b0cfb1e-6e28-4b23-9a97-fdadda0f111c/files/environment-assessment-manual.pdf). |
| Habitat | An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic component (DPIE 2014). |
| Indirect impact | Where an event or circumstance is a direct consequence of the action (ref http://www.environment.gov.au/system/files/resources/0b0cfb1e-6e28-4b23-9a97-fdadda0f111c/files/environment-assessment-manual.pdf). |
| Matters of NES | A matter of national environmental significance (NES) protected by a provision of Part 3 of the EPBC Act |
| Mitchell landscape | Landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1:250,000 (DPIE 2014). |
| Mitigation | Action to reduce the severity of an impact. (DPIE 2014). |
| Mitigation measure | Any measure that facilitates the safe movement of wildlife and/or prevents wildlife mortality. |
| Population | All the individuals that interbreed within a given area. |
| proposal Area/ proposal Area | The area of land that is directly impacted on by a proposed Major proposal that is under the EP&A Act, including access roads, and areas used to store construction materials (DPIE 2014). |
| study area | The area directly affected by the development and any additional areas likely to be affected by the development, either directly or indirectly (DPIE 2014). |
| Target species | A species that is the focus of a study or intended beneficiary of a conservation action or connectivity measure. |

Abbreviations

| | |
|----------|--|
| BBCC | BioBanking Credit Calculator |
| BC Act | Biodiversity Conservation Act 2016 |
| BVT | Biometric Vegetation Type |
| CEMP | Construction Environmental Management Plan |
| DP&E | Department of Planning and Environment |
| DPI | Department of Primary Industries |
| DPIE | Department of Planning, Industry and Environment |
| EEC | Endangered ecological community |
| EIS | Environmental Impact Statement |
| EPBC Act | Environmental Protection and Biodiversity Conservation Act 1999 (Federal). |
| FBA | Framework for Biodiversity Assessment |
| FM Act | Fisheries Management Act 1994 (NSW) |
| GDE | Groundwater dependent ecosystems |
| IBRA | Interim Biogeographically Regionalisation of Australia |
| MNES | Matters of National Environmental Significance |
| DPIE | Office of Environment and Heritage |
| PCT | Plant Community Type |

| | |
|---------|---|
| REF | Review of Environmental Factors |
| SEARs | Secretary's Environmental Assessment Requirements |
| SEPP | State Environmental Planning Policy |
| TECs | Threatened Ecological Communities |
| TSC Act | Threatened Species Conservation Act 1995 (NSW). |
| TSPD | Threatened Species Profile Database |
| VIS | Vegetation information system |

1 Introduction

1.1 Background

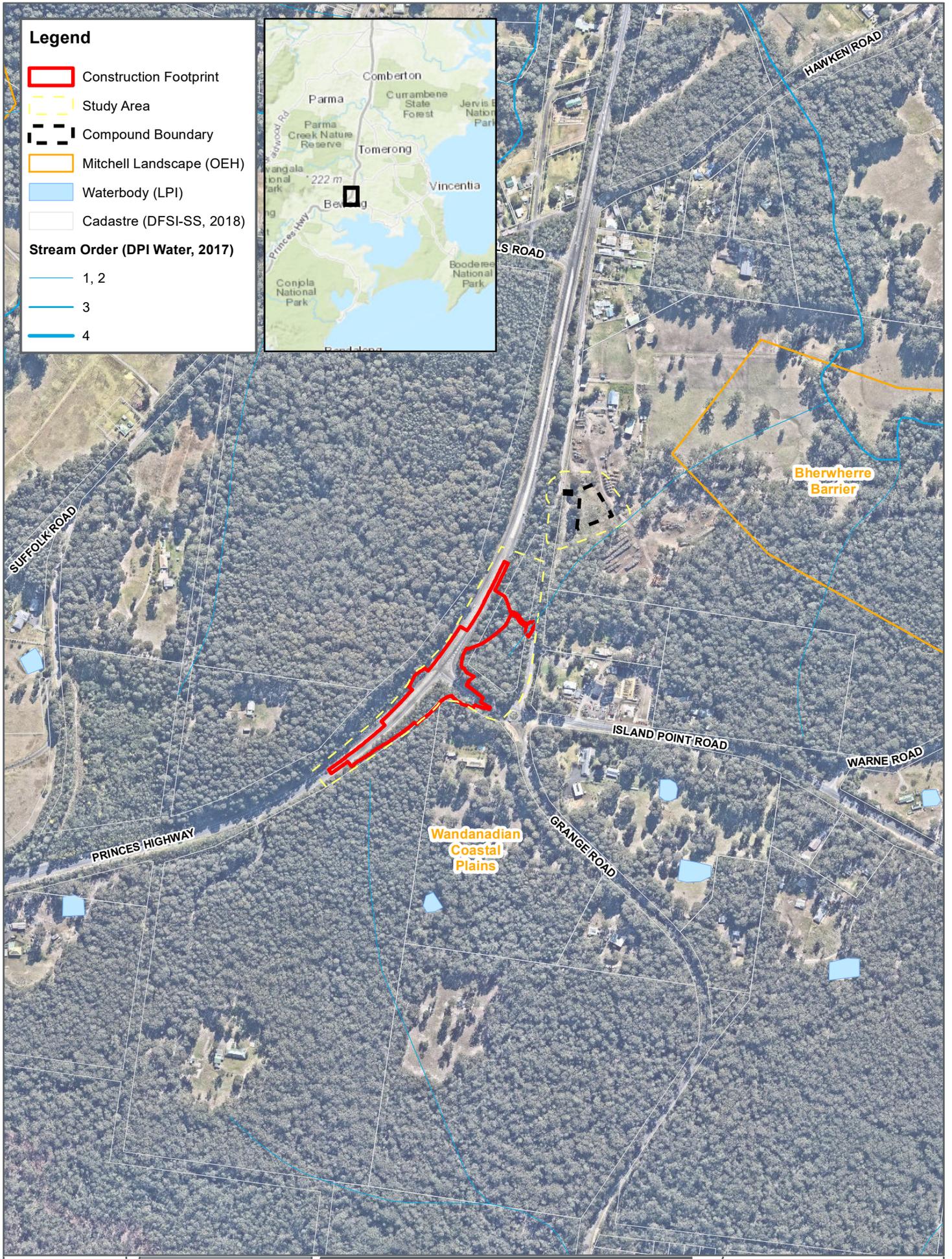
Roads and Maritime Services NSW (Roads and Maritime) proposes to construct a roundabout at the intersection of the Princes Highway and Island Point Road, Tomerong, within the Shoalhaven City Council Local Government Area (LGA) (the proposal). This section of the Princes Highway is the main route connecting Nowra in the north to southern coast towns such as Ulladulla and Batemans Bay. Island Point Road provides access to St Georges Basin, Sanctuary Point and surrounding villages. It is also one of two main access routes to HMAS Creswell, a Navy Base located in the Jervis Bay Territory, at the southern extent of Jervis Bay.

The existing intersection is an unsignalised, seagull T-junction with north and southbound through lanes on the Princes Highway, and raised concrete medians and triangular islands. A southbound overtaking lane starts about 100m south of the intersection. The posted speed limit is 80km/h in the southbound direction and 100km/h in the northbound direction on Princes Highway, and 80km/h on Island Point Road. There is a small, single lane roundabout at the intersection of Island Point Road and Grange Road, about 120m east of Princes Highway.

The proposal is funded under the NSW Government's Safer Roads Program, a key initiative of the NSW Road Safety Strategy, which aims to make NSW roads safer and reduce crashes on the road network. This program provides treatments where there are clusters of casualty crashes on local and regional roads. At the intersection of Princes Highway and Island Point Road, between 1 July 2011 and 30 September 2016, there were 36 recorded crashes resulting in 45 casualties, including 11 serious injury crashes.

In addition to the road safety benefits, traffic modelling has shown that a roundabout will provide a higher level of intersection performance, reduced queue lengths and improved traffic efficiency.

Refer to **Figure 1.1** below for the regional context of the proposal.



Legend

- Construction Footprint
- Study Area
- Compound Boundary
- Mitchell Landscape (OEH)
- Waterbody (LPI)
- Cadastre (DFSIS-SS, 2018)

Stream Order (DPI Water, 2017)

- 1, 2
- 3
- 4

FIGURE 1.1
 1:8,000 Scale at A4

m

0 50 100 150

Site Locality
 ISLAND POINT ROAD ROUNDABOUT



1.2 The proposal

The proposal would upgrade the existing T-junction at the Princes Highway/Island Point Road intersection into a new roundabout. This would require the upgrade of about 380 m of the Princes Highway and 95 m of Island Point Road to support the new infrastructure.

Key features of the proposal would include:

- Two southbound lanes entering and exiting the roundabout on Princes Highway
- Two lanes entering the roundabout from Island Point Road
- One northbound lane entering the roundabout and one northbound slip lane on Princes Highway
- Relocation of the existing street lights at the intersection
- A cyclist crossing point for crossing Princes Highway on southern side of roundabout.

The objectives of the proposal include:

- Improve road safety and reduce the occurrence of crashes at the intersection of Princes Highway and Island Point Road, targeting the dominant crash types that have been recorded at the intersection (primary objective)
- Improve traffic efficiency and intersection performance (secondary objective).

Before the development of the proposal a range of treatment options were considered. These options were developed through an extensive investigation and review of the intersection. This investigation included research into previous upgrade works to the intersection, crash history data, a Road Safety Audit of the existing road, community consultation, traffic modelling and an options assessment.

Once treatment options had been identified they were assessed by comparing safety Benefit to Coast Ratio (BCR) values, expected traffic efficiency outcomes, and estimated project costs. Potential treatment options that would increase the existing road safety risk or would introduce new road safety risks were eliminated from further consideration. Each remaining option was given a ranking to determine the preferred treatment for implementation. The following treatment options were investigated during the concept stage:

1. Install a roundabout
 - a. With a free flowing northbound lane
 - b. With the northbound lane passing through the roundabout.
2. Traffic signals on the existing intersection arrangement
3. Reconfigure the intersection to a channelised right turn (CHR) arrangement
 - a. With a realigned left turn lane into Island Point Road
 - b. With the left turn into Island Point Road removed and a new access provided at Grange Road
 - c. With the right turn out of Island Point Road banned and a turn-around facility located to the south
 - d. With the right turn out of Island Point Road banned and relocated to a new location.
4. Grade separated interchange
5. Do nothing – no change to existing arrangement:

Option 1 was identified as the most suitable with a BCR of 2.2. Option 1 would treat the severity and incidence of crash types that are prevalent in the past five years, reducing the number of conflict points between traffic travelling in different directions. It is in line with the Safe Systems approach to road safety, as a crash resulting from driver error would occur at

low speeds. In addition, cyclists would be accounted for with a sheltered staged crossing to Island Point Road. Traffic modelling ranked this as the most efficient option with a high level of service (LOS) until 2047. This option would meet both project objectives of improving road safety and improving traffic efficiency.

The proposal area is comprised of two components, the construction footprint and the compound site. The construction footprint would be entirely located within the Princes Highway and Island Point Road road reserves and Roads and Maritime-owned lands in lot 8 DP 855413. This would be predominantly located on the eastern side of the Princes Highway; however, a small incursion into the western road reserve will be required to support the northbound slip lane. The compound site would be located on private land to the north-east of the construction footprint in lot 25 DP 792969.

Native woody vegetation is present within the construction footprint, predominantly within the eastern road reserve and lot 8 DP 855413. The proposal will require the clearing of portions of this vegetation for the construction of the two southbound lanes and for the two lanes entering the new roundabout from Island Point Road. The compound site contains a mixture of native woody vegetation, native grasslands and exotic grasslands. Use of the compound site would not require the removal of native woody vegetation. Storage of equipment and vehicle access would occur within areas of native grassland. However, erection of structures and vehicle laydown areas would be contained within exotic grasslands and would be temporary structures only, not requiring earthworks.

The proposal is anticipated to begin in November 2019 with an approximate completion date expected in mid-2020. Work would be undertaken during working hours detailed below:

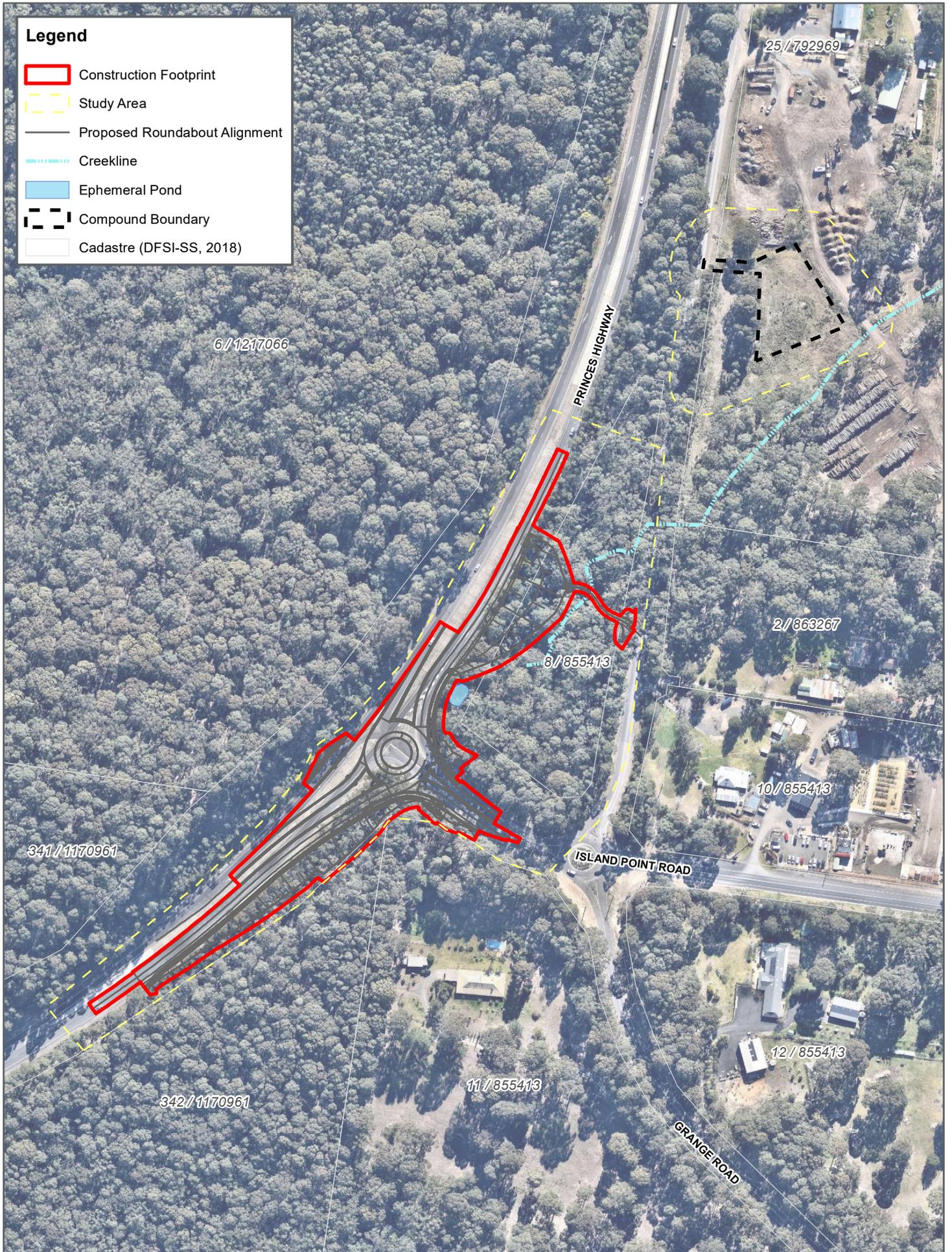
- Monday – Friday: 8:00am to 6:00pm
- Saturday: 8:00am to 5:00pm
- Sunday and Public Holidays: No work

Night work will be required throughout multiple stages of the project to reduce disruptions to traffic, reduce disruptions to residents and to ensure the safety of workers. Night work will take place during the hours detailed below:

- Sunday – Friday: 7:00pm to 5:00am
- Saturday and Public Holidays: No work

As part of the assessment of the proposal area, a larger area was investigated to adequately consider the potential ecological impacts of the proposal. This area is referred to in this report collectively as the study area and as the construction footprint study area and compound study area, respectively for the two separate assessment areas.

An overview of the proposal is provided in Error! Reference source not found.. This figure shows the proposed extent of works and the extent of the study area.



Legend

- Construction Footprint
- Study Area
- Proposed Roundabout Alignment
- Creekline
- Ephemeral Pond
- Compound Boundary
- Cadastre (DFSI-SS, 2018)

FIGURE 1.2
 1:3,000 Scale at A4

m
 0 20 40 60

Proposed Location
 ISLAND POINT ROAD ROUNDABOUT

1.3 Legislative context

A Review of Environmental Factors (REF) is prepared to satisfy Roads and Maritime duties under s.5.5 of the *Environmental Planning and Assessment Act 1974* (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 that activity” and s.5.5 in making decisions on the likely significance of any environmental impact. This biodiversity impact assessment forms part of the REF being prepared for the Island Point Road Roundabout Installation, and assesses the biodiversity impacts of the proposal to meet the requirements of the EP&A Act.

Under s.5.5 of the EP&A Act, Roads and Maritime must consider the effect of an activity on:

- Any conservation agreement entered into under the *National Parks and Wildlife Act 1974* (NP&W Act)
- Any plan of management adopted under the NP&W Act for the conservation area to which the agreement relates
- Any joint management agreement entered into under the *Threatened Species Conservation Act 1995* (TSC Act)
- Any Biodiversity Stewardship Site Agreement entered into under Part 5.5 of the BC Act
- Any BioBanking agreement entered into under Part 7A of the TSC Act
- Any wilderness area (within the meaning of the *Wilderness Act 1987*) in the locality
- Areas of Outstanding Biodiversity Value (AOBV). Formally critical habitat areas
- Threatened species, populations and ecological communities, and their habitats and whether there is likely to be a significant effect
- Any other protected fauna or protected native plants within the meaning of the NP&W Act.

Sections 7.2A of the BC Act and Part 7A of the *Fisheries Management Act 1994* (FM Act) require the significance of the impact on threatened species, populations and endangered ecological communities listed under the BC Act or FM Act be assessed using a five-part test (under Section 7.3 of the BC Act) or seven-part test (under Section 220ZZ of the FM Act). Where a significant impact is likely to occur, a species impact statement (SIS) must be prepared in accordance with the Director-General’s requirements or a Biodiversity Development Assessment Report (BDAR) must be prepared by an accredited assessor in accordance with the Biodiversity Assessment Method (BAM).

In September 2015, a “strategic assessment” approval was granted by the Federal Minister in accordance with the EPBC Act. The approval applies to Roads and Maritime activities being assessed under Part 5 of the EP&A Act with respect to potential impact on nationally listed threatened species, ecological communities and migratory species.

As a result, Roads and Maritime proposals assessed via an REF:

- Must address and consider potential impact on nationally listed threatened species, populations, ecological communities and migratory species, including application of the “avoid, minimise, mitigate and offset” hierarchy
- Do not require referral to the Federal Department of the Environment for these matters, even if the activity is likely to have a significant impact.

Roads and Maritime must consider impacts to nationally listed threatened species, ecological communities and migratory species as part of the approval process under the strategic assessment. To help with this, assessments are required in accordance with the Matters of National Environmental Significance: Significant impact guidelines 1.1. Environment Protection and Biodiversity Conservation Act 1999 (DoE 2013).

2 Methods

2.1 Personnel

This Biodiversity Assessment was conducted by Bo Davidson, terrestrial ecologist with Cardno NSW/ACT Pty Ltd (Cardno). Bo has a BSc of Environmental Science (2009) and M Environment (2013) and six years consulting experience. He has conducted ecological assessments throughout the greater Sydney region as well as in the Hunter, New England and South Coast regions.

Bo has experience in conducting native flora and fauna surveys, fauna habitat and ecological community identification and quantification and targeted threatened flora and fauna surveys using a range of active and passive techniques as well as experience as a terrestrial and freshwater aquatic spotter-catcher. Bo has successfully completed the NSW Biodiversity Assessment Method (BAM) Accredited Assessor training and is currently in the process of gaining formal accreditation.

2.2 Background research

Background research was conducted for the study area and (where relevant), a wider 10 km locality (Study locality). Details of the applicable databases searched as part of background research are provided in **Table 2.1** below.

Table 2.1: Details of database search

| Database | Date accessed | Search area (km) | URL |
|--|---------------|------------------|---|
| NSW Department of Planning, Industry and Environment (DPIE, formally Office of Environment and Heritage (DPIE)) South Coast - Illawarra Vegetation Integration (SCIVI) mapping | 01 May 2019 | 10 | https://datasets.seed.nsw.gov.au/dataset/southeast-nsw-native-vegetation-classification-and-mapping-scivi-vis_id-223006f8a |
| NSW DPIE BioNet database | 01 May 2019 | 10 | https://www.environment.nsw.gov.au/atlaspublicapp/UI/Modules/ATLAS/AtlasSearch.aspx |
| NSW DPIE Threatened Species Profile Database | 01 May 2019 | N/A | https://www.environment.nsw.gov.au/threatenedSpeciesApp/ |

| Database | Date accessed | Search area (km) | URL |
|---|---------------|------------------|---|
| NSW Department of Primary Industries (DPI) Fisheries Spatial Data Portal - Fish Freshwater Threatened Species | 01 May 2019 | 10 | https://webmap.industry.nsw.gov.au/Html5Viewer/index.html?viewer=Fisheries_Data_Portal |
| Federal Department of Environment and Energy (DoEE) Protected Matters Search Tool (PMST) | 01 May 2019 | 10 | http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf |
| NSW DPIE Critical Habitat Register | 01 May 2019 | N/A | https://www.environment.nsw.gov.au/criticalhabitat/criticalhabitatprotectionbydoctype.htm |
| Federal DoEE Register of Critical Habitat | 01 May 2019 | N/A | http://www.environment.gov.au/cgi-bin/sprat/public/publicregisterofcriticalhabitat.pl |
| NSW DPIE Vegetation Information System (VIS) database | 01 May 2019 | N/A | https://www.environment.nsw.gov.au/NSWVCA20PRapp/LoginPR.aspx |
| NSW DPIE Vegetation Types Database | 01 May 2019 | N/A | https://www.environment.nsw.gov.au/projects/biometric-dataset.htm |
| Federal Bureau of Meteorology's (BOM) Atlas of Groundwater Dependent Ecosystems (GDE) | 03 May 2019 | 10 | http://www.bom.gov.au/water/groundwater/gde/map.shtml |
| Federal DoEE directory of important wetlands | 01 May 2019 | 10 | http://www.environment.gov.au/cgi-bin/wetlands/search.pl?smode=DOIW |

| Database | Date accessed | Search area (km) | URL |
|---|---------------|------------------|---|
| NSW Department of Planning and Environment (DPE) State Environmental Planning Policy (Coastal Management) 2018 spatial data | 01 May 2019 | 10 | http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=SEPP_CoastalManagement |
| NSW DPI Aquatic Threatened Species and Ecological Communities database | 02 May 2019 | 10 | https://www.dpi.nsw.gov.au/fishing/species-protection/what-current |

2.3 Habitat assessment

A habitat assessment table (**Appendix B**) was completed as part of this assessment. This table contains all threatened species, populations and Threatened Ecological Communities (TECs) known or considered to have potential to occur within the Study locality based on the database search detailed in **Section 2.2** above.

The assessment table was used to identify threatened species, populations and TECs likely to occur within the study area. A threatened species, population or TEC is considered likely to occur where:

- The geographic distribution of the species is known or predicted to include the IBRA subregion in which the development site is located
- The development site contains habitat features or components associated with the species
- Past surveys undertaken at the development site indicate the species is present.

This habitat assessment was used to inform the requirements of the field survey.

2.4 Field survey

The field survey was conducted by Bo Davidson on 06 and 07 May 2019. **Table 2.2** below details the weather conditions during the survey period.

Table 2.2: Weather conditions during survey period

| Field Survey Date | Temperature (°C) | Rainfall (mm) | Sunrise / Sunset | Moonrise / Moonset |
|-------------------|------------------|---------------|------------------|--------------------|
| 06 May 2019 | 9.1 - 19.6 | 0.2 | 06:37 - 17:10 | 07:30 - 18:16 |
| 07 May 2019 | 6.4 - 21.7 | 0.0 | 06:38 - 17:09 | 08:33 - 19:00 |

Sources: Nowra RAN Air Station AWS (Australian Bureau of Meteorology, 2019), Timeanddate.com (Time and Date AS 1995-2019, 2019a), (Time and Date AS 1995-2019, 2019b)

2.4.1 Vegetation surveys

Flora surveys consisted of two techniques, a random meander and the survey of three vegetation floristic and structural plots. The number of survey plots was informed by vegetation mapping resources consulted during background research (see **Section 2.2** above) as well as initial site appraisal. The study area was divided into three vegetation zones for the purposes of vegetation assessment. The size of each vegetation zone and the number of plots conducted in each zone (as per Table 3 of the FBA (NSW OEH, 2014)) is detailed in **Table 2.3** below.

Table 2.3: Plots conducted for vegetation zones

| Vegetation zone | Area (ha) | Number of plots conducted |
|-----------------|-----------|---------------------------|
| Z1 | 1.93 | 1 |
| Z2 | 0.78 | 1 |
| Z3 | 0.72 | 1 |
| Z4 | 0.48 | 0 |

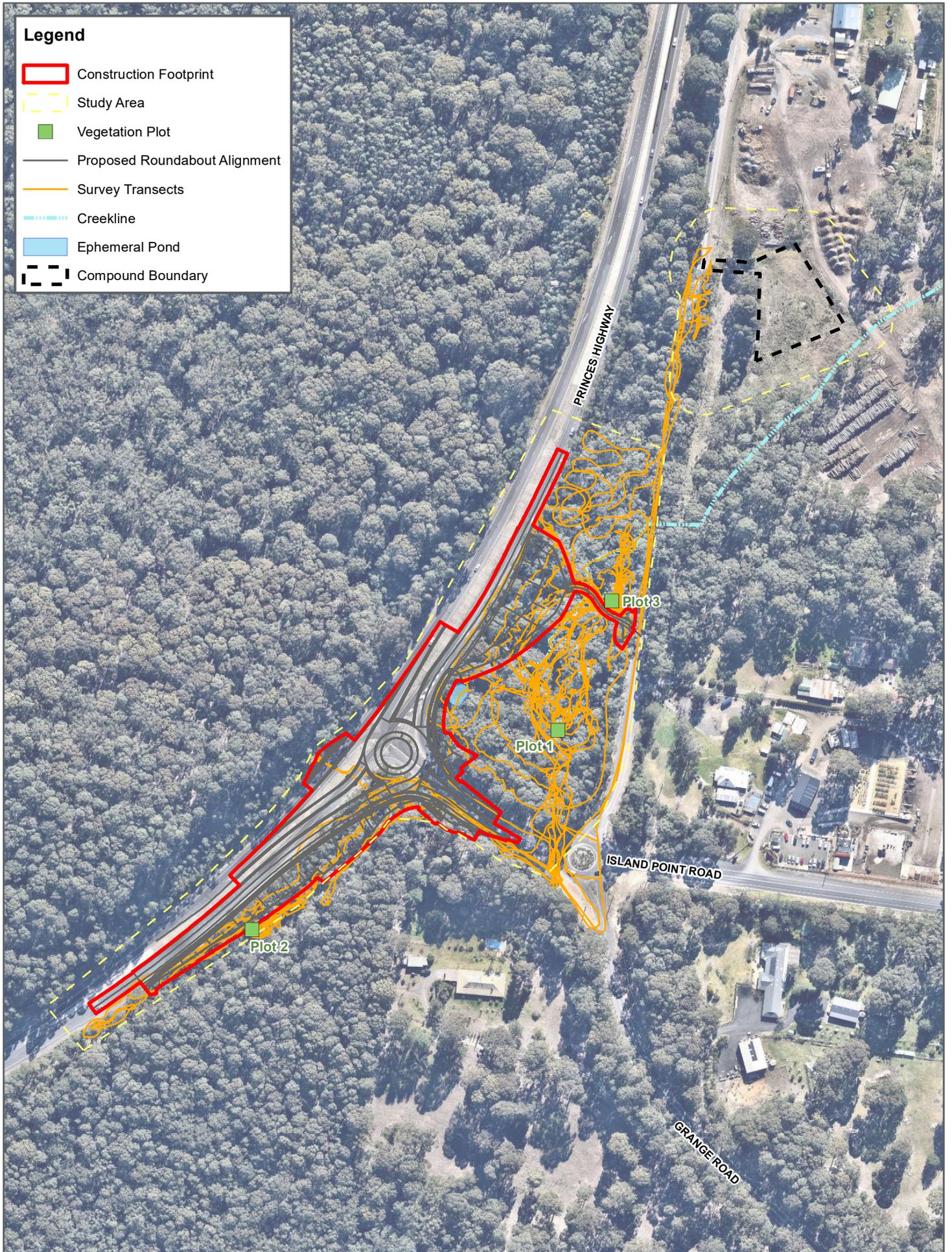
Note. Zone 4 could not be accessed during the site survey period as this zone was located on private property. Consequently, plot survey was not conducted in this zone

The vegetation plot survey consisted of a standard 20 x 20 m floristic and 20 x 50 m structural vegetation plot. The survey was conducted in line with the vegetation assessment plot requirements in Section 5.3.4 of the Biodiversity Assessment Method (BAM). This methodology consists of a complete census of vascular plant species within the 20 x 20 m floristic plot, the abundance and approximate cover (percentage of total plot area) for each species. Data collected from the 20 x 50 m structural plot comprised tree stem size classes and abundance, number of hollow-bearing trees and leaf litter cover percentage (assessed as the average of the cover in five regularly spaced 1 x 1 m sub-plots).

Plot locations were selected based on the review of available vegetation mapping and site assessment of differences in community distribution and condition. Options for the placement of the 400 m² plots within the identified vegetation zones and avoiding edge areas, ecotones, internal disturbances (tracks within lot 8 DP 855413) etc were limited by the small size of the study areas and nearby roads and private property boundaries.

Final plot locations were selected to represent the conditions present within the three identified native vegetation zones and avoiding influence by internal and external disturbed areas, where possible. This methodology is in line with Section 5.3.4.6 of the BAM, which states “plots should not be located in or near ecotones, vehicle tracks and their edges, or other disturbed areas that are readily distinguishable from the broad condition state of the vegetation zone”.

Figure 2.1 below shows the location of the three vegetation plots and random meander survey transect route within the study area.



Legend

- Construction Footprint
- Study Area
- Vegetation Plot
- Proposed Roundabout Alignment
- Survey Transects
- Creekline
- Ephemeral Pond
- Compound Boundary

FIGURE 2.1

1:3,000 Scale at A4



Vegetation Survey Locations

ISLAND POINT ROAD ROUNDABOUT

2.4.2 Targeted flora surveys

Before the start of fieldwork, a list of threatened flora species considered to have potential to occur within the study area was developed, based on the results of the background research (see **Section 2.2**). Criteria used to develop this list of species was based on the number and currency of occurrence records (DPIE BioNet) in the study locality and known habitat preferences, geographical limitations and life history of the species (from the DPIE threatened species profile database). This assessment was documented in a habitat assessment table (**Appendix B**), any species considered to have a moderate or high likelihood of occurrence was identified for the targeted threatened flora survey.

The weather conditions during survey are documented above in **Table 2.1**. Conditions were sunny and mild throughout the survey period.

Threatened flora surveys consisted of floristic plot and random meander surveys throughout the entire study area. The survey methodology and effort followed Section 5.2 of the NSW Department of Environment and Conservation (DEC), now DPIE Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).

As shown in **Table 2.1** above, one vegetation assessment plot was conducted in each identified vegetation zone, with the exception of zone 4 which could not be accessed during fieldwork. Assessment of this zone was conducted visually from the nearest road reserve access and through review of high resolution aerial imagery (Nearmap) and available vegetation mapping resources.

With reference to Table 5.2 of the draft survey guidelines, a minimum of one vegetation plot per stratification unit of <2 hectares is recommended. For the purposes of threatened flora survey, the identified vegetation zones are considered to be equivalent to stratification survey units.

Random meander surveys were conducted throughout the study area over both survey days, both as dedicated surveys and during movement between survey points for plot flora surveys and targeted threatened fauna surveys. Random meander surveys were designed to cover the entire study area at an adequate density (<5 m) between meander lines through the use of a handheld GPS unit (see **Figure 2.1**). Areas of likely threatened flora occurrence (creek lines, track edges etc) were surveyed in greater detail and on multiple occasions during the survey period.

2.4.3 Targeted fauna surveys

Before the start of fieldwork, a list of threatened fauna species considered to have potential to occur within the study area was developed, based on the results of the background research (see **Section 2.2**). Criteria used to develop this list of species was based on the number and currency of occurrence records (DPIE BioNet) in the Study locality and known habitat preferences, geographical limitations and life history of the species (from the DPIE threatened species profile database). This assessment was documented in a species assessment table, any species considered to have a moderate or high likelihood of occurrence was identified for the targeted threatened flora survey.

The weather conditions during survey are documented above in **Table 2.1**. Conditions were sunny and mild throughout the survey period.

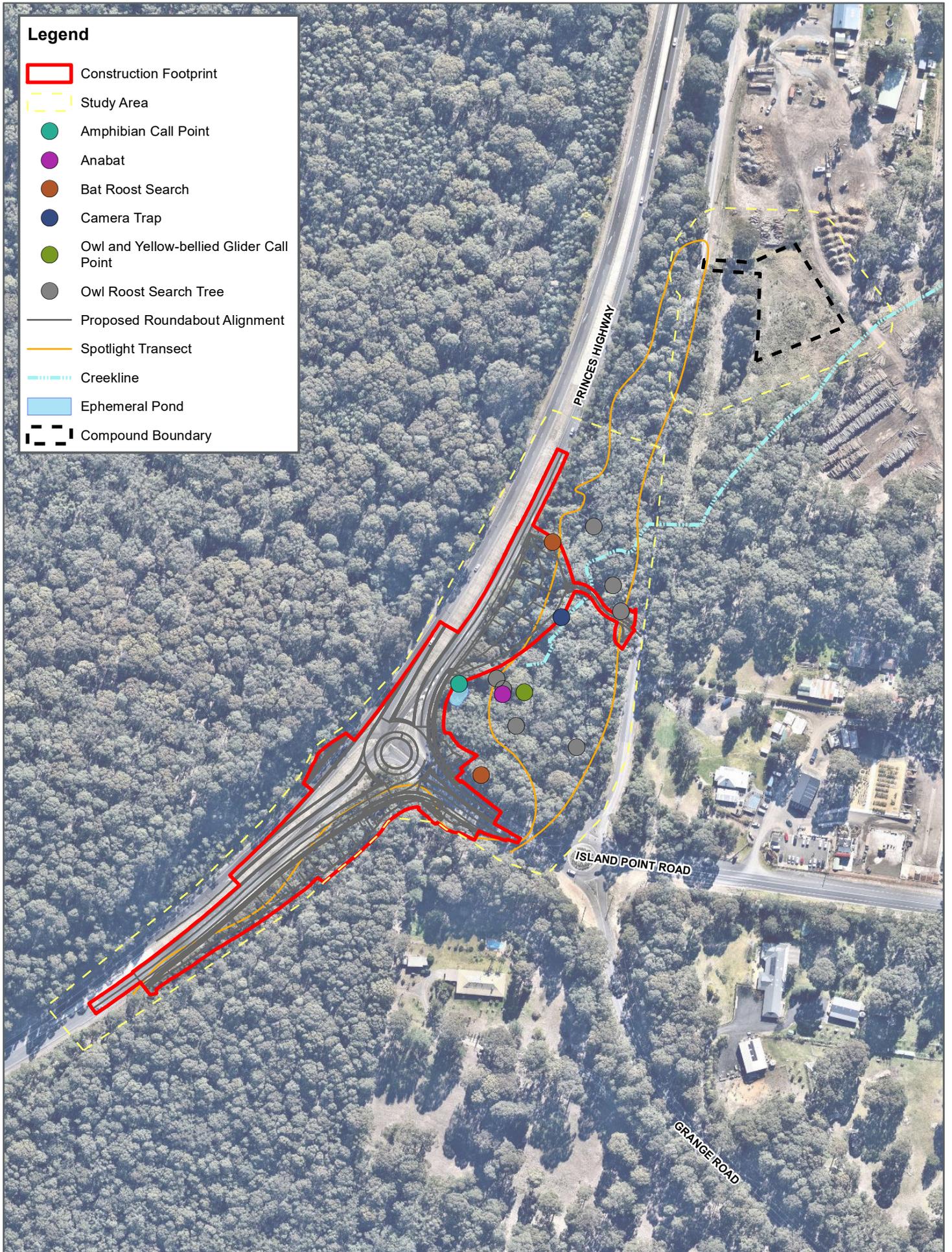
Table 2.4 below details the survey method groups and the survey techniques employed for the identified threatened fauna species.

Table 2.4. Threatened fauna species survey groups and survey methods employed

| Survey method group | Survey methods employed |
|-------------------------|--|
| Amphibians and reptiles | Diurnal and nocturnal habitat searches, call playback |
| Diurnal birds | Area surveys, opportunistic recordings |
| Microbats | Diurnal potential roost search, echolocation detector (Anabat Express) |
| Nocturnal birds | Spotlighting, call playback |
| Nocturnal mammals | Spotlighting, call playback, baited remote camera |

Targeted survey design for these threatened fauna survey method groups was based on relevant state and federal survey guidelines and, where present specific survey guidelines. These requirements and survey effort conducted for all species identified as requiring targeted surveys are detailed in **Section 2.4.5** below.

Figure 2.2 below shows the location of threatened fauna survey locations and transects (where applicable).



Legend

- Construction Footprint
- Study Area
- Amphibian Call Point
- Anabat
- Bat Roost Search
- Camera Trap
- Owl and Yellow-bellied Glider Call Point
- Owl Roost Search Tree
- Proposed Roundabout Alignment
- Spotlight Transect
- Creekline
- Ephemeral Pond
- Compound Boundary

FIGURE 2.2
 1:3,000 Scale at A4

m
 0 20 40 60

Threatened Species Survey

ISLAND POINT ROAD ROUNDABOUT



2.4.4 Aquatic Surveys

The study area was assessed as containing a single ephemeral creek line (a tributary of Suffolk Creek, located about 300 m to the north-east of the study area) and small waterbody. The creek line is mapped as a Class 3 waterway on sheet WCL_014E of the Shoalhaven City Council Local Environmental Plan 2014 (SLEP 2014) Riparian Lands and Watercourses Map Series (Shoalhaven City Council, 2014) and as a 1st order waterway under the Strahler stream classification system (NSW Department of Primary Industries (Water), 2017). Due to this classification a detailed aquatic fauna survey was not required. However, an assessment of the stream's habitat sensitivity and classification for fish passage was undertaken as per the NSW DPI (Fisheries) Policy and Guidelines for fish habitat conservation and management (2013 update) (NSW Department of Primary Industries (Fisheries), 2013).

A Riparian, Channel and Environmental (RCE) assessment was undertaken by Cardno during the site inspection. This assessment involves evaluation and scoring of the characteristics of the nearby land, the condition of riverbanks, channel and bed of the watercourse, and degree of disturbance evident at each site. The maximum score (52) indicates a stream with little or no obvious physical disruption and the lowest score (13) a heavily channelled stream without any riparian vegetation. The stream was also classified for key fish habitat sensitivity and fish passage as per table 1 and table 2 of the NSW DPI Policy and guidelines for fish habitat conservation and management (NSW DPI, 2013). This assigns a waterway to one of three habitat sensitivity classes and one of four fish passage classes depending on waterway characteristics including nature of flow (permanent, intermittent), permanence of standing water, channel definition, in-stream habitat and aquatic vegetation etc.

No standing water within the creek line and insufficient standing water within the small waterbody was present to conduct water quality testing during the site survey period. **Figure 2.2** above shows the location of the creek line and waterbody within the study area. The RCE assessment was conducted throughout the creek line.

2.4.5 Summary of survey effort

Table 2.5 below summarises the survey effort conducted for all threatened flora and fauna species identified as requiring targeted surveys during the background research. This table details the survey areas relevance to the proposal Area, minimum survey requirements as per relevant survey guidelines, the survey methods employed and the justification for these methods, survey effort and a discussion of survey limitations.

Table 2.5 Targeted threatened species survey details

| Species | Targeted survey area relevance to proposal Area | Minimum survey requirements | Survey completed | Survey limitations |
|---|---|---|---|---|
| Threatened flora | | | | |
| Biconvex Paperbark (<i>Melaleuca biconvexa</i>) | Random meander survey for this species included entire projected impact footprint | <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>NSW Guide to Surveying Threatened Plants (NSW Office of Environment and Heritage, 2016)</p> <p>2004 guidelines: One vegetation plot for each stratification unit < 2ha in size.</p> <p>2016 guidelines: Transect surveys with a spacing of 5 m for 2.67 person hours for each 2 hectare area of suitable habitat.</p> <p>Survey period: All year</p> | <p>Three vegetation plots conducted within three stratification units of <2ha. Random meander survey covering entire study area with a spacing of less than 5 m between all meander transects.</p> <p>Random meander method was selected as the study area was relatively small (3.6 hectare of suitable habitat) and could be easily covered in adequate density within the survey period.</p> <p>Three person hours were dedicated to vegetation plot surveys and a total of 6 person hours were dedicated to random meander flora surveys during the survey period.</p> | No seasonal limitations for this species. Survey time and effort adequate for detection |
| Magenta Lilly Pilly (<i>Syzygium paniculatum</i>) | Random meander survey for this species included entire projected impact footprint | <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>NSW Guide to Surveying Threatened Plants (NSW Office of Environment and Heritage, 2016)</p> <p>2004 guidelines: One vegetation plot for each stratification unit < 2ha in size.</p> | <p>Three vegetation plots conducted within three stratification units of <2ha. Random meander survey covering entire study area with a spacing of less than 5 m between all meander transects.</p> <p>Random meander method was selected as the study area was relatively small (3.6 hectare of suitable habitat) and could be</p> | No seasonal limitations for this species. Survey time and effort adequate for detection |

| Species | Targeted survey area relevance to proposal Area | Minimum survey requirements | Survey completed | Survey limitations |
|--|--|---|---|--|
| | | <p>2016 guidelines: Transect surveys with a spacing of 5 m for 2.67 person hours for each 2 hectare area of suitable habitat.</p> <p>Survey period: All year</p> | <p>easily covered in adequate density within the survey period.</p> <p>Three person hours were dedicated to vegetation plot surveys and a total of 6 person hours were dedicated to random meander flora surveys during the survey period.</p> | |
| <p>Scrub Turpentine (<i>Rhodamnia rubescens</i>)</p> | <p>Random meander survey for this species included entire projected impact footprint</p> | <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>NSW Guide to Surveying Threatened Plants (NSW Office of Environment and Heritage, 2016)</p> <p>2004 guidelines: One vegetation plot for each stratification unit < 2ha in size.</p> <p>2016 guidelines: Transect surveys with a spacing of 5 m for 2.67 person hours for each 2 hectare area of suitable habitat.</p> <p>Survey period: All year</p> | <p>Three vegetation plots conducted within three stratification units of <2ha. Random meander survey covering entire study area with a spacing of less than 5 m between all meander transects.</p> <p>Random meander method was selected as the study area was relatively small (3.6 hectare of suitable habitat) and could be easily covered in adequate density within the survey period.</p> <p>Three person hours were dedicated to vegetation plot surveys and a total of 6 person hours were dedicated to random meander flora surveys during the survey period.</p> | <p>No seasonal limitations for this species. Survey time and effort adequate for detection</p> |
| Threatened fauna | | | | |
| <p>Barking Owl (<i>Ninox connivens</i>)</p> | <p>Spotlight surveys conducted</p> | <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> | <p>Diurnal habitat search under all large and hollow-bearing trees for pellets and whitewash.</p> | <p>No evidence of regular site usage by owls during diurnal habitat searches.</p> |

| Species | Targeted survey area relevance to proposal Area | Minimum survey requirements | Survey completed | Survey limitations |
|---|---|--|--|--|
| | within projected impact footprint. Call playback surveys conducted within forest adjacent to projected impact footprint | <p>Habitat search under large hollow-bearing trees for pellets and whitewash.</p> <p>One call playback and spotlight point per 800 m to 1 km. Call playback to be preceded by 10 minutes' passive listening and 10 minutes of spotlighting followed by 5 minutes of continuous call broadcast, followed by a further 10 minutes of listening and spotlighting. Call playback to be repeated for a minimum of 5 nights under calm conditions.</p> <p>Survey period (breeding): May – December</p> | Call playback (15 Watt portable speaker) and spotlight surveys conducted at one point (study area length about 630 m) following the 2004 draft survey guidelines for two nights under calm conditions during an appropriate season. | Due to lack of observed signs of site use for breeding activity, reduced call playback and spotlight survey effort considered justified. |
| Eastern Bentwing-bat (<i>Miniopterus schreibersii oceanensis</i>) | Diurnal roost search of potential bat roost in stormwater tunnel adjacent to projected impact footprint. Anabat Express unit deployed within likely flyway adjacent to projected impact footprint | <p>Survey guidelines for Australia's threatened bats. Guidelines for detecting bats listed as threatened under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth of Australia, 2010).</p> <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>Commonwealth guidelines: 1 device deployed for 30-60 minutes or all night over 4 - 5 nights.</p> <p>NSW guidelines: 1 device deployed for a minimum of 4 hours over 2 nights per stratification unit (up to 100 ha).</p> <p>Survey period (breeding): December – February</p> | <p>Diurnal roost search of large stormwater culvert under Princes Highway for signs of microbat presence (roosting bats, guano, carcasses etc)</p> <p>One Anabat Express unit deployed for an entire night and for four hours on the following night with a clearing adjacent to the creek line within the study area. Call data analysed by Dr Anna McConville (ECHO Ecology and Surveying)</p> | <p>Survey conducted outside of breeding period. Unable to determine if potential roost site is used as a maternity roost.</p> <p>Anabat Express unit deployed for 2 nights. Adequate against the NSW guidelines.</p> |
| Eastern False Pipistrelle (<i>Falsistrellus tasmaniensis</i>) | Anabat Express unit deployed within likely flyway adjacent | Survey guidelines for Australia's threatened bats. Guidelines for detecting bats listed as threatened under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth of Australia, 2010). | One Anabat Express unit deployed for an entire night and for four hours on the following night with a clearing adjacent to | Anabat Express unit deployed for 2 nights. Adequate against the NSW guidelines. |

| Species | Targeted survey area relevance to proposal Area | Minimum survey requirements | Survey completed | Survey limitations |
|--|--|---|--|---|
| | to projected impact footprint | <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>Commonwealth guidelines: 1 device deployed for 30-60 minutes or all night over 4 - 5 nights.</p> <p>NSW guidelines: 1 device deployed for a minimum of 4 hours over 2 nights per stratification unit (up to 100 ha).</p> <p>Survey period (breeding): All year</p> | the creek line within the study area. Call data analysed by Dr Anna McConville (ECHO Ecology and Surveying) | |
| Eastern Freetail-bat (<i>Mormopterus norfolkensis</i>) | Anabat Express unit deployed within likely flyway adjacent to projected impact footprint | <p>Survey guidelines for Australia’s threatened bats. Guidelines for detecting bats listed as threatened under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth of Australia, 2010).</p> <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>Commonwealth guidelines: 1 device deployed for 30-60 minutes or all night over 4 - 5 nights.</p> <p>NSW guidelines: 1 device deployed for a minimum of 4 hours over 2 nights per stratification unit (up to 100 ha).</p> <p>Survey period (breeding): All year</p> | One Anabat Express unit deployed for an entire night and for four hours on the following night with a clearing adjacent to the creek line within the study area. Call data analysed by Dr Anna McConville (ECHO Ecology and Surveying) | Anabat Express unit deployed for 2 nights. Adequate against the NSW guidelines. |
| Eastern Pygmy-possum (<i>Cercartetus nanus</i>) | Spotlight surveys conducted | Survey guidelines for Australia’s threatened mammals. Guidelines for detecting mammals listed as threatened under | 1 1 km transect from the south to the north of the study area along the west boundary and returning | Survey outside of survey period for this species. |

| Species | Targeted survey area relevance to proposal Area | Minimum survey requirements | Survey completed | Survey limitations |
|--|--|---|---|---|
| | within projected impact footprint | <p>the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth of Australia, 2011)</p> <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>Commonwealth guidelines: 2 200 m transects per 5 hectare site over two separate nights. Using a 50 or 75-watt spotlight)</p> <p>NSW guidelines: Spotlighting on foot, 2 x 1 hour transects of up to 1km per stratification unit (up to 50 ha). Using a 100-watt spotlight.</p> <p>Survey period: October – March</p> | <p>north to south along the eastern boundary.</p> <p>Surveyed for one hour on two nights with a 100-watt spotlight.</p> | Adequate spotlight survey conducted for the size of the study area |
| Gang-gang Cockatoo (<i>Callocephalon fimbriatum</i>) | Diurnal point surveys conducted adjacent to projected impact footprint. Incidental observations included entire projected impact footprint | <p>Survey Guidelines for Australia’s Threatened Birds. Guidelines for detecting birds listed as threatened under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth of Australia, 2010)</p> <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>Commonwealth guidelines: 10 - 20-minute area searches for survey areas of 1-3 ha.</p> <p>NSW guidelines: 20-minute area search for survey areas of 1 ha</p> <p>Survey period (breeding): December – January</p> | <p>Two 20-minute area searches on both survey days in two portions of the study area of about 2 hectares and 0.6 hectare respectively.</p> <p>Opportunistic recording of all diurnal birds conducted during all diurnal works</p> | <p>Adequate level of survey conducted during an appropriate season for the detection of this species.</p> <p>Survey not conducted during an appropriate season for breeding behaviour</p> |

| Species | Targeted survey area relevance to proposal Area | Minimum survey requirements | Survey completed | Survey limitations |
|---|--|--|--|---|
| Greater Broad-nosed Bat (<i>Scoteanax rueppellii</i>) | Anabat Express unit deployed within likely flyway adjacent to projected impact footprint | <p>Survey guidelines for Australia's threatened bats. Guidelines for detecting bats listed as threatened under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth of Australia, 2010).</p> <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>Commonwealth guidelines: 1 device deployed for 30-60 minutes or all night over 4 - 5 nights.</p> <p>NSW guidelines: 1 device deployed for a minimum of 4 hours over 2 nights per stratification unit (up to 100 ha).</p> <p>Survey period (breeding): All year</p> | One Anabat Express unit deployed for an entire night and for four hours on the following night with a clearing adjacent to the creek line within the study area. Call data analysed by Dr Anna McConville (ECHO Ecology and Surveying) | Anabat Express unit deployed for 2 nights. Adequate against the NSW guidelines. |
| Greater Glider (<i>Petauroides volans</i>) | Spotlight surveys conducted within projected impact footprint | <p>Survey guidelines for Australia's threatened mammals. Guidelines for detecting mammals listed as threatened under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth of Australia, 2011)</p> <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>Commonwealth guidelines: 2 200 m transects per 5 hectare site over two separate nights. Using a 50 or 75-watt spotlight)</p> <p>NSW guidelines: Spotlighting on foot, 2 x 1 hour transects of up to 1km per stratification unit (up to 50 ha). Using a 100-watt spotlight.</p> | <p>1 1 km transect from the south to the north of the study area along the west boundary and returning north to south along the eastern boundary.</p> <p>Surveyed for one hour on two nights with a 100-watt spotlight.</p> | Adequate spotlight survey conducted for the size of the study area. |

| Species | Targeted survey area relevance to proposal Area | Minimum survey requirements | Survey completed | Survey limitations |
|---|--|--|--|--|
| Green and Golden Bell Frog (<i>Litoria aurea</i>) | Habitat search and call playback surveys conducted within small waterbody adjacent to projected impact footprint | <p>Survey period: All year</p> <p>EPBC Act Species Profile and Threats (SPRAT) database survey guidelines (Commonwealth of Australia, 2019)</p> <p>NSW National Parks and Wildlife Service (NPWS) Environmental Impact Assessment Guidelines. Green and Golden Bell Frog <i>Litoria aurea</i> (Lesson 1829) (NSW National Parks and Wildlife Service, 2003)</p> <p>Commonwealth guidelines: 1-hour survey for wetlands less than 50 m in length. Survey to include a mixture of diurnal habitat searches, nocturnal spotlight habitat searches, call detection and tadpole searches. Surveys conducted during September – March in warm calm conditions following rainfall. Minimum of four survey events</p> <p>NSW guidelines: 1-hour survey for wetlands less than 0.3 ha. Survey to include a mixture of diurnal habitat searches, nocturnal spotlight habitat searches, call detection and tadpole searches. Surveys conducted during species' activity period in warm calm conditions following rainfall. Minimum of three survey events</p> <p>Survey period: November to March</p> | One hour mixed diurnal and nocturnal area search and tadpole search of small waterbody on two days/nights. Call playback conducted on both nights, preceded by 10 minutes passive listening followed by 5 minutes of call broadcast followed by 10 minutes of passive listening. | <p>Surveys not conducted during species survey period. Minimum survey replicates (3) not conducted.</p> <p>Survey period not preceded by significant rainfall. Conditions not optimal for high amphibian activity.</p> <p>As survey period was outside of species survey period, survey for three nights not considered likely to increase likelihood of detection</p> |
| Little Lorikeet (<i>Glossopsitta pusilla</i>) | Diurnal point surveys conducted adjacent to projected impact footprint. Incidental observations included entire | <p>Survey Guidelines for Australia's Threatened Birds. Guidelines for detecting birds listed as threatened under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth of Australia, 2010)</p> <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> | One 20-minute area search on both survey days in two portions of the study area of about 2 hectares and 0.6 hectare respectively. | Adequate level of survey conducted during an appropriate season for the detection of this species. |

| Species | Targeted survey area relevance to proposal Area | Minimum survey requirements | Survey completed | Survey limitations |
|--|---|---|--|--|
| | projected impact footprint | <p>Commonwealth guidelines: 10 - 20 minute area searches for survey areas of 1-3 ha.</p> <p>NSW guidelines: 20-minute area search for survey areas of 1 ha</p> <p>Survey period (breeding): All year</p> | Opportunistic recording of all diurnal birds conducted during all diurnal works | |
| Masked Owl (<i>Tyto novaehollandiae</i>) | Spotlight surveys conducted within projected impact footprint. Call playback surveys conducted within forest adjacent to projected impact footprint | <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>Habitat search under large hollow-bearing trees for pellets and whitewash.</p> <p>One call playback and spotlight point per 800 m to 1 km. Call playback to be preceded by 10 minutes' passive listening and 10 minutes of spotlighting followed by 5 minutes of continuous call broadcast, followed by a further 10 minutes of listening and spotlighting. Call playback to be repeated for a minimum of 8 nights under calm conditions.</p> <p>Survey period (breeding): May – August</p> | <p>Diurnal habitat search under all large and hollow-bearing trees for pellets and whitewash.</p> <p>Call playback (15 Watt portable speaker) and spotlight surveys conducted at one point (study area length about 630 m) following the 2004 draft survey guidelines for two nights under calm conditions during an appropriate season.</p> | <p>No evidence of regular site usage by owls during diurnal habitat searches.</p> <p>Due to lack of observed sign of site use for breeding activity, reduced call playback and spotlight survey effort considered justified.</p> |
| Powerful Owl (<i>Ninox strenua</i>) | Spotlight surveys conducted within projected impact footprint. Call playback surveys conducted within forest | <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>Habitat search under large hollow-bearing trees for pellets and whitewash.</p> <p>One call playback and spotlight point per 800 m to 1 km. Call playback to be preceded by 10 minutes' passive listening and</p> | <p>Diurnal habitat search under all large and hollow-bearing trees for pellets and whitewash.</p> <p>Call playback (15 Watt portable speaker) and spotlight surveys conducted at one point (study area length about 630 m) following the 2004 draft survey</p> | <p>No evidence of regular site usage by owls during diurnal habitat searches.</p> <p>Due to lack of observed sign of site use for breeding activity, reduced call playback and</p> |

| Species | Targeted survey area relevance to proposal Area | Minimum survey requirements | Survey completed | Survey limitations |
|--|---|--|---|--|
| | adjacent to projected impact footprint | 10 minutes of spotlighting followed by 5 minutes of continuous call broadcast, followed by a further 10 minutes of listening and spotlighting. Call playback to be repeated for a minimum of 5 nights under calm conditions. Survey period (breeding): May – August | guidelines for two nights under calm conditions during an appropriate season. | spotlight survey effort considered justified. |
| Sooty Owl (<i>Tyto tenebricosa</i>) | Spotlight surveys conducted within projected impact footprint. Call playback surveys conducted within forest adjacent to projected impact footprint | Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004). Habitat search under large hollow-bearing trees for pellets and whitewash. One call playback and spotlight point per 800 m to 1 km. Call playback to be preceded by 10 minutes' passive listening and 10 minutes of spotlighting followed by 5 minutes of continuous call broadcast, followed by a further 10 minutes of listening and spotlighting. Call playback to be repeated for a minimum of 6 nights under calm conditions. Survey period (breeding): April – August | Diurnal habitat search under all large and hollow-bearing trees for pellets and whitewash. Call playback (15 Watt portable speaker) and spotlight surveys conducted at one point (study area length about 630 m) following the 2004 draft survey guidelines for two nights under calm conditions during an appropriate season. | No evidence of regular site usage by owls during diurnal habitat searches. Due to lack of observed sign of site use for breeding activity, reduced call playback and spotlight survey effort considered justified. |
| Spotted-tailed Quoll (<i>Dasyurus maculatus</i>) | Spotlight surveys conducted within projected impact footprint. Remote camera deployed in creek line adjacent to projected impact footprint | Survey guidelines for Australia's threatened mammals. Guidelines for detecting mammals listed as threatened under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth of Australia, 2011) Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004). Commonwealth guidelines: 2 200 m transects per 5 hectare site over two separate nights. Using a 50 or 75-watt | 30-minute search of suitable habitat for signs of species' presence on both survey days. 1 1 km transect from the south to the north of the study area along the west boundary and returning north to south along the eastern boundary. | Adequate spotlight survey conducted for the size of the study area. Remote camera deployment for three weeks not feasible. Due to small size of the study area, survey unlikely to detect resident individuals with reference |

| Species | Targeted survey area relevance to proposal Area | Minimum survey requirements | Survey completed | Survey limitations |
|--|--|--|---|---|
| | | <p>spotlight). Daytime searches for potential denning sites, latrine sites and tracks. Remote camera deployment in areas of suitable habitat for a minimum of three weeks. Due to species' large territory size, survey of small areas (<5 ha) are considered unlikely to detect resident individuals.</p> <p>NSW guidelines: 30-minute search of areas of suitable habitat for signs of denning, scats and tracks. Spot lighting on foot, 2 x 1 hour transects of up to 1km per stratification unit (up to 50 ha). Using a 100-watt spotlight.</p> <p>Survey period: All year</p> | <p>Surveyed for one hour on two nights with a 100-watt spotlight. Baited remote camera deployed for one full night and four hours on the second survey night</p> | <p>to the Commonwealth guidelines</p> |
| <p>Yellow-bellied Glider (<i>Petaurus australis</i>)</p> | <p>Spotlight surveys conducted within projected impact footprint. Call playback surveys conducted within forest adjacent to projected impact footprint</p> | <p>Survey guidelines for Australia's threatened mammals. Guidelines for detecting mammals listed as threatened under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth of Australia, 2011)</p> <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>Commonwealth guidelines: 2 200 m transects per 5 hectare site over two separate nights. Using a 50 or 75-watt spotlight). One call playback point per 1 km. Call playback to be preceded by 10 minutes' passive listening and 10 minutes of spotlighting followed by 5 minutes of continuous call broadcast, followed by a further 10 minutes of listening and spotlighting.</p> <p>NSW guidelines: Spot lighting on foot, 2 x 1 hour transects of up to 1km per stratification unit (up to 50 ha). Using a 100-watt spotlight. 2 call playback points per stratification unit up to 200 ha. Call playback to be preceded by 10 minutes'</p> | <p>1 1 km transect from the south to the north of the study area along the west boundary and returning north to south along the eastern boundary.</p> <p>Surveyed for one hour on two nights with a 100-watt spotlight. Call playback (15 Watt portable speaker) and spotlight surveys conducted at one point (study area length about 630 m) following the 2004 draft survey guidelines for two nights under calm conditions during an appropriate season.</p> | <p>Spotlight and call playback survey considered adequate against NSW survey guidelines</p> |

| Species | Targeted survey area relevance to proposal Area | Minimum survey requirements | Survey completed | Survey limitations |
|---|---|---|---|--|
| | | <p>passive listening and 10 minutes of spotlighting followed by 5 minutes of continuous call broadcast, followed by a further 10 minutes of listening and spotlighting. Playback survey to be repeated on a minimum of two nights.</p> <p>Survey period: All year</p> | | |
| <p>Yellow-bellied Sheath-tail-bat (<i>Saccolaimus flaviventris</i>)</p> | <p>Anabat Express unit deployed within likely flyway adjacent to projected impact footprint</p> | <p>Survey guidelines for Australia's threatened bats. Guidelines for detecting bats listed as threatened under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth of Australia, 2010).</p> <p>Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation, 2004).</p> <p>Commonwealth guidelines: 1 device deployed for 30-60 minutes or all night over 4 - 5 nights.</p> <p>NSW guidelines: 1 device deployed for a minimum of 4 hours over 2 nights per stratification unit (up to 100 ha).</p> <p>Survey period (breeding): All year</p> | <p>One Anabat Express unit deployed for an entire night and for four hours on the following night with a clearing adjacent to the creek line within the study area. Call data analysed by Dr Anna McConville (ECHO Ecology and Surveying)</p> | <p>Anabat Express unit deployed for 2 nights. Adequate against the NSW guidelines.</p> |

2.5 Limitations

Survey efficacy is influenced by a range of factors. For this type of survey, such limitations are generally due to a single, short duration survey that does not account for seasonal variation. Given the short period of time spent on site, the detection of certain species may be affected by.

- Seasonal migration (particularly migratory birds)
- Seasonal flowering periods (some species are cryptic and are unlikely to be detected outside of the known flowering period)
- Seasonal availability of food, such as blossoms for some fauna
- Weather conditions during the survey period (some species may go through cycles of activity related to specific weather conditions, for example some microchiropteran bats, reptiles and frogs can be inactive during cold weather)
- Species lifecycle (cycles of activity related to breeding).

These potential limitations have been addressed by applying the precautionary principle in cases where the survey methodology may have given a false negative result (eg a species that could reasonably be expected to occur, based on previous records and available habitat, was not observed). All species have been assessed on the basis of the presence of their habitat and the likely significance of the habitat to a viable local population.

3 Existing environment

The study area is located on the Wandandian Plain with the topography of the study area characterised by flat to gently sloping with an overall north-easterly aspect. The study area is located within the Jervis subregion of the Sydney Basin Interim Biogeographic Regionalisation for Australia (IBRA) bioregion and within the Wandandian Coastal Plains NSW Landscape (formally Mitchell Landscapes). The nearest NPWS estate is the Corramy Regional Park, located about 2 km to the south-west of the study area. The Study locality also contains the Conjola National Park, Jerrawangala National Park, Jervis Bay National Park, Parma Creek Nature Reserve and Woollamia Nature Reserve.

An unnamed tributary of Suffolk Creek has its headwaters in the south-west of the main body of study area, discharging from the north-east under a culvert under Grange Road. This waterway is classified as a 1st order stream under the Strahler Stream Order Method (10 m riparian buffer) and a Class 3 waterway on sheet WCL_014E of the SLEP 2014 Riparian Lands and Watercourses Map Series (Shoalhaven City Council, 2014). A small ephemeral pond is located in the south-west corner of the main body of the study area, presumed to have been constructed as part of the stormwater management infrastructure for the Princes Highway/Island Point Road junction. No important wetlands (mapped under the Directory of Important Wetlands in Australia (DIWA)) are located within the study area. The nearest mapped DIWA wetlands is St Georges Basin, located about 2 km to the south-east. The Study locality also includes the DIWA – listed Currumbene Creek and Moona Moona Creek wetlands.

The study area is located within the Snapper Point Formation, Wandrawandian Siltstone geological landscape. This landscape is described as “fine to medium-grained sandstone, siltstone, wave ripped conglomerate. Fine-grained quartz-lithic silty claystone and siltstone” (GeoAust - Mineral Exploration Magazine NSW, 2008).

The study area is not within or located near to any areas mapped as critical habitat areas under the BC Act. The nearest declared critical habitat area is the Endangered population of Little Penguins at Manly, located about 150 km to the north-east of the study area.

The following sections describe the biodiversity values of the study area.

3.1 Plant community types

Table 3.1 below summarises the PCTs identified in the study area, their condition, legislative status (if relevant) and area present within the proposal area and study area (ha).

Table 3.1 Plant community types within the study area

| Plant community type (PCT) | Condition class | Threatened ecological community? | Area (ha) in construction footprint | Area (ha) in compound site | Area (ha) in total proposal area | Area (ha) in study area |
|---|-----------------|----------------------------------|-------------------------------------|----------------------------|----------------------------------|-------------------------|
| Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (1206) | Moderate/ Good | No | 0.31 | 0.24 | 0.55 | 1.93 |
| | Moderate/ Good | No | 0.55 | 0.00 | 0.55 | 0.78 |
| Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (694) | Moderate/ Good | No | 0.06 | 0.00 | 0.06 | 0.48 |
| Total | | | 0.92 | 0.24 | 1.16 | 3.19 |

The following sections provide detailed descriptions of the PCTs present within the study area. As shown in **Table 3.1** above, one PCT occurred as two separate zones (zone 1 and zone 2) due to observable differences in condition. These are described separately below.

Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion

Vegetation formation: Wet Sclerophyll Forests (Grassy sub-formation)

Vegetation class: Southern Lowland Wet Sclerophyll forests

PCT: 1206

BVT: SR641

Other mapping sources: WSF p104 (Tozer et al, 2006)

Conservation status: Not listed

Estimate of per cent cleared: 0.15

Condition: Moderate/good

Extent in the study area: 1.90 ha

Plots completed in vegetation zone: 1

| Structure | Average height and height range (m)* | Average cover and cover range (%)* | Typical species |
|------------------|--------------------------------------|------------------------------------|---|
| Trees | - | - | <i>Corymbia maculata</i> ; <i>Eucalyptus pilularis</i> ; <i>Eucalyptus paniculata</i> subsp. <i>paniculata</i> ; <i>Corymbia gummifera</i> ; <i>Eucalyptus globoidea</i> |
| Small trees | - | - | <i>Elaeocarpus reticulatus</i> ; <i>Notelaea longifolia</i> ; <i>Personia linearis</i> ; <i>Synoum glandulosum</i> |
| Shrubs | - | - | <i>Breynia oblongifolia</i> ; <i>Leucopogon lanceolatus</i> ; <i>Hibbertia aspera</i> ; <i>Macrozamia communis</i> |
| Ground covers | - | - | <i>Dianella caerulea</i> ; <i>Entolasia stricta</i> ; <i>Lepidosperma urophorum</i> ; <i>Lomandra longifolia</i> ; <i>Pteridium esculentum</i> ; <i>Schelhammera undulata</i> |
| Vines & climbers | - | - | <i>Cissus hypoglauca</i> ; <i>Pandorea pandorana</i> ; <i>Eustrephus latifolius</i> ; <i>Tylophora barbata</i> |

* These data not provided for this PCT in the VIS database

Description: This PCT is described as “Open to tall open forest with a moist shrubby understorey; Landscape Position: Occurs on sheltered slopes with loamy soils below 250m mostly between Nowra and Batemans Bay, and mainly east of the Clyde River” in the NSW VIS database. The occurrence of this PCT within zone 1 of the study area is consistent with this description with a tall open canopy and shrubby understory. The occurrence of this PCT within study area is located at an elevation of about 40 m Above Sea Level (ASL) within flat to gently undulating topography on sandstone/siltstone derive soils of the Snapper Point Formation, Wandrawandian Siltstone geological landscape.

Within the assessment plot in zone 1 of the study area the canopy of this PCT was dominated by Blackbutt (*Eucalyptus pilularis*) Grey Ironbark (*Eucalyptus paniculata* subsp. *paniculata*) and Turpentine (*Syncarpia glomulifera*). The midstory strata was dominated by Lance Beard-heath (*Leucopogon lanceolatus*) Large-leaf Mock-olive (*Notelaea longifolia*) and Two-vein Hickory (*Acacia binervata*). The ground stratum contained Black-fruit Saw-sedge (*Gahnia melanocarpa*), Blue Flax-lily (*Dianella caerulea*) and Maidenhair Fern (*Adiantum aethiopicum*) and the climbers Common Silkpod (*Parsonsia straminea*), Snake Vine (*Hibbertia scandens*) and Small-leaf Glycine (*Glycine microphylla*). Weed density was low, with Sprenger’s Asparagus (*Asparagus aethiopicus*) recorded at low density within the plot.

Identification of this PCT was based on comparison with the plot data collected with the positive diagnostic species list on Page 434 of Tozer et al 2006 for WSF p104 (commensurate

with PCT 1206 in the NSW VIS database). With reference to this resource there is a 95 per cent confidence interval for this vegetation type if at least 22 positive diagnostic species are present within a 0.4 hectare (20 x 20 m) plot provided the total number of species recorded is 34 or greater. Plot data for plot 1 (zone 1) provided in **Appendix A** demonstrates that this confidence level was achieved (23 positive diagnostic species from a total of 39 species recorded).

A portion of this vegetation zone was located within the proposed access route from Grange Road into the compound site and nearby study area. The portion of this vegetation zone within the compound site contained scattered overstory vegetation and open areas dominated by native grasses, predominantly Blady Grass (*Imperata cylindrica*) as well as the climbers Native Sarsaparilla (*Hardenbergia violacea*) and Variable Glycine (*Glycine tabacina*) as well as scattered shrubs including Sydney Golden Wattle (*Acacia longifolia*) and Tickbush (*Kunzea ambigua*). The forest vegetation within the west of the compound study area is considered to form part of the same vegetation community and zone.



Photograph 1: Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion – zone 1

Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion

Vegetation formation: Wet Sclerophyll Forests (Grassy sub-formation)

Vegetation class: Southern Lowland Wet Sclerophyll forests

PCT: 1206

BVT: SR641

Other mapping sources: WSF p104 (Tozer et al, 2006)

Conservation status: Not listed

Estimate of per cent cleared: 0.15

Condition: Moderate/good

Extent in the study area: 0.63 ha

Plots completed in vegetation zone: 1

| Structure | Average height and height range (m)* | Average cover and cover range (%)* | Typical species |
|------------------|--------------------------------------|------------------------------------|---|
| Trees | - | - | <i>Corymbia maculata</i> ; <i>Eucalyptus pilularis</i> ; <i>Eucalyptus paniculata</i> subsp. <i>paniculata</i> ; <i>Corymbia gummifera</i> ; <i>Eucalyptus globoidea</i> |
| Small trees | - | - | <i>Elaeocarpus reticulatus</i> ; <i>Notelaea longifolia</i> ; <i>Personia linearis</i> ; <i>Synoum glandulosum</i> |
| Shrubs | - | - | <i>Breynia oblongifolia</i> ; <i>Leucopogon lanceolatus</i> ; <i>Hibbertia aspera</i> ; <i>Macrozamia communis</i> |
| Ground covers | - | - | <i>Dianella caerulea</i> ; <i>Entolasia stricta</i> ; <i>Lepidosperma urophorum</i> ; <i>Lomandra longifolia</i> ; <i>Pteridium esculentum</i> ; <i>Schelhammera undulata</i> |
| Vines & climbers | - | - | <i>Cissus hypoglauca</i> ; <i>Pandorea pandorana</i> ; <i>Eustrephus latifolius</i> ; <i>Tylophora barbata</i> |

*These data not provided for this PCT in the VIS database

Description: This PCT is described as “Open to tall open forest with a moist shrubby understorey; Landscape Position: Occurs on sheltered slopes with loamy soils below 250m mostly between Nowra and Batemans Bay, and mainly east of the Clyde River” in the NSW VIS database. The occurrence of this PCT within zone 2 of the study area is consistent with this description with a tall open canopy and shrubby understory. However, within this vegetation zone, the PCT shows a greater degree of disturbance than within zone 1, with the canopy dominated by sub-adult trees and a higher density of midstory coloniser species (acacias). The occurrence of this PCT within study area is located at an elevation of about 40 m Above Sea Level (ASL) within flat to gently undulating topography on sandstone/siltstone derive soils of the Snapper Point Formation, Wandrawandian Siltstone geological landscape.

Within the assessment plot in zone 2 of the study area the canopy of this PCT was dominated by Blackbutt (*Eucalyptus pilularis*) and Spotted Gum (*Corymbia maculata*). The midstory strata was dominated by Parramatta Wattle (*Acacia parramattensis*), Prickly-leaved Paperbark (*Melaleuca styphelioides*) and Lance Beard-heath (*Leucopogon lanceolatus*). The ground stratum contained high densities of Australian Basket Grass (*Oplismenus imbecillis*), Long-leaved Wallaby Grass (*Rytidosperma longifolium*) and Kidney Weed (*Dichondra repens*) and the climbers Old Man’s Beard (*Clematis aristata*), Small-leaf Glycine (*Glycine microphylla*) and Variable Glycine (*Glycine tabacina*). Weed density was low, with Sprenger’s Asparagus (*Asparagus aethiopicus*), Milk Thistle (*Sonchus spp.*) and Paddy’s Lucerne (*Sida rhombifolia*) recorded at low density within the plot, mainly along the forest/road reserve interface.

Identification of this PCT was based on comparison with the plot data collected with the positive diagnostic species list on Page 434 of Tozer et al 2006 for WSF p104 (commensurate with PCT 1206 in the NSW VIS database). With reference to this resource there is a 95 per cent confidence interval for this vegetation type if at least 22 positive diagnostic species are present within a 0.4 hectare (20 x 20 m) plot provided the total number of species recorded is 34 or greater. Plot data for plot 1 (zone 1) provided in **Appendix A** demonstrates that this confidence level was not achieved (11 positive diagnostic species from a total of 36 species recorded). However, this is attributable to the disturbed nature of this zone, with the canopy observed to contain diagnostic species and this PCT is consistent with the SCIVI mapping consulted during the background research.

A portion of this zone is located on the western side of the Princes Highway. Within the study area the zone portion is represented by understory species, predominantly Blady Grass as well as scattered exotic species including Fleabane (*Conyza sp.*) and Purpletop.



Photograph 2: Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion – zone 2

Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion

Vegetation formation: Wet Sclerophyll Forests (Shrubby sub-formation)

Vegetation class: North Coast Wet Sclerophyll Forests

PCT: 694

BVT: ME030, SR516

Other mapping sources: WSF p99 (Tozer et al, 2006)

Conservation status: Not listed

Estimate of per cent cleared: 0.5

Condition: Moderate/good

Extent in the study area: 0.67 ha

Plots completed in vegetation zone: 1

| Structure | Average height and height range (m) | Average cover and cover range (%) | Typical species |
|------------------|-------------------------------------|-----------------------------------|---|
| Trees | 26.2 18.8 - 33.6 | 37.3 21.7 - 52.9 | <i>Livistona australis</i> ; <i>Syncarpia glomulifera</i> ; <i>Eucalyptus pilularis</i> ; <i>Eucalyptus paniculata</i> subsp. <i>paniculata</i> ; <i>Eucalyptus botryoides</i> ; <i>Banksia integrifolia</i> ; <i>Angophora costata</i> |
| Small trees | 10.0 4.9 - 15.1 | 29.1 7.6 - 50.6 | <i>Synoum glandulosum</i> ; <i>Notelaea longifolia</i> ; <i>Acmena smithii</i> ; <i>Myrsine variabilis</i> ; <i>Leptospermum laevigatum</i> ; <i>Pittosporum undulatum</i> |
| Shrubs | 2.3 1.7 - 2.9 | 18.1 0.0 - 38.1 | <i>Breynia oblongifolia</i> |
| Ground covers | 1.4 0.6 - 2.4 | 49.9 16.8 - 83.0 | <i>Lomandra longifolia</i> ; <i>Pteridium esculentum</i> ; <i>Dianella caerulea</i> ; <i>Entolasia stricta</i> ; <i>Oplismenus imbecillis</i> ; <i>Imperata cylindrica</i> var. <i>major</i> ; <i>Pseuderanthemum variabile</i> ; <i>Commelina cyanea</i> ; <i>Dichondra repens</i> |
| Vines & climbers | - | - | - |

Description: This PCT is described as "Illawarra Escarpment Bangalay-Banksia Forest represents a structural variant of the tall Illawarra escarpment forests described in regional vegetation classifications covering the Illawarra and southern Sydney area. South from Garie in Royal NP, the coastal escarpment Illawarra Escarpment Blackbutt Forest is a tall coastal eucalypt forest with a moist open understorey found south of Audley in the Hacking River valley. The canopy is dominated by blackbutt (*Eucalyptus pilularis*) and turpentine (*Syncarpia glomulifera*), with grey ironbark (*Eucalyptus paniculata*) occurring less frequently. An open cover of palms and mesic trees and shrubs is typical above a ground cover of ferns, grasses, rushes and climbers. It is restricted to deep red-brown-coloured clay soils derived from the layer of Narrabeen shale that is exposed along the northern Illawarra escarpment and in the Hacking River gorges.

The distribution of the community is strongly associated with high rainfall (areas which receive more than 1200 millimetres of mean annual rainfall), sheltered aspects and elevations less than 200 meters above sea level. South of the study area the community extends along the escarpment foothills and coastal lowlands as far as Batemans Bay. The underlying Narrabeen claystones beneath the Hawkesbury sandstone plateau. The escarpment here is exposed to the open ocean and the full force of the prevailing southerly winds. A stunted sometimes gnarled open forest occurs on these clayey soils. Low-growing bangalay (*Eucalyptus botryoides*) and coast banksia (*Banksia integrifolia*) mix with turpentine (*Syncarpia glomulifera*)

and smooth-barked apple (*Angophora costata*). The latter appears to decrease in frequency as the influence of the sandstone talus from the eroding clifflines diminishes. The understorey retains a moist open shrub and small tree layer that closely resembles the taller forests found along the Hacking River and Illawarra escarpment. This mix of rainforest species is retained by a combination of the fertile soils and very high mean annual rainfall. Most locations are close to the open ocean extending from sea level to the top of the escarpment at elevations around 250 metres above sea level. The community extends southward along the escarpment to Austinmer. The community can be considered to form part of the broader forest community Illawarra Gully Wet Forest." in the NSW VIS database.

The occurrence of this PCT within zone 3 of the study area is consistent with this description with a tall open canopy and shrubby understorey. The occurrence of this PCT within study area is located at an elevation of about 36 m Above Sea Level (ASL) within flat to gently undulating topography on sandstone/siltstone derive soils of the Snapper Point Formation, Wandrawandian Siltstone geological landscape. The occurrence of this PCT within the study area largely follows the banks of the ephemeral creek line, transitioning into PCT 1206 to the north and south.

Within the assessment plot in zone 3 of the study area the canopy of this PCT was dominated by Blackbutt (*Eucalyptus pilularis*), Grey Ironbark (*Eucalyptus paniculata* subsp. *paniculata*) and *Eucalyptus saligna* x *botryoides*. The midstory strata was dominated by Biconvex Paperbark (*Melaleuca biconvexa*) and Pale-fruit Ballart (*Exocarpos strictus*) as well as sub-adult canopy species. The shrub layer was dominated by Coffee Bush (*Breynia oblogifolia*), Lance Beard-heath (*Leucopogon lanceolatus*) and Narrow-leaved Geebung (*Persoonia linearis*). The ground stratum contained high densities of Australian Basket Grass (*Oplismenus imbecillis*), Bordered Panic (*Entolasia marginata*) and Kidney Weed (*Dichondra repens*) and the climbers Common Silkpod (*Parsonsia straminea*), Kangaroo Vine (*Cissus hypoglauca*) and Small-leaf Glycine (*Glycine microphylla*). Weed density was low, with Blackberry (*Rubus fruticosus* agg) and Sprenger's Asparagus (*Asparagus aethiopicus*) recorded at low density within the plot.

Identification of this PCT was based on comparison with the plot data collected with the positive diagnostic species list on Page 417 of Tozer et al 2006 for WSF p99 (commensurate with PCT 694 in the NSW VIS database). With reference to this resource there is a 95 per cent confidence interval for this vegetation type if at least 19 positive diagnostic species are present within a 0.4 hectare (20 x 20 m) plot provided the total number of species recorded is 30 or greater. Plot data for plot 1 (zone 1) provided in **Appendix A** demonstrates that this confidence level was achieved (27 positive diagnostic species from a total of 41 species recorded).



Photograph 3: Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion – zone 3

Exotic Grasslands

Zone 4 comprised exotic grassland within the east of the compound site. As detailed above, this area could not be accessed during the site survey but from visual appraisal from the Grange Road road reserve, zone 4 appeared to be largely dominated by the exotic grass Giant Paspalum (*Paspalum urvillei*). The distinctive tall glume of this species could be observed throughout zone 4. Native species were apparent, largely within the southern portion of this zone, with the ephemeral creek line within zone 4 dominated by a stand of Bracken Fern (*Pteridium esculentum*).

As detailed for zone 1 above, the proposed access route from Grange Road and the eastern portion of the compound study area showed a stronger influence from the nearby PCT 1206 vegetation along Grange Road, being dominated by scattered native trees and areas of native grasslands dominated by native grasses, climbers and scattered shrubs.

See **Photograph 4** below for an example of the condition of this vegetation zone.



Photograph 4: Exotic grassland – zone 4

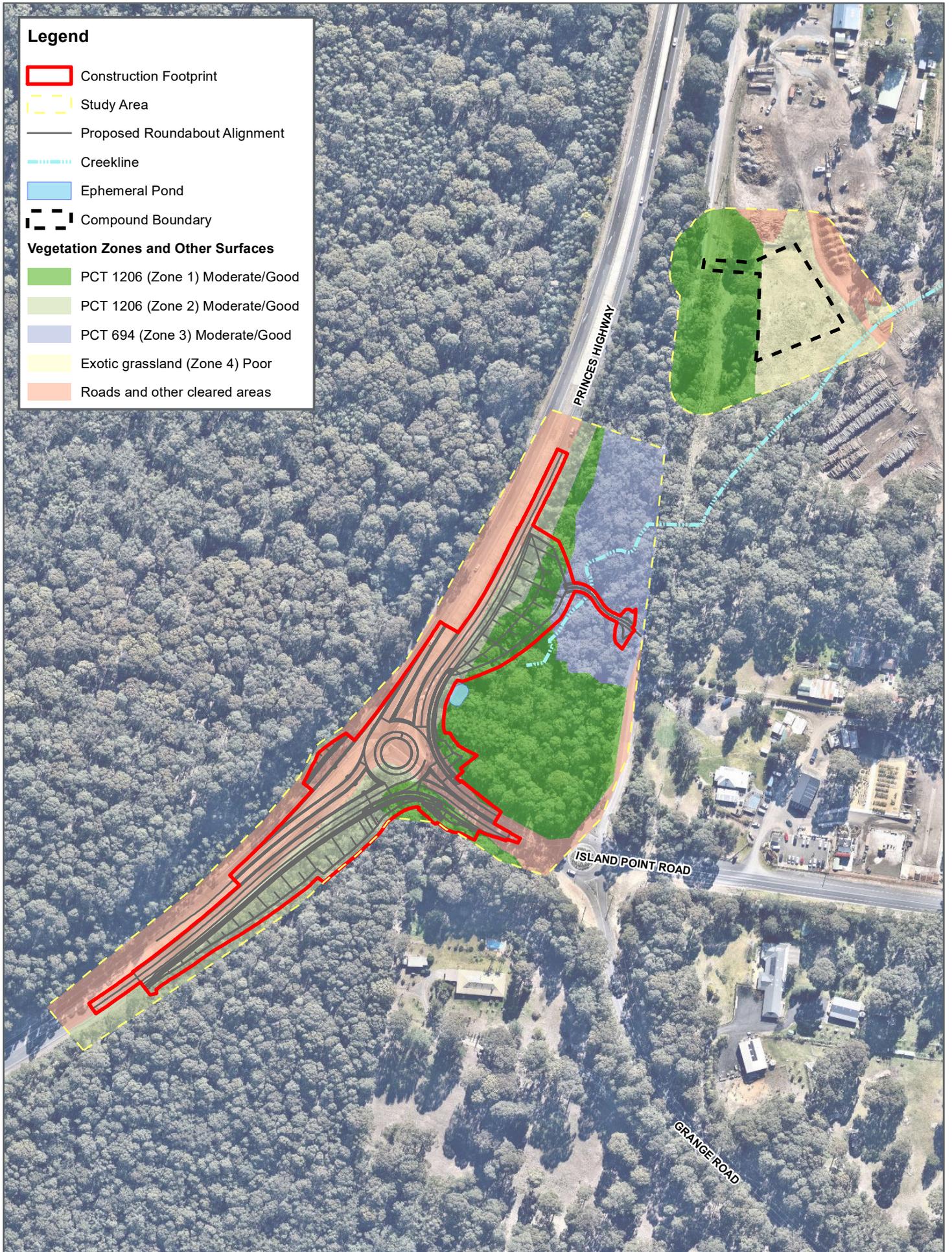
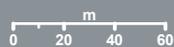


FIGURE 3.1

1:3,000 Scale at A4



Plant Community Types

ISLAND POINT ROAD ROUNDABOUT

3.2 Threatened ecological communities

With reference to the PCT descriptions above and the NSW VIS database, the PCTs within the study area were not assessed as conforming to any TEC listed under the NSW BC Act and/or the Commonwealth EPBC Act.

No TECs were identified within the study area.

3.3 Groundwater dependent ecosystems

Based on the Australian Government BOM Groundwater Dependent Ecosystems (GDE) Atlas mapping, consulted during the background research, one terrestrial GDE was identified as occurring within the study area (Australian Government Bureau of Meteorology, 2019a). As shown in **Figure 3.2** below, this GDE corresponds to the PCT identified in vegetation zones 1 and 2, Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (PCT 1206). This occurrence is described as a moderate potential GDE from regional studies. This mapping excluded the other native vegetation PCT identified within the study area, Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (PCT 694).

The BOM GDE Atlas uses the term “potential” to “*reflect the uncertainty inherent in identifying ecosystems as groundwater-dependant using desktop methods. Finer scale studies or fieldwork are needed to confirm this analysis*” (Australian Government Bureau of Meteorology, 2019b). Based on this definition, this terrestrial GDE has been mapped using desktop methods and uncertainty remains as to its dependence on groundwater. As no ground water survey was undertaken to identify the presence of an aquifer supporting this potential GDE, the assessments detailed in this report have assumed the presence of groundwater resources resulting in the moderate potential classification.

No aquatic GDEs were mapped as occurring within the study area, with the nearest mapped being St Georges Basin, located about 1.7 km to the south-east of the study area.

The study area falls within the St Georges Basin water sharing area of the Clyde River and Jervis Bay Catchments, with reference to Appendix 2 of the NSW DPI Water Water Sharing Plan for the Clyde River Unregulated and Alluvial Water Sources (NSW Department of Primary Industries Water, 2016). This plan identifies the groundwater of the catchment as consisting of the dominant Sydney Basin – South Coast groundwater sources as well as numerous small coastal sand aquifers, small alluvial aquifers and aquifers of the Lachlan Fold Belt. Drainages identified as supporting the most significant alluvial groundwater deposits include Tomerong Creek, for which the ephemeral drainage line within the study area forms a tributary. It is considered likely the terrestrial GDE present within the study area is dependent on the local alluvial aquifer network.

Legend

- Construction Footprint
- Study Area
- Proposed Roundabout Alignment
- Creekline
- Ephemeral Pond
- Compound Boundary
- Terrestrial Groundwater Dependent Ecosystem (BoM)

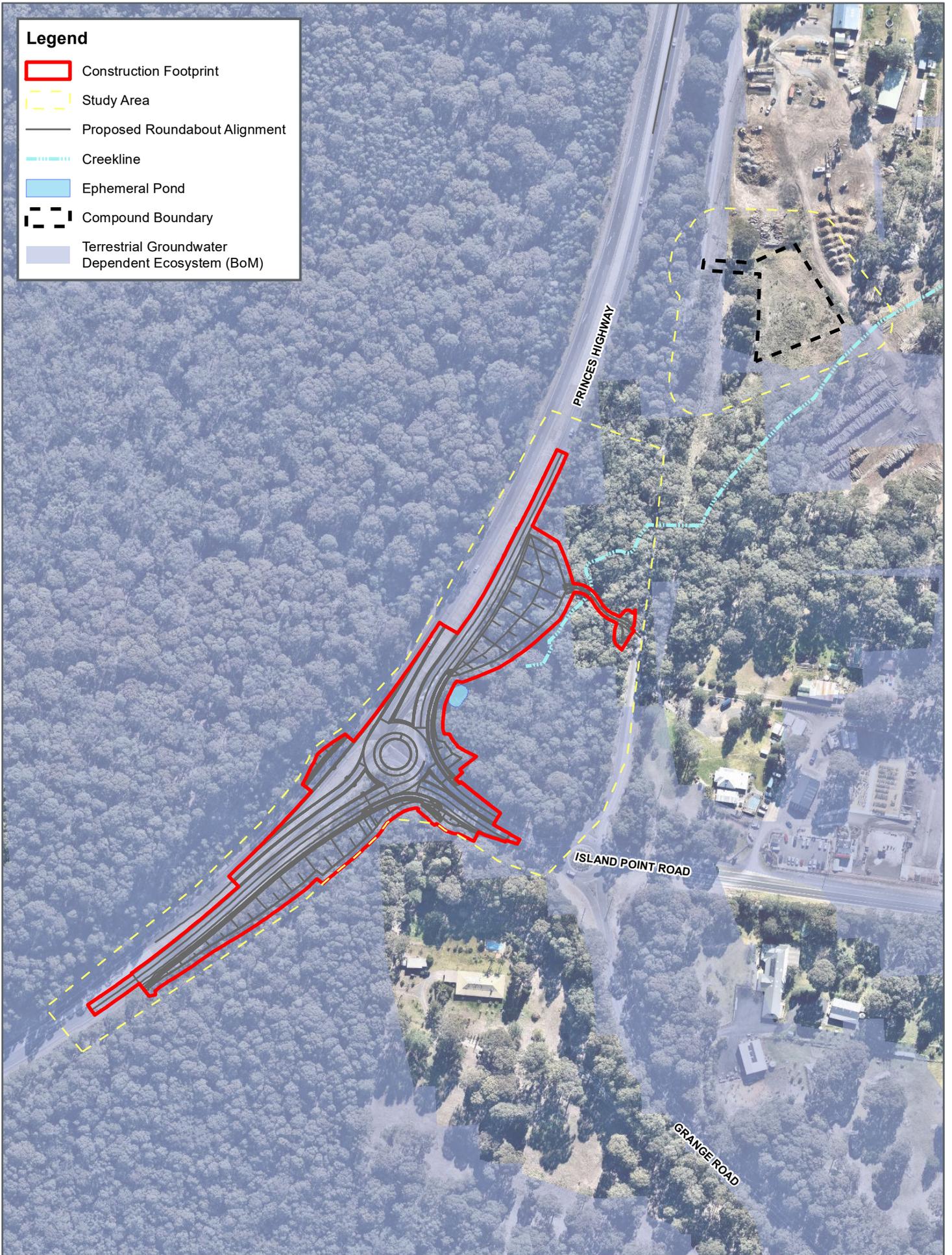
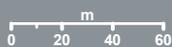


FIGURE 3.2

1:3,000 Scale at A4



Groundwater

ISLAND POINT ROAD ROUNDABOUT

Assessment of the ecological value and risk of the proposal to this GDE has been assessed in accordance with the ecological valuation and risk assessment process as detailed in Figure 3 of the NSW DPI Office of Water Risk Assessment Guidelines for Groundwater Dependent Ecosystems (NSW Department of Primary Industries Office of Water, 2012). See **Figure 3.2** below for this process.

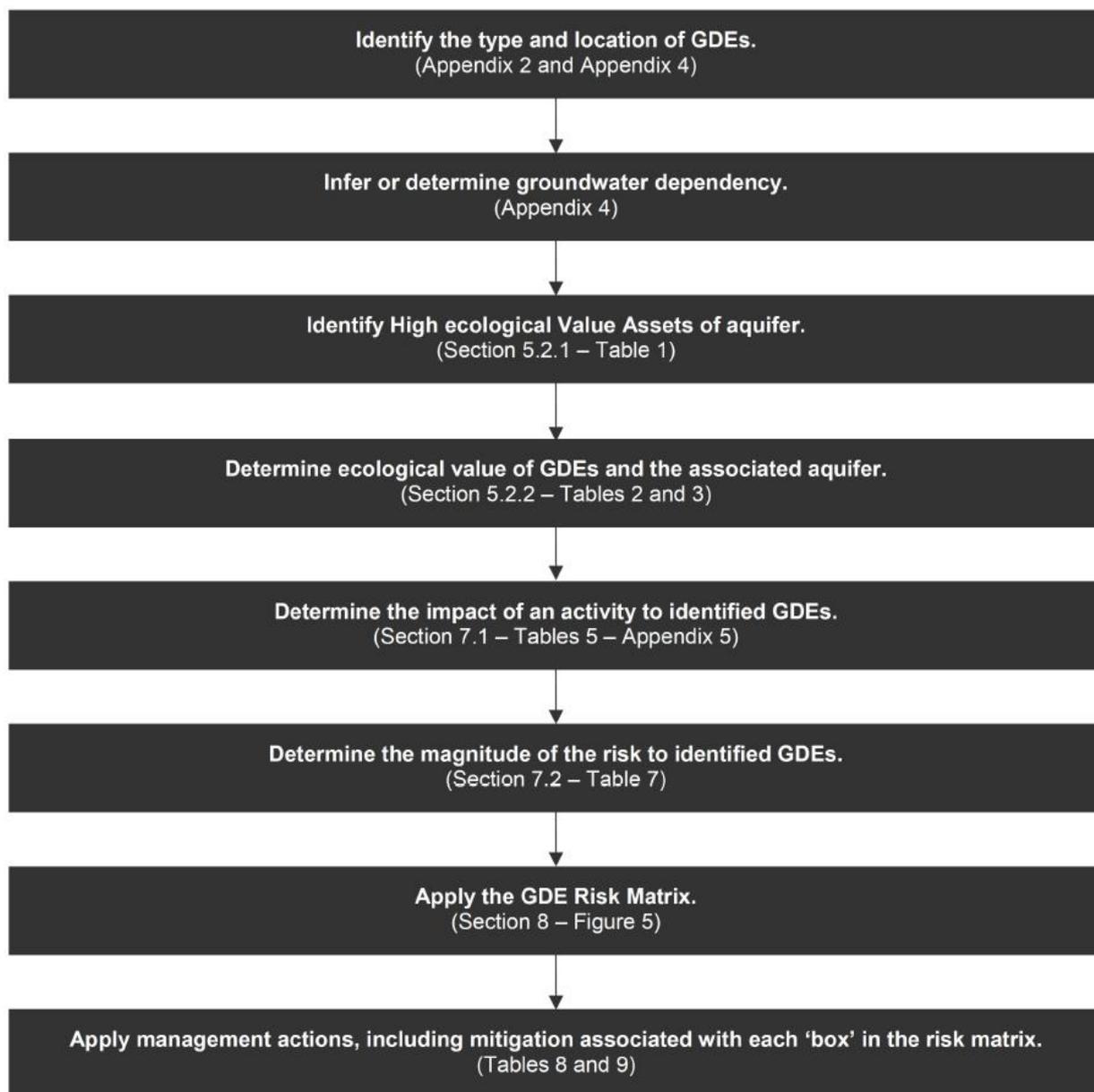


Figure 3.3: Ecological valuation and risk assessment process

As detailed above, mapping from the Australian Bureau of Meteorology (BOM) identified this vegetation as a potential terrestrial GDE and information from Clyde River water sharing plan identified this GDE as likely supported by a local alluvial aquifer. This assessment meets steps 1 and 2 of the above risk assessment process. Evaluation of the ecological value of this GDE (steps 3 and 4) has been undertaken in accordance with Table 1 (general) and Table 2 (detailed) assessments as per the NSW DPI Office of Water Risk Assessment Guidelines for Groundwater Dependent Ecosystems. Refer to **Table 3.2** and **Table 3.3** below for the results of this assessment.

Table 3.2 General aquifer ecological valuation

| | Yes | No | List/Comments |
|--|-----|----|--|
| Does the aquifer or portion of it occur within a state reserve or support any GDEs within a subcatchment identified as High Conservation Value; eg. Stressed Rivers; high value vegetation, SEPP wetlands, DIWA wetland etc? | | No | <p>The Suffolk / Tomerong Creek sub-catchment area contains portions of Jerrawangala National Park and lands mapped as coastal wetlands under the State Environmental Planning Policy (Coastal Management) 2018 (Coastal Management SEPP 2018).</p> <p>However, these are located about 4.6 and 6.9 km from the study area respectively. These high value areas are considered unlikely to be reliant on the alluvial aquifer supporting the potential GDE within the study area</p> |
| Does the aquifer support obligate/entirely dependent GDEs including: karsts, springs, mound springs, subterranean aquifer ecosystems and some wetlands such as hanging swamps | | No | All mapped GDEs within the study area are mapped as terrestrial GDEs and are represented by native forest |
| Does the aquifer support GDEs that have any endemic, relictual, rare, or endangered biota (fauna or flora) populations or communities as listed under the <i>NSW Threatened Species Act 1995</i> , <i>NSW Fisheries Management Act 1994</i> or the <i>Commonwealth Environment Protection and Biodiversity Conservation Act 1999</i> or identified by an acknowledged expert taxonomist / regional ecologist as being important? | Yes | | The GDE within the study area supports a population of two threatened flora species, biconvex paperbark and magenta Lilly Pilly, both listed under the BC Act and EPBC Act |

Table 3.3 Identification of the ecological value of individual GDEs within an aquifer

| | High | Moderate | Low | Unknown | Comments |
|---|--|---|---|---------|--|
| GDE environment | | | | | |
| GDE or part thereof occurs or is reserved in National Estates, listed wetlands, SEPP 26 etc | Yes | N/A | No | | Low |
| Presence of exotic flora or fauna within GDE | None exist | Exotic species in small numbers. | Exotic species in large populations of one or more species. | | Moderate |
| Removal or alteration of GDE type or subtype | No detectable change in physical structure, species composition or size in GDE type or subtype | Minor change or alteration in physical structure, species composition, or size resulting in a temporary change in GDE type or subtype | Major change/alternation in physical structure, species composition, or size resulting in a permanent change in GDE type or subtype | | Moderate Existing road network has removed historical GDE terrestrial vegetation and changes surface flow behaviour |
| Aquifer | | | | | |
| Water quantity parameters | | | | | |
| Alteration of the frequency and/or magnitude and/or timing of watertable level fluctuations | No detectable change from natural seasonal variation | Fluctuation in groundwater levels resulting in temporary change to part of any dependent habitat type | Fluctuation in groundwater levels resulting in permanent loss of any dependent habitat type | | High Terrestrial GDE vegetation does not appear to have been altered by changes to the watertable |
| Alteration of groundwater pressure | No detectable change from natural seasonal variation | Fluctuation in groundwater pressure resulting in temporary change to part of any dependent habitat type | Fluctuation in groundwater pressure resulting in permanent loss of any dependent habitat type | | Unknown |
| Alteration to direction of hydraulic gradients | No detectable change from natural seasonal variation | Temporary changes resulting in short-term alterations to habitat conditions | Permanent reversals in hydraulic gradients resulting in changes to any dependent habitat type | | High |

| | High | Moderate | Low | Unknown | Comments |
|---|--|---|--|---------|---|
| Alteration of base flow conditions | No detectable change from natural seasonal variation | Temporary reduction in baseflow conditions exceeding seasonal variation | Permanent loss or reversal of base flow conditions | | High |
| Degree of acid runoff or acidification of aquifer | No detectable change from natural seasonal variation | Temporary exposure of acid sulfate soils with likely runoff into dependent ecosystems | Permanent exposure of acid sulfate soils with likely runoff into dependent ecosystems | | High. Area not mapped as prone to ASS |
| Degree of nutrient load | No detectable change from natural seasonal variation | Temporary increase in nutrient load to dependent ecosystems | Permanent increase in nutrient load to dependent ecosystems | | Low. Existing road network has created a permanent source of new nutrient inflows to the GDE |
| Degree of groundwater salinity. | No detectable change from natural seasonal variation | Temporary increase in salinity to dependent ecosystem | Permanent increase in salinity to dependent ecosystem | | Unknown |
| Degree of bioaccumulation; ie heavy metal contamination | No detectable change from natural seasonal variation | Temporary exposure of dependent ecosystems to heavy metals and/or toxins | Permanent exposure of dependent ecosystem to heavy metal and/or toxins | | Unknown |
| Aquifer structure | | | | | |
| Degree of alteration of aquifer structure; eg quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction, compaction of aquifer, etc | No detectable change in aquifer structure | Minor change/alteration of aquifer structure resulting in a temporary change in GDE habitat. ** | Major change/alternation of aquifer structure resulting in a permanent change in GDE habitat. ** | | Low. Historical works for the road network has permanently altered the aquifer structure and surface water recharge behaviours |
| Biodiversity | | | | | |
| Rarity within catchment/aquifer | | | | | |
| Presence of Threatened, Rare, Vulnerable or Endangered | Yes | N/A | No | | High |

| | High | Moderate | Low | Unknown | Comments |
|---|---|--|---|---------|---|
| species, population or ecological community within GDE | | | | | Threatened species documented within the GDE |
| Presence of indicator, keystone, flagship, endemic or significant species, populations or communities within GDE.*** | Yes | N/A | No | | High study area contains lands mapped as a biodiversity corridor in the SLEP |
| Patch size rank of GDE relative to other patches of the same GDE type/subtype (as appropriate) | > 50 | 49 to 30 | < 30 | | High |
| Patch size percentage of GDE relative to original / historic extent | > 50% | 49 to 30% | < 30% | | High The VIS database identifies PCT 1206 (associated terrestrial GDE vegetation type) as having a estimated cleared extent of 0.15% |
| Diversity within catchment/aquifer | | | | | |
| Diversity of groundwater dependent native flora and fauna species within a GDE | Presence of five or more species or >80% number of species relative to a reference site | Presence of two to four species or 80-50% of species relative to reference sites | Presence of one species or less than 50 per cent of species relative to reference sites | | Unknown |
| Special features within catchment/aquifer | | | | | |
| Provides drought refuge for terrestrial or aquatic species. | The only water source within a radius of >10km | The only water source within a radius of 1-9km and no access to multiple water sources | Access to multiple water sources. | | Low |
| Presence of rare physical/physico-chemical features or environments; eg karsts, mound springs, natural saline wetlands, peat swamps etc | Occurs only within the aquifer | Occurs only within the catchment | Occurs only within the state | | Low |

| | High | Moderate | Low | Unknown | Comments |
|---|--|---|--|---------|----------|
| Delivers ecosystem services through biogeochemical processes: carbon processing, nitrification / denitrification, biodegradation through aquifer connectivity | Unconfined aquifer with connection to terrestrial and aquatic ecosystems | Semi confined aquifer with limited (spatial and or temporal) connectivity to terrestrial and aquatic ecosystems | Confined aquifer has very limited or no connection to terrestrial and aquatic ecosystems | | High |
| Total number of attributes | 9 | 2 | 5 | | |
| Overall value | | | | | High |
| Comments | | | | | |

* Note: Methods to determine magnitude (eg temporary or permanent) of change or alteration will depend on the criteria and habitat type being monitored. A discussion on these methods is outside the scope of this document.

** Minor and/or major changes to aquifer structure depend on the aquifer type and its location. Determination of what is minor or major is outside the scope of this document.

*** Species or communities are deemed significant if they occur within a fauna corridor or identified as a key habitat under the NSW National Parks and Wildlife Service programs (Key Habitat and Fauna Corridor Mapping Project of Northern NSW), Identified Critical Habitats, or identified within biodiversity strategies or regional/local biodiversity assessments.

This assessment concluded the terrestrial GDE present is considered to have a high overall ecological value. This is due primarily to the presence of threatened species under the NSW BC Act and Commonwealth EPBC Act. The remaining steps in the risk assessment process are detailed in **Section 4** of this report.

3.4 Threatened species and populations

Table 3.4 below identifies threatened species recorded in the study area and those considered to have a moderate or greater likelihood of occurrence within the study area based on the habitat assessment tables (see **Appendix B**).

Table 3.4 Habitat assessment and surveys results

| Scientific name | Common Name | Status | | Potential occurrence |
|--|--------------------------------|--------|----------|----------------------|
| | | BC Act | EPBC Act | |
| Threatened Flora | | | | |
| <i>Melaleuca biconvexa</i> | Biconvex Paperbark | V | V | Recorded |
| <i>Rhodamnia rubescens</i> | Scrub Turpentine | CE | - | Low |
| <i>Syzygium paniculatum</i> | Magenta Lilly Pilly | E | V | Recorded |
| Threatened Fauna | | | | |
| <i>Callocephalon fimbriatum</i> | Gang-gang Cockatoo | V | - | Moderate |
| <i>Cercartetus nanus</i> | Eastern Pygmy-possum | V | - | Moderate |
| <i>Dasyurus maculatus</i> | Spotted-tailed Quoll | V | E | Moderate |
| <i>Falsistrellus tasmaniensis</i> | Eastern False Pipistrelle | V | - | Recorded |
| <i>Glossopsitta pusilla</i> | Little Lorikeet | V | - | Moderate |
| <i>Litoria aurea</i> | Green and Golden Bell Frog | E | V | Moderate |
| <i>Miniopterus schreibersii oceanensis</i> | Eastern Bentwing-bat | V | - | Recorded |
| <i>Mormopterus norfolkensis</i> | Eastern Freetail-bat | V | - | Recorded |
| <i>Ninox connivens</i> | Barking Owl | V | - | Moderate |
| <i>Ninox strenua</i> | Powerful Owl | V | - | Moderate |
| <i>Petauroides volans</i> | Greater Glider | - | V | Moderate |
| <i>Petaurus australis</i> | Yellow-bellied Glider | V | - | Moderate |
| <i>Saccolaimus flaviventris</i> | Yellow-bellied Sheath-tail-bat | V | - | Moderate |
| <i>Scoteanax rueppellii</i> | Greater Broad-nosed Bat | V | - | Moderate |
| <i>Tyto novaehollandiae</i> | Masked Owl | V | - | Moderate |
| <i>Tyto tenebricosa</i> | Sooty Owl | V | - | Moderate |

Two threatened flora species were recorded within the study area during surveys, the Biconvex Paperbark and Magenta Lilly Pilly.

A population of around 284 Biconvex Paperbark (*Melaleuca biconvexa*) were recorded (81 mature and 203 recruits or immature) from within the main body of the study area, north of the Island Point Road junction. Occurrences of this species elsewhere in the study area were not observed. The population was largely restricted to the ephemeral creek line and nearby banks extending out into the flat understory in the east of the study area as scattered occurrences in several locations. See **Photograph 5** below for an example of the occurrence of this species within the study area.



Photograph 5: Biconvex Paperbark (Melaleuca biconvexa) within the study area

An estimated 42 individuals (12 mature and 30 immature) are located within the construction footprint.

With reference to the NSW BioNet database, this species is known from 676 records from the Study locality with a total estimated population of 109,737. This population is dispersed throughout creek and drainage lines across the Wandandian Plain to the north-east, east, south and south-west of the study area with major populations in the suburbs of Basin View, St Georges Basin and elsewhere within Tomerong, north of the study area. Based on the available data, the species is not limited in the Study locality and the population within the study area represents a small subset of the local population.

Two immature Magenta Lilly Pilly (*Syzygium paniculatum*) were documented within the study area, both located within the east of the main body of the study area, next to Grange Road. See **Photograph 6** below for an example of this species within the study area.



Photograph 6: Magenta Lilly Pilly (*Syzygium paniculatum*) within the study area

With reference to the NSW BioNet database, this species is known from 16 records from the Study locality with a total estimated population of 22. This population is dispersed throughout study area with the majority of records located close to the coastline, within the suburbs of Basin View, Sanctuary Point, Tomerong, Vincentia and Huskisson. Based on the available data, the species has a dispersed but small population within the Study locality and the occurrence of this species within the study area represents a significant subset of this population (around 10 per cent). Neither individual identified within the study area is located within the proposal Area.

The Scrub Turpentine (*Rhodamnia rubescens*) was surveyed for during an appropriate season and no individuals were documented. This is a large, distinctive species and the survey effort is considered adequate to detect a resident population of this species, if present within the study area. Consequently, it is considered to have a low likelihood of occurrence within the study area.

Three threatened microbat species were recorded as “probable” based on the Anabat Express data analysis, the Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) and the Eastern Freetail-bat (*Mormopterus norfolkensis*). Although these species could not be confidently identified from the call analysis, they are all known from recent occurrence records from the Study locality (NSW BioNet database) and suitable roosting habitat is present for all three species. In addition, the Greater Broad-nosed Bat (*Scoteanax rueppellii*) and Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) are also known from recent occurrence records and the study area supports suitable habitat. Although not detected during surveys, these species are considered likely to use the study area and suitable habitat-bearing tree roosting resources are present.

The study area was identified as containing 7 habitat-bearing trees (containing hollows of various sizes as well as deep fissures and sheets of loose bark). These are suitable roosting resources for the Eastern False Pipistrelle, Eastern Freetail-bat, Greater Broad-nosed Bat and

Yellow-bellied Sheath-tail-bat. In addition, two large culvert and stormwater pipe (1,200 mm and 750 mm) were identified underneath the Princes Highway in the north-west and under Island Point Road in the south of the main body of the study area, respectively. **Photograph 7** shows the entrance to the 1,200 mm pipe under the Princes Highway.



Photograph 7: Large stormwater pipe culvert entrance under the Princes Highway

These structures provide potential roosting resource for the Eastern Bentwing-bat. One other smaller culverts (375 mm) was also identified, above (west) of the small waterbody. Due to the small size of this pipe it is considered less suitable as a potential bat roost due to the risk of total flooding during high rainfall events. A full walkthrough survey of the large stormwater pipe under the Princes Highway did not identify any evidence of recent microbat use (roosting bats, guano, carcasses etc). Use of these structures by this species is also considered somewhat limited by the lack of clear entry flyways into the pipelines due to the culvert design (see **Photograph 7**).

None of the hollow-bearing trees identified are located within the proposal Area. The Study locality contains large areas of similar woodland habitat containing habitat-bearing trees and these resources are not considered limited in the Study locality. The local populations of tree roosting threatened microbats are not considered dependent on the roosting resources of the study area for their long-term survival in the locality. Similar road culverts and other man-made potential roosting structures for the Eastern Bentwing-bat are also present in the Study locality, along the Princes Highway as well as within the small townships such as Basin View, Sanctuary Point and St Georges Basin. Although surveys could not be conducted during this species' breeding season (December – February) the large stormwater pipe is considered unlikely to be used as a maternity roost. This species is predominantly known to use caves as breeding habitat and there are currently 7 cave roost sites identified as key management sites for this species (NSW Office of Environment and Heritage, 2019). The nearest of these is located in Bungonia Nature Reserve, located about 60 km to the north-west of the study area.

The small waterbody in the south-west of the main body of the study area is considered to provide sub-optimal habitat for the Green and Golden Bell Frog (*Litoria aurea*). Although this waterbody contains aquatic vegetation known to be preferred by this species (Cumbudgi reeds), the study area lacks many of the other microhabitat features necessary for this species. The DPIE profile describes optimum habitat for this species as “water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available” (NSW Office of Environment and Heritage, 2017). As shown in **Photograph 8** below, this waterbody is heavily shaded by the surrounding forest vegetation and lacks nearby grassy foraging areas.



Photograph 8: Small waterbody within the study area

This waterbody is not considered to constitute high quality habitat for this species. However, as surveys could not be conducted during a season appropriate for the detection of this species, the species is assumed to use this habitat on occasion. The local population of this species is not considered dependent on these resources for its long-term survival. Finally, this waterbody is not located within the proposal Area.

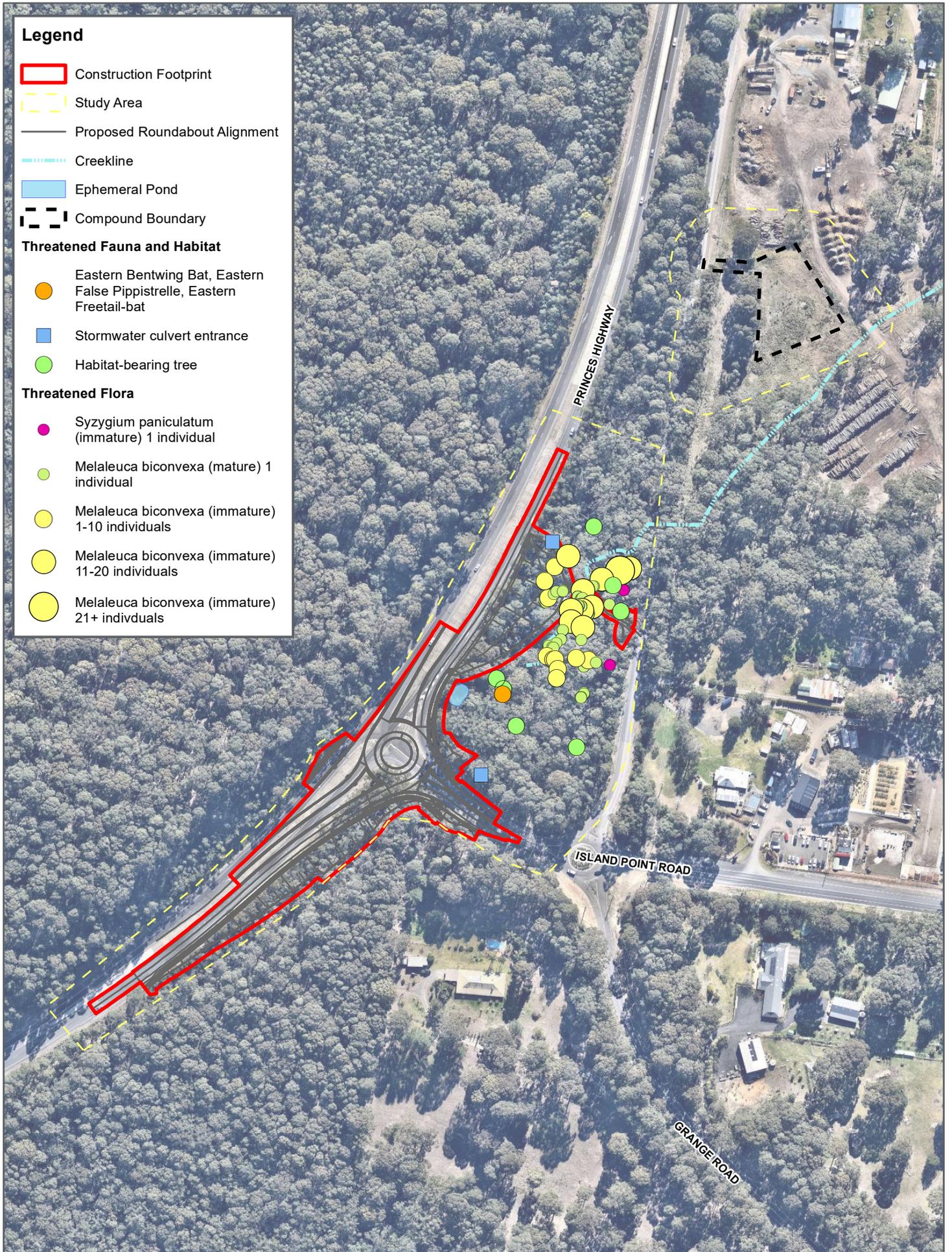
Several threatened large forest owl species are known from recent occurrence records in the locality, the Barking Owl (*Ninox connivens*), Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*) and Sooty Owl (*Tyto tenebricosa*). These species are known to use the habitat type present in the study area (sclerophyll forest) and the study area contains potential breeding resources in the form of hollow-bearing trees. As discussed in **Table 2.5** above, no evidence of recent site use by owl species was apparent (whitewash, pellets etc) and none of these species were encountered during spotlight and call playback surveys conducted. However, due to the number of recent records and the known habitat size requirements of many of these species (the Masked Owl is known to have a home range of 500 – 1000 hectares (NSW Office of Environment and Heritage, 2017)), these species are assumed to use the resources of the study area on occasion. None of the hollow-bearing trees identified are located within the proposal Area. These resources are not limited in the Study locality, large areas of similar native sclerophyll forest with hollow-bearing resources are present, including

numerous protected areas of NSW NPWS estate. These species are not considered reliant on the resources of the study area for their long-term survival in the Study locality.

The hollow-dependent threatened arboreal and semi-arboreal mammals, the Eastern Pygmy Possum (*Cercartetus nanus*), Greater Glider (*Petauroides volans*) Spotted-tail Quoll (*Dasyurus maculatus*) and Yellow-bellied Glider (*Petaurus australis*) are also considered likely to use the study area as part of their wider foraging ranges. Although not detected during surveys, all are known from recent occurrence records (DPIE BioNet) and the study area supports suitable habitat for these species, including hollow-bearing trees. None of the hollow-bearing trees identified are located within the proposal Area. These resources are not limited in the Study locality, large areas of similar native sclerophyll forest with hollow-bearing resources are present, including numerous protected areas of NSW NPWS estate. These species are not considered reliant on the resources of the study area for their long-term survival in the Study locality.

The diurnal woodland birds considered likely to occur within the study area, the Gang Gang Cockatoo (*Callocephalon fimbriatum*) and Little Lorikeet (*Glossopsitta pusilla*) are also considered unlikely to be dependent on the resources of the study area. As detailed above, the available foraging habitat of the study area (sclerophyll forest) is not limited in the Study locality. This habitat contains numerous hollow-bearing resources and much of this habitat is on protected NPWS estate. None of these species are considered reliant on the resources of the study area for their long-term survival in the Study locality. Finally, none of the hollow-bearing trees (potential breeding habitat for these species) identified are located within the proposal Area.

Figure 3.4 below shows the location of all recorded threatened flora and fauna species and the locations of high value threatened fauna habitat features.



Legend

- Construction Footprint
- Study Area
- Proposed Roundabout Alignment
- Creekline
- Ephemeral Pond
- Compound Boundary

Threatened Fauna and Habitat

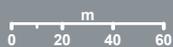
- Eastern Bentwing Bat, Eastern False Pippistrelle, Eastern Freetail-bat
- Stormwater culvert entrance
- Habitat-bearing tree

Threatened Flora

- *Syzygium paniculatum* (immature) 1 individual
- *Melaleuca biconvexa* (mature) 1 individual
- *Melaleuca biconvexa* (immature) 1-10 individuals
- *Melaleuca biconvexa* (immature) 11-20 individuals
- *Melaleuca biconvexa* (immature) 21+ individuals

FIGURE 3.4

1:3,000 Scale at A4



Threatened Flora and Fauna

ISLAND POINT ROAD ROUNDABOUT

3.4.1 Aquatic results

Assessed against the modified RCE, the stream was assigned a RCE score of 44. This indicated the stream is in an overall good condition with a well-defined channel, stabilised banks and contiguous riparian vegetation (native). Although the stream was assessed as good condition by the modified RCE, it was assessed as class 4 unlikely fish habitat and type 3 minimally sensitive fish habitat as defined by table 1 and table 2 of the NSW DPI Policy and guidelines for fish habitat conservation and management (NSW Department of Primary Industries (Fisheries), 2013). The stream was assessed as small, intermittent and lacking important fish habitat resources (deep pools, gravel beds, snags and aquatic vegetation).

This waterway would provide intermittent habitat for native aquatic and semi-aquatic fauna such as amphibians, eels and turtles. It is not considered important habitat for any threatened fish species due to a lack of deep pools, intermittent flow and limited in-stream habitat. The stretches of the waterway within the study area were also not considered to be important habitat for threatened amphibians considered to have potential to be present within the study area such as the Green and Golden Bell Frog. This portion of the stream lacks suitable aquatic vegetation (reed beds) preferred by this species, is heavily shaded and lacks nearby required habitat components (grassy foraging areas) (NSW Office of Environment and Heritage, 2017).

The waterbody present in the south-west of the main body of the study area was small, ephemeral and had been artificially constructed, presumably as part of the original Princes Highway/Island Point Road junction stormwater management infrastructure. At the time of survey, this waterbody contained a small amount of standing water at its lowest point and the entire waterbody based was dominated by native aquatic vegetation (predominantly Cumbudgi (*Typha orientalis*) and Knotweed (*Persicaria praetermissa*). This waterbody did not have visible connectivity with the ephemeral stream downslope and does not provide habitat for fish passage. The waterbody is located above the headwaters of the ephemeral stream and does not provide connectivity with waterways elsewhere in the sub-catchment.

The Australian Grayling (*Prototrochetes marena*) was identified as known to occur from within the Study locality, with NSW Department of Primary Industries (DPI) Fisheries Spatial Data Portal - Fish Freshwater Threatened Species identifying Wandandian Creek, located about 4 km to the south-west of the study area as mapped indicative habitat. The waterway within the study area does not have connectivity with this waterway and suitable habitat is not present. The waterway within the study area lacks permanent standing water and as detailed above does not provide habitat connectivity for fish passage in the locality.

No other threatened freshwater fish species listed under the NSW FM Act or Commonwealth EPBC Act were identified as likely to occur within the Study locality.

3.5 Critical habitat (where applicable)

No AOBV (formally critical habitat) is located within the study area or Study locality. The nearest declared AOBV is the Little Penguin (*Eudyptula minor*) colony in Manly, located about 150 km to the north of the study area.

3.6 Wildlife connectivity corridors

Lot 8 DP 855413 is mapped as Biodiversity – habitat corridor under the SLEP 2014, Terrestrial Biodiversity Map Sheet BIO_014E (Shoalhaven City Council, 2014). The vegetation within this lot provides a portion of a vegetation corridor along and across the Princes Highway road reserve with lots to the east and west also forming parts of the mapped habitat corridor (lot 25 DP 792969 and lot 6 DP 1217066). The compound site in lot 25 DP 792969 does not include lands mapped as habitat corridors under this instrument.

3.7 SEPPs (where applicable)

The study area does not contain any lands mapped as “coastal wetlands” or “littoral rainforest” or lands mapped as proximity areas from these items under the State Environmental Planning Policy (Coastal Management) 2018 (Coastal Management SEPP 2018) map viewer (NSW Department of Planning and Environment, 2018). The nearest mapped lands are located on the edge of Home Bay in the St Georges Basin estuarine lake within the suburbs of Basin View and St Georges Basin, located about 1.7 km to the south-east of the study area.

The Shoalhaven City Council LGA is listed in Schedule 1 of the State Environmental Planning Policy 44 (Koala Habitat Protection) (Koala Habitat SEPP) as an LGA to which the SEPP applies. With reference to Schedule 2 of the SEPP and the plot species data provided in **Appendix A** of this report, the study area has not been assessed as conforming to potential Koala habitat as defined by the SEPP “*areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component*”. The study area was not assessed as containing any eucalypt feed tree species listed under Schedule 2 of the SEPP.

The Koala (*Phascolarctos cinereus*) is known from a single record from the Study locality (DPIE BioNet), dated from 2002. As detailed in the habitat assessment table (**Appendix B**) this species was considered to have a low likelihood of occurrence within the study area due to a lack of suitable feed tree species (did not meet the definition of potential Koala habitat as defined by Part 4 of SEPP44) and a lack of recent occurrence records from the Study locality.

Part four of SEPP44 defines potential Koala habitat as “*areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component*”. With reference to the vegetation plot data in **Appendix** and Schedule 2 of SEPP44, none of the eucalypt species documented within the study area are recognised as potential Koala feed tree species.

3.8 Matters of National Environmental Significance

No TEC MNES were identified from within the study area. The following threatened species MNES were recorded or presumed to be present within the study area:

Recorded

- Biconvex Paperbark (*Melaleuca biconvexa*)
- Magenta Lilly Pilly (*Syzygium paniculatum*).

Presumed present

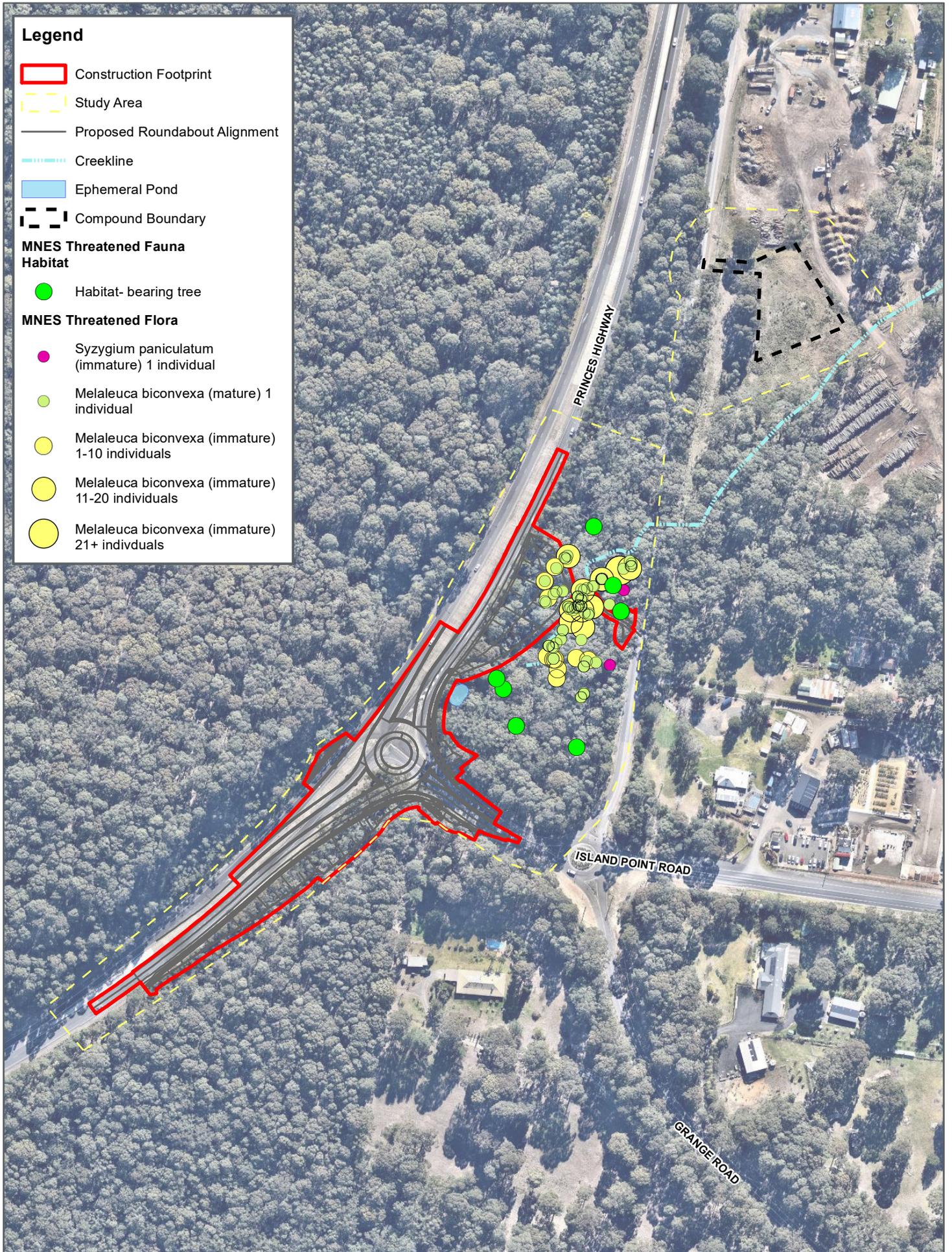
- Greater Glider (*Petauroides volans*)
- Green and Golden Bell Frog (*Litoria aurea*)
- Spotted-tailed Quoll (*Dasyurus maculatus*).

The PMST search conducted for this assessment did not identify any items of world and national heritage within the Study locality.

The PMST search did not identify any wetlands of international importance (Ramsar wetlands) within the Study locality. The nearest Ramsar wetlands are the Towra Point Nature Reserve wetlands in the Sydney suburb of Kurnell, located about 130 km to the north of the study area (NSW Office of Environment and Heritage, 2012).

None of the migratory species known or considered likely to occur within the Study locality (from the DPIE BioNet and PMST database searches) were considered likely to occur within the study area (see the assessment table in **Appendix B**). The study area lacks suitable habitat for these species such as intertidal fresh and saltwater mudflats and sandflats, beaches, estuarine waterways and other coastal habitats.

Figure 3.5 below identifies all MNES recorded threatened species and areas of potential habitat and important habitat features for MNES threatened species assumed to be present within the study area.



Legend

- Construction Footprint
- Study Area
- Proposed Roundabout Alignment
- Creekline
- Ephemeral Pond
- Compound Boundary

MNES Threatened Fauna Habitat

- Habitat-bearing tree

MNES Threatened Flora

- *Syzygium paniculatum* (immature) 1 individual
- *Melaleuca biconvexa* (mature) 1 individual
- *Melaleuca biconvexa* (immature) 1-10 individuals
- *Melaleuca biconvexa* (immature) 11-20 individuals
- *Melaleuca biconvexa* (immature) 21+ individuals

FIGURE 3.5

1:3,000 Scale at A4



Recorded MNES

ISLAND POINT ROAD ROUNDABOUT

4 Impact assessment

4.1 Construction impacts

4.1.1 Removal of native vegetation

The proposal will require clearing of native woody vegetation and exotic grasslands for the construction footprint and compound site. **Table 4.1** below details the predicted extent of direct impact on native vegetation within the study area as a result of the proposal.

Table 4.1: Impacts on vegetation

| Plant community type (PCT) | Status | | Proposal area (hectares) | Per cent cleared in CMA |
|---|------------|------------|--|-------------------------|
| | TSC Act | EPBC Act | | |
| Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (PCT 1206) | Not listed | Not listed | 0.89 0.86 ha within construction footprint and 0.03 ha within compound site | 0.15 |
| Spotted Gum - Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (PCT 694) | Not listed | Not listed | 0.06 Construction footprint only | 0.5 |
| Total | | | 0.95 | |

As shown in **Table 3.1** above, the proposal would remove portions of both native PCTs from the study area. This clearing is required for the proposed Princes Highway southbound lanes, Island Point Road upgrades, the associated earthworks (batters) and for widening of the existing access track. Use of the compound site would impact on the majority of the exotic grassland vegetation present. However, no clearing of PCT 1206 woody vegetation would be required. Disturbance to associated native grasslands of this PCT within the compound site would be restricted to vehicle access through these grasslands and passive materials (stormwater infrastructure) storage. As clearing of native grasslands for material storage is not required, the above calculations include the vehicle access corridor but exclude the storage area in the total clearing area impact shown in **Table 3.1**.

Neither of the native PCTs identified in the study area are associated with TECs under the BC Act and/or EPBC Act and neither have been overcleared, according to data from the NSW VIS database. Based on the SCIVI mapping consulted during the background research, the proposal is estimated to have the following level of impact on these PCTs within the Study locality:

- PCT 1206. A loss of 0.89 hectares from a mapped occurrence of 9981.64 ha, or 0.009 per cent
- PCT 694. A loss of 0.06 hectares from a mapped occurrence of 1515.15 ha, or 0.004 per cent.

The proposal is not considered to represent a significant reduction of any PCT present in the study area within the Study locality.

The following Key Threatening Processes (KTPs) under the BC Act and/or EPBC Act are relevant to the clearing of vegetation and have the potential to be exacerbated by the proposal.

- Anthropogenic Climate Change (BC Act), loss of climatic habitat caused by anthropogenic emissions of greenhouse gases (EPBC Act)
 - The Project will contribute to greenhouse gas emissions through site activities and removal of vegetation. Due to the small size of the proposal Area, the proposal is not considered likely to significantly exacerbate this KTP

- Clearing of native vegetation (BC Act), land clearance (EPBC Act)
 - The proposal will result in the removal of a small portion of native vegetation. This impact is not considered a significant exacerbation of this KTP on the locality scale
- Loss of Hollow-bearing Trees (BC Act)
 - The proposal is not anticipated to require the removal of any hollow-bearing trees identified in the study area. The proposal is considered unlikely to exacerbate this KTP
- Removal of dead wood and dead trees (BC Act)
 - The proposal is not anticipated to require the removal of any dead trees identified in the study area. Dead wood resources would be removed for the required road upgrade works. However, the resources to be removed from the impact area are not considered to represent a significant reduction of these resources in the locality. The proposal is considered unlikely to exacerbate this KTP.

4.1.2 Removal of threatened fauna habitat

Table 4.2 details the direct impact on threatened fauna habitat for all threatened fauna species recorded in the study area or presumed to be present (based on the site survey and habitat assessment (**Appendix B**).

Table 4.2: Impacts on threatened fauna and fauna habitat

| Species | Potential occurrence | Impacted by proposal? | Impact |
|---|----------------------|-----------------------|--|
| Barking Owl (<i>Ninox connivens</i>) | Moderate | Yes | Loss of 0.95 ha of potential foraging and roosting habitat |
| Eastern Bentwing-bat (<i>Miniopterus schreibersii oceanensis</i>) | Recorded | Yes | Loss of 0.95 ha of potential foraging habitat |
| Eastern False Pipistrelle (<i>Falsistrellus tasmaniensis</i>) | Recorded | Yes | Loss of 0.95 ha of potential foraging habitat |
| Eastern Freetail-bat (<i>Mormopterus norfolkensis</i>) | Recorded | Yes | Loss of 0.95 ha of potential foraging habitat |
| Eastern Pygmy-possum (<i>Cercartetus nanus</i>) | Moderate | Yes | Loss of 0.95 ha of potential foraging habitat |
| Gang-gang Cockatoo (<i>Callocephalon fimbriatum</i>) | Moderate | Yes | Loss of 0.95 ha of potential foraging and roosting habitat |
| Greater Broad-nosed Bat (<i>Scoteanax rueppellii</i>) | Moderate | Yes | Loss of 0.95 ha of potential foraging habitat |
| Greater Glider (<i>Petauroides volans</i>) | Moderate | Yes | Loss of 0.95 ha of potential foraging habitat |
| Green and Golden Bell Frog (<i>Litoria aurea</i>) | Moderate | Yes | Loss of 0.95 ha of potential foraging habitat |
| Little Lorikeet (<i>Glossopsitta pusilla</i>) | Moderate | Yes | Loss of 0.95 ha of potential foraging and roosting habitat |
| Masked Owl (<i>Tyto novaehollandiae</i>) | Moderate | Yes | Loss of 0.95 ha of potential foraging habitat |
| Powerful Owl (<i>Ninox strenua</i>) | Moderate | Yes | Loss of 0.95 ha of potential foraging habitat |
| Sooty Owl (<i>Tyto tenebricosa</i>) | Moderate | Yes | Loss of 0.95 ha of potential foraging habitat |
| Spotted-tailed Quoll (<i>Dasyurus maculatus</i>) | Moderate | Yes | Loss of 0.95 ha of potential foraging habitat |
| Yellow-bellied Glider (<i>Petaurus australis</i>) | Moderate | Yes | Loss of 0.95 ha of potential foraging habitat |
| Yellow-bellied Sheathtail-bat (<i>Saccolaimus flaviventris</i>) | Moderate | Yes | Loss of 0.95 ha of potential foraging habitat |

The proposal would remove foraging and/or sheltering and/or roosting habitat for these species. However, this habitat is not limited in the Study locality and represents general resources for these species and not associated with crucial life stages (breeding). None of these species are considered dependent on the foraging and refuge habitat provided by the native vegetation present within the study area. The vegetation communities present are not limited in the Study locality (see **Section 4.1.1** above).

The study area does contain important habitat features for many of these species comprising seven habitat-bearing trees (with hollows, loose bark and deep fissures), a small marshy waterbody, ephemeral creek line and two large stormwater culverts which could provide roosting resources for the Eastern Bentwing-bat. However, these resources are located outside of the construction footprint and their removal would not be required for the proposal. The utility of these resources for the species listed above may be indirectly impacted, these potential impact are discussed below in **Section 4.2**.

The following KTPs under the BC Act and/or EPBC Act are relevant to direct impact on fauna habitat and have the potential to be exacerbated by the proposal.

- Bushrock Removal (BC Act)
 - No significant bushrock features were identified within the study area. The study area lacked areas of exposed bedrock, cliffs, boulders etc. The proposal would not exacerbate this KTP in the locality
- Clearing of native vegetation (BC Act), land clearance (EPBC Act)
 - The proposal will result in the removal of a small portion of native vegetation. This would represent a loss of potential foraging and roosting habitat for threatened fauna. However, the projected level of impact on native vegetation in the Study locality is considered to be small and no local threatened fauna species population is considered to be dependent on the resources of the study area for their long-term survival. This impact is not considered a significant exacerbation of this KTP on the locality scale
- Loss of Hollow-bearing Trees (BC Act)
 - No hollow-bearing trees identified during the site survey would need to be removed for the proposal. The proposal is considered unlikely to exacerbate this KTP
- Removal of dead wood and dead trees (BC Act)
 - The proposal is not anticipated to require the removal of any dead trees identified in the study area. Dead wood resources would be removed for the required road upgrade works. However, the resources to be removed from the impact area are not considered to represent a significant reduction of these resources in the locality. The proposal is considered unlikely to exacerbate this KTP.

4.1.3 Removal of threatened flora

Table 4.3 below details the projected direct impact on threatened flora and their habitats within the study area as a result of the proposal.

Table 4.3 Impacts on threatened flora

| Threatened species | Status* | | Habitat individuals to be impacted | Habitat individuals in the study area |
|---|---------|----------|------------------------------------|---------------------------------------|
| | BC Act | EPBC Act | | |
| Biconvex Paperbark (<i>Melaleuca biconvexa</i>) | V | V | 42 individuals 0.95 ha habitat | 284 individuals 3.19 ha habitat |
| Magenta Lilly Pilly (<i>Syzygium paniculatum</i>) | E | V | 0 individuals 0.95 ha habitat | 2 individuals 3.19 ha habitat |

*V = Vulnerable, E = Endangered

As detailed in **Section 3** above, populations of both of these species were documented in the study area. The majority of these populations are located outside of the proposal Area and would not be directly impacted as a result of the proposal. However, a small number of Biconvex Paperbark individuals would be removed for the Princes Highway southbound lane batter as well as a result of track improvement work to facilitate truck access within the main body of the study area.

The total area of suitable habitat for these two species shown in **Table 4.3** considered the PCTs associated with these species in the DPIE BioNet database. The Biconvex Paperbark is associated with PCT 694 and the Magenta Lilly Pilly is associated with PCT 1206. However, as portions of both populations were found in both PCTs present, the total area of available habitat listed in **Table 4.3** includes the available areas of both PCTs within the study area.

4.1.4 Aquatic impacts

As detailed in **Section 3.3.1** above, the ephemeral creek line within the study area was identified as class 4 unlikely fish habitat and type 3 minimally sensitive fish habitat as defined by table 1 and table 2 of the NSW DPI Policy and guidelines for fish habitat conservation and management (NSW Department of Primary Industries (Fisheries), 2013). The stream was assessed as small, intermittent and lacking important fish habitat resources (deep pools, gravel beds, snags and aquatic vegetation). This creek line is not considered to provide potential habitat for any threatened fish species listed under the NSW FM Act or Commonwealth EPBC Act known or considered likely to occur in the Study locality.

The proposal would require disturbance to the creek line base for the upgrade of the existing access track. This would result in the removal of instream vegetation and disturbance of the creek channel. The construction footprint would also intrude close (within 10 m) to the western edge of the creek line for the installation of the new batter north of the intersection. These earthworks would be a potential source of sediment and contaminant inflows into the creek environment. This has the potential to smother riparian and in-stream vegetation, contaminate soils and provide a vector for contaminant and sediment outflows from the study area. Exposure of soil next to the creek line would also provide a new vector for weed colonisation, which could migrate into the creek line environment. Clearing of nearby vegetation to the west of the creek line would also change the local light and ambient temperature regimes, potentially affecting existing vegetation assemblages and creating conditions more suitable for weed colonisation.

The installation of the proposed batter to the west of the creek line would also change the local surface hydrology of the study area, which would likely facilitate higher energy surface flows entering the western bank of the creek line during rain events. This has the potential to lead to new scouring of the bank, sediment mobilisation and downstream transport and adverse impact on riparian vegetation through root exposure and destabilisation.

The study area is located on lands mapped as class 5 Acid Sulphate Soil (ASS) risk on the Acid Sulfate Soils Map - Sheet ASS_014 of the SLEP 2014 (Shoalhaven City Council, 2014). The study area is also not mapped as high or low probability of ASS occurrence on the ASS Risk Map (NSW Office of Environment and Heritage, 1998). The proposal is considered to have a low risk of ASS mobilisation.

Impact to this creek line would be small. The small amount of nearby land to be cleared by the proposal is not considered likely to significantly alter the functioning and habitat utility of this creek line after the completion of works.

4.1.5 Injury and mortality

Injury and mortality of resident fauna may occur during all phases of the Project:

- Resident fauna may be injured or killed during vegetation clearing works
- Increased traffic and plant may lead to a higher collision risk during works

- Compound site fencing, bunding and other temporary structures may create trap points for local fauna within the study area.

Fauna mortality during vegetation clearing is considered likely to be minimal. As detailed in **Section 3** above, the vegetation to be removed for the proposal Area was not assessed as containing high value fauna habitat features such as habitat-bearing trees in which nocturnal fauna may be sheltering during clearing works. Fauna such as macropods, likely to be present within this area during clearing works would be able to self-relocate during works and the removal of a small portion of native vegetation required is not considered likely to lead to significant fauna mortality.

However, disturbance caused by clearing activity would likely mobilise resident fauna to relocate out of the study area into nearby vegetation. This may result in a greater risk of collision with public vehicles on the nearby minor roads (Island Point Road and Grange Road) during works.

Additional road traffic associated with the proposal work phase is not considered likely to represent a significant increase in local traffic volumes. The Princes Highway is the major transport corridor along the NSW east coast. Staff and contractor vehicle traffic for the proposal are not considered likely to significantly increase the risk of fauna collision on the existing road network. The proposal would not create new roads through fauna habitat areas, and would not lead to novel fauna/vehicle interaction points.

Fauna may become disorientated and trapped by temporary infrastructure within the compound site. This can lead to injury and mortality through entanglement with fencing and other barriers or create points of interaction between fauna and vehicles.

Local native fauna considered most at risk from these impact comprise large terrestrial mammals including kangaroos and wallabies (family Macropodidae), large arboreal mammals which may be forced to the ground to cross roads during works, including possums and gliders (families Petauridae, Phalangeridae and Pseudocheiridae). Glider species which may be impacted include the threatened Greater Glider and Yellow-bellied Glider, both identified in this report as occurring in the study area.

4.2 Indirect/operational impacts

4.2.1 Wildlife connectivity and habitat fragmentation

As detailed in **Section 3**, lot 8 DP 855413 is identified as biodiversity – habitat corridor in the SLEP 2014. This vegetation forms part of local habitat connectivity through the study area into native vegetation to the north, east and south with existing native vegetation on nearby lots also identified as habitat corridor lands in this instrument.

The proposal would remove native vegetation from the western edge of this lot for the widening of the Princes Highway. However, the proposal would not isolate any portion of the native vegetation present. Clearing would occur along the eastern edge of the existing roadway and north-south connectivity within this lot would be retained through the vegetation in the east of the lot. This lot is not the only vegetation providing fauna dispersal habitat east of the highway. Large areas of similar native vegetation are present on lot 11 DP 855413, lot 342 DP 1170961 and lot 12 DP 855413. None of the vegetation on these lots would be removed by the proposal. Lot 25 DP 792969, proposed to contain the compound site also contains large areas of native vegetation mapped as habitat corridor. As detailed above, the proposal would not require the removal of native vegetation from this lot and no fragmentation, isolation or constriction of fauna habitat for fauna dispersal potential through this vegetation is anticipated as a result of the proposal.

The existing Princes Highway roadway represents an existing barrier to east-west fauna dispersal. The width of this roadway next to the study area is estimated to be 25 m. The greatest widening of this roadway is required for the batter within lot 8 DP 855413 with a

maximum estimated new cleared width of 60 m along an estimated 110 m, of the total works length of 380 m. The remainder of the works are anticipated to require a total cleared width of between 28 m (at the southern extent of works) to 45 m (the greatest width required for the proposed batter on the east side of the Princes Highway, south of the Island Point Road turnoff). Widening of Island Point Road would be limited, from a current cleared width of 20 m to an estimated maximum of 30 m (near the junction with the Princes Highway) along a distance of 90 m. No works are proposed along Grange Road; the proposal would not impact on existing habitat connectivity over this roadway.

The required clearing is not considered likely to significantly reduce fauna dispersion capability across the Princes Highway through mapped habitat corridor lands. The extent of works is limited (380 m along the Princes Highway) and existing connectivity to the north and south of the works extent would not be significantly altered by the required upgrades of Island Point Road.

Arboreal mammal dispersion across the Princes Highway and Island Point Road would not be interrupted by the proposal. The approved NSW Recovery Plan for the Yellow-bellied Glider states gliding distances of up to 140 m have been recorded for this species (NSW National Parks and Wildlife Service, 2003). However, this distance is strongly related to the vegetation present (height) with gaps as narrow as 50 m identified as dispersal barriers in some vegetation types.

The proposal would not introduce new dispersal barriers, but it would increase the width of the Princes Highway within the construction footprint as detailed above. The woody native vegetation communities present within the study areas are representative of tall, wet sclerophyll forests, providing high points for glider dispersal across the highway. As above, the widening of the Princes Highway would not result in the isolation or fragmentation of any area of habitat, with the existing distance between native forest vegetation retained to the north and south of the construction footprint.

The existing Princes Highway represents an existing dispersal barrier to non-gliding arboreal mammals. However, the large northern stormwater pipe would provide a dispersal corridor for some arboreal and semi-arboreal mammals such as the Common Brushtail Possum (*Trichosurus vulpecula*) and Spotted-tailed Quoll. This structure would not be removed or permanently blocked by the proposal.

4.2.2 Edge effects on adjacent native vegetation and habitat

Edge effects are secondary impacts on vegetation and fauna habitat caused by the creation of new borders between vegetation and cleared areas. These effects typically create changes in populations and community structures within the edge area (Levin, 2009). Edge effects resulting from the creation of new habitat borders include:

- The creation of new, potentially adverse microclimate conditions (higher light exposure, changes in relative humidity etc) which may be disadvantageous to native flora and fauna
- Creation of a new vector for the entry of new exotic weed species, either from existing nearby populations or from new colonists of the newly exposed cleared area
- Higher inflows of stormwater sediment and pollutants from the newly exposed cleared area into nearby retained vegetation
- Higher incidence of human utilisation (creation of new tracks, dumping etc).

The proposal will create new borders through clearing of native vegetation along the east side of the Princes Highway and the north and south sides of Island Point Road. This will result in areas of exposed soil upslope of retained vegetation, creating potential for the movement of unconsolidated sediments and associated contaminants into retained vegetation.

The vegetation of Princes Highway road reserve and within lot 8 DP 855413 is located next to existing road networks and consequently, edge effects already impact along the road/bushland interface throughout much of the study area. Evidence of edge effects are

apparent along this boundary with the primary weed populations present within cleared lands next to the sealed road surface. See **Section 4.2.3** below for an assessment of the weed risk to the study area.

Clearing of native vegetation for the proposal would move the existing road/bushland boundary further into existing native vegetation. This would likely have an adverse impact on the retained vegetation after clearing through changing the solar, wind, ambient temperature and relative humidity conditions in the new boundary. This would likely favour more light and dry tolerant exotic and native species at the detriment of existing shade tolerant species, including the retained threatened Biconvex Paperbark population. However, with reference to the Commonwealth Approved Conservation Advice for this species, this species is known to occur in exposed locations as a dominant canopy species (Australian Government Department of Environment and Energy, 2008). The strongest microhabitat driver for this species is the presence of streams or damp drainage lines. As detailed above, the existing drainage line would not be removed or significantly altered by the proposal. The other threatened flora population present within the study area, the Magenta Lilly Pilly is located in the east of the study area. No significant vegetation removal is proposed in this area and the microclimatic conditions for this population are not considered likely to be significantly altered by the proposal. The widening of the existing access track in this area will retain a 10 m buffer distance from the two identified individuals.

Exposure of new areas of unconsolidated soil and the installation of new batters next to retained vegetation would create new sources of sediment and consolidated contaminants (fuel, lubricants etc from plant and other vehicles) which could migrate into retained vegetation during rain events. This effect is already present from the nearby road networks; however, the proposal would exacerbate these impacts particularly through the creation of large areas of new exposed soil. This impact would be largely limited to the construction phase and would the impact would recede as the exposed area is consolidated by recovering vegetation.

Clearing of vegetation next to the high value fauna habitat features identified in the study area (habitat-bearing trees) may decrease the utility of these items for native fauna, including threatened species. However, these items are located near to a busy roadway network with artificial lighting.

4.2.3 Invasion and spread of weeds

Existing weed populations are largely present within cleared lands next to the sealed road surface. These are predominantly exotic perennial grass (African Love Grass (*Eragrostis curvula*)) and perennial and annual woody weeds (Paddys Lucerne (*Sida rhombifolia*) and Purpletop (*Verbena sp.*). Low densities of the priority weeds (under the *Biosecurity Act 2015*) Blackberry (*Rubus fruticosus* agg.) and Lantana (*Lantana camara*) were present along the margins of the study area, next to the existing roads.

Clearing of native vegetation would provide opportunities for colonisation of exposed soil by existing weed populations. Mobilisation of weed seed and propagules in stormwater runoff from cleared areas would provide a vector for spread of these species deeper into retained vegetation downslope, particularly along the ephemeral drainage line. As detailed above, changes in the local microclimate along the new cleared boundary would also favour weed colonisation into nearby retained vegetation.

The proposal could also lead to the introduction of new weed species through contaminated soil in imported fill, through soil and weed seed on unclean plant and equipment and from potting soil used for post works revegetation. The introduction and spread of several weed species are recognised as KTPs under the BC Act:

- Invasion and establishment of exotic vines and scramblers
- Invasion and establishment of Scotch broom (*Cytisus scoparius*)
- Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)

- Invasion, establishment and spread of *Lantana camara*
- Invasion of native plant communities by Bitou bush and Boneseed (*Chrysanthemoides monilifera*)
- Invasion of native plant communities by exotic perennial grasses
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.

The proposal could result in the introduction of the above weeds through the processes detailed above.

4.2.4 Invasion and spread of pests

Numerous exotic insect and animal species are recognised as significant pests in NSW. These species can have serious adverse impact on native flora and fauna species through competition for resources, direct predation and as vectors for parasites and diseases. The introduction and spread of several feral pests are recognised as KTPs under the BC Act:

- Competition and grazing by the feral European rabbit
- Competition and habitat degradation by Feral Goats, *Capra hircus* Linnaeus 1758
- Competition from feral honeybees
- Habitat degradation and loss by Feral Horses (brumbies, wild horses), *Equus caballus*
- Herbivory and environmental degradation caused by feral deer
- Importation of red imported fire ants into NSW
- Introduction of the large earth bumblebee (*Bombus terrestris*)
- Invasion and establishment of the Cane Toad
- Invasion of the yellow crazy ant (*Anoplolepis gracilipes*) into NSW
- Predation and hybridisation by Feral Dogs, *Canis lupus familiaris*
- Predation by feral cats
- Predation by the European Red Fox
- Predation by the Plague Minnow (*Gambusia holbrooki*)
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*).

The proposal is not considered likely to lead to the proliferation of existing or the importation of large exotic mammal pest species such as feral cats, foxes or wild dogs. The proposal would not involve the translocation, keeping or breeding of any pest species. The compound site may attract resident feral animals (such as foxes) through the provision of additional foraging resources (food waste) and through providing additional sheltering resources (under new structures). However, any such impact would be limited to the construction phase and is considered unlikely to lead to a significant increase in the local population of any pest species in the long-term.

The proposal may lead to the inadvertent introduction of new insect pest species through contaminated soil used for construction or on uncleaned plant and other equipment.

4.2.5 Invasion and spread of pathogens and disease

Pathogens and diseases affecting native species can be introduced through the transport of contaminated media or in infected host fauna (either deliberately or incidentally translocated). Several pathogens and diseases are recognised as KTPs under the BC Act and could affect native species present in the study area and Study locality, including threatened species:

- Infection by *Psittacine circoviral* (beak and feather) disease affecting endangered psittacine species.
- Infection of frogs by amphibian chytrid causing the disease chytridiomycosis.
- Infection of native plants by *Phytophthora cinnamomi*.
- Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae.

Phytophthora cinnamomi and Exotic Rust Fungi could have an adverse impact on native flora species within the study area, including of the two threatened flora species identified (both members of the family Myrtaceae). Both of these diseases can be introduced in contaminated soil used for construction or on uncleaned plant and other machinery. These diseases can also be introduced through contaminated water used for dust suppression or otherwise discharged into an area (NSW Department of Environment and Climate Change, 2008). This risk can be managed through the use of treated water onsite and is not considered a high risk for the proposal.

Chytridiomycosis is a significant fungal infection affecting amphibian populations worldwide. It is spread by physical contact between infected host amphibians and through spores in contaminated water (Commonwealth of Australia, 2016). The proposal may introduce this disease through the incidental translocation of infected host amphibians in tubestock used for revegetation works or through discharge of contaminated water used on site. This risk can be managed through local sourcing of landscaping tubestock and use of treated water onsite and is not considered a high risk for the proposal.

Psittacine circoviral (beak and feather) disease is primarily transmitted by contamination of nesting hollows with spores from infected birds (Australian Government Department of Environment and Heritage, 2005). The proposal is not considered likely to lead to the introduction of this disease into the study area. The proposal does not include likely transmission vectors such as the introduction of potentially infected host fauna.

4.2.6 Changes to hydrology

The proposal would lead to local changes in surface hydrology, largely due to the installation of new batters to support the upgrade of the Princes Highway. These batters would be located above the retained native vegetation areas on the east side of the Princes Highway. This would change the local surface flow regimes flowing into downstream areas.

However, long-term hydrological changes to the surface hydrology of the study area are considered to be minor. The study area is already affected by the Princes Highway/Island Point Road hardstand watershed. Although the proposal would increase the overall size of this hardstand watershed, this is not considered likely to substantially increase the surface water flows entering the retained vegetation of the study area after the completion of works. The proposal is also not considered likely to substantially increase stormwater discharge into retained vegetation after the works. The proposal would replace one existing stormwater pipe and culvert within the Princes Highway roadway and install an additional pipe and culvert in the Island Point Road roadway.

4.2.7 Noise, light and vibration

Noise

Construction generated traffic would be limited to workers' vehicles and material transport. These movements would make negligible difference to existing traffic noise levels on the Princes Highway.

Light

With reference to **Section 1.2** of this report, night work is proposed for the proposal. Artificial light sources could affect habitat utility for resident native fauna during night works. New street lighting along the Princes Highway would not increase local artificial light sources after the completion of works, as this work would replace and relocate existing light sources.

Vibration

Vibration generated by construction works is not considered likely to significantly increase current vibration impacts from the existing roadways. No blasting is anticipated during the construction phase, if blasting is required, further detailed assessment would be required and a blast management plan prepared.

4.2.8 Groundwater dependent ecosystems

As discussed in **Section 3.3** the PCT Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (1206) is mapped as a terrestrial GDE in the Australian Government BOM Groundwater Dependent Ecosystems (GDE) Atlas. Assessment under Section 5.2.2 of the Risk assessment guidelines for groundwater dependent ecosystems identified this GDE as possessing high ecological value. This section applies steps 5, 6 and 7 of the risk assessment process. The proposal would include direct clearing of this terrestrial GDE as well as local alterations to surface water flow patterns and surface water recharge of local aquifers. The Risk assessment guidelines for groundwater dependent ecosystems provides a method for determining the risk of an activity to the ecological value of an aquifer and associated GDEs. **Table 4.4** below applies Table 5 of Section 7.1 (determine the impact of an activity to identified GDEs) of the risk assessment guidelines.

Table 4.4 Aquifer/GDE impact checklist for a proposed activity

| | Likely | Unlikely | Insufficient data |
|--|--------|----------|-------------------|
| Water quantity impacts | | | |
| Will there be an alteration to the watertable levels (rising or dropping water tables)? | | X | |
| Will there be any alteration to the aquifer flow paths? | | X | |
| Will there be any alteration of aquifer discharge volume to off-site GDEs? | | X | |
| Will there be an alteration of the frequency/timing of water table level fluctuations? | | X | |
| Will there be any alteration of river base flow in the karst / cave? | | X | |
| Will there be an alteration of surface river base flow? | | X | |
| Will there a reduction in artesian/spring water pressure? | | X | |
| Water quality impacts | | | |
| Will there be an alteration to the natural groundwater chemistry and / or chemical gradients? | | X | |
| Will acid sulfate soils be exposed, resulting in the acidification of aquifer and acid runoff? | | X | |
| Will there be an alteration in nutrient loads? | X | | |
| Will there be an alteration in sediment loads? | X | | |
| Will there be an alteration in groundwater salinity levels? | | X | |
| Will there be an alteration in groundwater temperatures? | | X | |
| Will there be any bioaccumulation of heavy metals? | | X | |
| Aquifer Integrity impacts | | | |
| Will there be any substrate alteration compaction; eg aquifer, river gravel bed compaction by heavy machinery or over extraction of water? | X | | |
| Will there be any cracking or fracturing of the bedrock? | | X | |
| Biological integrity impacts | | | |
| Will there be an alteration to the number of native species within the groundwater dependent communities (fauna and flora)? | | X | |
| Will there be an alteration to the species composition of the groundwater dependent communities (fauna and flora)? | | X | |
| Will exotic flora or fauna be introduced? | | | |

| | Likely | Unlikely | Insufficient data |
|--|----------|-----------------|-------------------|
| Will there be any removal or alteration of a GDE type/subtype habitat; eg quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction? | X | | |
| Total | 4 | 15 | |
| Impact | | Unlikely | |

Based on this assessment, the proposal is considered unlikely to impact the identified GDE. The proposal would involve the clearing of terrestrial vegetation GDE and minor alterations to surface hydrology through an increase in hardstands and modifications to the existing road network stormwater infrastructure. However, the proposal is not considered likely to substantially alter the groundwater expression and surface recharge of the underlying aquifer supporting the terrestrial GDE. The proposal would not involve excavation into the watertable, fracturing of underlying bedrock or groundwater extraction.

Table 4.5 below applies Table 7 of Section 7.2 (determine the magnitude of the risk to identified GDEs) of the risk assessment guidelines.

Table 4.5 Aquifer and GDE risk assessment

| Risk factors | High | Moderate | Low | Insufficient data or unknown | Assessment |
|---|---|---|---|------------------------------|------------|
| Water quantity asset | | | | | |
| What will be the risk of a change in groundwater levels/pressure on GDEs? | Reduction in groundwater level(s) or piezometric pressure beyond seasonal variation, resulting in permanent loss or alteration of defined habitat type. | Reduction in groundwater level(s) or piezometric pressure beyond seasonal variation, resulting in temporary loss or alteration of defined habitat type. | No change to aquifer water levels or pressure. | | Low |
| What will be the risk of a change in the timing or magnitude of groundwater level fluctuations on GDEs? | Fluctuation in groundwater level(s) or piezometric pressure beyond established seasonal variation, resulting in permanent loss or alteration of defined habitat type. | Fluctuation in groundwater level(s) or piezometric pressure beyond seasonal variation, resulting in temporary loss or alteration of defined habitat type. | No change in timing of water level fluctuations | | Low |
| What will be the risk of changing base flow conditions on GDEs? | Permanent reversal of base flow conditions. | Temporary reversal of base flow conditions exceeding seasonal variation. | No change in direction of flow | | Low |
| Water quality asset | | | | | |
| What is the risk of changing the chemical conditions of the aquifer? | Permanent change; eg. in pH, DO, nutrients, temperature and/or turbidity | Temporary change; eg. in pH, DO, nutrients, temperature and/or turbidity. | Negligible change (<5%). | | Low |
| What is the risk on the aquifer by a change in the freshwater/salt water interface? | Permanent change in location or gradient of | Temporary change in location or gradient of | No change or not applicable | | Low |

| Risk factors | High | Moderate | Low | Insufficient data or unknown | Assessment |
|--|--|---|---|------------------------------|---|
| | salt/freshwater interface | salt/freshwater interface | | | |
| What is the likelihood of a change in beneficial use (BU) of the aquifer? | Reduction in water quality beyond designated BU category (for identified trigger parameters) | Reduction in water quality within designated BU category (for identified trigger parameters) | Negligible change for identified triggers (<5%) | | Low |
| Aquifer integrity asset | | | | | |
| What is the risk of damage to the geologic structure? | Permanent destruction of the aquifer matrix. Major cracking/fracturing of the bedrock/stream bed leading complete dewatering of the GDE. | Temporary adjustment to the aquifer matrix. Minor cracking/fracturing of the bedrock/stream bed leading to partial dewatering of the GDE. | No change | | Low |
| Biological integrity asset | | | | | |
| What is the risk of alterations to the number of native species within the groundwater dependent communities (fauna and flora)? | > 10% reduction in No. of species. | 10 to 5% reduction in No. of species. | No reduction in No. of species | | Low |
| What is the risk of alterations to the species composition of the groundwater dependent communities (fauna and flora)? | > 10% change in species composition. | 10 to 5% change in species composition. | No change in species composition. | | Low |
| What is the risk of increasing the presence of exotic flora or fauna? | Large populations of one or more species. | Species in small numbers. | None exist. | | Moderate |
| What is the risk of removing or altering a GDE subtype habitat; eg. quarrying of limestone around karsts, tramping of cave habitats, sand and gravel extraction? | > 20% removal or alteration of habitat area. | 10 to 20% removal or alteration of habitat. | No removal or alteration of habitat. | | High The total removal of the terrestrial GDE is estimated to be about 40 % of the |

| Risk factors | High | Moderate | Low | Insufficient data or unknown | Assessment |
|-----------------------|------|----------|-----|------------------------------|---|
| | | | | | total occurrence of the GDE within the study area |
| Risk valuation | 1 | 1 | 9 | | |
| Risk | | | | | Low |

Exception rule: If the number of **unknowns** exceed 50 per cent of questions, the risk is considered to be high until proven otherwise.

*Note: Methods to determine magnitude or degree of alteration will depend on the criteria and habitat type being monitored. A discussion on these methods is outside the scope of this document.

Based on this assessment, the risk to this GDE is considered to be low. The proposal is not considered likely to significantly alter the groundwater expression this terrestrial GDE depends upon. Impacts would be limited to physical clearing of the terrestrial GDE vegetation (including associated threatened species) and changes to surface hydrology.

Considering the above assessments, Figure 5 of the risk assessment guidelines (the risk assessment matrix) has been applied, see **Figure 4.1** below.

| | | | |
|--|---------------------------------|--------------------------------------|----------------------------------|
| Category 1 High Ecological Value (HEV) Sensitive Environmental Area (SEA) | A | B | C |
| Category 2 Moderate Ecological Value (MEV) Sensitive Environmental Area (SEA) | D | E | F |
| Category 3 Low Ecological Value (LEV) | G | H | I |
| | Category 1. Low Risk | Category 2. Moderate Risk | Category 3. High Risk |

Figure 4.4 Risk matrix for GDE impact assessment

Based on the assessment above (**Table 4.4** and **Table 4.5**) the GDE has been assessed as falling within risk matrix box A (high ecological value/low risk). Table 8 of the risk assessment guidelines recommend management actions for each matrix box. These management actions are discussed in **Section 5** below.

4.3 Cumulative impacts

The proposal is expected to add a number of cumulative impact including removal of 0.95ha of vegetation from the study area, a portion of a population of one threatened flora species and 0.95 hectares of habitat for two threatened flora species and 16 threatened fauna species and increased activity on Island Point Road, Grange Road and the Princes Highway. **Table 4.6** identifies past, present and future projects in the local region which could increase cumulative impact of the proposal on the local scale.

Table 4.6 Past, present and future projects

| Project | Construction impacts | Operational impacts |
|---|---|---|
| <p>Nowra Bridge Upgrade:</p> <p>Roads and Maritime is planning for a new 4 lane bridge over the Shoalhaven River, upgraded intersections and additional lanes on the Princes Highway. The project would improve traffic flow and ease congestion on a major section of the Princes Highway and deliver faster and more reliable journeys within the Nowra-Bomaderry area.</p> <p>The REF and concept design was made for public display in August 2018 from a submissions report was provided.</p> <p>Roads and Maritime will soon issue a Request for Tenders for the detailed design and construction of the project. It is expected that the successful contractor will be announced in the first half of 2020</p> | <p>Due to the timing of the bridge upgrade it is not expected that there will be any construction impact to the proposed roundabout</p> | <p>The operational impact of the bridge will ease congestion on the Princes Highway and deliver safer and reliable travel to the Shoalhaven LGA</p> |
| <p>Princes Highway Upgrade:</p> <p>The NSW government has committed to upgrade the Princes Highway that includes duplicating sections of the Princes Highway from Jervis Bay Road to Sussex Inlet Road</p> | <p>Due to the timing of the road duplication it is not expected that there will be any impacts to the proposed roundabout.</p> | <p>The operational impact of the road duplication will improve the safety and connectivity in the South Coast region.</p> |

The above project would be located around 22 km from the study area and would be located within a predominantly urban landscape. The cumulative impacts of this project and the proposal are not considered likely to significantly exacerbate the impacts on the biodiversity values detailed in this report.

4.4 Assessments of significance

Under Part 7.3 of the *Biodiversity Conservation Act 2016* (BC Act) a five-part test is required to determine whether a significant impact on any threatened species or TEC listed under the BC Act known or considered likely to occur on a site as a result of a proposed action. If a significant impact is considered likely, based on the test then further assessment through a Species Impact Statement (SIS) is required or a Biodiversity Development Assessment Report (BDAR) must be prepared by an accredited assessor in accordance with the Biodiversity Assessment Method (BAM).

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* an Assessment of Significance (AoS) is required to determine whether a significant impact on any threatened species or TEC listed under the act known or considered likely to occur on a site as a result of a proposed action. If a significant impact is considered likely, based on the test then further assessment through a referral to the federal Minister of the Environment and Energy is required. Referrals under the EPBC Act are no longer required for Roads and Maritime Services proposals under Part 5 of the EP&A Act in accordance with the Strategic Assessment process. However, significance assessments are still required to be completed.

A total of 24 BC Act listed threatened species (two flora and 22 fauna) were documented or considered to have a moderate or high likelihood of occurrence within the study area. Five MNES threatened species under the EPBC Act (two flora and three fauna) were documented to considered to have a moderate or high likelihood of occurrence within the study area.

Based on this assessment, Assessments of Significance (AoS) were undertaken for these species in accordance with the *Threatened species assessment guidelines – assessment of significance* for EPBC Act listed species and the *Matters of National Environmental Significance – Assessment of significance guidelines* for EPBC Act listed species (NSW Office of Environment and Heritage, 2018) (Australian Government Department of the Environment, 2013). **Table 4.7** below summarises the results of these assessments. The full assessments are provided in **Appendix C**.

Table 4.7: Summary of the findings of significance assessments

| BC Act significance assessments | | | | | | |
|---|---|---|---|---|---|----------------------------|
| Threatened species, or communities | Significance assessment question ¹ | | | | | Likely significant impact? |
| | a | b | c | d | e | |
| Biconvex Paperbark (<i>Melaleuca biconvexa</i>) | N | X | N | N | N | No |
| Magenta Lilly Pilly (<i>Syzygium paniculatum</i>) | N | X | N | N | N | No |
| Barking Owl (<i>Ninox connivens</i>) | N | X | N | N | N | No |
| Eastern Bentwing-bat (<i>Miniopterus schreibersii oceanensis</i>) | N | X | N | N | N | No |
| Eastern False Pipistrelle (<i>Falsistrellus tasmaniensis</i>) | N | X | N | N | N | No |
| Eastern Freetail-bat (<i>Mormopterus norfolkensis</i>) | N | X | N | N | N | No |
| Eastern Pygmy-possum (<i>Cercartetus nanus</i>) | N | X | N | N | N | No |
| Gang-gang Cockatoo (<i>Callocephalon fimbriatum</i>) | N | X | N | N | N | No |
| Greater Broad-nosed Bat (<i>Scoteanax rueppellii</i>) | N | X | N | N | N | No |
| Green and Golden Bell Frog (<i>Litoria aurea</i>) | N | X | N | N | N | No |
| Little Lorikeet (<i>Glossopsitta pusilla</i>) | N | X | N | N | N | No |
| Masked Owl (<i>Tyto novaehollandiae</i>) | N | X | N | N | N | No |
| Powerful Owl (<i>Ninox strenua</i>) | N | X | N | N | N | No |
| Sooty Owl (<i>Tyto tenebricosa</i>) | N | X | N | N | N | No |
| Spotted-tailed Quoll (<i>Dasyurus maculatus</i>) | N | X | N | N | N | No |
| Yellow-bellied Glider (<i>Petaurus australis</i>) | N | X | N | N | N | No |
| Yellow-bellied Sheathtail-bat (<i>Saccolaimus flaviventris</i>) | N | X | N | N | N | No |
| Little Lorikeet (<i>Glossopsitta pusilla</i>) | N | X | N | N | N | No |
| Masked Owl (<i>Tyto novaehollandiae</i>) | N | X | N | N | N | No |
| Powerful Owl (<i>Ninox strenua</i>) | N | X | N | N | N | No |

| BC Act significance assessments | | | | | | |
|---|---|---|---|---|---|----------------------------|
| Threatened species, or communities | Significance assessment question ¹ | | | | | Likely significant impact? |
| | a | b | c | d | e | |
| Sooty Owl (<i>Tyto tenebricosa</i>) | N | X | N | N | N | No |
| Spotted-tailed Quoll (<i>Dasyurus maculatus</i>) | N | X | N | N | N | No |
| Yellow-bellied Glider (<i>Petaurus australis</i>) | N | X | N | N | N | No |
| Yellow-bellied Sheathtail-bat (<i>Saccolaimus flaviventris</i>) | N | X | N | N | N | No |

| EPBC Act Assessments | | |
|---|-----------------------------------|----------------------------|
| Threatened species, or communities | Important population ² | Likely significant impact? |
| Biconvex Paperbark (<i>Melaleuca biconvexa</i>) | No | No |
| Magenta Lilly Pilly (<i>Syzygium paniculatum</i>) | No | No |
| Greater Glider (<i>Petauroides volans</i>) | No | No |
| Green and Golden Bell Frog (<i>Litoria aurea</i>) | No | No |
| Spotted-tailed Quoll (<i>Dasyurus maculatus</i>) | N/A | No |

Notes: Y= Yes (negative impact), N= No (no or positive impact), X= not applicable, ?= unknown impact.

1. Significance Assessment Questions as set out in the *Biodiversity Conservation Act 2016*.
 - a In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.
 - b In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:
 - i. Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or
 - ii. Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.
 - c In relation to the habitat of a threatened species or ecological community:
 - i. The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity;
 - ii. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity; and
 - iii. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.
 - d Whether the action proposed is likely to have an adverse effect any declared area of outstanding biodiversity value (either directly or indirectly).
 - e Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.
2. A 'population of a species' as determined by the *Environment Protection and Biodiversity Conservation Act 1999* is an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:
 - a. a geographically distinct regional population, or collection of local populations, or a population, or collection of local populations, that occurs within a particular bioregion.

Important Population as determined by the *Environment Protection and Biodiversity Conservation Act 1999*, is one that for a vulnerable species:

- a is likely to be key source populations either for breeding or dispersal
- b is likely to be necessary for maintaining genetic diversity
- c is at or near the limit of the species range.

These assessments concluded the proposal is not likely to have a significant impact on any BC Act listed entities, and further assessment through a SIS or BDAR is not considered necessary. These assessments also concluded the proposal is not likely to have a significant impact on any EPBC Act listed MNES.

4.5 Impact summary

Table 4.5 below provides a summary of the impacts of the proposal on biodiversity values. This table considers the impacts of the proposal on significant biodiversity values assessed within the study area (threatened species populations and habitat) as well as impacts to native vegetation and local hydrology. This table also summarises the indirect impacts of the proposal on biodiversity values including impacts such as facilitating exotic species colonisation, fragmentation of habitat, spread of pathogens and diseases and changes to local surface hydrology.

Table 4.8 provides the nature of identified impacts (direct/indirect/cumulative), the physical and temporal extent of the impacts (site/local/regional and short term/long term) and provides an assessment of the confidence in the assessment of these impacts (known/unknown/unpredictable/irreversible). Finally, this table identifies KTPs which could arise from or be exacerbated by the proposal.

Table 4.8: Summary of impacts

| Impact | Biodiversity values | Nature of impact | Extent of impact | Duration | Does the proposal constitute or exacerbate a key threatening process? | Confidence in assessment |
|-------------------------------------|---|----------------------|---------------------|------------------------|--|--------------------------|
| Removal of native vegetation | Native vegetation | Direct Cumulative | Site based | Sort term Long term | <ul style="list-style-type: none"> Clearing of native vegetation | Known |
| Removal of threatened fauna habitat | Barking Owl (<i>Ninox connivens</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> Clearing of native vegetation Removal of dead wood and dead trees | Known |
| | Eastern Bentwing-bat (<i>Miniopterus schreibersii oceanensis</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> Clearing of native vegetation Removal of dead wood and dead trees | Known |
| | Eastern False Pipistrelle (<i>Falsistrellus tasmaniensis</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> Clearing of native vegetation Removal of dead wood and dead trees | Known |
| | Eastern Freetail-bat (<i>Mormopterus norfolkensis</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> Clearing of native vegetation Removal of dead wood and dead trees | Known |
| | Eastern Pygmy-possum (<i>Cercartetus nanus</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> Clearing of native vegetation Removal of dead wood and dead trees | Known |
| | Gang-gang Cockatoo (<i>Callocephalon fimbriatum</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> Clearing of native vegetation Removal of dead wood and dead trees | Known |
| | Greater Broad-nosed Bat (<i>Scoteanax rueppellii</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> Clearing of native vegetation Removal of dead wood and dead trees | Known |
| | Greater Glider (<i>Petauroides volans</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> Clearing of native vegetation Removal of dead wood and dead trees | Known |
| | Green and Golden Bell | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> Clearing of native vegetation Removal of dead wood and dead trees | Known Unknown |

| Impact | Biodiversity values | Nature of impact | Extent of impact | Duration | Does the proposal constitute or exacerbate a key threatening process? | Confidence in assessment |
|-----------------------------|--|--------------------|---------------------|-------------------------|--|--------------------------|
| | Frog (<i>Litoria aurea</i>) | | | | <ul style="list-style-type: none"> • Infection of frogs by amphibian chytrid causing the disease chytridiomycosis | |
| | Little Lorikeet (<i>Glossopsitta pusilla</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> • Clearing of native vegetation • Removal of dead wood and dead trees | Known |
| | Masked Owl (<i>Tyto novaehollandiae</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> • Clearing of native vegetation • Removal of dead wood and dead trees | Known |
| | Powerful Owl (<i>Ninox strenua</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> • Clearing of native vegetation • Removal of dead wood and dead trees | Known |
| | Sooty Owl (<i>Tyto tenebricosa</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> • Clearing of native vegetation • Removal of dead wood and dead trees | Known |
| | Spotted-tailed Quoll (<i>Dasyurus maculatus</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> • Bushrock removal • Clearing of native vegetation • Removal of dead wood and dead trees | Known |
| | Yellow-bellied Glider (<i>Petaurus australis</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> • Clearing of native vegetation • Removal of dead wood and dead trees | Known |
| | Yellow-bellied Sheath-tail-bat (<i>Saccolaimus flaviventris</i>) | Direct Indirect | Site based Local | Sort term Long term | <ul style="list-style-type: none"> • Clearing of native vegetation • Removal of dead wood and dead trees | Known |
| Removal of threatened flora | Biconvex Paperbark (<i>Melaleuca biconvexa</i>) | Direct Indirect | Site based | Short term Long term | <ul style="list-style-type: none"> • Clearing of native vegetation | Known |
| | Magenta Lilly Pilly (<i>Syzygium paniculatum</i>) | Indirect | Site based | Short term Long term | <ul style="list-style-type: none"> • Clearing of native vegetation | Known |
| Aquatic impacts | Ephemeral creek line | Indirect | Site based Local | Short term Long term | <ul style="list-style-type: none"> • Clearing of native vegetation | Known |
| | Ephemeral waterbody | Indirect | Site based Local | Short term Long term | <ul style="list-style-type: none"> • Clearing of native vegetation | Known |

| Impact | Biodiversity values | Nature of impact | Extent of impact | Duration | Does the proposal constitute or exacerbate a key threatening process? | Confidence in assessment |
|--|---|------------------|---------------------|------------|--|--|
| Injury and mortality of fauna | Macropods, possums and gliders | Direct | Site based | Short term | | Known |
| Fragmentation of identified biodiversity links and habitat corridors | Native vegetation and habitat corridors | Direct/ indirect | Site based Local | Long term | <ul style="list-style-type: none"> • Clearing of native vegetation | Known |
| Edge effects on adjacent native vegetation and habitat | Native vegetation | Indirect | Site based | Long term | <ul style="list-style-type: none"> • Clearing of native vegetation | Known Unpredictable |
| | Biconvex Paperbark (<i>Melaleuca biconvexa</i>) | Indirect | Site based | Long term | <ul style="list-style-type: none"> • Clearing of native vegetation | Known Unpredictable |
| | Magenta Lilly Pilly (<i>Syzygium paniculatum</i>) | Indirect | Site based | Long term | <ul style="list-style-type: none"> • Clearing of native vegetation | Known Unpredictable |
| Invasion and spread of weeds | Native vegetation | Indirect | Site based | Long term | <ul style="list-style-type: none"> • Invasion and establishment of exotic vines and scramblers • Invasion and establishment of Scotch broom (<i>Cytisus scoparius</i>) • Invasion of native plant communities by African Olive (<i>Olea europaea</i> L. subsp. <i>cuspidata</i>) • Invasion, establishment and spread of <i>Lantana camara</i> • Invasion of native plant communities by Bitou bush and Boneseed (<i>Chrysanthemoides monilifera</i>) • Invasion of native plant communities by exotic perennial grasses • Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants | Known (<i>Lantana camara</i>) Unpredictable |
| Invasion and spread of pests | Native vegetation | Indirect | Site based | Long term | <ul style="list-style-type: none"> • Competition and grazing by the feral European rabbit (<i>Oryctolagus cuniculus</i>) | Unpredictable |

| Impact | Biodiversity values | Nature of impact | Extent of impact | Duration | Does the proposal constitute or exacerbate a key threatening process? | Confidence in assessment |
|--|--|------------------|------------------|-----------|---|--------------------------|
| | | | | | <ul style="list-style-type: none"> • Herbivory and environmental degradation caused by feral deer • Predation and hybridisation of feral dogs (<i>Canis lupus familiaris</i>) • Predation by the European red fox (<i>Vulpes vulpes</i>) • Predation by the feral cat (<i>Felis catus</i>) • Predation by Plague Minnow or Mosquito Fish (<i>Gambusia holbrooki</i>) • Predation, habitat degradation, competition and disease transmission by feral pigs (<i>Sus scrofa</i>) | |
| | Threatened fauna | Indirect | Site based | Long term | <ul style="list-style-type: none"> • Predation and hybridisation of feral dogs (<i>Canis lupus familiaris</i>) • Predation by the European red fox (<i>Vulpes vulpes</i>) • Predation by the feral cat (<i>Felis catus</i>) • Predation by Plague Minnow or Mosquito Fish (<i>Gambusia holbrooki</i>) • Predation, habitat degradation, competition and disease transmission by feral pigs (<i>Sus scrofa</i>) | Unpredictable |
| Invasion and spread of pathogens and disease | Native vegetation | Indirect | Site based | Long term | <ul style="list-style-type: none"> • Infection of native plants by <i>Phytophthora cinnamomi</i> • Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae | Unpredictable |
| | Gang-gang Cockatoo (<i>Callocephalon fimbriatum</i>) | Indirect | Site based | Long term | <ul style="list-style-type: none"> • Infection by psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations | Unpredictable |
| | Green and Golden Bell Frog (<i>Litoria aurea</i>) | Indirect | Site based | Long term | <ul style="list-style-type: none"> • Infection of frogs by amphibian chytrid causing the disease chytridiomycosis | Unpredictable |

| Impact | Biodiversity values | Nature of impact | Extent of impact | Duration | Does the proposal constitute or exacerbate a key threatening process? | Confidence in assessment |
|----------------------------------|---|------------------------|------------------|-------------------------|--|--------------------------|
| | Little Lorikeet (<i>Glossopsitta pusilla</i>) | Indirect | Site based | Long term | <ul style="list-style-type: none"> Infection by psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations | Unpredictable |
| Groundwater dependent ecosystems | Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (PCT 1206) (terrestrial GDE) | Indirect - operational | Site based | Short term Long term | <ul style="list-style-type: none"> Clearing of native vegetation | Unpredictable |
| Changes to hydrology | Ephemeral creek line | Direct/ indirect | Site based | Short term Long term | <ul style="list-style-type: none"> Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands Clearing of native vegetation | Known Unpredictable |
| | Ephemeral waterbody | Direct/ indirect | Site based | Short term Long term | <ul style="list-style-type: none"> Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands Clearing of native vegetation | Known Unpredictable |
| | Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (PCT | Direct/ indirect | Site based | Short term Long term | <ul style="list-style-type: none"> Clearing of native vegetation | Known Unpredictable |

| Impact | Biodiversity values | Nature of impact | Extent of impact | Duration | Does the proposal constitute or exacerbate a key threatening process? | Confidence in assessment |
|----------------------------|----------------------------|---------------------|---------------------|------------|---|--------------------------|
| | 1206) (terrestrial GDE) | | | | | |
| Noise, light and vibration | Native fauna | Direct/ indirect | Site based Local | Short term | No | Known |

5 Avoid, minimise and mitigate impacts

All actions have an impact on the floral and faunal diversity of a site. These consist of:

- Direct impacts such as the clearing of vegetation, waterbodies and other habitat features
- Indirect impacts through mechanisms such as increased surface and sediment runoff, introduction of exotic species and diseases, increased disturbances through greater pedestrian and traffic utilisation, increased noise and light pollution and introduction of exotic domestic herbivores (sheep, cattle etc) and predators (cats and dogs).

These impacts are associated with all phases of works, from initial land clearing through to site operations and some impacts can continue after the completion of a work. Although all actions have impacts on floral and faunal values, a biodiversity sensitive approach can lead to a substantial decrease in the impacts of any development. In addition, a variety of techniques and technologies are available to reduce the potential impacts of a development throughout all stages.

This section details the approach adopted by the proposal to avoid and minimise impact on biodiversity values within the study area. For impacts which cannot be avoided or minimised, appropriate mitigation measures have been provided.

5.1 Avoidance and minimisation

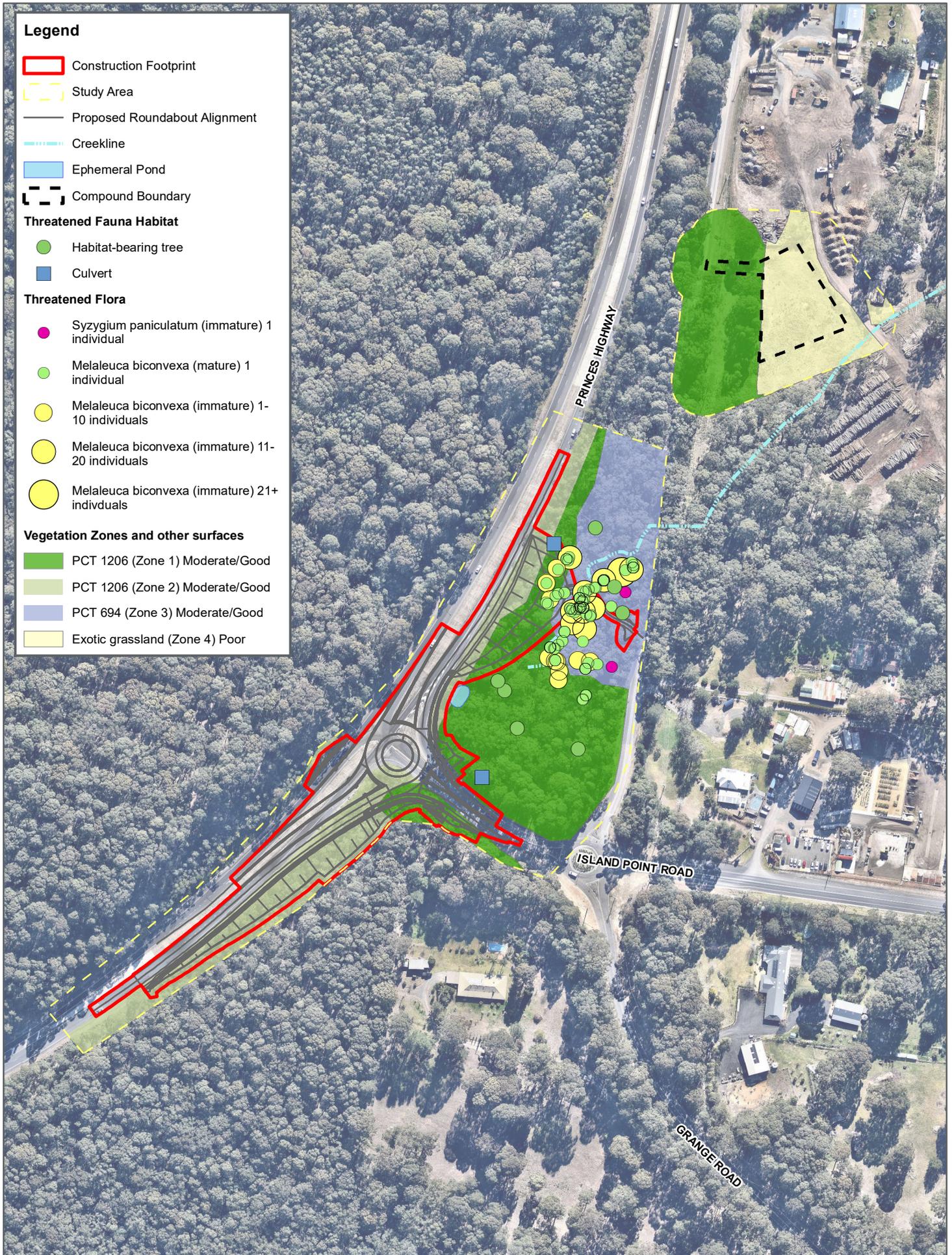
The proposal has been designed to avoid direct impact on the majority of important biodiversity values within the study area. The proposal Area would be located outside of lands containing the ephemeral creek line, waterbody and all identified habitat-bearing trees. The two large stormwater pipes and culverts, providing potential roosting habitat for the Eastern Bentwing-bat would also not be removed or modified by the proposal.

The proposal would also avoid clearing the majority of the higher value PCTs from the study area (zone 1 and zone 3). The majority of native vegetation clearing would occur within vegetation zone 2, which was identified as possessing the lowest Vegetation Integrity Score (VIS) of the three native vegetation zones within the study area (see **Appendix A**). This zone was largely dominated by less mature vegetation which had recovered since historic clearing for the Princes Highway. Hardstands and clearing of vegetation within the compound site would be situated within exotic grasslands of vegetation zone 4. No clearing of native vegetation would be required for the operational use of this portion of the proposal Area. However, portions of native grassland in the west of the compound site would be used for passive materials storage. This would not require the clearing of native grassland vegetation from this portion of the compound site.

The proposal would avoid clearing any individuals of one threatened flora species identified within the study area, the Magenta Lilly Pilly. The two individuals recorded within the study area are located in the east of lot 8 DP 855413 and no direct disturbance to these individuals or their surrounding environment would occur as a result of the proposal.

The impact to the other threatened flora species, the Biconvex Paperbark has been minimised to the extent possible. The batter required to support the two new proposed southbound lanes of the Princes Highway would require the removal of a sub-set of this population (42 of 284 individuals recorded within the study area). The majority of this population and areas of high value habitat (riparian corridor and the PCT Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (PCT 694) would be retained after the works.

Figure 5.1 below shows the proposal Area in relation to the important biodiversity values within the study area.



Legend

- Construction Footprint
- Study Area
- Proposed Roundabout Alignment
- Creekline
- Ephemeral Pond
- Compound Boundary
- Threatened Fauna Habitat**
- Habitat-bearing tree
- Culvert
- Threatened Flora**
- *Syzygium paniculatum* (immature) 1 individual
- *Melaleuca biconvexa* (mature) 1 individual
- *Melaleuca biconvexa* (immature) 1-10 individuals
- *Melaleuca biconvexa* (immature) 11-20 individuals
- *Melaleuca biconvexa* (immature) 21+ individuals
- Vegetation Zones and other surfaces**
- PCT 1206 (Zone 1) Moderate/Good
- PCT 1206 (Zone 2) Moderate/Good
- PCT 694 (Zone 3) Moderate/Good
- Exotic grassland (Zone 4) Poor

FIGURE 5.1
1:3,000 Scale at A4



Extent of Impacts

ISLAND POINT ROAD ROUNDABOUT

5.2 Mitigation measures

For impacts on biodiversity values which cannot be avoided or minimised, a range of mitigation measures are available. **Table 5.1** below details applicable mitigation measures to be implemented in the study area, specific to the anticipated impact. These mitigation measures are derived from the Roads and Maritime's *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Maritime Services, 2011).

Table 5.1: Mitigation measures

| Impact | Mitigation measures | Timing and duration | Likely efficacy of mitigation | Residual impacts anticipated |
|--|--|---------------------|-------------------------------|--|
| Removal of native vegetation | Native vegetation removal will be minimised through detailed design. | Detailed design | Effective | Yes, the proposal will require the removal of native vegetation |
| | Pre-clearing surveys will be undertaken in accordance with <i>Guide 1: Pre-clearing process</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011). | Before construction | Effective | |
| | Vegetation removal will be undertaken in accordance with <i>Guide 4: Clearing of vegetation and removal of bushrock</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011). | During construction | Effective | |
| | The unexpected species find procedure is to be followed under <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011) if threatened ecological communities or species, not assessed in the biodiversity assessment, are identified in the proposal Area. | During construction | Proven | |
| Removal of threatened species habitat and habitat features | Habitat removal will be minimised through detailed design. | Detailed design | Effective | Yes, the proposal will require the removal of native vegetation providing habitat for threatened species. The proposal will avoid the removal of high value fauna habitat features (habitat-bearing trees, waterbodies, artificial structures (large culverts)) |
| | Habitat removal will be undertaken in accordance with <i>Guide 4: Clearing of vegetation and removal of bushrock</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011) and replaced or re-instated in accordance with <i>Guide 5: Re-use of woody debris and bushrock</i> . | During construction | Effective | |
| | The unexpected species find procedure is to be followed under <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011) if threatened fauna, not assessed in the biodiversity assessment, are identified in the proposal Area. | During construction | Proven | |
| Removal of threatened plants | Pre-clearing surveys will be undertaken in accordance with <i>Guide 1: Pre-clearing process</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011). | During construction | Proven | Yes, the proposal will remove a portion of one threatened flora species population (Biconvex Paperbark) from the study area |
| | The unexpected species find procedure is to be followed under <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA | During construction | Proven | |

| Impact | Mitigation measures | Timing and duration | Likely efficacy of mitigation | Residual impacts anticipated |
|----------------------------------|--|--|-------------------------------|--|
| | 2011) if threatened flora species, not assessed in the biodiversity assessment, are identified in the proposal Area. | | | |
| Aquatic impacts | Aquatic habitat will be protected in accordance with <i>Guide 10: Aquatic habitats and riparian zones</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011) and Section 3.3.2 <i>Standard precautions and mitigation measures</i> of the <i>Policy and guidelines for fish habitat conservation and management Update 2013</i> (DPI (Fisheries NSW) 2013) | During construction | Effective | Yes, the proposal would require removal of vegetation from the ephemeral drainage line and disturbance to the creek bed |
| Groundwater dependent ecosystems | Interruptions to water flows associated with groundwater dependent ecosystems will be minimised through detailed design | Detailed design | Effective | Yes, the proposal would result in the removal of terrestrial GDE containing threatened flora populations and alterations to surface hydrology. |
| | <p>Prior to construction, implement risk management actions for identified risk matrix level (A) as per the DPI Risk assessment guidelines for groundwater dependent ecosystems Including:</p> <ul style="list-style-type: none"> • Establish exclusion zones at the GDE boundary limit as per on the design and erect environmental exclusion zone signage • Implement erosion and sediment control plan • Monitor terrestrial GDE on Lot 8 DP 855413 for one occasion at the completion of works, to compare against the Biodiversity Assessment (baseline data). <p>Monitoring is to comprise vegetation plot (species richness and percent cover) and qualitative health assessment of threatened flora populations and is to be stipulated in the CEMP. Two vegetation plots are to be located within the two vegetation zones comprising the GDE vegetation (PCT 1206). Qualitative health assessment of the two threatened flora species present, <i>Melaleuca biconvexa</i> and <i>Syzygium paniculatum</i>, will comprise descriptions of evidence of die-back, physical damage, stress (yellowing) and signs of infection by flora pathogens (<i>Phytophthora cinnamomi</i> and Myrtle Rust).</p> | <p>Prior to construction</p> <p>During construction</p> <p>Post construction</p> | Effective | <p>No, the proposal would not interrupt surface water flows associated with the terrestrial GDE present.</p> <p>No disturbance to subsurface water (through extraction, strata fracturing, major excavation etc) would occur as a result of the proposal</p> |

| Impact | Mitigation measures | Timing and duration | Likely efficacy of mitigation | Residual impacts anticipated |
|--|--|---------------------|-------------------------------|---|
| Edge effects on adjacent native vegetation and habitat | Limit of works and exclusion zones are to be identified and demarcated as per the boundary limit on the design in accordance with <i>Guide 2: Exclusion zones</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011). | During construction | Effective | Yes. The newly exposed bushland boundary would be prone to novel edge effects after clearing |
| Injury and mortality of fauna | Fauna will be managed in accordance with <i>Guide 9: Fauna handling</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011). | During construction | Effective | None |
| | Timing of work to avoid large forest owl breeding and microbat torpor periods (autumn/winter). If works are required to occur within the autumn/winter period, additional survey by a suitably qualified ecologist are to be undertaken for evidence of large forest owl nest presence prior to the commencement of clearing. If evidence of nest presence is determined, expert advice is to be sought to manage nest presence | Detailed design | Effective | No. Mitigation measure will avoid impact to these fauna during important lifecycle stages |
| | Avoid entry into potential microbat roost structures. Erect exclusion fencing | During construction | Effective | No. Mitigation measure will prevent physical disturbance of roosting individuals |
| Invasion and spread of weeds | Weed species will be managed in accordance with <i>Guide 6: Weed management</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011). Due to the low density of priority weed species within the study area, recommended weed control measures are to comprise physical removal of <i>Lantana camara</i> (Lantana) and <i>Rubus fruticosus</i> agg. (Blackberry) prior to the commencement of clearing. Removed weed material is to be transported off-site following removal for appropriate disposal and is not to be stockpiled on site. Weed management requirements are to be documented in the CEMP. | During construction | Effective | None |

| Impact | Mitigation measures | Timing and duration | Likely efficacy of mitigation | Residual impacts anticipated |
|--|---|---------------------|-------------------------------|------------------------------|
| Invasion and spread of pathogens and disease | <p>The risk of pathogen contamination will be managed in accordance with <i>Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).</p> <p>With reference to Section 4.2.5, the Project may introduce the flora pathogens <i>Phytophthora cinnamomi</i> and exotic Rust Fungi as well as the amphibian chytrid fungus through media such as unclean fill, untreated water and contaminated plants or soil media from imported plants used for any revegetation works.</p> <p>Specific measures to minimise the risk of pathogen infection comprise (with reference to best practice guidelines in Table 7.1 of <i>Guide 7: Pathogen management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).</p> <ul style="list-style-type: none"> • Restrict personnel to designated tracks and trails • Use of onsite fill where possible • Offsite cleaning of soil and plant material from contaminated plant and equipment prior to use on site • Restrict vehicles to designated tracks, trails and parking areas • Use of treated water for dust suppression and other site requirements • Use a certified supply of plants and soil that is disease-free. <p>Pathogen management requirements are to be documented in the CEMP</p> | During construction | Effective | None |

6 Offset strategy

6.1 Quantification of impacts

Road and Maritime provides assessment guidelines for whether an action or impact requires the development of a Biodiversity Offset Strategy (BOS). **Table 6.1** below identifies whether offsets for the proposal are required for any residual impact after the implementation of the avoidance and mitigation measures detailed in **Section 5** above against the Road and Maritime assessment guidelines.

Table 6.1: Assessment of offset requirement assessment for the proposal

| Description of activity or impact | Consider offsets or supplementary measures | Offsets or supplementary measures recommended for the proposal |
|--|--|--|
| Activities in accordance with Roads and Maritime Services Environmental assessment procedure: Routine and Minor Works (RTA 2011) | No | No. proposal is not an activity in accordance with Roads and Maritime Services Environmental assessment procedure: Routine and Minor Works |
| Works on cleared land, plantations, exotic vegetation where there are no threatened species or habitat present | No | No. proposal is not a work on cleared land, plantations, exotic vegetation where there are no threatened species or habitat present |
| Works involving clearing of vegetation planted as part of a road corridor landscaping program (this includes where threatened species or species comprising listed ecological communities have been used for landscaping purposes) | No | No. proposal does not involve clearing of vegetation planted as part of a road corridor landscaping program |
| Works involving clearing of national or NSW listed critically endangered ecological communities (CEEC) | Where there is any clearing of an CEEC in moderate to good condition | No. No national or NSW listed CEEC was identified within the study area |
| Works involving clearing of nationally listed threatened ecological community (TEC) or nationally listed threatened species habitat | Where clearing >1 ha of a TEC or habitat in moderate to good condition | No. Five nationally listed threatened species (two flora and three fauna) were recorded or considered to be present within the study area: <ul style="list-style-type: none"> • Biconvex Paperbark (<i>Melaleuca biconvexa</i>) • Magenta Lilly Pilly (<i>Syzygium paniculatum</i>) • Greater Glider (<i>Petauroides volans</i>) • Green and Golden Bell Frog (<i>Litoria aurea</i>) • Spotted-tailed Quoll (<i>Dasyurus maculatus</i>). All PCTs (threatened species habitat) within the study area was assessed as moderate to good condition. |

| Description of activity or impact | Consider offsets or supplementary measures | Offsets or supplementary measures recommended for the proposal |
|---|--|--|
| | | The proposal would not involve the clearing of >1 ha of habitat for these federally listed species |
| Works involving clearing of NSW endangered or vulnerable ecological community | Where clearing > 5 ha or where the ecological community is subject to an SIS | No. No NSW listed TEC was identified within the study area |
| Works involving clearing of NSW listed threatened species habitat where the species is a species credit species as defined in the DPIE Threatened Species Profile Database (TSPD) | Where clearing > 1ha or where the species is the subject of an SIS | No. 10 NSW listed threatened species (two flora and eight fauna) recorded or considered to be present within the study area are listed as species credit species in the DPIE Threatened Species Profile Database: <ul style="list-style-type: none"> • Biconvex Paperbark (<i>Melaleuca biconvexa</i>) • Magenta Lilly Pilly (<i>Syzygium paniculatum</i>) • Barking Owl (<i>Ninox connivens</i>) • Eastern Bentwing-bat (<i>Miniopterus schreibersii oceanensis</i>) • Eastern Pygmy-possum (<i>Cercartetus nanus</i>) • Gang-gang Cockatoo (<i>Callocephalon fimbriatum</i>) • Green and Golden Bell Frog (<i>Litoria aurea</i>) • Masked Owl (<i>Tyto novaehollandiae</i>) • Powerful Owl (<i>Ninox strenua</i>) • Sooty Owl (<i>Tyto tenebricosa</i>). The proposal would not remove >1 ha of habitat for these species credit species. Offset not required |
| Works involving clearing of NSW listed threatened species habitat and the species is an ecosystem credit species as defined in DPIE's Threatened Species Profile Database (TSPD) | Where clearing > 5ha or where the species is the subject of an SIS | No. Seven NSW listed threatened fauna species recorded or considered to be present within the study area are listed as ecosystem credit species in the DPIE Threatened Species Profile Database: <ul style="list-style-type: none"> • Eastern False Pipistrelle (<i>Falsistrellus tasmaniensis</i>) • Eastern Freetail-bat (<i>Mormopterus norfolkensis</i>) |

| Description of activity or impact | Consider offsets or supplementary measures | Offsets or supplementary measures recommended for the proposal |
|--|--|--|
| | | <ul style="list-style-type: none"> • Greater Broad-nosed Bat (<i>Scoteanax rueppellii</i>) • Little Lorikeet (<i>Glossopsitta pusilla</i>) • Spotted-tailed Quoll (<i>Dasyurus maculatus</i>) • Yellow-bellied Glider (<i>Petaurus australis</i>) • Yellow-bellied Sheath-tail-bat (<i>Saccolaimus flaviventris</i>). <p>The proposal would not remove >5 ha of habitat for these ecosystem credit species.</p> <p>Offset not required</p> |
| Type 1 or Type 2 key fish habitats (as defined by NSW Fisheries) | Where there is any net loss of habitat | <p>No.</p> <p>The ephemeral creek line within the study area was assessed as a Type 3 minimally sensitive fish habitat</p> |

Based on this assessment, the proposal does not require offsetting for residual impact on biodiversity values.

7 Conclusion

This BA was conducted as part of an REF for the proposed upgrade of the Princes Highway/Island Point Road intersection at Tomerong. The proposal would involve the replacement of the existing T-junction with a new roundabout, the installation of two southbound lanes entering the roundabout, one northbound lane entering the roundabout and a northbound slip lane on the Princes Highway, a cyclist crossing point on the Princes Highway south of the roundabout and relocation of existing intersection lighting. The construction footprint would be located within the existing Princes Highway and Island Point Road road reserves and Roads and Maritime lands in lot 8 DP 855413. The construction footprint would also include the widening of an existing track to provide access from Grange Road for vehicles to the batter supporting the proposed southbound lanes north of the intersection within lot 8 DP 855413. A compound site to support site offices and vehicle laydown would be located within private lands in lot 25 DP 792969.

Ecological surveys for this BA were conducted by a qualified and experienced ecologist on 06 and 07 May 2019. This survey covered the entire proposal Area within the road reserves and lot 8 DP 855413 as well as a wider study area. Access into lot 25 DP 792969 was not possible during the survey period and assessments of this area was conducted from the Grange Road road reserve. Flora surveys consisted of a complete meander survey of the construction footprint and study area and the conduction of three vegetation floristic and structural plots (20 x 50 m) with the three vegetation zones identified. Threatened fauna surveys targeted the following fauna groups and techniques:

- Amphibians and reptiles. Diurnal and nocturnal habitat searches and call playback
- Diurnal birds. Point area surveys and opportunistic recordings
- Microbats. Diurnal potential roost searches, echolocation detector surveys (Anabat Express)
- Nocturnal birds. Spotlighting and call playback
- Nocturnal mammals. Spotlighting and call playback.

Survey identified the native vegetation of the study area consisted of two PCTs:

- Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (PCT 1206)
- Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (694).

Surveys also included assessment of the aquatic habitat value of the ephemeral creek line. This included an RCE assessment and classification of the fish habitat value of the waterway in line with the key fish habitat sensitivity and fish passage classes as per table 1 and table 2 of the NSW DPI Policy and guidelines for fish habitat conservation and management. As this waterway is classified as a first order stream under the Strahler stream classification method, no detailed aquatic surveys were conducted.

PCT 1206 was identified as comprising two distinct zones due to observable differences in vegetation maturity and disturbance history. However, both zones were observed to be in moderate/good condition with a complete strata assemblage and low densities of exotic weeds. The compound study area also contained cleared exotic grasslands. Neither of the above PCTs are known to be associated with TECs listed under the NSW BC Act or the Commonwealth EPBC Act, with reference to the NSW VIS database.

The study area contained several important habitat features comprising seven habitat trees, a small waterbody, an ephemeral creek line and two large stormwater culverts providing potential roosting resources for threatened structure-roosting microbats. The native vegetation communities present also provided foraging, roosting and refuge habitat for native fauna.

The following threatened species were detected during surveys.

- Biconvex Paperbark (*Melaleuca biconvexa*)

- Magenta Lilly Pilly (*Syzygium paniculatum*)
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)
- Eastern Freetail Bat (*Mormopterus norfolkensis*).

A population of about 284 Biconvex Paperbark were detected within the construction footprint, located predominantly within and next to the ephemeral creek line. Two Magenta Lilly Pilly were detected within the east of the construction footprint. The three threatened microbat species were detected from analysis of the Anabat Express data.

The following additional threatened species were considered likely to occur within the study area, based on the presence of suitable habitat and recent occurrence records from the Study locality:

- Barking Owl (*Ninox connivens*)
- Gang Gang Cockatoo (*Callocephalon fimbriatum*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*)
- Greater Glider (*Petauroides volans*)
- Green and Golden Bell Frog (*Litoria aurea*)
- Eastern Pygmy Possum (*Cercartetus nanus*)
- Little Lorikeet (*Glossopsitta pusilla*)
- Masked Owl (*Tyto novaehollandiae*)
- Powerful Owl (*Ninox strenua*)
- Sooty Owl (*Tyto tenebricosa*)
- Spotted-tailed Quoll (*Dasyurus maculatus*)
- Yellow-bellied Glider (*Petaurus australis*)
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*).

The ephemeral waterway was identified as having a good overall condition, with an RCE score 44 (from a maximum of 52). However, due to a lack of permanent water and important key fish habitat resources (deep pools, gravel beds, snags and aquatic vegetation) the stream was assessed as class 4 unlikely fish habitat and type 3 minimally sensitive fish habitat. The stream is not considered likely to provide habitat for any threatened fish species listed under the FM Act.

The proposal would result in the removal of portions of both native PCTs from the construction footprint to support the new roundabout and additional southbound lanes as well as for required widening of an existing access track to provide access from Grange Road to the base of a new batter north of the intersection. This would also require the removal of a portion of the Biconvex Paperbark population west of the ephemeral creek line. Neither Magenta Lilly Pilly individual would be removed by the proposal. The compound site would not require the removal of PCT 1206 woody vegetation with access through this vegetation occurring within cleared lands dominated by native grasses. The portion of the compound site for structures and vehicle laydown is dominated by exotic grasslands, comprising low value habitat for native flora and fauna.

No high value threatened fauna habitat would be removed by the proposal, with all identified habitat-bearing trees and the small waterbody to be retained. The two large culverts would also not be removed or modified by the proposal.

The proposal would pose a variety of secondary impacts. These comprise increase risk of fauna mortality during works, an increase in edge effects on retained vegetation abutting newly cleared lands, invasion of novel and spread of existing weed populations, changes to local surface hydrology and noise, light and vibration impacts on fauna habitat utility.

The majority of these secondary impacts would be restricted to the construction phase and would not be ongoing. As the proposal would upgrade an existing road network many of these secondary impacts are already present and are not anticipated to be significantly exacerbated by the proposal.

Assessments of significance under the BC Act and/or EPBC Act were conducted for all species recorded on site or considered likely to occur. These assessments concluded there would not be a significant impact on these species as a result of the proposal. The proposal would not result in the local (within the study area) extinction of the two threatened flora species recorded or remove high value fauna habitat features (habitat-bearing trees and the small waterbody). The proposal would not result in the fragmentation or isolation of any area of native vegetation or threatened species habitat with local vegetation retaining existing connectivity along and across the Princes Highway after the works. The habitat within the study area is not considered important to the long-term survival of any threatened species within the Study locality. Large areas of similar habitat are present on nearby lands and no threatened species is considered dependent on the resources of the study area for their long-term survival. Based on the results of these tests, further assessment through a SIS is not considered necessary.

The proposal has considered the ecological values present within the study area and the proposal has been designed to avoid many of the high value ecological features present (habitat-bearing trees, culverts and the small waterbody). The construction footprint would also largely be located within less mature native vegetation abutting the existing road network. Use of the compound site would not require the removal of woody vegetation and impacts to associated native grasslands would be limited to passive materials storage.

The proposal will implement standard mitigation measures in accordance with the Roads and Maritime biodiversity management guidelines. Key mitigation measures to be enacted for the proposal comprise:

- Timing of work to avoid large forest owl breeding and microbat torpor periods (autumn/winter)
- Avoid entry into potential microbat roost structures. Erect exclusion fencing
- Include flora and fauna management measures within the Construction Environment Management plan to manage the ecological values present in the study area.

Based on this assessment, the proposal would not trigger the requirement for the development of a BOS.

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Appendix A – Species recorded

Recorded flora

| Family | Scientific Name | Common name | Status | | Abundance in each plot* | | | Incidental observation |
|------------------|--------------------------------------|-----------------------|---------|----------|-------------------------|---|------|------------------------|
| | | | TSC Act | EPBC Act | 1 | 2 | 3 | |
| Apocynaceae | <i>Parsonsia straminea</i> | Common Silkpod | - | - | 6 | | 2 | |
| Araliaceae | <i>Hydrocotyle sibthorpioides</i> | - | - | - | 50 | | | |
| Arecaceae | <i>Livistona australis</i> | Cabbage Tree | - | - | | | 2 | |
| Asparagaceae | <i>Asparagus aethiopicus</i> | Sprengers Asparagus | - | - | 10 | | 3 | 2 |
| | <i>Lomandra longifolia</i> | Spiny-head Mat-rush | - | - | 3 | | 3 | 3 |
| Asphodelaceae | <i>Dianella caerulea</i> | Blue Flax-lily | - | - | 20 | | 2 | 3 |
| | <i>Geitenoplesium cymosum</i> | Scrambling Lily | - | - | | | | 1 |
| Asteraceae | <i>Bidens pilosa</i> | Cobblers Pegs | - | - | | | | * |
| | <i>Cyanthillium cinereum</i> | Ironweed | - | - | | | 1 | |
| | <i>Ozothamnus diosmifolius</i> | White Dogwood | - | - | | | 3 | |
| | <i>Sigesbeckea orientalis</i> | Eastern St Pauls-wort | - | - | | | 6 | |
| | <i>Sonchus ssp.</i> | Milk Thistle | - | - | | | 1 | |
| Blechnaceae | <i>Doodia aspera</i> | Prickly Rasp Fern | - | - | 20 | | | 20 |
| Campanulaceae | <i>Pratia purpurascens</i> | Whiteroot | - | - | 100 | | | |
| Convolvulaceae | <i>Dichondra repens</i> | Kidney Weed | - | - | 200 | | 1000 | 500 |
| | <i>Polymeria calycina</i> | Slender Bindweed | - | - | 2 | | | 20 |
| Cyperaceae | <i>Gahnia melanocarpa</i> | Black-fruit Saw-sedge | - | - | 15 | | 4 | |
| | <i>Gahnia sieberiana</i> | Red-fruit Saw-sedge | - | - | | | | 20 |
| | <i>Lepidosperma laterale</i> | Variable Swordsedge | - | - | | | | 2 |
| Dennstaedtiaceae | <i>Pteridium esculentum</i> | Bracken Fern | - | - | 10 | | | 10 |
| Dicksoniaceae | <i>Calochlaena dubia</i> | False Bracken | - | - | | | | 10 |
| Dilleniaceae | <i>Hibbertia diffusa</i> | - | - | - | 5 | | | 3 |
| | <i>Hibbertia scandens</i> | Snake Vine | - | - | 2 | | | 1 |
| Ericaceae | <i>Leucopogon juniperinus</i> | Prickly Beard-heath | - | - | 12 | | 12 | 6 |
| Fabaceae | <i>Acacia binervata</i> | Two-veined Hickory | - | - | 5 | | | 5 |
| | <i>Acacia irrorata ssp. irrorata</i> | Green Wattle | - | - | 1 | | | 3 |
| | <i>Acacia parramattensis</i> | Parramatta Wattle | - | - | | | 6 | |
| | <i>Desmodium varians</i> | - | - | - | | | 6 | |
| | <i>Glycine microphylla</i> | Small-leaf Glycine | - | - | 20 | | 20 | 100 |
| | <i>Glycine tabacina</i> | Variable Glycine | - | - | 10 | | 20 | |
| Lauraceae | <i>Cryptocarya microneura</i> | - | - | - | | | | 1 |
| | <i>Cassytha glabella</i> | Slender Devil's twine | - | - | 5 | | | 3 |
| Luzuriagaceae | <i>Eustrephus microphylla</i> | Wombat Berry | - | - | 2 | | 6 | |

| Family | Scientific Name | Common name | Status | | Abundance in each plot* | | | Incidental observation | |
|---------------------------|--|----------------------------|------------------|----------|-------------------------|-----|-----|------------------------|--|
| | | | TSC Act | EPBC Act | 1 | 2 | 3 | | |
| Malvaceae | <i>Sida rhombifolia</i> | Paddys Lucerne | - | - | | 10 | | | |
| Menispermaceae | <i>Stephania japonica var discolor</i> | Snake Vine | - | - | | | 3 | | |
| Myrtaceae | <i>Corymbia maculata</i> | Spotted Gum | - | - | 1 | 3 | 3 | | |
| | <i>Eucalyptus botryoides</i> | Bangalay | - | - | | | 1 | | |
| | <i>Eucalyptus paniculata</i> | Grey Ironbark | - | - | 6 | 17 | 3 | | |
| | <i>Eucalyptus pilularis</i> | Blackbutt | - | - | 4 | | 3 | | |
| | <i>Eucalyptus saligna</i> | Sydney Blue Gum | - | - | 2 | | 3 | | |
| | <i>Kunzea ambigua</i> | Tickbush | - | - | 6 | 10 | | | |
| | <i>Leptospermum polygalifolium</i> | Tantoon | - | - | 12 | 6 | 3 | | |
| | <i>Melaleuca biconvexa</i> | Biconvex Paperbark | V | V | | | 5 | | |
| | <i>Melaleuca styphelioides</i> | Prickly-leaf Paperbark | - | - | | 20 | | | |
| | <i>Syncarpia glomulifera</i> | Turpentine | - | - | 5 | | | | |
| | <i>Syzygium paniculatum</i> | Magenta Lilly Pilly | E | V | | | 1 | | |
| | Oleaceae | <i>Notelaea longifolia</i> | Large Mock-olive | - | - | 12 | 6 | | |
| | Oxalidaceae | <i>Oxalis exilis</i> | - | - | | 5 | | | |
| Phyllanthaceae | <i>Breynia oblongifolia</i> | Coffee Bush | - | - | 20 | | 20 | | |
| Pittosporaceae | <i>Billardiera scandens</i> | Apple Berry | - | - | 2 | | | | |
| | <i>Bursaria spinosa</i> | Blackthorn | - | - | | 6 | | | |
| | <i>Pittosporum undulatum</i> | Sweet Pittosporum | - | - | | | 2 | | |
| Poaceae | <i>Deyeuxia decipiens</i> | Trickery bent grass | - | - | | 1 | | | |
| | <i>Entolasia marginata</i> | Bordered Panic | - | - | 20 | 20 | 100 | | |
| | <i>Entolasia stricta</i> | Wiry Panic | - | - | 6 | | 50 | | |
| | <i>Eragrostis curvula</i> | African Love Grass | - | - | | 5 | | | |
| | <i>Imperata cylindrica</i> | Blady Grass | - | - | 100 | | | | |
| | <i>Microleana stipoides</i> | Weeping Meadow Grass | - | - | | 20 | | | |
| | <i>Notodanthonia longifolia</i> | - | - | - | | 100 | | | |
| | <i>Oplismenus imbecillis</i> | Creeping Beard Grass | - | - | 2 | 20 | 100 | | |
| | <i>Panicum simile</i> | Two-colour Panic | - | - | 10 | | | | |
| | Primulaceae | <i>Rapanea howittiana</i> | Brush Muttonwood | - | - | 6 | | | |
| <i>Rapanea variabilis</i> | | Variable Muttonwood | - | - | | | 10 | | |
| Proteaceae | <i>Persoonia linearis</i> | Narrow-leaved Geebung | - | - | 2 | | 3 | | |
| Pteridaceae | <i>Adiantum aethiopicum</i> | Common Maidenhair Fern | - | - | 1000 | 1 | 50 | | |
| Ranunculaceae | <i>Clematis aristata</i> | Old Mans Beard | - | - | | 1 | | | |

| Family | Scientific Name | Common name | Status | | Abundance in each plot* | | | Incidental observation |
|-------------|-----------------------------|--------------------|---------|----------|-------------------------|----|---|------------------------|
| | | | TSC Act | EPBC Act | 1 | 2 | 3 | |
| Rosaceae | <i>Rubus fruticosus</i> agg | Blackberry | - | - | | | 2 | |
| Rubiaceae | <i>Galium propinquum</i> | - | - | - | | 5 | | |
| Santalaceae | <i>Exocarpus strictus</i> | Pale-fruit Ballart | - | - | 2 | 1 | 1 | |
| Solanaceae | <i>Solanum prinophyllum</i> | Forest Nightshade | - | - | | 12 | | |
| | <i>Solanum stelligenum</i> | Devil's Needles | - | - | | 5 | | |
| Verbenaceae | <i>Lantana camara</i> | Lantana | - | - | | | | * |
| | <i>Verbena</i> ssp. | Purpletop | - | - | | | | * |
| Vitaceae | <i>Cissus hypoglauca</i> | Billangai | - | - | | | 1 | |

Vegetation condition assessment table

| Site value | Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (PCTID 1206) | Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion (PCTID 1206) | Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion (PCTID 694) |
|-----------------------------------|---|---|--|
| Plot number: | 1 | 2 | 3 |
| Native plant species | 38 | 32 | 38 |
| Native tree cover (%) | 60 | 25.6 | 51.5 |
| Native shrub cover (%) | 15.2 | 22.4 | 18 |
| Native ground cover – grass (%) | 16.4 | 36.6 | 19.1 |
| Native ground cover – forb (%) | 5.6 | 21.4 | 10.1 |
| Native ground cover – fern (%) | 20.5 | 0.1 | 4.5 |
| Native ground cover – other (%) | 2 | 0.5 | 16.9 |
| High Threat Weed Cover (%) | 0.1 | 0.1 | 0.2 |
| Number of hollow trees | 0 | 0 | 2 |
| Canopy Regeneration | Yes | Yes | Yes |
| Fallen logs (m) | 32 | 104 | 37 |
| Vegetation Integrity Score | 81.4 | 65 | 79.2 |
| Condition category | Good - High | Good - High | Good - High |

Recorded fauna

| Fauna group | Scientific Name | Common name | Status | |
|-------------|---------------------------------|---------------------------|---------|----------|
| | | | TSC Act | EPBC Act |
| Amphibians | <i>Crinia signifera</i> | Common Eastern Froglet | - | - |
| Birds | <i>Acanthiza lineata</i> | Striated Thornbill | - | - |
| | <i>Alisterus scapularis</i> | Australian King-parrot | - | - |
| | <i>Anthochaera carunculata</i> | Red Wattlebird | - | - |
| | <i>Cacatua galerita</i> | Sulphur-crested Cockatoo | - | - |
| | <i>Caligavis chrysops</i> | Yellow-faced Honeyeater | - | - |
| | <i>Colluricincla harmonica</i> | Grey Shrike-thrush | - | - |
| | <i>Coracina novaehollandiae</i> | Black-faced Cuckoo-shrike | - | - |
| | <i>Corvus coronoides</i> | Australian Raven | - | - |
| | <i>Dacelo novaeguineae</i> | Laughing Kookaburra | - | - |
| | <i>Eolophus roseicapillus</i> | Galah | - | - |
| | <i>Eopsaltria australis</i> | Eastern Yellow Robin | - | - |
| | <i>Macropygia amboinensis</i> | Brown Cuckoo-dove | - | - |
| | <i>Malurus cyaneus</i> | Superb Fairy-wren | - | - |
| | <i>Meliphaga lewinii</i> | Lewin's Honeyeater | - | - |
| | <i>Pardalotus punctatus</i> | Spotted Pardalote | - | - |
| | <i>Platycercus elegans</i> | Crimson Rosella | - | - |
| | <i>Rhipidura albiscapa</i> | Grey Fantail | - | - |
| | <i>Sphecotheres vieillotii</i> | Australasian Figbird | - | - |
| | <i>Strepera graculina</i> | Pied Currawong | - | - |
| | <i>Trichoglossus haematodus</i> | Rainbow Lorikeet | - | - |
| | <i>Zosterops lateralis</i> | Silvereye | - | - |
| Mammals | <i>Perameles nasuta</i> | Long-nosed Bandicoot | - | - |
| | <i>Petaurus breviceps</i> | Sugar Glider | - | - |
| | <i>Wallabia bicolor</i> | Swamp Wallaby | - | - |

Appendix B – Habitat assessment table

Likelihood of occurrence criteria

| Likelihood | Criteria |
|------------|--|
| Recorded | The species was observed in the study area during the current survey |
| High | It is highly likely that a species inhabits the study 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 (10km) and is known or likely to maintain resident populations in the study area. Also includes species known or likely to visit the study area during regular seasonal movements or migration. |
| Moderate | Potential habitat is present in the study area. Species unlikely to maintain sedentary populations, however may seasonally use resources within the study 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 study 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. |
| Low | It is unlikely that the species inhabits the study area and has not been recorded recently in the locality (10km). It may be an occasional visitor, but habitat similar to the study 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 study area or the species are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded. |
| None | Suitable habitat is absent from the study area. |

Habitat assessment table

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|--------|----------|--|-------------------------------|---|
| Threatened Ecological Communities | | | | | |
| Araluen Scarp Grassy Forest in the South East Corner Bioregion (BC Act) | E | - | This community is largely restricted to the escarpment and associated ridges on the northern and western sides of the Araluen valley, occurring typically on sandy loams derived from granite, usually on steep slopes between approximately 200 and 700 metres in altitude. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions (BC Act) | E | - | Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions is currently known from parts of the Local Government Areas of Sutherland, Wollongong, Shellharbour, Kiama, Shoalhaven, | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|----------|---|-------------------------------|---|
| | | | Eurobodalla and Bega Valley but may occur elsewhere in these bioregions | | |
| Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion (BC Act) Cumberland Plain Shale Woodlands and Shale-gravel Transition Forest (EPBC Act) | E | CE | Blue Mountains Shale Cap Forest is found on deep fertile soils formed on Wianamatta Shale, on moist sheltered sites at lower to middle altitudes of the Blue Mountains and Wollemi areas. Extensive occurrences of shale are at Springwood, Berambing to Kurrajong Heights, Mountain Lagoon and Colo Heights. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (BC Act) Subtropical and Temperate Coastal Saltmarsh (EPBC Act) | E | V | Coastal Saltmarsh occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the sea. It is frequently found as a zone on the landward side of mangrove stands. | Known (DPIE) Likely (PMST) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Coastal Upland Swamp in the Sydney Basin Bioregion (BC Act) Coastal Upland Swamps in the Sydney Basin Bioregion (EPBC Act) | E | E | Coastal Upland Swamps occur primarily on impermeable sandstone plateaux with shallow groundwater aquifers in the headwaters and impeded drainage lines of streams, and on sandstone benches with abundant seepage moisture. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Cumberland Plain Woodland in the Sydney Basin Bioregion (BC Act) Cumberland Plain Shale Woodlands and Shale-gravel Transition Forest (EPBC Act) | CE | CE | Occurs on soils derived from Wianamatta Shale, and throughout the driest part of the Sydney Basin. Before European settlement, was extensive across the Cumberland Plain, western Sydney. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (BC Act) | E | - | Associated with coastal areas subject to periodic flooding and in which standing fresh water persists for at least part of the year in most years. Typically occurs on silts, muds or humic loams in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, backswamps, lagoons and lakes but may | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|----------|--|-------------------------------|---|
| | | | also occur in backbarrier landforms where floodplains adjoin coastal sandplains. Generally occur below 20 m elevation on level areas | | |
| Illawarra lowlands grassy woodland in the Sydney Basin Bioregion (BC Act) Illawarra and south coast lowland forest and woodland ecological community (EPBC Act) | E | CE | This community comprises vegetation types that occupy the Illawarra coastal plain and escarpment foothills. | Known (DPIE) Likely (PMST) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Illawarra Subtropical Rainforest in the Sydney Basin Bioregion (BC Act) | E | - | Illawarra Subtropical Rainforest (ISR) is a rainforest community that occupies high nutrient soils in the Illawarra region, south of Sydney. Occupies the Illawarra coastal plain and escarpment foothills, rarely extending onto the upper escarpment slopes. Usually found on Permian volcanic rocks, but can occur on a range of rock types. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (BC Act) Littoral Rainforest and Coastal Vine Thickets of Eastern Australia (EPBC Act) | E | CE | Occurs on sand dunes and on soil derived from underlying rocks. Stands on headlands exposed to strong wind-action may take the form of dense, wind-pruned thickets. Stands are generally taller in sheltered sites such as hind dunes, although wind-pruning may still occur on their windward sides. Most stands occur within two kilometres of the sea, though are occasionally found further inland within reach of the maritime influence. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Lowland Grassy Woodland in the South East Corner Bioregion (BC Act) Lowland Grassy Woodland in the South East Corner Bioregion (EPBC Act) | E | CE | The community typically occurs in undulating terrain up to 500 m in elevation on granitic substrates (eg adamellites, granites, granodiorites, gabbros, etc) but may also occur on locally steep sites and on acid volcanic, alluvial and fine-grained sedimentary substrates. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|--------|----------|---|-------------------------------|---|
| Melaleuca armillaris Tall Shrubland in the Sydney Basin Bioregion (BC Act) | E | - | Occurs in the Local Government Areas of Shellharbour and Kiama, where remnants have been recorded at Dunmore, Jamberoo Valley, and in small patches in and around Killalea State Park. May occur elsewhere within the Sydney Basin Bioregion. Occupies very dry rocky ridges away from the coast, usually where volcanic soils overlay latite. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Milton Ulladulla Subtropical Rainforest in the Sydney Basin Bioregion (BC Act) | E | - | Confined to soils derived entirely or partially from the Milton Monzonite. The largest remnant occurs within a steep gully on Currowar Creek; however, much smaller remnants closer to the town of Milton indicate that this community would have been widespread on rolling hills throughout the area. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Moist Shale Woodland in the Sydney Basin Bioregion (BC Act) Cumberland Plain Shale Woodlands and Shale-gravel Transition Forest (EPBC Act) | E | CE | Mainly occurs in the hilly country with higher elevations where there is increased rainfall. Occurs on clay soils derived from Wianamatta shale and is intermediate between Cumberland Plain Woodland on drier sites and Western Sydney Dry Rainforest on wetter sites. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions (BC Act) Alpine Sphagnum Bogs and Associated Fens ecological community (EPBC Act) | E | E | The Montane Peatlands community is associated with accumulated peaty or organic-mineral sediments on poorly drained flats in the headwaters of streams. It occurs on undulating tablelands and plateaux, above 400-500 m elevation, generally in catchments with basic volcanic or fine-grained sedimentary substrates or, occasionally, granite. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|--------|----------|---|-------------------------------|---|
| Mount Gibraltar Forest in the Sydney Basin Bioregion (BC Act) Southern Highlands Shale Forest and Woodland of the Sydney Basin Bioregion (EPBC Act) | E | E | Restricted to clay soils on microsyenite intrusions in the central parts of the Southern Highlands. Occurs on gentle to steep slopes with correspondingly deep and shallow soils respectively; combined with aspect, these factors contribute to the variability evident in the floral composition of this community. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Natural Temperate Grassland of the South Eastern Highlands (EPBC Act) | - | CE | Natural Temperate Grassland is confined to the Southern Tablelands, a region bounded by the ACT, Yass, Boorowa, the Abercrombie River, Goulburn, the Great Eastern Escarpment, the Victorian border and the eastern boundary of Kosciusko National Park. The community occurs in a number of distinct plant associations. According to the association present, the community is found in various topographical positions and on a variety of substrates. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (BC Act) | E | - | Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. Generally occurs below 50 m elevation, but may occur on localised river flats up to 250 m above sea level. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Robertson Basalt Tall Open-forest in the Sydney Basin and South Eastern Highlands Bioregions (BC Act) Southern Highlands Shale Forest and Woodland of the Sydney Basin Bioregion (EPBC Act) | CE | E | Robertson Basalt Tall Open Forest is restricted chiefly to occurrences of Robertson Basalt on the Southern Highlands of NSW but also found on the Cambewarra Range to the south. It is found in the Wingecarribee and Shoalhaven Local Government Areas, but may occur elsewhere in the Sydney Basin Bioregion. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|----------|--|-------------------------------|---|
| Robertson Rainforest in the Sydney Basin Bioregion (BC Act) | E | - | Occurs almost exclusively on highly fertile soils derived from basalt and basanite. Occurs on the gently undulating Robertson Plateau in the eastern parts of the Southern Highlands, at altitudes of between 500 to 700 metres. Appears to be restricted to the Robertson Basalt; no observations of the community have been recorded on the surrounding Wianamatta Shale. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Shale Sandstone Transition Forest in the Sydney Basin Bioregion (BC Act) Cumberland Plain Shale Woodlands and Shale-gravel Transition Forest (EPBC Act) | CE | CE | Occurs at the edges of the Cumberland Plain, where clay soils from the shale rock intergrade with earthy and sandy soils from sandstone, or where shale caps overlay sandstone. The boundaries are indistinct, and the species composition varies depending on the soil influences. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Southern Highlands Shale Woodlands in the Sydney Basin Bioregion (BC Act) Cumberland Plain Shale Woodlands and Shale-gravel Transition Forest (EPBC Act) | E | CE | Restricted to clay soils derived from Wianamatta Shale. Occurs at elevations of between 600 to 800 m. Generally found on gently rolling hills, though sometimes on steeper slopes in some areas. Found in areas where rainfall ranges from 1400 mm in the east to 900 mm in the west. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Southern Sydney sheltered forest on transitional sandstone soils in the Sydney Basin Bioregion (BC Act) | E | - | The terrain is primarily gentle, with slopes not often exceeding 10°, and where sandstone outcrops occur infrequently. The community is typically associated with sheltered heads and upper slopes of gullies on transitional zones where sandstone outcrops may exist, but where soils are influenced by lateral movement of moisture, nutrients and sediment from more fertile substrates. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner | E | E | Associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins | Known (DPIE) Likely (PMST) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|--------|----------|--|-------------------------------|---|
| bioregions (BC Act) Coastal Swamp Oak <i>Casuarina glauca</i> Forest of New South Wales and South East Queensland ecological community (EPBC Act) | | | and estuarine fringes associated with coastal floodplains | | |
| Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (BC Act) | E | - | Associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains. Generally occurs below 20 m (though sometimes up to 50 m) elevation. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregions (BC Act) | E | - | Tableland Basalt Forest typically occurs on loam or clay soils associated with basalt or, less commonly, alluvium, fine-grained sedimentary rocks, granites and similar substrates that produce relatively fertile soils. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes Bioregions (BC Act) | E | - | Tablelands Snow Gum Grassy Woodland occurs in the South Eastern Highlands Bioregion; part of this region is the 'Southern Tablelands' and the northern section of the bioregion is the 'Central Tablelands'. There are outlying occurrences of this community in the Sydney Basin, South East Corner and NSW South Western Slopes Bioregions, where suitable habitat exists | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| <i>Themeda</i> grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions (BC Act) | E | - | <i>Themeda</i> Grassland on seacliffs and coastal headlands is found on a range of substrates in the NSW North Coast, Sydney Basin and South East Corner bioregions. Stands on sandstone are infrequent and small. Larger stands are found on old sand dunes above cliffs, as for example at Cape Banks and Henry Head in Botany Bay National Park, and on metasedimentary headlands, as for | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|--------|----------|---|-------------------------------|---|
| | | | example at McCauleys Headland in Coffs Coast Regional Park, Look-at-me-now Headland, Dammerels Head and Bare Bluff in Moonee Beach Nature Reserve and Wilson's Headland in Yuraygir National Park. | | |
| Western Sydney Dry Rainforest in the Sydney Basin Bioregion (BC Act) Western Sydney Dry Rainforest and Moist Woodland on Shale (EPBC Act) | E | CE | Restricted to hilly country where it occurs on the sheltered lower slopes and in gullies. Generally found at higher elevation, in areas receiving higher rainfall than much of the Cumberland Plain Woodland. Occurs on clay soils derived from Wianamatta shale | Predicated (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| White Box Yellow Box Blakelys Red Gum Woodland (BC Act) White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (EPBC Act) | E | CE | Box-Gum Woodland is found from the Queensland border in the north, to the Victorian border in the south. It occurs in the tablelands and western slopes of NSW. | Known (DPIE) | None: Not mapped as present within the study area. Vegetation assessment did not identify the presence of this TEC within the study area |
| Threatened Flora | | | | | |
| Albatross Mallee (<i>Eucalyptus langleyi</i>) | V | V | The main occurrence of the Albatross Mallee is to the south-west of Nowra as far as Yarramunmun Creek. A very small population is found to the north of the Shoalhaven River in the Bomaderry Creek Regional Park. Found in mallee shrubland on poorly-drained, shallow, sandy soils on sandstone. | 7 (DPIE) Likely (PMST) | None. study area at the southern extend of the species' known range. Suitable mallee shrubland not present within the study area |
| Austral Toadflax (<i>Thesium australe</i>) | V | V | Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Although originally described from material collected in the SW Sydney area, populations have not been seen in a long time. It may persist in some areas in the broader region. Occurs in grassland on | Likely (PMST) | None. study area lacks suitable grassy woodland habitat containing <i>Themeda australis</i> |

| Common Name (Scientific Name) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|--------|----------|---|-------------------------------|--|
| | | | coastal headlands or grassland and grassy woodland away from the coast. Often found in association with Kangaroo Grass (<i>Themeda australis</i>). | | |
| <i>Banksia vincentia</i> | CE | CE | Known from only one site at Vincentia, NSW. Low sedgeland and grassy heath, sometimes amongst emergent mallee <i>Eucalyptus gummifera</i> and other tall shrubs of <i>Banksia</i> and <i>Hakea</i> | Known (PMST) | None. study area not located within known limited occurrence of this species. study area lacks suitable low sedgeland and grassy heath habitat |
| Biconvex Paperbark (<i>Melaleuca biconvexa</i>) | V | V | Biconvex Paperbark is only found in NSW, with scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north. Biconvex Paperbark generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects. | 676 (DPIE) Known (PMST) | Recorded. A population of this species was recorded within the study area during surveys |
| Bynoe's Wattle (<i>Acacia bynoeana</i>) | E | V | Bynoe's wattle is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. The species is currently known from about 30 locations, with the size of the populations at most locations being very small (1-5 plants). It has recently been found in the Colymea and Parma Creek areas west of Nowra. Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches | Likely (PMST) | Low. This species is not known from records in the Study locality (DPIE). The habitat of the study area is considered broadly suitable. Surveys not conducted during an appropriate season; however, species not considered cryptic. Identification of potential individuals possible out of season |
| Eastern Australian Underground Orchid (<i>Rhizanthella slateri</i>) | V | E | Occurs from south-east Queensland to south-east NSW. In NSW, currently known from fewer than 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. Habitat requirements are poorly understood and no particular vegetation type has been | 2 (DPIE) Known (PMST) | Low. This species is not known from recent records in the locality (DPIE). The habitat of the study area is broadly suitable but this habitat type is not limited in the locality. This species is not listed as associated with the PCTs present in the study area in the BioNet database |

| Common Name (Scientific Name) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|----------|--|-------------------------------|--|
| | | | associated with the species, although it is known to occur in sclerophyll forest. | | |
| East Lynne Midge-orchid (<i>Genoplesium vernale</i>) | V | V | The East Lynne Midge Orchid is currently known from only a narrow belt, approximately 12 km wide, of predominantly Dry Sclerophyll Forest from 17 km south of Batemans Bay to 24 km north of Ulladulla. The East Lynne Midge Orchid grows in dry sclerophyll woodland and forest extending from close to the coast to the adjoining coastal ranges | May (PMST) | Low. The study area is north of the species' known range and the species is not known from occurrence records from the Study locality (DPIE). Habitat of the study area is broadly suitable |
| Ettrema Mallee (<i>Eucalyptus sturgissiana</i>) | V | - | The Ettrema Mallee is mostly restricted to the Northern Budawang Range in Morton National Park, with a few occurrences on the nearby coastal plain. Usually grows as an emergent in low shrub-heath. Grows on sandy, swampy soils. | 6 (DPIE) | None. The study area lacks suitable shrub heath on sandy swampy soils for this species. Survey was conducted at an appropriate time for this species and no individuals were encountered |
| <i>Eucalyptus langleyi</i> population north of the Shoalhaven River in the Shoalhaven Local Government Area | EP | - | This endangered population of the Albatross Mallee occurs north of the Shoalhaven River in the Shoalhaven Local Government Area. The population occurs as a series of fragmented stands across approximately 1.3 km ² and occurs on both sides of the boundary between Bomaderry Creek Regional Park and land owned by Shoalhaven City Council | 7 (DPIE) | None. study area is south of the declared area for this endangered population. Suitable mallee shrubland not present within the study area |
| Halbury Rustyhood (<i>Pterostylis vernalis</i>) | CE | CE | <i>Pterostylis vernalis</i> grows in open sites around moss gardens in shallow soil over sandstone sheets or moss gardens on heavy laterite associated soils, in heath and dry heathy forest/woodland. | May (PMST) | None. Species is not known from historical records in the Study locality (DPIE). study area lacks suitable moss gardens on sandstone sheet microhabitat |
| Illawarra Greenhood (<i>Pterostylis gibbosa</i>) | E | E | In the Illawarra region, the species grows in woodland dominated by Forest Red Gum <i>Eucalyptus tereticornis</i> , Woollybutt <i>E. longifolia</i> and White Feather Honey-myrtle <i>Melaleuca decora</i> . Near Nowra, the species grows in an open forest of Spotted Gum <i>Corymbia maculata</i> , Forest Red Gum and Grey Ironbark <i>E. paniculata</i> . In the Hunter | Likely (PMST) | Low. Species is not known from historical records in the Study locality (DPIE). The habitat of the study area is considered broadly suitable |

| Common Name (Scientific Name) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|--------|----------|---|-------------------------------|---|
| | | | region, the species grows in open woodland dominated by Narrow-leaved Ironbark <i>E. crebra</i> , Forest Red Gum and Black Cypress Pine <i>Callitris endlicheri</i> . | | |
| Jervis Bay Leek Orchid (<i>Prasophyllum affine</i>) | E | E | Jervis Bay Leek Orchid is currently known from three areas south-east of Nowra on South Coast. These are Kinghorne Point, Wowly Gully near the town of Callala Bay, and near the township of Vincentia. Grows on poorly drained grey clay soils that support low heathland and sedgeland communities | Likely (PMST) | None. The study area lacks suitable heathland or sedgeland communities on poorly drained grey clay soils |
| Kangaloon Sun Orchid (<i>Thelymitra kangaloonica</i>) | CE | CE | <i>Thelymitra kangaloonica</i> (<i>Thelymitra sp. Kangaloon</i>) is only known to occur on the southern tablelands of NSW in the Moss Vale / Kangaloon / Fitzroy Falls area at 550-700 m above sea level. It is known to occur at three swamps that are above the Kangaloon Aquifer. These swamps are a part of the ecological community "Coastal Upland Swamp" | May (PMST) | None. The study area occurs below the lower elevation range limit of this species |
| Leafless Tongue Orchid (<i>Cryptostylis hunteriana</i>) | V | V | The Leafless Tongue Orchid has been recorded from as far north as Gibraltar Range National Park south into Victoria around the coast as far as Orbost. The larger populations typically occur in woodland dominated by Scribbly Gum (<i>Eucalyptus sclerophylla</i>), Silvertop Ash (<i>E. sieberi</i>), Red Bloodwood (<i>Corymbia gummifera</i>) and Black Sheoak (<i>Allocasuarina littoralis</i>); appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (<i>C. subulata</i>) and the Tartan Tongue Orchid (<i>C. erecta</i>). | 11 (DPIE) Known (PMST) | Low. study area lacks associated plant communities |
| Magenta Lilly Pilly (<i>Syzygium paniculatum</i>) | E | V | The Magenta Lilly Pilly is found only in NSW, in a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest. On the south coast the Magenta Lilly Pilly occurs on | 16 (DPIE) Known (PMST) | Recorded. A population of this species was recorded within the study area during surveys |

| Common Name (Scientific Name) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|----------|--|-------------------------------|--|
| | | | grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. | | |
| Narrow-leaved Wilsonia (<i>Wilsonia backhousei</i>) | V | - | Narrow-leaved Wilsonia is a perennial, sprawling, matted shrub less than 15 cm tall. This is a species of the margins of salt marshes and lakes. | 3 (DPIE) | None. The study area lacks lake edge and saltmarsh habitats |
| Nowra Heath-myrtle (<i>Triplarina nowraensis</i>) | E | E | There are five known populations of Nowra Heath Myrtle. Three of these form a cluster to the immediate west of Nowra. A fourth, much smaller population is found 18km south-west of Nowra in the Boolijong Creek Valley. The fifth population is located north of the Shoalhaven River on the plateau above Bundanon. Nowra Heath Myrtle occurs on poorly drained, gently sloping sandstone shelves or along creek lines underlain by Nowra Sandstone. | Likely (PMST) | None. This species is not known from occurrence records in the Study locality (DPIE). The study area lacks sandstone shelf habitat |
| Scrub Turpentine (<i>Rhodamnia rubescens</i>) | CE | - | Occurs in coastal districts north from Batemans Bay in New South Wales, approximately 280 km south of Sydney, to areas inland of Bundaberg in Queensland. Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils | 8 (DPIE) | Moderate. Known from recent occurrence records in the Study locality (DPIE). study area considered to contain broadly suitable habitat |
| Swamp Everlasting (<i>Xerochrysum palustre</i>) | - | V | Found in Kosciuszko National Park and the eastern escarpment south of Badja. Also found in eastern Victoria. Grows in swamps and bogs which are often dominated by heaths. Also grows at the edges of bog margins on peaty soils with a cover of shrubs or grasses. | May (PMST) | None. This species is not known from occurrence records in the Study locality (DPIE). The study area lacks significant swamp and bog habitats |
| Thick-lipped Spider-orchid (<i>Caladenia tessellata</i>) | E | V | The Thick Lip Spider Orchid is known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Populations in Kiama and Queanbeyan are presumed extinct. It was also recorded in the Huskisson area in the 1930s. The species occurs on the | Known (PMST) | Low. This species is not known from recent occurrence records in the Study locality (DPIE). study area considered to contain broadly suitable habitat |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|-----------|-------------|--|----------------------------------|---|
| | | | coast in Victoria from east of Melbourne to almost the NSW border. Generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil. | | |
| Thick-lipped Spider-orchid (<i>Caladenia tessellata</i>) | E | V | The Thick Lip Spider Orchid is known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Populations in Kiama and Queanbeyan are presumed extinct. It was also recorded in the Huskisson area in the 1930s. The species occurs on the coast in Victoria from east of Melbourne to almost the NSW border. Generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil. | Known (PMST) | Low. This species is not known from recent occurrence records in the Study locality (DPIE). study area considered to contain broadly suitable habitat |
| Villous Mintbush (<i>Prostanthera densa</i>) | V | V | This species has been recorded from the Currarong area in Jervis Bay, Royal National Park (Marley), Cronulla, Helensburgh and Port Stephens (Nelson Bay). The Sydney and Royal National Park populations were thought possibly extinct, but the species is now known to occur at Bass and Flinders Point in Cronulla. <i>Prostanthera densa</i> generally grows in sclerophyll forest and shrubland on coastal headlands and near coastal ranges, chiefly on sandstone, and rocky slopes near the sea. | Likely (PMST) | None. Species not known from recent occurrence records in the Study locality (DPIE). Species not detected. study area does not contain suitable coastal headland or near coastal range habitat |
| White-flowered Wax Plant (<i>Cynanchum elegans</i>) | E | E | The White-flowered Wax Plant usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; Coastal Tea-tree <i>Leptospermum laevigatum</i> – Coastal Banksia <i>Banksia integrifolia</i> subsp. <i>integrifolia</i> coastal scrub; Forest Red Gum <i>Eucalyptus tereticornis</i> aligned open forest and woodland; Spotted Gum <i>Corymbia maculata</i> aligned open forest and woodland; and | Likely (PMST) | None. Species not known from recent occurrence records in the Study locality (DPIE). Survey conducted during an appropriate season for detection. Species not detected. study area considered to contain broadly suitable but suboptimal habitat |

| Common Name (Scientific Name) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|----------|--|-------------------------------|--|
| | | | Bracelet Honeymyrtle <i>Melaleuca armillaris</i> scrub to open scrub. | | |
| Yellow Gnat-orchid (<i>Genoplesium baueri</i>) | E | E | The species has been recorded from locations between Ulladulla and Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections have been made from those sites in recent years. Grows in dry sclerophyll forest and moss gardens over sandstone. | Known (PMST) | Low. This species is not known from occurrence records in the Study locality (DPIE). study area lacks exposed sandstone supporting moss gardens |
| Threatened and migratory fauna | | | | | |
| Amphibians | | | | | |
| Giant Burrowing Frog (<i>Heleioporus australiacus</i>) | V | V | The northern population largely confined to the sandstone geology of the Sydney Basin and extending as far south as Ulladulla. Found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based. Spends more than 95% of its time in non-breeding habitat in areas up to 300 m from breeding sites. | 64 (DPIE) Known (PMST) | Low. Species is known from recent records from the Study locality (DPIE). However, the study area lacks suitable sandstone shelving microhabitat preferred by this species |
| Green and Golden Bell Frog (<i>Litoria aurea</i>) | E | V | Inhabits marshes, dams and stream-sides, particularly those containing Bullrushes (<i>Typha</i> spp.) or Spikerushes (<i>Eleocharis</i> spp.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (<i>Gambusia holbrooki</i>), have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas. | 7 (DPIE) Known (PMST) | Moderate. Species is known from recent records from the Study locality (DPIE) and suitable (but sub-optimal) habitat is present. Surveys not conducted during an appropriate season and conditions (after rainfall) |
| Littlejohn's Frog (<i>Litoria littlejohni</i>) | V | V | This species breeds in the upper reaches of permanent streams and in perched swamps. Non-breeding habitat is heath based forests | 73 (DPIE) Known (PMST) | Low. Species is known from recent records from the Study locality (DPIE). However, study area lacks suitable altitude for this species |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|------------|---|-------------------------------|--|
| | | | and woodlands where it shelters under leaf litter and low vegetation, and hunts for invertebrate prey either in shrubs or on the ground. | | |
| Stuttering Frog (<i>Mixophyes balbus</i>) | E | V | Stuttering Frogs occur along the east coast of Australia from southern Queensland to north-eastern Victoria. Considered to have disappeared from Victoria and to have undergone considerable range contraction in NSW, particularly in south-east NSW. Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. | Likely (PMST) | Low. Not known from recent occurrence records in the Study locality (DPIE). study area lacks foothill and escarpment habitat preferred by this species |
| Birds | | | | | |
| Australian Bittern (<i>Botaurus poiciloptilus</i>) | E | E | Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (<i>Typha</i> spp.) and spikerushes (<i>Eleocharis</i> spp.). | Known (PMST) | Low. Species not known from occurrence records in the Study locality (DPIE). Small stand of swampland within the study area not considered an important habitat resource for the local population |
| Australian Painted Snipe (<i>Rostratula australis</i>) | E | E | Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds. | May (PMST) | Low. Species not known from occurrence records in the Study locality (DPIE). Small stand of swampland within the study area not considered an important habitat resource for the local population |
| Barking Owl (<i>Ninox connivens</i>) | V | - | Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (eg western NSW) due to the higher density of prey on these fertile riparian soils. | 1 (DPIE) | Moderate. No evidence of habitat tree usage by owls observed. Suitable nesting trees observed. Sclerophyll forest woodland not limited in the locality |
| Bar-tailed Godwit (<i>Limosa lapponica baueri</i>) | - | V,B,C, J,K | It is found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. Less frequently it occurs in salt lakes and brackish wetlands, sandy ocean beaches and rock platforms | Likely (PMST) | None. study area lacks coastal shoreline habitat |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|-------------|--|-------------------------------|--|
| Black Bittern (<i>Ixobrychus flavicollis</i>) | V | - | Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves. | 3 (DPIE) | Low. Small stand of swampland within the study area not considered an important habitat resource for the local population due to size and ephemeral nature |
| Black-faced Monarch (<i>Monarcha melanopsis</i>) | - | B | The Black-faced Monarch mainly occurs in rainforest ecosystems, including semi-deciduous vine-thickets, complex notophyll vine-forest, tropical (mesophyll) rainforest, subtropical (notophyll) rainforest, mesophyll (broadleaf) thicket/shrubland, warm temperate rainforest, dry (monsoon) rainforest and (occasionally) cool temperate rainforest | Known (PMST) | None. Not known from occurrence records in the Study locality (DPIE). study area lacks preferred rainforest and rainforest-aligned habitats |
| Common Greenshank (<i>Tringa nebularia</i>) | - | B,C,J, K | The Common Greenshank is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. Habitats include embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms. | Likely (PMST) | None. study area lacks mud and sandflat salt or freshwater habitat |
| Common Noddy (<i>Anous stolidus</i>) | - | C,J | During the breeding season, the Common Noddy usually occurs on or near islands, on rocky islets and stacks with precipitous cliffs, or on shoals or cays of coral or sand. During the non-breeding period, the species occurs in groups throughout the pelagic zone | 1 (DPIE) | None. study area lacks coastal shoreline habitat |
| Common Sandpiper (<i>Actitis hypoleucos</i>) | - | B,C,J, K | The species utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. The Common Sandpiper has been recorded in estuaries and deltas of streams, as well as on banks farther upstream; around lakes, pools, billabongs, | Likely (PMST) | None. study area lacks significant salt or freshwater wetland habitat. The local population of this species is not considered dependent on the small pond within the study area |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|------------|---|-------------------------------|---|
| | | | reservoirs, dams and claypans, and occasionally piers and jetties. | | |
| Curlew Sandpiper (<i>Calidris ferruginea</i>) | E | CE,B,C,J,K | It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes inland. | May (PMST) | None. study area lacks significant salt or freshwater wetland habitat. The local population of this species is not considered dependent on the small pond within the study area |
| Dusky Woodswallow (<i>Artamus cyanopterus cyanopterus</i>) | V | - | Often reported in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests and very occasionally in moist forests or rainforests. | 5 (DPIE) | Low. Species is known from recent records from the Study locality (DPIE). However, the study area is not considered to represent suitable habitat with the species known to only occasionally use moist forest habitat |
| Eastern Bristlebird (<i>Dasyornis brachypterus</i>) | E | E | Habitat for central and southern populations is characterised by dense, low vegetation including heath and open woodland with a heathy understorey. In northern NSW the habitat occurs in open forest with dense tussocky grass understorey and sparse mid-storey near rainforest ecotone; all of these vegetation types are fire prone. | 45 (DPIE) Known (PMST) | None. study area lacks heath or forest and woodland with dense heathy understorey habitat |
| Eastern Curlew (<i>Numenius madagascariensis</i>) | - | CE,C,J,K | The Eastern Curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. The birds are often recorded among saltmarsh and on mudflats fringed by mangroves, and sometimes use the mangroves. The birds are also found in saltworks and sewage farms. The numbers of Eastern Curlew recorded during one study were correlated with wetland areas. | 2 (DPIE) Known (PMST) | None. study area lacks mud and sandflat salt or freshwater habitat |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|----------|--|-------------------------------|--|
| Eastern Ground Parrot (<i>Pezoporus wallicus wallicus</i>) | V | - | The Ground Parrot occurs in high rainfall coastal and near coastal low heathlands and sedgeland, generally below one metre in height and very dense (up to 90% projected foliage cover). These habitats provide a high abundance and diversity of food, adequate cover and suitable roosting and nesting opportunities for the Ground Parrot, which spends most of its time on or near the ground. When flushed, birds fly strongly and rapidly for up to several hundred metres, at a metre or less above the ground. | 50 (DPIE) | None. study area lacks low heath and sedgeland habitat |
| Eastern Osprey (<i>Pandion cristatus</i>) | V | B | Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water | 6 (DPIE) Known (PMST) | Low. Surveys conducted during an appropriate season for the detection of active nests. No nests or evidence of resident individuals were observed. Sclerophyll forest habitat of the study area not limited in the locality |
| Fairy Prion (<i>Pachyptila turtur subantarctica</i>) | - | V | The fairy prion (southern) breeds on Macquarie Island and a number of other subantarctic islands outside of Australia. There are 80 to 250 breeding pairs in Australia and a global population of 80 000. In Australia, breeding is recorded on two rock stacks off Macquarie Island and on the nearby Bishop and Clerk Island. The population may have been larger before the arrival of black rats on Macquarie Island | Likely (PMST) | None. study area lacks marine and coastal habitat |
| Fork-tailed Swift (<i>Apus pacificus</i>) | - | C,J,K | The Fork-tailed Swift is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher. In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland | Likely (PMST) | Low. This species is highly aerial and mobile. study area lacks preferred open foraging areas |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|-----------|-------------|--|----------------------------------|--|
| | | | and tea-tree swamps, low scrub, heathland or saltmarsh. | | |
| Gang-gang Cockatoo (<i>Callocephalon fimbriatum</i>) | V | - | In spring and summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In autumn and winter, the species often moves to lower altitudes in drier more open eucalypt forests and woodlands, particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas. | 42 (DPIE) | Moderate. Species known from recent occurrence records from the Study locality (DPIE) and the study area contains suitable habitat. Surveys not conducted during an appropriate season for detection of breeding activity |
| Glossy Black Cockatoo (<i>Calyptorhynchus lathami</i>) | V | - | Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak (<i>Allocasuarina littoralis</i>) and Forest Sheoak (<i>A. torulosa</i>) are important foods. Inland populations feed on a wide range of sheoaks, including Drooping Sheoak, <i>Allocasuarina diminuta</i> , and <i>A. gymnathera</i> . Belah is also utilised and may be a critical food source for some populations. | 392 (DPIE) | Low. study area lack significant feed tree density. Local population not considered dependent on the resources of the study area. Survey conducted during an appropriate season for breeding activity |
| Grey-tailed Tattler (<i>Tringa brevipes</i>) | - | C,J,K | The Grey-tailed Tattler is often found on sheltered coasts with reefs and rock platforms or with intertidal mudflats. It can also be found at intertidal rocky, coral or stony reefs as well as platforms and islets that are exposed at low tide. It has been found around shores of rock, shingle, gravel or shells and also on intertidal mudflats in embayments, estuaries and coastal lagoons, especially fringed with mangroves | 1 (DPIE) | None. study area lacks coastal shoreline and estuarine habitat |
| Hooded Plover (<i>Thinornis rubricollis</i>) | CE | V | In south-eastern Australia Hooded Plovers prefer sandy ocean beaches, especially those that are broad and flat, with a wide wave-wash zone for feeding, much beachcast seaweed, and backed by sparsely vegetated sand-dunes for shelter and nesting. Occasionally Hooded Plovers are found on | 4 (DPIE) | None. study area lacks coastal shoreline and estuarine habitat |

| Common Name (Scientific Name) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|--------|----------|--|-------------------------------|--|
| | | | tidal bays and estuaries, rock platforms and rocky or sand-covered reefs near sandy beaches, and small beaches in lines of cliffs. They regularly use near-coastal saline and freshwater lakes and lagoons, often with saltmarsh. | | |
| Latham's Snipe (<i>Gallinago hardwickii</i>) | - | C,J,K | In Australia, Latham's Snipe occurs in permanent and ephemeral wetlands up to 2000 m above sea-level. They usually inhabit open, freshwater wetlands with low, dense vegetation (eg swamps, flooded grasslands or heathlands, around bogs and other water bodies). However, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity | 1 (DPIE) | None. study area lacks open freshwater wetland habitat and grasslands |
| Little Eagle (<i>Hieraaetus morphnoides</i>) | V | - | The Little Eagle is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW. Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used. | 1 (DPIE) | Low. No large stick nests were observed. Sclerophyll forest habitat of the study area not limited in the locality |
| Little Lorikeet (<i>Glossopsitta pusilla</i>) | V | - | Forages primarily in the canopy of open <i>Eucalyptus</i> forest and woodland, yet also finds food in <i>Angophora</i> , <i>Melaleuca</i> and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, eg paddocks, roadside remnants and urban trees also help sustain viable populations of the species. | 29 (DPIE) | Moderate. Species is known from recent occurrence records in the Study locality and suitable habtiat is present including habitat-bearing trees. Sclerophyll forest habitat not limited in the Study locality |
| Little Tern (<i>Sternula albifrons</i>) | E | B,C,J,K | Almost exclusively coastal, preferring sheltered environments; however may occur several kilometres from the sea in harbours, inlets and rivers (with occasional offshore islands or coral cay records). Nests in small, | May (PMST) | None. study area lacks coastal, marine and estuarine habitat |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|------------|---|-------------------------------|--|
| | | | scattered colonies in low dunes or on sandy beaches just above high tide mark near estuary mouths or adjacent to coastal lakes and islands. | | |
| Masked Owl (<i>Tyto novaehollandiae</i>) | V | - | Lives in dry eucalypt forests and woodlands from sea level to 1100 m. A forest owl, but often hunts along the edges of forests, including roadsides. The typical diet consists of tree-dwelling and ground mammals, especially rats. Pairs have a large home-range of 500 to 1000 hectares. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting. | 48 (DPIE) | Moderate. No evidence of habitat tree usage by owls observed. Suitable nesting trees observed. Sclerophyll forest woodland not limited in the locality |
| Northern Siberian Bar-tailed Godwit (<i>Limosa lapponica menzbieri</i>) | - | CE,B,C,J,K | The Bar-tailed Godwit is found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It is found often around beds of seagrass and, sometimes, in nearby saltmarsh. It has been sighted in coastal sewage farms and saltworks, saltlakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef-flats. | May (PMST) | None. study area lacks coastal, marine and estuarine habitat |
| Orange-bellied Parrot (<i>Neophema chrysogaster</i>) | CE | CE | On the mainland, the Orange-bellied Parrot spends winter mostly within 3 km of the coast in sheltered coastal habitats including bays, lagoons, estuaries, coastal dunes and saltmarshes. The species also inhabits small islands and peninsulas and occasionally saltworks and golf courses. Birds forage in low samphire herbland or taller coastal shrubland. | May (PMST) | None. study area located deeper inland than the coastal fringe habitat preferred by this species. study area lacks coastal vegetation types preferred by this species |
| Oriental Cuckoo (<i>Cuculus optatus</i>) | - | J,K | Inhabitant of rainforest margins, monsoon forest, vine scrub, riverine thickets, wetter, densely canopied eucalypt forest, paperbark swamps and mangroves. It feeds mainly on | Known (PMST) | Low. Not known from recent occurrence records in the Study locality (DPIE). study area lacks rainforest and rainforest-aligned vegetation communities preferred by this species |

| Common Name (Scientific Name) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|--------|----------|---|-------------------------------|--|
| | | | insects and their larvae, foraging for them in trees and bushes as well as on the ground | | |
| Painted Honeyeater (<i>Grantiella picta</i>) | V | V | Inhabits Boree/ Weeping Myall (<i>Acacia pendula</i>), Brigalow (<i>A. harpophylla</i>) and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus <i>Amyema</i> . | May (PMST) | Low. study area lacks preferred Box-Ironbark forest habitat and significant mistletoe resources |
| Pectoral Sandpiper (<i>Calidris melanotos</i>) | - | B,J,K | In Australasia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. | May (PMST) | None. study area lacks significant salt or freshwater wetland habitat. The local population of this species is not considered dependent on the small pond within the study area |
| Pied Oystercatcher (<i>Haematopus longirostris</i>) | E | - | Favours intertidal flats of inlets and bays, open beaches and sandbanks. Forages on exposed sand, mud and rock at low tide, for molluscs, worms, crabs and small fish. The chisel-like bill is used to pry open or break into shells of oysters and other shellfish | 7 (DPIE) | None. study area lacks coastal and estuarine habitat |
| Powerful Owl (<i>Ninox strenua</i>) | V | - | The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine <i>Syncarpia glomulifera</i> , Black She-oak <i>Allocasuarina littoralis</i> , Blackwood <i>Acacia melanoxylon</i> , Rough-barked Apple <i>Angophora floribunda</i> , Cherry Ballart <i>Exocarpus cupressiformis</i> and a number of eucalypt species. | 99 (DPIE) | High. No evidence of habitat tree usage by owls observed. Suitable nesting trees observed. Sclerophyll forest woodland not limited in the locality |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|------------|---|-------------------------------|--|
| Rainbow Bee-eater (<i>Merops ornatus</i>) | - | J | The Rainbow Bee-eater occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation | 1 (DPIE) | Low. Sclerophyll forest habitat not limited in the Study locality. Species not known to breed in southern Australia and study area lacks suitable open areas with loamy soil for breeding |
| Red Knot (<i>Calidris canutus</i>) | - | E,B,C, J,K | In NSW the Red Knot mainly occurs in small numbers on intertidal mudflats, estuaries, bays, inlets, lagoons, harbours and sandflats and sandy beaches of sheltered coasts. It is occasionally found on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms and is a rare visitor to terrestrial saline wetlands and freshwater swamps. | Likely (PMST) | None. study area lacks coastal and estuarine habitat |
| Regent Honeyeater (<i>Anthochaera phrygia</i>) | CE | CE | The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. | 1 (DPIE) Known (PMST) | Low. Not known from recent occurrence records in the Study locality (DPIE). study area lacks preferred Box-Ironbark and River Sheoak communities with high mistletoe density |
| Rufous Fantail (<i>Rhipidura rufifrons</i>) | - | B | In east and south-east Australia, the Rufous Fantail mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood (<i>Eucalyptus microcorys</i>), Mountain Grey Gum (<i>E. cypellocarpa</i>), Narrow-leaved Peppermint (<i>E. radiata</i>), Mountain Ash (<i>E. regnans</i>), Alpine Ash (<i>E. delegatensis</i>), Blackbutt (<i>E. pilularis</i>) or Red Mahogany (<i>E. resinifera</i>); usually with a dense shrubby understorey often including ferns | Known (PMST) | Low. Species is not known from recent occurrence records (DPIE). study area lacks gully habitat with a dense shrubby understorey |
| Satin Flycatcher (<i>Myiagra cyanoleuca</i>) | - | B | Satin Flycatchers inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests | Known (PMST) | Low. Species is not known from recent occurrence records (DPIE). study area considered broadly suitable for this species; however, sclerophyll forest habitat not limited in the Study locality |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|----------|---|-------------------------------|---|
| Scarlet Robin (<i>Petroica boodang</i>) | V | - | The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat. The Scarlet Robin is primarily a resident in forests and woodlands, but some adults and young birds disperse to more open habitats after breeding. | 2 (DPIE) | Low. study area lacks forest with an open, grassy understorey. Local population is not considered dependent on the resource of the study area |
| Sharp-tailed Sandpiper (<i>Calidris acuminata</i>) | - | B,C,J,K | In Australasia, the Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They also occur in saltworks and sewage farms. | Likely (PMST) | None. study area lacks significant fresh or saltwater wetland habitat. The small ephemeral pond is not considered important to the local population |
| Short-tailed Shearwater (<i>Ardenna tenuirostris</i>) | - | J,K | In summer months, the Short-tailed Shearwater is the most common shearwater along the south and south-east coasts of Australia. Enormous flocks of birds head south to breeding grounds off these coasts as they return from wintering grounds in the North Pacific. | 18 (DPIE) | None. study area lacks coastal and estuarine habitat |
| Sooty Owl (<i>Tyto tenebricosa</i>) | V | - | Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. Roosts by day in the hollow of a tall forest tree or in heavy vegetation; hunts by night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum | 21 (DPIE) | Moderate. No evidence of habitat tree usage by owls observed. Suitable nesting trees observed. Sclerophyll forest woodland not limited in the locality |

| Common Name (Scientific Name) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|--------|----------|--|-------------------------------|---|
| | | | (<i>Pseudocheirus peregrinus</i>) or Sugar Glider (<i>Petaurus breviceps</i>) | | |
| Sooty Oystercatcher (<i>Haematopus fuliginosus</i>) | V | - | Sooty Oystercatchers are found around the entire Australian coast, including offshore islands, being most common in Bass Strait. Favours rocky headlands, rocky shelves, and exposed reefs with rock pools, beaches and muddy estuaries. Forages on exposed rock or coral at low tide for foods such as limpets and mussels. | 11 (DPIE) | None. study area lacks coastal and estuarine habitat |
| Sooty Tern (<i>Onychoprion fuscata</i>) | V | - | Large flocks can be seen soaring, skimming and dipping but seldom plunging in off shore waters. Breeds in large colonies in sand or coral scrapes on offshore islands and cays including Lord Howe and Norfolk Islands. | 1 (DPIE) | None. study area lacks coastal and marine habitat |
| Spectacled Monarch (<i>Monarcha trivirgatus</i>) | - | B | Usually considered a denizen of the dense rainforests and moist eucalypt forests of eastern and north-eastern Australia, the Spectacled Monarch sometimes also inhabits mangroves and other densely vegetated habitats. | May (PMST) | None. Not known from occurrence records in the Study locality (DPIE). study area lacks preferred rainforest and rainforest-aligned habitats |
| Square-tailed Kite (<i>Lophoictinia isura</i>) | V | - | Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. In arid north-western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland. | 53 (DPIE) | Low. No large stick nests were observed. Sclerophyll forest habitat of the study area not limited in the locality |
| Swift Parrot (<i>Lathamus discolor</i>) | E | CE | Migrates to the Australian south-east mainland between February and October. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany <i>Eucalyptus robusta</i> , Spotted Gum <i>Corymbia maculata</i> , Red | Likely (PMST) | Low. Not known from recent occurrence records in the Study locality (DPIE). study area contains preferred feed tree eucalypt species; however, this habitat is not limited in the Study locality |

| Common Name (Scientific Name) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|--------|----------|---|-------------------------------|---|
| | | | Bloodwood <i>C. gummifera</i> , Forest Red Gum <i>E. tereticornis</i> , Mugga Ironbark <i>E. sideroxylon</i> , and White Box <i>E. albens</i> . | | |
| Turquoise Parrot (<i>Neophema pulchella</i>) | V | - | Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter. | 6 (DPIE) | Low. Not known from recent occurrence records in the Study locality (DPIE). study area contains forest habitat next to farmland with creek lines; however, this habitat is not limited in the Study locality |
| Varied Sittella (<i>Daphoenositta chrysoptera</i>) | V | - | Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. | 7 (DPIE) | Low. Not known from recent occurrence records in the Study locality (DPIE). study area contains suitable forest habitat; however, this habitat is not limited in the Study locality |
| Wedge-tailed Shearwater (<i>Ardenna pacificus</i>) | - | J | The Wedge-tailed Shearwater is a pelagic, marine bird known from tropical and subtropical waters. The species tolerates a range of surface-temperatures and salinities, but is most abundant where temperatures are greater than 21 °C and salinity is greater than 34.6 ‰. In tropical zones the species may feed over cool nutrient-rich waters. The species has been recorded in offshore waters of eastern Victoria and southern NSW, mostly over continental slope with sea-surface temperatures of 13.9–24.4 °C | 13 (DPIE) | None. study area lacks coastal and marine habitat |
| White-bellied Sea-Eagle (<i>Haliaeetus leucogaster</i>) | V | C | Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea. Occurs at sites near the sea or sea-shore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, and forest (including rainforest). | 15 (DPIE) | Low. No large stick nests were observed. study area not located within 1 km of a significant waterbody or waterway. Sclerophyll forest habitat of the study area not limited in the locality |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|--------|----------|--|-------------------------------|--|
| White-throated Needletail (<i>Hirundapus caudacutus</i>) | - | C,J,K | Found across a range of habitats, more often over wooded areas, where it is almost exclusively aerial. Large tracts of native vegetation, particularly forest, may be a key habitat requirement for the species. Found to roost in tree hollows in tall trees on ridge-tops, on bark or rock faces. Appears to have traditional roost sites. | 15 (DPIE) Known (PMST) | Low. This species is highly aerial and mobile. This species has a preference for foraging over forest and woodland habitat; however, this habitat is not limited in the Study locality. study area lacks preferred breeding habitat |
| Fish and elasmobranchs | | | | | |
| Australian Grayling (<i>Prototroctes maraena</i>) | E | V | The Australian Grayling is diadromous, spending part of its lifecycle in freshwater and at least part of the larval and/or juvenile stages in coastal seas. Adults (including pre spawning and spawning adults) inhabit cool, clear, freshwater streams with gravel substrate and areas alternating between pools and riffle zones | Known (DPI) May (PMST) | None. study area lacks suitable permanent streams with gravel substrates |
| Black Rockcod (<i>Epinephelus daemeli</i>) | V | V | Adult Black Rockcod are usually found in caves, gutters and beneath bommies on rocky reefs, from near shore environments to depths of at least 50 m. Small juveniles are often found in coastal rock pools, and larger juveniles around rocky shores in estuaries. | Known (DPI) | None. study area lacks marine and coastal near-shore habitat |
| Grey nurse Shark (<i>Carcharias taurus</i>) | CE | CE | Grey nurse Sharks are found predominantly in inshore coastal waters. Grey nurse Sharks congregate at a number of sites along the coast of NSW and southern Queensland. These sites have rocky reef with gravel or sand filled gutters, overhangs or caves and are termed aggregation | Known (DPI) | None. study area lacks marine habitat |
| White Shark (<i>Carcharodon carcharias</i>) | V | V,B | White Sharks are typically found from inshore habitats (eg islands, rocky reefs and shallow coastal bays) to the outer continental shelf and slope areas. Within Australian waters, the majority of recorded White Shark movements occur between the coast and the 100 metre depth contour; however both | Known (DPI) | None. study area lacks marine and estuarine habitat |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|-----------|-------------|--|----------------------------------|---|
| | | | adults and juveniles have been recorded diving to depths of over 1,200 m. | | |
| Insects | | | | | |
| Giant Dragonfly (<i>Petalura gigantea</i>) | E | - | Live in permanent swamps and bogs with some free water and open vegetation. Adults emerge from late October and are short-lived, surviving for one summer after emergence. Adults spend most of their time settled on low vegetation on or adjacent to the swamp. They hunt for flying insects over the swamp and along its margins. Adults fly over the swamp and along its margins hunting for flying insects. | 4 (DPIE) | Low. Species known from recent occurrence records from the study locality (DPIE). The study area is not considered to constitute important habitat for this species, lacking significant swamps and bogs with permanent water and open vegetation. All local records occur within open boggy heath vegetation in the suburb of Vincentia |
| Mammals | | | | | |
| Brush-tailed Rock Wallaby (<i>Petrogale penicillata</i>) | E | V | Occurs in forests and woodlands along the Great Divide and on the western slopes in escarpment country with rocky outcrops, steep rocky slopes, gorges, boulders and isolated rocky areas. The majority of populations favour north-facing aspects, but some southern aspects have been recorded. Apart from the critical rock structure, Brush-tailed Rock-wallaby also requires adjacent vegetation types, associated types include, dense rainforest, wet sclerophyll, vine thicket, dry sclerophyll forest and open forest. They also require suitable caves and rocky overhangs for shelter and also for 'lookout' posts. | 2 (DPIE) Likely (PMST) | None. study area lacks gorge, cliff and rocky habitats required for this species |
| Eastern Bentwing-bat (<i>Miniopterus schreibersii oceanensis</i>) | V | - | Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. | 34 (DPIE) | Recorded. This species was recorded as potentially present during Anabat call detector surveys |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|----------|---|-------------------------------|--|
| Eastern Chestnut Mouse (<i>Pseudomys gracilicaudatus</i>) | V | - | In NSW the Eastern Chestnut Mouse is mostly found, in low numbers, in heathland and is most common in dense, wet heath and swamps. In the tropics it is more an animal of grassy woodlands. | 21 (DPIE) | None. study area lacks suitable dense, wet heath and swamp habitat |
| Eastern False Pipistrelle (<i>Falsistrellus tasmaniensis</i>) | V | - | Prefers moist habitats, with trees taller than 20 m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. | 16 (DPIE) | Recorded. This species was recorded as potentially present during Anabat call detector surveys |
| Eastern Freetail-bat (<i>Mormopterus norfolkensis</i>) | V | - | Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures. | 31 (DPIE) | Recorded. This species was recorded as potentially present during Anabat call detector surveys |
| Eastern Pygmy-possum (<i>Cercartetus nanus</i>) | V | - | Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. | 27 (DPIE) | Moderate. Species known from recent occurrence records from the study locality (DPIE) and the study area contains suitable habitat. Surveys not conducted during an appropriate season for detection |
| Greater Broad-nosed Bat (<i>Scoteanax rueppellii</i>) | V | - | Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. | 19 (DPIE) | Moderate. Species known from recent occurrence records in the study locality (DPIE). study area contains suitable foraging and roosting tree habitat |
| Greater Glider (<i>Petauroides volans</i>) | - | V | Feeds exclusively on eucalypt leaves, buds, flowers and mistletoe. Shelter during the day in tree hollows and will use up to 18 hollows in their home range. Occupy a relatively small home range with an average size of 1 to 3 ha. | 27 (DPIE) Known (PMST) | High. Species known from recent occurrence records in the study locality (DPIE). study area contains suitable foraging and roosting tree habitat |
| Grey-headed Flying-fox (<i>Pteropus poliocephalus</i>) | V | V | Grey-headed Flying-foxes are generally found within 200 km of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia. Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths | 95 (DPIE) Known (PMST) | Low. No evidence of study area usage as a camp observed during survey. Sclerophyll forest habitat not limited in the study locality. Local population not considered dependent on the resources of the study area |

| Common Name (Scientific Name) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|---|--------|----------|--|-------------------------------|---|
| | | | and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Individual camps may have tens of thousands of animals and are used for mating, and for giving birth and rearing young. | | |
| Koala (<i>Phascolarctos cinereus</i>) | V | V | Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species | 1 (DPIE) Known (PMST) | Low. study area not observed to contain known feed tree species for the Koala (SEPP44 Schedule 2). Occurrence records in the study locality greater than 10 years old |
| Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>) | V | V | Found in well-timbered areas containing gullies. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (<i>Petrochelidon ariel</i>), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years. | 4 (DPIE) Known (PMST) | Low. study area lacks gully habitat with cave-bearing features. Sclerophyll forest foraging habitat not limited in the Study locality |
| Long-nosed Potoroo (<i>Potorous tridactylus</i>) | V | V | Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. | 1 (DPIE) Known (PMST) | Low. Species is not known from recent occurrence records. study area lacks some important microhabitat features (dense heathy understorey). Sclerophyll forest habitat not limited in the Study locality |
| New Holland Mouse (<i>Pseudomys novaehollandiae</i>) | - | V | Known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes. It is a social animal, living predominantly in burrows | 11 (DPIE) Known (PMST) | None. study area lacks suitable heathland or heathy understorey habitat |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|-----------|-------------|---|----------------------------------|--|
| | | | shared with other individuals. Distribution is patchy in time and space, with peaks in abundance during early to mid-stages of vegetation succession typically induced by fire. | | |
| New Zealand Fur-seal (<i>Arctocephalus forsteri</i>) | V | - | Occurs in Australia and New Zealand. Reports of non-breeding animals along southern NSW coast particularly on Montague Island, but also at other isolated locations to north of Sydney. Prefers rocky parts of islands with jumbled terrain and boulders. | 1 (DPIE) | None. study area lacks marine habitat |
| Southern Brown Bandicoot (eastern) (<i>Isoodon obesulus obesulus</i>) | E | E | Southern Brown Bandicoots are largely crepuscular (active mainly after dusk and/or before dawn). They are generally only found in heath or open forest with a heathy understorey on sandy or friable soils. | 8 (DPIE) Known (PMST) | Low. study area lacks heathland or forest and woodland with heathy understory habitat |
| Southern Myotis (<i>Myotis macropus</i>) | V | - | Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface. | 16 (DPIE) | Low. study area and nearby lands lacks significant open water habitat for foraging such as permanent creek lines and large dams |
| Spotted-tailed Quoll (<i>Dasyurus maculatus</i>) | V | E | Spotted-tailed quolls live in various environments including forests, woodlands, coastal heathlands and rainforests. They are sometimes seen in open country, or on grazed areas and rocky outcrops. They are mainly solitary animals, and will make their dens in rock shelters, small caves, hollow logs and tree hollows. They use these dens for shelter and to raise young. These animals are highly mobile. They can move up to several kilometres in a night and may have quite large territories. Within their territories, they will have latrine areas where they | 8 (DPIE) Known (PMST) | Moderate. No evidence of site usage by this species was observed (latrine sites). Suitable denning resources observed (hollow-bearing trees). Sclerophyll forest woodland not limited in the locality |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|--------|----------|---|-------------------------------|--|
| | | | defecate. These are often in exposed areas, such as on rocky outcrops. | | |
| Squirrel Glider (<i>Petaurus norfolcensis</i>) | V | - | Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey. | 1 (DPIE) | Low. Not known from recent occurrence records in the study locality (DPIE). study area lacks preferred Blackbutt-Bloodwood forest communities |
| White-footed Dunnart (<i>Sminthopsis leucopus</i>) | V | - | The White-footed Dunnart is found in a range of different habitats across its distribution, including coastal dune vegetation, coastal forest, tussock grassland and sedgeland, heathland, woodland and forest. In NSW, the species seems to favour vegetation communities with an open understorey structure (contrasting with populations in Victoria which apparently prefer dense shrub and ground layers). It is patchily distributed across these habitats and, where present, typically occurs at low densities. | 25 (DPIE) | Low. Species is known from recent occurrence records in the study locality (DPIE). The study area is not considered likely to provide high value habitat for this species. This species is known to have a preference for disturbed areas (after logging, fire etc) with populations rarely persisting after the recovery of a dense forest understorey |
| Yellow-bellied Glider (<i>Petaurus australis</i>) | V | - | Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. | 434 (DPIE) | High. This species is known from recent occurrence records in the study locality (DPIE) and suitable habitat is present within the study area, including potential denning trees |
| Yellow-bellied Sheathtail-bat (<i>Saccolaimus flaviventris</i>) | V | - | The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia. Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. | 2 (DPIE) | Moderate. This species is known from recent occurrence records in the study locality (DPIE) and suitable habitat is present within the study area, including potential roosting trees |
| Reptiles | | | | | |
| Broad-headed Snake (<i>Hoplocephalus bungaroides</i>) | E | V | The Broad-headed Snake is largely confined to Triassic and Permian sandstones, including the Hawkesbury, Narrabeen and | Likely (PMST) | Low. Not known from occurrence records in the study locality (DPIE). study area lacks suitable rock |

| Common Name (<i>Scientific Name</i>) | BC Act | EPBC Act | Habitat requirements | Number of records (source) | Likelihood of occurrence |
|--|-----------|-------------|--|----------------------------------|--|
| | | | Shoalhaven groups, within the coast and ranges in an area within approximately 250 km of Sydney. Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. | | escarpment habitat. Sclerophyll forest habitat of the study area not limited in the Study locality |
| Green Turtle (<i>Chelonia mydas</i>) | V | V | Usually found in tropical waters around Australia but also occurs in coastal waters of NSW, where it is generally seen on the north or central coast, with occasional records from the south coast. Ocean-dwelling species spending most of its life at sea. Carnivorous when young but as adults they feed only on marine plant material. | 4 (DPIE) | None. study area lacks marine habitat |
| Hawksbill Turtle (<i>Eretmochelys imbricata</i>) | - | V | Major nesting of hawksbill turtles in Australia occurs at Varanus Island and Rosemary Island in Western Australia, and in the northern Great Barrier Reef and Torres Strait, Queensland. Hawksbill turtles spend their first five to ten years drifting on ocean currents. During this pelagic phase, they are often found in association with rafts of Sargassum. | 3 (DPIE) | None. study area lacks marine habitat |
| Rosenberg's Goanna (<i>Varanus rosenbergi</i>) | V | - | Found in heath, open forest and woodland. Associated with termites, the mounds of which this species nests in; termite mounds are a critical habitat component. Individuals require large areas of habitat. | 1 (DPIE) | Low. Occurrence records in the study locality greater than 10 years old (DPIE). Study area lacks important microhabitat features (termite mounds) |

Appendix C – Five-part tests and assessments of significance (BC Act and EPBC Act)

Five-part Tests (BC Act)

Under Part 7.2A of the *Biodiversity Conservation Act 2016* (BC Act) a five-part test is required to determine whether a significant impact on any threatened species or TEC listed under the NSW BC Act known or considered likely to occur on a site as a result of a proposed action. If a significant impact is considered likely, based on the test then further assessment through a Species Impact Statement (SIS) is required or a Biodiversity proposal Assessment Report (BDAR) must be prepared by an accredited assessor in accordance with the Biodiversity Assessment Method (BAM).

The following listed entities are known to occur or to have suitable habitat and a potential to occur in the proposal Area and would be impacted upon by the proposal.

Flora

Biconvex Paperbark (*Melaleuca biconvexa*)

This species is listed as vulnerable under the BC Act.

Biconvex Paperbark is a shrub or small tree, usually up to 10 m tall, though occasionally as high as 20 m. The bark is that of a typical paperbark. The leaves are small, to 18 mm long and 4 mm wide; each leaf has a centre-vein in a groove and the leaf blade curves upwards on either side of this centre-vein. Leaf placement is distinctive, with each pair of leaves emerging at right angles from the branch. Each pair is offset at right angles to the previous pair so the branch has a squarish appearance when looked at 'end-on'. This species' white flowers are usually clustered in dense heads and the fruit is urn-shaped and 3 - 5 mm in diameter.

Distribution

Biconvex Paperbark is only found in NSW, with scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north.

Habitat and ecology

- Biconvex Paperbark generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects.
- Flowering occurs over just 3-4 weeks in September and October.
- Resprouts after fire.

A population of this species was identified within the study area during surveys.

(a) *In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.*

The proposal would remove 42 individuals from the study area, including 12 mature trees. A total of 81 mature trees were identified within the study area. The removal of a small number of mature trees is not considered likely to disrupt the breeding cycle of this population. The majority of mature trees and the overall population would be retained after the development and the clearing of suitable habitat on the western edge of the study area would not disrupt habitat connectivity and dispersal downslope along the drainage line feature or significantly inhibit pollination by airborne animal vectors (nectar feeding birds and insects). The widening of the existing access track to

facilitate access to the required batter north of the intersection is not considered to be a significant barrier to dispersal along the north-south access of the construction footprint.

The proposal is not considered likely to have an adverse impact on the life cycle of the population within the study area to the extent that it would be placed at risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- (i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or**
- (ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not applicable to a threatened species.

(c) In relation to the habitat of a threatened species or ecological community:

- (i) The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity;**
- (ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity; and**
- (iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The proposal would remove 42 individuals and around 0.95 hectares of suitable habitat for this species from the study area; however, the majority of the population and suitable habitat (2.24 ha) would be retained.

The portion of the study area containing this species (lot 8 DP 855413) is bounded by sealed roads on all sides. The impact of the proposal on the population present and suitable habitat would largely occur on the western side of this lot and would not lead to fragmentation of the native vegetation within this lot. Current north, east and south continuity would be retained after the proposal work and the retained portion of this population would continue to have habitat continuity along the existing ephemeral drainage line within the lot. The widening of the existing track within this lot is not considered a significant increase in habitat fragmentation, with the existing track to be widened to 5 m. The proposal is not considered likely to fragment or isolate a portion of this population within the study area.

The species is well represented in the Study locality and the long-term survival of this population is not considered dependent on the sub-population present within the study area. Larger populations are present within the suburbs of Basin View, St Georges Basin and elsewhere within Tomerong, north of the study area. The population within the study area is not considered important to the long-term survival of the species in the Study locality.

(d) Whether the action proposed is likely to have an adverse effect any declared area of outstanding biodiversity value (either directly or indirectly).

At present, there are four AOBV declared under the BC Act:

- Gould's Petrel - critical habitat declaration;
- Little penguin population in Sydney's North Harbour - critical habitat declaration;
- Mitchell's Rainforest Snail in Stotts Island Nature Reserve - critical habitat declaration; and

- Wollemi Pine - critical habitat declaration.

Of the above listed AOBV, the Little penguin population in Sydney's North Harbour - critical habitat is located closest to the proposal Area. However, as the proposal Area is located over 150 km from the AOBV, the proposal would not be expected to have any direct or indirect effect on this or any other declared AOBV.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposal would or may constitute, introduce or exacerbate the following Key Threatening Processes (KTPs) relevant to this species:

- Anthropogenic climate change
- Clearing of native vegetation
- Infection of native plants by *Phytophthora cinnamomi*
- Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae
- Invasion and establishment of exotic vines and scramblers
- Invasion and establishment of Scotch Broom (*Cytisus scoparius*)
- Invasion of native plant communities by African Olive *Olea europaea* subsp. *cuspidata* (Wall. ex G. Don) Cif
- Invasion of native plant communities by *Chrysanthemoides monilifera*
- Invasion of native plant communities by exotic perennial grasses
- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
- Removal of dead wood and dead trees.

The proposal would result in a small loss of native vegetation, production of greenhouse gases and removal of dead wood. However, these KTPs arising from the development are not considered significant on the locality scale. The majority of native vegetation including the majority of the population of this species and its suitable habitat would be retained following works.

The introduction of pest weeds and diseases may occur in untreated water, unclean fill and from revegetation plantings. However, these impacts can be mitigated through appropriate controls. With appropriate mitigation, the proposal is not considered likely to significantly exacerbate these KTPs on the locality scale.

Conclusion

The study area supports a population of this species, located within and next to an ephemeral drainage line. The proposal would require the removal of a portion of the population, with the majority of the population and suitable habitat to be retained following works. The species is well represented in the Study locality and suitable habitat is not limited. The long-term survival of the species in the Study locality is not considered dependent on this population. Secondary impacts on this species are not considered likely to lead to the decline of the population with many of these impacts already present due to the existing road network.

As the proposal will retain the majority of the population and suitable habitat, the population is anticipated to persist following works. Consequently, the proposal is not considered likely to have a significant impact on this species. Further assessment through a SIS or BDAR is not considered necessary.

Magenta Lilly Pilly (*Syzygium paniculatum*)

This species is listed as endangered under the BC Act.

The Magenta Lilly Pilly is a small to medium sized rainforest tree that grows to 8 m tall. The bark is flaky and the leaves are shiny, dark-green above and paler underneath. Leaves can be up to 10 cm long. Plants produce white flower-clusters at the end of each branch, between November and February. The petals are small and are accompanied by prominent long stamens. The deep magenta fruits, which may be spherical or egg-shaped, mature in May, and contain a single seed.

Distribution

The Magenta Lilly Pilly is found only in NSW, in a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest.

Habitat and ecology

- On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest
- On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.

A population of two individuals of this species was identified within the study area during surveys.

A national recovery plan for this species has been drafted (NSW Office of Environment and Heritage, 2012). Page 16 of this recovery plan states "*Thurlby (2010) found that there is extremely low genetic diversity within 11 subpopulations sampled across the species range, with a distinct north-south genetic divide centred on the Central Coast. Given this, all confirmed naturally occurring populations of Magenta Lilly Pilly are considered to be important and, therefore, all habitat in which these populations occur is considered to be critical to the survival of the species*".

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The proposal would not remove any individuals from the study area or directly impact suitable habitat next to these individuals. The vegetation to be removed by the proposal predominantly constitutes lower value habitat for this species with a less suitable microclimate. The clearing of marginal suitable habitat on the western edge of the study area would not disrupt habitat connectivity and dispersal through nearby native vegetation or significantly inhibit pollination and seed dispersal by airborne animal vectors (nectar feeding birds and insects and frugivorous birds and mammals). The widening of the existing access track within the construction footprint is not considered a significant alteration to the immediate surrounding environment and a buffer distance of around 10 m would be maintained from each of the identified individuals.

The proposal is not considered likely to disrupt the life cycle of this species to the extent that the population is likely to be placed at risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- (iii) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or***

- (iv) *Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

Not applicable to a threatened species.

(c) *In relation to the habitat of a threatened species or ecological community:*

- (iv) *The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity;***
- (v) *Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity; and***
- (vi) *The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.***

The proposal would not remove any individuals from the study area. The vegetation to be removed by the proposal predominantly constitutes lower value habitat for this species with a less suitable microclimate than the east of the study area where the present population occurs. Around 0.95 hectares of predominantly lower value habitat for this species would be removed by the proposal. Clearing of vegetation in the east of the study area would comprise the widening of an existing access track and is not considered a significant alteration to the local environmental conditions for this species.

The portion of the study area containing this species (lot 8 DP 855413) is bounded by sealed roads on all sides. The impact of the proposal on suitable habitat would largely occur on the western side of this lot and would not lead to further fragmentation or isolation of the native vegetation within this lot. Current north, east and south continuity would be retained after the proposal work and this population would continue to have habitat continuity through the vegetation in the east of this lot. Widening of the existing access track to 5 m is not considered a significant increase in local habitat fragmentation for this species.

The habitat to be directly removed by the proposal is considered to be of predominantly lower habitat value than the vegetation supporting the two individuals of this species. The construction footprint is largely dominated by recovering vegetation since the original Princes Highway works. The vegetation within the proposal Area also largely occurs on an artificially constructed batter and consequently lacks the damper, less exposed habitat preferred by this species. The habitat containing the two individuals is composed of older, more established vegetation on flat topography with a more suitable microclimate. The habitat to be removed by the proposal is not considered important to the long-term survival of the population within the study area.

(d) *Whether the action proposed is likely to have an adverse effect any declared area of outstanding biodiversity value (either directly or indirectly).*

At present, there are four AOBV declared under the BC Act:

- Gould's Petrel - critical habitat declaration;
- Little penguin population in Sydney's North Harbour - critical habitat declaration;
- Mitchell's Rainforest Snail in Stotts Island Nature Reserve - critical habitat declaration; and
- Wollemi Pine - critical habitat declaration.

Of the above listed AOBV, the Little penguin population in Sydney's North Harbour - critical habitat is located closest to the proposal Area. However, as the proposal Area is located over 150 km from the AOBV, the proposal would not be expected to have any direct or indirect effect on this or any other declared AOBV.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposal would or may constitute, introduce or exacerbate the following Key Threatening Processes (KTPs) relevant to this species:

- Anthropogenic climate change
- Clearing of native vegetation
- Infection of native plants by *Phytophthora cinnamomi*
- Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae
- Invasion and establishment of exotic vines and scramblers
- Invasion and establishment of Scotch Broom (*Cytisus scoparius*)
- Invasion of native plant communities by African Olive *Olea europaea* subsp. *cuspidata* (Wall. ex G. Don) Cif
- Invasion of native plant communities by *Chrysanthemoides monilifera*
- Invasion of native plant communities by exotic perennial grasses
- Invasion, establishment and spread of Lantana (*Lantana camara* L. sens. Lat)
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
- Removal of dead wood and dead trees.

The proposal would result in a small loss of native vegetation, production of greenhouse gases and removal of dead wood. However, these KTPs arising from the development are not considered significant on the locality scale. The majority of native vegetation including the majority of the population of this species and its suitable habitat would be retained following works.

The introduction of pest weeds and diseases may occur in untreated water, unclean fill and from revegetation plantings. However, these impacts can be mitigated through appropriate controls. With appropriate mitigation, the proposal is not considered likely to significantly exacerbate these KTPs on the locality scale.

Conclusion

The study area supports a population of two individuals of this species, located close to the eastern boundary of lot 8 DP 855413. The proposal would not require the removal of these individuals. The proposal would largely remove lower quality habitat, comprising less mature native vegetation next to the existing Princes Highway. An existing access track would be upgraded to a width of 5 m, requiring clearing of some higher value habitat in the east of the construction footprint. However, this clearing would maintain a buffer distance of around 10 m from both individuals and significant alteration to the current microclimate conditions for these individuals is not considered likely.

The species is well represented in the Study locality and suitable habitat is not limited. Secondary impact on this species are not considered likely to lead to the decline of the population with many of these impact already present.

Although the habitat to be removed by the proposal is considered to represent 'critical habitat' as defined by the National Recovery Plan, the habitat to be removed is predominantly considered to be of lower habitat value than the more mature native vegetation currently supporting the population in the east of the study area. As the proposal will retain the entire population and the majority of suitable habitat, the proposal is not considered likely to inhibit the long-term persistence of this species within the study area. Consequently, the proposal is not considered likely to have a

significant impact on this species. Further assessment through a SIS or BDAR is not considered necessary.

Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)

This species is listed as vulnerable under the BC Act.

The Eastern Bentwing-bat has chocolate to reddish-brown fur on its back and slightly lighter coloured fur on its belly. It has a short snout and a high 'domed' head with short round ears. The wing membranes attach to the ankle, not to the base of the toe. The last bone of the third finger is much longer than the other finger-bones giving the "bent wing" appearance. It weighs up to 20 grams, has a head and body length of about 6 cm and a wingspan of 30 - 35 cm.

Distribution

Eastern Bentwing-bats occur along the east and north-west coasts of Australia.

Habitat and ecology

- Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.
- Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young.
- Maternity caves have very specific temperature and humidity regimes.
- At other times of the year, populations disperse within about 300 km range of maternity caves.
- Cold caves are used for hibernation in southern Australia.
- Breeding or roosting colonies can number from 100 to 150,000 individuals.
- Hunt in forested areas, catching moths and other flying insects above the tree tops.

This species was potentially detected from the Anabat survey data, but the call could not be reliably differentiated from other species and the species is considered to have been detected based on the precautionary principle. The species is also known from recent occurrence records from the Study locality and suitable habitat is present within the study area for the species in the form of native forests foraging habitat and potential structure roost sites in the form of two large stormwater pipes and culverts. A visual inspection of these structures was undertaken during surveys; however, no evidence of use by microbats (such as roosting individuals, carcasses or guano was observed).

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The proposal would remove a small (0.95 ha) of potential native forest foraging habitat for this species from the study area. This vegetation is largely composed of regenerating trees after historic clearing for the Princes Highway. More mature native vegetation in the east of the study area would be largely retained after the work and continue to provide foraging habitat for this species.

The study area contains two large stormwater pipes and culverts, under the Princes Highway and Island Point Road. These structures provide potential roosting resources for this species. However, utility for this species is considered limited due to a lack of clear entrance flyways due to the culvert design. These resources would not be removed or modified by the proposal and would continue to provide roosting resources after the works.

Although surveys could not be conducted during this species' breeding season (December – February) the large stormwater pipe is considered unlikely to be used as a maternity roost. This species is predominantly known to use caves as breeding habitat and there are currently seven cave roost sites identified as key management sites for this species (NSW Office of Environment

and Heritage, 2019). The nearest of these is located in Bungonia Nature Reserve, located about 60 km to the north-west of the study area.

The proposal is not considered likely to have an adverse impact on the life cycle of this species to the extent that a viable local population is likely to be placed at risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- (i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or**
- (ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not applicable to a threatened species.

(c) In relation to the habitat of a threatened species or ecological community:

- (i) The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity;**
- (ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity; and**
- (iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The proposal would remove 0.95 hectares of native forest foraging habitat for this species from the study area. This form of foraging habitat is not limited in the Study locality and the level of predicted impact is not considered a significant reduction in this resource for this species. The two potential roosting resources for this species would not be removed or modified by the proposal. However, roosting individuals may be disturbed during work in the vicinity of these structures. This impact would be restricted to the work phase and the features would be retained after the completion of works.

The proposal would largely remove native forest habitat from the western edge of the study area. This habitat is largely comprised of recovering native forests previously cleared for highway installation/upgrades. Widening of an existing access track from Grange Road to the proposed batter north of the intersection is not considered to represent a significant increase in habitat fragmentation for this species. Connectivity to vegetation to the west is limited by the existing Princes Highway and the proposed widening of a portion of this roadway is not considered to represent a significant increase in the level of habitat fragmentation represented by the existing roadway. The existing highway does not represent a significant dispersal barrier for this airborne species.

The foraging habitat to be removed by the proposal is not considered important to the long-term survival of the species in the Study locality. Similar forest habitat is not limited in the Study locality and the local population of this species is not considered dependent on these resources for their long-term survival. Impact to roosting individuals within the two potential roosting structures would be limited to the work period and these structures would not be modified by the proposal.

(d) Whether the action proposed is likely to have an adverse effect any declared area of outstanding biodiversity value (either directly or indirectly).

At present, there are four AOBV declared under the BC Act:

- Gould's Petrel - critical habitat declaration;
- Little penguin population in Sydney's North Harbour - critical habitat declaration;
- Mitchell's Rainforest Snail in Stotts Island Nature Reserve - critical habitat declaration; and
- Wollemi Pine - critical habitat declaration.

Of the above listed AOBV, the Little penguin population in Sydney's North Harbour - critical habitat is located closest to the proposal Area. However, as the proposal Area is located over 150 km from the AOBV, the proposal would not be expected to have any direct or indirect effect on this or any other declared AOBV.

(e) Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposal would or may constitute, introduce or exacerbate the following KTPs relevant to this species:

- Anthropogenic climate change
- Clearing of native vegetation
- Removal of dead wood and dead trees.

The proposal would result in a small loss of native vegetation, production of greenhouse gases and removal of dead wood. However, these KTPs arising from the development are not considered significant on the locality scale. The majority of native vegetation including areas containing high value habitat features for this species would be retained after the works.

Conclusion

This species was detected from Anabat call data during surveys in the study area and is known from numerous occurrence records from the Study locality. The study area contains suitable native forest foraging habitat, a small portion of which would be removed by the proposal. This form of habitat is not limited in the Study locality and the local population of this species is not considered dependent on this resource for its long-term survival. The study area also contains two potential roosting structures in the form of large stormwater pipes under the Princes Highway and Island Point Road. Neither of these structures would be removed or modified by the proposal.

No significant impact on this species is anticipated by the proposal. Consequently, further assessment through the preparation of a SIS or BDAR is not considered necessary.

Eastern Pygmy Possum (*Cercartetus nanus*)

Eastern Pygmy-possums are tiny (15 to 43 grams) active climbers, with almost bare, prehensile (capable of curling and gripping) tails, and big, forward-pointing ears. They are light-brown above and white below. Adults have a head and body length between 70 - 110 mm and a tail length between 75 - 105 mm.

Distribution

The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extends from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes.

Habitat and ecology

- Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest
- Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable
- Also feeds on insects throughout the year; this feed source may be more important in habitats where flowers are less abundant such as wet forests
- Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (*Pseudocheirus peregrinus*) dreys or thickets of vegetation, (eg grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks
- Appear to be mainly solitary, each individual using several nests, with males having non-exclusive home-ranges of about 0.68 hectares and females about 0.35 hectares
- Young can be born whenever food sources are available, however most births occur between late spring and early autumn
- Agile climbers, but can be caught on the ground in traps, pitfalls or postholes; generally nocturnal
- Frequently spends time in torpor especially in winter, with body curled, ears folded and internal temperature close to the surroundings.

This species was not detected during spotlight surveys within the study area. However, it is known from numerous recent occurrence records in the Study locality. The habitat of the study area is considered suitable but sub-optimal with the study area lacking the heath and woodland habitat preferred by this species. The majority of occurrence records in the Study locality are within areas of coastal heath (near Vincentia and Huskisson) or at higher elevation in the western foothills within and next to Jerrawangala National Park.

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The proposal Area does not contain important habitat features which could be used for roosting, breeding or winter torpor sites (hollow-bearing trees, stumps, grass trees, possum dreys etc). The study area contains seven habitat-bearing trees, several of which contain hollows which could be potentially used by this species. These features would be retained after the completion of works. However, disturbance of surrounding vegetation may affect the utility of these features for breeding, roosting or overwintering during works. This impact would be restricted to the work phase and these resources would continue to be available after the works. Disruption to these resources (hollow-bearing trees) would be limited to the works phase and these resources would be retained after the works. These resources are not limited in the Study locality, with large areas

of mature native forest present. As detailed above, the habitat of the study area is not considered highly suitable for this species.

The proposal is not considered likely to have an adverse effect on habitat for the local population of this species to the extent that it would be placed at greater risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- (i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or**
- (ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not applicable to a threatened species.

(c) In relation to the habitat of a threatened species or ecological community:

- (i) The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity;**
- (ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity; and**
- (iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The proposal would remove largely regenerating native vegetation from the western edge of the study area, abutting the existing Princes Highway, estimated to be 0.95 ha. This habitat was not assessed as containing important habitat resources for this species (stumps, grass trees, possum dreys and habitat-bearing trees). More mature, higher condition native vegetation, containing habitat-bearing trees would be retained in the east of the study area and would maintain its current level of connectivity to native vegetation on lands to the north, east and south after the works. The small amount of lower condition habitat to be removed by the proposal is not considered important to the long-term survival of the species in the Study locality.

The proposal would predominantly remove native forest habitat from the western edge of the study area. This habitat is largely comprised of recovering native forests previously cleared for highway installation/upgrades. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant reduction in habitat connectivity within the study area. Connectivity to vegetation to the west is limited by the existing Princes Highway and the proposed widening of a portion of this roadway is not considered to represent a significant increase in the level of habitat fragmentation represented by the existing roadway.

The habitat to be removed by the proposal is not considered to be important to the long-term survival of the species in the Study locality and lacks important habitat features. Higher value habitat containing mature native forest and habitat-bearing trees would be retained within the study area after the works.

(d) Whether the action proposed is likely to have an adverse effect any declared area of outstanding biodiversity value (either directly or indirectly).

At present, there are four AOBV declared under the BC Act:

- Gould's Petrel - critical habitat declaration;
- Little penguin population in Sydney's North Harbour - critical habitat declaration;

- Mitchell's Rainforest Snail in Stotts Island Nature Reserve - critical habitat declaration; and
- Wollemi Pine - critical habitat declaration.

Of the above listed AOBV, the Little penguin population in Sydney's North Harbour - critical habitat is located closest to the proposal Area. However, as the proposal Area is located over 150 km from the AOBV, the proposal would not be expected to have any direct or indirect effect on this or any other declared AOBV.

(e) Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposal would or may constitute, introduce or exacerbate the following KTPs relevant to this species:

- Anthropogenic climate change
- Clearing of native vegetation
- Removal of dead wood and dead trees.

The proposal would result in a small loss of native vegetation, production of greenhouse gases and removal of dead wood. However, these KTPs arising from the development are not considered significant on the locality scale. The majority of native vegetation including areas containing high value habitat features for this species would be retained after the works.

Conclusion

This species was not recorded in the study area during surveys; however, it is known from recent occurrence records in the Study locality and suitable (but suboptimal) habitat is present in the study area. The proposal would largely remove lower value habitat in the form of recovering native forest along the eastern edge of the Princes Highway. No important habitat resources (stumps, dreys, grass trees or hollow-bearing trees) would be removed by the proposal. The proposal would not increase fragmentation of habitat for this species with retained vegetation maintaining connectivity with habitat to the north, east and south after the works. The proposal Area and study area is considered to represent suboptimal habitat for this species, lacking significant densities of typical nectar trees for this species, banksias and grevilleas.

The proposal is not considered likely to have a significant impact on this species in the Study locality. Consequently, further assessment through the preparation of a SIS or BDAR is not considered necessary.

Green and Golden Bell Frog (*Litoria aurea*)

This species is listed as endangered under the BC Act.

A relatively large, stout frog, ranging in size from approximately 45 mm to approximately 100 mm snout to vent length. Diagnostic features are a gold or creamish white stripe running along the side, extending from the upper eyelids almost to the groin, with a narrow dark brown stripe beneath it, from nostril to eye. It also has blue or bluish-green colour on the inside of the thighs. The colour of the body varies. Usually a vivid pea-green, splotched with an almost metallic brassy brown or gold. The backs of some individuals may be almost entirely green; in others golden-brown markings may dominate.

Distribution

Formerly distributed from the NSW north coast near Brunswick Heads, southwards along the NSW coast to Victoria where it extends into east Gippsland. Records from west to Bathurst, Tumut and the ACT region. Since 1990 there have been approximately 50 recorded locations in NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range, however they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (one an island population). There is only one known population on the NSW Southern Tablelands.

Habitat and ecology

- Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.)
- Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available
- Some sites, particularly in the Greater Sydney region occur in highly disturbed areas
- The species is active by day and usually breeds in summer when conditions are warm and wet
- Males call while floating in water and females produce a raft of eggs that initially float before settling to the bottom, often amongst vegetation
- Tadpoles feed on algae and other plant-matter; adults eat mainly insects, but also other frogs
- Preyed upon by various wading birds and snakes.

This species was not detected in the study area during surveys. The study area is within the known range of this species and the species is well documented from the Study locality with seven records present in the BioNet database, three of which date from later than 1995 (1997, 2011 and 2012). The study area contains a small waterbody dominated by suitable aquatic vegetation (*Typha* sp.). Surveys could not be conducted during an appropriate season for the detection of this species (September - March) or under suitable weather conditions (after significant rainfall).

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The proposal would remove marginal native forest habitat from the proposal Area; however, the small waterbody would be retained. The waterbody and surrounding habitat are considered sub-optimal for this species, lacking open grassy basking habitat and dominated by tall, dense native vegetation. This species is known to have a preference for fringing vegetation no higher and denser than woodlands. The habitat available in the study area is not considered to represent habitat important to the life cycle of this species in the locality.

The proposal is not considered likely to place the local population of this species at risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- (i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or**
- (ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not applicable to a threatened species.

(c) In relation to the habitat of a threatened species or ecological community:

- (i) The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity;**
- (ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity; and**
- (iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The proposal would remove a small (0.95 ha) portion of marginal forest foraging habitat for this species from the locality. As described above, this habitat lacks many key attributes preferred by this species and is not considered important to the long-term survival of the local population of this species. The small waterbody would not be removed by the proposal.

Connectivity to vegetation to the west is limited by the existing Princes Highway and the proposed widening of a portion of this roadway is not considered to represent a significant increase in the level of habitat fragmentation represented by the existing roadway. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant reduction in habitat connectivity within the study area. Structures allowing dispersal underneath this road are present in the form of a large stormwater pipe and culvert, which would not be modified by the proposal.

The local population of this species is not considered to use the habitat of the proposal Area on a regular basis and is not considered to be dependent on these resources for important life cycle components (breeding) due to a lack of several key habitat attributes. Similar native forest is not limited in the Study locality and dispersal through the study area into nearby habitat along the ephemeral creek line would not be inhibited by the proposal.

(d) Whether the action proposed is likely to have an adverse effect any declared area of outstanding biodiversity value (either directly or indirectly).

At present, there are four AOBV declared under the BC Act:

- Gould's Petrel - critical habitat declaration;
- Little penguin population in Sydney's North Harbour - critical habitat declaration;
- Mitchell's Rainforest Snail in Stotts Island Nature Reserve - critical habitat declaration; and
- Wollemi Pine - critical habitat declaration.

Of the above listed AOBV, the Little penguin population in Sydney's North Harbour - critical habitat is located closest to the proposal Area. However, as the proposal Area is located over 150 km from the AOBV, the proposal would not be expected to have any direct or indirect effect on this or any other declared AOBV.

(e) Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

Development of the proposal Area would or may constitute, introduce or exacerbate the following KTPs relevant to this species:

- Anthropogenic climate change
- Infection of frogs by amphibian chytrid causing the disease chytridiomycosis
- Clearing of native vegetation
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
- Removal of dead wood and dead trees.

The proposal would result in a small loss of native vegetation, production of greenhouse gases and removal of dead wood. However, these KTPs arising from the development are not considered significant on the locality scale. The habitat to be removed from the study area is not considered important to the long-term survival of this species in the Study locality.

The introduction of diseases and pest weeds may occur in untreated water, unclean fill and from important seedling stock. However, this impact can be mitigated through appropriate controls. With appropriate mitigation, the proposal is not considered likely to significantly exacerbate these KTPs on the locality scale.

Conclusion

This species is known from the Study locality and potential habitat is present in the form of an ephemeral waterbody containing suitable aquatic vegetation. However, the wider study area was not assessed as containing suitable habitat as detailed in the DPIE Species Profile for this species, lacking areas of grassland and with native vegetation communities considered too dense to form optimum habitat for this species. The waterbody and wider study area is considered to comprise marginal habitat for this species.

The proposal is not considered likely to have a significant impact on this species. Consequently, further assessment through the preparation of a SIS or BDAR is not considered necessary.

Hollow-roosting Woodland Birds

This test has been applied to the following species, due to their similar habitat requirements:

- Gang Gang Cockatoo (*Callocephalon fimbriatum*)
- Little Lorikeet (*Glossopsitta pusilla*).

Gang-gang Cockatoos are one of the more distinctive and charismatic members of Australia's avifauna. These birds are primarily slate-grey, with the males easily identified by their scarlet head and wispy crest, while females have a grey head and crest and feathers edged with salmon pink on the underbelly. They range in length from 32 to 37 cm, with a wingspan of 62 to 76 cm. The call has been likened to a creaking gate or cork being pulled from a bottle.

Distribution

The Gang-gang Cockatoo is distributed from southern Victoria through south- and central-eastern New South Wales. In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the Australian Capital Territory. It is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee.

Habitat and ecology

- In spring and summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests
- In autumn and winter, the species often moves to lower altitudes in drier more open eucalypt forests and woodlands, particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas
- May also occur in sub-alpine Snow Gum (*Eucalyptus pauciflora*) woodland and occasionally in temperate rainforests
- Favours old growth forest and woodland attributes for nesting and roosting. Nests are located in hollows that are 10 cm in diameter or larger and at least 9 m above the ground in eucalypts.

The Little Lorikeet is a small (16-19 cm; 40 g) bright green parrot, with a red face surrounding its black bill and extending to the eye. The undertail is olive-yellow with a partly concealed red base, and the underwing coverts are bright green. The mantle is imbued with light brown. The call in flight is diagnostically different from other lorikeets, being a shrill and rolling screech: 'zit-zit' or 'zzet'. Although difficult to observe while foraging high in treetops, a flock's constantly chattering contact calls give it away. Flight is fast, direct and through or above the canopy.

Distribution

The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs.

Habitat and ecology

- Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity
- Isolated flowering trees in open country, eg paddocks, roadside remnants and urban trees also help sustain viable populations of the species
- Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards

- Gregarious, travelling and feeding in small flocks (<10), though often with other lorikeets. Flocks numbering hundreds are still occasionally observed and may have been the norm in past centuries
- Roosts in treetops, often distant from feeding areas
- Nests in proximity to feeding areas if possible, most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts. Entrance is small (3 cm) and usually high above the ground (2–15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees often chosen, including species like *Allocasuarina*
- Nesting season extends from May to September. In years when flowering is prolific, Little Lorikeet pairs can breed twice, producing 3-4 young per attempt. However, the survival rate of fledglings is unknown.

None of these species were detected during surveys in the study area. However, all are known from recent occurrence records in the locality and suitable native forests including hollow-bearing trees are present within the study area.

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The proposal Area does not contain important habitat features which could be used for breeding (hollow-bearing trees). The study area contains seven habitat-bearing trees, several of which contain hollows which could be potentially used by these species. These features would be retained after the completion of works. However, disturbance of surrounding vegetation may affect the utility of these features for breeding during works. Surveys were conducted early in the breeding season for these species with no observed use of hollows. However, these surveys cannot be considered conclusive.

This impact would be restricted to the work phase and these resources would continue to be available as potential breeding sites after the works. These resources are not limited in the Study locality, with large areas of mature native forest present containing hollow-bearing resources.

The proposal is not considered likely to have an adverse effect on habitat for the local population of these species to the extent that they would be placed at greater risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- (i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or***
- (ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.***

Not applicable to a threatened species.

(c) In relation to the habitat of a threatened species or ecological community:

- (i) The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity;***
- (ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity; and***
- (iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.***

The proposal would remove largely regenerating native vegetation from the western edge of the study area, abutting the existing Princes Highway, estimated to be 0.95 ha. This habitat was not assessed as containing important habitat resources for these species (habitat-bearing trees). More mature, higher condition native vegetation, containing habitat-bearing trees would be retained in the east of the study area. The small amount of lower condition habitat to be removed by the proposal is not considered important to the long-term survival of these species in the Study locality.

Native forest in the east of the study area would maintain similar level of connectivity with native vegetation to the north, east and south after the works. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant reduction in habitat connectivity within the study area for this species. Connectivity to vegetation to the west is limited by the existing Princes Highway and the proposed widening of a portion of this roadway is not considered to represent a significant increase in the level of habitat fragmentation represented by the existing roadway for these mobile, aerial species.

The habitat to be removed by the proposal is not considered to be important to the long-term survival of these species in the Study locality and lacks important habitat features. Higher value habitat containing mature native forest and habitat-bearing trees would be retained within the study area after the works.

(d) Whether the action proposed is likely to have an adverse effect any declared area of outstanding biodiversity value (either directly or indirectly).

At present, there are four AOBV declared under the BC Act:

- Gould's Petrel - critical habitat declaration;
- Little penguin population in Sydney's North Harbour - critical habitat declaration;
- Mitchell's Rainforest Snail in Stotts Island Nature Reserve - critical habitat declaration; and
- Wollemi Pine - critical habitat declaration.

Of the above listed AOBV, the Little penguin population in Sydney's North Harbour - critical habitat is located closest to the proposal Area. However, as the proposal Area is located over 150 km from the AOBV, the proposal would not be expected to have any direct or indirect effect on this or any other declared AOBV.

(e) Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposal would or may constitute, introduce or exacerbate the after the KTPs relevant to these species:

- Anthropogenic climate change
- Clearing of native vegetation
- Removal of dead wood and dead trees.

The proposal would result in a small loss of native vegetation, production of greenhouse gases and removal of dead wood and dead trees. However, these KTPs arising from the proposal are not considered significant on the locality scale. The majority of native vegetation including areas containing high value habitat features (hollow-bearing live and dead trees) for these species would be retained after the works.

Conclusion

These species were not recorded in the study area during surveys; however, they are known from recent occurrence records in the Study locality and suitable habitat is present in the study area. The proposal would largely remove lower value habitat in the form of recovering native forest along the eastern edge of the Princes Highway. No important habitat resources (hollow-bearing trees)

would be removed by the proposal. The proposal would not significantly increase fragmentation of habitat for these species with retained vegetation maintaining connectivity with habitat to the north, east and south after the works.

No significant impact on these species is anticipated as a result of the proposal. Consequently, further assessment through a SIS or BDAR is not considered necessary.

Large Forest Owls

This test has been applied to the following species, due to their similar habitat requirements:

- Barking Owl (*Ninox connivens*)
- Masked Owl (*Tyto novaehollandiae*)
- Powerful Owl (*Ninox strenua*)
- Sooty Owl (*Tyto tenebricosa*).

All of these species are listed as vulnerable under the BC Act.

The Barking Owl is medium-sized owl (42 cm, 650 g), smaller than the similar Powerful Owl and larger than the Southern Boobook. It has bright yellow eyes and no facial-disc. Upperparts are brown or greyish-brown, and the white breast is vertically streaked with brown. The large talons are yellow. Males are typically larger than their mate and have a more square crown. The quick, dog-like 'wook-wook' territorial call is diagnostic, but the yapping of foxes and dogs is sometimes attributed to this species. Pairs of birds perform call-and-answer duets, the male's tone being the deeper, which often rise to an excited rapid pitch. This species is also famous for a rarely use high-pitched tremulous scream that has earned it the name 'screaming-woman bird'.

Distribution

The Barking Owl is found throughout continental Australia except for the central arid regions. Although common in parts of northern Australia, the species has declined greatly in southern Australia and now occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains and in some northeast coastal and escarpment forests. Many populations crashed as woodland on fertile soils was cleared over the past century, leaving linear riparian strips of remnant trees as the last inhabitable areas. Surveys in 2001 demonstrated that the Pilliga Forest supported the largest population in southern Australia. The owls sometimes extend their home range into urban areas, hunting birds in garden trees and insects attracted to streetlights.

Habitat and ecology

- Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (eg western NSW) due to the higher density of prey on these fertile riparian soils
- Roost in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. During nesting season, the male perches in a nearby tree overlooking the hollow entrance
- Preferentially hunts small arboreal mammals such as Squirrel Gliders and Common Ringtail Possums, but when loss of tree hollows decreases these prey populations the owl becomes more reliant on birds, invertebrates and terrestrial mammals such as rodents and rabbits. Can catch bats and moths on the wing, but typically hunts by sallying from a tall perch
- Requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 hectares, with 2000 hectares being more typical in NSW habitats
- Two or three eggs are laid in hollows of large, old trees. Living eucalypts are preferred though dead trees are also used. Nest sites are used repeatedly over years by a pair, but they may switch sites if disturbed by predators (eg goannas)
- Nesting occurs during mid-winter and spring, being variable between pairs and among years. As a rule of thumb, laying occurs during August and fledging in November. The female incubates for 5 weeks, roosts outside the hollow when chicks are 4 weeks old, then fledging occurs 2-3 weeks later. Young are dependent for several months
- Territorial pairs respond strongly to recordings of Barking Owl calls from up to 6 km away, though humans rarely hear this response farther than 1.5 km. Because disturbance

reduces the pair's foraging time, and can pull the female off her eggs even on cold nights, recordings should not be broadcast unnecessarily nor during the nesting season.

The Masked Owl is a medium-sized owl to 40 - 50 cm long, with dark eyes set in a prominent flat, heart-shaped facial disc that is encircled by a dark border. The feet are large and powerful, with fully feathered legs down to the toes. The owl exists in several colour forms, with wide variation in plumage. The upperparts are grey to dark brown with buff to rufous mottling and fine, pale spots. The wings and tail are well barred. The underparts are white to rufous-brown with variable dark spotting. The palest birds have a white face with a brown patch around each eye; the darkest birds have a chestnut face. The dark form of the Masked Owl is much browner than the Sooty Owl *Tyto tenebricosa*.

Distribution

Extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90 per cent of NSW, excluding the most arid north-western corner. There is no seasonal variation in its distribution.

Habitat and ecology

- Lives in dry eucalypt forests and woodlands from sea level to 1100 m
- A forest owl, but often hunts along the edges of forests, including roadsides
- The typical diet consists of tree-dwelling and ground mammals, especially rats
- Pairs have a large home-range of 500 to 1000 hectares
- Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.

The Powerful Owl is the largest owl in Australasia. It is a typical hawk-owl, with large yellow eyes and no facial-disc. Adults reach 60 cm in length, have a wingspan of up to 140 cm and weigh up to 1.45 kilograms. Males are larger than females. The upper parts of the Powerful Owl are dark, greyish-brown with indistinct off-white bars. The underparts are whitish with dark greyish-brown V-shaped markings. Juvenile Powerful Owls have a white crown and underparts that contrasts with its small, dark streaks and dark eye patches. The call of this species may be heard at any time of the year, but it is more vocal during the autumn breeding season. It has a slow, deep and resonant double hoot, with the female's being higher pitched and expressing an upward inflection on the second note.

Distribution

The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered records on the western slopes and plains suggesting occupancy before land clearing. Now at low densities throughout most of its eastern range, rare along the Murray River and former inland populations may never recover.

Habitat and ecology

- The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest
- The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine *Syncarpia glomulifera*, Black She-oak *Allocasuarina littoralis*, Blackwood *Acacia melanoxylon*, Rough-barked Apple *Angophora floribunda*, Cherry Ballart *Exocarpus cupressiformis* and a number of eucalypt species
- The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider. There may be marked regional differences in the prey taken by Powerful Owls. For example, in southern NSW, Ringtail Possum make up

the bulk of prey in the lowland or coastal habitat. At higher elevations, such as the tableland forests, the Greater Glider may constitute almost all of the prey for a pair of Powerful Owls. Flying foxes are important prey in some areas; birds comprise about 10-50 per cent of the diet depending on the availability of preferred mammals. As most prey species require hollows and a shrub layer, these are important habitat components for the owl

- Pairs of Powerful Owls demonstrate high fidelity to a large territory, the size of which varies with habitat quality and thus prey densities. In good habitats a mere 400 can support a pair; where hollow trees and prey have been depleted the owls need up to 4000 ha
- Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. While the female and young are in the nest hollow the male Powerful Owl roosts nearby (10-200 m) guarding them, often choosing a dense "grove" of trees that provide concealment from other birds that harass him
- Powerful Owls are monogamous and mate for life. Nesting occurs from late autumn to mid-winter, but is slightly earlier in north-eastern NSW (late summer - mid autumn). Clutches consist of two dull white eggs and incubation lasts approximately 38 days.

The Sooty Owl is a medium-sized owl to 45 cm long, with dark eyes set in a prominent flat, heart-shaped facial disc. Dark sooty-grey in colour, with large eyes in a grey face, fine white spotting above and below, and a pale belly. The plumage of the fledglings is similar to the adult, but has tufts of down on the head and underparts.

Distribution

Occupies the easternmost one-eighth of NSW, occurring on the coast, coastal escarpment and eastern tablelands. Territories are occupied permanently.

Habitat and ecology

- Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests
- Roosts by day in the hollow of a tall forest tree or in heavy vegetation; hunts by night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum (*Pseudocheirus peregrinus*) or Sugar Glider (*Petaurus breviceps*)
- Nests in very large tree-hollows.

None of these species were detected during surveys in the study area. However, all are known from recent occurrence records in the locality and suitable native forests including hollow-bearing trees are present within the study area.

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The proposal Area does not contain important habitat features which could be used for breeding (hollow-bearing trees). The study area contains seven habitat-bearing trees; however, none of these contained hollows considered large enough to be potentially used by these species. These features would be retained after the completion of works. However, disturbance of surrounding vegetation may affect the utility of these features for breeding during works. Surveys were conducted during a season appropriate for the detection of nesting behaviour. However, no evidence of the use of the hollow-bearing resources or regular roosts (whitewash, pellets etc) was apparent.

This impact would be restricted to the work phase and these resources would continue to be available as potential breeding sites after the works. These resources are not limited in the Study locality, with large areas of mature native forest present.

The proposal is not considered likely to have an adverse effect on habitat for the local population of these species to the extent that they would be placed at greater risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- (i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or**
- (ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not applicable to threatened species.

(c) In relation to the habitat of a threatened species or ecological community:

- (i) The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity;**
- (ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity; and**
- (iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The proposal would remove largely regenerating native vegetation from the western edge of the study area, abutting the existing Princes Highway, estimated to be 0.95 ha. This habitat was not assessed as containing important habitat resources for these species (habitat-bearing trees). More mature, higher condition native vegetation, containing habitat-bearing trees would be retained in the east of the study area and would maintain its current level of connectivity to native vegetation on lands to the north, east and south after the works. The small amount of lower condition habitat to be removed by the proposal is not considered important to the long-term survival of these species in the Study locality.

Native forest in the east of the study area would maintain a similar level of connectivity with native vegetation to the north, east and south after the works. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant reduction in habitat connectivity within the study area for these species. Connectivity to vegetation to the west is limited by the existing Princes Highway and the proposed widening of a portion of this roadway is not considered to represent a significant increase in the level of habitat fragmentation represented by the existing roadway for these large aerial species.

The habitat to be removed by the proposal is not considered to be important to the long-term survival of these species in the Study locality and lacks important habitat features. Higher value habitat containing mature native forest and habitat-bearing trees would be retained within the study area after the works.

(d) Whether the action proposed is likely to have an adverse effect any declared area of outstanding biodiversity value (either directly or indirectly).

At present, there are four AOBV declared under the BC Act:

- Gould's Petrel - critical habitat declaration;
- Little penguin population in Sydney's North Harbour - critical habitat declaration;
- Mitchell's Rainforest Snail in Stotts Island Nature Reserve - critical habitat declaration; and

- Wollemi Pine - critical habitat declaration.

Of the above listed AOBV, the Little penguin population in Sydney's North Harbour - critical habitat is located closest to the proposal Area. However, as the proposal Area is located over 150 km from the AOBV, the proposal would not be expected to have any direct or indirect effect on this or any other declared AOBV.

(f) Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposal would or may constitute, introduce or exacerbate the following KTPs relevant to these species:

- Anthropogenic climate change
- Clearing of native vegetation
- Removal of dead wood and dead trees.

The proposal would result in a small loss of native vegetation, production of greenhouse gases and removal of dead wood and dead trees. However, these KTPs arising from the proposal are not considered significant on the locality scale. The majority of native vegetation including areas containing high value habitat features (hollow-bearing live and dead trees) for these species would be retained after the works.

Conclusion

These species were not recorded in the study area during surveys; however, they are all known from recent occurrence records in the Study locality and suitable habitat is present in the study area. The proposal would largely remove lower value habitat in the form of recovering native forest along the eastern edge of the Princes Highway. No important habitat resources (hollow-bearing trees) would be removed by the proposal and the hollows present are not considered large enough to provide nesting resources for these species. The proposal would not increase fragmentation of habitat for these species with retained vegetation maintaining connectivity with habitat to the north, east and south after the works.

No significant impact on these species is anticipated as a result of the proposal. Consequently, further assessment through the preparation of a SIS or BDAR is not considered necessary.

Spotted-tailed Quoll (*Dasyurus maculatus*)

This species is listed as vulnerable under the BC Act.

The Spotted-tailed Quoll is about the size of a domestic cat, from which it differs most obviously in its shorter legs and pointed face. The average weight of an adult male is about 3500 grams and an adult female about 2000 grams. It has rich-rust to dark-brown fur above, with irregular white spots on the back and tail, and a pale belly. The spotted tail distinguishes it from all other Australian mammals, including other quoll species. However, the spots may be indistinct on juvenile animals.

Distribution

The range of the Spotted-tailed Quoll has contracted considerably since European settlement. It is now found in eastern NSW, eastern Victoria, south-east and north-eastern Queensland, and Tasmania. Only in Tasmania is it still considered relatively common.

Habitat and ecology

- Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline
- Individual animals use hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den sites
- Mostly nocturnal, although will hunt during the day; spends most of the time on the ground, although also an excellent climber and will hunt possums and gliders in tree hollows and prey on roosting birds
- Use communal 'latrine sites', often on flat rocks among boulder fields, rocky cliff-faces or along rocky stream beds or banks. Such sites may be visited by multiple individuals and can be recognised by the accumulation of the sometimes characteristic 'twisty-shaped' faeces deposited by animals
- A generalist predator with a preference for medium-sized (500g-5kg) mammals. Consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits, reptiles and insects. Also eats carrion and takes domestic fowl
- Females occupy home ranges of 200-500 hectares, while males occupy very large home ranges from 500 to over 4000 hectares. Are known to traverse their home ranges along densely vegetated creek lines
- Average litter size is five; both sexes mature at about one year of age. Life expectancy in the wild is about 3-4 years.

This species was not detected in the study area; however, the species has a very large home range and adequate survey could not be conducted within the available survey period. The species is known from recent occurrence records in the Study locality and suitable native vegetation with hollow-bearing trees is present within the study area.

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The proposal Area does not contain important habitat features which could be used for breeding dens (hollow-bearing trees, hollow logs, caves etc). The study area contains seven habitat-bearing trees, several of which contain hollows which could be potentially used by this species. These features would be retained after the completion of works. However, disturbance of surrounding vegetation may affect the utility of these features for breeding during works. This impact would be restricted to the work phase and these resources would continue to be available as potential breeding sites after the works.

The proposal is not considered likely to permanently remove potential breeding resources for the species from the study area. Disruption to potential breeding resources (hollow-bearing trees) would be limited to the work phase and potential breeding resources would be retained after the

works. These resources are not limited in the Study locality, with large areas of mature native forest present.

The proposal is not considered likely to have an adverse effect on habitat for the local population of this species to the extent that it would be placed at greater risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- (i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or**
- (ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not applicable to a threatened species.

(c) In relation to the habitat of a threatened species or ecological community:

- (i) The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity;**
- (ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity; and**
- (iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The proposal would remove largely regenerating native vegetation from the western edge of the study area, abutting the existing Princes Highway, estimated to be 0.95 ha. This habitat was not assessed as containing important habitat resources for this species (caves, hollow logs and habitat-bearing trees). More mature, higher condition native vegetation, containing habitat-bearing trees would be retained in the east of the study area and would similar levels of connectivity to native vegetation on lands to the north, east and south after the works. The small amount of lower condition habitat to be removed by the proposal is not considered important to the long-term survival of the species in the Study locality.

The proposal would remove native forest habitat from the western edge of the study area. This habitat is largely comprised of recovering native forests previously cleared for highway installation/upgrades. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant reduction in habitat connectivity within the study area for north-south dispersion. Connectivity to vegetation to the west is limited by the existing Princes Highway and the proposed widening of a portion of this roadway is not considered to represent a significant increase in the level of habitat fragmentation represented by the existing roadway. Structures allowing dispersal underneath this road are present in the form of a large stormwater pipe and culvert, which would be retained after the works.

The habitat to be removed by the proposal is not considered to be important to the long-term survival of the species in the Study locality and lacks important habitat features (habitat trees, caves, large logs etc). Higher value habitat containing mature native forest and habitat-bearing trees would be retained within the study area after the works.

(d) Whether the action proposed is likely to have an adverse effect any declared area of outstanding biodiversity value (either directly or indirectly).

At present, there are four AOBV declared under the BC Act:

- Gould's Petrel - critical habitat declaration;
- Little penguin population in Sydney's North Harbour - critical habitat declaration;
- Mitchell's Rainforest Snail in Stotts Island Nature Reserve - critical habitat declaration; and
- Wollemi Pine - critical habitat declaration.

Of the above listed AOBV, the Little penguin population in Sydney's North Harbour - critical habitat is located closest to the proposal Area. However, as the proposal Area is located over 150 km from the AOBV, the proposal would not be expected to have any direct or indirect effect on this or any other declared AOBV.

(e) Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposal would or may constitute, introduce or exacerbate the following KTPs relevant to this species:

- Anthropogenic climate change
- Clearing of native vegetation
- Removal of dead wood and dead trees.

The proposal would result in a small loss of native vegetation, production of greenhouse gases and removal of dead wood. However, these KTPs arising from the development are not considered significant on the locality scale. The majority of native vegetation including areas containing high value habitat features for this species would be retained after the works.

Conclusion

This species was not recorded in the study area during surveys; however, it is known from recent occurrence records in the Study locality and suitable habitat is present in the study area. The proposal would largely remove lower value habitat in the form of recovering native forest along the eastern edge of the Princes Highway. No important habitat resources (hollow-bearing trees, hollow logs) would be removed by the proposal. The proposal would not increase fragmentation of habitat for this species with retained vegetation maintaining similar levels of connectivity with habitat to the north, east and south after the works.

The proposal is not considered likely to have a significant impact on this species in the Study locality. Consequently, further assessment through the preparation of a SIS or BDAR is not considered necessary.

Tree-roosting Microbats

This test has been applied to the following species, due to their similar habitat requirements:

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)
- Eastern Freetail-bat (*Mormopterus norfolkensis*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*)
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*).

All of these species are listed as vulnerable under the BC Act.

The Eastern False Pipistrelle is relatively large with a head-body length of about 65 mm. It weighs up to 28 grams. It is dark to reddish-brown above and paler grey on its underside. It has long slender ears set well back on the head and some sparse hair on the nose.

Distribution

The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania.

Habitat and ecology

- Prefers moist habitats, with trees taller than 20 m
- Generally, roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings
- Hunts beetles, moths, weevils and other flying insects above or just below the tree canopy
- Hibernates in winter
- Females are pregnant in late spring to early summer.

The Eastern Freetail-bat has dark brown to reddish brown fur on the back and is slightly paler below. Like other freetail-bats it has a long (3 - 4 cm) bare tail protruding from the tail membrane. Freetail-bats are also known as mastiff-bats, having hairless faces with wrinkled lips and triangular ears. They weigh up to 10 grams.

Distribution

The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW.

Habitat and ecology

- Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range
- Roost mainly in tree hollows but will also roost under bark or in man-made structures
- Usually solitary but also recorded roosting communally, probably insectivorous.

The Greater Broad-nosed Bat is a large powerful bat, up to 95 mm long, with a broad head and a short square muzzle. It is dark reddish-brown to mid-brown above and slightly paler below. It is distinguished from other broad-nosed bats by its greater size. While similar to the Eastern False Pipistrelle *Falsistrellus tasmaniensis*, it differs by having only two (not four) upper incisors.

Distribution

The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500 m.

Habitat and ecology

- Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest
- Although this species usually roosts in tree hollows, it has also been found in buildings

- Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m
- Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species
- Little is known of its reproductive cycle, however a single young is born in January; before birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the single young.

The Yellow-bellied Sheath-tail-bat is a very distinctive, large, insectivorous bat up to 87 mm long. It has long, narrow wings, a glossy, jet-black back, and a white to yellow belly extending to the shoulders and just behind the ear. Characteristically, it has a flattened head and a sharply-pointed muzzle. The tail is covered with an extremely elastic sheath that allows variation in the tail-membrane area. Males have a prominent throat pouch; females have a patch of bare skin in the same place.

Distribution

The Yellow-bellied Sheath-tail-bat is a wide-ranging species found across northern and eastern Australia. In the most southerly part of its range - most of Victoria, south-western NSW and adjacent South Australia - it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes.

Habitat and ecology

- Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows
- When foraging for insects, flies high and fast over the forest canopy, but lower in more open country
- Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory
- Breeding has been recorded from December to mid-March, when a single young is born
- Seasonal movements are unknown; there is speculation about a migration to southern Australia in late summer and autumn.

The Eastern False Pipistrelle and the Eastern Freetail-bat were potentially detected from the Anabat survey data, but their calls could not be reliably differentiated and are considered to have been detected based on the precautionary principle. The Greater Broad-nosed Bat and Yellow-bellied Sheath-tail-bat were not detected during surveys but are known from recent occurrence records from the Study locality and suitable habitat is present within the study area for all of these species.

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The proposal Area does not contain important habitat features which could be used for roosting (hollow-bearing trees). The study area contains seven habitat-bearing trees, containing hollows, fissures and loose bark which could be potentially used by these species. These features would be retained after the completion of works. However, disturbance of surrounding vegetation may affect the utility of these features for roosting during works.

This impact would be restricted to the work phase and these resources would continue to be available as potential roosting sites after the works. These resources are not limited in the Study locality, with large areas of mature native forest present containing habitat-bearing trees.

The proposal is not considered likely to have an adverse effect on habitat for the local population of these species to the extent that they would be placed at greater risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- (i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or**
- (ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not applicable to a threatened species.

(c) In relation to the habitat of a threatened species or ecological community:

- (i) The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity;**
- (ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity; and**
- (iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The proposal would remove largely regenerating native vegetation from the western edge of the study area, abutting the existing Princes Highway, estimated to be 0.95 ha. This habitat was not assessed as containing important habitat resources for these species (habitat-bearing trees). More mature, higher condition native vegetation, containing habitat-bearing trees would be retained in the east of the study area and would maintain similar levels of connectivity to native vegetation on lands to the north, east and south after the works. The small amount of lower condition habitat to be removed by the proposal is not considered important to the long-term survival of these species in the Study locality. Large areas of native vegetation are present in the Study locality including numerous protected national parks and reserves.

Native forest in the east of the study area would maintain similar levels of connectivity with native vegetation to the north, east and south after the works. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant reduction in habitat connectivity within the study area for these species. Connectivity to vegetation to the west is limited by the existing Princes Highway and the proposed widening of a portion of this roadway is not considered to represent a significant increase in the level of habitat fragmentation represented by the existing roadway for these highly mobile, aerial species.

The habitat to be removed by the proposal is not considered to be important to the long-term survival of these species in the Study locality and lacks important habitat features. Higher value habitat containing mature native forest and habitat-bearing trees would be retained within the study area after the works.

(d) Whether the action proposed is likely to have an adverse effect any declared area of outstanding biodiversity value (either directly or indirectly).

At present, there are four AOBV declared under the BC Act:

- Gould's Petrel - critical habitat declaration;
- Little penguin population in Sydney's North Harbour - critical habitat declaration;
- Mitchell's Rainforest Snail in Stotts Island Nature Reserve - critical habitat declaration; and
- Wollemi Pine - critical habitat declaration.

Of the above listed AOBV, the Little penguin population in Sydney's North Harbour - critical habitat is located closest to the proposal Area. However, as the proposal Area is located over 150 km from the AOBV, the proposal would not be expected to have any direct or indirect effect on this or any other declared AOBV.

(e) Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposal would or may constitute, introduce or exacerbate the following KTPs relevant to these species:

- Anthropogenic climate change;
- Clearing of native vegetation; and
- Removal of dead wood and dead trees.

The proposal would result in a small loss of native vegetation, production of greenhouse gases and removal of dead wood and dead trees. However, these KTPs arising from the proposal are not considered significant on the locality scale. The majority of native vegetation including areas containing high value habitat features (hollow-bearing live and dead trees) for these species would be retained after the works.

Conclusion

Two of these species were recorded in the study area during surveys and are all known from recent occurrence records in the Study locality. Suitable habitat is present in the study area including potential roosting resources (habitat-bearing trees). The proposal would largely remove lower value habitat in the form of recovering native forest along the eastern edge of the Princes Highway. No important habitat resources (hollow-bearing trees) would be removed by the proposal. The proposal would not increase fragmentation of habitat for these species with retained vegetation maintaining connectivity with habitat to the north, east and south after the works.

No significant impact on these species is anticipated as a result of the proposal. Consequently, further assessment through the preparation of a SIS or BDAR is not considered necessary.

Yellow-bellied Glider (*Petaurus australis*)

This species is listed as vulnerable under the BC Act.

The Yellow-bellied Glider is a large, active, sociable and vocal glider. Adults weigh 450 - 700 grams, have a head and body length of about 30 cm and a large bushy tail that is about 45 cm long. It has grey to brown fur above with a cream to yellow belly, which is paler in young animals. The dark stripe down the back is characteristic of the group. It has a large gliding membrane that extends from the wrist to the ankle. It has a loud, distinctive call, beginning with a high-pitched shriek and subsiding into a throaty rattle.

Distribution

The Yellow-bellied Glider is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria.

Habitat and ecology

- Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils
- Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south
- Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein
- Extract sap by incising (or biting into) the trunks and branches of favoured food trees, often leaving a distinctive 'V'-shaped scar
- Live in small family groups of two - six individuals and are nocturnal
- Den, often in family groups, in hollows of large trees
- Very mobile and occupy large home ranges between 20 to 85 ha to encompass dispersed and seasonally variable food resources.

This species was not detected during surveys in the study area or evidence of recent site use observed (sap chew scars). However, it is known from recent occurrence records in the locality and suitable native forests including hollow-bearing trees and known feed tree species (Blackbutt, Spotted Gum, Sydney Blue Gum) are present within the study area.

(a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The proposal Area does not contain important habitat features which could be used for breeding or denning (hollow-bearing trees). The study area contains seven habitat-bearing trees, several of which contain hollows; however, these are considered too small to be likely used as den sites for this species. These features would be retained after the completion of works. However, disturbance of surrounding vegetation may affect the utility of these features for breeding and denning during works. This impact would be restricted to the work phase and these resources would continue to be available as potential breeding sites after the works. The presence of this species within the study area was not detected and it is considered likely that these resources were not being used by this species at the time of survey.

The proposal is not considered likely to permanently remove potential denning or breeding resources for the species from the study area. Disruption to potential denning and breeding resources (hollow-bearing trees) would be limited to the work phase and these resources would be retained after the works. These resources are not limited in the Study locality, with large areas of mature native forest present.

The proposal is not considered likely to have an adverse effect on habitat for the local population of this species to the extent that it would be placed at greater risk of extinction.

(b) In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- (i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or**
- (ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

Not applicable to a threatened species.

(c) In relation to the habitat of a threatened species or ecological community:

- (i) The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity;**
- (ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity; and**
- (iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The proposal would remove largely regenerating native vegetation from the western edge of the study area, abutting the existing Princes Highway, estimated to be 0.95 ha. This habitat was not assessed as containing important habitat resources for this species (habitat-bearing trees) and largely contains potential foraging resources which are not limited in the Study locality. More mature, higher condition native vegetation, containing habitat-bearing trees and mature sap feed trees would be retained in the east of the study area and would maintain similar levels of connectivity to native vegetation on lands to the north, east and south after the works. The small amount of lower condition habitat to be removed by the proposal is not considered important to the long-term survival of the species in the Study locality.

The proposal would remove native forest habitat from the western edge of the study area. This habitat is largely comprised of recovering native forests previously cleared for highway installation/upgrades. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant reduction in habitat connectivity within the study area for this species. Connectivity to vegetation to the west is limited by the existing Princes Highway and the proposed widening of a portion of this roadway is not considered to represent a significant increase in the level of habitat fragmentation represented by the existing roadway.

The habitat to be removed by the proposal is not considered to be important to the long-term survival of the species in the Study locality and lacks important habitat features. Higher value habitat containing mature native forest and habitat-bearing trees would be retained within the study area after the works.

(d) Whether the action proposed is likely to have an adverse effect any declared area of outstanding biodiversity value (either directly or indirectly).

At present, there are four AOBV declared under the BC Act:

- Gould's Petrel - critical habitat declaration;
- Little penguin population in Sydney's North Harbour - critical habitat declaration;
- Mitchell's Rainforest Snail in Stotts Island Nature Reserve - critical habitat declaration; and

- Wollemi Pine - critical habitat declaration.

Of the above listed AOBV, the Little penguin population in Sydney's North Harbour - critical habitat is located closest to the proposal Area. However, as the proposal Area is located over 150 km from the AOBV, the proposal would not be expected to have any direct or indirect effect on this or any other declared AOBV.

(e) *Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.*

The proposal would or may constitute, introduce or exacerbate the following KTPs relevant to this species:

- Anthropogenic climate change
- Clearing of native vegetation
- Removal of dead wood and dead trees.

The proposal would result in a small loss of native vegetation, production of greenhouse gases and removal of dead wood. However, these KTPs arising from the development are not considered significant on the locality scale. The majority of native vegetation including areas containing high value habitat features for this species would be retained after the works.

Conclusion

This species was not recorded in the study area during surveys; however, it is known from recent occurrence records in the Study locality and suitable habitat is present in the study area including mature sap feed trees and potential denning resources (hollow-bearing trees); however, these are considered to be too small to be likely used as dens. The proposal would largely remove lower value habitat in the form of recovering native forest along the eastern edge of the Princes Highway. No important habitat resources (hollow-bearing trees) would be removed by the proposal. The proposal would not significantly increase fragmentation of habitat for this species with retained vegetation maintaining connectivity with habitat to the north, east and south after the works.

The proposal is not considered likely to have a significant impact on this species in the Study locality. Consequently, further assessment through the preparation of a SIS or BDAR is not considered necessary.

Assessments of Significance (EPBC Act)

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* an Assessment of Significance (AoS) is required to determine whether a significant impact on any threatened species or TEC listed under the act known or considered likely to occur on a site as a result of a proposed action. If a significant impact is considered likely, based on the test then further assessment through a referral to the federal Minister of the Environment and Energy is required. Referrals under the EPBC Act are no longer required for Roads and Maritime Services proposals under Part 5 of the EP&A Act in accordance with the Strategic Assessment process. However, significance assessments are still required to be completed.

AoS under the EPBC Act are guided by the Matters of National Environmental Significance: Significant Impact Guidelines 1.1 (Australian Government Department of the Environment, 2013).

The following listed entities were identified on or to have suitable habitat and a potential to occur on the proposal Area.

Flora

Biconvex Paperbark (*Melaleuca biconvexa*)

This species is listed as vulnerable under the EPBC Act.

Biconvex Paperbark is a shrub or small tree, usually up to 10 m tall, though occasionally as high as 20 m. The bark is that of a typical paperbark. The leaves are small, to 18 mm long and 4 mm wide; each leaf has a centre-vein in a groove and the leaf blade curves upwards on either side of this centre-vein. Leaf placement is distinctive, with each pair of leaves emerging at right angles from the branch. Each pair is offset at right angles to the previous pair so the branch has a squarish appearance when looked at 'end-on'. This species' white flowers are usually clustered in dense heads and the fruit is urn-shaped and 3 - 5 mm in diameter.

Distribution

Biconvex Paperbark is only found in NSW, with scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north.

Habitat and ecology

- Biconvex Paperbark generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects
- Flowering occurs over just 3-4 weeks in September and October
- Resprouts after fire.

A population of this species was identified within the study area during surveys. For species listed as vulnerable under the EPBC Act, the Matters of National Environmental Significance: Significant Impact Guidelines 1.1, an AoS must consider 'important populations' of the species. An 'important population' is a population identified as such in a recovery plan or that are:

- Key source populations either for breeding or dispersal
- Populations that are necessary for maintaining genetic diversity
- Populations that are near the limit of the species range.

At the time of writing, no state or federal recovery plan for this species has been published, consequently no important populations are listed in any such document. With reference to the three remaining attributes listed above, the following conclusions have been drawn:

- The population within the study area is not considered to be a key breeding or dispersal population for this species. The portion of the study area containing this population (lot 8 DP 855413) is bounded by sealed roads on all sides, limiting the populations potential to

spread vegetatively within the local area. Records from the DPIE BioNet database show that the species is well represented within the Study locality, with populations present within numerous vegetated drainage lines. Several larger populations are present in the suburbs of Basin View, St Georges Basin and elsewhere within Tomerong, north of the study area. The local population is not considered dependent on the individuals present in the study area for breeding and dispersal

- As detailed above, this species is not limited in occurrence in the Study locality. The sub-population within the study area is not considered necessary for maintaining the genetic diversity of the local population
- The extent of this species known range within its southern population occurrence (with reference to the DPIE species profile mapping (NSW Office of Environment and Heritage, 2018) extends north to south Nowra (approximately 20 km from the study area), west to Yerringong (approximately 14 km from the study area) and south to South Durras (approximately 70 km from the study area). The population within the study area is not considered to be near the limit of the species southern population range.

Based on the above assessment, the population of this species within the study area is not considered to be an 'important population'.

(a) Lead to a long-term decrease in the size of an important population of a species;

The proposal would remove 42 individuals from a total population of 284 within the study area. This would lead to a decrease in the size of this population; however, as detailed above, the population of this species within the study area is not considered to represent an 'important population' as defined by the Matters of National Environmental Significance: Significant Impact Guidelines 1.1. The species is well represented in the Study locality and the long-term survival of this population is not considered dependent on the sub-population present within the study area.

The majority of the population and suitable habitat within the study area would be retained after the proposal works.

(b) Reduce the area of occupancy of an important population;

The proposal would remove 42 individuals and 0.95 hectares of suitable habitat for this species from the study area; however, the majority of the population and suitable habitat would be retained. As detailed above, this population is not considered to represent an 'important population' of the species and the loss of a small number of individuals and area of suitable habitat is not considered to be a significant reduction in the area of occupancy of this species in the Study locality. The species is well represented and suitable habitat is not limited in the Study locality.

The long-term survival of the species in the Study locality is not considered dependent on the population within the study area.

(c) Fragment an existing important population into two or more populations;

The portion of the study area containing this species (lot 8 DP 855413) is bounded by sealed roads on all sides. The impact of the proposal on the population present and suitable habitat would occur on the western side of this lot and would not lead to fragmentation of the native vegetation within this lot. North-south continuity would be retained after the proposal work and the retained portion of this population would continue to have habitat continuity along the existing ephemeral drainage line.

As detailed above, the population of this species within the study area is not considered to represent an 'important population' of this species.

(d) Adversely affect habitat critical to the survival of a species;

The proposal would remove areas of suitable habitat from the study area for this species and permanently change the hydrological and solar environment for the retained portion of the population after the works. However, the primary habitat feature relied upon by this population, the ephemeral drainage line would be retained and continue to provide an appropriate microhabitat for the survival of this population after the works.

The installation of the required roadside batter and in-channel work for the access track upgrade would potentially lead to increased sediment and contaminant mobilisation and movement into the drainage line after the works. This has the potential to adversely impact portions of this population further downslope during the work period. However, the drainage line is an existing vector for stormwater and associated contaminant outflows from the existing road network. Effects of sediment and contaminant inflows on this species and other vegetation within the study area (stressed or senescing vegetation, unusual areas of cleared land, soil staining and standing water hydrocarbon sheens) was not apparent during surveys. The long-term impact of this work is not considered likely to significantly increase the impact of this vector on the habitat present for this species.

As detailed in above tests, suitable habitat is not limited in the locality, with DPIE BioNet records indicating that this species is well represented within drainage lines of the Study locality. The habitat within the study area is not considered critical to the survival of the species in the Study locality. The population within the study area is also not considered to represent an 'important population' of the species, as detailed at the start of this section.

(e) Disrupt the breeding cycle of an important population;

As detailed at the start of this section, the population within the study area is not considered to represent an 'important population' of the species. The proposal would remove 42 individuals from the study area, including 12 mature trees. A total of 81 mature trees were identified within the study area. The removal of a small number of mature trees is not considered likely to disrupt the breeding cycle of this population. The majority of mature trees and the overall population would be retained following development and the clearing of suitable habitat on the western edge of the study area would not disrupt habitat connectivity and dispersal downslope along the drainage line feature or significantly inhibit pollination by airborne animal vectors (nectar feeding birds and insects). The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant reduction in habitat connectivity within the study area.

(f) Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

The proposal would remove a small portion of the available habitat for this species from the study area, with the majority (including mature sclerophyll forest and the drainage line habitat feature) retained. Clearing of vegetation fringing the retained population and the installation of a new batter would affect the surface hydrology and solar environment for retained individuals abutting the cleared area. However, the majority of the population (on the eastern side of the drainage line) would maintain similar ambient conditions to present following development and would be less vulnerable to potential sediment and contaminant inflows during works. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant alteration to the existing conditions in the east of the study area.

The proposal would have an adverse impact on habitat for this species, particularly on the western side of the drainage line. However, the majority of suitable habitat would be retained and the long-

term impacts of the proposal on habitat quality for this species is not considered likely to lead to population decline within the study area. The population is currently exposed to runoff from the existing road network via the drainage line without apparent deleterious effects. Ongoing recruitment was apparent with numerous immature and sapling individuals present. The retained portion of this population after work is not considered likely decline in the long-term.

(g) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

The proposal has the potential to introduce new invasive plant species through contaminated fill and on contaminated plant and equipment used during works. This would be of greatest concern along the lower edge of the constructed batter abutting the drainage line. Clearing of this area would provide a new vector for the establishment and spread of exotic weeds into the species' habitat downslope. The existing native vegetation currently abuts sealed roads supporting populations of exotic weeds (predominantly grasses) and the roads and drainage line provide a vector for the spread of these weeds into native vegetation areas. However, limited colonisation into areas of native vegetation was observed.

Retention of the majority of native vegetation and suitable habitat for this species within the study area after the work would limit the colonisation potential of existing and new weed species into suitable habitat for this species. Weed populations establishing during and after work would be largely limited to the periphery of suitable habitat for this species.

The proposal has the potential to introduce new invasive species into suitable habitat for this species. However, invasive species are already present within the study area and the proposal is not considered likely to significantly exacerbate this population after the works.

(h) Introduce disease that may cause the species to decline; or

The proposal has the potential to introduce diseases including Myrtle Rust (*Puccinia psidii*) which is known to affect species of the family Myrtaceae (which includes *Melaleuca biconvexa*). This pathogen may be introduced through unclean fill, contaminated equipment and plant and through infected plants used for post work regeneration.

Myrtle Rust is can be transmitted through wind, water and by insect and animal vectors (NSW Department of Primary Industries, 2019). Many of these infection vectors are already present within the study area. The study area is located next to a busy road network and waterborne vectors for disease introduction are present through overland flows from these roads into suitable habitat for this species. The proposal is not considered likely to significantly exacerbate the risk of disease introduction into the study area.

(i) Interfere substantially with the recovery of the species.

As detailed earlier in this section, the population of this species within the study area is not considered to constitute an 'important population'. The long-term survival and recovery of the species is not considered reliant on this population. The species is well represented in the Study locality and suitable habitat is not limited. The proposal would retain the majority of the population and suitable habitat and the population is expected to persist within the study area after the works.

Conclusion

The study area supports a population of this species, located within and next to an ephemeral drainage line. The proposal would require the removal of a portion of the population, with the majority of the population and suitable habitat to be retained after the works. Assessed against the definitions in the Matters of National Environmental Significance: Significant Impact Guidelines 1.1,

this population is not considered to represent an 'important population' and the long-term survival of the species in the Study locality is not considered dependent on this population. The species is well represented in the Study locality and suitable habitat is not limited. Secondary impact on this species are not considered likely to lead to the decline of the population with many of these impacts already present.

As the proposal will retain the majority of the population and suitable habitat, the population is anticipated to persist after the works. Consequently, the proposal is not considered likely to have a significant impact on this species.

Magenta Lilly Pilly (*Syzygium paniculatum*)

This species is listed as vulnerable under the EPBC Act.

The Magenta Lilly Pilly is a small to medium sized rainforest tree that grows to 8 m tall. The bark is flaky and the leaves are shiny, dark-green above and paler underneath. Leaves can be up to 10 cm long. Plants produce white flower-clusters at the end of each branch, between November and February. The petals are small and are accompanied by prominent long stamens. The deep magenta fruits, which may be spherical or egg-shaped, mature in May, and contain a single seed.

Distribution

The Magenta Lilly Pilly is found only in NSW, in a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest.

Habitat and ecology

- On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest
- On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities

A population of this species was identified within the study area during surveys. For species listed as vulnerable under the EPBC Act, the Matters of National Environmental Significance: Significant Impact Guidelines 1.1, an AoS must consider 'important populations' of the species. An 'important population' is a population identified as such in a recovery plan or that are:

- Key source populations either for breeding or dispersal
- Populations that are necessary for maintaining genetic diversity
- Populations that are near the limit of the species range.

A national recovery plan for this species has been drafted (NSW Office of Environment and Heritage, 2012). Page 16 of this recovery plan states "*Thurlby (2010) found that there is extremely low genetic diversity within 11 subpopulations sampled across the species range, with a distinct north-south genetic divide centred on the Central Coast. Given this, all confirmed naturally occurring populations of Magenta Lilly Pilly are considered to be important and, therefore, all habitat in which these populations occur is considered to be critical to the survival of the species*".

Consequently, this population is considered to be an 'important population' as defined by the Matters of National Environmental Significance: Significant Impact Guidelines 1.1.

(a) Lead to a long-term decrease in the size of an important population of a species;

As above, the population within the study area is considered to be an 'important population' of the species. A total of two individuals of this species were documented within the study area. Both are located in the eastern portion of lot 8 DP 855413 and would not be removed by the proposal.

The proposal would not lead to a long-term decrease in the size of an important population of this species.

(b) Reduce the area of occupancy of an important population;

The proposal would not reduce the area of occupancy of the population present. The two individuals identified in the study area are located in the east of the construction footprint study area. The proposal would predominantly remove potential habitat for this species from the western edge of the study area for the road widening and associated batter works. This vegetation is of lower condition, largely comprising vegetation established following earlier works for the

construction of the Princes Highway. This habitat is considered to be of lower utility for this species than habitat available elsewhere in the study area. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant alteration to the existing conditions in the east of the study area. The disturbance corridor for this track upgrade would maintain around a 10 m buffer from the two identified individuals.

(c) Fragment an existing important population into two or more populations;

The portion of the study area containing this species (lot 8 DP 855413) is bounded by sealed roads on all sides. The impact of the proposal on suitable habitat would largely occur on the western side of this lot. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant increase in habitat fragmentation within the study area.

(d) Adversely affect habitat critical to the survival of a species;

As detailed at the start of this section, the national recovery plan for this species states “*all habitat in which these populations occur is considered to be critical to the survival of the species*”. The proposal would remove a portion of native sclerophyll vegetation from the proposal Area. Within the definition of the recovery plan, this habitat should be considered critical habitat.

However, the majority of habitat to be directly removed by the proposal is considered to be of lower habitat value than the vegetation supporting the two identified individuals of this species. The proposal Area is largely dominated by recovering vegetation since the original Princes Highway works. The vegetation within the proposal Area also largely occurs on an artificially constructed batter and consequently lacks the damper, less exposed habitat preferred by this species. The habitat containing the two individuals is composed of older, more established vegetation on flat topography with a more suitable microclimate. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant alteration to the existing conditions in the east of the study area and a buffer distance of around 10 m would be maintained for these two individuals from the edge of this corridor.

As a result, although the proposal would adversely affect habitat defined as critical under the recovery plan for this species, the majority of this habitat is considered to have lower habitat value for this species. The portion of the study area supporting the existing population is considered to comprise higher value habitat. The widening of the existing access track is not considered likely to significantly alter the microclimate for the individuals present.

(e) Disrupt the breeding cycle of an important population;

As detailed at the start of this section, the population within the study area is considered to represent an ‘important population’ of the species. The proposal would not remove any individuals from this population from the study area. The vegetation to be removed by the proposal constitutes lower value habitat for this species with a less suitable microclimate. The clearing of marginal suitable habitat on the western edge of the study area would not disrupt habitat connectivity and dispersal through nearby native vegetation or significantly inhibit pollination by airborne animal vectors (nectar feeding birds and insects and frugivorous birds and mammals). The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant dispersal barrier for pollinators.

The proposal is not considered likely to disrupt the breeding cycle of this important population.

(f) Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

The proposal would remove a small portion of marginal suitable habitat for this species from the study area, with the majority (including mature sclerophyll forest and the drainage line habitat feature) retained. The native vegetation to be removed within the proposal Area is considered to be of lower habitat value and more exposed to unsuitable microhabitat conditions. The population of this species within the study area (on the eastern side of the drainage line) and its immediate surrounding habitat would maintain similar ambient conditions to present following development and would be less vulnerable to potential sediment and contaminant inflows during work as this habitat is located on the opposite slope to the proposal Area. A buffer distance of around 10 m would be maintained from the two identified individuals from the access track upgrade works.

The proposal would have an adverse impact on lower quality habitat for this species on the western side of the drainage line. However, the most suitable habitat would be largely retained and the long-term impact of the proposal on habitat quality for this species is not considered likely to lead to population decline within the study area. The widening of the existing access track is not considered likely to significantly alter the local climatic conditions for the two individuals identified. The population is currently exposed to runoff from the existing road network via the drainage line without apparent deleterious effects. The population of this species within the study area is not considered likely decline in the long-term as a result of the proposal.

(g) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

The proposal has the potential to introduce new invasive plant species through contaminated fill and on contaminated plant and equipment used during works. This would be of greatest concern along the lower edge of the constructed batter abutting the drainage line. Clearing of this area would provide a new vector for the establishment and spread of exotic weeds into the species' habitat downslope. The existing native vegetation currently abuts sealed roads supporting populations of exotic weeds (predominantly grasses) and the roads and drainage line provide a vector for the spread of these weeds into native vegetation areas. However, limited colonisation into areas of native vegetation was observed.

Retention of the majority of native vegetation and suitable habitat areas for this species within the study area following works would limit the colonisation potential of existing and new weed species into suitable habitat for this species. Weed populations establishing during and following work would be largely limited to the periphery of suitable habitat for this species. The population of this species is located in the east of the study area, estimated to be 10 m from the edge of the proposal Area (access track corridor). The proposal is not considered likely to significantly increase the likelihood of the introduction of new invasive species into this portion of the study area.

The proposal has the potential to introduce new invasive species into suitable habitat for this species. However, invasive species are already present within the study area and the proposal is not considered likely to significantly exacerbate this population after works.

(h) Introduce disease that may cause the species to decline; or

The proposal has the potential to introduce diseases including Myrtle Rust (*Puccinia psidii*) which is known to affect species of the family Myrtaceae (which includes *Syzygium paniculatum*). This pathogen may be introduced through unclean fill, contaminated equipment and plant and through infected plants used for post work regeneration.

Myrtle Rust is can be transmitted through wind, water and by insect and animal vectors (NSW Department of Primary Industries, 2019). Many of these infection vectors are already present within the study area. The study area is located next to a busy road network and waterborne

vectors for disease introduction are present through overland flows from these roads into suitable habitat for this species. The proposal is not considered likely to significantly exacerbate the risk of disease introduction into the study area.

(i) Interfere substantially with the recovery of the species.

As detailed earlier in this section, the population of this species within the study area is considered to constitute an 'important population' with reference to the National Recovery Plan. However, the long-term survival and recovery of the species is not considered reliant on this population. The two individuals within the study area are immature and indicate that the study area is suitable for the recruitment of the species. The proposal would retain the majority of more mature, better condition native vegetation habitat for this species and habitat utility for the continued spread of the population within the study area would be retained after the works. The species is well represented in the Study locality and suitable habitat is not limited. The proposed access track widening would largely occur within an existing cleared corridor and is not considered likely to significantly alter the local microclimate for the nearby population of this species.

Conclusion

The study area supports a population of two individuals of this species, located close to the eastern boundary of lot 8 DP 855413. The proposal would not require the removal of these individuals or nearby good quality habitat. The proposal would remove lower quality habitat, largely comprising less mature native vegetation next to the existing Princes Highway. The required access track through the construction footprint would largely occur within an existing corridor and would maintain a buffer distance of around 10 m from the two identified individuals.

Assessed against the definitions in the Matters of National Environmental Significance: Significant Impact Guidelines 1.1, this population is considered to represent an 'important population', with reference to the published National Recovery Plan and under this plan all habitat in which an important population occurs is to be considered 'critical habitat'. However, as above the habitat to be removed by the proposal is considered to represent lower quality habitat than the mature native vegetation supporting the current population in the east of the study area. This habitat is largely comprised of less mature vegetation, recovering from historical clearing for the installation of the Princes Highway.

The species is well represented in the Study locality and suitable habitat is not limited. Secondary impact on this species are not considered likely to lead to the decline of the population with many of these impacts already present. A buffer distance (10 m) would also be maintained from the existing individuals and the edge of the proposal Area.

Although the habitat to be removed by the proposal is considered to represent 'critical habitat' as defined by the National Recovery Plan, the habitat to be removed is largely considered to be of lower habitat value than the more mature native vegetation currently supporting the population in the east of the study area. As the proposal will retain the entire population and the majority of suitable habitat, the proposal is not considered likely to inhibit the long-term persistence of this species within the study area. Consequently, the proposal is not considered likely to have a significant impact on this species.

Fauna

Greater Glider (*Petauroides volans*)

This species is listed as vulnerable under the EPBC Act.

The greater glider is the largest gliding possum in Australia, with a head and body length of 35–46 cm and a long furry tail measuring 45–60 cm. The greater glider has thick fur that increases its apparent size. Its fur colour is white or cream below and varies from dark grey, dusky brown through to light mottled grey and cream above. It has large furry ears and a short snout. Its tail is not prehensile.

Distribution

The greater glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria (Wombat State Forest), with an elevational range from sea level to 1200 m above sea level. An isolated inland subpopulation occurs in the Gregory Range west of Townsville, and another in the Einasleigh Uplands.

The broad extent of occurrence is unlikely to have changed appreciably since European settlement. However, the area of occupancy has decreased substantially mostly due to land clearing. This area is probably continuing to decline due to further clearing, fragmentation impacts, fire and some forestry activities.

Habitat and ecology

The greater glider is an arboreal nocturnal marsupial, largely restricted to eucalypt forests and woodlands. It is primarily folivorous, with a diet mostly comprising eucalypt leaves, and occasionally flowers. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows. The distribution may be patchy even in suitable habitat. The greater glider favours forests with a diversity of eucalypt species, due to seasonal variation in its preferred tree species.

This species was not identified within the study area during surveys; however, suitable habitat was observed to be present and the species is known from recent occurrence records. For species listed as vulnerable under the EPBC Act, the Matters of National Environmental Significance: Significant Impact Guidelines 1.1, an AoS must consider 'important populations' of the species. An 'important population' is a population identified as such in a recovery plan or that are:

- Key source populations either for breeding or dispersal
- Populations that are necessary for maintaining genetic diversity
- Populations that are near the limit of the species range.

At the time of writing, no state or federal recovery plan for this species has been published, consequently no important populations are listed in any such document. With reference to the three remaining attributes listed above, the following conclusions have been drawn:

- The population within the study area is not considered to be a key breeding or dispersal population for this species. The portion of the study area containing important habitat resources (Hollow-bearing trees) (lot 8 DP 855413) is bounded by sealed roads on all sides, limiting the utility of the study area for this species. Large areas of similar habitat are present in the locality and the local population of this species is not considered dependent on the resources of the study area for its long-term survival
- The species has a wide distribution but low population density across the NSW east coast. The approved Conservation Advice for this species does not identify any key populations required for the maintenance of local or regional genetic diversity (Australian Government Department of Environment and Energy, 2016)

- With reference to the DPIE species profile mapping (NSW Office of Environment and Heritage, 2017) the known range of the species includes the entire NSW east coast and as far west as Dubbo. The population within the Study locality is not considered to be near the limit of the species range.

Based on the above assessment, the population of this species within the Study locality is not considered to be an 'important population'.

(a) Lead to a long-term decrease in the size of an important population of a species;

The proposal Area contains suitable foraging and refuge habitat for this species in the form of native forests. No important habitat features for this species (hollow-bearing trees) which could be used for denning were present within the proposal Area; however, these hollows were considered to be too small to be likely den sites. The wider study area contained seven habitat-bearing trees which would not be removed by the proposal.

The proposal would remove a small (0.95 ha) portion of suitable foraging habitat for this species from the locality. This habitat is situated next to the existing Princes Highway and is largely composed of regenerating native forest following previous highway works. More established native vegetation in the east of the study area would be largely retained and would maintain similar levels of connectivity with native vegetation to the north, east and south after the works.

The local population of this species is considered to use the habitat of the proposal Area as part of a wider foraging range and is not considered to be dependent on these resources for important life cycle components (breeding). Important habitat features (hollow-bearing trees) would be retained after the works. Similar native forest is not limited in the Study locality and dispersal through the study area into nearby habitat would not be inhibited by the proposal.

The proposal is not considered likely to lead to a long-term decrease in the size of the local population of this species. As detailed above, the local population is not considered to represent an 'important population' of the species.

(b) Reduce the area of occupancy of an important population;

The proposal would remove a small portion of foraging habitat for this species. However, as detailed above, this habitat is not considered to be important to the long-term survival of the species in the Study locality and lacks important habitat features. Higher value habitat containing mature native forest and habitat-bearing trees would be retained within the study area after the works.

The small amount of suitable habitat to be removed by the proposal is not considered to represent a significant reduction in suitable habitat for the species in the Study locality. Large areas of similar native forest are present in the Study locality and the proposal would not inhibit dispersal of the species through the study area into areas of nearby habitat. As detailed above, the local population is not considered to represent an 'important population' of the species.

(c) Fragment an existing important population into two or more populations;

The proposal would remove native forest habitat from the western edge of the study area. This habitat is largely comprised of recovering native forests previously cleared for highway installation/upgrades. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant increase in habitat fragmentation in the east of the study area. Connectivity to vegetation to the west is limited by the existing Princes Highway and the proposed widening of a portion of this roadway is not considered to represent a significant increase in the level of habitat fragmentation represented by the existing roadway.

The proposal is not considered likely to fragment the local existing population of this species or create significant new barriers to dispersal. As detailed above, the local population is not considered to represent an 'important population' of the species.

(d) Adversely affect habitat critical to the survival of a species;

No critical habitat features are detailed for this species in the Approved Conservation Advice; however, hollow-bearing trees are considered critical resources for this species persistence in a landscape (Australian Government Department of Environment and Energy, 2016). As detailed above, the proposal Area was not observed to contain hollow-bearing trees. The native vegetation to be removed from the proposal Area is largely of lower condition, comprising recovering vegetation after historical clearing.

The proposal is not considered likely to adversely affect habitat critical to the survival of the species in the Study locality.

(e) Disrupt the breeding cycle of an important population;

As detailed above, the proposal Area does not contain important habitat features which could be used for breeding dens (hollow-bearing trees). The study area contains seven habitat-bearing trees, several of which contain hollows which could be potentially used by this species; however, these are considered unlikely to be used due to their small size. These features would be retained after the completion of works. However, disturbance of surrounding vegetation may affect the utility of these features for breeding during works. This impact would be restricted to the works phase and these resources would continue to be available as potential breeding sites after works.

The proposal is not considered likely to permanently remove potential breeding resources for the species from the study area. Disruption to potential breeding resources (hollow-bearing trees) would be limited to the works phase and potential breeding resources would be retained after the works. These resources are not limited in the Study locality, with large areas of mature native forest present. The proposal is not considered likely to significantly disrupt the breeding cycle of this species. As detailed above, the local population is not considered to represent an 'important population' of the species.

(f) Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

The proposal would remove largely regenerating native vegetation from the western edge of the study area, abutting the existing Princes Highway. This habitat was not assessed as containing important habitat resources for this species (habitat-bearing trees). More mature, higher condition native vegetation, containing habitat-bearing trees would be retained in the east of the study area and would maintain similar levels of connectivity to native vegetation on lands to the north, east and south after the works. The small amount of lower condition habitat to be removed by the proposal is not considered important to the long-term survival of the species in the Study locality.

The proposal is not considered likely to adversely impact habitat for this species in the Study locality to the extent that the species is likely to decline.

(g) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

The Approved Conservation Advice for this species does not identify invasive predators as a major threat to the survival of the species (Australian Government Department of Environment and Energy, 2016). The proposal would not involve the introduction of additional domestic or wild predators or competitors for this species. The proposal is also not likely to increase the local population of existing feral predators through processes such as providing an artificial food supply.

(h) Introduce disease that may cause the species to decline; or

The Approved Conservation Advice for this species does not identify any major diseases affecting this species. The proposal would not involve processes likely to introduce vectors for disease introduction for this species such as the introduction of potentially infected host fauna.

(i) Interfere substantially with the recovery of the species.

The proposal would remove a small portion of native vegetation from the western edge of the construction footprint study area as well as vegetation along the edges of the existing access track. The vegetation to be removed lacks important habitat features for this species. Better condition, more mature native vegetation containing potential denning and breeding resources for the species in the east of the study area would be largely retained and the proposal would not significantly increase fragmentation of habitat for this species with retained vegetation maintaining connectivity with habitat to the north, east and south after the works.

The study area is already isolated from habitat to the west by the existing Princes Highway and the proposal is not considered likely to significantly increase the level of habitat fragmentation caused by this roadway.

The proposal is not considered likely to interfere with the recovery of the species.

Conclusion

This species was not recorded in the study area during surveys; however, it is known from recent occurrence records in the Study locality and suitable habitat is present in the study area. The proposal would largely remove lower value habitat in the form of recovering native forest along the eastern edge of the Princes Highway. No important habitat resources (hollow-bearing trees) would be removed by the proposal. The proposal would not significantly increase fragmentation of habitat for this species with retained vegetation maintaining connectivity with habitat to the north, east and south after the works.

The proposal is not considered likely to have a significant impact on this species in the Study locality.

Green and Golden Bell Frog (*Litoria aurea*)

This species is listed as vulnerable under the EPBC Act.

A relatively large, stout frog, ranging in size from approximately 45 mm to approximately 100 mm snout to vent length. Diagnostic features are a gold or creamish white stripe running along the side, extending from the upper eyelids almost to the groin, with a narrow dark brown stripe beneath it, from nostril to eye. It also has blue or bluish-green colour on the inside of the thighs. The colour of the body varies. Usually a vivid pea-green, splotched with an almost metallic brassy brown or gold. The backs of some individuals may be almost entirely green; in others golden-brown markings may dominate.

Distribution

Formerly distributed from the NSW north coast near Brunswick Heads, southwards along the NSW coast to Victoria where it extends into east Gippsland. Records from west to Bathurst, Tumut and the ACT region. Since 1990 there have been approximately 50 recorded locations in NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range, however they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (one an island population). There is only one known population on the NSW Southern Tablelands.

Habitat and ecology

- Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.)
- Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available
- Some sites, particularly in the Greater Sydney region occur in highly disturbed areas
- The species is active by day and usually breeds in summer when conditions are warm and wet
- Males call while floating in water and females produce a raft of eggs that initially float before settling to the bottom, often amongst vegetation
- Tadpoles feed on algae and other plant-matter; adults eat mainly insects, but also other frogs
- Preyed upon by various wading birds and snakes.

This species was not detected on the proposal Area during surveys. However, it is known from recent occurrence records in the Study locality and suitable habitat was observed to be present in the form of a small waterbody containing *Typha* spp. reeds. Surveys could not be conducted during an appropriate season for the detection of this species (September - March) or under suitable weather conditions (after significant rainfall).

For species listed as vulnerable under the EPBC Act, the Matters of National Environmental Significance: Significant Impact Guidelines 1.1, an AoS must consider 'important populations' of the species. An 'important population' is a population identified as such in a recovery plan or that are:

- Key source populations either for breeding or dispersal
- Populations that are necessary for maintaining genetic diversity
- Populations that are near the limit of the species range.

No national recovery plan for this species has been drafted; however, the Australian Government has published significant impact guidelines for the species (Australian Government Department of

the Environment, Water, Heritage and the Arts, 2009). These guidelines define important populations, survey methodologies and impact assessment. Page 7 of this recovery plan states “*Because of the continued decline of the green and golden bell frog, the restricted nature of all known populations in New South Wales and the uncertainty about the current status of the Victorian populations, all current populations of green and golden bell frog are regarded as an ‘important population’. A current population is defined as a site where one or more green and golden bell frogs have been detected on at least one occasion since 1995, even if they have not recently been discovered at the site (due to the species tendency towards local extinction and recolonisation cycles).*”

According to data from the BioNet database, there are seven records of this species from the Study locality, with the nearest located an estimated 3 km to the north-east, dating from 2011. Two other records from the locality are also dated from later than 1995 (1997 and 2012). Consequently, this population is considered to be an ‘important population’ as defined by the Matters of National Environmental Significance: Significant Impact Guidelines 1.1.

The habitat within the study area lacks several important habitat attributes for this species, as identified on Page 3 of the Significant Impact Guidelines “*The habitat of the green and golden bell frog comprises one or more water bodies and associated terrestrial habitats (grassy areas and vegetation no higher than woodlands) within its known range*”. The study area lacks grassy areas and is dominated by native forests. Consequently, this habitat is considered marginal for the species.

Page 12 of the Significant Impact Guidelines for this species provide species-specific significant impact thresholds. There is a possibility of a significant impact on the green and golden bell frog, and a referral under the EPBC Act should be considered, if the action results in:

1. *The removal or degradation of aquatic or ephemeral habitat either where the green and golden bell frog has been recorded since 1995 or habitat that has been assessed as being suitable according to these guidelines. This can include impacts from chytrid and mosquito fish originating off-site;*

The study area is within the known range of this species and the species is well documented from the Study locality with seven records present in the BioNet database, three of which date from later than 1995 (1997, 2011 and 2012). Consequently, the species is considered to have potential to occur in the study area. However, no records from within the study area are present in this resource or in the Atlas of Living Australia database (Atlas of Living Australia, 2019).

As above, the study area contains an ephemeral waterbody with suitable aquatic vegetation. However, the study area lacks the suite of habitat features identified in the Significant Impact Guidelines. The study area does not contain grassy areas next to the waterbody and the dominant vegetation (forest) is not suitable for this species, which prefers vegetation assemblages “*no higher than woodlands*”.

Based on this assessment, the study area is not considered to meet threshold 1, with the species not known from recent occurrence records in the study area and the habitat of the study area is not considered to contain suitable habitat for the species as defined in the Significant Impact Guidelines.

The waterbody would not be removed by the proposal.

2. *The removal or degradation of terrestrial habitat within 200 metres of habitat identified in threshold 1; or*

As detailed above, the study area was not assessed as meeting threshold 1. Consequently, impact to terrestrial vegetation within 200 m of this habitat item do not apply. The study area is also not within 200 m of any other waterbody, with reference to the NSW Spatial Data Catalogue (NSW Spatial Services, 2013). Consequently, the impact on the study area does not meet threshold 2 of this test.

3. A break in the continuity of vegetation fringing ephemeral or permanent waterways or other vegetated corridors linking habitats meeting the criteria in threshold 1.

As above, no habitat meeting the criteria in threshold 1 was identified within the study area or within 200 m of the study area. Consequently, the impact on the study area does not meet threshold 3 of this test. The vegetation to be removed by the proposal would also not create a significant break in the continuity of vegetation in the Study locality. Vegetation would retain similar levels of connectivity with vegetation to the north, east and south and to the west on lands to the north and south of the proposal Area.

Conclusion

This species is known from the Study locality and potential habitat is present in the form of an ephemeral waterbody containing suitable aquatic vegetation. However, the wider study area was not assessed as containing suitable habitat as detailed in the Significant Impact Guidelines for this species, lacking areas of grassland and with native vegetation communities considered too dense to form optimum habitat for this species. The waterbody and wider study area is considered to comprise marginal habitat for this species.

Assessed against the Significant Impact Criteria thresholds, the impact on habitat for this species within the study area is not considered significant.

Spotted-tailed Quoll (*Dasyurus maculatus*)

This species is listed as endangered under the EPBC Act.

The Spotted-tailed Quoll is about the size of a domestic cat, from which it differs most obviously in its shorter legs and pointed face. The average weight of an adult male is about 3500 grams and an adult female about 2000 grams. It has rich-rust to dark-brown fur above, with irregular white spots on the back and tail, and a pale belly. The spotted tail distinguishes it from all other Australian mammals, including other quoll species. However, the spots may be indistinct on juvenile animals.

Distribution

The range of the Spotted-tailed Quoll has contracted considerably since European settlement. It is now found in eastern NSW, eastern Victoria, south-east and north-eastern Queensland, and Tasmania. Only in Tasmania is it still considered relatively common.

Habitat and ecology

- Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline
- Individual animals use hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den sites
- Mostly nocturnal, although will hunt during the day; spends most of the time on the ground, although also an excellent climber and will hunt possums and gliders in tree hollows and prey on roosting birds
- Use communal 'latrine sites', often on flat rocks among boulder fields, rocky cliff-faces or along rocky stream beds or banks. Such sites may be visited by multiple individuals and can be recognised by the accumulation of the sometimes characteristic 'twisty-shaped' faeces deposited by animals
- A generalist predator with a preference for medium-sized (500g-5kg) mammals. Consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits, reptiles and insects. Also eats carrion and takes domestic fowl
- Females occupy home ranges of 200-500 hectares, while males occupy very large home ranges from 500 to over 4000 hectares. Are known to traverse their home ranges along densely vegetated creek lines
- Average litter size is five; both sexes mature at about one year of age. Life expectancy in the wild is about 3-4 years.

This species was not detected in the study area; however, the species has a very large home range and adequate survey could not be conducted within the available survey period. The species is known from recent occurrence records in the Study locality and suitable native vegetation with hollow-bearing trees is present within the study area.

(a) Lead to a long-term decrease in the size of a population;

The proposal Area contains suitable foraging and refuge habitat for this species in the form of native forests. No important habitat features for this species (caves, hollow-bearing trees, hollow logs) which could be used for denning were present within the proposal Area. The wider study area contained seven habitat-bearing trees which would not be removed by the proposal.

The proposal would remove a small (0.95 ha) portion of suitable foraging habitat for this species from the locality. This habitat is situated next to the existing Princes Highway and is largely composed of regenerating native forest following previous highway works. More established native vegetation in the east of the study area would be largely retained and would maintain similar levels of connectivity with native vegetation to the north, east and south after works. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant increase in habitat fragmentation in the east of the study area.

The local population of this species is considered to use the habitat of the proposal Area as part of a wider foraging range and is not considered to be dependent on these resources for important life cycle components (breeding). Important habitat features (hollow-bearing trees and the ephemeral creek line) would be retained after the works. Similar native forest is not limited in the Study locality and dispersal through the study area into nearby habitat would not be inhibited by the proposal.

The proposal is not considered likely to lead to a long-term decrease in the size of the local population of this species.

(b) Reduce the area of occupancy of the species;

The proposal would remove a small portion of foraging and refuge habitat for this species. However, as detailed above, this habitat is not considered to be important to the long-term survival of the species in the Study locality and lacks important habitat features. Higher value habitat containing mature native forest and habitat-bearing trees would be retained within the study area after the works.

The small amount of suitable habitat to be removed by the proposal is not considered to represent a significant reduction in suitable habitat for the species in the Study locality. Large areas of similar native forest are present in the Study locality and the proposal would not inhibit dispersal of the species through the study area into areas of nearby habitat.

(c) Fragment an existing population into two or more populations;

The proposal would remove native forest habitat from the western edge of the study area. This habitat is largely comprised of recovering native forests previously cleared for highway installation/upgrades. Native forest in the east of the study area would maintain similar levels of connectivity with native vegetation to the north, east and south after the works. The widening of the existing access track through the construction footprint to 5 m is not considered to represent a significant increase in habitat fragmentation in the east of the study area. Connectivity to vegetation to the west is limited by the existing Princes Highway and the proposed widening of a portion of this roadway is not considered to represent a significant increase in the level of habitat fragmentation represented by the existing roadway. Structures allowing dispersal underneath this road are present in the form of a large stormwater pipe and culvert, which would be retained after the works.

The proposal is not considered likely to fragment the local existing population of this species or create significant new barriers to dispersal.

(d) Adversely affect habitat critical to the survival of a species;

Page 10 of the National Recovery Plan for the Spotted-tailed Quoll describes critical habitat for the species as “*trees with hollows, hollow logs, a complex vegetation structure, >50 per cent canopy cover and rock or burrow den sites*” (Australian Government Department of Environment, Land, Water and Planning, 2016). As detailed above, the proposal Area was not observed to contain important habitat features. The native vegetation to be removed from the proposal Area is largely of lower condition, comprising recovering vegetation following historical clearing.

The proposal is not considered likely to adversely affect habitat critical to the survival of the species in the Study locality.

(e) Disrupt the breeding cycle of a population;

As detailed above, the proposal Area does not contain important habitat features which could be used for breeding dens (hollow-bearing trees, hollow logs, caves etc). The study area contains seven habitat-bearing trees, several of which contain hollows which could be potentially used by this species. These features would be retained after the completion of works. However, disturbance of surrounding vegetation may affect the utility of these features for breeding during works. This impact would be restricted to the work phase and these resources would continue to be available as potential breeding sites after the works.

The proposal is not considered likely to permanently remove potential breeding resources for the species from the study area. Disruption to potential breeding resources (hollow-bearing trees) would be limited to the work phase and potential breeding resources would be retained after the works. These resources are not limited in the Study locality, with large areas of mature native forest present. The proposal is not considered likely to significantly disrupt the breeding cycle of this species.

(f) *Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;*

The proposal would largely remove regenerating native vegetation from the western edge of the study area, abutting the existing Princes Highway. This habitat was not assessed as containing important habitat resources for this species (caves, hollow logs and habitat-bearing trees). More mature, higher condition native vegetation, containing habitat-bearing trees would be largely retained in the east of the study area and would maintain similar levels of connectivity to native vegetation on lands to the north, east and south after the works. The small amount of lower condition habitat to be removed by the proposal is not considered important to the long-term survival of the species in the Study locality.

The proposal is not considered likely to adversely impact habitat for this species in the Study locality to the extent that the species is likely to decline.

(g) *Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;*

The National Recovery Plan for this species identify competition with and predation by wild and domestic introduced dogs (*Canis lupus familiaris*), feral cats (*Felis catus*) and the European Red Fox (*Vulpes vulpes*) as one of the likely drivers of the species' decline and recovery potential.

The proposal would not involve the introduction of additional domestic or wild predators or competitors for this species. The proposal is also not likely to increase the local population of existing feral predators through processes such as providing an artificial food supply.

(h) *Introduce disease that may cause the species to decline, or*

The National Recovery Plan for this species does not identify any major diseases affecting this species. The proposal would not involve processes likely to introduce vectors for disease introduction for this species such as the introduction of potentially infected host fauna.

(i) *Interfere with the recovery of the species.*

The proposal would remove a small portion of native vegetation from the western edge of the study area. The area lacks important habitat features for this species. Better condition, more mature native vegetation containing potential denning and breeding resources for the species in the east of the study area would be largely retained and the proposal would not significantly increase fragmentation of habitat for this species with retained vegetation maintaining connectivity with habitat to the north, east and south after the works. Widening of the existing access track within the construction footprint is not considered to represent a significant increase in habitat fragmentation within the study area.

The study area is already isolated from habitat to the west by the existing Princes Highway and the proposal is not considered likely to significantly increase the level of habitat fragmentation caused by this roadway. Structures (stormwater pipes and culverts) allowing species dispersal under this roadway would be retained after the works.

The proposal is not considered likely to interfere with the recovery of the species.

Conclusion

This species was not recorded in the study area during surveys; however, it is known from recent occurrence records in the Study locality and suitable habitat is present in the study area. The proposal would largely remove lower value habitat in the form of recovering native forest along the eastern edge of the Princes Highway. No important habitat resources (hollow-bearing trees, hollow logs and the ephemeral creek line) would be removed by the proposal. The proposal would not increase fragmentation of habitat for this species with retained vegetation maintaining connectivity with habitat to the north, east and south after the works.

The proposal is not considered likely to have a significant impact on this species in the Study locality.



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Appendix D

Heritage Assessment Report



A U S T R A L
A R C H A E O L O G Y

**Island Point Road Roundabout
Installation, Princes Highway,
Tomerong, New South Wales:
Aboriginal Archaeological Survey Report**

FINAL REPORT

New South Wales Roads and Maritime Services

26 July 2019

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Document Information

| | |
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| Client: | Roads and Maritime Services |
| Prepared by: | Molly Quinn and Alexander Beben |
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SUMMARY

Austral Archaeology (Austral) has been commissioned by Roads and Maritime Services (Roads and Maritime) to undertake an Aboriginal Archaeological Survey Report (ASR) for the study area as part of the proposed installations at Island Point Road, Tomerong, New South Wales (NSW). This report will form part of a Review of Environmental Factors being prepared by Cardno under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EPA Act), in accordance with stage 2 of the Roads and Maritime guideline Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHI).

This report details the Aboriginal archaeological assessment of land situated at Lot 25, DP792969, Lot 11, DP855413 and Lot 8, DP 855413 (the study area) [Figure 1.1] within the Shoalhaven City Council Local Government Area (LGA), and the parish of Wandandian in the county of St. Vincent. The project consists of the installation of a roundabout at the intersection of Princes Highway and Island Point Road at Tomerong. The roundabout will have two southbound lanes, one northbound through-lane and one northbound slip lane.

Predicted Nature of Archaeology within the Study Area

No previously recorded Aboriginal archaeological sites will be impacted by the proposed works.

In the greater St. Georges Basin region, site types are varied and include shell middens, rock shelters, grinding grooves, scar trees, engravings, and burials (Koettig 1989). The majority of sites do not occur in the landforms observed in the study area. Sites in the immediate area are mainly artefact scatters, middens, and axe grinding grooves. As the study area does not contain water or exposed sandstone surfaces, only artefact scatters, isolated finds or middens would have potential of being present. Based upon prior studies in the region, middens and artefact scatters are more likely to be present in elevated land, such as ridges or spurs, or near water sources, which are not present in the study area. Therefore, the study area has little potential for archaeological sites.

The study area is surrounded by gently undulating lowland, which consists of low rises, gentle slopes, and various watercourses which are surrounded by plateaus and spurs (Navin 1990). Tomerong is at the edge of the Nowra sandstone, which is to the west of the study area, and the Wandandian siltstone of the Permian age, which underlies the study area and continues to the east (AASC 2002). The entirety of the study area is classified as Wandandian Coastal Plains, which is defined by undulating slopes and wide flat valleys (Mitchell 2002). The study area contains no watercourses or elevated plateaus, which are the two landforms with archaeological potential in the greater area.

Results of Archaeological Investigations in the Study Area

The pedestrian survey undertaken as part of the assessment process identified [58-2-0478], which is considered an isolated occurrence and of low scientific significance comparative to the local and regional context. The predicted impacts of the study will not impact [58-2-0478].

Based on the low potential of the study area to contain further Aboriginal heritage sites, it is considered that the predicted impact of the proposed works has low potential of impacting on further Aboriginal cultural material which, if present, will only consist of single-use or transient sites, represented by low-density scatters or isolated artefacts.

Recommendations

- [58-2-0478] is located outside of the area of construction impact. To ensure that impact to the site does not occur, a 10 metre exclusion zone must be established around the site during construction works. This must be a hard barrier to ensure personnel or equipment do not impact on the Aboriginal object during project works. Should impacts be proposed to [58-2-0478] then an Aboriginal Heritage Impact Permit (AHIP) will need to be prepared pursuant to Section 90 of the National Parks and Wildlife Act 1974 (NPW Act);
- If there are any changes to the proposed project design then a re-analysis of Aboriginal heritage constraints should be undertaken by a qualified archaeological consultant;

- All contractors undertaking earthworks in the study area should be briefed on the protection of Aboriginal heritage objects under the NPW Act and the penalties for damage to these items;
- All contractors undertaking earthworks in the study area should undergo an induction on identifying Aboriginal heritage objects; and
- Any unexpected finds must be managed in accordance with the Roads and Maritime Services Unexpected Heritage Management Procedure (2015).



CONTENTS

| | |
|---|------------|
| SUMMARY | iii |
| CONTENTS | v |
| 1 INTRODUCTION | 1 |
| 1.1 Project Description | 1 |
| 1.2 Assessment Objectives | 1 |
| 1.3 Federal and State Legislation | 1 |
| 1.4 Section Summary | 7 |
| 1.5 Project Team and Qualifications | 7 |
| 1.6 Acknowledgements | 7 |
| 1.7 Abbreviations | 8 |
| 2 ARCHAEOLOGICAL CONTEXT | 9 |
| 2.1 Introduction | 9 |
| 2.2 Population and Contact History | 9 |
| 2.3 Regional Archaeological Context | 9 |
| 2.4 Local Archaeological Context | 10 |
| 2.5 Studies within and adjacent to the current study area | 11 |
| 2.6 Heritage Database Search Results | 12 |
| 2.6.1 <i>Aboriginal Heritage Information Management System Search Results</i> | 12 |
| 2.6.2 <i>Other Heritage Register Search Results</i> | 15 |
| 3 LANDSCAPE CONTEXT | 17 |
| 3.1 Geological Context and Soil Landscapes | 17 |
| 3.2 Hydrology | 19 |
| 3.3 Flora and Fauna | 19 |
| 3.4 Past Land Use Practices | 19 |
| 3.5 Potential Land Use Impacts on the Archaeological Resource | 20 |
| 4 PREDICTIVE STATEMENT | 21 |
| 5 ARCHAEOLOGICAL SURVEY | 23 |
| 5.1 Survey Methodology | 23 |
| 5.2 Survey Results | 23 |
| 5.2.1 <i>Landform Element 1 – Wandandian Coastal Plains</i> | 25 |
| 5.3 Identified Aboriginal Sites | 25 |
| 6 ASSESSMENT OF HERITAGE SIGNIFICANCE | 27 |
| 6.1 Introduction to the Heritage Assessment Process | 27 |
| 6.2 Basis for Assessment of Aboriginal Sites | 27 |
| 6.3 Preliminary Assessment of Aboriginal Sites | 27 |
| 6.4 Aboriginal Stakeholder Comments | 28 |
| 7 IMPACT ASSESSMENT AND MANAGEMENT RECOMMENDATIONS | 29 |
| 7.1 The Proposed Work and Potential Impacts | 29 |
| 7.2 Conclusions | 31 |
| 7.3 Recommendations | 31 |
| 8 REFERENCES | 32 |

Figures

Figure 1.1 Study Area in relation to St. George’s Basin..... 3
 Figure 1.2 Detailed aerial of the study area 4
 Figure 1.3 Recorded AHIMS sites around the Study Area 16
 Figure 1.4 Landforms around Study Area 18
 Figure 1.2 Study area; cleared dirt track 24
 Figure 1.3 Study area; typical vegetation 24
 Figure 1.4 Isolated artefact 58-2-0478 26
 Figure 1.5 Location of 58-2-0478 26
 Figure 6.1 Proposed area of impact within Study Area in relation to 58-2-0487 30

Tables

Table 1.1 Federal Acts 5
 Table 1.2 State Acts 5
 Table 1.3 State and Local Planning Instruments 6
 Table 1.4 Aboriginal Community Consultation Guidelines 6
 Table 1.5 AHIMS Search Results..... 13
 Table 1.6 Summary of AHIMS Sites..... 14
 Table 1.7 Landform Elements 23

1 INTRODUCTION

This Aboriginal Archaeological Survey Report (ASR) has been prepared by Austral Archaeology (Austral) for Cardno on behalf of Roads and Maritime Services (Roads and Maritime) in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECC 2010a) [Code of Practice]. This report has been prepared in accordance with Stage 2 of the *Procedure for Aboriginal Cultural Heritage Consultation and Investigations* (Road and Maritime Services 2011) [PACHCI]. This document is a stand-alone technical report that will form part of a Review of Environmental Factors being prepared by Cardno under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EPA Act).

The study area consists of land at Island Point Road, Tomerong, New South Wales (NSW) covering Lot 25, DP792969, Lot 11, DP855413 and Lot 8, DP855413 (Figure 1.1) The study area is bounded on the north by the intersection of Princes Highway and Grange Road, on the south by privately owned residential land, on the east by Grange Road, and on the west by Princes Highway. Heavy residential development has occurred to the south and east of the study area; additional residential and commercial development has taken place in Jervis Bay, 10 kilometres to the east. The study area is located about 2 kilometres north of St. Georges Basin and 20 kilometres south of Nowra.

1.1 Project Description

The proposed works include creation of access tracks within the study area. In practical terms, this will include:

- Clearing of vegetation;
- Tree removal;
- Ground disturbance and movement of soil;
- The creation of internal access roads.

The nature of the proposed works is further discussed in Section 7.

1.2 Assessment Objectives

The scope of this ASR is based on the legal requirements, guidelines and policies of the Office of Environment and Heritage (OEH), formerly the Department of Environment, Climate Change and Water (DECCW). The guiding documents for this assessment are the *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (DECC 2011) [the Guide to Reporting] and the Code of Practice.

The scope of works includes the following:

- Undertake a literary review of available data, including previous studies/investigations from around the study area;
- Undertake necessary consultation with relevant Government agencies and key local Aboriginal stakeholders; and
- Document the results of archaeological survey undertaken in accordance with the Code of Practice.

1.3 Federal and State Legislation

Aboriginal archaeological and cultural heritage assessments in NSW are carried out under the auspices of a range of State and Federal acts, regulations and guidelines. The acts and regulations allow for the management and protection of Aboriginal places and objects, and the guidelines set out best practice for community consultation in accordance with the requirements of the acts.

Error! Reference source not found. details the Australian acts and guidelines which have been identified as being applicable or with the potential to be triggered with regards to the proposed development. Table 1.2 identifies and details NSW legislation potentially applicable to the study

area. Table 1.3 identifies and details local legislation, including council policies, which may be applicable. Table 1.4 details aboriginal consultation legislation set in place by OEH.

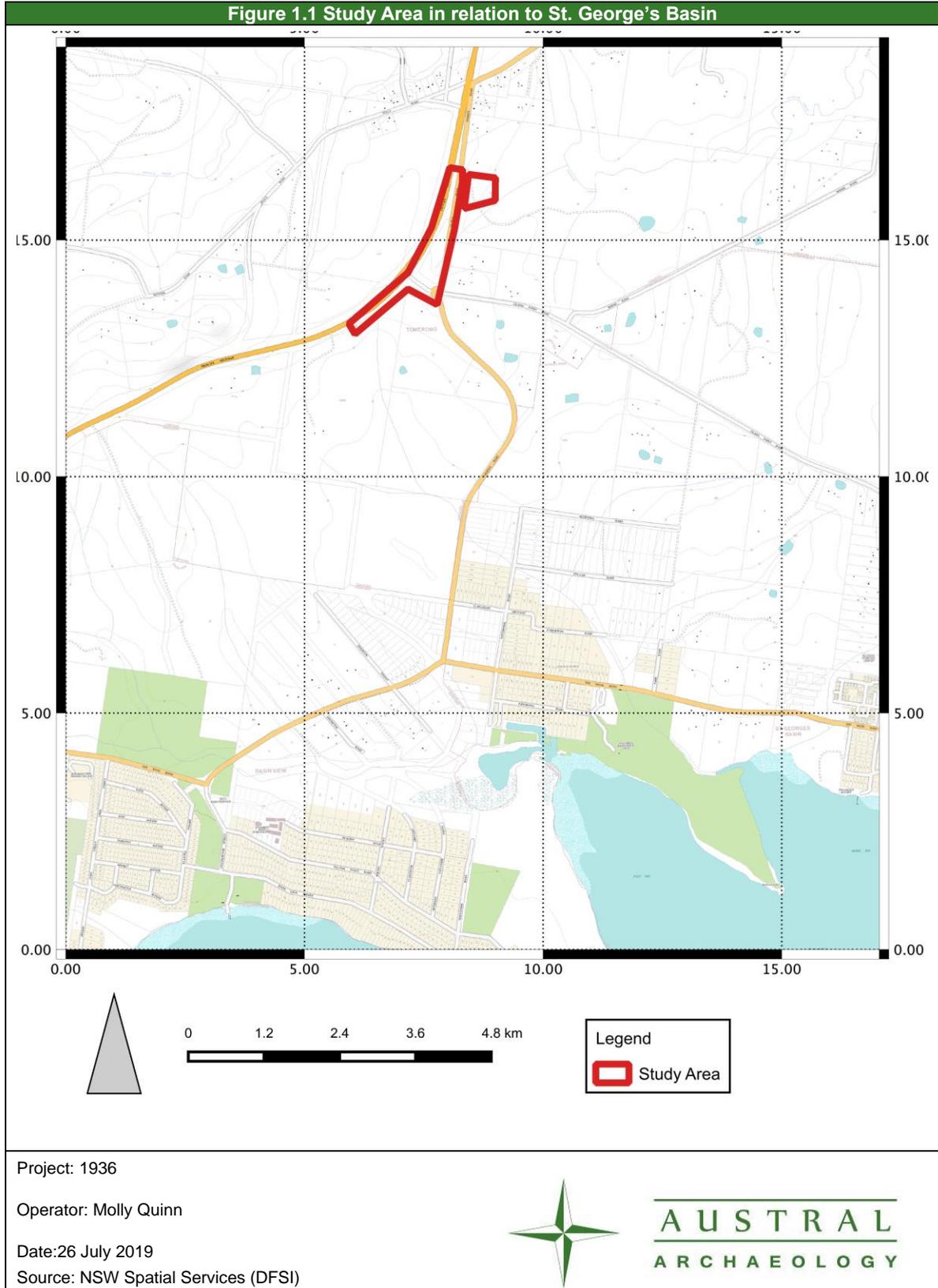
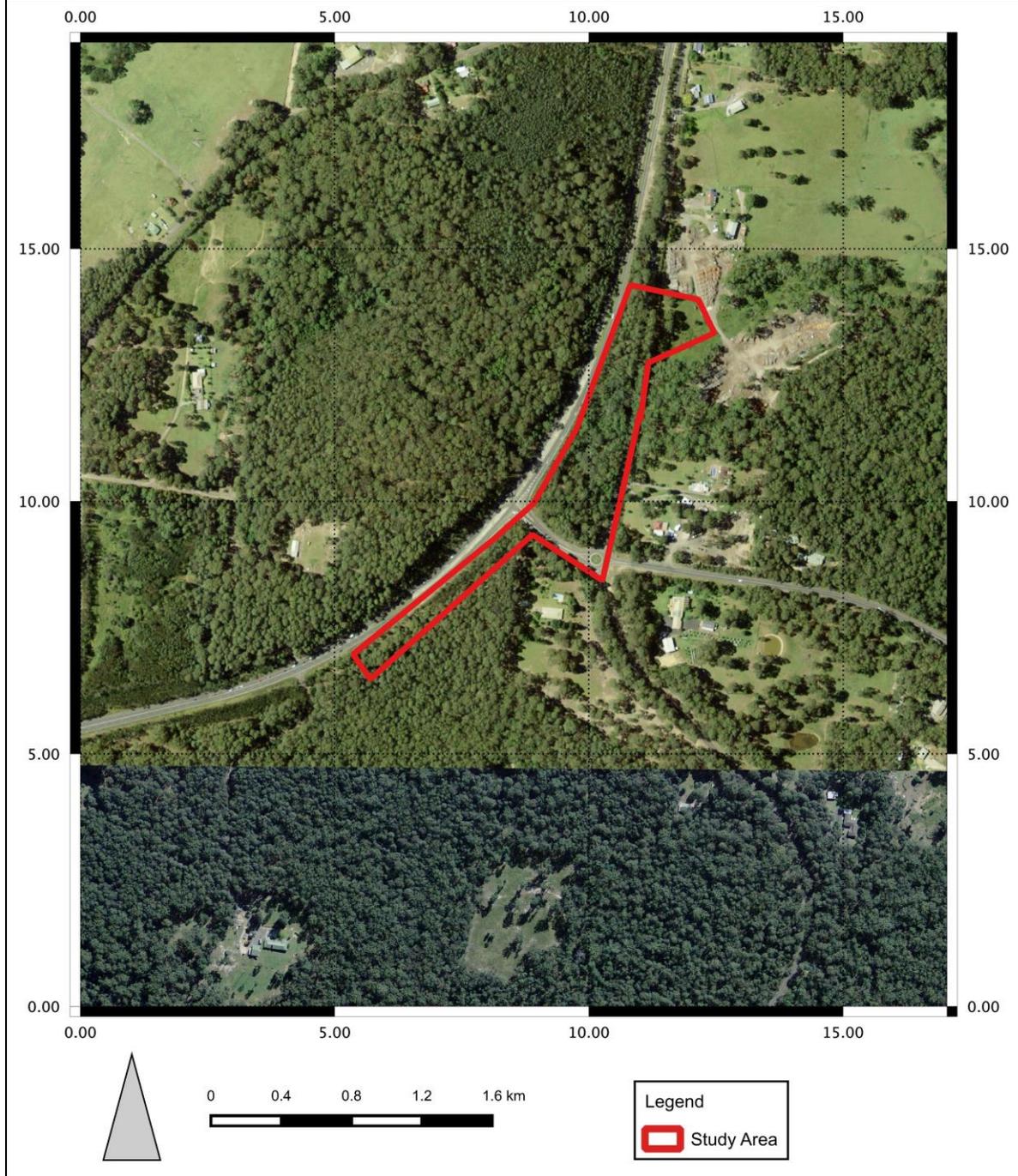


Figure 1.2 Detailed aerial of the study area



Project: Island Point Road

Operator: Molly Quinn

Date: 26 July 2019

Source: NSW Department of Lands



Table 1.1 Federal Acts

| Federal Acts: | Applicability and implications |
|---|---|
| <i>Environment Protection and Biodiversity Conservation Act 1999</i> | This act has not been triggered and so does not apply. <ul style="list-style-type: none"> • No sites listed on the National Heritage List (NHL) are present or in close proximity to the study area. • No sites listed on the Commonwealth Heritage List (CHL) are present or in close proximity to the study area. |
| <i>Aboriginal and Torres Strait Islander Heritage Protection Amendment Act 1987</i> | Applies. <ul style="list-style-type: none"> • This Act provides blanket protection for Aboriginal heritage in circumstances where such protection is not available at the state level. This Act may also override state and territory provisions. |

Table 1.2 State Acts

| State Acts: | Applicability and implications |
|--|---|
| <i>National Parks and Wildlife Act 1974 (NP&W Act 1974)</i> | Applies. <ul style="list-style-type: none"> • Section 86 – Prohibits both knowingly and unknowingly causing harm or desecration to any Aboriginal object or place without either an AHIP, or other suitable defence from the Act. • Section 87 – Allows for activities carried out under an AHIP or following due diligence to be a defence against harm of an Aboriginal object. • Section 89A – Requires that the NSW OEH must be notified of any Aboriginal objects discovered, within a reasonable time. • Section 90 – Requires an application for an AHIP in the case of destruction of a site through development or relocation. |
| <i>National Parks and Wildlife Regulations 2009 (NP&W Regulation 2009)</i> | Applies. <ul style="list-style-type: none"> • Section 80A – States minimum standards of due diligence to have been carried out • Section 80C – Requires Aboriginal community consultation process to be undertaken before applying for an AHIP. • Section 80D – Requires production of a cultural heritage assessment report to accompany AHIP applications. |
| <i>Environmental Planning and Assessment Act 1979 (EPA Act)</i> | Applies. <ul style="list-style-type: none"> • This project is being assessed under Part 5 of the EP&A Act 1979. • Sections 86, 87, 89A and 90 of the NP&W Act 1974 will apply. |
| <i>NSW Heritage Act 1977</i> | This Act has not been triggered and so does not apply. <ul style="list-style-type: none"> • No Aboriginal sites listed on the State Heritage Register (SHR) are present or in close proximity to the study area. |

Table 1.3 State and Local Planning Instruments

| Planning Instruments | Applicability and implications |
|---------------------------------|--|
| Local Environmental Plans (LEP) | <p>The following LEP is applicable:</p> <ul style="list-style-type: none"> • <i>Shoalhaven Local Environmental Plan 2014</i> - Section 5.10; which seeks to conserve local environmental, historic and aboriginal heritage. The plan requires the application for consent if an archaeological site or area of potential will be destroyed, altered, or disturbed in any way. Development consent under the clause is not needed if a 'consenting authority' advises development would not affect the significance of the heritage item, place, or area. |
| Development Control Plans (DCP) | <p>The following DCP is applicable:</p> <ul style="list-style-type: none"> • <i>Shoalhaven Development Control Plan 2014</i>. The plan recommends due diligence for any site to which one or more of the following apply: <ul style="list-style-type: none"> ○ Recorded Aboriginal objects or places on AHIMS; or ○ within 200 metres of a waterbody; or ○ within a sand dune system; or ○ on a ridge top, ridge line or headland; or ○ within 200 metres below or above a cliff face; or ○ Within 20 metres of or in a cave, rock shelter, or a cave mouth. |

Table 1.4 Aboriginal Community Consultation Guidelines

| Guidelines | Applicability and implications |
|--|--|
| <i>OEH Aboriginal cultural heritage consultation requirements for proponents 2010.</i> | <p>The development is to be conducted in accordance with Part 5 of the EPA Act.</p> <ul style="list-style-type: none"> • As the project is to be assessed under Part 6 of the NP&W Act, approvals under Section 90 of the NP&W Act 1974 as amended 2010 will be required, S89A of the Act will apply, and the Part 4 Guidelines will apply. |

1.7 Abbreviations

The following are common abbreviations that are used within this report:

| | |
|---------------------------|---|
| BCE | Before Common Era |
| Consultation Requirements | <i>Aboriginal Cultural Heritage Consultation Requirements for Proponents</i> |
| Code of Practice | <i>Code of Practice for the Investigation of Aboriginal Objects in NSW</i> |
| DA | Development Application |
| DCP | Development Control Plan |
| DECCW | Department of Environment, Climate Change and Water |
| EPA Act | <i>Environmental Planning and Assessment Act 1979</i> |
| EPBC Act | <i>Environmental Protection and Biodiversity Act 1999</i> |
| EPI | Environmental Planning Instrument |
| Heritage Act | <i>NSW Heritage Act 1977</i> |
| ICOMOS | International Council on Monuments and Sites |
| LEP | Local Environmental Plan |
| LGA | Local Government Area |
| NPW Act | <i>National Parks and Wildlife Act 1974</i> |
| NSW | New South Wales |
| OEH | Office of Environment and Heritage |
| PACHCI | <i>Procedure for Aboriginal Cultural Heritage Consultation and Investigation</i> |
| RTA | Road Traffic Authority |
| Guide to Reporting | <i>Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW</i> |
| The proponent | Roads and Maritime Services |
| Study Area | Entirety of Lot 25, DP792969, Lot 11, DP855413 and Lot 8, DP855413 |

Refer also to the document Heritage Terms and Abbreviations, published by the Heritage Office and available on the website: <http://www.environment.nsw.gov.au/heritage/index.htm>.

2 ARCHAEOLOGICAL CONTEXT

2.1 Introduction

The pre-European context of the south coast has considerable antiquity and extends back into the Pleistocene to at least 20,000 years Before Common Era [BCE] (Lampert 1971). Most recorded archaeological sites close to the current shoreline post-date the stabilisation of present sea-level roughly 6,000 years ago. Recent surveys and archaeological studies around Jervis Bay and in the greater St. Georges Basin have recorded varied site types including lithic quarries, scarred trees, rock shelters, burials, open campsites, middens, and axe grinding grooves (Koettig 1989, Navin 1990, Silcox 1991). A few of these site types are relatively common in the area, namely middens, open campsites (artefact scatters), and grinding grooves.

Of these more common sites, several recorded middens were located near the centre of Tomerong, and axe grinding grooves were recorded in West Tomerong, immediately adjacent to a creek (Marshall and Webb 2010). Open artefact scatters (campsites) have been found on areas which are exposed and accessible; not many large artefact scatters have been recorded, and as such there is no clear pattern to their distribution. Most recorded open scatters in the greater South Coast region are found on elevated locations near creeks and wetlands. It is suggested that in the immediate St. Georges Basin area, low-density scatters are common and not of high significance (Marshall and Webb 1994). The most likely site types to exist in, or around, the study area would be low-density artefact scatters of a similar nature, middens, and/or grinding grooves on exposed bedrock.

2.2 Population and Contact History

The present study area is thought to lie within the boundary of the Wandandian people, as mapped by Tindale (1974). The Wandandian are Dhurga speakers whose territory is believed to have extended south from the Shoalhaven River and Jervis Bay to Ulladulla, and west to the Shoalhaven River north of Braidwood (Tindale 1974). The Wandandian were part of a larger inter-tribal group known as the Murring; whose territory extended from Shoalhaven down south to Double Bay (Howitt 1904). The Wodi Wodi people occupied land to the north, and the Wiradjuri to the east (Tindale 1974).

Population estimates at the time of contact are notoriously problematic as Aboriginal groups avoided the early settlers and were highly mobile. Several settlers and explorers recorded observations from 1770 onward. The initial contact period offers descriptions of local populations as 'numerous', while post-1800 the population in the region declined rapidly due to the spread of disease from Europeans. Permanent European Settlement of Jervis Bay began in 1828, and by 1839, a census in Shoalhaven in records the local aboriginal population as 180 (Berry 1838, which conflicts slightly with a local observation of only 62 individuals (Eades 1976).

Models of occupation, and contact potential, have been the course of some debate. Several studies suggest seasonal and transient occupation, wherein coastal resources were used in warmer months and the hinterland was occupied in winter (Poiner 1976, Bowdler 1970), while others suggest mixed-use throughout the year (Attenbrow 1976). Recent studies have pointed to sustained use of the hinterland compounded by a coastal bias in previous research (Boot 2002, Knight 1996). Ultimately, occupation is documented in both the hinterland and coastal region, and movement between the two areas as well as contact between small mobile groups, is more than likely.

2.3 Regional Archaeological Context

The limited ethnographic accounts of early settlers and explorers were once considered the primary source for archaeological enquiry. However, with the spread of urban development within the south coast region, archaeological investigations have been conducted in direct response to the spread of urban development.

Archaeological sites dating to the Pleistocene have been recorded in the region, including a site at Bass Point, south of Lake Illawarra, which was dated to 20,250 years Before Present [BP] (Bowdler 1976:254; Hughes and Djohadze 1980). Archaeological deposits at Burrill Lake, near Ulladulla and about 100 kilometres from the current study area; have been dated to about 25,800 years BP (Lampert 1971:13, 64).

The south coast and greater St. Georges Basin contains a multitude of recorded sites, mainly found along the coast due to more commercial research completed prior to development. Most sites recorded in the greater basin date to the Holocene period, up to the last 6,000 years (Clarke and Kuskie 2006). This is likely due to the stabilisation of sea levels, which lead to the development of coastal estuaries, mangrove flats and sand barriers. These changes would have provided additional resource diversity and environmental predictability for Aboriginal people. These results may also be due to the greater survivability of sites from this time, and a preference for the occupation of the coastal zone during this period.

Jervis Bay is particularly rich archaeologically, with multiple recorded middens in the immediate area. Jewfish Bay, which lies 8 kilometres south of Tomerong, has 13 recorded middens alone (Navin 1990). One site complex with a recorded burial, midden, and open scatter lies 9 kilometres north east of Tomerong (Navin 1990).

2.4 Local Archaeological Context

The following presents a synopsis of the results of previous archaeological investigations within the local region around the current study area.

Recent surveys and archaeological studies around Jervis Bay and in the greater St. Georges Basin have recorded varied site types, including lithic quarries, scarred trees, rock shelters, burials, open campsites, middens, and axe grinding grooves (Koettig 1989, Navin 1990, Silcox 1991, Boot 2002). A few of the site types are relatively common in the area, namely middens, open campsites (artefact scatters), and grinding grooves.

Clark and Kuskie (2006) assessed Aboriginal cultural resources across the Shoalhaven region which included a predictive model for Aboriginal sites in the region. Based on a review of ethnohistorical records, the physical environment of the region, known Aboriginal sites, and areas of cultural significance, Clark and Kuskie determined that:

- Terrain close to the Shoalhaven and Crookhaven rivers (primary resource zones) have a higher probability for containing evidence for a wide range of occupation types, including semi-permanent and transient camping, as well as transitory movement, and that evidence of occupation in these regions is occurs regularly and for longer periods of time.
- Terrain units close to high order creeks and wetlands (secondary resource zones) have a high probability for camping and transitory movement, with occupation less likely to be temporally regular.
- Areas not in the primary or secondary resource zones are likely to have been subject to sporadic and short-term occupation.

A predictive model for each site type was assembled by Kuskie (2005), and lists potential for the following:

- Artefact scatters have high potential to occur on low gradient slopes near water, and moderate to low potential to occur on simple slopes away from water (Kuskie 2005). They are found in the region on level, well drained ground (Navin 1990).
- Burials are the most likely to be found in soft sediments such as sand or silts (Navin 1990). Burials may also be found in trees, caves, or sand deposits (Kuskie 2005)
- Culturally modified trees occur throughout the region, in large old-growth forests and on well-preserved land.
- Lithic quarries and grinding grooves require exposed bedrock and are more commonly found inland.
- Middens are common in the coastal region and occur mainly near sources of water. They are usually located on elevated ground near creeks (Navin 1990).

All the recorded archaeology within a 10-kilometre diameter of the study area consists of various site types in close proximity to water and/or exposed bedrock which represent camping and temporally repetitive occupation. The studies also correlate isolated artefacts, consistent with transient occupation, in areas with little water. The study area has potential for isolated artefacts

to occur, but due to the lack of standing water, exposed bedrock, and old growth of vegetation has low potential for other archaeological sites.

2.5 Studies within and adjacent to the current study area

The study area has not been the subject of prior analysis and contains no previously recorded sites within. Three sites are within 500 metres of the study area; two are isolated artefacts and one in an artefact scatter encompassing four artefacts recorded by Koettig in 1989.

In 1989, a survey report was completed prior to the construction of a by-pass around Tomerong by Margaret Koettig for the Roads and Traffic Authority (RTA). The survey was completed between Suffolk Creek, which meanders 1 kilometre to 500 metres north and northwest of the study area and Tomerong Creek, which is 1.5 kilometres north. One artefact scatter, GR1, was located, which lies 150 metres north of the study area within a ridgeline. The scatter was 34 metres west of the Princes Highway, and contains four artefacts (1 quartzite flake, 1 silcrete flake, 1 chert flake, and 1 broken chert flake, all less than 30 millimetres in size) distributed over a distance of approximately 100 metres. The survey encompassed low ridgeline between the creek and south to the present Grange Road, which is south of the survey area. Landforms present recorded between Grange Road and Suffolk Creek (which includes the current study area) were noted as cleared alluvial flats. Areas of potential were noted as those immediately adjacent to Suffolk Creek, and a ridgeline south of Grange road, with no areas of potential within the study area. The four artefacts recorded as a scatter are closer to the creek than the study area, and on an elevated ridge; these may be background scatter of larger sites near the creek and reflect transitional debris rather than long term occupation or camping.

In 1990, Kerry Navin completed a survey detailing alternate routes for the Princes Highway bypass for the RTA, which was a further analysis of Koettig's 1989 report. The survey walked transects which represent the current alignment of the Princes Highway and Grange Road, which are respectively the western and eastern borders of the study area. The study area was again surveyed during this study. Two sites were identified; one to the east of Grange Road and 100 metres east of the study area, and one 300 metres to the north-east of the study area. These two recorded sites are described as: "small amounts of shell material – very small, fractured pieces of *anadara trapezie* (bimbia) and *mytilus planulatus* (mussel) were located in two highly disturbed areas" (Navin 1990) and were 250 metres from Suffolk creek. It is likely, again, compared to major studies in the hinterland and associated St. Georges Basin, sites with higher significance and archaeological density would be closer to the creek, or on ridgelines, or areas of high elevation. The small amounts of shell identified by Navin were concluded by Navin (1991) to be isolated background scatter to more dense sites closer to Suffolk creek, representing transient movement between areas of higher resource density. It is noted in the report (Navin 1991) that due to the disturbance of the area, these two sites hold low archaeological significance.

Additional sites recorded by both Koettig (1989) and Navin (1990, 1991) include grinding grooves and open campsites to the west of the study area, where landforms transition from undulating alluvial flats to hillslopes with exposed bedrock. As the landform changes to the Nowra sandstone underlying hills and slopes to the west of the study area, more sites have been found. These include grinding grooves and lithic quarries, which utilise the exposed bedrock associated with this landform. These sites lie on Nowra sandstone, and thus have the resources for grinding grooves, rockshelters, and lithic quarries. The largest complex identified to the west consists of four scarred trees, two artefact scatters, two isolated artefacts, one midden and one major site complex located directly along the banks of Currumbene Creek (Navin 1991, Navin 2000).

In 1990, Rex Silcox completed test excavations associated with GR1 for the RTA. Of the test pits that were excavated only those on ridgelines retrieved artefacts. Silcox concluded that due to the lack of artefacts found, the area is of very low significance and suggests that no further archaeological work is needed in the area prior to development.

The studies which record the sites closest to the study area (Navin 1990, Koettig 1989) detail landforms in the immediate area. They concluded that high archaeological potential was to the north of the study area, near Tomerong and Suffolk creeks. Additional regions of high potential were to the south of the study area, past the southern extent of Granges Road, in a region of high elevation. Both surveys noted that the alluvial flats around Princes Highway only contain areas of moderate to high archaeological potential and significance when in immediate proximity to creeks and tributaries, of which the study area is not.

Numerous additional studies have been completed within 5 kilometres of the study area. These studies have identified sites to the north and south of the study area that are predominantly located close to watercourses or on elevated plateaus. Those within immediate proximity to the study area are next to (<50 metres) from direct sources of water such as tributaries, or on elevated spurs or plateaus. To the south-east of the site, a survey by Rex Silcox in 1991 for the Shoalhaven City Council identified a scatter of 8 quartz artefacts 100 metres to the East of a tributary to Suffolk creek, on a broad spur ridge (SGB1), as well as another scatter with eight artefacts on another ridge 100 metres to the south (SGB2). Both SGB1 and SGB2 lie on the region of high elevation to the south of Grange Road, which was identified as an area of archaeological potential in the studies of both Navin (1990) and Koettig (1989). Kuskie and Clarke (2007) identified two isolated artefacts in an upgrade of Turpentine Road, one kilometre to the south of the study area. They concluded archaeological potential in the area was low due to previous disturbance and the shallow nature of the surrounding soil deposit.

A high volume of sites have been identified further south and closer to St. Georges Basin. Areas with high elevation close to creeks were identified as high potential regions again in a study by Paton and Wood (1995), who located ten artefacts within a 50-metre x 50 metre area close to running water sources several kilometres to the south of the study area. Additional sites were located near watercourses and ridges bordering watercourses a few kilometres south of the study area by Marshall and Webb (1994).

In close proximity to St. Georges Basin (i.e. within a few hundred metres), a large knapping site was identified along with two additional artefact scatters (Kuskie 1995a, Kuskie 2000c). Several more studies have found ample sites along watercourses like these, further from the study area (Clarke and Kuskie 2006, Attenbrow 1981).

Scar trees have been identified within one kilometre of the site to the southwest (Kuskie et al 1995, Mills 2002) but only in areas where vegetation has not been cleared.

Becroft Peninsula, the northern section of Jervis Bay, contains over 130 recorded aboriginal sites alone (Cane 1988), the majority of which are middens and rock shelters. Large complexes like this to the far (>2 kilometres) east of the study area are extremely common due to the abundance of resources available at Jervis Bay.

To conclude, the review of previously completed archaeological studies indicates that previously identified sites in the region share the common attribute of proximity to a water source- those which are found directly next to resources like Currumbene Creek and Jervis Bay have more archaeological evidence than those found near smaller tributaries. Studies which closely examine regions between watercourses have found little to no archaeological evidence, mainly limited to isolated artefacts (Attenbrow 1981, Clark and Kuskie 2007).

2.6 Heritage Database Search Results

2.6.1 Aboriginal Heritage Information Management System Search Results

A search of the OEH Aboriginal Heritage Information Management System (AHIMS) database was undertaken on 27 May 2019 (Client Service ID 423326). The results from the AHIMS search identified 40 previously recorded sites within a 10 by 10-kilometre zone around the study area (Table 2.1). The nearest previously recorded site is (#58-2-0283) recorded approximately 150 metres to the northeast of the current study area.

Of the 40 previously recorded sites registered on AHIMS, the highest percentage of site type, or sites most commonly found in the area, are artefact sites (including isolated finds, artefact scatters and undefined artefact sites). The second highest percentage of sites are axe grinding grooves (Table 1.6).



Table 1.5 AHIMS Search Results

| Site ID | Site Name | Site Status | Site Features | Site Types |
|-----------|--------------------------------|-------------|-----------------|---------------------|
| 58-2-0305 | Pelican Rd | Valid | Artefact | Open Camp Site |
| 58-2-0306 | Fisherman's Road | Valid | Artefact | Open Camp Site |
| 58-2-0307 | Nebraska Rd | Valid | Artefact | Isolated Find |
| 58-2-0309 | St. Georges Basin 1 | Valid | Artefact | Open Camp Site |
| 58-2-0310 | St. Georges Basin 2 | Valid | Artefact | Isolated Find |
| 58-2-0311 | St Georges Basin 3 | Valid | Artefact | Open Camp Site |
| 52-5-0293 | Wandandian Creek Site 2 | Valid | Artefact | Open Camp Site |
| 52-5-0294 | Wandandian Creek Site 1 | Valid | Artefact | Open Camp Site |
| 52-5-0297 | Suffolk Creek Site 1 | Valid | Artefact | Open Camp Site |
| 58-2-0345 | Nebraska road, Nebraska Estate | Valid | Artefact | Isolated Find |
| 58-2-0273 | TBP 2 | Valid | Artefact | Open Camp Site |
| 58-2-0274 | TBP 3 | Valid | Artefact | Open Camp Site |
| 58-2-0275 | GR1 | Valid | Artefact | Open Camp Site |
| 58-2-0277 | Tomerong 1 | Valid | Artefact | Open Camp Site |
| 58-2-0278 | Tomerong 3 | Valid | Artefact | Open Camp Site |
| 58-2-0279 | Tomerong 2 | Valid | Artefact | Open Camp Site |
| 58-2-0280 | Tomerong 4 | Valid | Grinding Groove | Axe Grinding Groove |
| 58-2-0281 | Tomerong 5 | Valid | Grinding Groove | Axe Grinding Groove |
| 58-2-0282 | Tomerong 6 | Valid | Artefact | Open Camp Site |
| 58-2-0283 | Tomerong 7 | Valid | Shell, Artefact | Midden |
| 58-2-0284 | Tomerong 8 | Valid | Shell, Artefact | Midden |
| 58-2-0285 | SGB1, St. Georges Basin | Valid | Artefact | Open Camp Site |
| 58-2-0286 | SGB2, St. Georges Basin | Valid | Artefact | Open Camp Site |



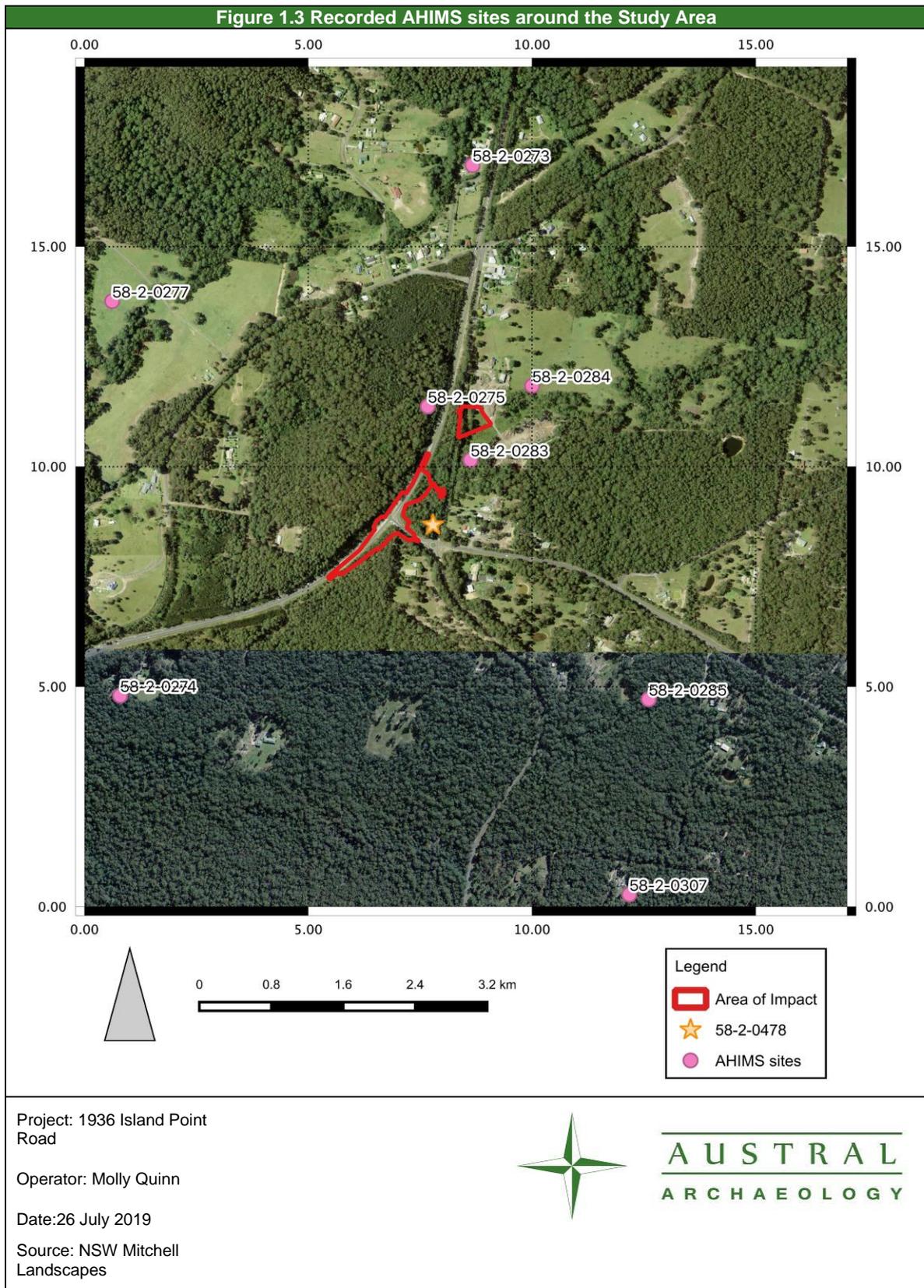
| Site ID | Site Name | Site Status | Site Features | Site Types |
|-----------|------------------------------------|-------------|-------------------------------------|--------------------------------|
| 58-2-0364 | PB 19 | Valid | Artefact | Open Camp Site |
| 58-2-0365 | PB 17 | Valid | Artefact | Open Camp Site |
| 58-2-0379 | Pipeline Site 2 | Valid | Artefact | Open Camp Site |
| 58-2-0344 | Pelican Road 1, Nebraska Estate | Valid | Artefact | Open Camp Site |
| 58-2-0356 | Isolated Artefact 1 | Valid | Shell, Artefact, Grinding Groove | Axe Grinding Groove, Midden |
| 58-2-0288 | Morgan Road PB 18 | Valid | Artefact | Open Camp Site |
| 58-2-0417 | CSCA1 (Corramy SCA) | Valid | Artefact | Open Camp Site |
| 58-2-0418 | CSCA2 (Corramy SCA) | Valid | Artefact | Open Camp Site |
| 58-2-0419 | CSCA3 (Corramy SCA) | Valid | Artefact | Open Camp Site |
| 58-2-0420 | CSCA4 (Corramy SCA) | Valid | Artefact | Open Camp Site |
| 58-2-0421 | CSCA5 (Corramy SCA) | Valid | Artefact | Open Camp Site |
| 58-2-0422 | CSCA6 (Corramy SCA) | Valid | Artefact | Open Camp Site |
| 58-2-0425 | CSCA9 (Corramy SCA) | Valid | Artefact | Open Camp Site |
| 58-2-0354 | Bewong 1 | Valid | Artefact | Open Camp Site |
| 58-2-0355 | Bewong 2 | Valid | Grinding Groove | Axe Grinding Groove |
| 58-2-0346 | Fishermans Road Nebraska Estate | Valid | Artefact | Open Camp Site |
| 58-2-0407 | St Georges Basin 3 | Valid | Artefact | Open Camp Site |

Table 1.6 Summary of AHIMS Sites

| Site Features | Number | Percentage |
|-----------------------------|--------|------------|
| Isolated Finds | 3 | 7.5% |
| Midden | 2 | 5% |
| Open Camp Site | 31 | 77.5% |
| Axe Grinding Groove, Midden | 1 | 2.5% |
| Axe Grinding Groove | 3 | 7.5% |
| Total | 40 | 100% |

2.6.2 *Other Heritage Register Search Results*

Searches of the Australian Heritage Places Inventory (AHPI), the Register of the National Estate (RNE) and the NSW Heritage Branch State Heritage Inventory websites were undertaken and did not identify any recorded Aboriginal objects or places in or around the development area.



3 LANDSCAPE CONTEXT

3.1 Geological Context and Soil Landscapes

The natural environment of an area influences not only the availability of local resources, such as food and raw materials for artefacts, but also determines the likely presence and/or absence of various archaeological site types which may be encountered during a field investigation.

Resource distribution and availability is strongly influenced by the environment. The location of different site-types (such as rock-shelters, middens, open camp-sites, axe grinding grooves, engravings etc) are strongly influenced by the nature of soils, the composition of vegetation cover and the climatic characteristics of any given region. Equally important is the range of other associated characteristics which are specific to different land systems and their geology. In turn this affects resource availability of, for example, fresh drinking water, plant and animal foods, raw materials for stone tools, wood and vegetable fibre used for tool production and maintenance.

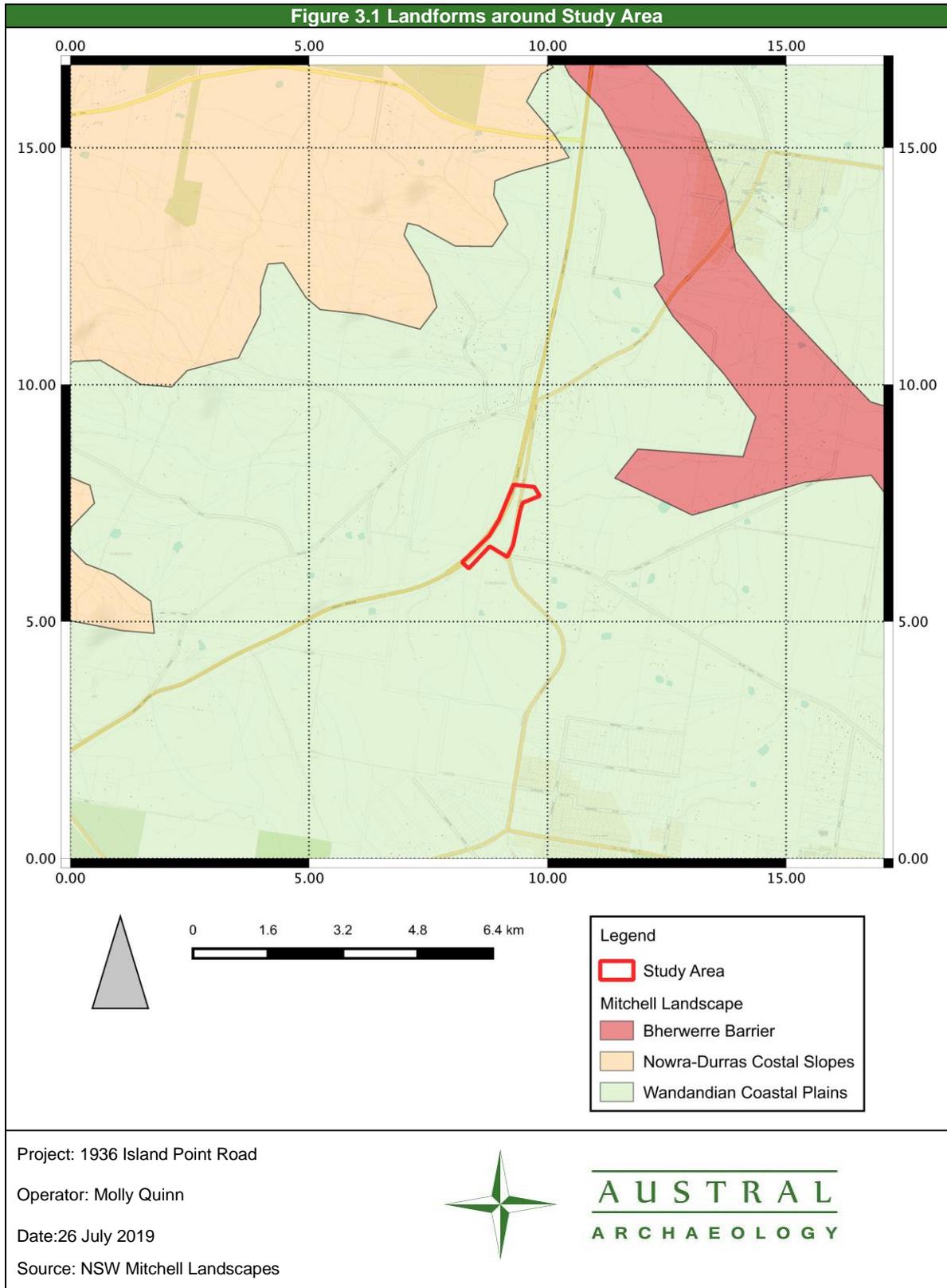
Therefore, examining the environmental context of an area is essential in accurately assessing potential past Aboriginal land-use practices and/or predicting site types and distribution patterns within any given landscape, cultural or not. The information that is outlined below is applicable for the assessment of site potential of the current study area. The study area consists of one physiographic soil landscape. Soil landscapes have distinct morphological and topological characteristics that result in specific archaeological potential. Because they are defined by a combination of soils, topography, vegetation and weathering conditions, soil landscapes are essentially terrain units that provide a useful way to summarise archaeological potential and exposure.

The study area is defined by gently undulating lowland, which consist of low rises, gentle slopes, and various watercourses which are surrounded by plateaus and spurs (Navin 1990). Tomerong is at the edge of the Nowra sandstone, which lies to the west of the study area, and the Wandrawandian siltstone of the Permian age, which underlies the study area and continues to the east (AASC 2002). Typical soil of Wandrawandian siltstone is sandy clay loam, which overlies a light clay sub-soil.

The study area is classified as Wandandian Coastal Plains, which is defined by undulating slopes and wide flat valleys with dendritic drainage (OEH Landscape Descriptions 2008b). The topsoil consists of a friable brown sandy clay loam, which has been mixed via machine disturbance (dirt road track) with underlying light brown clay deposits in the north of the study area, and only silty loam (presumably topsoil removed from the westerly adjacent Princes Highway) in the south of the study area. These soil types align with that typical of Wandrawandian siltstone. The soil horizon is shallow, and topsoil has been removed and/or displaced in the majority of the northern half of the study area, while imported soil in the southern half makes the original soil unobservable.

The study area lies completely on undulating alluvial lowland flats of the Wandandian Coastal Plains (Figure 3). Within the study area, no ridge lines or defined water drainage was observable. The study area was not located on an elevated spur, or on a gentle slope adjacent to a creek (the most likely landforms to contain areas of archaeological potential). The study area generally sloped to the north-east (less than 5% grade), which continued outside the study area to the north and the east; the landform continued sloping down to meet with Suffolk Creek, changing into sandy slopes termed 'Bherwerre Berrier' by the Mitchell classification system (OEH Landscape Descriptions 2008b) and associated with ocean dunes. To the west and the south, the landform around the study area continued to rise until it began to change into a landform defined by hills and peaks, referred to as the Nowra-Durras Coastal slopes.

The landforms which surround the study area provided more resources than that within the study area itself, namely aquatic resources associated with marshes, streams, and the open ocean. As such, the archaeological potential in the landform present in the study area is far less than those which surround it. It is likely that Aboriginal people would have traversed through the study area to access coastal and terrestrial resources found in landforms surrounding the study area rather than settling in the study area, especially as these resource-laden landforms are relatively close and simple to access.



3.2 Hydrology

The study area is located within the Shoalhaven River Catchment, comprising an area of 5,640 kilometres². The Shoalhaven River has four main tributaries; the Mongarlowe, Corang, Endrick and Kangaroo rivers.

No creeks run through the study area, nor do drainage channels. A small drainage channel, which may have been a 1st order stream prior to the construction of Grange Road, intersects with Grange Road and partially crosses into the study area, though is difficult to discern. The channel is ephemeral and would only be of use after long rains. The major watercourse in the vicinity of the study area is Suffolk Creek, which meanders roughly 500 metres to the north and east. Suffolk Creek runs west to east, and eventually joins Tomerong Creek. Additionally, Bolerang Creek flows about 5 kilometres south of the study area. Both Bolerang and Suffolk Creek are 2nd order streams, meaning that they have short, 1st order tributaries which drain into them. As the Strahler stream order increases, bodies of water become large and therefore have more resources and are thus more likely to have evidence of Aboriginal occupation and use. Places of high archaeological potential in the local area are defined as those within 50 metres of a water source (Clarke and Kuskie 2006). Additionally, a small ditch has flooded with water, located in the corner of the study area- to the immediate north of Island Point Road and immediate east of Princes Highway. This body of water is not natural and is likely due from drainage from the neighbouring modern roads.

The study area is at least 300 metres from any permanent, non-ephemeral, water, and therefore does not have potential based on proximity to a water source.

3.3 Flora and Fauna

Prior to the removal of the natural vegetation, the ecological diversity of the area would have provided a wide range of resources for Aboriginal people. Aboriginal people frequenting the study area would have exploited resources from the nearby coastline as well as Jervis Bay. Vegetation has been predominantly cleared but would have consisted of thick Eucalypt forest with dense undergrowth of acacia, ferns, and grasses, namely spotted gum (*Corymbia maculata*) and forest oak (*Allocasuarina torulosa*) with extensive macrozamia (*Macrozamia sp.*) and blady grass (*Imperata cylindrica*) understorey (OEH Landscape Descriptions 2008b).

Isolated mature trees which remain standing within the study area are indicative of tall, wet sclerophyll forests. It is suggested that controlled burning may have been practiced by Aboriginal people (Navin 1990, Silcox 1991, Lampert 1973). Ethnohistorical observations include the following as food sources: fish species including break, trumpeter, whiting, salmon, shark and eel, whales, seals, marine worms, shellfish, possum, kangaroo, wombat, birds, goanna, grubs, honey, kangaroo apple, native cranberry, honeysuckle, pigface, macrozamia, cabbage tree, fruit and yams (Boot 2002).

Subsistence strategies would reflect surrounding resources; groups of individuals travelling in the hinterland and along the coast who would have exploited close resources, rather than exporting resources elsewhere (Kuskie and Clarke 2007). Evidence of long-term occupation is found where abundant resources were located, namely in regions of great biodiversity, hence the large amount of sites along the coast and along sources of water such as creeks.

3.4 Past Land Use Practices

The land in the study area has been cleared of vegetation and re-populated by trees within the last century, evident in the lack of old growth. It is likely land was used for ploughing or cattle at some point, as it lies adjacent to several plot used as farms. Piling of topsoil, likely removed during construction of the current Princes Highway, is present in the south of the study area.

Old maps depict the previous alignment of the Princes Highway, located to the west of the study area and around 2 kilometres west of the current alignment (Tomerong Plan Maps, 1927: NSW Land Registry: Parish and Historic Maps). The realignment of the highway occurred after the surveys completed by Koettig (1989) and Navin (1990), which both recommended the new and current alignment, known as 'Option A'. The construction of this new stretch of highway would have disturbed the landform in the region, namely through the construction of the embankment associated with the road.

In the north of the study area, soil has been shifted by a small machine to create a dirt racing track roughly 1 to 1.5 metres wide, meandering through the length of the area (**Error! Reference source not found.**). Historic installation of a fence line, as well as a concrete drain underlying the adjacent highway are also present in the study area.

3.5 Potential Land Use Impacts on the Archaeological Resource

The main impacts on the subject land relate to extensive land clearance, construction of fences and vehicle tracks, and sub-surface utility services and ongoing residential development surrounding the study area.

These activities would have contributed to the removal of the original native vegetation as evidenced by the recent regrowth in the study area, eliminating the possibility for scar trees and burials (which have been recorded as placed in trees).

The disturbance of the original soil and movement of topsoil would move any potential artefacts from their original context and would potentially have destroyed certain artefacts with the involvement of large machinery. Additional impacts have come from the continued ground impact of motorbikes and associated vehicles on the dirt track. The track has removed existing sandy loam typical of Wandrawandian siltstone and exposed the clay-loam present beneath. These activities account for the high disturbance within the study area.

The activity noted on the study area accounts for widespread artefact displacement rather than the complete destruction of Aboriginal sites.

4 PREDICTIVE STATEMENT

In general, an archaeological predicative statement on any study area draws on surrounding environmental data, previous archaeological research and predicative models for Aboriginal occupation. Another essential aspect to predicting the archaeological integrity of a site and something that must be considered is previous land uses and the degree of disturbance across the study area. These are addressed in the following sections.

The Shoalhaven region surrounding the study area is believed to have experienced a moderate climate during the Holocene (Boot 2002) and this, together the abundant resources on the coastline, made the region conducive to Aboriginal occupation in the past. The study area lies within a resource base associated primarily with Jervis Bay. Habitats associated with the bay and ocean would have supported a wide range of animals, fish, birds and mammals.

Exploitation of the available resources within the landscape would have resulted in patterns of movement and settlement associated with camping, hunting, gathering, stone procurement, ceremonies, and other cultural activities conducted throughout the region. Some of these activities, mainly stone tool knapping, are seen in the archaeological record.

Archaeological sites within the region are believed to record the activities and lifeways of speakers of the Dhurga language. Consistent with the broader Illawarra region, sites are predominantly middens, open scatters and isolated occurrences of flaked stone on the ground surface of sensitive landforms. Most sites in the Jervis Bay Coastal region have been associated with creek lines or other sources of permanent water, or elevated areas with good views of the surrounding area (Clark and Kuskie 2006). The main trends in relation to cultural heritage sites in association with the study area are that:

- Stone artefact sites likely occur across the hinterland as a low-density background scatter, representing transient movement between the hinterland and coastline.
- Scarred trees may occur in areas of remnant native woodland and grinding grooves as well as lithic quarries may be found on exposed bedrock.
- Shell middens have been recorded around the bay, usually on elevated dry ground near an aquatic environment.

In summary, the main trends broadly seen across the Jervis Bay Coastal Region are that:

- Archaeological sites have the potential to occur on most landforms.
- Site frequency and density are dependent on their location in the landscape.
- There is a constant presence of low-density surface open artefact scatters and isolated finds, representing movement between resources of the hinterland and the coastline.
- Aboriginal scarred trees may be present in areas where remnant old growth vegetation exists.
- Surface artefact scatters are commonly located near water sources along creek banks. More complex sites are usually located close to water sources with major confluences being key locations for occupation sites.
- Subsurface archaeological deposits may exist in areas where no visible surface archaeological remains are evident.

As a result of these statements, it is reasoned that key landforms which comprise raised flat terrain near sources of water within the wider Coastal Plain that remain undisturbed are archaeologically and culturally sensitive, as indicated by the frequent presence of Aboriginal archaeological sites within such settings. Specific investigations surrounding and within the study area have highlighted the local character of archaeological sensitivity as determined by the available resources and landforms and the degrees of past disturbances.

Based on these trends the following predictions can be made for the study area:

- As no original, level ground exists in the study area, there is low to medium potential for artefact scatters and no potential for *in situ*, or in original context, artefact scatters. Much of the development area appears to be moderately to heavily disturbed due to past land clearance, vehicular use, and landform modification, namely the construction of the Princes Highway in close proximity.
- Burials are the most likely to be found in soft sediments such as sand or silts (Navin 1990). Burials may also be found in trees, caves, or sand deposits (Kuskie 2005). None of these occur in the study area, as all trees are recent growth and less than 100 years of age.
- Culturally modified trees occur throughout the region, but the potential for presence in the study area is zero to nil, as all trees present are recent growth.
- Lithic quarries and grinding grooves require exposed bedrock. As such, their potential to exist in the study area is zero to nil.
- Middens are common in the coastal region and occur mainly near sources of water. They are usually located on elevated ground near creeks (Navin 1990). As such, their potential for presence in the study area is low.
- High levels of past disturbances within the study area mean that the general archaeological landscape is not suitable for conservation.
- Low potential for stone artefact sites is present as there are no immediately nearby sources of water.
- Scarred trees are unlikely to be present due to cleared and regrowth vegetation areas.
- Grinding grooves, lithic quarries, rock shelters and other sites associated with exposed bedrock are not present due to a lack of suitable requirements (exposed bedrock).
- Shell middens have low potential due to the distance from a water source and lack of observable elevated, flat ground.

These traits therefore frame the level of archaeological sensitivity that can be expected within the study area across the range of landforms present and depositional environments present. These factors inform the survey sampling strategy and conclusions of the field survey discussed in the following section.

5 ARCHAEOLOGICAL SURVEY

5.1 Survey Methodology

The specific survey methodology developed for this assessment was guided by the survey requirements as set out in the Code of Practice. The survey methodology was designed to optimise the investigation of areas where archaeological materials may be present and visible, as well as investigation of the broader archaeological potential of the study area.

On the basis of the predictive statement, archaeological site distribution is linked with proximity to creek lines and flat, gently sloping elevated topography. The field inspection of the study area therefore paid close attention to areas of favourable landform condition, of which none were present or identifiable.

The key survey variables of ground visibility, which considers the amount of ground surface which is visible and not covered by any vegetation; and exposure, which defines areas where dispersed surface soils and vegetative matter afford a clear assessment of the ground, were assessed across the study area and within each landform element. Overall survey coverage and calculated survey effectiveness was recorded. Note that the effectiveness of the field survey was largely dependent on the degree of ground surface visibility.

The study area falls within a single landform, Wandandian Coastal Plains, and as such was investigated as a single survey unit via pedestrian coverage. Areas of higher surface visibility and inherent archaeological potential were subject to proportionately closer inspection. In areas of very low surface visibility and low archaeological likelihood due to landform or disturbance levels, transects were walked at intervals of approximately 1 metre distance.

Photographs were taken of all survey units and landforms which may provide an indication on the archaeological potential.

5.2 Survey Results

An archaeological survey of the study area was undertaken on 20 May 2019 by Alexander Beben (Austral Archaeology), Molly Quinn (Austral Archaeology) and Jesse Ferguson of the Nowra LALC. One flake was observed in a spoil heap in the northern portion of the study area. No other Aboriginal heritage objects or places were observed during the field survey. No areas of archaeological sensitivity were observed.

The study area consisted of approximately 68,000 metres² of flat, undulating (0% - 5%) terrain. The majority of the study area was disturbed by modern activity. The effective survey coverage in the exposed disturbed portion was high at 60% (Figure 3.2 and Figure 3.3). The remainder of the study area was mostly covered in leaf fall, and visibility was poor, resulting in coverage at 40%. The overall effective survey coverage was therefore lower, around 50%. The survey data for the landform elements within it are presented in Sections 5.2.1 to 5.2.3 below, and the survey results for each of the individual landform elements are tabulated in Table 3.1.

Table 3.1 Landform Elements

| Landform Element | Landform Area (sq m) | Visibility % | Exposure % | Effective Coverage Area (sq m) | % of landform effectively surveyed (= area effectively surveyed/ landform x 100) |
|---------------------------|----------------------|--------------|------------|--------------------------------|--|
| Wandandian Coastal Plains | 68000 | 40 | 60 | 34,000 | 65% |

Figure 3.2 Study area; cleared dirt track



Figure 3.3 Study area; typical vegetation



5.2.1 *Landform Element 1 – Wandandian Coastal Plains*

In the northern portion of the site, underlying clay was exposed due to high levels of disturbance, which gave exceptional visibility and exposure. The study area is divided by Granges Road into northern and southern parts. The northern area is dominated by flat (0-10% slope) undulating ground with no clear natural water sources. Most of the ground was covered by leaf fall. A portion of the soil was exposed by disturbance; the ground surface in the north has been disturbed by recent building of what appears to be a track for motorcycle or recreational dirt bike racing. As such, the area contains several built mounds for the track, and embankments which have moved soil and altered the landscape. The southern area is completely covered by a large mound, which is roughly two metres high with steep embankments on either side. This is likely from the construction of Princes Highway, and no trace of the original landscape remains. Furthermore, based on landform characteristics of previous sites as well as high disturbance of the study area, the study area is considered to have a low potential to contain Aboriginal heritage sites.

5.3 Identified Aboriginal Sites

One flake was identified in a spoil heap associated with the building of the dirt track in the northern portion of the site. It was located in a soil heap 600 millimetres high which has been removed from the original location and pushed to the side of the track to create a turning platform (Figure 3.4 and Figure 3.5). The flake was recorded as an isolated find and given AHIMS site name 58-2-0478. No proposed works are located closer than 20 metres of 58-2-0478.

Figure 3.4 Isolated artefact 58-2-0478



Figure 3.5 Location of 58-2-0478



6 ASSESSMENT OF HERITAGE SIGNIFICANCE

6.1 Introduction to the Heritage Assessment Process

An assessment of significance seeks to determine and establish the importance or value that a place, site or item may have to the community at large. The concept of cultural significance is intrinsically connected to the physical fabric of the item or place, its location, setting and relationship with other items in its surrounds. The assessment of cultural significance is ideally a holistic approach that draws upon the response these factors evoke from the community.

Archaeological sites require a different approach to significance assessment because the extent of the heritage resource and the degree to which it can contribute to our understanding of the past is not fully known at the outset. For example, it is the significance of the potential of the site to reveal information about the past that needs to be assessed when establishing the cultural significance of archaeological deposits.

Similarly, it is the significance of the type of information that can be revealed by the archaeological deposits, especially where the information is not available through any other source and the contribution it can make to our understanding of a place, which may also be of cultural heritage significance.

6.2 Basis for Assessment of Aboriginal Sites

The OEH Aboriginal Heritage Unit assessment criteria for archaeological significance have been developed to deal specifically with archaeological resources and covers the following potentials:

- A) **Research Potential.** This criterion is designed to qualify the significance of potential research which may be carried out at a site. Significance is apportioned according to the amount of new information which might be contained in the deposit, rather than the potential to yield a large number of artefacts. A site may have high significance under this criterion if it has an intact stratigraphic sequence and good integrity, the potential to provide a chronology extending into the past, or if it is connected to other sites within the region. Within this criterion are the subsets of representativeness and rarity. Representativeness is the ability of the site to demonstrate a representative type of site or deposit. This is important to maintain a contingency sample of all site types. Rarity is often described within the framework of representativeness as it relates to the distinctive features of a site which set it apart from similar sites.
- B) **Educational Potential.** This allows the educational value of a site to be considered as a component of significance. Under this criterion, an archaeologist may assess the potential of a site to educate the general public. The OEH has acknowledged that this criterion is open to misinterpretation by archaeologists who have the ability to convey the value of a site to other archaeologists. The OEH recommends that, in cases where significance is determined on educational potential, the onus is on the archaeologist go to the public for an assessment of this value.
- C) **Aesthetic Significance.** Aesthetic significance is not inherent in a place but arises from the response that people have to it. It is pertinent to remember that this response can vary dramatically between cultures and social groups; therefore, an assessment of significance based on aesthetic value should incorporate the views of different cultures.

For a full description of assessment procedures refer to the Aboriginal Cultural Heritage: Standards and Guidelines Kit (NPWS 1997). These criteria have been designed to deal specifically with the archaeological resource; however, they do not provide a framework for the assessment of social significance to the Aboriginal community. For this reason, the criteria for assessment provided in the Australia ICOMOS Charter for the Conservation of Places of Cultural Significance (the Burra Charter) are sometimes also used to assess significance as they provide a framework for a more holistic assessment of significance.

6.3 Preliminary Assessment of Aboriginal Sites

No Aboriginal archaeological sites have been previously recorded within the study area. The field survey undertaken identified one isolated find, a silcrete flake. Two aboriginal archaeological sites have been recorded 180 and 160 metres to the north-west and north-east of the study area, respectively (58-2-0275, 58-2-0283).

The area immediately surrounding the study area is generally characterised by sites of small amounts of surface artefact density. This is likely due to the area being used in a transient way by Aboriginal people in the past, who used the location of the study area to travel from the hinterland to the coastline.

Based on previous archaeological research, areas adjacent to creek lines with elevated flat terrain, as well as those with exposed bedrock, represent landforms which may contain Aboriginal archaeological sites. No areas in the study area contain these landforms.

Any remaining archaeological deposits present in the study area would likely represent a low-density background scatter of stone artefacts, evidence of people moving rather than of long-term occupation sites. Archaeological deposits of this nature would consist of isolated stone artefacts or small scatters. These sites would likely be low in scientific significance, and low in research potential, but may have some cultural value for Aboriginal people.

The historic de-vegetation of the study area and construction of dirt roads, as well as the proximity to Princes Highway, detract from the aesthetic character. As such, the area is considered to be of low aesthetic significance.

6.4 Aboriginal Stakeholder Comments

The Nowra LALC representative was Jesse Ferguson, who participated in survey on 20 May 2019. In the Island Point Road Aboriginal Stakeholder Report, Mr. Ferguson noted 'The area has been highly disturbed and the natural landscape is unrecognisable due to the highway...the area has been destroyed through continual building', further stating that the project was unlikely to affect any significant known or potential Aboriginal cultural heritage features as identified by the survey.

7 IMPACT ASSESSMENT AND MANAGEMENT RECOMMENDATIONS

7.1 The Proposed Work and Potential Impacts

The proposed works include creation of access tracks, and the storage and movement of road equipment within the study area (**Error! Reference source not found.**) In practical terms, this will include:

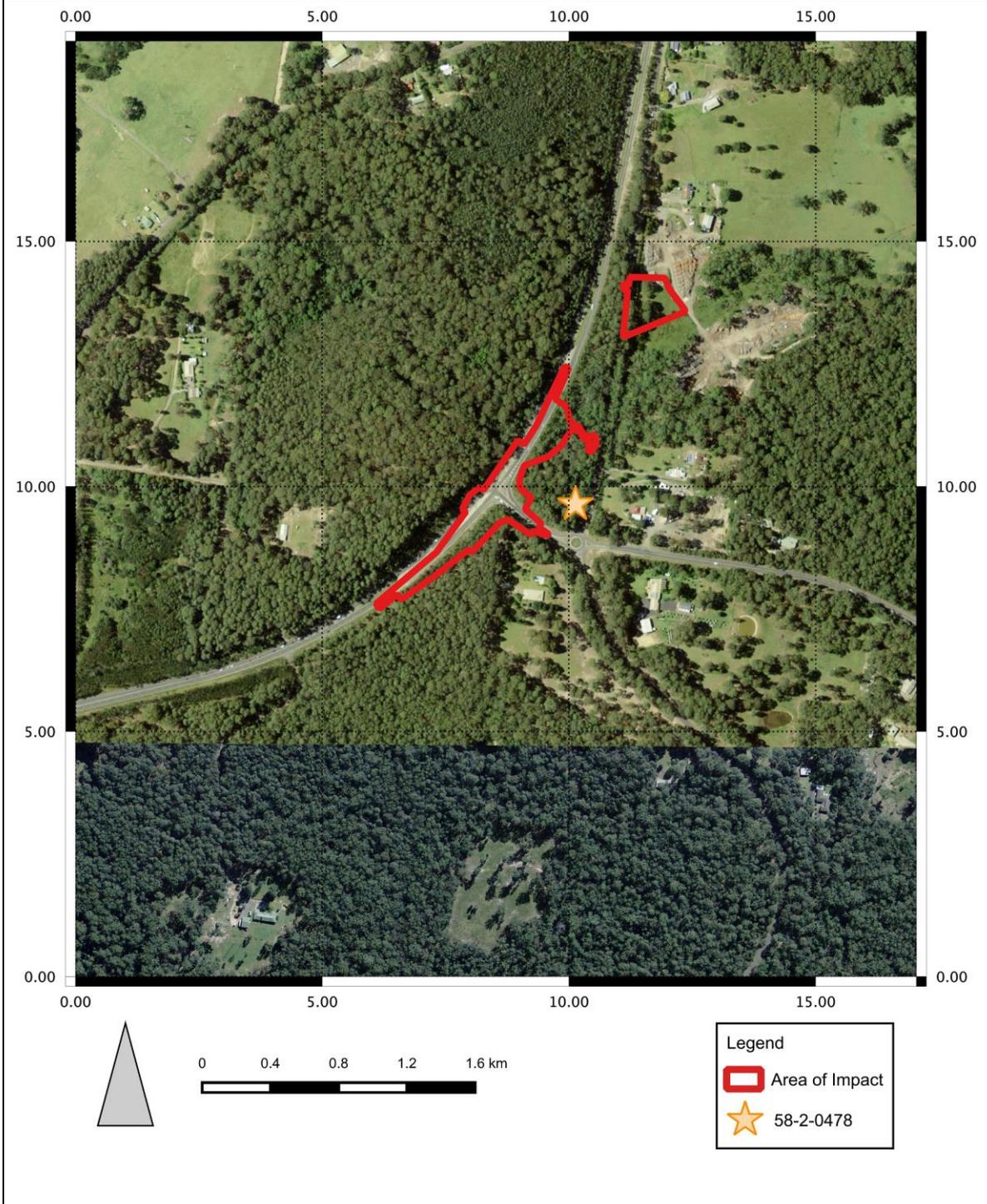
- Clearing of vegetation;
- Tree removal;
- Ground disturbance and movement of soil;
- The creation of internal access roads.

Potential impacts to the recorded site, which consists of one lithic flake, include the accidental disturbance, and movement of the flake.

As the lithic was found in a pile of spoil from a modern track, the context has already been compromised and therefore the only real risk to the site is potential destruction via large machinery, which may be used to remove vegetation or dirt.

If a small (10 metre diameter) buffer is applied to the site, it is highly unlikely the site would be disturbed in any way. The proposed impacts are not close to the identified site 58-2-0487.

Figure 6.1 Proposed area of impact within Study Area in relation to 58-2-0487



Project: 1936

Operator: Molly Quinn

Date: 26 July 2019

Source: NSW Spatial Services (DFS)



7.2 Conclusions

No Aboriginal archaeological sites have been previously recorded within the study area. The field survey undertaken identified one isolated find, a silcrete flake.

The location of the study area was likely used in a transient way by Aboriginal people. The location of water, namely streams and tributaries as well as the open ocean, largely defines where sites and Aboriginal archaeology is found, due to the abundance of resources. The study area contains no permanent water and is not elevated and flat, and as such lacks qualities which would have made it suitable for long term habitation. As the Shoalhaven region was once in use by Aboriginal people, it is likely that the study area would have been travelled on at some point by Aboriginal people while moving between resource-laden areas but not occupied, especially as ample resources and better, elevated camping locations existed nearby.

High ground surface visibility along the dirt track in the study area afforded good survey coverage of the disturbed soil, and no Aboriginal heritage sites were observed. Based on the lack of suitable landforms in the study area for archaeological sites, as well as historical and modern disturbance in the form of the embankment to the south and tracks in the north, it is considered that this landform has a low potential to contain Aboriginal heritage objects

7.3 Recommendations

The following recommendations have been developed based on results of the background research and field survey and consideration of the proposed development design and predicted impact of the proposed works on archaeological resources. The recommendations have been developed after considering the archaeological context, consultation with the local Aboriginal community, the proposed development design and the predicted impact of the proposed development on archaeological resources.

The following recommendations should be implemented as part of the project:

- [58-2-0478] is located outside of the area of construction impact. To ensure that impact to the site does not occur, a 10 metre exclusion zone must be established around the site during construction works.
- If there are any changes to the proposed project design then a re-analysis of Aboriginal heritage constraints should be undertaken by a qualified archaeological consultant;
- All contractors undertaking earthworks in the study area should be briefed on the protection of Aboriginal heritage objects under the NPW Act and the penalties for damage to these items;
- All contractors undertaking earthworks in the study area should undergo an induction on identifying Aboriginal heritage objects; and
- Any unexpected finds must be managed in accordance with the Roads and Maritime Services Unexpected Heritage Management Procedure (2015).

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APPENDICES

Appendix A: AHIMS Search Results

| SiteID | SiteName | Datum | Zone | Easting | Northing | Contact | Site Status | SiteFeatures | SiteTypes | Reports |
|-----------|--|-----------|----------------------------------|---------|----------|-----------|-------------|--------------|----------------|---------------|
| 58-2-0305 | Pelican Rd: Contact | ACD | 56 | 279000 | 6115000 | Open site | Valid | Artefact :- | Open Camp Site | 98621,103924 |
| 58-2-0306 | Fishermans Road Contact | Recorders | B Marshall | | | Open site | Valid | Artefact :- | Open Camp Site | 98621,103924 |
| 58-2-0307 | Nebraska Rd: Contact | ACD | 56 | 279150 | 6115300 | Open site | Valid | Artefact :- | Isolated Find | 98621,103924 |
| 58-2-0309 | St Georges Basin 1: Contact | Recorders | B Marshall | | | Open site | Valid | Artefact :- | Open Camp Site | 103716 |
| 58-2-0310 | St Georges Basin 2 Contact | ACD | 56 | 280030 | 6114420 | Open site | Valid | Artefact :- | Isolated Find | 103716 |
| 58-2-0311 | St Georges Basin 3: Contact | Recorders | Mr:Peter Kuskie,Mr:Edward Clarke | | | Open site | Valid | Artefact :- | Open Camp Site | 99567,103716 |
| 52-5-0293 | Wandandian Creek Site 2: Contact | ACD | 56 | 274820 | 6113220 | Open site | Valid | Artefact :- | Open Camp Site | 101716 |
| 52-5-0294 | Wandandian Creek Site 1: Contact | Recorders | Vivienne Wood | | | Open site | Valid | Artefact :- | Open Camp Site | 98350,101716 |
| 52-5-0297 | Suffolk Creek Site 1: Contact | ACD | 56 | 276580 | 6116540 | Open site | Valid | Artefact :- | Open Camp Site | 98143 |
| 58-2-0345 | Nebraska road,Nebraska Estate: Contact | Recorders | Robert Paton,Vivienne Wood | | | Open site | Valid | Artefact :- | Isolated Find | 98621,103924 |
| 58-2-0273 | TBP 2: Contact | ACD | 56 | 278700 | 6117350 | Open site | Valid | Artefact :- | Open Camp Site | |
| 58-2-0274 | TBP 3: Contact | Recorders | Rex Silcox | | | Open site | Valid | Artefact :- | Open Camp Site | |
| 58-2-0275 | GRI: Contact | ACD | 56 | 278580 | 6116670 | Open site | Valid | Artefact :- | Open Camp Site | 1641,1825,190 |
| 58-2-0277 | Tomerong 1: Contact | Recorders | Rex Silcox | | | Open site | Valid | Artefact :- | Open Camp Site | 1641,1825,190 |
| 58-2-0278 | Tomerong 3: Contact | ACD | 56 | 277270 | 6116730 | Open site | Valid | Artefact :- | Open Camp Site | 1641,1825,190 |
| 58-2-0279 | Tomerong 2: Contact | Recorders | Ms,Jillian Comber,Kerry Navin | | | Open site | Valid | Artefact :- | Open Camp Site | 1641,1825,190 |

Report generated by AHIMS Web Service on 27/05/2019 for Molly Quinn for the following area at Datum: GDA, Zone : 56, Eastings : 274729 - 282790, Northings : 6112885 - 6119424 with a Buffer of 0 meters. Additional Info : Background research for due diligence. Number of Aboriginal sites and Aboriginal objects found is 40
This information is not guaranteed to be free from error omission. Office of Environment and Heritage (NSW) and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.



AHIMS Web Services (AWS) Extensive search - Site list report

Your Ref/PO Number : 1
Client Service ID : 423250



AHIMS Web Services (AWS)
Extensive search - Site list report

Your Ref/PO Number : 1
Client Service ID : 423250

| SiteID | SiteName | Datum | Zone | Eastng | Northng | Context | Site Status | SiteFeatures | SiteTypes | Reports |
|-----------|---|-------|------|--------|---------|-----------|-------------|--|----------------------------|------------------------------|
| 58-2-0280 | Tomerong 4; Contact | AGD | 56 | 277350 | 6118220 | Open site | Valid | Grinding Groove :- | Ave Grinding Groove | 1825,103095 |
| 58-2-0281 | Tomerong 5; Contact | AGD | 56 | 277610 | 6117850 | Open site | Valid | Grinding Groove :- | Ave Grinding Groove | 1825,103095 |
| 58-2-0282 | Tomerong 6; Contact | AGD | 56 | 278350 | 6117870 | Open site | Valid | Artefact :- | Open Camp Site | 1825,103095 |
| 58-2-0283 | Tomerong 7; Contact | AGD | 56 | 278700 | 6116520 | Open site | Valid | Shell :- Artefact :- | Midden | 1825 |
| 58-2-0284 | Tomerong 8; Contact | AGD | 56 | 278870 | 6116730 | Open site | Valid | Shell :- Artefact :- | Midden | 1825 |
| 58-2-0285 | SGB1:St. Georges Basin; Contact | AGD | 56 | 279200 | 6115850 | Open site | Valid | Artefact :- | Open Camp Site | 2034,98350,99 |
| 58-2-0286 | SGB2:St. Georges Basin; Contact | AGD | 56 | 280500 | 6115400 | Open site | Valid | Artefact :- | Open Camp Site | 2034,98350,99 |
| 58-2-0364 | PG 19 Contact | AGD | 56 | 277950 | 6118650 | Open site | Valid | Artefact :- | Permits 595 | 98359,98360,9 9058,103095 |
| 58-2-0365 | PG 17 Contact | AGD | 56 | 278990 | 6118390 | Open site | Valid | Artefact : 1 | Permits | 98359,98360,9 9058,103095 |
| 58-2-0379 | Pipeline Site 2 Contact | AGD | 56 | 277200 | 6118100 | Open site | Valid | Artefact : 1 | Permits | 98143,103095 |
| 58-2-0344 | Pelican Road 1;Nebraska Estate; Contact | AGD | 56 | 279050 | 6114950 | Open site | Valid | Artefact :- | Open Camp Site | 98621,103924 |
| 58-2-0356 | Isolated Artefact 1 Contact | AGD | 56 | 275200 | 6113860 | Open site | Valid | Shell :- Artefact : 1, Grinding Groove :- | Ave Grinding Groove,Midden | |
| 58-2-0288 | Morgan Road PG 18; Contact | AGD | 56 | 278110 | 6118150 | Open site | Valid | Artefact :- | Open Camp Site | 1552,2200,990 58,103095 |
| 58-2-0417 | CSCA1 (Corramy SCA) Contact | AGD | 56 | 275811 | 6113281 | Open site | Valid | Artefact : 1 | Permits | |
| 58-2-0418 | CSCA2 (Corramy SCA) Contact | AGD | 56 | 275874 | 6113543 | Open site | Valid | Artefact : 1 | Permits | |

Report generated by AHIMS Web Service on 27/05/2019 for Molly Quinn for the following area at Datum:GDA, Zone : 56, Eastings : 274729 - 282790, Northings : 6112885 - 6119424 with a Buffer of 0 meters. Additional Info : Background research for due diligence. Number of Aboriginal sites and Aboriginal objects found is 40
This information is not guaranteed to be free from error omission. Office of Environment and Heritage (NSW) and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or omission.



AHIMS Web Services (AWS)
Extensive search - Site list report

Your Ref/PO Number : 1
Client Service ID : 423250

| SiteID | SiteName | Datum | Zone | Easting | Northing | Contact | Site Status | SiteFeatures | SiteTypes | Reports |
|-----------|---------------------------------|------------------|------|-----------------------------|----------|-----------|-------------|--------------------|---------------------|--------------|
| 58-2-0419 | CSCA3 (Corrany SCA) | ACD | 56 | 275841 | 611303 | Open site | Valid | Artefact : 6 | | |
| | Contact | Recorders | | Tom Knight,Doctor,Sue Feary | | | | | Permits | |
| 58-2-0420 | CSCA4 (Corrany SCA) | ACD | 56 | 276056 | 611303 | Open site | Valid | Artefact : 1 | | |
| | Contact | Recorders | | Tom Knight,Doctor,Sue Feary | | | | | Permits | |
| 58-2-0421 | CSCA5 (Corrany SCA) | ACD | 56 | 276185 | 6112836 | Open site | Valid | Artefact : 3 | | |
| | Contact | Recorders | | Tom Knight,Doctor,Sue Feary | | | | | Permits | |
| 58-2-0422 | CSCA6 (Corrany SCA) | ACD | 56 | 276189 | 6112748 | Open site | Valid | Artefact : 6 | | |
| | Contact | Recorders | | Tom Knight,Doctor,Sue Feary | | | | | Permits | |
| 58-2-0425 | CSCA9 (Corrany SCA) | ACD | 56 | 276372 | 6113416 | Open site | Valid | Artefact : 1 | | |
| | Contact | Recorders | | Tom Knight | | | | | Permits | |
| 58-2-0354 | Bewong 1 | ACD | 56 | 274840 | 6113640 | Open site | Valid | Artefact :- | Open Camp Site | |
| | Contact | Recorders | | Mr.Peter Kuskie | | | | | Permits | |
| 58-2-0355 | Bewong 2 | ACD | 56 | 275010 | 6113730 | Open site | Valid | Grinding Groove :- | Axe Grinding Groove | |
| | Contact | Recorders | | Mr.Peter Kuskie | | | | | Permits | |
| 58-2-0346 | Fishermans Road Melrosea Estate | ACD | 56 | 279180 | 6114680 | Open site | Valid | Artefact :- | Open Camp Site | 98621.103924 |
| | Contact | Recorders | | R Connoily,B Marshall | | | | | Permits | |
| 58-2-0407 | St Georges Basin 3 | ACD | 56 | 280100 | 6114380 | Open site | Deleted | Artefact :- | | |
| | Contact | Recorders | | Mr.Edward Carke | | | | | Permits | |

Appendix B: Nowra LALC Stakeholder Report

Appendix E

ISEPP Consultation



9 July 2019

SF2016/044350

Mr Scott Wells
Principal Transport Engineer
Shoalhaven City Council
PO Box 42
Nowra NSW 2541

Dear Mr Wells

Consultation regarding proposed HW1 Island Point Road Roundabout Installation

Thank you for your email responding to my request for comment on the proposed roundabout installation at the intersection of Princes Highway and Island Point Road, Tomerong. In regards to your comments:

- Landscaping in the roundabout: landscaping within the inner circle of the roundabout has now been included in the scope of works. The landscaping will comprise of densely planted native clumping grasses (Iomandra or similar) in the centre of the roundabout, with a ring of concrete around the perimeter to allow for parking of maintenance vehicles
- Geometry in relation to left turn into Island Point Road: the roundabout has been designed in accordance with Austroads Guide to Road Design Part 4b which promotes deceleration of vehicles on approach to the roundabout. As the intersection is on an arterial road, a design speed of 50 km/h has been applied at the roundabout. The left turn movement into Island Point Road has a radius 45 m with adverse crossfall, and as such, an appropriate speed to perform the turn would be in the range of 30-35 km/h. Additionally, sight lines have been checked in accordance with the relevant guide and any queuing at the smaller roundabout east of HW1 should be visible to approaching southbound drivers
- Cyclist travelling north on Princes Highway: northbound cyclists should not be travelling through the roundabout as there is a continuing shoulder (existing condition). A staged crossing has been provided on the southern side of the intersection to allow northbound cyclists to access Island Point Road, and for those coming out of Island Point Road wishing to travel north on the highway.
- Signposting: a roundabout 'symbolic' sign is not necessary on the northbound approach as there is a separate northbound through lane, however a "Roundabout Ahead" sign (W2-7) has been specified in the central median. The signposting plan has been updated to reflect this

Roads and Maritime Services

- Footpath width behind kerb ramps: it is undesirable to reduce the length of the paths as they are integral in encouraging speed reduction on approach to the intersection. The design has been updated to provide a minimum of 1.2m of footpath width behind the kerb ramps through localised widening
- Speed zones: the current posted speeds are 80km/h in the southbound direction and 100km/h in the northbound direction, which will be reduced to 80km/h in both directions due to the roundabout construction
- Headlight screening of northbound vehicles on Princes Highway: delineation of northbound traffic will be improved by increased separation provided by the concrete medians. Vehicles turning right out of Island Point Road will only need to give way to southbound vehicles, as such, the risk of confusion caused by the headlights of northbound vehicles is considered to be negligible and that screening is not required

As previously discussed, Roads and Maritime are currently undertaking an environmental assessment, aiming for public display in mid-September 2019. Please be in touch should you have any further comments on the proposal.

Yours faithfully

Ben Beattie
Project/Contract Manager

Appendix F

Noise and Vibration Estimator Assessment

Distanced Based Assessment (Noisiest Plant)

Steps for Assessment:

- Schedule noisy works to occur in standard hours where possible or before 11pm and implement Standard Measures.
- Select the representative noise area category. The worksheet titled 'Representative Noise Environ.' provides a number of examples to help select the noise area category.
- Select the noisiest plant. If not found in drop-down list, refer to 'Source List' and select a representative plant with equivalent sound power level.
- Is there line of sight to receiver? Select the appropriate scenario from the drop down list.
Identify and implement standard mitigation measures where feasible and reasonable. Include any shielding implemented as part of the standard mitigation measures by changing the selection in the 'Is there line of sight to receiver' drop-down list. Solid barriers can be in the form of road cutting, timber lapped and capped fence, shipping container, site office, etc. Substantial solid barriers are barriers greater than 5 metres in height or multiple rows of houses or a sound barrier specifically designed to mitigate construction noise. Please note that vegetation and trees are not considered to be a form of solid barrier and any gaps would compromise the acoustic integrity of the solid barrier.
- Determine if there are any receivers (both residential and non-residential receivers) within the affected distance for each relevant time period. Consider background LA90 noise measurements to check assumption in Step #2 if:
 - there are many affected receivers and the impact duration at any one receiver is more than 3 weeks; or
 - there are a few affected receivers and the impact duration at any one receiver is more than 6 weeks.
 Note that consideration need to be given to the construction staging plan when determining impact duration.
- Identify if there are any receivers within the additional mitigation measures distances and identify feasible and reasonable measures at each receiver.
- Where night works are involved, identify sleep disturbance affected distance.
- Document the outcomes of these steps.

(Note that suitable noise management levels for other noise-sensitive businesses not identified in the Construction Noise Estimator should be investigated on a project-by-project basis. Please contact a Roads and Maritime noise specialist for more information)

| Abbreviation | Measure |
|--------------|---------------------------|
| N | Notification |
| SN | Specific notifications |
| PC | Phone calls |
| IB | Individual briefings |
| RO | Respite offer |
| R1 | Respite period 1 |
| R2 | Respite period 2 |
| DR | Duration respite |
| AA | Alternative accommodation |
| V | Verification |

Note that spot check verification of noise levels and individual briefings are not required for projects with less than 3 weeks impact duration

Please pick from drop-down list in orange cells

| Noise area category | | R2 |
|--|------------|---------------------------|
| RBL or LA90 Background level (dB(A)) | Day | 45 |
| | Evening | 40 |
| | Night | 35 |
| LAeq(15minute) Noise Mangement Level (dB(A)) | Day | 55 |
| | Day (OOHW) | 50 |
| | Evening | 45 |
| | Night | 40 |
| Noisiest plant | | Chainsaw |
| Is there line of sight to receiver? | | No (behind solid barrier) |

Stage 1 - veg clearing
Dayworks
Distance to nearest house = 130m

| Residential receiver | | LAeq(15minute) noise level above background (LA90) | | | | | | | | | | | LAeq(15minute) 75 dB(A) or greater (Highly affected) | | | Sleep disturbance L _{max} 65 dB(A) | | |
|---|-----------------|--|------------|-----|-----------------|-----------|----------------------|----------------|-------------------|------------------|------------|-----------------------|--|---------------------|--------------------------|--|----|----|
| | | 5 to 10 dB(A) | | | 10 to 20 dB(A) | | | 20 to 30 dB(A) | | | > 30 dB(A) | | | | | | | |
| | | Affected distance (m) | Noticeable | | Clearly audible | | Moderately intrusive | | | Highly intrusive | | | Measures | Within distance (m) | Mitigation level (dB(A)) | Affected distance (m) | | |
| Undeveloped green fields, rural areas with isolated dwellings | Day | | 120 | | | | | | | | | | | | | | | |
| | Day (OOHW) | 175 | | | | | | | | | | | | | | | | |
| | Evening | 250 | | | | | | | | | | | | | | | | |
| | Night | 365 | N | 365 | 40 | N, R2, DR | 250 | 45 | N, PC, SN, R2, DR | 120 | 55 | AA, N, PC, SN, R2, DR | 45 | 65 | N, PC, RO | 20 | 75 | 75 |
| | Highly Affected | 20 | | | | | | | | | | | | | | | | |
| Developed settlements (urban and suburban) | Day | 135 | | | | | | | | | | | | | | | | |
| | Day (OOHW) | 200 | | | | | | | | | | | | | | | | |
| | Evening | 305 | | | | | | | | | | | | | | | | |
| | Night | 460 | N | 460 | 40 | N, R2, DR | 305 | 45 | N, PC, SN, R2, DR | 135 | 55 | AA, N, PC, SN, R2, DR | 50 | 65 | N, PC, RO | 20 | 75 | 85 |
| | Highly Affected | 20 | | | | | | | | | | | | | | | | |
| Propagation across a valley / over water | Day | 160 | | | | | | | | | | | | | | | | |
| | Day (OOHW) | 255 | | | | | | | | | | | | | | | | |
| | Evening | 405 | | | | | | | | | | | | | | | | |
| | Night | 630 | N | 630 | 40 | N, R2, DR | 405 | 45 | N, PC, SN, R2, DR | 160 | 55 | AA, N, PC, SN, R2, DR | 60 | 65 | N, PC, RO | 20 | 75 | 95 |
| | Highly Affected | 20 | | | | | | | | | | | | | | | | |

| Non-residential receiver | | LAeq(15minute) noise level above NML | | | | | | | | | | |
|---|--------|--------------------------------------|-----------------------|---------|---------------------|--------------------------|---------|---------------------|--------------------------|-----------|--|--------------------------|
| | | Standard hours | | | <10 dB(A) | | | 10 to 20 dB(A) | | | LAeq(15minute) 75 dB(A) or greater (Highly affected) | |
| Undeveloped green fields, rural areas with isolated dwellings | Period | NML | Affected distance (m) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) |
| | | | | | | | | | | | | |
| Hospital wards and operating theatres | Day | 65 | 45 | | | | | | | N, PC, RO | 20 | 75 |
| Place of worship | Day | 55 | 120 | | | | N | 45 | 65 | N, PC, RO | 20 | 75 |
| Active recreation | Day | 65 | 45 | | | | | | | N, PC, RO | 20 | 75 |
| Passive recreation | Day | 60 | 75 | | | | N | 25 | 70 | N, PC, RO | 20 | 75 |
| Industrial premise | Day | 75 | 20 | | | | | | | N, PC, RO | 20 | 75 |
| Offices, retail outlets | Day | 70 | 25 | | | | | | | N, PC, RO | 20 | 75 |

| Non-residential receiver | | LAeq(15minute) noise level above NML | | | | | | | | | | | | | |
|--|---------|--------------------------------------|-----------------------|---------|---------------------|--------------------------|-----------|---------------------|--------------------------|-------------------|---------------------|--------------------------|-----------------------|---------------------|--------------------------|
| | | OOHW | | | < 5 dB(A) | | | 5 to 15 dB(A) | | | 15 to 25 dB(A) | | > 25 dB(A) | | |
| Developed settlements (urban and suburban) | Period | NML | Affected distance (m) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) |
| | | | | | | | | | | | | | | | |
| | Night | 65 | 45 | N | 45 | 65 | N, R2, NR | 25 | 70 | N, PC, SN, R2, DR | 11 | 80 | AA, N, PC, SN, R2, DR | 4 | 90 |
| Place of worship | Evening | 55 | 120 | | | | N, R1, DR | 75 | 60 | N, R1, DR | 25 | 70 | N, R1, DR, PC, SN | 11 | 80 |
| | Night | 55 | 120 | N | 120 | 55 | N, R2, NR | 75 | 60 | N, PC, SN, R2, DR | 25 | 70 | AA, N, PC, SN, R2, DR | 11 | 80 |
| Active recreation | Evening | 65 | 45 | | | | N, R1, DR | 25 | 70 | N, R1, DR | 11 | 80 | N, R1, DR, PC, SN | 4 | 90 |
| Passive recreation | Evening | 60 | 75 | | | | N, R1, DR | 45 | 65 | N, R1, DR | 20 | 75 | N, R1, DR, PC, SN | 6 | 85 |
| | Evening | 75 | 20 | | | | N, R1, DR | 11 | 80 | N, R1, DR | 4 | 90 | N, R1, DR, PC, SN | 1 | 100 |
| Industrial premise | Night | 75 | 20 | N | 20 | 75 | N, R2, NR | 11 | 80 | N, PC, SN, R2, DR | 4 | 90 | AA, N, PC, SN, R2, DR | 1 | 100 |
| | Evening | 70 | 25 | | | | N, R1, DR | 20 | 75 | N, R1, DR | 6 | 85 | N, R1, DR, PC, SN | 2 | 95 |
| Offices, retail outlets | Night | 70 | 25 | N | 25 | 70 | N, R2, NR | 20 | 75 | N, PC, SN, R2, DR | 6 | 85 | AA, N, PC, SN, R2, DR | 2 | 95 |

| Non-residential receiver | | LAeq(15minute) noise level above NML | | | | | | | | | | |
|--|--------|--------------------------------------|-----------------------|---------|---------------------|--------------------------|---------|---------------------|--------------------------|-----------|--|--------------------------|
| | | Standard hours | | | <10 dB(A) | | | 10 to 20 dB(A) | | | LAeq(15minute) 75 dB(A) or greater (Highly affected) | |
| Developed settlements (urban and suburban) | Period | NML | Affected distance (m) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) |
| | | | | | | | | | | | | |
| Hospital wards and operating theatres | Day | 65 | 50 | | | | | | | N, PC, RO | 20 | 75 |
| Place of worship | Day | 55 | 135 | | | | N | 50 | 65 | N, PC, RO | 20 | 75 |
| Active recreation | Day | 65 | 50 | | | | | | | N, PC, RO | 20 | 75 |
| Passive recreation | Day | 60 | 85 | | | | N | 30 | 70 | N, PC, RO | 20 | 75 |

| | | | | | | | | |
|-------------------------|-----|----|----|--|--|-----------|----|----|
| Industrial premise | Day | 75 | 40 | | | N, PC, RO | 40 | 75 |
| Offices, retail outlets | Day | 70 | 70 | | | N, PC, RO | 40 | 75 |

| | OOHW | | LAeq(15minute) noise level above NML | | | | | | | | | | | | |
|---------------------------------------|---------|-----|--------------------------------------|-----------|---------------------|--------------------------|---------------|---------------------|--------------------------|-------------------|---------------------|--------------------------|-----------------------|---------------------|--------------------------|
| | Period | NML | Affected distance (m) | < 5 dB(A) | | | 5 to 15 dB(A) | | | 15 to 25 dB(A) | | | > 25 dB(A) | | |
| | | | | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) |
| Hospital wards and operating theatres | Evening | 65 | 110 | | | | N, R1, DR | 70 | 70 | N, R1, DR | 22 | 80 | N, R1, DR, PC, SN | 7 | 90 |
| | Night | 65 | 110 | N | 110 | 65 | N, R2, NR | 70 | 70 | N, PC, SN, R2, DR | 22 | 80 | AA, N, PC, SN, R2, DR | 7 | 90 |
| Place of worship | Evening | 55 | 260 | | | | N, R1, DR | 170 | 60 | N, R1, DR | 70 | 70 | N, R1, DR, PC, SN | 22 | 80 |
| | Night | 55 | 260 | N | 260 | 55 | N, R2, NR | 170 | 60 | N, PC, SN, R2, DR | 70 | 70 | AA, N, PC, SN, R2, DR | 22 | 80 |
| Active recreation | Evening | 65 | 110 | | | | N, R1, DR | 70 | 70 | N, R1, DR | 22 | 80 | N, R1, DR, PC, SN | 7 | 90 |
| Passive recreation | Evening | 60 | 170 | | | | N, R1, DR | 110 | 65 | N, R1, DR | 40 | 75 | N, R1, DR, PC, SN | 13 | 85 |
| Industrial premise | Evening | 75 | 40 | | | | N, R1, DR | 22 | 80 | N, R1, DR | 7 | 90 | N, R1, DR, PC, SN | 2 | 100 |
| | Night | 75 | 40 | N | 40 | 75 | N, R2, NR | 22 | 80 | N, PC, SN, R2, DR | 7 | 90 | AA, N, PC, SN, R2, DR | 2 | 100 |
| Offices, retail outlets | Evening | 70 | 70 | | | | N, R1, DR | 40 | 75 | N, R1, DR | 13 | 85 | N, R1, DR, PC, SN | 4 | 95 |
| | Night | 70 | 70 | N | 70 | 70 | N, R2, NR | 40 | 75 | N, PC, SN, R2, DR | 13 | 85 | AA, N, PC, SN, R2, DR | 4 | 95 |

| Non-residential receiver Propagation across a valley / over water | | Standard hours | | LAeq(15minute) noise level above NML | | | | | | | | |
|--|-----|-----------------------|-----------|--------------------------------------|--------------------------|----------------|---------------------|--------------------------|--|---------------------|--------------------------|----|
| Period | NML | Affected distance (m) | <10 dB(A) | | | 10 to 20 dB(A) | | | LAeq(15minute) 75 dB(A) or greater (Highly affected) | | | |
| | | | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | |
| Classroom at schools and other educational institutions | Day | 55 | 340 | | | | N | 130 | 65 | N, PC, RO | 45 | 75 |
| Hospital wards and operating theatres | Day | 65 | 130 | | | | | | | N, PC, RO | 45 | 75 |
| Place of worship | Day | 55 | 340 | | | | N | 130 | 65 | N, PC, RO | 45 | 75 |
| Active recreation | Day | 65 | 130 | | | | | | | N, PC, RO | 45 | 75 |
| Passive recreation | Day | 60 | 210 | | | | | | | N, PC, RO | 45 | 75 |
| Industrial premise | Day | 75 | 45 | | | | N | 80 | 70 | N, PC, RO | 45 | 75 |
| Offices, retail outlets | Day | 70 | 80 | | | | | | | N, PC, RO | 45 | 75 |

| | OOHW | | LAeq(15minute) noise level above NML | | | | | | | | | | | | |
|---------------------------------------|---------|-----|--------------------------------------|-----------|---------------------|--------------------------|---------------|---------------------|--------------------------|-------------------|---------------------|--------------------------|-----------------------|---------------------|--------------------------|
| | Period | NML | Affected distance (m) | < 5 dB(A) | | | 5 to 15 dB(A) | | | 15 to 25 dB(A) | | | > 25 dB(A) | | |
| | | | | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) |
| Hospital wards and operating theatres | Evening | 65 | 130 | | | | N, R1, DR | 80 | 70 | N, R1, DR | 30 | 80 | N, R1, DR, PC, SN | 7 | 90 |
| | Night | 65 | 130 | N | 130 | 65 | N, R2, NR | 80 | 70 | N, PC, SN, R2, DR | 30 | 80 | AA, N, PC, SN, R2, DR | 7 | 90 |
| Place of worship | Evening | 55 | 340 | | | | N, R1, DR | 210 | 60 | N, R1, DR | 80 | 70 | N, R1, DR, PC, SN | 30 | 80 |
| | Night | 55 | 340 | N | 340 | 55 | N, R2, NR | 210 | 60 | N, PC, SN, R2, DR | 80 | 70 | AA, N, PC, SN, R2, DR | 30 | 80 |
| Active recreation | Evening | 65 | 130 | | | | N, R1, DR | 80 | 70 | N, R1, DR | 30 | 80 | N, R1, DR, PC, SN | 7 | 90 |
| Passive recreation | Evening | 60 | 210 | | | | N, R1, DR | 130 | 65 | N, R1, DR | 45 | 75 | N, R1, DR, PC, SN | 15 | 85 |
| Industrial premise | Evening | 75 | 45 | | | | N, R1, DR | 30 | 80 | N, R1, DR | 7 | 90 | N, R1, DR, PC, SN | 2 | 100 |
| | Night | 75 | 45 | N | 45 | 75 | N, R2, NR | 30 | 80 | N, PC, SN, R2, DR | 7 | 90 | AA, N, PC, SN, R2, DR | 2 | 100 |
| Offices, retail outlets | Evening | 70 | 80 | | | | N, R1, DR | 45 | 75 | N, R1, DR | 15 | 85 | N, R1, DR, PC, SN | 4 | 95 |
| | Night | 70 | 80 | N | 80 | 70 | N, R2, NR | 45 | 75 | N, PC, SN, R2, DR | 15 | 85 | AA, N, PC, SN, R2, DR | 4 | 95 |

| | | | | | | | | |
|-------------------------|-----|----|----|--|--|-----------|----|----|
| Industrial premise | Day | 75 | 40 | | | N, PC, RO | 40 | 75 |
| Offices, retail outlets | Day | 70 | 70 | | | N, PC, RO | 40 | 75 |

| | OOHW | | L _{Aeq(15minute)} noise level above NML | | | | | | | | | | | | |
|---------------------------------------|---------|-----|--|-----------|---------------------|--------------------------|---------------|---------------------|--------------------------|-------------------|---------------------|--------------------------|-----------------------|---------------------|--------------------------|
| | Period | NML | Affected distance (m) | < 5 dB(A) | | | 5 to 15 dB(A) | | | 15 to 25 dB(A) | | | > 25 dB(A) | | |
| | | | | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) |
| Hospital wards and operating theatres | Evening | 65 | 110 | | | | N, R1, DR | 70 | 70 | N, R1, DR | 22 | 80 | N, R1, DR, PC, SN | 7 | 90 |
| | Night | 65 | 110 | N | 110 | 65 | N, R2, NR | 70 | 70 | N, PC, SN, R2, DR | 22 | 80 | AA, N, PC, SN, R2, DR | 7 | 90 |
| Place of worship | Evening | 55 | 260 | | | | N, R1, DR | 170 | 60 | N, R1, DR | 70 | 70 | N, R1, DR, PC, SN | 22 | 80 |
| | Night | 55 | 260 | N | 260 | 55 | N, R2, NR | 170 | 60 | N, PC, SN, R2, DR | 70 | 70 | AA, N, PC, SN, R2, DR | 22 | 80 |
| Active recreation | Evening | 65 | 110 | | | | N, R1, DR | 70 | 70 | N, R1, DR | 22 | 80 | N, R1, DR, PC, SN | 7 | 90 |
| Passive recreation | Evening | 60 | 170 | | | | N, R1, DR | 110 | 65 | N, R1, DR | 40 | 75 | N, R1, DR, PC, SN | 13 | 85 |
| Industrial premise | Evening | 75 | 40 | | | | N, R1, DR | 22 | 80 | N, R1, DR | 7 | 90 | N, R1, DR, PC, SN | 2 | 100 |
| | Night | 75 | 40 | N | 40 | 75 | N, R2, NR | 22 | 80 | N, PC, SN, R2, DR | 7 | 90 | AA, N, PC, SN, R2, DR | 2 | 100 |
| Offices, retail outlets | Evening | 70 | 70 | | | | N, R1, DR | 40 | 75 | N, R1, DR | 13 | 85 | N, R1, DR, PC, SN | 4 | 95 |
| | Night | 70 | 70 | N | 70 | 70 | N, R2, NR | 40 | 75 | N, PC, SN, R2, DR | 13 | 85 | AA, N, PC, SN, R2, DR | 4 | 95 |

| Non-residential receiver Propagation across a valley / over water | | Standard hours | | L _{Aeq(15minute)} noise level above NML | | | | | | | | |
|--|-----|-----------------------|-----------|--|--------------------------|----------------|---------------------|--------------------------|--|---------------------|--------------------------|----|
| Period | NML | Affected distance (m) | <10 dB(A) | | | 10 to 20 dB(A) | | | L _{Aeq(15minute)} 75 dB(A) or greater (Highly affected) | | | |
| | | | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | |
| Classroom at schools and other educational institutions | Day | 55 | 340 | | | | N | 130 | 65 | N, PC, RO | 45 | 75 |
| Hospital wards and operating theatres | Day | 65 | 130 | | | | | | | N, PC, RO | 45 | 75 |
| Place of worship | Day | 55 | 340 | | | | N | 130 | 65 | N, PC, RO | 45 | 75 |
| Active recreation | Day | 65 | 130 | | | | | | | N, PC, RO | 45 | 75 |
| Passive recreation | Day | 60 | 210 | | | | | | | N, PC, RO | 45 | 75 |
| Industrial premise | Day | 75 | 45 | | | | N | 80 | 70 | N, PC, RO | 45 | 75 |
| Offices, retail outlets | Day | 70 | 80 | | | | | | | N, PC, RO | 45 | 75 |

| | OOHW | | L _{Aeq(15minute)} noise level above NML | | | | | | | | | | | | |
|---------------------------------------|---------|-----|--|-----------|---------------------|--------------------------|---------------|---------------------|--------------------------|-------------------|---------------------|--------------------------|-----------------------|---------------------|--------------------------|
| | Period | NML | Affected distance (m) | < 5 dB(A) | | | 5 to 15 dB(A) | | | 15 to 25 dB(A) | | | > 25 dB(A) | | |
| | | | | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) |
| Hospital wards and operating theatres | Evening | 65 | 130 | | | | N, R1, DR | 80 | 70 | N, R1, DR | 30 | 80 | N, R1, DR, PC, SN | 7 | 90 |
| | Night | 65 | 130 | N | 130 | 65 | N, R2, NR | 80 | 70 | N, PC, SN, R2, DR | 30 | 80 | AA, N, PC, SN, R2, DR | 7 | 90 |
| Place of worship | Evening | 55 | 340 | | | | N, R1, DR | 210 | 60 | N, R1, DR | 80 | 70 | N, R1, DR, PC, SN | 30 | 80 |
| | Night | 55 | 340 | N | 340 | 55 | N, R2, NR | 210 | 60 | N, PC, SN, R2, DR | 80 | 70 | AA, N, PC, SN, R2, DR | 30 | 80 |
| Active recreation | Evening | 65 | 130 | | | | N, R1, DR | 80 | 70 | N, R1, DR | 30 | 80 | N, R1, DR, PC, SN | 7 | 90 |
| Passive recreation | Evening | 60 | 210 | | | | N, R1, DR | 130 | 65 | N, R1, DR | 45 | 75 | N, R1, DR, PC, SN | 15 | 85 |
| Industrial premise | Evening | 75 | 45 | | | | N, R1, DR | 30 | 80 | N, R1, DR | 7 | 90 | N, R1, DR, PC, SN | 2 | 100 |
| | Night | 75 | 45 | N | 45 | 75 | N, R2, NR | 30 | 80 | N, PC, SN, R2, DR | 7 | 90 | AA, N, PC, SN, R2, DR | 2 | 100 |
| Offices, retail outlets | Evening | 70 | 80 | | | | N, R1, DR | 45 | 75 | N, R1, DR | 15 | 85 | N, R1, DR, PC, SN | 4 | 95 |
| | Night | 70 | 80 | N | 80 | 70 | N, R2, NR | 45 | 75 | N, PC, SN, R2, DR | 15 | 85 | AA, N, PC, SN, R2, DR | 4 | 95 |

Distanced Based Assessment (Noisiest Plant)

Steps for Assessment:

- Schedule noisy works to occur in standard hours where possible or before 11pm and implement Standard Measures.
- Select the representative noise area category. The worksheet titled 'Representative Noise Environ.' provides a number of examples to help select the noise area category.
- Select the noisiest plant. If not found in drop-down list, refer to 'Source List' and select a representative plant with equivalent sound power level.
- Is there line of sight to receiver? Select the appropriate scenario from the drop down list. Identify and implement standard mitigation measures where feasible and reasonable. Include any shielding implemented as part of the standard mitigation measures by changing the selection in the 'Is there line of sight to receiver' drop-down list. Solid barriers can be in the form of road cutting, timber lapped and capped fence, shipping container, site office, etc. Substantial solid barriers are barriers greater than 5 metres in height or multiple rows of houses or a sound barrier specifically designed to mitigate construction noise. Please note that vegetation and trees are not considered to be a form of solid barrier and any gaps would compromise the acoustic integrity of the solid barrier.
- Determine if there are any receivers (both residential and non-residential receivers) within the affected distance for each relevant time period. Consider background LA90 noise measurements to check assumption in Step #2 if:
 - there are many affected receivers and the impact duration at any one receiver is more than 3 weeks; or
 - there are a few affected receivers and the impact duration at any one receiver is more than 6 weeks.
 Note that consideration need to be given to the construction staging plan when determining impact duration.
- Identify if there are any receivers within the additional mitigation measures distances and identify feasible and reasonable measures at each receiver.
- Where night works are involved, identify sleep disturbance affected distance.
- Document the outcomes of these steps.

(Note that suitable noise management levels for other noise-sensitive businesses not identified in the Construction Noise Estimator should be investigated on a project-by-project basis. Please contact a Roads and Maritime noise specialist for more information)

| Abbreviation | Measure |
|--------------|---------------------------|
| N | Notification |
| SN | Specific notifications |
| PC | Phone calls |
| IB | Individual briefings |
| RO | Respite offer |
| R1 | Respite period 1 |
| R2 | Respite period 2 |
| DR | Duration respite |
| AA | Alternative accommodation |
| V | Verification |

Note that spot check verification of noise levels and individual briefings are not required for projects with less than 3 weeks impact duration

Please pick from drop-down list in orange cells

| Noise area category | | R2 |
|--|------------|---------------------------|
| RBL or LA90 Background level (dB(A)) | Day | 45 |
| | Evening | 40 |
| | Night | 35 |
| LAeq(15minute) Noise Mangement Level (dB(A)) | Day | 55 |
| | Day (OOHW) | 50 |
| | Evening | 45 |
| | Night | 40 |
| Noisiest plant | | Asphalt Profiler |
| Is there line of sight to receiver? | | No (behind solid barrier) |

Stage 3 - median pavement
Nightworks
Distance to nearest house = 130m

| Residential receiver | | LAeq(15minute) noise level above background (LA90) | | | | | | | | | | | LAeq(15minute) 75 dB(A) or greater (Highly affected) | | | Sleep disturbance L _{max} 65 dB(A) | | |
|---|-----------------|--|---------------------|--------------------------|-----------------|---------------------|--------------------------|----------------------|---------------------|--------------------------|-------------------|-----------------------|--|-----------|---------------------|--|-----------------------|----|
| | | 5 to 10 dB(A) | | | 10 to 20 dB(A) | | | 20 to 30 dB(A) | | | > 30 dB(A) | | | Measures | Within distance (m) | Mitigation level (dB(A)) | Affected distance (m) | |
| | | Noticeable | | | Clearly audible | | | Moderately intrusive | | | Highly intrusive | | | | | | | |
| Affected distance (m) | | Measures | Within distance (m) | Mitigation level (dB(A)) | Measures | Within distance (m) | Mitigation level (dB(A)) | Measures | Within distance (m) | Mitigation level (dB(A)) | Measures | Within distance (m) | Mitigation level (dB(A)) | Measures | Within distance (m) | Mitigation level (dB(A)) | Affected distance (m) | |
| Undeveloped green fields, rural areas with isolated dwellings | Day | 140 | | | | | | N | 55 | 65 | N, PC, RO | 25 | 75 | N, PC, RO | 25 | 75 | 110 | |
| | Day (OOHW) | 200 | | | | | | N, R1, DR | 140 | 55 | N, R1, DR, PC, SN | 25 | 75 | N, PC, RO | 25 | 75 | | |
| | Evening | 290 | | | | | | N, R1, DR | 200 | 50 | N, R1, DR, PC, SN | 30 | 70 | N, PC, RO | 25 | 75 | | |
| | Night | 420 | N | 420 | 40 | N, R2, DR | 290 | 45 | N, PC, SN, R2, DR | 140 | 55 | AA, N, PC, SN, R2, DR | 55 | 65 | N, PC, RO | 25 | | 75 |
| | Highly Affected | 25 | | | | | | | | | | | | N, PC, RO | 25 | 75 | | |
| Developed settlements (urban and suburban) | Day | 155 | | | | | | N | 60 | 65 | N, PC, RO | 25 | 75 | N, PC, RO | 25 | 75 | 120 | |
| | Day (OOHW) | 240 | | | | | | N, R1, DR | 155 | 55 | N, R1, DR, PC, SN | 25 | 75 | N, PC, RO | 25 | 75 | | |
| | Evening | 360 | | | | | | N, R1, DR | 240 | 50 | N, R1, DR, PC, SN | 35 | 70 | N, PC, RO | 25 | 75 | | |
| | Night | 545 | N | 545 | 40 | N, R2, DR | 360 | 45 | N, PC, SN, R2, DR | 155 | 55 | AA, N, PC, SN, R2, DR | 60 | 65 | N, PC, RO | 25 | | 75 |
| | Highly Affected | 25 | | | | | | | | | | | | N, PC, RO | 25 | 75 | | |
| Propagation across a valley / over water | Day | 190 | | | | | | N | 70 | 65 | N, PC, RO | 25 | 75 | N, PC, RO | 25 | 75 | 145 | |
| | Day (OOHW) | 310 | | | | | | N, R1, DR | 190 | 55 | N, R1, DR, PC, SN | 25 | 75 | N, PC, RO | 25 | 75 | | |
| | Evening | 485 | | | | | | N, R1, DR | 310 | 50 | N, R1, DR, PC, SN | 45 | 70 | N, PC, RO | 25 | 75 | | |
| | Night | 750 | N | 750 | 40 | N, R2, DR | 485 | 45 | N, PC, SN, R2, DR | 190 | 55 | AA, N, PC, SN, R2, DR | 70 | 65 | N, PC, RO | 25 | | 75 |
| | Highly Affected | 25 | | | | | | | | | | | | N, PC, RO | 25 | 75 | | |

| Non-residential receiver | | LAeq(15minute) noise level above NML | | | | | | | | | | | |
|---|--|--------------------------------------|-----|-----------------------|-----------|---------------------|--------------------------|----------------|---------------------|--------------------------|--|---------------------|--------------------------|
| | | Standard hours | | | <10 dB(A) | | | 10 to 20 dB(A) | | | LAeq(15minute) 75 dB(A) or greater (Highly affected) | | |
| Undeveloped green fields, rural areas with isolated dwellings | | Period | NML | Affected distance (m) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) |
| Classroom at schools and other educational institutions | | Day | 55 | 140 | | | | N | 55 | 65 | N, PC, RO | 25 | 75 |
| Hospital wards and operating theatres | | Day | 65 | 55 | | | | | | | N, PC, RO | 25 | 75 |
| Place of worship | | Day | 55 | 140 | | | | N | 55 | 65 | N, PC, RO | 25 | 75 |
| Active recreation | | Day | 65 | 55 | | | | | | | N, PC, RO | 25 | 75 |
| Passive recreation | | Day | 60 | 95 | | | | N | 30 | 70 | N, PC, RO | 25 | 75 |
| Industrial premise | | Day | 75 | 25 | | | | | | | N, PC, RO | 25 | 75 |
| Offices, retail outlets | | Day | 70 | 30 | | | | | | | N, PC, RO | 25 | 75 |

| Non-residential receiver | | LAeq(15minute) noise level above NML | | | | | | | | | | | | | | |
|--|--|--------------------------------------|-----|-----------------------|-----------|---------------------|--------------------------|---------------|---------------------|--------------------------|-------------------|---------------------|--------------------------|-----------------------|---------------------|--------------------------|
| | | OOHW | | | < 5 dB(A) | | | 5 to 15 dB(A) | | | 15 to 25 dB(A) | | | > 25 dB(A) | | |
| Developed settlements (urban and suburban) | | Period | NML | Affected distance (m) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) |
| Hospital wards and operating theatres | | Evening | 65 | 55 | | | | N, R1, DR | 30 | 70 | N, R1, DR | 14 | 80 | N, R1, DR, PC, SN | 4 | 90 |
| | | Night | 65 | 55 | N | 55 | 65 | N, R2, NR | 30 | 70 | N, PC, SN, R2, DR | 14 | 80 | AA, N, PC, SN, R2, DR | 4 | 90 |
| Place of worship | | Evening | 55 | 140 | | | | N, R1, DR | 95 | 60 | N, R1, DR | 30 | 70 | N, R1, DR, PC, SN | 14 | 80 |
| | | Night | 55 | 140 | N | 140 | 55 | N, R2, NR | 95 | 60 | N, PC, SN, R2, DR | 30 | 70 | AA, N, PC, SN, R2, DR | 14 | 80 |
| Active recreation | | Evening | 65 | 55 | | | | N, R1, DR | 30 | 70 | N, R1, DR | 14 | 80 | N, R1, DR, PC, SN | 4 | 90 |
| Passive recreation | | Evening | 60 | 95 | | | | N, R1, DR | 55 | 65 | N, R1, DR | 25 | 75 | N, R1, DR, PC, SN | 8 | 85 |
| Industrial premise | | Evening | 75 | 25 | | | | N, R1, DR | 14 | 80 | N, R1, DR | 4 | 90 | N, R1, DR, PC, SN | 1 | 100 |
| | | Night | 75 | 25 | N | 25 | 75 | N, R2, NR | 14 | 80 | N, PC, SN, R2, DR | 4 | 90 | AA, N, PC, SN, R2, DR | 1 | 100 |
| Offices, retail outlets | | Evening | 70 | 30 | | | | N, R1, DR | 25 | 75 | N, R1, DR | 8 | 85 | N, R1, DR, PC, SN | 3 | 95 |
| | | Night | 70 | 30 | N | 30 | 70 | N, R2, NR | 25 | 75 | N, PC, SN, R2, DR | 8 | 85 | AA, N, PC, SN, R2, DR | 3 | 95 |

| Non-residential receiver | | LAeq(15minute) noise level above NML | | | | | | | | | | | |
|---|--|--------------------------------------|-----|-----------------------|-----------|---------------------|--------------------------|----------------|---------------------|--------------------------|--|---------------------|--------------------------|
| | | Standard hours | | | <10 dB(A) | | | 10 to 20 dB(A) | | | LAeq(15minute) 75 dB(A) or greater (Highly affected) | | |
| Developed settlements (urban and suburban) | | Period | NML | Affected distance (m) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) |
| Classroom at schools and other educational institutions | | Day | 55 | 155 | | | | N | 60 | 65 | N, PC, RO | 25 | 75 |
| Hospital wards and operating theatres | | Day | 65 | 60 | | | | | | | N, PC, RO | 25 | 75 |
| Place of worship | | Day | 55 | 155 | | | | N | 60 | 65 | N, PC, RO | 25 | 75 |
| Active recreation | | Day | 65 | 60 | | | | | | | N, PC, RO | 25 | 75 |
| Passive recreation | | Day | 60 | 105 | | | | N | 35 | 70 | N, PC, RO | 25 | 75 |

Distanced Based Assessment (Noisiest Plant)

Steps for Assessment:

- Schedule noisy works to occur in standard hours where possible or before 11pm and implement Standard Measures.
- Select the representative noise area category. The worksheet titled 'Representative Noise Environ.' provides a number of examples to help select the noise area category.
- Select the noisiest plant. If not found in drop-down list, refer to 'Source List' and select a representative plant with equivalent sound power level.
- Is there line of sight to receiver? Select the appropriate scenario from the drop down list.

Identify and implement standard mitigation measures where feasible and reasonable. Include any shielding implemented as part of the standard mitigation measures by changing the selection in the 'Is there line of sight to receiver' drop-down list. Solid barriers can be in the form of road cutting, timber lapped and capped fence, shipping container, site office, etc. Substantial solid barriers are barriers greater than 5 metres in height or multiple rows of houses or a sound barrier specifically designed to mitigate construction noise. Please note that vegetation and trees are not considered to be a form of solid barrier and any gaps would compromise the acoustic integrity of the solid barrier.

- Determine if there are any receivers (both residential and non-residential receivers) within the affected distance for each relevant time period. Consider background LA90 noise measurements to check assumption in Step #2 if:
 - there are many affected receivers and the impact duration at any one receiver is more than 3 weeks; or
 - there are a few affected receivers and the impact duration at any one receiver is more than 6 weeks.

Note that consideration need to be given to the construction staging plan when determining impact duration.

- Identify if there are any receivers within the additional mitigation measures distances and identify feasible and reasonable measures at each receiver.
- Where night works are involved, identify sleep disturbance affected distance.
- Document the outcomes of these steps.

(Note that suitable noise management levels for other noise-sensitive businesses not identified in the Construction Noise Estimator should be investigated on a project-by-project basis. Please contact a Roads and Maritime noise specialist for more information)

| Abbreviation | Measure |
|--------------|---------------------------|
| N | Notification |
| SN | Specific notifications |
| PC | Phone calls |
| IB | Individual briefings |
| RO | Respite offer |
| R1 | Respite period 1 |
| R2 | Respite period 2 |
| DR | Duration respite |
| AA | Alternative accommodation |
| V | Verification |

Note that spot check verification of noise levels and individual briefings are not required for projects with less than 3 weeks impact duration

Please pick from drop-down list in orange cells

| Noise area category | | R2 |
|--|------------|---------------------------|
| RBL or LA90 Background level (dB(A)) | Day | 45 |
| | Evening | 40 |
| | Night | 35 |
| LAeq(15minute) Noise Mangement Level (dB(A)) | Day | 55 |
| | Day (OOHW) | 50 |
| | Evening | 45 |
| | Night | 40 |
| Noisiest plant | | Concrete Truck |
| Is there line of sight to receiver? | | No (behind solid barrier) |

Stage 5 - new median and roundabout construction Nightworks
Distance to nearest house = 130m

Residential receiver

| Affected distance (m) | LAeq(15minute) noise level above background (LA90) | | | | | | | | | | | | LAeq(15minute) 75 dB(A) or greater (Highly affected) | | | Sleep disturbance LAmax 65 dB(A) Affected distance (m) | | |
|---|--|---------------------|--------------------------|----------------|---------------------|--------------------------|----------------|---------------------|--------------------------|-------------------|---------------------|--------------------------|--|----|-----------|---|----|----|
| | 5 to 10 dB(A) | | | 10 to 20 dB(A) | | | 20 to 30 dB(A) | | | > 30 dB(A) | | | | | | | | |
| | Measures | Within distance (m) | Mitigation level (dB(A)) | Measures | Within distance (m) | Mitigation level (dB(A)) | Measures | Within distance (m) | Mitigation level (dB(A)) | Measures | Within distance (m) | Mitigation level (dB(A)) | | | | | | |
| Undeveloped green fields, rural areas with isolated dwellings | Day | 75 | | | | | N | 25 | 65 | N, PC, RO | 15 | 75 | N, PC, RO | 15 | 75 | 55 | | |
| | Day (OOHW) | 120 | | | | | N, R1, DR | 75 | 55 | N, R1, DR, PC, SN | 15 | 75 | N, PC, RO | 15 | 75 | | | |
| | Evening | 175 | | | | | N, R1, DR | 120 | 50 | N, R1, DR, PC, SN | 20 | 70 | N, PC, RO | 15 | 75 | | | |
| | Night | 250 | N | 250 | 40 | N, R2, DR | 175 | 45 | N, PC, SN, R2, DR | 75 | 55 | AA, N, PC, SN, R2, DR | 25 | 65 | N, PC, RO | | 15 | 75 |
| Developed settlements (urban and suburban) | Highly Affected | 15 | | | | | | | | | | | N, PC, RO | 15 | 75 | 60 | | |
| | Day | 85 | | | | | N | 30 | 65 | N, PC, RO | 15 | 75 | N, PC, RO | 15 | 75 | | | |
| | Day (OOHW) | 135 | | | | | N, R1, DR | 85 | 55 | N, R1, DR, PC, SN | 15 | 75 | N, PC, RO | 15 | 75 | | | |
| | Evening | 200 | | | | | N, R1, DR | 135 | 50 | N, R1, DR, PC, SN | 20 | 70 | N, PC, RO | 15 | 75 | | | |
| Propagation across a valley / over water | Night | 305 | N | 305 | 40 | N, R2, DR | 200 | 45 | N, PC, SN, R2, DR | 85 | 55 | AA, N, PC, SN, R2, DR | 30 | 65 | N, PC, RO | 15 | 75 | |
| | Highly Affected | 15 | | | | | | | | | | | N, PC, RO | 15 | 75 | | | |
| | Day | 95 | | | | | N | 35 | 65 | N, PC, RO | 15 | 75 | N, PC, RO | 15 | 75 | | | |
| | Day (OOHW) | 160 | | | | | N, R1, DR | 95 | 55 | N, R1, DR, PC, SN | 15 | 75 | N, PC, RO | 15 | 75 | | | |
| Propogation across a valley / over water | Evening | 255 | | | | | N, R1, DR | 160 | 50 | N, R1, DR, PC, SN | 20 | 70 | N, PC, RO | 15 | 75 | 70 | | |
| | Night | 405 | N | 405 | 40 | N, R2, DR | 255 | 45 | N, PC, SN, R2, DR | 95 | 55 | AA, N, PC, SN, R2, DR | 35 | 65 | N, PC, RO | | 15 | 75 |
| | Highly Affected | 15 | | | | | | | | | | | N, PC, RO | 15 | 75 | | | |
| | Day | 95 | | | | | | | | | | | N, PC, RO | 15 | 75 | | | |

Non-residential receiver

| Standard hours | LAeq(15minute) noise level above NML | | | | | | LAeq(15minute) 75 dB(A) or greater (Highly affected) | | | | | |
|---|--------------------------------------|-----|-----------------------|---------|---------------------|--------------------------|--|---------------------|--------------------------|-----------|----|----|
| | Period | NML | Affected distance (m) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | | | |
| Classroom at schools and other educational institutions | Day | 55 | 75 | | | | N | 25 | 65 | N, PC, RO | 15 | 75 |
| Hospital wards and operating theatres | Day | 65 | 25 | | | | | | | N, PC, RO | 15 | 75 |
| Place of worship | Day | 55 | 75 | | | | N | 25 | 65 | N, PC, RO | 15 | 75 |
| Active recreation | Day | 65 | 25 | | | | | | | N, PC, RO | 15 | 75 |
| Passive recreation | Day | 60 | 45 | | | | N | 20 | 70 | N, PC, RO | 15 | 75 |
| Industrial premise | Day | 75 | 15 | | | | | | | N, PC, RO | 15 | 75 |
| Offices, retail outlets | Day | 70 | 20 | | | | | | | N, PC, RO | 15 | 75 |

| Standard hours | LAeq(15minute) noise level above NML | | | | | | | | | | | |
|---------------------------------------|--------------------------------------|-----|-----------------------|---------|---------------------|--------------------------|-----------|---------------------|--------------------------|-----------------------|---------------------|--------------------------|
| | Period | NML | Affected distance (m) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) |
| Hospital wards and operating theatres | Evening | 65 | 25 | | | | N, R1, DR | 20 | 70 | N, R1, DR, PC, SN | 3 | 90 |
| | Night | 65 | 25 | N | 25 | 65 | N, R2, NR | 20 | 70 | AA, N, PC, SN, R2, DR | 3 | 90 |
| Place of worship | Evening | 55 | 75 | | | | N, R1, DR | 45 | 60 | N, R1, DR, PC, SN | 8 | 80 |
| | Night | 55 | 75 | N | 75 | 55 | N, R2, NR | 45 | 60 | AA, N, PC, SN, R2, DR | 8 | 80 |
| Active recreation | Evening | 65 | 25 | | | | N, R1, DR | 20 | 70 | N, R1, DR, PC, SN | 3 | 90 |
| | Evening | 60 | 45 | | | | N, R1, DR | 25 | 65 | N, R1, DR, PC, SN | 5 | 85 |
| Industrial premise | Evening | 75 | 15 | | | | N, R1, DR | 8 | 80 | N, R1, DR, PC, SN | 1 | 100 |
| | Night | 75 | 15 | N | 15 | 75 | N, R2, NR | 8 | 80 | AA, N, PC, SN, R2, DR | 1 | 100 |
| Offices, retail outlets | Evening | 70 | 20 | | | | N, R1, DR | 15 | 75 | N, R1, DR, PC, SN | 2 | 95 |
| | Night | 70 | 20 | N | 20 | 70 | N, R2, NR | 15 | 75 | AA, N, PC, SN, R2, DR | 2 | 95 |

Non-residential receiver Developed settlements (urban and suburban)

| Standard hours | LAeq(15minute) noise level above NML | | | | | | LAeq(15minute) 75 dB(A) or greater (Highly affected) | | | | | |
|---|--------------------------------------|-----|-----------------------|---------|---------------------|--------------------------|--|---------------------|--------------------------|-----------|----|----|
| | Period | NML | Affected distance (m) | Measure | Within distance (m) | Mitigation level (dB(A)) | Measure | Within distance (m) | Mitigation level (dB(A)) | | | |
| Classroom at schools and other educational institutions | Day | 55 | 85 | | | | N | 30 | 65 | N, PC, RO | 15 | 75 |
| Hospital wards and operating theatres | Day | 65 | 30 | | | | | | | N, PC, RO | 15 | 75 |
| Place of worship | Day | 55 | 85 | | | | N | 30 | 65 | N, PC, RO | 15 | 75 |
| Active recreation | Day | 65 | 30 | | | | | | | N, PC, RO | 15 | 75 |
| Passive recreation | Day | 60 | 50 | | | | N | 20 | 70 | N, PC, RO | 15 | 75 |



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