



Roads &
Maritime

Heathcote Road Upgrade Infantry Parade to The Avenue

Review of environmental factors

October 2016

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**Heathcote Road Upgrade
Infantry Parade to The Avenue
Review of environmental factors
October 2016**

Prepared by WSP | Parsons Brinckerhoff and Roads and Maritime Services

(WSP | Parsons Brinckerhoff Reference: 2113368-ENV-REP-001)

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Document controls

Approval and authorisation

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Accepted on behalf of NSW Roads and Maritime Services by:	Ankur Arora Project Development Manager Greater Sydney Program Office
Signed:	
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Draft	June 2016	Bella See Cara Renshaw	Chris Fay Delyth Toghill
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Executive summary

This document is a Review of Environmental Factors (REF) for the proposed 'Heathcote Road Upgrade – Infantry Parade to The Avenue' required under Part 5 of the NSW *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 the protective measures (safeguards) that would be implemented when building and operating the proposal.

The proposal

Roads and Maritime Services (Roads and Maritime) is planning for a future upgrade of a 2.2 kilometre section of Heathcote Road from two lanes to four lanes between Infantry Parade at Holsworthy and The Avenue at Voyager Point.

Key features of the proposal include:

- Widening the existing two lane road to a four lane divided road over a distance of about two kilometres
- Duplicating three existing road bridges over Harris Creek, Williams Creek and the T2 Airport Railway Line
- Replacing two existing road bridges over Harris Creek and Williams Creek
- Partially removing the existing pedestrian bridge over Harris Creek
- Building a new combined footpath and cycleway (called a shared use path) along the majority of Heathcote Road that is being widened
- Converting the existing roundabout at Macarthur Drive to a four way signalised intersection
- Installing traffic lights at The Avenue and Heathcote Road intersection
- Ancillary work to facilitate construction of the proposal including, but not limited to, temporary construction facilities, for example compound and stockpile sites, relocating utilities, installing storm water drainage systems, street lighting, road signage, landscaping, safety barriers and communications infrastructure.

Need for the proposal

Heathcote Road is an arterial road which provides regional access between Sydney's southern suburbs and the motorway network around Liverpool namely the M5 Motorway, M7 Motorway and M31 Motorway. The need for the upgrade to Heathcote Road is driven by the road's poor safety record, congestion and delays that are currently experienced.

Congestion and delays are due to a number of pinch points along the section between Infantry Parade and The Avenue. This includes congestion of morning peak traffic at the Macarthur Drive intersection and multiple merge points along Heathcote Road where two traffic lanes need to merge back into one lane. These issues are likely to worsen in the future, with intersection movements forecast to increase by about 30 per cent between 2016 and 2026 and a further 30 per cent between 2026 and 2036. From 2009 to 2015 there were 59 crashes recorded on Heathcote Road in the proposal area. The average crash rate is expected to increase from 13 crashes per annum in 2016 to 22 crashes per annum by 2036. In addition, there are no shared paths connecting to Holsworthy Railway Station, with pedestrians and cyclists using the grassed verge and the road.

Holsworthy is also identified as a target growth area under Liverpool City Council's residential strategy. Improvements to Heathcote Road between Lucas Heights and Moorebank are identified in the NSW Long Term Transport Master Plan (Transport for NSW, 2012).

Proposal objectives

The objectives of the proposal are to:

- Improve road safety
- Improve freight access and efficiency
- Reduce traffic congestion and improve travel times
- Increase road capacity catering for current and predicted traffic volumes
- Enhance network connectivity
- Improve travel time reliability and efficiency
- Improve pedestrian and cyclist access and connectivity to Holsworthy Train Station and surrounds.

Options considered

The selection of the preferred option began in 2010. In considering options to upgrade Heathcote Road, strategic designs were prepared for the duplication of the Harris Creek road bridge and its approaches to achieve a four lane divided road between Infantry Parade and Macarthur Drive. In February 2015 a strategic design was developed for the widening of Heathcote Road to four lanes between Infantry Parade, Hammondville and The Avenue, Voyager Point.

In late 2015, Roads and Maritime started to develop potential options for the strategic design. This took into consideration environmental and social issues identified in a preliminary environmental investigation to avoid and minimise potential impacts. In total, 11 options were considered for traffic lanes and intersections, bridges over Harris Creek, T2 Airport Railway Line, Williams Creek, and the shared use path along the length of the proposal.

All options were compared against the strategic alternative of doing nothing. A value management workshop was held in March 2016. The preferred option as described above, best met the proposal objectives in terms of safety and future traffic flows. The preferred option would also provide the best balance between technical, environmental and social benefits and costs.

Statutory and planning framework

The objective of State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) is to facilitate the effective delivery of infrastructure across NSW. Clause 94 of ISEPP permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent.

As the current proposal is for a road and is to be carried out on behalf of Roads and Maritime, it can be assessed under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act). Development consent from council is not required.

This REF fulfils the requirements of Section 111 of the EP&A Act and has been prepared in accordance with Clause 228 of the Environmental Planning and Assessment Regulation 2000.

Community and stakeholder consultation

Consultation with the local community and stakeholders was carried out in June and July 2015, when Roads and Maritime invited comment on the proposed road upgrade. A community newsletter was distributed to 6,250 residents living in surrounding areas and emailed directly to emergency services, Government agencies, schools, large businesses and other key stakeholders in the local area. The newsletter was also displayed on the proposal website.

Eighteen submissions were received with main issues focusing on the safety of road users, pedestrians and cyclists, the design of the proposed upgrade and operational noise. A consultation report was released in January 2016 summarising the feedback received and Roads and Maritime's response.

Consultation with other government agencies and stakeholders has also occurred to develop the concept design, to help identify key environmental and community issues and opportunities, and to discuss potential safeguards and management measures.

The next stage of the proposal is to display the REF for community and stakeholder feedback. Following the public display period, submissions will be collated and responses to them will be detailed in a submissions report. After considering the submissions, Roads and Maritime will determine whether the proposal should proceed.

Environmental impacts

In order to identify the potential environmental impacts associated with building the proposal and impacts associated with its operation, several environmental factors have been investigated as part of preparing this REF. The key impacts and benefits that would likely occur under the proposal are outlined below.

Key environmental factors

Biodiversity

The proposal would remove about 6.24 hectares of native vegetation. Of this, about 3.4 hectares of threatened ecological communities would be removed, including:

- Castlereagh scribbly gum woodland
- Castlereagh shale – gravel transition forest
- Castlereagh swamp woodland
- Cumberland river-flat forest.

This would represent less than one percent reduction of these communities in the broader locality. The removal of about 2.37 hectares of Castlereagh scribbly gum woodland in moderate to good condition triggers the need for biodiversity offsets in the order of 145 ecosystem credits. Offsets are not required for other threatened ecological communities as clearing will be below one hectare for each.

The proposal would also remove 46 individuals of the *Grevillea parviflora* subsp. *parviflora* (Vulnerable, *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act) and *Threatened Species Conservation Act 1995* (TSC Act)) and 75 individuals of the species *Hibbertia puberula* (Endangered, TSC Act). Both species are found in abundance outside the project area. Three threatened fauna species (Grey-headed Flying fox, Southern Myotis and Eastern Free-tail Bat) have been recorded but found unlikely to roost or breed in affected trees. Assessments of significance for these flora and fauna species concluded that potential impacts would not result in significant impacts. Aquatic ecology impacts from bridge construction over Harris and Williams Creeks would impact on about 0.28 hectares of the riparian zone. Impacts are considered minor due to the small area of impact and absence of threatened aquatic species and populations.

The compound site for the proposal has been located in an area that minimises the need for removal of vegetation. Safeguards are included to minimise potential impacts on biodiversity, in particular the loss of biodiversity and disturbances to Harris and Williams Creeks riparian zones. The opportunity to further reduce direct impacts would be further investigated when optimising the proposal footprint during detailed design. An Offset Strategy would be developed during detailed design as a result of impacting on Castlereagh scribbly gum woodland.

Overall, the proposal is not likely to significantly impact threatened species, populations or ecological communities or their habitats, within the meaning of the *Threatened Species Conservation Act 1995* or *Fisheries Management Act 1994*, nor is the proposal likely to significantly impact threatened species, populations, ecological communities or migratory species, within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*.

Surface water and flooding

Potential impacts to water quality could arise during construction if construction activities are not appropriately managed. Construction activities that are considered to pose a greater potential to impact upon water quality include:

- General earthwork
- Storage of materials
- Construction of drainage infrastructure
- Removal of riparian and aquatic vegetation
- Accidental leaks or spills
- Construction of in-stream structures in waterways.

The project area lies within flood prone land. If flooding was to occur during construction, this may impact water quality through erosion, sedimentation and contamination. This has a high risk of occurring if flooding occurs during excavation work.

Once the project becomes operational, the potential impacts to water quality would remain unchanged from the existing conditions. The potential for flooding impacts during the operation of the proposal would decrease as the proposal improves the flood immunity of the existing Harris and Williams Creek Bridges, resulting in a minor beneficial impact.

Safeguards and management measures have been identified and include measures to minimise construction impacts to soil and water, water quality and to reduce the risk of flooding and accidental spills.

Noise and vibration

Residents would be highly affected by noise during construction with levels exceeding between 30 to 50 dB(A) above day and night time noise management levels (NMLs), respectively. The Holsworthy Public School, Holsworthy Preschool and Holsworthy Early Education and Childcare Centre would also be highly noise affected receivers during construction. At worst, noise levels would be 35 dB(A) above the non-residential criteria. Night work is required to install the bridges and remove the Macarthur Drive roundabout and there is the potential for sleep disturbance while the proposal is being built.

During operation, the proposal would not result in any noticeable change to noise levels (less than 1 dB(A) change) and would not increase the likelihood of sleep disturbance to nearby residents. However, the noise assessment identifies 24 acute residential receivers and two acute non-residential sensitive receivers (Holsworthy Early Education and Child Care Centre and classrooms closest to Heathcote Road at Holsworthy Public School). These acute receivers are affected by road traffic noise of 65 dB(A) or more during the day or 60 dB(A) or more at night; and would be eligible for consideration for mitigation. Noise mitigation options have been identified to reduce the predicted noise exceedances and number of affected receivers. A detailed feasible and reasonable assessment to finalise noise mitigation options would be undertaken during detailed design.

Vibration-generating equipment would be used to build the proposal. The use of vibration intensive equipment may lead to potential damage to buildings and disturbance or annoyance to neighbours. Appropriate safeguards are proposed to mitigate these impacts.

Safeguards and management measures have been identified to reduce both construction noise and vibration impacts and improve amenity of sensitive receivers. Construction activities would occur in accordance with a Construction Noise and Vibration Management Plan developed in accordance with Roads and Maritime's Construction Noise and Vibration Guideline. Noise mitigation options for acute receivers would be further investigated during detailed design and in consultation with sensitive receivers.

Non-Aboriginal heritage

The proposal would impact on three bridges of local significance, including Holsworthy Pedestrian Bridge (listed on the Liverpool Local Environment Plan), Harris Creek Bridge and Williams Creek Bridge (listed on the Road and Maritime s170 Register).

Holsworthy Pedestrian Bridge would be partially removed, which would include removal of the superstructure and abutments only. The piers, iron fixings and plaque elements are components of the bridge that are of heritage significance. As a result, these would remain in place. The superstructure and abutments are later additions to the original bridge and have minor contribution to heritage value. Therefore, the partial removal of the bridge would result in a minor impact. The pedestrian bridge is also a contributing element of the Holsworthy Group / Old Army Internment Camp Group. This item would also experience a minor impact as a result of the changes to the pedestrian bridge. The pedestrian bridge is also an identified element of the Holsworthy Group heritage item located in the Holsworthy Military Reserve. Work within the curtilage of this item includes use of a site compound during construction, and the partial removal of the Holsworthy Pedestrian Bridge. Use of the site compound is unlikely to impact on the heritage values of this item. The proposed work to the Holsworthy Pedestrian Bridge would result in a minor impact to the Holsworthy Group.

Duplicating and replacing the current Harris and Williams Creek Bridges would result in the removal of the heritage bridge items, and would directly impact the defining elements inherent to the item's significance. The railings are a distinct feature, the structures are unobtrusive and the superstructures of both bridges provide a clear view of the local setting. As a result of these heritage values, the replacement of the bridges is considered a major impact. The proposal has considered options of retaining and duplicating the bridges, however the impact cannot be avoided as the bridges do not meet the required safety and flood immunity objectives of the proposal.

During operation of the proposal, there would be no physical impacts on the area's heritage sites further to those generated during construction. Potential traffic increases from the proposal would have limited effect on the heritage values or the importance of this site.

Safeguards and management measures have been identified to reduce impacts to the heritage items listed above, including retention and protection of the Holsworthy Pedestrian Bridge piers, iron fixings and plaque elements and heritage interpretation. In addition, the REF includes a safeguard that the detailed design of the road bridges and associated shared path would be designed to balance safety and complement the surrounding landscape character and heritage values, including the consideration of material types and finishes.

Summary of beneficial effects

- Reduced travel time for people travelling along Heathcote Road especially during the morning peak period
- Easing congestion and providing additional network capacity through providing a specific filter lane for traffic turning into all intersections, in particular the Macarthur Drive intersection
- Improvements to pedestrian and cycle access, in particular to Holsworthy Train Station and Hammondville Park
- Improved safety for all road users, particularly at the intersections of Macarthur Drive and The Avenue

Justification and conclusion

Roads and Maritime recognises that in order to build and operate the proposal, there would be a number of changes to the local area. There would also be some temporary impacts while the proposal is being built. Such impacts are consistent with similar road development projects and would be safeguarded and managed by implementing measures set out in published Roads and Maritime environmental management guidance. These measures would be effective in reducing the magnitude, extent, duration and scope of the proposal's impacts. This includes managing and timing the work to minimise the disruption in as feasible and reasonable a manner as possible for

road users, residents and other affected stakeholders. Overall, the proposal is considered justified due to the long term benefit to the local and regional community and economy and its impacts can be managed with few residual adverse outcomes. It is also a proposal whose impacts would not be materially significant. This means the proposal can be self-determined under Part 5 of the NSW EP&A Act.

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1 Introduction

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

1.1 Proposal identification

Roads and Maritime Services (Roads and Maritime) is planning for a future upgrade of 2.2 kilometres of Heathcote Road between Infantry Parade at Holsworthy and The Avenue at Voyager Point from two lanes to four lanes. The NSW Government has provided \$4 million to plan for the future upgrade of Heathcote Road to reduce traffic congestion, meet current and future traffic volumes and improve pedestrian and cyclist connectivity to Holsworthy Train Station. In 2010 and 2011, strategic designs were developed for the duplication of the Heathcote Road Bridge over Harris Creek and the widening of bridge approaches to achieve a four lane divided road between Infantry Parade and Macarthur Drive. In July 2014, the strategic design process began for the widening of Heathcote Road to four lanes between Infantry Parade and The Avenue.

The proposal aims to ease congestion, reduce travel times and improve traffic flow during peak periods. It would also improve road safety while providing an alternative travel choice for people to walk and cycle from Holsworthy to Voyager Point. The proposal involves the following key features:

- Widening the existing two lane road to a four lane divided road
- Duplicating three existing road bridges over Harris Creek, Williams Creek and the T2 Airport Railway Line respectively
- Replacing two existing road bridges over Harris Creek and Williams Creek respectively
- Removing parts of the existing pedestrian bridge over Harris Creek
- Building a new combined footpath and cycleway (called a shared use path) along the southern side of the road between Infantry Parade and Soldiers Way, and the northern side of the road between Soldiers Way and The Avenue
- Converting the existing roundabout at Macarthur Drive to a four way signalised intersection
- Installing traffic lights at The Avenue and Heathcote Road intersection.

Ancillary work associated with the proposal includes:

- Providing future crossing points at all intersections
- Replacing existing and installing new stormwater drains comprising pipes, kerbs, gullies, catch and pipe drains, and chambers
- Replacing existing and installing new street lighting
- Replacing existing and installing new road signage
- Replacing existing and undertaking new amenity planting and landscaping
- Protecting and adjusting various utilities and drains to widen Heathcote Road
- Installing new safety barriers
- Upgrade two existing access tracks on land owned by the Department of Defence
- Installing electrical power cables to power the lighting and street signs, while also allowing for the future installation of intersection lighting
- Install communication infrastructure, electrical cabling, conduits and pits
- Regrading and resurfacing existing sections of Heathcote Road including the intersecting side roads.

Heathcote Road is a major arterial road in the Liverpool Local Government Area (LGA) south-west of Sydney. It connects Newbridge Road at Liverpool with the Princes Highway at Heathcote. The road passes through undeveloped bush land that comprises both National Park and Commonwealth land, transitioning to suburban environment at Holsworthy. The bushland includes both threatened and endangered communities, habitat and species while the suburban environment includes mixed residential, commercial and recreational land uses. The other key features of the environment are Harris Creek and Williams Creek that pass through the area. They discharge to the Hacking River and eventually Port Hacking. Construction of the proposal would

take about two years to complete, allowing for periods where no work would take place. It would cost about \$100 million to build the proposal based on concept design estimates. The cost estimate would be refined as the design progresses.

Figure 1-1 shows the proposal's location and Figure 1-2 overviews the proposal. Chapter 3 describes the proposal in more detail.

1.2 Purpose of the report

WSP | Parsons Brinckerhoff has prepared this Review of Environmental Factors (REF) on behalf of Roads and Maritime. For the purposes of this work, Roads and Maritime is the proponent and the determining authority under Part 5 of the NSW *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 the protective measures (safeguards) that would be implemented when building and operating the proposal. The description of the proposed work and its associated environmental impacts have been prepared in the context of Clause 228 of the NSW Environmental Planning and Assessment Regulation 2000, the NSW *Threatened Species Conservation Act 1995* (TSC Act), the NSW *Fisheries Management Act 1994* (FM Act), and the Commonwealth Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In doing so, the REF helps fulfil the requirements of:

- Section 111 of the EP&A Act in that Roads and Maritime “examines and takes into account to the fullest extent possible all matters affecting, or likely to affect, the environment by reason of the activity”
- The strategic assessment approval granted by the Commonwealth Government under the EPBC Act in 2015 with respect to the impacts of Roads and Maritime's activities on nationally-listed threatened species, ecological communities and migratory species.

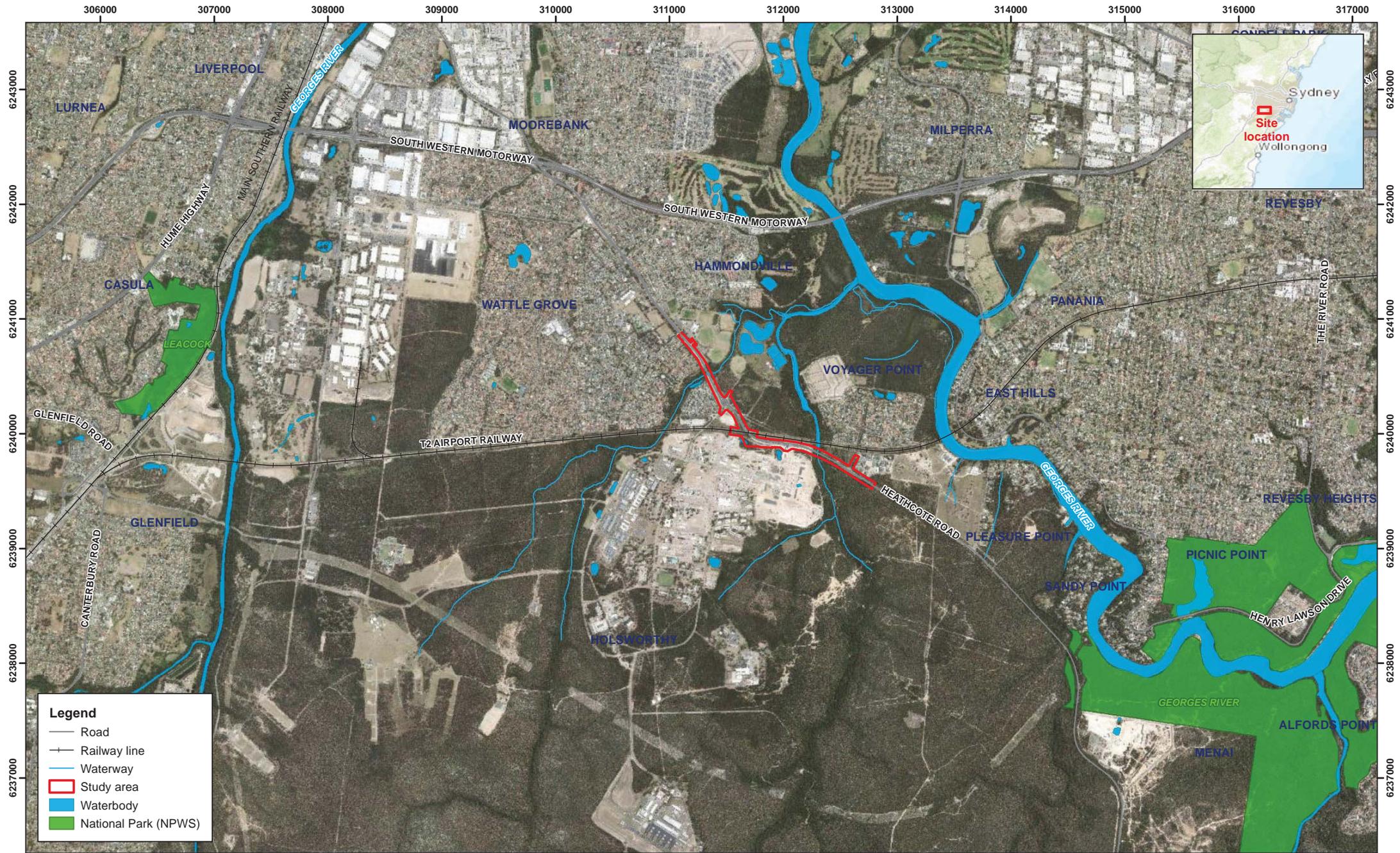
The findings of the REF would be considered when assessing:

- Whether the proposal is likely to have a significant impact on the environment and therefore the requirement for an environmental impact statement to be prepared and approval to be sought from the NSW Minister for Planning under Part 5.1 of the EP&A Act
- The significance of any effects on threatened species, populations or communities, as defined under the TSC Act and/or FM Act, therefore responding to the requirements of Section 5A of the EP&A Act by confirming if there is the need to prepare a Species Impact Statement
- The significance of any impact on nationally listed biodiversity matters defined under the EPBC Act, including whether there is a real possibility that the activity may threaten the long term survival of these matters, and whether offsets are required and able to be secured
- The potential for the proposal to significantly impact other matters of national environmental significance or Commonwealth land and the need to make a referral to the Commonwealth Government Department of the Environment for a decision by its Minister on whether assessment and approval is required under the EPBC Act.

1.3 Terms commonly used in this report

The following terms have been used throughout this report:

- The 'proposal' refers to the Heathcote Road Upgrade between Infantry Parade at Holsworthy and The Avenue. It also represents the 'activity' for the purposes of Part 5 of the EP&A Act
- The 'proposal footprint' refers to any land directly impacted by the proposal and is shown on Figure 1-1
- The 'study area' covers the extent of the existing environment described under each of the environmental aspect headings in Chapter 6. It varies between each aspect and represents the area that may be both directly and indirectly impacted by the proposal
- The 'locality' represents a wider area where information has been gathered to describe the environment of the study area and proposal footprint. The locality would not be impacted by the proposal.



Map: 2113368_GIS_004_A

Author: RP



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m

1:30,000

Coordinate system: GDA 1994 MGA Zone 56

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Heathcote Road Upgrade
Figure 1-1
Location of proposal

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Legend

- Bridge
- Intersection
- Road design
- Road
- Waterway
- Proposal area
- Study area
- Potential auxilliary area
- Waterbody

**Holsworthy
Army Barracks**

Map: 2113368_GIS_015_A2

Author: RP



Date: 17/08/2016

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**Heathcote Road Upgrade
Figure 1-2
Proposal overview**

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2 Need and options considered

This Chapter describes the detail of why the proposal is needed. It also describes and analyses the options considered during the proposal's development, and the process and rationale for selecting the preferred option.

2.1 Strategic need for the proposal

Strategically, Heathcote Road is an arterial road connecting Liverpool to the Princes Highway at Heathcote. It provides regional access between Sydney's southern suburbs and the motorway network around Liverpool namely the M5 Motorway, M7 Motorway and M31 Motorway.

Locally, the road forms an arterial route for the suburbs of Holsworthy, Wattle Grove, Hammondville and Voyager Point. It provides a key link for commuters who drive, walk or cycle to their nearest train station at Holsworthy.

The ability of the road to function efficiently is currently compromised around Holsworthy given that there is only one traffic lane in each direction. This has created a bottleneck, which has led to congestion and delays, especially during the morning peak period due to people wanting to travel to the Holsworthy Army Barracks and Holsworthy Railway Station. Part of this problem was addressed in 2014 through the Department of Defence upgrading the intersection and approaches to the Barracks. This provided dedicated filter lanes to enter and leave the site. However, to ease congestion locally the sections of Heathcote Road north and south of the Barracks would need upgrading and widening.

There is an existing shared use path on the southern side of Heathcote Road between Infantry Parade and Macarthur Drive that connects to a path leading to Holsworthy Railway Station. There are no shared use paths or footpaths connecting Holsworthy Railway Station to Voyager Point. As such people walk along the grassed verges and cycle along the road, which is potentially unsafe and dangerous.

In addition, the area has a poor road safety record. Between January 2009 and June 2015 a total of 59 crashes occurred in the local area. This included one fatality, 25 injuries, and 33 non-casualty crashes. The average crash rate is expected to increase from 13 crashes per annum 2016 to 22 crashes per annum by 2036.

Regionally, Holsworthy is identified as a target growth area under Liverpool City Council's residential strategy. This is supplemented by the expected use of Heathcote Road as a future regional connection between Sydney's southern suburbs, the proposed Western Sydney Airport at Badgerys Creek and the Western Sydney Employment Area at Erskine Park.

The proposal is also supported under a number of key Government policies and strategies.

2.1.1 NSW Long Term Transport Master Plan

The Long Term Transport Master Plan provides the framework for delivering an integrated, modern transport system across NSW over the next 20 years. It identifies transport actions and investment priorities over the short, medium and long-term that has emerged in response to six identified transport challenges:

- Integrating transport services
- Getting Sydney moving again
- Sustaining growth in Greater Sydney
- Providing essential access to regional NSW
- Supporting efficient and productive freight
- State-wide actions.

A central concept of the Master Plan is to provide an integrated transport system across the State, and includes an action to invest in targeted measures to improve congestion and road safety, and to respond to growing pressure on the road network. Heathcote Road between Lucas Heights and

Moorebank is identified specifically as a corridor for targeted improvement. The proposal directly responds to the need to ease congestion and improve safety as identified in the above Plan.

2.1.2 NSW A Plan for Growing Sydney

A Plan for Growing Sydney extends to 2036 and replaces the Metropolitan Strategy and Metropolitan Plan. It sets out the long-term framework to develop Sydney on the global stage based on integrated ‘radical’ public transport links and cross-regional transport connections to support economic development. A focussed objective of the Plan is relieving and preventing congestion over the next two decades in the context of the expected population growth in Sydney’s population. The Plan also focusses on objectives to generate economic benefit including job creation. The Plan identifies the South West Growth Centre (SWGC) and WSEA as key locations to deliver housing and employment over the coming years. It also highlights the land along the M5 Motorway corridor south of Liverpool as an Urban Investigation Area for future growth. The proposal, in easing congestion to access these growth and employment areas from the south responds to the core aim of the above Strategy in providing the required transport infrastructure to allow Sydney to grow. The proposal also would provide access improvement to Holsworthy Railway Station for drivers, pedestrians and cyclists, which would assist in improving connectivity to the rail network.

2.1.3 Supporting NSW strategies and plans

The proposal is supported under the policies, goals, objectives and targets of a number of strategic planning documents.

- State planning documents
 - NSW State Infrastructure Strategy (NSW Government, 2012b)
 - National Road Safety Strategy 2011-2020 (Transport and Infrastructure Council, 2010)
 - NSW Road Safety Strategy 2012-2021 (Transport for NSW, 2012c)
 - Sydney’s Cycling Future: Cycling for Everyday Transport (Transport for NSW, 2013a)
 - Sydney’s Walking Future: Connecting People and Places (Transport for NSW, 2013b)
 - 2020 Strategy (Roads and Maritime, 2015)
 - State Priorities: Making it Happen (NSW Government, 2015).
- Local planning documents
 - Liverpool Residential Development Strategy (Liverpool City Council, 2008)
 - Liverpool Retail Centres Hierarchy Review (Liverpool City Council, 2012)
 - Business Centres and Corridors Strategy (Liverpool City Council, 2013).

Table 2-1 summarises how the proposal is consistent with the relevant provisions of the above strategies and policies.

Table 2-1: Supporting NSW strategies and policies

Document description
State planning documents
<p><i>NSW State Infrastructure Strategy</i></p> <p>This strategy is an assessment of priority infrastructure problems and solutions for the next two decades for the NSW Government, the community and business. This Strategy aims to address infrastructure challenges in the areas such as urban roads, buses and light rail, international gateways, passenger rail, water and energy.</p> <p>The proposal would provide an investment in Sydney’s roads and transport infrastructure.</p>

Document description

National Road Safety Strategy 2011-2020 and NSW Road Safety Strategy 2012-2021

This Strategy sets key objectives to be achieved in the next decade which focus on lowering fatalities and serious injuries and encouraging shared responsibility for road safety outcomes.

The proposal would create 'safer roads' by improving access, visibility for road users, dividing carriageways and signalling intersections.

Sydney's Cycling Future: Cycling for Everyday Transport

This document presents a new direction for planning and prioritisation of cycling in Sydney. It supports cycling as a method of everyday transport and aims to invest and connect bicycle networks, promote better use of cycling networks and engage with government, councils, developers and bicycle users.

The proposal would provide cycling access throughout, which would make it a more attractive travel choice for people in the future.

Sydney's Walking Future: Connecting People and Places

This document supports walking as a method of everyday transport and aims to invest in and connect people to places through safe walking networks, promote walking transport and engage with government, councils, developers and non-government organisations.

The proposal would provide pedestrian access throughout, the aim of which is to make it a more attractive travel choice for people in the future.

State Priorities: Making it Happen

This replaces NSW 2021: A Plan to make NSW Number One by setting out 12 key priorities to improve liveability. The proposal responds to two priorities as it would:

- Provide new transport infrastructure to access the area, consistent with the *building infrastructure* priority
- Be built and it would operate under a number of environmental safeguards and management measures to avoid and minimise environmental impacts consistent with the *keeping our environment clean* priority.

Local planning documents

Liverpool Residential Development Strategy

This Strategy aims to establish a direction for housing Liverpool's population over 25 years and identifies opportunities to accommodate residential development within the Liverpool LGA. This includes developing a balanced approach between new release areas and redeveloping existing areas to meet the needs of residents.

The proposal would improve access for communities who rely on Heathcote Road, meeting future demands from population and employment growth in the area by increasing infrastructure capacity and efficiency.

Liverpool Retail Centres Hierarchy Review

This Review (combined with the below Strategy) seeks to guide the assessment of future proposals for new centres, expansion of existing centres or development in out of centre locations.

The proposal would improve access for communities who rely on Heathcote Road to access retail centres.

Document description

Business Centres and Corridors Strategy

This Strategy was developed to guide future development of business centres and corridors in a sustainable and logical manner within the Liverpool LGA.

The proposal would concentrate infrastructure and services in the Liverpool LGA.

2.2 Existing infrastructure

This section describes the existing roads and infrastructure in the area, which has helped define the options.

2.2.1 Road network

Table 2-2 describes the existing road infrastructure that forms and intersects with the proposal footprint. Figure 1-2 shows the location of the main infrastructure described below.

Table 2-2: Existing road network and infrastructure

Road description

Heathcote Road (Arterial)

- Running east to west connecting Liverpool and The Princes Highway
- A two lane undivided road through the study area widening to four lanes on the approaches to the:
 - Soldiers Way intersection
 - The Avenue intersection
 - Two lane roundabout intersection with Macarthur Drive
- About 2.2 kilometres long in a 55 metre wide road corridor
- Includes two signalised intersections, a roundabout and T intersection
- Other key features:
 - Divided concrete and grassed median of varying widths separating the carriageway
 - A travel lane width of 3.5 metres
 - Lit along the length of both kerbs between Infantry Parade and Macarthur Drive, at the Soldiers Way Intersection and The Avenue Intersection
 - Includes shared use path off its southern kerb between Infantry Parade and Macarthur Drive
 - About 36,000 vehicles use the road each day
 - Operates with an 60 kilometre per hour (km/h) posted speed limit west of the railway line and 80 km/h east of the railway line
 - General straight horizontal alignment that follows the natural topography with little modification
 - Kerbside open channel drainage for the majority of the alignment
 - Pavement for about half of the alignment in good condition, varying in thickness and composition.

Road description
The Avenue (Local collector road)
<ul style="list-style-type: none"> • Running north south connecting Voyager Point to Heathcote Road • Comprising a two lane undivided road • About 650 metres long in a 40 metre wide road corridor • Other key features: <ul style="list-style-type: none"> – Divided concrete and grassed median of varying widths separating the carriageway for about two thirds of the alignment – A travel lane width of 3.5 metres – Operates with an 60 km/h posted speed limit – General straight horizontal alignment that follows the natural topography with little modification – Kerbside open channel drainage.
Soldiers Way (Private access)
<ul style="list-style-type: none"> • Running north south connecting the Holsworthy Army Barracks to Heathcote Road • Comprising a divided road with concrete median at the intersection with Heathcote Road to be retained • The northbound approach comprising a single right hand turn lane and two left hand turn lanes, with two lanes the southbound approach to be retained • Other key features: <ul style="list-style-type: none"> – Lit at the intersection with Heathcote Road – Includes shared use path off its western kerb to be tied into by the proposed works – A travel lane width of 3.5 metres.
Macarthur Drive (Local collector road)
<ul style="list-style-type: none"> • Running north south connecting Holsworthy Station to Heathcote Road • Comprising a four lane divided road • About 220 metres long in a 30 metre wide road corridor • Other key features: <ul style="list-style-type: none"> – Divided concrete and grassed median of varying width separating the carriageway to the roundabout at The Boulevard – Lit along the eastern kerb and at the intersection with Heathcote Road – Footpath on both kerbs – A travel lane width of 3.5 metres – Operates with an 60 km/h posted speed limit – General straight horizontal alignment that follows the natural topography with little modification – Kerbside pit and pipe drainage.
Infantry Parade (Local collector road)
<ul style="list-style-type: none"> • Running north east to south west connecting Holsworthy to Heathcote Road • Comprising a two lane undivided road, with the exception of the intersection with Heathcote Road where the western approach comprises two through lanes providing for left, through and right turn movements • Other key features: <ul style="list-style-type: none"> – Lit along the western kerb and at the intersection with Heathcote Road – Includes a footpath connecting to the shared use path on Heathcote Road – Operates with a 40 km/h posted speed limit.

2.2.2 Bridges

The proposal consists of three two lane road bridges over Harris Creek, the T2 Airport (Railway) Line and Williams Creek.

- The existing Harris Creek Bridge is narrow, 7.3 metre between kerbs, and was built in the 1940s. The existing bridge is considered to be structurally sound
- The bridge over the T2 Airport (Railway) Line was built in 1985 and is an asset owned by Sydney Trains. The existing bridge over Williams Creek is a narrow two lane bridge, 6.7 metre between kerbs and safety barriers and was built in the 1940s. The existing bridge is considered to be structurally sound
- The existing road bridges over Harris Creek and Williams Creek are listed on the Roads and Maritime's Section 170 Register. A pedestrian bridge also crosses Harris Creek on the western side of Heathcote Road. This bridge is heritage listed and owned by Liverpool Council as discussed in section 6.8.

2.2.3 Civil infrastructure

Drainage

The existing stormwater drainage located along Heathcote Road consists of both open channels and pit and pipe networks. At each of the intersections there is a pit and pipe network diverting water out of the roadway. The Avenue intersection network discharges into an open channel transferring to Williams Creek. The Macarthur Drive intersection has one network that discharges on the northern side of the roadway at chainage 600 into an open channel prior to discharge to Harris Creek. Two drainage culverts running adjacent to the roadway, south of the Macarthur Drive intersection, capture flows from the catchment to the south of Heathcote Road prior to discharge into Harris Creek.

The roadway consists of open channel drainage for the majority of the alignment discharging into Harris and Williams Creeks. An open channel on the southern side of Heathcote Road between the railway line and Williams Creek passes under Holsworthy Barracks Access Road via a 5 cell culvert that drains eastward to Williams Creek. The road drainage at this location consists of numerous pits and pipes that discharge in the same location.

Retaining walls

There are two retaining walls within the study area:

- West of the railway line on the southern side of Heathcote Road (Chainage 800 to 950)
- The eastern side of The Avenue (Chainage 20 -140).

Utilities and services

There are a number of utilities within the proposal footprint. The main utilities in the area are:

- Endeavour Energy
 - Underground and overhead services (low and high voltage)
- APA Group
 - Gas Main
 - Ethane gas pipeline
- Sydney Water
 - Sewer
 - Stormwater
- Telstra, NBN Co and Optus
 - Telecommunications network

2.3 Proposal objectives

This section describes the criteria that were used to develop the proposal's options.

2.3.1 Proposal objectives

The proposal objectives are to:

- Improve road safety
- Improve freight access and efficiency
- Reduce traffic congestion and improve travel times
- Increase road capacity catering for current and predicted traffic volumes
- Enhance network connectivity
- Improve travel time reliability and efficiency
- Improve pedestrian and cyclist access and connectivity to Holsworthy Train Station and surrounds.

2.3.2 Development criteria

The concept design shall support the proposal objectives by:

- Designing the proposal in a manner that is informed by environmental investigations to minimise adverse impacts while maximising environmental benefits
- Satisfying the technical and procedural requirements of Roads and Maritime, Sydney Trains and other stakeholders with respect to the design of the proposal works
- Optimising the concept design to ensure that the proposal can be practically and efficiently constructed and maintained while meeting all other proposal objectives
- Applying appropriate urban design, landscape and visual principles in the concept design of the proposal elements
- Designing all connections, modifications and improvements necessary to link the proposal works to the existing road system
- Planning temporary arrangements that minimise disruption to local and through traffic and that maintain access to adjacent properties during construction
- Developing, implementing and maintaining effective management systems for quality, work health and safety, environmental, proposal reporting, risk management, value management and value engineering, constructability assessment, safety audits and community participation.

2.3.3 Urban design objectives

The proposal's urban design objectives are:

- Linking the more developed northern section of the road corridor with sensitive bushland to the south
- Protecting sensitive environments adjacent to the road corridor including endangered ecological communities, riparian crossings and local residences
- Providing effective linkages to Holsworthy Train Station and Holsworthy Army Barracks with improved amenity for pedestrians and cyclists
- Integrating the proposed Holsworthy Army Barracks entry feature 'Anzac Memorial' into the road corridor design
- Reference to the rich military heritage of the area within the road corridor design.

2.4 Alternatives and options considered

A number of alternatives and options were identified and considered in developing the proposal and selecting the preferred option. They are summarised in this section.

2.4.1 Method for selecting the preferred option

The options development process leading to the selection of a preferred option began in 2010 with strategic designs. These designs included the duplication of the Harris Creek road bridge and its approaches to achieve a four lane divided road between Infantry Parade and Macarthur Drive. In February 2015, a strategic design was developed for the widening of Heathcote Road to four lanes between Infantry Parade, Hammondville and The Avenue, Voyager Point.

In late 2015, Roads and Maritime started to develop potential options for the above strategic design taking into consideration the proposal objectives (refer to section 2.3.1). This was supplemented by a preliminary environmental investigation (PEI) prepared in December 2015 to identify environmental constraints to development, with the aim of either avoiding or minimising environmental impact. The PEI process represents the integration of environmental, economic and social concerns, a principle of ecologically sustainable development (ESD), into Roads and Maritime development decisions.

Part of the above process involved holding a value management workshop in March 2016, which was the process used for a representative group of specialists and stakeholders to compare the identified options and select a preferred option.

2.4.2 Identified options

Eleven (11) options were identified and analysed as described in Table 2-3. They were compared against the strategic alternative of doing nothing. The bold text shows the main difference between each option.

Table 2-3: Proposed options

Option	Description
Strategic alternative	
Option A1	Do nothing : adopt the current alignment, intersection arrangement and design of Heathcote Road.
Traffic lanes and intersections	
Option B1	Upgrade the existing roundabout at Macarthur Drive.
Option B2	Build a signalised intersection at Macarthur Drive.
Harris Creek Road Bridge	
Option C1	Build a second bridge to the north .
Option C2	Build a second bridge to the south .
Option C3	Build two new bridges.

Option	Description
T2 Airport Railway Line Road Bridge	
Option D1	Build a second bridge to the north .
Option D2	Build a second bridge to the south .
Williams Creek Bridge	
Option E1	Build a second bridge to the north .
Option E2	Build two new bridges.
Shared use path	
Option F1	Build a shared use path off the: <ul style="list-style-type: none"> • Southern kerb between Infantry Parade and Soldiers Way • Northern kerb between Soldiers Way and The Avenue.
Option F2	Build a shared use path off the: <ul style="list-style-type: none"> • Southern kerb between Infantry Parade and The Avenue.

2.4.3 Analysis of options

Figure 2-1 compares and analyses the options against the proposal objectives described in section 2.3.

Options	DESCRIPTION							
	Reduce traffic congestion and improve travel times	Improve travel time, reliability and efficiency	Increase road capacity catering for current and predicted traffic volumes and enhance network connectivity	Improve pedestrian and cyclist access and connectivity to Holsworthy Train Station and surrounds	Improve freight access and efficiency	Improve road safety	Minimise social and environmental impacts	Is consistent with the urban design objectives?
Strategic alternative								
A1	● No additional capacity introduced	● No additional capacity introduced	● No additional capacity introduced	● No dedicated cycle provisions and disconnected footpath	● No new infrastructure would be built	● No improvement or changes would be made or introduced	● Increased travel times and loss of amenity. It would, however, avoid impact of upgrading the road	● No improvement to urban design
Traffic lanes and intersection								
B1	● Traffic lights at The Avenue would help to regulate traffic flows	● Increase from two to four lanes. Queuing at Macarthur Drive intersection during peak periods	● Separation for turning traffic at The Avenue. No improvement to Macarthur Drive intersection	● Improves pedestrian and cyclist facilities and connections	● Increase from two to four lanes. However, would not improve the conditions at Macarthur Drive intersection	● Widening from two to four lanes. However, does not include any off-road provisions for cyclists	● Environmental impacts, such as noise, dust, traffic disruption and visual intrusion during construction	● Meets the urban design objectives
B2	● Allows for additional control of traffic by signalling Macarthur Drive	● Increase from two to four lanes and signalised intersection at Macarthur Drive	● Separation for turning traffic and improvement to Macarthur Drive intersection	● Improves pedestrian and cyclist facilities and connections	● Increase from two to four lanes and signalised intersection at Macarthur Drive	● Shared path and crossing for pedestrians and cyclists	● Increased scale and duration of environmental impacts compared to B1	● Meets the urban design objectives
Harris Creek Road Bridge								
C1	● Improved road design to support widening and intersection works	● Improvements to the Heathcote Road corridor	● Improves road design and safety across the bridge	● Improves pedestrian and cyclist facilities and connections	● Improves road design and safety	● Safer lane and shoulder widths. Provides a shared path for cyclists	● Subject to overtopping during flood events	● Impacts on EEC and riparian crossing. Improves amenity and linkages for pedestrian and cyclists
C2	● Improved road design to support widening and intersection works	● Improvements to the Heathcote Road corridor	● Improves road design and safety across the bridge	● Improves pedestrian and cyclist facilities and connections	● Improves road design and safety	● Safer lane and shoulder widths. Provides a shared path for cyclists	● Subject to flooding and requires removal of heritage-listed Harris Creek pedestrian bridge	● Impact on EEC, riparian crossing and heritage values
C3	● Improved road design to support widening and intersection works	● Improvements to the Heathcote Road corridor	● Improves road design and safety across the bridge	● Improves pedestrian and cyclist facilities and connections	● Improves road design and safety	● Safer lane and shoulder widths. Provides a shared path for cyclists	● Removal of heritage-listed Harris Creek pedestrian bridge. Increased duration and greater vegetation removal compared to C1 and C2. Provides the greatest flood immunity	● No impact on EEC, riparian crossing and heritage values

● Yes ● No ● Partial

Options	DESCRIPTION							
	Reduce traffic congestion and improve travel times	Improve travel time, reliability and efficiency	Increase road capacity catering for current and predicted traffic volumes and enhance network connectivity	Improve pedestrian and cyclist access and connectivity to Holsworthy Train Station and surrounds	Improve freight access and efficiency	Improve road safety	Minimise social and environmental impacts	Is consistent with the urban design objectives?
T2 Airport Railway Line Road Bridge								
D1	● Improved road design to support widening and intersection works	● Improvements to the Heathcote Road corridor	● Improves road design and safety across the bridge	● Improves pedestrian and cyclist facilities and connections	● Improves road design and safety	● Safer lane and shoulder widths. Provides a shared path for cyclists	● Subject to flooding. Requires shutdown of the railway line. Potentially requires construction outside of the existing road corridor	● Linkages to Holsworthy Train Station and improves amenity for pedestrians and cyclists
D2	● Improved road design to support widening and intersection works	● Improvements to the Heathcote Road corridor	● Improves road design and safety across the bridge	● Improves pedestrian and cyclist facilities and connections	● Improves road design and safety	● Safer lane and shoulder widths. Provides a shared path for cyclists	● Subject to flooding. Requires shutdown of the railway line	● Linkages to Holsworthy Train Station and improves amenity for pedestrians and cyclists
Williams Creek Bridge								
E1	● Improved road design to support widening and intersection works	● Improvements to the Heathcote Road corridor	● Improves road design and safety across the bridge	● Improves pedestrian and cyclist facilities and connections	● Improves road design and safety	● Safer lane and shoulder widths. Provides a shared path for cyclists	● Environmental impacts, such as noise, dust, traffic disruption and visual intrusion during construction	● Impacts on EEC, riparian crossings and heritage values. Provides linkages to Holsworthy Train Station and improves amenity for pedestrians and cyclists
E2	● Improved road design to support widening and intersection works	● Improvements to the Heathcote Road corridor	● Improves road design and safety across the bridge	● Improves pedestrian and cyclist facilities and connections	● Improves road design and safety	● Safer lane and shoulder widths. Provides a shared path for cyclists	● Increased duration and greater vegetation removal compared to E1. Requires removal of the existing road bridge	● Impacts on EEC, riparian crossings and heritage values. Provides linkages to Holsworthy Train Station and improves amenity for pedestrians and cyclists
Shared use path								
F1	● Off-road shared path to remove cyclists from the roadway	● Off-road shared path to remove cyclists from the roadway	● Off-road shared path to remove cyclists from the roadway	● Improves pedestrian and cyclist facilities and connection	● Improves pedestrian and cyclist access to the Holsworthy Train Station	● Provision of an off-road path for pedestrians and cyclists	● Encroaches on the adjacent open drain between the Holsworthy Barracks and William Creek	● Linkages to Holsworthy Train Station and improves amenity for pedestrians and cyclists
F2	● Off-road shared path to remove cyclists from the roadway	● Off-road shared path to remove cyclists from the roadway	● Off-road shared path to remove cyclists from the roadway	● Improves pedestrian and cyclist facilities and connection	● Improves pedestrian and cyclist access to the Holsworthy Train Station	● Provision of an off-road path for pedestrians and cyclists	● Located away from the Holsworthy Barracks	● Linkages to Holsworthy Train Station and improves amenity for pedestrians and cyclists

● Yes ● No ● Partial

Figure 2-1: Comparison of proposed options

2.5 Preferred option

The preferred option would comprise:

- Widening the existing road to four lanes
- Replacing the roundabout at Macarthur Drive with a signalised intersection
- Keeping the existing signalised intersection at Soldiers Way
- Installing traffic lights at The Avenue intersection
- Building a second bridge to the north of the existing Harris Creek Road bridge and replacing the existing bridge
- Building a second bridge to the south of the existing T2 Airport Railway Line road bridge and keeping the existing bridge
- The inclusion of a shared use path off the southern kerb between Infantry Parade and Soldiers Way and the northern kerb between Soldiers Way and The Avenue.

The above outcome would be achieved by combining Option B2, Option C3, Option D2, Option E2 and Option F1 (refer to Figure 2-1). The preferred option is based on the following analysis outcomes:

- The preferred road design and alignment provides the best technical design to deliver road network improvements in general accordance with the proposal objectives
- Congestion would be reduced and traffic flows improved while maintaining safety. In particular it would improve the performance of intersections by providing separated turning lanes
- Converting the roundabout at the Macarthur Drive intersection to a signalised intersection would reduce congestion and better regulate all traffic movements at the Macarthur Drive intersection if traffic volumes and turning movements increase
- It would also provide a solution that could be built with minimal environmental impacts and accommodate planned and future development in the area.

The ESD principles include the integration principle, which is based on Our Common Future, the published output from the 1987 United Nations World Commission on Environment and Development (UNWCED). Its core realises that there is the integration of economic, social development and environmental considerations into the decision-making process for development. This 'triple bottom line' as termed in Our Common Future has been considered in the options development and selection process by:

- Adopting a simple and cost-effective design where possible
- Selecting a design that would provide for the future development of Holsworthy listed as a targeted growth area in Liverpool City Council's residential strategy
- Selecting a design that is consistent with the strategic design, where the supporting environmental assessment concluded that the impacts of the proposal could be mitigated to acceptable levels adopting various safeguards.

3 Description of the proposal

This Chapter describes the proposal including how it would be built and how it would operate.

3.1 The proposal

Roads and Maritime's preferred option (proposal) to widen and upgrade the 2.2 kilometre section of Heathcote Road from Infantry Parade at Holsworthy and The Avenue at Voyager Point comprises the following key features, which are also shown on Figure 1-2.

- About two kilometres of 23 metre-wide dual carriageway
- Replacement of the existing road bridges over Harris Creek and Williams Creek with two new bridges in each location, one of which would include a shared use path
- Removal of deck and abutments of the existing pedestrian bridge over Harris Creek
- Construction of a new bridge to the west of existing bridge over the T2 Airport Railway Line
- Construction of a shared use path that would be separated, and in certain locations set back, from the southern kerb line between Infantry Parade and Soldiers Way and the northern kerb line between Soldiers Way and The Avenue
- Conversion of the roundabout at Macarthur Drive to a four way signalised intersection
- Installing traffic lights at the T-Junction at The Avenue.

Ancillary work associated with the proposal includes:

- Providing future crossing points at all intersections
- Replacing existing and installing new stormwater drains comprising pipes, kerbs, gullies, catch and pipe drains, and chambers
- Replacing existing and installing new street lighting
- Replacing existing and installing new road signage
- Replacing existing and undertaking new amenity planting and landscaping
- Protecting and adjusting various utilities and drains to widen Heathcote Road
- Installing new safety barriers
- Upgrade two existing access tracks on land owned by the Department of Defence
- Installing electrical power cables to power the lighting and street signs, while also allowing for the future installation of intersection lighting
- Install communication infrastructure, electrical cabling, conduits and pits
- Regrading and resurfacing existing sections of Heathcote Road including the intersecting side roads.

Figure 3-1 shows the key features of the proposal including the existing environmental context described in Chapter 2. To help describe how the proposal would be built and how it would operate it has been divided into sections as shown on Figure 3-1.



Map: 2113368_GIS_017_A
 Date: 8/09/2016
 Data source: © Roads and Maritime Services

Author: RP
 Approved by: CR



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 Coordinate system: GDA 1994 MGA Zone 56
 Scale ratio correct when printed at A3



Heathcote Road Upgrade
Figure 3-1
 Map 1 of 3
 Overview of the proposal

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Holsworthy Barracks Entrance

Legend

- Bridge
- Intersection
- Shared path
- Rail
- Proposal area
- Study area
- Outline of works

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Heathcote Road Upgrade
Figure 3-1
 Map 2 of 3
 Overview of the proposal

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Roads and Maritime Services

Heathcote Road Upgrade
Figure 3-1
 Map 3 of 3
 Overview of the proposal

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3.2 Design

This section describes the proposal's concept design.

3.2.1 Design standards

The following guidelines and standards have been used to inform and develop the concept design:

- Guide to Road Safety (eight parts) (Austroads, 2002)
- Guide to Road Design (eight parts) (Austroads, 2009)
- Guide Supplements
 - Road Design (eight parts) (Roads and Maritime, 2011b)
 - Asset Management (eight parts) (Roads and Maritime, 2011a)
 - Pavement Technology (10 parts) (Roads and Maritime, 2013b)
 - Road Safety (nine parts) (Roads and Maritime, 2011c)
 - Transport Planning (one part) (Roads and Maritime, 2011d)
 - Traffic Management (13 parts) (Roads and Maritime, 2013d).

3.2.2 Design criteria

The above standards describe the criteria that should be adopted for specific road types (ie rural roads, sub-arterials, highways, motorways) and conditions (ie rural, semi-urban, urban). The criteria have been developed to ensure all roads are designed to be safe, effective, well-planned and easily maintained. The adoption of the criteria is often referred to as being 'consistent with design standards'. Where different criteria have been adopted this is referred to as a 'departure from standards'. Any departures from the standards need justifying to ensure they still provide a safe outcome. Table 3-1 shows design criteria that have been adopted. The full design criteria for the proposal are the provided in Appendix D.

Table 3-1: Design criteria

Aspect	Design criteria
General specification	
Horizontal alignment	Describes the route of the road
	<ul style="list-style-type: none"> • Road: typically northwest to southeast
Vertical alignment	Describes the height of the road relative to the surrounding land. It describes where the road would be built below (cutting) or above (fill) the surrounding land
	<ul style="list-style-type: none"> • Bridges: up to 6.5 metres above ground level • Road: up to 1 metre above ground level (fill) • Road: up to 1 metre below ground level (cut)
Engineering specification	
Lane width	<ul style="list-style-type: none"> • Traffic lanes: 3.5 metres wide • Turning lanes: 3.3 metres wide
Shared use path	Describes a shared area of pavement separated from the traffic lanes where people can walk and cycle
	<ul style="list-style-type: none"> • Main alignment: typically 3 metres wide except in the following locations: • Bridges: 3.6 metres wide • The Avenue, Heathcote Road to Lilli Pili Drive: 2.8 metres wide.

Aspect	Design criteria
Intersections	<ul style="list-style-type: none"> Two existing intersections (unchanged): Infantry Parade and Soldiers Way Two existing intersections (to be upgraded): Macarthur Drive and The Avenue
Pavement type (road surface)	<p>Describes the material used to construct a new road surface (pavement)</p> <ul style="list-style-type: none"> New sections of road: composite pavement Resurfaced sections of road: flexible pavement Typical composite composition: <ul style="list-style-type: none"> Asphalt pavement over a concrete sub base Typical flexible composition: <ul style="list-style-type: none"> Asphalt pavement over a gravel sub base
Design specification	
Speed	<ul style="list-style-type: none"> Infantry Parade to the Rail Bridge: posted speed of 80km/h Rail Bridge to The Avenue: posted speed of 60km/h
Vehicle type	<ul style="list-style-type: none"> Design capacity: 19.5 metre long semi-trailer (26 metre long B double traffic if necessary)
Stopping sight distance	<p>Describes the distance people would need to see along the road to safely stop</p> <ul style="list-style-type: none"> On the approach to the intersections: 100 metre visibility

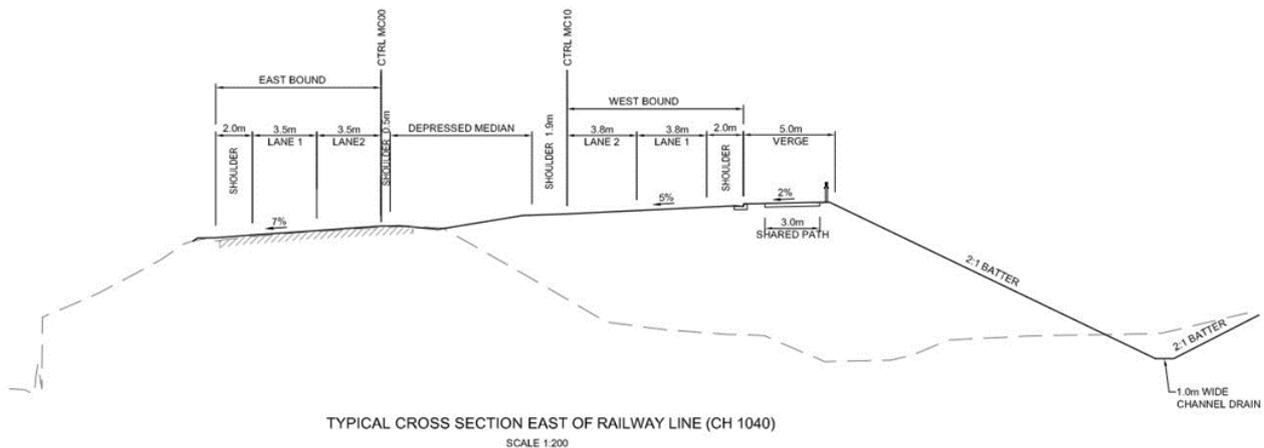


Figure 3-2: Typical cross section

3.2.3 Engineering constraints

Building and operating the proposal would be restricted by a number of engineering and development constraints. Table 3-2 lists the main constraints and discusses how they have been addressed in the concept design.

Table 3-2: Engineering and development constraints

Constraint	Concept design provision
High density of utilities in the area	Relocate the utilities either adjacent to the proposal boundary due to space constraint and ground conditions or beneath the shared user path.
Required clearance over the T2 Airport Railway Line	Provide a vertical clearance of 6.5 metre between the top of rail and underside of bridge
Frequent flooding of Harris Creek and Williams Creek	Increase the height of the new bridges and the approach lanes sufficiently to provide the required flood protection. Locate piers outside of the creek channel to ensure that the new bridges do not increase the flood risk of both creeks.
Two creeks crossings along Heathcote Road	Under-bore Sydney Water, Jemena and Endeavour Energy assets beneath Harris and Williams Creeks.

3.3 Major design features

This section describes the major design features of the proposal.

3.3.1 Road infrastructure

Main road

The road would be widened to about 23 metres. This would create four lanes of traffic and a median that would vary in width. It would also allow for a shared user path. The road would be wider on its approach and exit to an intersection. It would also be slightly narrower where it would cross the two creeks and the railway line.

The road would be widened on different sides:

- Infantry Parade and Macarthur Drive: northern side
- Macarthur Drive and Solider Way: southern side
- Soldiers Way and The Avenue: northern side.

The section of road at the new intersection at Soldiers Way has already been upgraded to four lanes.

Road bridges

Three new bridges would be built under the proposal while two existing bridges would be replaced. One of the bridges at each of the three bridge locations would also include an integrated shared use path. Table 3-3 describes their form and structure of each bridge. One of the bridges at each of the three bridge locations would also include an integrated shared use path.

Table 3-3: Bridges along the corridor

Bridge description
<p>Harris Creek Road Bridge (new and replacement bridge)</p> <p><i>The proposal includes the duplication and replacement of the existing two lane bridge over Harris Creek. The bridges are required at this location to carry the west and east bound carriageways over Harris Creek. The bridges will be a twin type arrangement consisting of two separate structures independently carrying the west and east bound carriageways. The existing bridge doesn't meet the current standards, is a major flooding constraint and reaching the end of its life.</i></p>
<ul style="list-style-type: none"> • About 60 metres long, the northern bridge 10 metre wide and the southern bridge 14 metre wide • Pre-stressed concrete winged plank construction • Three spans about 20 metres wide • Piers located outside of normal flow channel • Two traffic lanes, 3.5 metres wide • Outside shoulders 1.5 metres and inside 0.5 metres • Provision of a 3.6 metre wide shared use path on the southern bridge • Safety barriers would be installed on the outside of the bridge • Lighting may be installed over the bridge.
<p>T2 Airport Railway Line Road Bridge (new bridge)</p> <p><i>The duplication of the existing two lane bridge over the East Hill railway line would involve the construction of a new bridge over the railway with a vertical clearance of 6.5 metres between the top of rail and underside of bridge to meet the requirements of Sydney Trains.</i></p>
<ul style="list-style-type: none"> • About 30 metres long and 16 metres wide • Pre-stressed concrete bulb tee construction • Vertical clearance of 6.5 metres between the top of railway and underside of bridge • Span arrangement is governed by the existing twin tracks and the required vertical clearance requirement • Two traffic lanes, 3.5 metres wide • Outside shoulders 1.5 metres and inside 0.5 metres • Provision of a 3.6 metre wide shared use path • Safety barriers would be installed on the outside of the bridge • Lighting may be installed over the bridge • Scuppers would be installed to provide stormwater drainage.

Bridge description

Williams Creek Road Bridge (new and replacement bridge)

The proposal includes the duplication and replacement of the existing two lane bridge over Williams Creek. The bridges are required at this location to carry the west and east bound carriageways over Williams Creek. The bridge will be a twin type arrangement consisting of two separate structures independently carrying the west and east bound carriageways. The existing bridge doesn't meet the current standards, is a major flooding constraint and reaching the end of its life.

- About 30 metres long, the northern bridge 10 metres wide and the southern bridge 14 metres wide
- Pre-stressed concrete spaced plank construction
- Three spans about 10 metres wide
- Piers located outside of normal flow channel
- Two traffic lanes, 3.5 metres wide
- Outside shoulders 1.5 metres and inside 1.0 metres (Northern Bridge)
- Outside shoulders 2 metres and inside 0.5 metres (Southern Bridge)
- Safety barriers would be installed on the outside of the bridge
- Lighting may be installed over the bridge.

Pedestrian bridges

The proposal will require the partial removal of the superstructure of the Holsworthy Pedestrian Bridge to allow for the new Harris Creek road bridge construction. This involves demolition of the bridge superstructure and abutments, leaving the piers, iron fixings and plaque of the bridge to remain. A number of utilities are attached to this bridge which will require relocation, refer to section 3.6.

Intersections

The proposal includes three intersection/junction upgrades. Table 3-4 describes the intersection configuration.

Table 3-4: Intersections along the corridor

Intersection description

Macarthur Drive intersection: new four way signalised intersection

Heathcote Road:

- Four lane approaches and two lane exit north and south bound
- Dual through lanes north and south bound
- Dual right turn only lanes south bound, and a slip lane for left turns only
- Single northbound right turn only lane, and a slip lane for left turns only.

Macarthur Drive:

- Four lane approach (from the west) including dual left hand turn only, and a single right turn only lane.

Harris Creek Reserve

- Three lane approach (from the east) including a single right turn only lane.

Crossing provisions:

- Dropped kerb pedestrian crossing on all arms
- Dropped kerb cycle crossing on the southern arms.

Intersection description
Soldiers Way intersection: improved crossing provisions
Crossing provisions: <ul style="list-style-type: none"> • Dropped kerb cycle crossing on the western arm across Heathcote Road.
The Avenue intersection: signalisation of the existing T-junction
Heathcote Road: <ul style="list-style-type: none"> • Two through lane approach northbound, including a single right turn only lane • Two southbound through lane, and a slip lane for left turns only. The Avenue: <ul style="list-style-type: none"> • Single lane approach providing for left and right turn movements. Crossing provisions: <ul style="list-style-type: none"> • Dropped kerb pedestrian crossing on The Avenue • Dropped kerb cycle crossing at The Avenue • No pedestrian access has been provided across Heathcote Road.

Side roads

The proposal intersects with a side access road used to access Harris Creek Oval. The configuration and width of the road would be altered to support all in, out and through movements. The road would be signalised as it forms the northern arm of the Macarthur Drive intersection.

Shared use path

The shared use path would be designed in accordance with Minimisation of Conflict on Pedestrian Cycle Routes (Austroads Research Report, 2006). It would be built along the southern side of the road between Infantry Parade and Soldiers Way, and the northern side of the road between Soldiers Way and The Avenue. The path would be about three metres throughout and it would involve:

- Widening the existing footpath on the southern side of the road to the west of Macarthur Drive
- Building a new path on the southern side of the road to the east of Macarthur Drive up to Soldiers Way
- Building a new path on the northern side of the road to the east of Soldiers Way to Infantry Parade.

The proposal would also involve building a 2.5 metre wide shared use path on the eastern side of The Avenue from Heathcote Road to Lilli Pilli Drive.

3.3.2 Urban design and landscape

The proposal's urban and landscape design strategy is to reinforce the vegetated character of the road corridor through the use of appropriate native planting and restore areas outside the corridor disturbed by construction with appropriate native vegetation from local ecological communities.

The road therefore needs to be designed and landscaped to be functional in its future context and setting, by fitting in with its future landform. It also needs to provide an environment that people can easily navigate around and the Liverpool City Council can easily maintain.

Objectives

The objectives as presented in the strategy are to:

- Link the more developed northern section of the road corridor with sensitive bushland to the south
- Protect sensitive environments adjacent to the road corridor including endangered ecological communities, riparian crossings and local residences
- Provide effective linkages to Holsworthy Train Station and Holsworthy Army Barracks with improved amenity for pedestrians and cyclists
- Integrate the proposed Holsworthy Army Barracks entry feature 'Anzac Memorial' into the road corridor design
- Reference the rich military heritage of the area within the road corridor design.

Design principles

The corresponding design principles are to:

- Reinforce the vegetated character of the road corridor through the use of appropriate native planting
- Restore areas outside the corridor disturbed by construction with appropriate native vegetation from local ecological communities
- Introduce appropriate riparian planting at the Harris Creek and Williams Creek crossings
- Select batter vegetation on either side of the road corridor to screen the built form and reduce the scale of infrastructure elements.
- Embellish the entry features to Holsworthy Barracks with feature/gateway planting.

Planting strategy

The planting proposal is to:

- Mark upgraded intersections with feature planting
- Select grasses, low groundcovers and groups of native trees that adhere to sightline and stopping distance standards
- Ensure the drainage swales are planted with appropriate wetland vegetation, integrating water sensitive urban design where possible.

3.3.3 Stormwater and road drainage

The proposal would include the following drainage infrastructure:

- Longitudinal drains
- Cross drains
- Bridge drainage
- Swales.

Longitudinal drains

Longitudinal drains would run alongside the road. They are designed to remove surface water from the road as quickly as possible. The longitudinal drains collect water and either discharge it to a cross drain, a water detention basin, a water quality basin, to the ground or to a surface water course.

Cross drains

Cross drains transfer water under the road and are designed to collect water from longitudinal drains however they are also installed along natural low points on a road to allow natural stormwater runoff from the surrounding land to drain across a road.

Bridge drains

Scuppers are installed on bridges. They are designed to remove surface water from the road as quickly as possible. The scuppers either allow the water to fall directly to the ground or they connect into a short section of pipe to channel the water to allow it to fall directly to the ground.

Swales

Swales are designed to regulate the capture and discharge of water to prevent surface watercourses from becoming overloaded, areas from locally flooding or to prevent scour and erosion.

Flood protection

An overall purpose of the stormwater and road drainage strategy is to provide improved flood immunity. This involves designing the road and the stormwater system to handle the runoff that would occur during a particular storm event. Under this proposal:

- The overall road would be designed to handle the rainfall that would typically fall from a storm event that would only occur once every 100 years
- The longitudinal and cross drainage would be designed to handle the runoff from a storm event that would occur once every 10 years and one traffic lane within a 100 year storm event
- The bridge drainage would be designed to handle the runoff from a storm event that would occur once every 10 years.

Liverpool City Council's drainage specification: AUS-SPEC-2\NSW-220 (Liverpool City Council 2000) will need to be utilised wherever drainage discharges or within Council land. The main alignment will be detailed to Roads and Maritime Specifications. Table 3-5 describes the drainage that would be installed in each location.

Table 3-5: Stormwater and drainage infrastructure

Location	Stormwater and drainage infrastructure
Infantry Parade to Harris Creek	<ul style="list-style-type: none">• Mixture of new catch and piped drains flowing south to a low point north of Harris Creek• Discharge into Harris Creek.
Harris Creek to Macarthur Drive	<ul style="list-style-type: none">• Use of existing open channels flowing north to a low point and discharging into Harris Creek• New piped drains also flowing north, also discharging to Harris Creek• Three new cross drains.
Macarthur Drive to Chainage 840	<ul style="list-style-type: none">• Flow to a low point on the eastern side of chainage 840. An existing culvert is located here• New catch drains on the eastern side of the road flowing to the low point• Piped drainage system flowing south to chainage 840• One new cross drain.
Chainage 840 to the East Hill Railway Line	<ul style="list-style-type: none">• New piped drains of the road flowing north to chainage 840• Discharge at chainage 840• One new cross drain.
East Hill Railway Line to Soldiers Way	<ul style="list-style-type: none">• Flow to a low point just to the western end of Soldiers Way• Mixture of piped and catch drains at the depressed median flowing to the low point• New catch and piped drains along the kerbs on both sides of the road flowing toward Soldiers Way• Discharge to an existing catch drain located south of the road• Two new cross drains• Existing drainage system to be maintained at Soldiers Way.

Location	Stormwater and drainage infrastructure
Soldiers Way to Williams Creek	<ul style="list-style-type: none"> • Flow to a low point just north of Williams Creek • New catch drains south of the road flowing to the low point • Four new cross drains within this section • Discharge to an existing pond located to the west of the road • Two new cross drains.
Williams Creek to The Avenue	<ul style="list-style-type: none"> • New catch drain on either side of the road flowing toward the low point at Williams Creek • New piped system from The Avenue to Williams creek • Existing drainage at The Avenue to be investigated and if possible maintained.

3.3.4 Street lighting

The concept lighting design has been prepared for the project and will be further developed at the detailed design phase. It will be developed in accordance with Roads and Maritime quality assurance specification R72: Street Lighting (Roads and Maritime, 2014d) and R151: Street Lighting (Roads and Maritime, 2013). All existing light poles are assumed to be removed for the concept design and new light poles to be installed throughout the project extents, except at the recently built Holsworthy Barracks Access Road intersection where existing street lighting is to remain. Street lighting installations will typically be single lighting columns with singular outreach arms. These will be located outside the clear zone at the back of the shared user path, on both sides of the proposed upgrade.

3.3.5 Signage, signalise and street furniture

Signposting requirements and related issues such as sign structures would be considered during the detail design phase of the proposal and it would be developed in accordance with the Road and Maritime quality assurance specifications:

- R131: Guide Posts (Roads and Maritime, 2009)
- R132: Safety Barrier Systems (Roads and Maritime, 2012)
- R143: Signposting (Roads and Maritime, 2015)
- R156: Maintenance Traffic Signals (Activity-Based) (Roads and Maritime, 2012)
- R157: Maintenance of Traffic Signals (Performance-Based) (Roads and Maritime, 2012)
- R201: Fencing (Roads and Maritime, 2013).

Existing traffic signals at the intersections with Infantry Parade and Holsworthy Barracks Access Road would be retained as is. New traffic signals are proposed at the intersections with Macarthur Drive and The Avenue. The traffic signals at Macarthur Drive, Holsworthy Barracks Access Road and The Avenue would provide road crossings for the proposed shared use path. Existing roadside furniture has been identified within this proposal and is to be updated throughout the detailed design phase.

3.3.6 Power supply

Electrical power cables would also need laying in the road margins to supply the street lighting, signage and other powered equipment. This would be supplied by building subsurface covered pits that would be designed in accordance with Roads and Maritime quality assurance specification R155: Design and Construction of Underground Cableways (Roads and Maritime, 2013c). The cable troughs would be prefabricated off-site and laid in an excavated trench and covered. Service access pits would be installed along the cableways for maintenance in the future.

3.3.7 Retaining walls, batter slopes, cutting and fill

The proposal has adopted 4:1 batter slopes where there is sufficient space available. Where space is limited, such as on the westbound approach to the bridge over the railway, the batters have

been steepened to a maximum of 2:1. An appropriate safety barrier would be required at such locations. Two retaining walls are required for the proposal:

- A large wall to the east of Macarthur Drive as the road rises above the rail line, about nine metres high and of reinforced soil wall construction, and
- A smaller retaining wall at the entry to Voyager Point along the eastern side of The Avenue, about 2.5 metres high and an L shaped canter levered concrete wall construction.

Table 3-6 describes the major batters and retaining walls along the corridor. Excavations would be required for the construction of the bridges and for the relocation of the utilities, cut and fill volumes are discussed in section 3.4.6.

Table 3-6: Main batters and retaining walls

Location	Description: batter heights
Batter slope to support the approach lanes to the road bridge over the Harris Creek	<ul style="list-style-type: none"> • 1.5 metre south of the bridge • 1.3 metre north of the bridge
Batter slope to support the approach lanes to the road bridge over the T2 Airport Railway Line	<ul style="list-style-type: none"> • 7.5 metre south of the bridge
Batter slope to support the approach lanes to the road bridge over the Williams Creek	<ul style="list-style-type: none"> • 3.2 metres south of the bridge • 3.6 metres north of the bridge
Reinforced soil retaining wall east of Macarthur Drive as the road rises above the T2 Airport Railway Line	<ul style="list-style-type: none"> • Nine metres on the southern side of the road
L shaped canter levered concrete retaining wall at The Avenue	<ul style="list-style-type: none"> • Joins to the existing retaining wall that is 2.5 metres on the eastern side of The Avenue.

3.4 Construction activities

The likely method, staging, work hours, plant and equipment requirements needed to build the proposal are described in this section. An indicative work plan and method are also provided.

At this stage, Roads and Maritime needs to secure funding to build the proposal. Roads and Maritime would then appoint a contractor to build the proposal. It is also possible that certain sections may be built at the same time depending on the sale and uptake of land and therefore the need to access the area.

The contractor appointed to build the proposal would prepare a detailed construction plan and method once the proposal's design is finalised. The work plan and method may allow for several activities to be undertaken at the same time. It would also account for the need to minimise traffic impacts on the major roads in the area, particularly during peak periods. The actual work method may vary from the description provided in this section due to the identification of additional constraints before work starts, ongoing detailed design refinements, feedback from community and stakeholder consultation, and contractor requirements/limitations.

3.4.1 Work methodology, construction staging and activities

The proposal would be built over about two years. It would be built in a sequence that prioritises the building of the three bridges. The staging would also assume that the road would be widened offline of the existing road. The existing traffic would then be transferred to new traffic lanes to allow the existing traffic lanes to be upgraded and resurfaced.

The indicative work stages would involve:

- Stage 0: relocating utilities and works to overhead wires, utilities and earth retaining walls during track possessions
- Stage 1: building the three new bridges and creating the bridge approaches
- Stage 1A: widening the road
- Stage 2: switching the traffic and demolishing and replacing the existing bridges
- Stage 3: upgrading and retaining the existing road and altering the intersections
- Stage 4: opening the road.

Each stage would generally involve a similar sequence of work activities namely:

- Activity 1: site establishment and environmental protection
- Activity 2: utility adjustment/installation, stormwater drainage work and major earthwork
- Activity 3: road, bridge and intersection removal, and/or building and repair
- Activity 4: supporting infrastructure installation (ie signage, lighting)
- Activity 5: amenity planting, landscaping and final earthwork
- Activity 6: finalisation work
- Activity 7: site demobilisation and handback.

Work stages

Figure 3-3 lists the key aspects of the proposal that may be built under each stage.

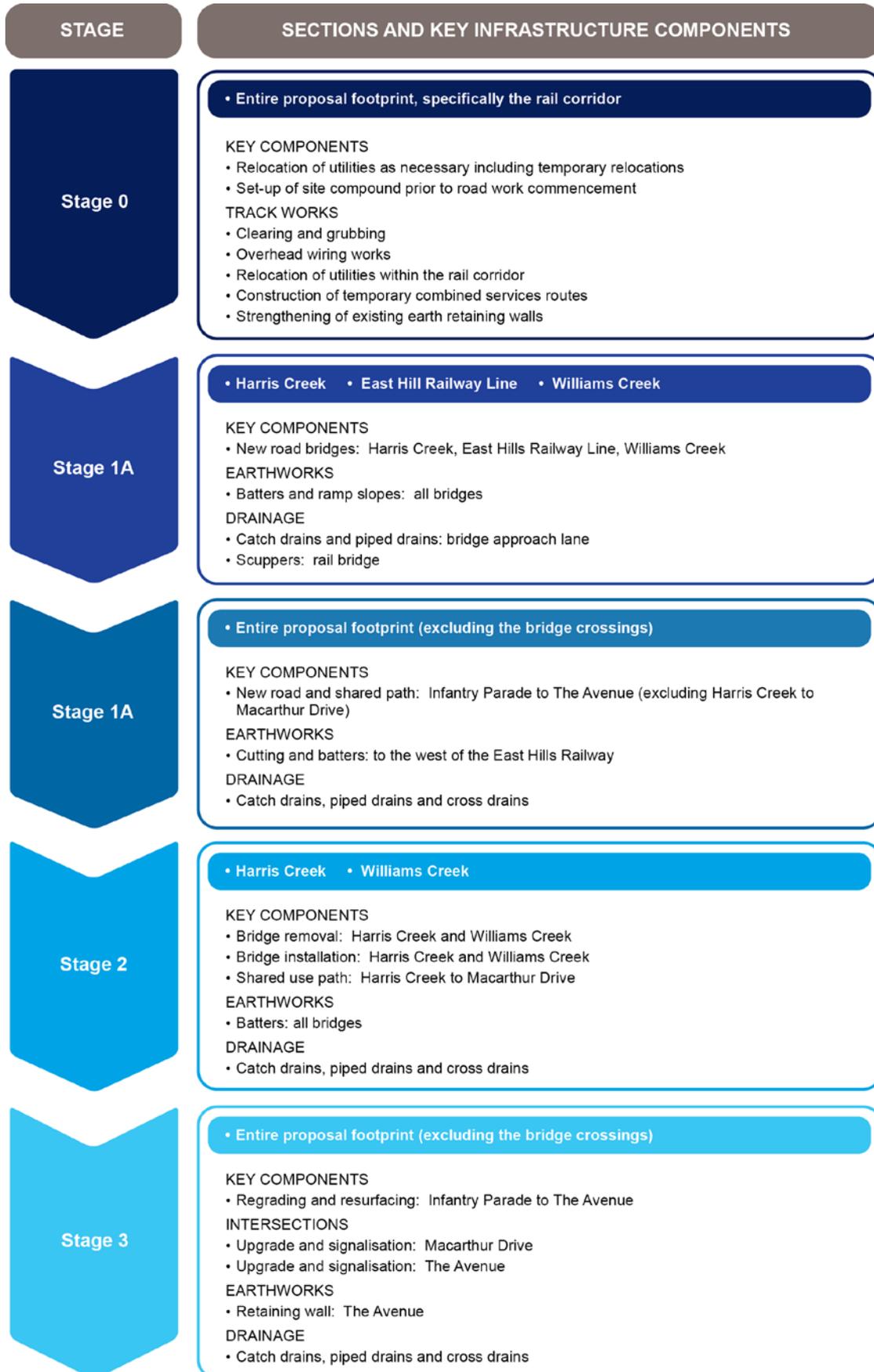


Figure 3-3: Proposed construction staging

Work activities

Table 3-7 describes the likely work activities that would be undertaken to build the proposal. It is likely that the following activities would take place across all work stages in all sections of the proposal footprint.

Table 3-7: Typical work activities

Activity and work description
Activity 1 (Site establishment and environmental controls)
<ul style="list-style-type: none">• Setup environmental, safety and traffic management controls (refer to Chapter 7)• Pre-clearance surveys and obtaining any permits or licences in advance• Site demarcation, exclusion fencing and barrier establishment, identification and protection of sensitive areas (ie habitat zones, trees)• Establish site compounds (refer to section 3.5), designated storage areas, stockpile areas and stabilised access to work zones across the proposal footprint• Establish piling pads for bridge construction (location to be determined during detailed design)• Land clearance (vegetation removal, clearing and grubbing) and property adjustments• Install security fencing• Install a temporary reduced speed limit (where required)• Install temporary creek site drainage controls where needed• Cover existing signage and provide diversionary signage for all road users, cyclists and pedestrians (and introduce temporary footpath closures/restrictions, where needed).
Activity 2 (Utility adjustments, drainage and major earthwork)
<p>Utilities</p> <ul style="list-style-type: none">• Protection (existing)• Adjustment and relocation (existing)• Installation and testing (new)• Tie-in (new) <p>Earthwork</p> <ul style="list-style-type: none">• Sequentially strip and excavate top soil and sub soil• Grade and compact areas (where required at this stage) <p>Drainage lines</p> <ul style="list-style-type: none">• Installation (new) <p>Note: the bridge utilities and drainage would be installed when building the bridges.</p>

Activity and work description

General utility work

The work activities would vary depending on whether the utility was being relocated, removed or installed.

Typically it would involve a mixture of

- Trench excavation
- Under-boring for water mains at Harris Creek
- Bedding material installation
- Pipeline and conduit installation
- Cable pulling to install new power and communications cables
- Pit and cutover excavation
- Valve, switch and other infrastructure installation to allow the transfer of utilities to the new alignment
- Utility and service testing and commissioning
- Concrete pouring to create protective slabs
- Backfill and compaction
- Ground surface restoration.

Drainage work

The work activities would vary depending on whether the drainage was being relocated, removed or installed.

Typically it would involve a mixture of:

- Set out the changes including the location, lengths, levels and outlets/inlets for pipes, culverts, pits, junction boxes and structures
- Include temporary diversions and erosion and sediment control measures
- Excavate overburden on existing structures and protect, cap, seal and remove any existing infrastructure
- Trench excavation for the new structures and inclusion of measures to protect any retained drainage structures
- Install foundation and bedding material
- Install and connect infrastructure
- Undertake integrity and flow testing
- Backfill and compaction with excavated materials or else import new clean fill
- Ground surface restoration.

Activity 3 (Road, bridge and intersections)

Road and shared use path

- Implement diversions and traffic management controls (where needed)
- Remove materials to support the new kerb/median alignment and depth (termed boxing out)
- Prepare and level the subgrade
- Place and compact pavement layers
- Install new stormwater drainage pits, pipes and connections
- Install new kerbs and stormwater inlets.

Activity and work description
<p>Bridges</p> <ul style="list-style-type: none"> • Prepare excavation platform and pad either side of the creek/railway lines, including vegetation clearance where required • Install foundation, including bored piling, pile caps and pad footings (which may include dredging or reclamation work – within the definition of the NSW <i>Fisheries Management Act 1994</i> – for work within/over Harris and Williams Creeks) • Build abutments, piers and batters on the approaches • Install superstructure, deck and pavement • Install drainage • Install utilities, communication, lighting and signage.
<p>Re-grading and resurfacing</p> <ul style="list-style-type: none"> • Strip and remove pavement surface layers • Grade, level and compact the subsurface • Lay and compact new pavement layers • Adjust and install stormwater drainage pits, pipes and connections • Adjust and install kerbs and stormwater inlets.
Activity 4 (Supporting infrastructure)
<ul style="list-style-type: none"> • Install power supply, cables and conduits • Install traffic signs and signals • Install permanent safety barriers • Install lighting (including conduits and cables).
Activity 5 (Landscaping, final earthwork)
<ul style="list-style-type: none"> • Final grading, levelling and compaction • Landscaping along the verges.
Activity 6 (Finalisation)
<ul style="list-style-type: none"> • Implement final kerb adjustments and side-road lines (where required) • Tie-ins to the existing roads • Permanent line markings.
Activity 7 (Site demobilisation)
<ul style="list-style-type: none"> • Demobilise the site compounds • Remove temporary traffic management controls to allow traffic to use all lanes and intersections • Remove temporary footpath restrictions/closures • Remove environmental, safety and traffic controls (refer to Chapter 7).

3.4.2 Construction hours and duration

This section describes the time it would take to build the proposal and the working hours.

Construction duration

It is expected that the proposal would take about two years to build. The program would be designed to minimise impacts on road users, residents, businesses and pedestrians, wherever possible. A large part of the construction work would involve detailed planning and coordinating the work schedule with utility and services providers, property owners, businesses, Transport for NSW, Sydney Trains, and the Department of Defence. The complexity of these issues together with

minimising impacts would mean that there would be intermittent periods of more intense construction work and periods when little or no work would take place.

The overall objective of the work program would be to undertake the work in a timely and efficient manner considering the need to:

- Allow traffic to use Heathcote Road particularly during the morning and evening peak periods
- Ensure the work does not conflict with the traffic management controls implemented on other projects in the area
- Ensure that the disruption to businesses and residents is minimised
- Obtain access to relocate utilities and coordinate the work to minimise user supply disruption
- Ensure the proposal's impacts would be managed in accordance with the safeguards and management measures identified in Chapter 7 of this REF to minimise environmental and social impacts.

Construction hours

The proposed work schedule can be broadly divided into:

- Work that is able to take place at any time
- Work needing to take place under temporary railway possession (rail bridge).

Standard hours

The majority of the work would take place during the daytime in accordance with the recommended standard hours for construction work set by the NSW Interim Construction Noise Guidelines 2009 namely:

- Monday to Friday 7am to 6pm
- Saturday 8am to 1pm
- No work on Sunday or public holidays.

Out of hours (night work and weekend work)

The ability to undertake night and weekend work (termed out of hours work) would be managed in accordance with adopted out-of-hours protocol (refer to section 6.6.5). The out of hours protocol would allow aspects of the new bridge over the railway line, and the Macarthur Drive intersection to be built.

Rail bridge

Sydney Trains and Transport for NSW have restrictions on doing work inside the rail corridor because of trains operations and worker safety concerns. As such, most of the work to build the railway bridge would be restricted to when trains are not running which is normally scheduled for three or four weekends every year, when Roads and Maritime could 'take possession' of the railway line. As such, the following work activities would be undertaken under possession. They would take place over the course of three or four weekends including both day and night work:

- Installing the bridge abutments and batters within the railway corridor
- Lifting and installing various parts of the bridge deck.

Other night work

The following activities would likely take place at night to minimise traffic disruption and for safety reasons:

- Removal of the Macarthur Drive roundabout and raised median islands
- Other intersection work including installation of signal posts and electrical work
- Final round surfacing and line marking.

3.4.3 Workforce

It is likely that about 50 people would be onsite on average at any one time. It would be likely that the workforce would drive to site. The Traffic Management Plan would outline designated parking areas (refer to section 6.5.4).

3.4.4 Plant and equipment

The plant and equipment needed to build the proposal would vary depending on the work activity being undertaken. Various equipment would be common to all work activities while certain specialist equipment would be brought onsite for specific activities. Figure 3-4 provides an indicative list of plant and equipment that would be used onsite. Not all the equipment would be used at the same time. Its use would depend on the activity being undertaken, which would be confirmed during the detailed design in consultation with the work contractor.

CONSTRUCTION EQUIPMENT LIST	ACTIVITY 1	ACTIVITY 2 UTILITIES	ACTIVITY 2 EARTHWORKS	ACTIVITY 2 DRAINAGE	ACTIVITY 3 BRIDGE AND RAMPS	ACTIVITY 3 ROAD CONSTRUCTION	ACTIVITY 4	ACTIVITY 5	ACTIVITY 6	ACTIVITY 7
Angle grinder		●		●	●	●	●		●	
Backhoe/excavator		●	●	●	●	●	●		●	
Bobcat	●	●	●	●	●	●	●	●	●	●
Cherry picker				●	●					
Compactor				●	●	●	●		●	
Concrete agitator				●	●	●	●		●	
Concrete pump				●	●	●	●		●	
Concrete saw		●		●	●	●	●		●	
Dozer			●							
Generator	●		●	●	●	●	●	●	●	●
Grader			●							
Hand tools	●	●	●	●	●	●	●	●	●	●
Hydraulic crane		●		●		●	●		●	
Jackhammer		●				●	●		●	
Linemarking machine							●		●	
Mini excavator		●	●			●	●		●	
Piling machine				●	●					
Paving machine				●	●	●				
Profiler				●	●	●				
Road planer				●	●	●				
Roller				●	●	●				
Small dozer		●		●	●	●	●		●	
Small excavator (10-20t)								●		
Small grader		●		●	●	●	●		●	
Suction sweep		●		●	●	●	●		●	
Tipper truck	●	●	●	●	●	●	●	●	●	●
Trucks	●	●	●	●	●	●	●	●	●	●
Vibratory roller				●	●	●	●		●	
Water cart			●	●	●	●	●	●	●	

Figure 3-4: Indicative plant and equipment

3.4.5 Earthwork

Excavations would be required to widen the road, build the bridges and to relocate utilities. The ability to reuse the material would depend on its physical and chemical properties. Uncontaminated material that is not suitable for use as structural fill could be used to line the utility trenches or in areas of landscaping. Material unsuitable for construction use would need to be transported offsite by a licensed contractor for disposal at a licensed waste management facility following testing and classification (refer to section 6.11.2). In summary, it is estimated that the proposal would require:

- About 1,750 cubic metres (m³) of material to be excavated
- About 61,500 m³ of fill material.

As such, the proposal would require the import of 60,000 m³ of material. This assumes that all the excavated (cut) material would be physically and chemically suitable to reuse as engineering fill. The area's history as a road reserve means some of the material may contain contaminants of concern, which would prevent its reuse, and material excavated from the vicinity of the two creeks may contain acid sulphate soils (refer to section 6.4). Any unsuitable or surplus material would be managed in accordance with Roads and Maritime policy, in order of preference:

- Reused as part of the proposal
- Transferred to another Roads and Maritime proposal site for use under the resource recovery exemption provisions of NSW Protection of the Environment Operations (Waste) Regulation 2014 (refer to section 4.2.7)
- Transferred to a Roads and Maritime stockpile site for a pre-identified future use on another proposal under the above exemption provisions
- Transferred offsite for use on another proposal under the above exemption provisions
- Transferred to a licenced waste recovery facility
- Disposed to a licenced facility either as a last resort or if the material contains either weed seed stock or elevated contaminants of concern.

Section 6.11.2 describes this in the context of the environmental assessment.

Stockpile management

Initially, stripped topsoil would be stored separately from the excavated spoil (subsoil). In all instances, the topsoil would be transferred offsite for stockpiling at the main site compound (refer to section 3.5). Ideally, the excavated material and imported material would be immediately transferred from areas of cut to areas of fill or landscaping areas, providing it is chemically and physically suitable to reuse as excavated natural material. However, program constraints and schedules may see the need to temporarily stockpile this material at the closest site compound (refer to section 3.5). Each stockpile would be managed in accordance with the Stockpile Site Management Guidelines (Roads and Maritime, 2008a) and quality assurance specification R50: Stabilisation of Earthworks (Roads and Maritime, 2011e) to ensure it was located away from sensitive areas such as watercourses, marshy areas, residents and/or flood-prone land to minimise the risk of leaching, erosion, sediment dispersion, dust dispersion and other amenity impacts. The location of any new stockpile sites outside of the main compound would need agreeing with Roads and Maritime as described in section 3.5.

Waste management and handling potentially contaminated material

While the excavated material would be representatively sampled to support its waste and reuse classification before work starts, there is still the risk that unexpected fill or dumped material or isolated poor quality material may be unearthed during the work. Therefore, there would be a process in place to allow all the material to be classified, sorted and separated. Depending on its classification, it would either be reused (and therefore stockpiled at the main site compound, refer to section 3.5) or it would be transported offsite for reuse, recycling or disposal. Additional controls would be implemented if the excavated material is suspected to contain elevated concentrations of contaminants (refer to section 3.5). This would include additional storage, handling and disposal controls.

3.4.6 Source and quantity of materials

Various construction materials would be needed to build the proposal. Major prefabricated deliveries are likely to be transported directly to their point of use given their size and scale. Otherwise, the materials would be transported to the site compound when needed. Table 3-8 shows estimates of the main material quantities that would be needed to build the proposal.

Table 3-8: Building material estimate

Material	Estimated quantity
Engineering fill (volume)	65,000 m ³
Pavement (composite and flexible): asphalt (volume)	12,000 m ³
Sub base (composite and flexible): selected material (volume)	1,880 m ³
Sub base (composite): concrete (volume)	3,500 m ³
Base (composite and flexible: crushed rock and aggregate (volume)	To be determined during detailed design
Asphalt and bitumen: general (volume)	96,000 litres
Concrete: general (volume)	60000 m ³
Kerbs (length)	4,500 metres
Retaining wall (length)	The Avenue: 110 metres Heathcote Road: 122 metres
Drainage materials: Precast Concrete and fibre reinforced concrete pipes (length)	2,130 metres
Drainage materials: Concrete Lining of Open Drains (length)	1,000 metres

These materials are widely available across the metropolitan area. They would be transported either directly to site or to the site compound (refer to section 3.5) via agreed haul routes (refer to section 3.4.7). Hazardous material would be stored in contained areas and certain work activities that would involve using some of the above materials (such as minor maintenance and refuelling) would only take place in contained areas (refer to section 3.5). Roads and Maritime would promote the use of locally-sourced materials that contain a high recycled content and low embodied energy where they are cost and performance competitive and comparable in engineering performance (refer to section 6.11.2).

3.4.7 Traffic management and access

Traffic management and access controls would be developed during the detailed design and implemented under a construction traffic management plan (refer to section 6.5).

Staging and traffic management

The purpose of building the proposal in stages is to reduce any impacts on operational traffic on Heathcote Road. Certain work activities would also likely take place at night to minimise any traffic-related impacts (refer to section 6.5.4).

Provisionally, traffic management controls would be needed:

- On the Heathcote Road, when installing the bridge piers, abutments and superstructures and undertaking cross-drainage work (Stage 1, Stage 2 and Stage 3)
 - Likely night time lane closures and occasional carriageway closures
- Improving and tying into the intersection at Macarthur Drive and The Avenue (Stage 3)
 - Temporary lights and/or stop-go operations
 - Temporary speed limit restrictions
- Undertaking the work to widen and upgrade the existing section of Heathcote Road (Stage 3)
 - Temporary lights and/or stop-go operations
 - Potential one-way operations
 - Temporary side road access restrictions
 - Temporary speed limit restrictions.

Access

It is not expected that there would be any private property access restrictions while the proposal is being built. However, the use of temporary traffic lights and/or stop-go signs at the various intersections and the implementation of reduced speed limits, as discussed above, may lead to marginal travel time delays. Also, there will be a need to limit or control access into and out of the major intersections while building the proposal.

Construction and delivery traffic and workforce vehicles

On average, it is expected that about 50 heavy vehicle trips would be needed to service building the proposal each day. This number would vary depending on the work activity, section and stage. The work traffic would be supplemented by additional material deliveries and workforce traffic. Deliveries would be scheduled to avoid peak periods and it would be expected that about 20 vehicles would arrive and leave site each weekday on average. Also, about 50 contractors would arrive and leave site each weekday on average. In total on average, there would be about 130 added vehicle movements per day generated in building the proposal. This may increase to about 300 vehicle movements during the busiest periods.

Haul routes

Haul routes describe the roads that the work and delivery traffic would use to enter and leave the area. Roads and Maritime would restrict the contractor(s) to using the major roads, thereby reducing the demand on local roads. In the case of the proposal, the main haul routes would be the M5 Motorway, Princes Highway and Heathcote Road. Equally, construction traffic would be prevented from hauling along local and minor roads. Haul routes would be defined in the Construction Traffic Management Plan.

3.5 Ancillary facilities (site compounds)

One site compound, covering an area of about 2,700 m², would be established on the western side of Heathcote Road to the north of Harris Creek. This would be used to support building the proposal. It would be supplemented by three specific laydown areas to support building/ demolishing the bridges.

The compound and site laydown areas would operate while the proposal is being built. This would include some limited out of hours operation when the related weekend and night work takes place (refer to section 3.4.2). It is expected that any site access directly from Heathcote Road would operate as a left-in, left-out arrangement with short deceleration lanes provided. Given that the speed limits are likely to be reduced to 40 km/h (up to a maximum of 60 km/h) during the construction period, no formal heavy vehicle acceleration lanes would be required to access Heathcote Road directly.



Figure 3-5: Proposed location of ancillary site

3.5.1 Site selection criteria

The compound and laydown areas were selected to achieve the following as per Stockpile Site Management Procedures (Roads and Maritime, 2008a):

- At least 40 metres away from the nearest waterway
- Including an area of low ecological and heritage conservation significance
- Of relatively level ground
- Outside of any area that would flood as a result of a storm event that would only typically occur once every 10 years
- On previously disturbed areas
- In public view to deter theft and illegal dumping.

The guidelines also promote locating the site at least 100 metres from noise sensitive receivers. However, there is no suitable location close to the proposal footprint where this could be achieved. The only alternatives would be located away from the proposal footprint, which would introduce additional challenges in terms of transportation and logistics issues. It would also extend the length of the construction program. Therefore, specific management controls would be introduced at the site compound to manage the work as described in Chapter 7.

3.5.2 Use and activities

Indicatively, the main compound would be used for:

- Material storage and laydown
- Temporary waste storage
- Stockpiling
- Refuelling
- Construction equipment, plant and vehicle storage
- Vehicle wash down
- Inspections, maintenance and repairs
- Temporary site offices, lunch room, and welfare facilities (toilets)
- Staff parking and amenities.

Indicatively, the laydown areas would be used for:

- Material storage and laydown
- Crane platform and access.

3.5.3 Material delivery and set down

Larger items, such as prefabricated bridge beams, are likely to be delivered to site under traffic management controls. These components would be set down in the laydown areas, inspected and then installed via crane.

3.6 Public utility adjustment

The proposal would require certain above and belowground utilities and services to be adjusted, relocated or installed along the alignment. The proposal would mainly be to relocate the utilities:

- Adjacent to the road reserve
- Along the road margin under the shared use path
- Under bore (drill under) Harris Creek and Williams Creek.

A Utility Options Report has been prepared for the proposal (WSP Parsons Brinckerhoff, 2016). This provides the detailed utility adjustments that would be needed to build the proposal and the consultation that has taken place with the utilities. The preferred locations for utilities are illustrated in the concept design (Appendix C). Tables summarising the adjustments and consultation with the utilities are provided in Appendix F. Public utility providers, as summarised in section 5.5.

3.7 Property acquisition

Roads and Maritime is not expecting to acquire any property or land to build the proposal based on the concept design. This would include the site compound and laydown areas which are located in the road reserve. There are however two existing tracks on the adjacent Department of Defence land that would be upgraded to provide access to the railway line to construct the bridge (refer to Figure 3-1, map 2) and for certain utilities to access their infrastructure. Their use, upgrade and any property adjustments would be in agreement with the Department of Defence and relevant utilities.

4 Statutory and planning framework

This Chapter describes the legislation, regulation and planning provisions that would apply to the proposal or to the land on which the proposal would be built by referring to relevant environmental planning instruments (EPIs). The Chapter also confirms the statutory position and identifies the approvals, licences, and notices needed in order for the proposal to proceed.

4.1 Environmental Planning and Assessment Act 1979

4.1.1 State Environmental Planning Policies

The following State environmental planning policies (SEPPs) are relevant to the proposal or the land on which the proposal would be built.

4.1.2 State Environmental Planning Policy (Infrastructure) 2007

State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) aims to facilitate the effective delivery of infrastructure across the State. Clause 94 of ISEPP permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent. As the proposal is for a road and is to be carried out by Roads and Maritime, it can be assessed under Part 5 of the NSW *Environmental Planning and Assessment Act 1979*. Development consent from council is not required.

The proposal is not located on land reserved under the NSW *National Parks and Wildlife Act 1974* and does not affect land or development regulated by State Environmental Planning Policy No. 14 - Coastal Wetlands, State Environmental Planning Policy No. 26 - Littoral Rainforests, State Environmental Planning Policy (State and Regional Development) 2011 or State Environmental Planning Policy (Major Development) 2005. Consequently, the provisions of ISEPP prevail over other EPIs and the proposal has a valid planning pathway under Part 5 of the EP&A Act.

Part 2 of the ISEPP contains provisions for public authorities to consult with local councils and other public authorities prior to the commencement of certain types of development. Consultation, including consultation as required by ISEPP (where applicable), is discussed in chapter 5 of this REF.

4.1.3 Local Environmental Plans

The proposal is located within the Liverpool City Council local government area (LGA). The operation of the Infrastructure SEPP means that the local environmental plans (LEPs) would not apply where they impose controls that are inconsistent with the Infrastructure SEPP. However, the LEP is still relevant in identifying land use objectives, potential land use impacts and planning policy conflicts. Table 4-1 describes the land use objectives of each zone and the proposal's consistency or otherwise with these objectives.

Council has been consulted on the proposal and would continue to be consulted throughout the proposal development and construction.

Table 4-1: Consistency with the LEP land use zoning objectives

Land use zone	Location	Consistency with the LEP objectives
SP2: Infrastructure	Heathcote Road and T2 Airport Railway Line corridor.	<ul style="list-style-type: none">• Yes - In the long-term, the proposal reinforces these land uses by ensuring the road and railway can be safely accessed.
SP2: Special activities	Department of Defence land.	<ul style="list-style-type: none">• Yes - In the long-term, the proposal reinforces this land use by providing improved travel conditions.

Land use zone	Location	Consistency with the LEP objectives
B2: Local Centre	Vacant parcel of land on the western side of Heathcote Road between Macarthur Drive and the bridge over the railway.	<ul style="list-style-type: none"> • Yes - The proposal reinforces this land use by providing improved transport options to this location through the upgrade of the Macarthur Drive intersection and provision of a shared use pathway.
RE1: Public recreation	Harris Creek Reserve, Harris Creek Oval and a parcel of land on the southern side of Williams Creek.	<ul style="list-style-type: none"> • Yes - Access to Harris Creek Oval from Heathcote Road would be retained under the proposal.
RE2: Private recreation	Moorebank Sports Club and Hammondville Park.	<ul style="list-style-type: none"> • Yes - Access to both of these facilities would be retained under the proposal.
E3: Environmental management	Land south of The Avenue on the eastern side of Heathcote Road and includes endangered ecological communities.	<ul style="list-style-type: none"> • Yes - The proposal has also been designed to reduce the required impact on and loss of these communities by restricting work to within the existing road corridor. This is supplemented by additional safeguards that are proposed to minimise the proposal's impact on this land use zone. • The proposal's impact on the values and condition of these communities is assessed in section 6.1 to ensure that the residual effects of building and operating the proposal would not adversely or significantly affect its survival and condition. • Consequently, while the proposal conflicts with the intent of this policy, measures have been taken to ensure feasible and reasonable controls would be implemented to minimise any impacts.
R2: Low density residential	Voyager Point.	<ul style="list-style-type: none"> • Yes - Upgrading the road supports and improves access to and from this residential area. • The existing road built adjacent to this zone detracts from the area's amenity, however in upgrading the road it is not expected that traffic volumes would increase as a result of the proposal. The neighbourhood's amenity in the long-term and the controls that would be implemented to minimise impacts to amenity are discussed in Chapter 6. • Overall there would be some conflict with this land use.

Land use zone	Location	Consistency with the LEP objectives
R3: Medium density residential	Residential development of Holsworthy located south of Infantry Parade and North of Williams Creek on the western side of Heathcote Road.	<ul style="list-style-type: none"> • Yes - In upgrading the road, this would indirectly support access to and from this residential area.
R4: High density residential	Residential development accessed from Macarthur Drive.	<ul style="list-style-type: none"> • Yes - Upgrading the road supports and improves access to and from this residential area.
W1: Natural waterway	Harris Creek and Williams Creek.	<ul style="list-style-type: none"> • Yes – The use and viability of this land use will not be compromised or detracted from in building and operating the proposal.

The LEP also includes provisions for dealing with items of local heritage significance. The impacts that the proposal has on the LEP Heritage listed Holsworthy Pedestrian Bridge is discussed in section 6.8.

4.2 Other relevant NSW legislation

The following State legislation is relevant to the proposal or the land on which the proposal would be built.

4.2.1 Heritage Act 1977

The *Heritage Act 1977* provides for the conservation of buildings, works, archaeological relics and places of heritage value. It principally achieves this by listing, and therefore protecting, heritage values under a number of registers. This includes the State heritage register (SHR), the heritage and conservation register (HCR), LEP heritage schedules, public authority heritage and conservation registers (termed section 170 registers), and interim heritage orders (IHOs). The Act requires Roads and Maritime to assess the proposal's impact on historic buildings, places, objects, works, relics and archaeological sites, to ensure their cultural heritage value is protected (refer to section 6.7.2 and 6.8.2). The Act sets out provisions that require a statement of heritage impact to be prepared where the proposal has the potential to impact on any values that are protected under the above Act. Finally, the Act sets out a process for obtaining permission from the NSW Heritage Council, as administrators of the Act, to investigate, excavate and/or impact on a heritage-listed item. In the case of the proposal, a statement of heritage impact (refer to Appendix L) was prepared given the observed presence of heritage items in the area (refer to section 6.8). As concluded in section 6.8, the proposal would directly affect the local heritage listed Harris Creek and Williams Creek bridges, and approval from the Heritage Council of NSW must be sought.

4.2.2 Roads Act 1993

Under the *Roads Act 1993* (NSW Government, 1993b) the consent of the relevant roads authority is required to dig up, erect a structure or carry out work in, on or over a road (refer to Section 138 of the Act). The licence (a road occupancy licence) would be obtained from the Transport Management Centre under Section 138 of the above Act in order to build the proposal as it would impact the operation of Heathcote Road, a classified road.

4.2.3 Noxious Weed Act 1993

The *Noxious Weed Act 1993* (NSW Government, 1993a) places a responsibility on Roads and Maritime to control, remove and eradicate noxious weeds within the road reserve and on land that they own. A total of 45 weed species were recorded within the study area. Of these, five are declared noxious within the local control authority area of Liverpool City Council and four are listed

as weeds of national significance (refer to section 6.1.2.8). Accordingly, there is high probability of needing to manage and control weeds while undertaking the work, which has been accounted for in the safeguards described in section 6.1.4.

4.2.4 Fisheries Management Act 1994

One of the objectives of the *Fisheries Management Act 1994* (FM Act) is to conserve key fish habitats. Creeks, whether permanently or intermittently flowing, are considered key fish habitat under the FM Act (NSW Department of Primary Industries (Fisheries), 2016). The FM Act applies to the proposal as Heathcote Road crosses over two waterbodies; Harris Creek and Williams Creek. Both of these watercourses are classified as supporting moderate key fish habitat watercourses (Class 2) as they have clearly defined banks with permanent connected waters. Database searches did not identify any threatened aquatic species, populations or ecological communities listed under the FM Act which are known or would likely utilise the study area. The observed aquatic habitats were identified as being of low quality for any threatened aquatic species. Consequently, no detailed aquatic surveys or habitat based assessment were conducted, and it was concluded that there would be no materially significant impact within the definitions of the above Act. Section 6.1 and Appendix G provide further information. Nonetheless, as a precautionary approach, watercourse crossings would be designed to ensure that they meet the minimum requirements for fish passage recommended for the classes of 'fish habitat' found at the stream crossings.

4.2.5 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* provides for the protection of vulnerable and endangered flora, fauna, communities and populations and their associated habitat. Section 109 to Section 113 of the above Act requires Roads and Maritime to prepare a species impact statement in instances where the proposal would have significant effect either on: terrestrial critical flora and fauna habitat or terrestrial threatened species, populations and ecological communities and their habitat. While the proposal would result in a direct impact on communities and species protected under the above Act (refer to section 6.1.3 and Appendix G) it was concluded that there would be no materially significant impact within the definitions of the above Act. Therefore a species impact statement was not required.

4.2.6 Contaminated Land Management Act 1997

The *Contaminated Land Management Act 1997* establishes a process for investigating and, where appropriate, remediating land that is considered to pose a significant risk to human health or the environment. The Act requires Roads and Maritime to immediately notify the NSW Environment Protection Authority (NSW EPA) if it is suspected that the work has resulted in ground contamination or encountered existing ground contamination. Section 6.4.3 discusses this further.

4.2.7 Protection of the Environment Operations Act 1997 (as amended)

Environmental protection is provisioned under the above Act. The underlying objective of the Act is to reduce pollution and manage the storage, treatment and disposal of waste. A key feature of the Act is the issuing of environmental protection licences (EPLs) for certain (scheduled) activities.

Roads and Maritime would not be required to obtain an EPL for the proposal as it does not form or involve any scheduled activities within the meaning and definition of the above Act. The Act would however require Roads and Maritime to manage the proposal to limit its potential to cause water, noise and/or air pollution, while managing its waste streams. This would be achieved through implementing the safeguards and management measures identified in Chapter 7 of this REF. A number of regulations have also been prepared in parallel to the Act. This includes the Protection of the Environment Operations (Waste) Regulation 2014 that allows Roads and Maritime to use excavated (natural) material under a resource recovery exemption as engineering fill instead of disposing of it. Roads and Maritime would also be required to notify the NSW EPA, which is responsible for administering the provisions of the Act, in instances where any pollution incident

has the potential to “cause or threaten material harm to the environment” (refer to Section 148 of the Act).

4.2.8 Water Management Act 2000

The *Water Management Act 2000* (NSW Government, 2000b) aims to provide for sustainable and integrated water management in the State to benefit both present and future generations. The relevant provisions of this Act are the need to obtain approval for either undertaking flood management work or in-ground work, including dewatering of excavations that would cause aquifer interference. In both cases, while the proposal would ensure the road is built to be protected from major flood events (refer to section 3.3.3 and section 6.2), and it would involve in-ground work (refer to section 3.4.1 and section 3.4.5), neither activity would trigger the approvals provisions within the meaning or definition of the above Act. The above Act also provides for the approval to control any work taking place within 40 metres of a creek or waterbody. Roads and Maritime or third parties who are acting on behalf of Roads and Maritime are exempt from the requirement for obtaining controlled activity approvals under Section 91E of the above Act.

4.3 Commonwealth legislation

The following Commonwealth legislation is relevant to the proposal or the land on which the proposal would be built.

4.3.1 Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) a referral is required to the Commonwealth Government for proposed actions that have the potential to significantly impact on matters of national environmental significance or the environment of Commonwealth land. While the proposal includes work located on Commonwealth land (refer to Chapter 3) and in areas that contain nationally listed threatened biota and supporting habitat, Chapter 6 and Appendix A concludes that the assessment of the proposal's impacts on

- Matters of national environmental significance and the environment of Commonwealth land is unlikely to be a significant impact. Accordingly, the proposal does not require referral to the Commonwealth Government Department of the Environment under the EPBC Act.
- Nationally listed threatened species, populations, endangered ecological communities and migratory species is unlikely to be significant. 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 is being carried out by or on behalf of a public authority. Under clause 94 of the ISEPP the proposal is permissible without consent. The proposal is not State significant infrastructure or State significant development. The proposal can be assessed under Part 5 of the EP&A Act. Roads and Maritime is the determining authority for the proposal. This REF fulfils Roads and Maritime's obligation under clause 111 of the EP&A Act to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity. Referral of the proposal to the Commonwealth Department of the Environment under the EPBC Act is not considered necessary nor is the need to undertake a strategic assessment (refer to section 1.2). In addition to the determination of this REF a number of licences, permits, notifications and approvals would be needed (refer to Chapter 7).

5 Consultation

This Chapter discusses the consultation carried out to date and the consultation proposed for the future.

5.1 Consultation strategy

Roads and Maritime have prepared a community and stakeholder engagement plan for the proposal. The plan demonstrates Roads and Maritime's commitment to meeting the reasonable needs and desires of the community for information and considering its views on the proposal. The communication and engagement objectives for the proposal are to:

- Provide regular and targeted information to the community and stakeholders on the progress of the proposal and construction activities, including the likely impacts and benefits
- Provide clear direction to the community and stakeholder whether we are providing information or seeking feedback so that expectations are clear
- Ensure community and stakeholder feedback and issues are considered in the decision-making process
- Ensure issues relating to proposal delivery are identified early and managed effectively
- Manage stakeholder feedback and complaints in a timely, respectful way
- Collaborate with government agencies and local council to ensure a whole-of-government approach to managing issues and providing consistent messages
- Monitor and evaluate stakeholder feedback and communication activities to measure success and review planning and delivery as required
- Build stakeholder and community confidence in Roads and Maritime and its decisions.

Stakeholder engagement has been and will continue to be delivered through a number of communication methods including, but not limited to:

- Community updates and newsletters
- Website updates and information
- Notification letters
- Media releases
- Advertisements (print and broadcast)
- Drop-in and door-knocking sessions
- Use of a proposal-specific email, resourced phone number and mail address.

This REF will be publically displayed and Roads and Maritime will seek comments, feedback and suggestions from the community. Roads and Maritime will then respond to this feedback in the form of a submissions report. Concerns, issues and solutions arising from the submissions report will contribute to developing the detailed design.

While the proposal is being built, the strategy will keep road users, businesses and the community informed ahead of planned traffic changes, night work, lane closures and detours by using message signs onsite, website information, bulk-distribution emails and letterbox drops. Those residents, businesses and landowners that potentially would be affected by the work would be contacted by phone, email and by holding face-to-face meetings to discuss specific issues such as freight and driveway access.

5.1.1 Stakeholder identification

This proposal potentially affects the following stakeholders as identified in the consultation strategy:

- Government agencies:
 - Sydney Trains
 - Transport for NSW
 - Office of Environment and Heritage (OEH)
 - Environmental Protection Authority
 - NSW Department of Planning and Environment
 - Fisheries NSW
 - Department of Defence – Holsworthy Army Barracks
 - Sydney Water
 - Bicycle NSW
 - State Minister for Roads and Freight
 - State Member for Holsworthy
 - Federal Member for Hughes
 - Liverpool City Council
- Other stakeholders:
 - Gandangarra Local Aboriginal Land Council
 - Tharawal Local Aboriginal Land Council
 - Local residents and businesses
 - Business chambers and groups
 - Local schools and child care facilities
 - Public transport users
 - Road users
 - Community groups
 - Action groups
 - Environmental groups
 - Sporting groups
 - Media
 - Utility companies.

5.2 Community involvement

Roads and Maritime consulted with the community during June and July 2015 on the proposed road upgrade to:

- Seek comment, feedback, ideas and suggestions for consideration when developing the concept design and carrying out the environmental impact assessment
- Build a database of interested and concerned community members with whom Roads and Maritime can continue to engage during the proposal’s development.

Consultation consisted of a letterbox drop to 6,250 residents living in Holsworthy, Wattle Grove, Moorebank, Voyager Point, Pleasure Point and Sandy Point. The newsletter was also emailed directly to emergency services, Government agencies, schools, large businesses and other key stakeholders in the local area. The information was also displayed on the proposal website.

Roads and Maritime received responses from 18 individuals and one organisation providing comments on a range of different matters. Key points (refer to Table 5-1) raised by the community included:

- Safety of road users, pedestrians and cyclists
- The design of the proposed upgrade
- Operational noise.

Table 5-1: Issues raised by the community during June/July 2015 consultation

Issue raised	Response/where addressed in REF
Resident	
<i>Noise:</i> measures to reduce noise impacts to adjacent residents	Section 6.5 describes the noise assessment that was undertaken to support the preparation of this REF. Predicting the noise levels at sensitive receivers while the proposal is being built and once the road is operational has allowed safeguard measures to be identified. During construction they involve limiting equipment use to certain times, maintaining equipment to its performance specifications and implementing a construction noise and vibration management plan. The operational measures consider the need for noise treatment controls to be introduced such as low noise pavement, noise barriers and potentially at-property treatment.

Issue raised	Response/where addressed in REF
<i>Proposal scope:</i> the upgrade should be continued to Princes Highway and Bangor Bypass	This proposal covers the section of Heathcote Road between Infantry Parade, Holsworthy and The Avenue, Voyager Point. Princes Highway and Bangor Bypass are outside the scope of this proposal.
<i>Safety:</i> speeding on Heathcote Road was an issue and there were requests to lower the speed	Roads and Maritime was required to review the road's design against safety criteria that determines the speed limit. These criteria are based on national and international standards. The safety of the design (including the speed limit) is also independently audited. Through this process it was determined that a speed limit of 80 km/h between the T2 Airport Railway Line and Voyager Point was safe for the road conditions. This would be used in combination with other intersection upgrades to reduce the crash rate on this section of Heathcote Road.
<i>Safety:</i> intersection at Heathcote Road and the Avenue would be unsafe even after the upgrade	A key objective of the proposal is to improve road safety due to high crash rates on Heathcote Road (refer to Chapter 2). Accordingly, the proposal to signalise this intersection aims to improve safety and reduce risks that contribute to crashes at such intersections. Design guidelines used for improving road safety are described in Chapter 3. This aspect has also been considered as part of the independent safety audit of the design.
<i>Design:</i> poor intersection design	All the major intersections would be upgraded to be consistent with current design standards (refer to Chapter 3). As described above, these standards focus on road user safety, performance, drivability and other metrics. Therefore, the intersection design is consistent with current design standards.
<i>Design:</i> road design concerns for the upgrade including maximisation of natural topography, flooding.	The road design and upgrade is partially constrained to the existing road corridor and road conditions. It balances the need to improve safety, minimise environmental impacts, and reduce flood risk. Section 6.2 summarises the flood assessment prepared in support of the proposal. The assessment was used to confirm the need to replace some of the existing bridges with new higher structures to reduce the risk of the road flooding in the future. A supplementary drainage assessment was undertaken to confirm the size, capacity and design of the stormwater infrastructure, to ensure it could cope with the rainfall during a severe storm event, and prevent flooding.
<i>Design:</i> provisions of an underpass at various points in the network	Providing an underpass to address safety and traffic congestion is not a cost effective solution. Changing the road geometry and improving intersections by installing traffic lights is expected to be a more cost effective solution to congestion.
Resident Organisation	
<i>Safety, Design, Pedestrians and cyclists:</i> lack of pedestrian and cyclist infrastructure on Heathcote Road	Pedestrian and cyclist safety are core objectives of the proposal. As such, an off road shared user path would be provided along Heathcote Road between Infantry Parade and The Avenue.

5.3 Aboriginal community involvement

Roads and Maritime has developed the Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI, Roads and Maritime, 2011f). The procedure advocates a four-stage process, of which, Stage 2 to Stage 4 involve Aboriginal community consultation:

- Stage 1: initial Roads and Maritime assessment
- Stage 2: site survey and further assessment
- Stage 3: formal consultation and preparation of a cultural heritage assessment report
- Stage 4: implement environmental impact assessment recommendations.

The proposal has been developed in consultation with the Gandangara Local Aboriginal Land Council (GLALC) and Tharawal Local Aboriginal Land Council (TLALC). The consultation was used as an opportunity to discuss the proposal, guide field investigation work and to inform the Aboriginal archaeology survey report that has been prepared to support this REF. GLALC and TLALC representatives also attended the field investigations on 5 August 2015 and provided survey and cultural assessment reports in accordance with Stage 2 of the PACHCI.

The aims of the consultation, field survey and report were to understand the heritage value of the area, to accurately locate and record the condition of registered sites, and to identify and record any new sites. As concluded in section 6.7 the proposal would not impact any objects, sites or potential archaeological deposits of Aboriginal heritage value.

5.4 ISEPP consultation

Liverpool City Council has been consulted about the proposal as per the requirements of Clauses 14 and 15 of the ISEPP. Appendix B contains an ISEPP consultation checklist that documents how ISEPP consultation requirements have been considered. Table 5-2 provides a response to the Council's main comments.

Table 5-2: Issues raised through ISEPP consultation

Issue raised	Response/where addressed in REF
Concern about removal of the superstructure of the heritage listed Holsworthy Pedestrian Bridge.	The abutments and the superstructure of the bridge are proposed to be removed. The piers of the bridge, including the plaque which references the connection of the bridge to the German Concentration Camp, will be retained. Retention of these items ensures the retention of some heritage significance (refer to Chapter 3).
Querying why a 1-in-100 year flood immunity cannot be achieved as this issue is likely to be of concern to the community.	The Hydrology report (Appendix H) describes why this immunity cannot be achieved. The proposal would increase the height of the Williams Creek bridge to cope with the water levels that occur from a storm event that typically occur about once every century. At Harris Creek the new bridges would cope with storms that typically occur about once every 40 years (northern bridge) and 50 years (southern bridge).

5.5 Government agency and stakeholder involvement

Various Government agencies and stakeholders have been consulted through letters and meetings about the proposal, including:

- Department of Defence
- Sydney Trains
- Utility providers.

Issues that have been raised as a result of consultation with the Department of Defence and Sydney Trains are outlined in Appendix E.

Given the large number of utilities in the area Roads and Maritime consulted with the following providers early in the design:

- Endeavour Energy
- NBN Co
- APA Group
- Optus
- Sydney Water
- Powertel
- Telstra.

Appendix F provides the full responses from the providers.

5.6 Ongoing or future consultation

This section describes the ongoing and future consultation that will take place during and following the REF's display and during construction should the proposal be determined.

5.6.1 Response to submissions

This REF will be placed on public display for comment by Government agencies, stakeholders and the community. Following the public display period, Roads and Maritime will collate submissions and respond to the comments. After considering the submissions, Roads and Maritime will determine whether the proposal should proceed as determined or whether any alterations are necessary. It will also decide if additional environmental assessment needs carrying out or additional environmental safeguards or management measures need implementing. A community update advising the community and stakeholders of the outcome of consultation will be distributed and Roads and Maritime will also meet with affected residents, businesses and other stakeholders.

5.6.2 Detailed design and pre-construction consultation

If the proposal is built, the community consultation and stakeholder engagement plan (refer to section 5.1 and section 5.2) would be updated to support the detailed design and pre-construction stages to ensure:

- There would be an integrated response to traffic management
- There would be provision for emergency vehicle access at all times while the proposal is being built
- Any necessary detours would be effectively managed to reduce impacts to general traffic and public transport
- Suitable and appropriate environmental safeguards and management measure refinements are made to account for design changes and refinements
- The work is scheduled to avoid conflicts with other projects that are being developed in the area at the same time (refer to section 6.12).

5.6.3 Construction consultation

The appointed work contractor would also be required to consult with the local community before and while the proposal is being built. This process would be managed through the construction environmental management plan (CEMP, refer to section 7.1). It would include:

- Issuing notices before starting work and relaying information on traffic management controls, temporary road closures, temporary access restrictions and planned noisy activities
- Undertaking door-knocking with affected residents
- Undertaking ongoing consultation with affected parties comprising meetings, letter-drops, posters and notifications.

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 factors 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.

Environmental factors assessed within this section include:

- Biodiversity
- Surface water and flooding
- Groundwater
- Soils and geology
- Traffic and transport
- Noise and vibration
- Aboriginal heritage
- Non-Aboriginal heritage
- Landscape character and visual impacts
- Socio-economic
- Other impacts (including air quality; greenhouse gas and climate change; waste and resource use and property impacts and land use)
- Cumulative impacts.

Technical study reports for some of these environmental factors are appended to this REF and can be referred to for detailed information. This includes: Biodiversity – Appendix G; Traffic and transport - Appendix I; Noise and vibration - Appendix J; Aboriginal heritage – Appendix K; and Non-Aboriginal heritage – Appendix L.

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

6.1 Biodiversity

This section summarises the assessed impacts on biodiversity values that are likely to occur when building and operating the proposal. Appendix G contains the supporting technical paper prepared by WSP | Parsons Brinckerhoff.

6.1.1 Methodology

The biodiversity assessment was based on desktop review of available documents and field surveys in summer 2015/2016 and autumn of 2016 as outlined in the technical report (Appendix G).

Study area

The study area considered the ecological values within the proposal footprint (refer to Figure 1-2 of Appendix G) and any areas likely to be affected by the proposal, either directly or indirectly. The study area is within the Sydney Basin bioregion and the Sydney Metro Catchment Management Authority (CMA) area.

Assessing ecological significance

Impact significance was assessed in accordance with the following guidelines:

- Threatened Species Assessment Guidelines: The Assessment of Significance (DECCW, 2007)
- Significant Impact Guidelines 1.1: Matters of National Environmental Significance (Commonwealth Department of the Environment, 2013).

The above two guidelines define the processes to determine if a proposal's impacts are significant within the statutory meaning and definition of the corresponding Acts. They provide a statutory basis for defining the proposal's impacts by simply defining if a proposal is predicted to have a significant impact, which would trigger additional legal and statutory requirements and provisions.

6.1.2 Existing environment

Vegetation communities

Field surveys mapped a total of 10.46 ha of plant communities (vegetation communities) occurring within the study area, of which 6.09 ha comprised native vegetation and the remainder 4.37 ha comprised exotic vegetation communities (Figure 6-1). A total of 6.24 ha of vegetation was mapped within the project area of which 3.41 ha comprised native vegetation communities.

Four plant community types were recorded within the study area and correspond to TECs. These are listed below and described in Table 6-1:

- Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion
- Shale Gravel Transition Forest in the Sydney Basin Bioregion
- Castlereagh Swamp Woodland Community
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

Vegetation recorded included three distinct areas of Castlereagh Scribbly Gum Woodland, three distinct areas of Shale Gravel Transition Forest, one distinct area of Castlereagh Swamp Woodland and one distinct area of Cumberland river-flat Forest. Table 6-1 lists the characteristics and condition of each area. Detailed information is provided in Appendix G.

Table 6-1: Threatened ecological communities in the project area

Condition Class	Project Area (ha)
Castlereagh Scribbly Gum Woodland	
Legislative classification and protection:	
<ul style="list-style-type: none"> • Vulnerable under the TSC Act as Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion • Endangered under the EPBC Act as Castlereagh Scribbly Gum and Agnes banks Woodlands of the Sydney Basin Bioregion 	
Good condition	1.19
Moderate condition	0.99
Low condition ^[note 1]	0.19
TOTAL	2.37

Condition Class	Project Area (ha)
Shale Gravel Transition Forest Legislative classification and protection: <ul style="list-style-type: none"> • Endangered under the TSC Act as Shale Gravel Transition Forest in the Sydney basin Bioregion • Critically Endangered under the EPBC Act as Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest 	
Good condition	0.05
Moderate condition	0.29
Low condition ^[note 1]	0.43
TOTAL	0.77
Castlereagh Swamp Woodland Legislative classification and protection: <ul style="list-style-type: none"> • Endangered under the TSC Act as Castlereagh Swamp Woodland Community 	
Good condition	0.03
Cumberland River-flat Forest Legislative classification and protection: <ul style="list-style-type: none"> • Endangered under the TSC Act as River-flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions 	
Moderate condition	0.24

Note 1: does not meet the threshold criteria and as such does not form part of the critically endangered community listed under the EPBC Act.

The other vegetation communities of exotic grasslands, mixed indigenous & non-indigenous planted vegetation, dams & detention basins occupy the remainder of undeveloped locations in the project area, totalling about 2.83 hectares. Figure 6-1 shows the vegetation communities in the study area.

Fauna Habitat: terrestrial

Much of the vegetation of the study area has been previously cleared for roads, buildings and playing fields. However, substantial areas of vegetation do remain in the south of the site, within Holsworthy Army Barracks adjacent to Heathcote Road, and the riparian zones of Harris and Williams Creek.

Past clearing has resulted in the loss of biodiversity values and habitat features and the majority of the existing terrestrial habitat is in poor condition, with limited habitat features such as hollow-bearing trees, ground cover (logs and fallen timber) and bush rock. However, in the riparian zones of Harris Creek and Williams Creek and areas south of the study area, the vegetation communities and habitats are in good condition with low weed invasion, and moderate occurrences of hollow-bearing trees, fallen timber, bush rock and denser understorey.

Migratory species

There are a number of birds that have the potential to migrate through the area. In total, 12 bird species (Table 6-4) listed as Migratory under the EPBC Act have a moderate or higher potential of

migrating over the area, based on the recorded habitats. However, no migratory species were incidentally observed during surveys and the project area is not considered to contain important habitat for any of these species, and as such has not been considered further.

Aquatic habitat

The proposal crosses two tributaries, which include Harris Creek and Williams Creek. The quality of these aquatic habitats has been compromised through the previous clearing of riparian (river corridor) habitats, high-nutrient runoff, weed invasion and the introduction of exotic fish species (*Eastern Gambusia*). Harris and Williams Creeks provide moderate fish habitat value (Class 2), however, due to weed invasion, nutrient runoff and invasion of exotic fish species, the majority of available habitat in the proposal area is of low quality. Consequently it was concluded that both creeks are unlikely to contain any threatened species listed under the FM Act.

Other aquatic habitat in the area includes dams and detention basins. On inspection, it was concluded that while they contain certain native and exotic plant and fish species and invertebrates, they are unlikely to contain any threatened species listed under the FM Act and they provide little value as fish habitat.

Groundwater dependent ecosystems

A number of groundwater dependent ecosystems (GDEs), both subsurface and surface dependent, are present within the study area. GDEs which are reliant on subsurface groundwater in the study area are shown in Figure 6-1 and include:

- Cumberland River-flat Forest
- Cumberland Shale-Gravel Transition Forest
- Castlereagh Shale-Gravel Transition Forest
- Castlereagh Scribbly Gum Woodland
- Castlereagh Swamp Woodland.

GDEs which are surface expressions of groundwater within the locality of the study area (<5km) include the Georges River and Voyager Point Wetlands.

Threatened flora

Two threatened species of plant were recorded within the study area (Figure 6-2):

- *Grevillea parviflora subsp. parviflora*: listed as vulnerable under the EPBC Act and the TSC Act. A total of 46 individual specimens were recorded in study area
- *Hibbertia puberula subsp. puberula*: listed as endangered under the TSC Act. A total of 75 individual specimens were recorded in study area.

A further nine species have a moderate or higher likelihood to occur in the study area based on potential habitat (Table 6-2).

Table 6-2: Threatened flora species recorded or with a moderate to high likelihood of occurrence

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Potential Occurrence
<i>Acacia bynoeana</i>	Bynoes Wattle	V	E	Moderate
<i>Acacia pubescens</i>	Downy Wattle	V	V	Moderate
<i>Allocasuarina glareicola</i>	–	E	E	Moderate
<i>Caesia parviflora var. minor</i>	Small Pale Grass-lily	–	E	Moderate
<i>Persoonia hirsuta</i>	Hairy Geebung	E	E	Moderate

Scientific Name	Common Name	EPBC Act Status	TSC Act Status	Potential Occurrence
<i>Persoonia nutans</i>	Nodding Geebung	E	E	Moderate
<i>Pimelea curviflora var. curviflora</i>	–	V	V	Moderate
<i>Pultenaea parviflora</i>	–	V	E	Moderate
<i>Pultenaea pedunculata</i>	Matted Bush-pea	–	E	Moderate

Notes: E= Endangered, V= Vulnerable

6.1.2.1 Threatened fauna

Three threatened fauna species were recorded within the study area (Figure 6-2):

- Eastern Freetail Bat – Listed as vulnerable under the TSC Act. Recorded during anabat surveys at Williams Creek. Individuals are likely to forage in areas with more open spaces and may potentially roost in tree hollows within the study area.
- Southern Myotis, Large-footed Myotis: listed as vulnerable under the TSC Act. Recorded during surveys. Individuals are likely to forage in areas of open water in dams/detention basins and over pools in Cumberland river-flat forest or Castlereagh Swamp Woodland. May possibly roost in tree hollows within the study area.
- Grey-headed Flying-fox: listed as vulnerable under the EPBC Act and TSC Act. Recorded flying over the study area at Williams Creek and may forage within the study area, however the species is unlikely to roost or breed within the project area due to a lack of likely camp sites.

Based on the presence of suitable habitat, a further 27 species have moderate or higher likelihood to occur (Table 6-3).

Table 6-3: Threatened fauna species recorded or with a moderate –high likelihood

Scientific Name	Common Name	EPBC Act Status	TSC Act status	Potential Occurrence
Amphibians				
<i>Litoria aurea</i>	Green and Golden Bell Frog	V	E	Moderate
<i>Pseudophryne australis</i>	Red-crowned Toadlet	–	V	High
Birds				
<i>Anthochaera phrygia (syn. Xanthomyza phrygia)</i>	Regent Honeyeater	EM	CE	Moderate
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	–	V	Moderate
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	–	V	Moderate
<i>Daphoenositta chrysoptera</i>	Varied Sittella	–	V	Moderate
<i>Glossopsitta pusilla</i>	Little Lorikeet	–	V	High

Scientific Name	Common Name	EPBC Act Status	TSC Act status	Potential Occurrence
<i>Hieraaetus morphnoides</i>	Little Eagle	–	V	High
<i>Lathamus discolor</i>	Swift Parrot	E	E	Moderate
<i>Lophoictinia isura</i>	Square-tailed Kite	–	V	Moderate
<i>Melithreptus gularis</i>	Black-chinned Honeyeater (eastern subspecies)	–	V	Moderate
<i>Ninox strenua</i>	Powerful Owl	–	V	High
<i>Petroica boodang</i>	Scarlet Robin	–	V	Moderate
<i>Petroica phoenicea</i>	Flame Robin	–	V	Moderate
Invertebrates				
<i>Meridolum corneovirens</i>	Cumberland Plain Land Snail	–	E	Moderate
Mammals				
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	–	V	High
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	Moderate
<i>Dasyurus maculatus maculatus</i>	Spotted-Tailed Quoll (Southern Subspecies)	E	V	High
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	–	V	High
<i>Isodon obesulus</i>	Southern Brown Bandicoot	E	E	Moderate
<i>Miniopterus australis</i>	Little Bent-wing Bat	–	V	High
<i>Miniopterus orianae oceanensis</i>	Eastern Bent-wing Bat	–	V	High
<i>Petaurus australis</i>	Yellow-bellied Glider	–	V	Moderate
<i>Phascolarctos cinereus</i>	Koala (NSW, ACT & QLD - excluding SE QLD)	V	V	High
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	–	V	High

Scientific Name	Common Name	EPBC Act Status	TSC Act status	Potential Occurrence
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	–	V	High
Reptiles				
<i>Varanus rosenbergi</i>	Heath Monitor (Rosenberg's Goanna)	–	V	High

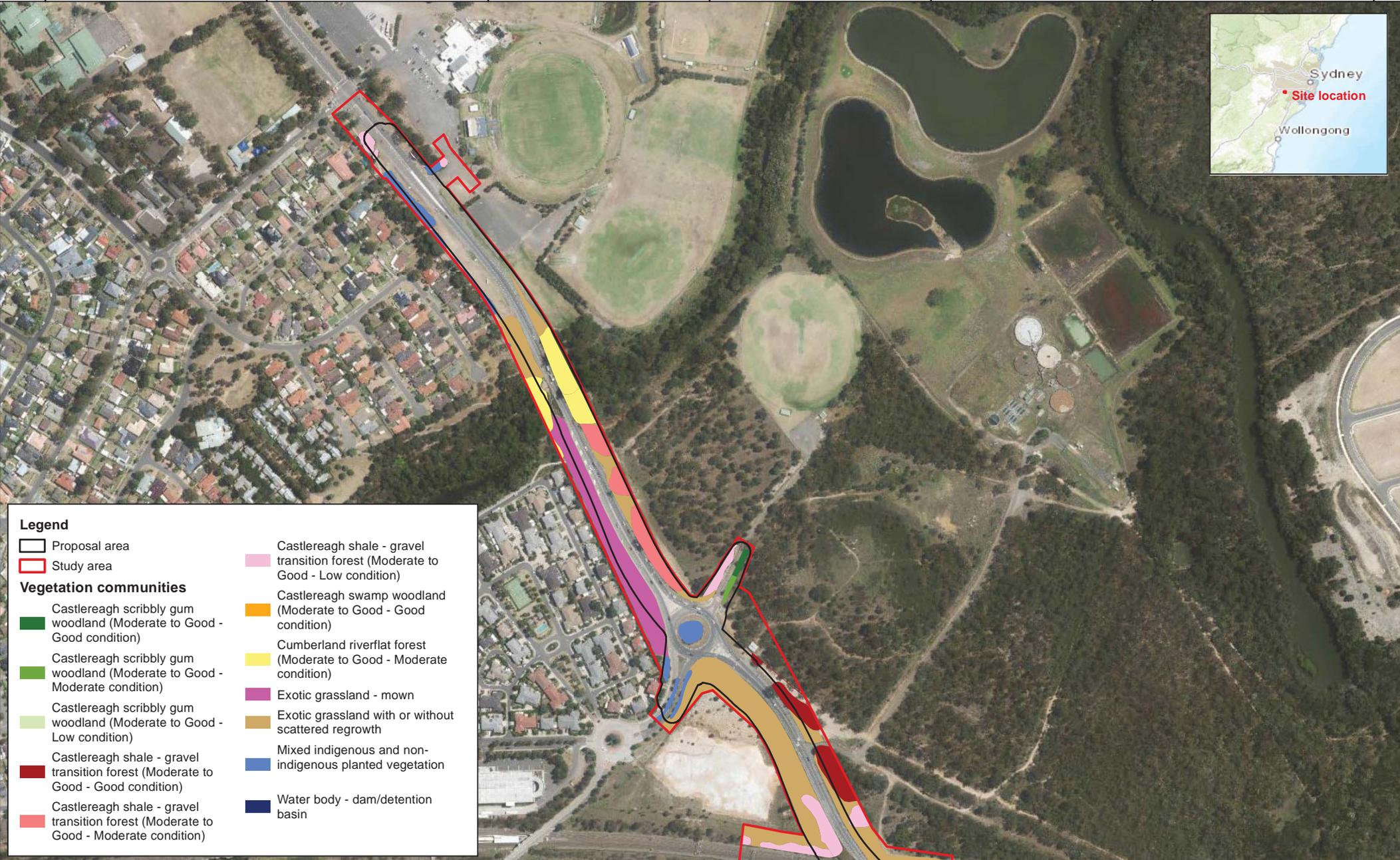
Notes: listed EPBC Migratory species have not been included in the table, these species have been included in Table 6.4 below; E= Endangered, V= Vulnerable, CE: critically endangered, EM: endangered migratory

Table 6-4: Threatened fauna migratory species (moderate – high likelihood)

Scientific name	Common name
<i>Actitis hypoleucos</i>	Common Sandpiper
<i>Apus pacificus</i>	Fork-tailed Swift
<i>Ardea (Bulbulcus) ibis</i>	Cattle Egret
<i>Cuculus opatus (syn. Cuculus saturatus)</i>	Oriental Cuckoo, Himalayan Cuckoo
<i>Gallinago hardwickii</i>	Latham's Snipe
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle
<i>Hirundapus caudacutus</i>	White-throated Needletail
<i>Merops ornatus</i>	Rainbow Bee-eater
<i>Monarcha melanopsis</i>	Black-faced Monarch
<i>Motacilla flava</i>	Yellow Wagtail
<i>Myiagra cyanoleuca</i>	Satin Flycatcher
<i>Rhipidura rufifrons</i>	Rufous Fantail

Weed species

A total of 45 weed species were recorded within the study area of these, five are declared noxious within the local control authority area of Liverpool city council and four are listed as weeds of national significance (WoNS). Noxious and WoNS species recorded within the study area are listed in Table 3.12 of Appendix G.



Legend

- Proposal area
- Study area

Vegetation communities

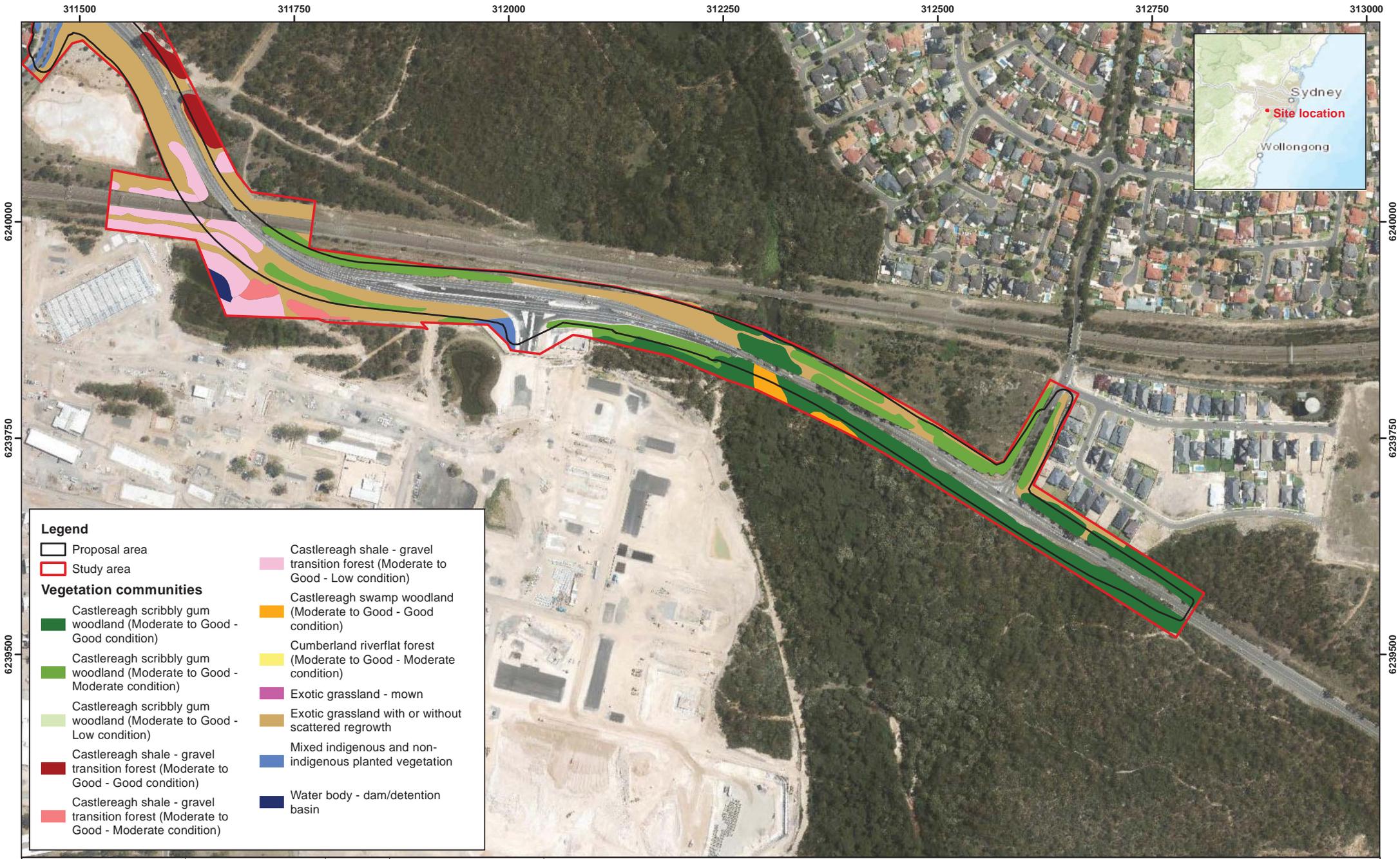
- Castlereagh scribbly gum woodland (Moderate to Good - Good condition)
- Castlereagh scribbly gum woodland (Moderate to Good - Moderate condition)
- Castlereagh scribbly gum woodland (Moderate to Good - Low condition)
- Castlereagh shale - gravel transition forest (Moderate to Good - Good condition)
- Castlereagh shale - gravel transition forest (Moderate to Good - Moderate condition)
- Castlereagh shale - gravel transition forest (Moderate to Good - Low condition)
- Castlereagh swamp woodland (Moderate to Good - Good condition)
- Cumberland riverflat forest (Moderate to Good - Moderate condition)
- Exotic grassland - mown
- Exotic grassland with or without scattered regrowth
- Mixed indigenous and non-indigenous planted vegetation
- Water body - dam/detention basin

Map: 2113368_GIS_020_A	Author: RP		
Date: 8/09/2016	Approved by: -		
Data source: © Roads and Maritime Services		Coordinate system: GDA 1994 MGA Zone 56 Scale ratio correct when printed at A3	



Heathcote Road Upgrade
Figure 6-1
Biodiversity - vegetation communities

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Legend

Proposal area
 Study area

Vegetation communities

<ul style="list-style-type: none"> Castlereagh scribbly gum woodland (Moderate to Good - Good condition) Castlereagh scribbly gum woodland (Moderate to Good - Moderate condition) Castlereagh scribbly gum woodland (Moderate to Good - Low condition) Castlereagh shale - gravel transition forest (Moderate to Good - Good condition) Castlereagh shale - gravel transition forest (Moderate to Good - Moderate condition) 	<ul style="list-style-type: none"> Castlereagh shale - gravel transition forest (Moderate to Good - Low condition) Castlereagh swamp woodland (Moderate to Good - Good condition) Cumberland riverflat forest (Moderate to Good - Moderate condition) Exotic grassland - mown Exotic grassland with or without scattered regrowth Mixed indigenous and non-indigenous planted vegetation Water body - dam/detention basin
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Map: 2113368_GIS_020_A Author: RP

Date: 8/09/2016 Approved by: -

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Heathcote Road Upgrade
Figure 6-1
 Biodiversity - vegetation communities

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- Legend**
- Threatened species**
- ▲ *Grevillea parviflora subsp. parviflora*
 - *Hibbertia puberula subsp. puberula*
 - Eastern freetail bat
 - Grey-headed flying fox
 - Southern myotis
 - Hollow bearing tree
 - Road
 - Proposal area
 - Study area
 - ▨ Hibbertia patch

Map: 2113368_GIS_021_A

Author: RP



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Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

Date: 8/09/2016

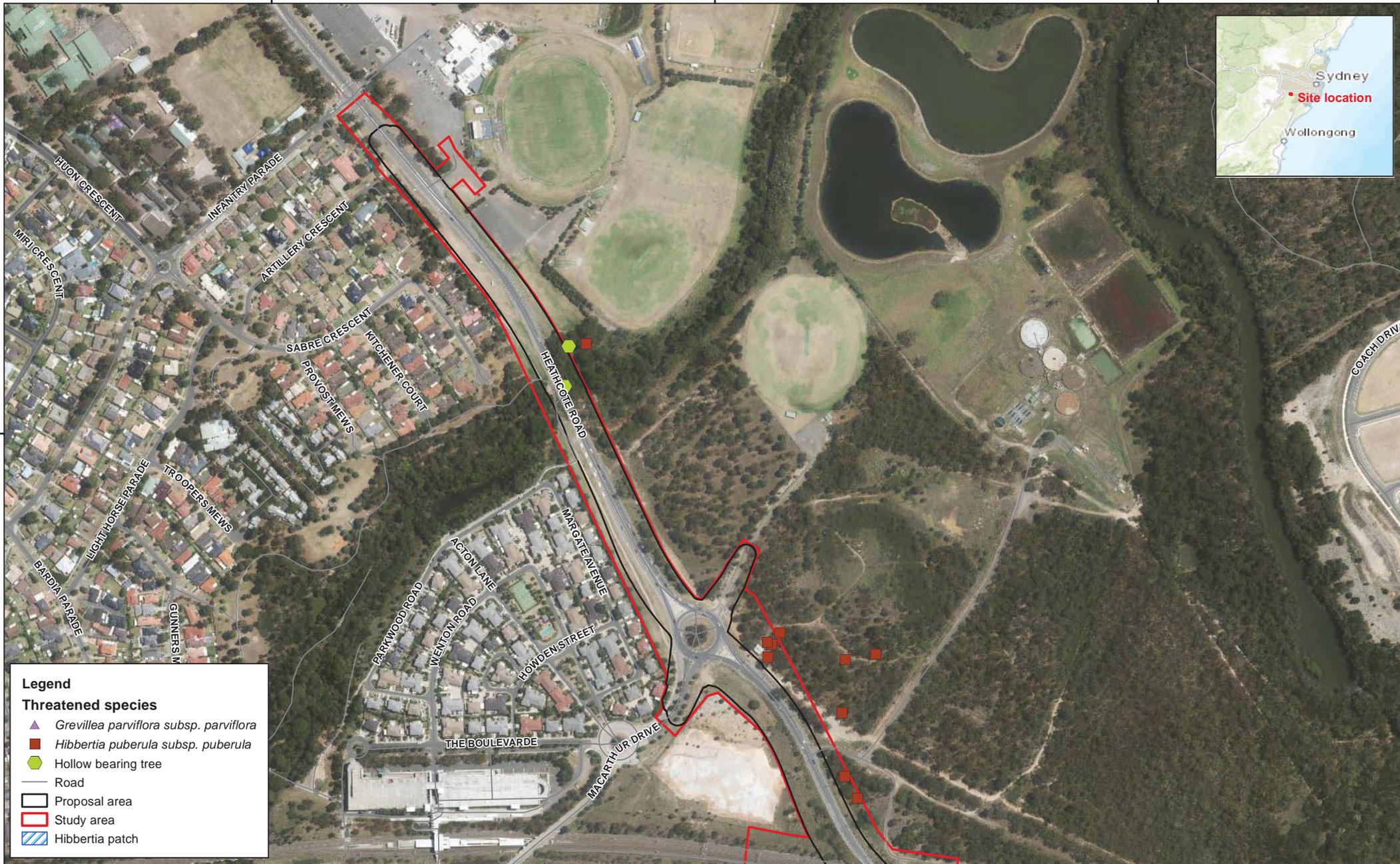
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Heathcote Road Upgrade
Figure 6-2
 Threatened flora & fauna recorded

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Legend

Threatened species

- ▲ *Grevillea parviflora* subsp. *parviflora*
- *Hibbertia puberula* subsp. *puberula*
- ⬡ Hollow bearing tree
- Road
- ▭ Proposal area
- ▭ Study area
- ▨ Hibbertia patch

Map: 2113368_GIS_021_A

Author: RP



Date: 8/09/2016

Approved by: CR

1:4,000

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

Data source: © Roads and Maritime Services



Heathcote Road Upgrade
Figure 6-2
 Threatened flora & fauna recorded

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6.1.3 Potential impacts

The proposal involves widening Heathcote Road in a bushland setting and crossing over two creeks. As such, it has the potential to have a range of direct and indirect impacts on local ecological values:

Direct impacts include:

- Removal of native vegetation and threatened species habitat
- Removal of threatened plants
- Aquatic impacts
- Injury and mortality.

Indirect impacts include:

- Changes to hydrology
- Wildlife habitat fragmentation
- Edge effects; including weed invasion, noise, light and vibration
- Invasion and spread of pests
- Invasion and spread of pathogens and disease.

Native vegetation removal

The process of widening the existing Heathcote Road and the duplication and replacement of new bridges would require the removal of about 3.41 hectares of remnant native vegetation. Table 6-5 summarises the extent of vegetation communities present within the study area and the vegetation to be cleared within the project area.

Table 6-5: Extent of threatened ecological communities within the study area, project area and per cent loss within the study area

Native vegetation community/fauna habitat	Vegetation clearing (ha) within project area ³
Castlereagh scribbly gum woodland	2.37
Castlereagh shale-gravel transition forest	0.77
Castlereagh swamp woodland	0.03
Cumberland river-flat forest	0.24
TOTAL	3.41
Total Area of Threatened Ecological Communities (EPBC Act)	3.13
Total Area of Threatened Ecological Communities (TSC Act)	3.41

Note 1: Based on VIS classification database

Note 2: Study area is defined as area within the proposal footprint and any areas likely to be affected by the proposal either directly or indirectly

Note 3: Project area is defined as the proposal footprint, the area which the proposal will directly impact

It should be noted that within a five kilometre radius of the project area 277 hectares of Castlereagh scribbly gum woodland and 328 hectares of Castlereagh shale-gravel transition forest are mapped (Tozer et al., 2010). The vegetation clearing undertaken for the proposal would represent less than a one per cent reduction of these communities within the locality. Therefore the impacts as a result of the proposal would be unlikely to significantly reduce the long-term survival prospects of the ecological community in the locality.

Given the vegetation to be removed within the project area consists of relatively small, fragmented patches of vegetation the impact of the proposal on the biodiversity values of the area would be unlikely to be significant.

As removal of over one hectare of threatened ecological communities is required, which is identified as being of moderate to good condition, the proposal has triggered the need for offsets in accordance with the Guideline for Biodiversity Offsets (Roads and Maritime, 2011). In accordance with the Framework for Biodiversity (FBA), for the removal of 2.37 ha of Castlereagh Scribbly Gum Woodland 145 ecosystem credits would be required to offset impacts associated with the proposal (Appendix G). An offset strategy would be developed during detailed design (refer to section 6.1.5).

Threatened flora loss

Two plant species that would be impacted by the proposal are *Hibbertia puberula* subsp. *puberula* and *Grevillea parviflora* subsp. *parviflora*. Table 6-6 shows the number of recorded individuals of these species that are likely to be lost to the proposal. Additional surveys outside the study area and along the road reserve of Heathcote Road recorded a further 75 individuals about 1 km south of the study area. This indicates that the species appears to be widespread and moderately abundant in the locality. An assessment of significance was conducted for this species and was concluded that the project is unlikely to have a significant impact on the local population.

Table 6-6: Impacts on threatened plants

Species	TSC Act Status ²	EPBC Act Status ¹	Habitat impacted by the proposal	Estimated number of individuals removed or affected
Species recorded during surveys				
<i>Grevillea parviflora</i> subsp. <i>Parviflora</i>	V	V	2.52 ha of occupied and potential habitat (Castlereagh Scribbly Gum Forest and Castlereagh Shale Gravel Transition Forest: <i>good and moderate condition</i>)	A total of 46 individual specimens will be removed within the study area.
<i>Hibbertia puberula</i>	E	–	2.52 ha of occupied and potential habitat (Castlereagh Scribbly Gum Forest and Castlereagh Shale Gravel Transition Forest: <i>good and moderate condition</i>)	A total of 75 individual specimens will be removed within the study area.
Species not recorded during surveys but considered to have a moderate likelihood of occurrence (e.g. in a soil seedbank)				
<i>Acacia bynoeana</i>	E	V	2.52 ha of occupied and potential habitat (Castlereagh Scribbly Gum Forest and Castlereagh Shale Gravel Transition Forest: <i>good and moderate condition</i>)	The possible number of individuals (e.g. in soil seedbank) that may be removed is unknown but is likely to be low given the failure to detect any seedlings or mature individuals during targeted surveys.
<i>Acacia pubescens</i>	V	V		
<i>Allocasuarina glareicola</i>	E	E		
<i>Caesia parviflora</i> var. <i>minor</i>	E	-		

Species	TSC Act Status ²	EPBC Act Status ¹	Habitat impacted by the proposal	Estimated number of individuals removed or affected
<i>Persoonia hirsute</i>	E	E		
<i>Persoonia nutans</i>	E	E		
<i>Pimelea curviflora</i> var. <i>curviflora</i>	V	V		
<i>Pultenaea parviflora</i>	E	V		
<i>Pultenaea pedunculata</i>	E	-		

Note:

(1) Vulnerable (V), Endangered (E), Migratory (M) as listed on the EPBC Act

(2) Vulnerable (V), Endangered (E), as listed on the TSC Act

Threatened fauna loss and habitat removal

There would be a combined total loss of about 6.24 hectares of habitat that supports the threatened fauna species. This includes the loss of four live hollow-bearing trees and removal of dead wood on the ground, which is scattered throughout the study area at a low density.

Three threatened species were recorded within the study area, with a further 27 with potential habitat (refer to Table 6-6). The three threatened species recorded within the study area included the Grey-headed Flying-fox, Southern Myotis and Eastern Free-tail Bat. While Grey-headed Flying-fox are known to occur in the area, this species is unlikely to roost or breed in the affected trees. As this species is highly mobile it is considered unlikely to be notably affected by the additional habitat fragmentation that would occur as a result of the proposal. The Southern Myotis and Eastern Free-tail Bat may use the habitats in the project area on an intermittent or continual basis. The proposal would be unlikely to significantly affect the habitat available to the species as the area to be removed would be less than the home range of a single individual or breeding pair of the species. Mitigation measures such as inspecting potential roosting sites during construction would be undertaken to ensure individuals would not be significantly impacted.

From assessments of significance undertaken (Appendix G) it was concluded that the proposal would be unlikely to result in a significant impact for all habitats, threatened species, populations and ecological communities. Through the implementation of appropriate mitigation measures, significant residual impacts to biodiversity within the locality are considered unlikely.

Table 6-7 summarises proposed impacts to habitats and the number of individual species potentially affected by the proposal.

Table 6-7: Impacts on threatened species and their habitats

Species	TSC Act Status	EPBC Act Status	Habitat impacted by the proposal	Estimated number of individuals removed or affected
Frog				
Green and Golden Bell Frog	E	V	0.27 hectares of potential habitat (Castlereagh swamp woodland, Cumberland river flat forest, and waterbodies)	Unknown. Likely to be low, if any, given the failure to detect the species during targeted surveys
Red-crowned Toadlet	V	–	1.47 hectares of potential habitat (Castlereagh scribbly gum woodland: <i>good condition</i> ; Castlereagh swamp woodland; Cumberland river flat forest and waterbodies)	Unknown. Likely to be low, if any, given the failure to detect the species during targeted surveys
Snail				
Cumberland Plain Land Snail	E	–	0.77 hectares of known and potential habitat to be removed (Castlereagh shale-gravel transition forest)	Unknown. Likely to be low, if any, given the failure to detect the species during targeted surveys
Reptiles				
Heath Monitor (Rosenberg's Goanna)	V	–	3.41 hectares of known and potential habitat to be removed (all native vegetation communities)	Unknown. Likely to be low, if any, given the failure to detect the species during targeted surveys

Species	TSC Act Status	EPBC Act Status	Habitat impacted by the proposal	Estimated number of individuals removed or affected
Migratory and/or nomadic blossom-feeding birds				
Regent Honeyeater	CE	E,M	5.92 hectares of potential habitat to be removed (all vegetation communities except exotic grasslands).	Possibly suitable albeit marginal habitat available. These species are only likely to use the habitats in the study area intermittently and are unlikely to breed in the locality
Swift Parrot	E	E		
Glossy Black-Cockatoo	V	–	3.41 hectares of potential habitat to be removed (all native vegetation communities)	Possibly suitable albeit marginal (low density of <i>Casuarinaceae</i> spp.) habitat available and individuals been recorded recently in locality
Small woodland birds				
Black-chinned Honeyeater (eastern subspecies)	V	-	3.41 hectares of potential habitat to be removed (all native vegetation communities)	These species are only likely to use the habitats in the proposal area intermittently. The area of habitat to be removed would represent less than the home range of a single individual or breeding pair of any of these species
Flame Robin	V	-		
Brown Treecreeper (eastern subspecies)	V	-		
Scarlet Robin	V	-		
Little Lorikeet	V	-		
Varied Sittella	V	-		

Species	TSC Act Status	EPBC Act Status	Habitat impacted by the proposal	Estimated number of individuals removed or affected
Large predatory birds with extensive home ranges				
Little Eagle	V	-	6.24 hectares of potential habitat to be removed (all vegetation communities)	These species are only likely to use the habitats in the proposal area intermittently. The area of habitat to be removed would represent less than the home range of a single individual or breeding pair of any of these species
Powerful Owl	V	-		
Square-tailed Kite	V	-		
Mammals				
Eastern Pygmy-possum	V	-	2.45 hectares of potential habitat to be removed (Castlereagh scribbly gum woodland, Castlereagh swamp woodland and Cumberland river flat forest)	This species has potential habitat within the study area. The area of habitat to be removed would represent less than the home range of a single individual or breeding pair
Spotted-Tailed Quoll (Southern Subspecies)	V	E		
Southern Brown Bandicoot	E	E		
Yellow-bellied Glider	V		1.46 hectares of potential habitat to be removed (Castlereagh scribbly gum: <i>good condition</i> , Castlereagh swamp woodland and Cumberland river flat forest)	
Koala	V	V	3.41 hectares of potential habitat to be removed (all native vegetation communities)	This species has potential habitat within the study area, individuals recorded in the locality

Species	TSC Act Status	EPBC Act Status	Habitat impacted by the proposal	Estimated number of individuals removed or affected
Insectivorous bats – hollow-dependent				
Eastern False Pipistrelle	V	-	6.24 hectares of potential habitat to be removed (all vegetation communities)	These species may use the habitats in the proposal area on a continual basis or intermittently. The area of habitat to be removed would represent less than the home range of a single individual or breeding pair of any of these species
Eastern Freetail-bat	V	-		
Greater Broad-nosed Bat	V	-		
Southern Myotis	V	-		
Yellow-bellied Sheathtail-bat	V	-		
Large-eared Pied Bat	V	V		
Insectivorous bats – not hollow-dependent				
Eastern Bent-wing Bat	V	-	6.24 hectares of potential habitat to be removed (all vegetation communities)	These species are only likely to use the habitats in the proposal area intermittently and are unlikely to breed there. The area of habitat to be removed would represent less than the home range of a single individual of these species
Little Bent-wing Bat	V	-		
Flying-fox				
Grey-headed Flying-fox	V	V	5.92 hectares of potential habitat to be removed (all vegetation communities except exotic grasslands).	These species are only likely to use the habitats in the proposal area intermittently and are unlikely to breed there. The area of habitat to be removed would represent less than the home range of a single individual of the species

Migratory species

The proposal would be unlikely to significantly affect any migratory species as the study area is unlikely to include important habitat for migratory species.

Aquatic impacts

The proposal will cross two creek lines, Harris and Williams Creek which are considered important aquatic habitat. The direct impacts to aquatic habitat would be limited to the bridge construction at both Harris and Williams Creeks, these works may have a number of associated effects that would include:

- Temporary displacement of native fish, eels, frogs, tortoises and invertebrates
- A limited loss (0.28 ha) of riparian (river corridor) and permanent aquatic habitat Potential leaching or washout of both herbicides and pesticides or other pollutants, already existing, into the creeks and dams due to ground excavation work during construction and riparian vegetation restoration work.
- Potential for sedimentation and pollution from the proposed construction work to impact the water quality and aquatic invertebrates of the creeks
- Temporary and permanent obstruction to fish passage due to in-stream structures
- Mobilisation of Acid Sulfate Soils during construction
- Permanent changes to stormwater runoff and flooding regimes.

These aquatic impacts, both temporary and permanent, would be considered minor changes to the aquatic habitat values of the area. Impacts as a result of construction, including possible minor increases in sediment discharge, pollution and herbicides or pesticides, would be temporary and considered minor in nature. Implementation of appropriate standard construction mitigation measures would ensure that the risk of these potential impacts would be minimised.

The direct disturbance of 0.28 ha is considered a small area and construction activities would be managed to ensure disturbance would be contained within this area. The minor reduction of aquatic habitat would not be considered to be a significant impact, particularly given the absence of threatened aquatic species and populations. The existing hydrological conditions of the streams in the project area are also already affected by altered stormwater runoff as a result of the surrounding urban area and so any further changes to the runoff regime would be unlikely to affect the aquatic biodiversity values of the area. Implementation of appropriate safeguards would also minimise the effects of the proposed impacts.

Injury and mortality

Injury and mortality may occur:

- During construction when vegetation and habitat is being cleared.
- Mobile machinery and plant that is moved to, from and on site.
- During public use of the road during the operational phase of the proposal.

Landscaping associated with the proposal may influence injury and mortality of animals during the operation phase due to the presence of new watering or feed sources or other artificial habitat adjacent to the road. Any mobile species affected by the proposal would be able to move out of the affected area. This would not be the case for less mobile or nocturnal species. Table 6-8 describes the potential injury and mortality impacts that may occur as a result of the proposal.

These impacts are unlikely to be significant because:

- The loss of smaller (non-native) reptiles and frogs would be unlikely to have a long-term effect on the overall viability of the population
- The impact on non-threatened bird, bats, tree-dwelling mammals and larger reptiles is negligible as they are likely to avoid the area
- There would be an unknown impact on the Green and Golden Bell Frog as its presence is unconfirmed despite extensive surveys during optimal conditions, thus is still moderately likely to occur in the area.

Table 6-8: Potential injury and mortality impacts

Activity with potential to cause mortality	Native animals with potential to be affected
<p>Vegetation/habitat removal during construction:</p> <ul style="list-style-type: none"> Removal of mature trees with active hollows and dead standing trees Removal of understorey, groundcover, topsoil and artificial (rubbish) debris 	<ul style="list-style-type: none"> Hollow-dependent bats (including threatened species as listed in Table 6-3) Hollow-nesting and canopy-nesting birds (including threatened species as listed in Table 6-3) Arboreal mammals Arboreal reptiles Arboreal frogs Invertebrates Small woodland birds (species which nest in understorey vegetation and breed locally) Ground-dwelling reptiles Frogs (possibly including the threatened Green and Golden Bell Frog, if it is present).
<p>Machinery/plant and vehicle movements during construction (between locations within the study area)</p>	<ul style="list-style-type: none"> Terrestrial, semi-aquatic and arboreal reptiles, frogs and mammals Birds.
<p>Roadkill post-construction (including impact of consideration of new watering or feed sources or other artificial habitat adjacent to road)</p>	<ul style="list-style-type: none"> Terrestrial, semi-aquatic and arboreal reptiles, frogs (possibly including the threatened Green and Golden Bell Frog, and mammals Birds, especially waterbirds, owls (e.g. Powerful Owl) and raptors (e.g. Little Eagle).

Hydrology changes

The existing hydrological conditions of the study area are already affected by altered landform and altered stormwater runoff and velocity as a result of surrounding land uses. The proposal may result in further alteration to local hydrology due to additional changes in landform, an increase in hard stand surfaces and therefore an increase in runoff being collected by the proposal's drainage network. The local drainage network discharges into Harris Creek and Williams Creek and the hydrology and drainage impacts of the proposal are described in section 6.2. The study area does not contain any native vegetation communities such as natural wetlands which are likely to be reliant on surface water. Given the already altered hydrological condition of the project and the lack of ecosystems reliant on surface water, impacts to surface water are unlikely to cause resultant significant impacts on native vegetation communities in the study area.

A reduction in surface water in dams and detention basins could result in the loss of habitat for fauna species such as frogs and tortoises which use artificial water bodies. However the changes to the hydrological regime as a result of the proposal would be relatively small in scale and unlikely to significantly affect any of the existing surface water bodies or fauna species that rely on them.

Wildlife habitat fragmentation

This describes the process where a single connected habitat is split (fragmented) into more than one area. Table 6-9 describes the potential wildlife fragmentation impacts that may occur as a result of the proposal.

Table 6-9: Potential impacts of the proposal related to wildlife habitat connectivity and fragmentation

Impact	Affected species
Genetic isolation due to the fragmentation of habitat and the road creating a barrier effect	<ul style="list-style-type: none"> • Native plants, including the threatened species listed in Table 6-2 • Cumberland plain land snails • Birds and bats • Ground and tree-dwelling mammals, frogs and reptiles.
Edge effects	<ul style="list-style-type: none"> • Native plants, including the threatened species listed in Table 6-2 • Cumberland plain land snails
Loss of migratory habitat	<ul style="list-style-type: none"> • Wetland birds
Loss of habitat that support species across their lifecycle	<ul style="list-style-type: none"> • Frogs (possibly including the green and golden bell frog) • Semi-aquatic and ground dwelling reptiles
Indirect impacts on threatened predators	<ul style="list-style-type: none"> • Powerful owl • Little eagle
Cumulative impacts on corridors and movement	<ul style="list-style-type: none"> • All species

Given the relatively minor nature of the proposed vegetation and habitat removal; the disturbed environment of the road reserve, which is already subject to edge effects; and the presence of a road barrier, the above impacts would be unlikely to be significant.

Wildlife connectivity

Wildlife corridors are links of native vegetation that join two or more areas of similar habitat and are important for sustaining ecological processes. Habitat in the area has been largely disturbed by broad scale urban development with some intact remnant habitat still occurring. From biodiversity surveys completed for this proposal no wildlife corridors have been officially mapped within the study area. The development of Voyager Point has resulted in reduced connectivity between northern remnant bushland and native bushland located in the south in Holsworthy Army Barracks. The result of increased urban development of Voyager Point and Holsworthy has restricted wildlife connectivity between the two watercourses of Harris Creek Reserve and Williams Creek.

Despite this, the remnant vegetation around Harris and Williams Creek provides some level of wildlife connectivity, however the proposed work would not be expected to impact upon the wildlife movement through this corridor. In addition appropriate mitigation would allow continued fauna movement in an approximate north to south direction around Harris and Williams Creeks.

Edge effects, including weed invasion noise, light and vibration (indirect)

As described above, by fragmenting habitat the result is to increase the edge length of the created smaller habitats. The increased edge lengths are then susceptible to specific effects as outlined in Table 6-10.

These effects are likely to alter habitat adjacent (generally within 20 m) of the roadway. The majority of the vegetation affected is already subject to such edge effects. The edge effects created by the proposal would be an incremental increase and is unlikely to result in significant adverse impacts on biodiversity.

Table 6-10: Potential edge effect impacts

Edge effects	Biodiversity with potential to be affected	Potential impacts
Soil moisture changes	Native plants, including threatened species (refer Table 6-2). Threatened ecological communities Cumberland Plains Land Snail	The implementation of a surface/storm water system would only occur over small areas adjacent to detention basins and table drains. Soil moisture changes are not likely to significantly affect biodiversity values.
Shading	Native plants, including threatened species (refer Table 6-2). Threatened ecological communities	Changes to shading would occur immediately adjacent to the roadway and over very small areas. Shading effects from the proposal are unlikely to significantly affect biodiversity values.
Light pollution	Bats, frogs and nocturnal birds and mammals	Under present conditions there is moderate light pollution in larger areas of habitat. Light pollution would be moderately higher as a result of the proposal due to new fixed street lighting and light from vehicles using the road. The proposed lighting for the roadway would be designed to minimise light spill. Significant ecological light pollution impacts on the site are unlikely.
Weed invasion	Native plants, including threatened species	The proposal has the potential to further disperse weeds. The greatest potential for weed dispersal and establishment would occur during earthwork, movement of soil and attachment of seed (and other propagules) to vehicles and machinery where these are utilised within or adjacent to retained vegetation. The proposal would involve substantial weed control and native vegetation restoration work along the affected creeks. With the weed management and vegetation restoration regime proposed, the overall impact of weed invasion on retained vegetation would be expected to decrease in the medium to long term.

Edge effects	Biodiversity with potential to be affected	Potential impacts
Noise and vibration	All fauna species	There are locations in the proposal footprint where the ambient noise is already reasonably high. Animals are likely to have learnt to live with it (habituation). It is also considered that the noise created on building the proposal would be temporary and the majority of species would avoid the work area where possible. Any species that are less mobile would be at risk for being impacted via habitat loss and/or fragmentation, injury or mortality as described above.

Pests, pathogens and diseases

Pests and pathogens would spread via the same mechanism as weeds. They can also be effectively managed and controlled by implementing site management controls and so the risk of introducing these organisms would be low and the impacts unlikely to be significant given the already disturbed nature of the project area.

The only pest species likely to be moved during the proposal is the Eastern Gambusia, which may be moved during the work around Harris Creek or Williams Creek. This species already occupies all of the streams in and adjacent to the proposal area. There is therefore little potential for the proposal to introduce this species to any location from where it is currently absent.

In the short term, removal of habitat may lead to increased competition for resources (e.g. tree hollows) and increased pressure on remaining habitats. The proposed installation of nest boxes prior to the commencement of construction may reduce these short-term impacts.

Plant and animal pathogens can affect threatened biodiversity through direct mortality and modification to vegetation structure and composition. The following pathogens are considered to have potential to affect the biodiversity of the study area and are the subject of Key Threatening Process listings:

- Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*).
- Exotic Rust Fungi (order *Pucciniales*, e.g. Myrtle rust fungus *Uredo rangeli*).
- Phytophthora Root Rot Fungus (*Phytophthora cinnamomi*).

The main way in which Exotic Rust Fungi and Phytophthora Root Rot Fungus are spread is through the movement of infected plant material and/or soil. The construction and operation of the proposal may increase the risk of disturbing and spreading these pathogens. With the implementation of hygiene procedures for the use of vehicles and the importation of materials to the site, the risk of introducing these pathogens would be low. Preferential use of plant materials sourced on-site (e.g. mulch, seeds) used for vegetation restoration would also help to minimise this risk.

Amphibian Chytrid Fungus can be spread through the movement of infected animals or water (including mud or moist soil) from infected areas. With the implementation of hygiene procedures for the use of vehicles and the importation of materials to the site, the likelihood of introducing this pathogen to uninfected areas is low.

Operation

Once operational, the road would be managed in accordance with Roads and Maritime Services' specifications. There would be certain impacts that would continue to have a permanent impact on the ecological values of the area as described above. In addition, the following impacts would only potentially occur once the proposal was operational.

Table 6-11: Operational impacts

Potential impact	Description
<p>Aquatic impacts: increased volumes of stormwater entering the creeks and dams as a result of the increased area of hard stand, which may affect the flows and channel patterns and aquatic habitat in the creeks</p>	<p>While the hardstand area would increase, the drainage infrastructure is being designed to cope with the rainfall and runoff that would typically occur from a storm that would occur once every 100 years. Providing the drainage infrastructure is maintained to prevent any lost capacity then the impact would be considered negligible.</p> <p>Increased surface water accumulation could adversely affect the Castlereagh Scribbly Gum Woodland, Shale Gravel Transition Forest, Castlereagh Swamp Woodland and Cumberland River-flat Forest communities. However, the proposal's drainage network would be designed to avoid increased surface water accumulation and therefore it is not expected that vegetation communities would be adversely affected by inundation or prolonged inundation.</p>
<p>Injury and mortality: vehicle strikes from wildlife crossing the operational road</p>	<p>It is likely that the wildlife would habituate to the presence of the road and the risk of road kill would decrease, nonetheless there is a residual long-term risk that cannot be discounted. The study area is not in an identified wildlife corridor and as such the impact is likely to be of minor significance.</p>
<p>Noise impacts: the operational movement of traffic and its effects on adjacent wildlife.</p>	<p>It is likely that all species would accommodate to the changed noise levels in the area, as they will have done with the building and operation of the other infrastructure in the area. The noise levels are unlikely to cause any behaviour responses or affect the health of any animal species, such that the impact is considered to be negligible.</p>
<p>Shading impacts: as a result of building culverts, bridge abutments, structures, piers and crossing points</p>	<p>There would be very few areas where shading would be introduced under the proposal relating to the culverts, bridge abutments and crossing points meaning the impacts would be of negligible-to-minor significance. Also the culverts do not form an important wildlife corridor as described above.</p>
<p>Light pollution: the introduction of road traffic lighting in the area</p>	<p>While the proposal would introduce more light, it would be designed to current standards which prevent back-spill and up-spill (refer to section 6.9.4) which would minimise ecological light pollution. There is also division in the scientific community about the attraction of certain species to artificial light or its effects on patterns and activities, as discussed in Appendix G. Therefore the lighting impacts would not be likely to be significant.</p>
<p>Weed invasion</p>	<p>There would be the potential for invasive weed species to (re) establish over time. Providing this is managed in accordance with the NSW Noxious Weed (Weed Control) Order 2014, the impact would be negligible.</p>

Conclusion on significance of impacts

Assessments of significance were completed for each threatened species, population and community recorded in the study area, or considered to have a moderate-to-high likelihood of occurring locally (refer to Tables 6-2 to 6-4). Section 6 of Appendix G describes the detail of these assessments.

The proposal is not likely to significantly impact threatened species, populations or ecological communities or their habitats, within the meaning of the *Threatened Species Conservation Act 1995* or *Fisheries Management Act 1994* and therefore a Species Impact Statement is not required.

The proposal is not likely to significantly impact threatened species, populations, ecological communities or migratory species, within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*.

6.1.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Biodiversity	<p>A Flora and Fauna Management Plan will be prepared in accordance with Roads and Maritime's <i>Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects</i> (RTA, 2011) and implemented as part of the CEMP. It will include, but not be limited to:</p> <ul style="list-style-type: none"> Plans showing areas to be cleared and areas to be protected, including exclusion zones, protected habitat features and revegetation areas Requirements set out in the <i>Landscape Guideline</i> (RTA, 2008) Pre-clearing survey requirements Procedures for unexpected threatened species finds and fauna handling Procedures addressing relevant matters specified in the <i>Policy and guidelines for fish habitat conservation and management</i> (DPI Fisheries, 2013) Protocols to manage weeds and pathogens. 	Contractor	Detailed design / pre-construction	<p>Core standard safeguard B1</p> <p>Section 4.8 of QA G36 <i>Environment Protection</i></p>
Biodiversity	Investigate measures to further avoid and minimise the construction footprint and native vegetation or habitat removal.	Contacto	Detailed design / pre-construction	Core standard safeguard B2
Native vegetation removal and re-establishment	Minimise native vegetation and habitat removal through detailed design. Harris Creek and Williams Creek to retain fauna passage and connectivity to areas south of Heathcote Road to enable movement for fauna south.	Roads and Maritime	Detailed design	Additional safeguard B3
Native vegetation removal and re-establishment	A Biodiversity Offset Strategy would be prepared during the detailed design phase to provide offsets equivalent to 145 ecosystem credits. This strategy would be prepared in accordance with the Guidelines for Biodiversity Offsets (Roads and Maritime, 2011h) and the NSW BioBanking Assessment Methodology 2014.	Roads and Maritime	Detailed design	Additional safeguard B4

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
General ecological mitigation	Ensure any fauna encountered onsite would be managed in accordance with Biodiversity Guidelines, Guide 9 (fauna handling) (Roads and Maritime, 2016b)	Contractor	Pre-construction	Additional safeguard B5
General ecological mitigation	In addition to the requirements of Core standard safeguard B1, the Flora and Fauna Management Plan would also include: <ul style="list-style-type: none"> • A site walkover to confirm clearing boundaries and sensitive location before starting work • Identify, in toolbox talks, where biodiversity controls would be included. 	Contractor	Pre-construction	Additional safeguard B6
Invasive and noxious weed management	Develop a weed management plan (WMP) in accordance with Biodiversity Guidelines, Guide 6 (Roads and Maritime, 2016b) to include: <ul style="list-style-type: none"> • Identification of the weeds on site (confirm during ecologist pre-clearing inspection) • Weed management priorities and objectives • Sensitive environmental areas within or adjacent to the site • The location of weed infested areas • Weed control methods • Measures to prevent the spread of weeds, including machinery hygiene procedures and disposal requirements • A monitoring program to measure the success of weed management • Communication with local Council noxious weed representative. 	Contractor	Pre-construction	Additional safeguard B7
Vegetation management	Develop a vegetation management plan for undertaking the work across Harris and Williams Creek in accordance with Greater Metropolitan Regional Environmental Plan No. 2 – Georges River Catchment.	Contractor	Pre-construction	Additional safeguard B8

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Risk of pathogen and pest species	If hygiene procedures are required onsite, ensure the Flora and Fauna Management Plan includes hygiene protocols to prevent the introduction and spread of such pathogens as specified in Biodiversity Guidelines: (Roads and Maritime, 2016b). Manage all pathogens (e.g. Chytrid, myrtle rust and phytophthora) in accordance with the Biodiversity Guidelines, Guide 7 (Roads and Maritime, 2016b).	Contractor	Pre-construction	Additional safeguard B9
Unexpected blockage of fish passage	<p>A detailed Environmental Work Method Statement (EWMS) will be prepared and implemented for all work undertaken within waterways. The EWMS will detail measures to avoid or minimise risks from erosion and sedimentation to water quality and biodiversity. It will be prepared in accordance with relevant guidelines including, but not limited to:</p> <ul style="list-style-type: none"> • Roads and Maritime Biodiversity Guidelines - Protecting and managing biodiversity on RTA projects • NSW DPI (Fisheries) guidelines Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings • Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management Update 2013 (Department of Primary Industries 2013). 	Contractor	Construction	Additional safeguard B10
Unexpected discovery of threatened species	If unexpected flora or fauna are discovered stop work immediately and implement the Roads and Maritime Unexpected Threatened Species Find Procedure in the Biodiversity Guidelines, Guide 1 (Roads and Maritime, 2016b)	Contractor	Construction	Additional safeguard B11
Injury and mortality impacts while building the proposal	<p>Implement the following controls: under the Flora and Fauna Management Plan:</p> <ul style="list-style-type: none"> • Manage fauna in accordance with Biodiversity Guidelines, Guide 9 (Roads and Maritime, 2016b) • Remove any habitat in accordance with Biodiversity Guidelines, Guide 4 (Roads and Maritime, 2016b). 	Contractor	Construction	Additional safeguard B12

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Native vegetation removal and re-establishment Threatened species habitat and habitat features	Implement the following controls under the Flora and Fauna Management Plan: <ul style="list-style-type: none"> • Undertake pre-clearance checks in accordance with Biodiversity Guidelines, Guide 1 (Roads and Maritime, 2016b) • Create exclusions zones in accordance with Biodiversity Guidelines, Guide 2 (Roads and Maritime, 2016b) • Re-establish native vegetation in accordance with Biodiversity Guidelines, Guide 3 (Roads and Maritime, 2016b) • Reinstate habitat in accordance with Biodiversity Guidelines, Guide 5 and Guide 8 (Roads and Maritime, 2016b) 	Contractor	Construction	Additional safeguard B13
Aquatic impacts	Protect aquatic habitat in accordance with Biodiversity Guidelines, Guide 10 Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (Roads and Traffic Authority 2011) and section 3.3.2 standard precautions and measures of the Policy Guidelines for Fish Habitat Conservation and Management (NSW Department of Primary Industry (Fisheries), 2013)	Contractor	Construction	Additional safeguard B14
Aquatic impacts	Watercourse crossings will be designed to ensure that they meet the minimum requirements for fish passage recommended for the classes of 'fish habitat' found at the stream crossings.	Contractor	Construction	Additional safeguard B15
Wildlife connectivity impacts	Implement connectivity controls in accordance with the Wildlife Connectivity Guidelines for Road Projects (Roads and Maritime, 2016c)	Contractor	Construction	Additional safeguard B16

Other safeguards and management measures that would address biodiversity impacts in relation to bushfire are identified in section 6.11.4.

6.1.5 Biodiversity offsets

The proposal will require the removal of approximately 6.24 ha of vegetation of which 3.41 ha is native vegetation that also constitutes habitat for threatened species. All of the native vegetation to be cleared is consistent with four threatened ecological communities.

The need for biodiversity offsets is founded in the theory of 'avoid, minimise and mitigate' the impacts of projects. The accepted approach to environmental assessment requires that, in the first instance, environmental impacts are avoided or minimised as far as possible and subsequently reduced to acceptable levels through appropriate mitigation techniques. Where measures to avoid and mitigate impacts are not feasible or cost effective, then offset strategies can be used to compensate the residual impacts of the development on biodiversity.

Given that the proposal would result in clearing of a threatened ecological community (2.37 ha of Castlereagh scribbly gum woodland), greater than one hectare and is in moderate to good condition, it is necessary to provide biodiversity offsets. In accordance with the Framework for Biodiversity (FBA) and calculated using the BioBank credit calculator, 145 ecosystem credits would be required to offset project impacts on Castlereagh Scribbly Gum Woodland.

A Biodiversity Offset Strategy would be prepared during the detailed design phase based on the above estimate of credits (refer to Chapter 7 of Appendix G).

A Biodiversity Offset Strategy will be developed during the detailed design phase of this proposal. The strategy will be developed in accordance with the Guideline for Biodiversity Offsets (Roads and Maritime 2011h) and the NSW BioBanking Assessment Methodology 2014. In determining the area, location and type of biodiversity offset depends on a number of factors. These include:

- Vegetation types and species that are impacted
- Regional and catchment landscapes (e.g. fragmentation and fauna movement corridors)
- Mitigation measures employed
- Availability of offsets
- Lag time between causing an impact and achieving an offset action.

6.2 Surface water and flooding

6.2.1 Methodology

The following documents guided the assessment:

- Acid Sulfate Soils Assessment Guidelines. (ASSMAC, 1998)
- Code of Practice for Water Management: Roads and Development Management (Roads and Maritime, 1999)
- Managing Urban Stormwater Soils and Construction: Volume 2D Main Road Construction (DECC, 2008)
- Stockpile Site Management Guidelines (Roads and Maritime, 2008a)
- The Blue Book: Managing Urban Stormwater (MUS): Soils and Construction, Volume 1 (Landcom, 2004)
- The Blue Book: Managing Urban Stormwater (MUS): Soils and Construction, Volume 2 (Landcom, 2008)
- Guideline for the Management of Contaminated Land (Roads and Maritime, 2013f)
- Technical Guideline: Temporary Stormwater Drainage for Road Construction (Roads and Maritime, 2011i)
- Guidelines for Construction Water Quality Monitoring (Roads and Maritime, undated)
- Water Policy (Roads and Maritime, undated).

The assessment:

- Identified and described the soil landscape and solid and drift geology characteristics of the study area by referring to:
 - 1:100,000 Geological Series Sheet 9130: Sydney, 1983
 - 1:100,000 Soil Landscape Series Sheet 9130: Sydney, 1989
 - Local government area acid sulphate soil mapping (various)
- Identified and described the surface water characteristics of the study area
- Confirmed the current drainage arrangements and discharge pathways across the study area focusing on the proposal footprint
- Confirmed the study area's contamination potential by referring to:
 - NSW EPA's contaminated land records
 - Pollution prosecutions and notices issued by NSW EPA
 - Historic mapping
 - Existing physiochemical testing of the soil and groundwater
- Confirmed the flood risk potential across the proposal footprint
- Identified key activities that could potentially affect surface water
- Determined the sensitivity of the subsurface to the changes that would occur as a result of undertaking the work
- Identified those adverse impacts that would need safeguarding or managing under the proposal.

Central to the assessment was assessing the likelihood for the proposal to impact on the local surface waters and the wider catchment. Consequently, the assessment considered the value that these resources provide and how and to what extent these values would be likely affected by the proposal. Exposure, contamination, migration, flood risk and change in function/quality were factors referred to in undertaking the assessment. The assessment considers the source of the potential impact, the impact pathway and the receiving environment.

Study area

The study area considered the impacts across the proposal footprint, within the local surface water catchment. Regional characteristics were used to provide wider context and reference.

6.2.2 Existing environment

Water quality: catchment values

The proposal footprint is located within the Georges River Catchment. The Georges River has a catchment area of about 960 square kilometres and a population of about one million people. The river is about 100 kilometres in length and has a number of important tributaries, including Harris and Williams Creek, both of which are located within the proposal footprint (refer to Figure 1-2). The overall ecological condition of freshwater reaches across the Georges River catchment in 2014–2015 was reported as 'fair' in the River Health Georges River Report Card 2014–2015. The 2012 State of the Environment Report indicates that the water quality recorded at the majority of the Liverpool LGA monitoring sites within the Georges River catchment is poor.

Water quality: surface water

Within the Liverpool LGA, the most common pollutants come from industrial and commercial premises, rural areas, roads, parks, gardens and households (Liverpool City Council, 2012).

Water quality in Harris Creek is influenced by a number of urban land uses upstream and within the vicinity of the proposal. Stormwater runoff which runs into Harris Creek can carry pollutants from residential housing, roads, sporting complexes and sewage treatment downstream of the bridge and mining upstream of the bridge.

Conversely, upstream of the proposal Williams Creek runs through bushland. The only urban influence upstream is the fringe of the Holsworthy Barracks located to the west of the creek.

Harris Creek and Williams Creek flow into the Georges River. Water quality data for the Georges River is outlined in Table 6-12. Between 2009 and 2015 the Georges River received an overall river health rating of 'fair'.

Table 6-12: Georges River water quality data 2009–2015

Year	Overall river health rating	Description
2009	C+	In 2009, during the first year of monitoring, the Georges River received a fair rating. This rating was attributed to a high degree of urbanisation in the lower and mid catchments has led to the loss of riparian and estuarine vegetation and the deterioration of water quality.
2010	C	The overall grade remained fair in 2010.
2011-2012	B	Between 2011 and 2012 there was a slight improvement in the overall grade, however the ecological condition of the river remained fair.
2012-2013	B	The ecological condition of the river remained fair during 2012 and 2013.
2013-2014	B-	During 2013 and 2014 the overall river rating decreased marginally compared to 2012 and 2013, this result is likely attributed to severe weather events which had a negative impact on water quality. Overall, the ecological condition retained a fair rating.
2014-2015	B-	Overall the river health rating remained unchanged from the previous year.

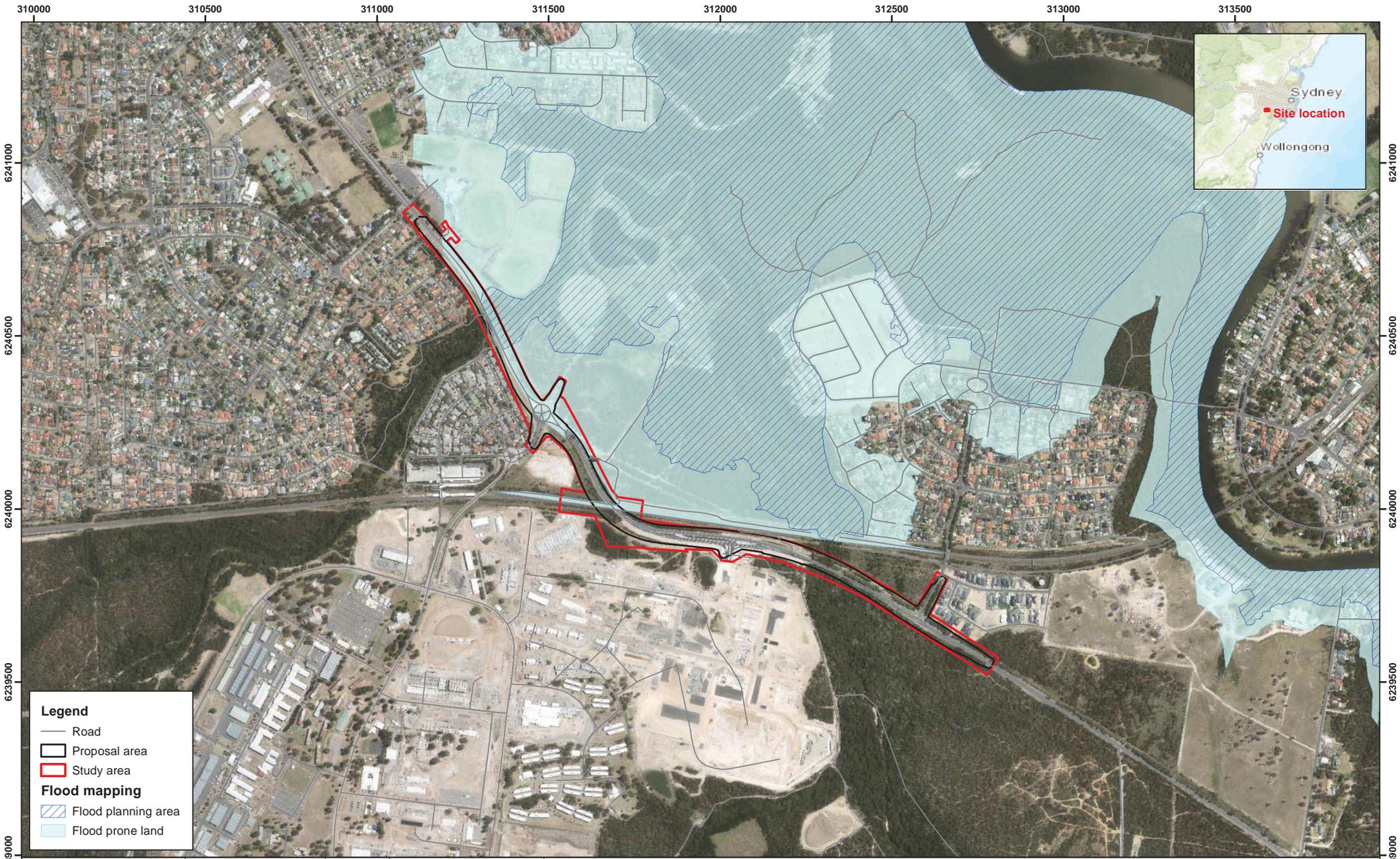
Source: Georges River Combined Councils Committee (GRCCC) 2009-2015

A Sydney Water STP is also located about 500 metres to the north east of the study area, which may present a risk of surface water contamination. This is discussed further in section 6.4.3.

Water quality: flood risk

The proposal footprint north of Heathcote Road to the west of Williams Creek is flood prone land (Liverpool City Council LEP, refer to Figure 6-3). The section of Heathcote Road between Williams Creek and Harris Creek is also identified as a major road where road inundation could occur in the *Georges River Floodplain Risk Management Study and Plan* (Bewsher Consulting, 2004).

The existing Harris Creek Bridge can withstand water levels from a storm event that would typically occur once every five years. The Williams Creek Bridge can withstand water levels from a storm that would occur once every decade. The proposal would increase the height of the Williams Creek Bridge to withstand water levels from a storm event typically occurring once every century. At Harris Creek, the new bridges would withstand storms that typically occur once every 40 years (northern bridge) and 50 years (southern bridge).



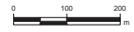
Legend

- Road
- ▭ Proposal area
- ▭ Study area

Flood mapping

- ▨ Flood planning area
- Flood prone land

Map: 2113368_GIS_008_A	Author: RP
Date: 8/09/2016	Approved by: IS

1:10,000

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3



Heathcote Road Upgrade
Figure 6-3
 Flood prone land

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6.2.3 Potential impacts

Construction impacts: surface water

Potential construction impacts to water quality could arise if activities are not appropriately managed. Construction activities with the highest risk include:

- General earthwork, including stripping of topsoil, excavation or placement of fill
- Storage of material at site compounds
- Construction of drainage infrastructure
- Removal of riparian and aquatic vegetation
- Leaks or spills from chemicals or fuels used during the construction of the proposal
- Construction of in-stream structures in waterways (for example work required for building Harris Creek and Williams Creek Bridges).

The surface waters of Harris and Williams Creeks are at the greatest risk of pollution during bridge construction and bridge approach road works due to the close proximity of these works in and around both creeks. Construction activities for the bridge construction and related road work with potential to impact water quality include:

- Sedimentation within the waterway resulting from activities on site such as earthwork, back-filling of bridge abutments and retaining walls and removal of the existing abutments and bridge structures at Williams Creek
- Risk of spills including:
 - Fuels and chemicals from machinery and plant on site. The majority of fuels and chemicals would be stored at the compound site (refer to section 3.5). On site use of chemicals and fuel would be managed with appropriate safeguards (as listed in section 6.2.4 and section 6.4.6).
 - Concrete as a result of activities such as forming and pouring of piers, headstock, abutments. If not properly contained, this could result in an increased alkalinity of the Harris and Williams Creeks.

The reasonable volumes of materials being excavated and backfilled (refer to section 3.4.6), and the work required at Harris Creek and Williams Creek has the potential to result in impacts to surface water quality. With implementation of safeguards recommended in section 6.2.4, the potential impacts are not likely to be significant.

Construction impacts: flooding

As shown in Figure 6-3 the proposal will require construction work to be undertaken on flood prone land. The compound and stockpile site would not be established on flood prone land.

Flooding during construction has the potential to impact water quality through erosion and sedimentation and contamination. This is particularly the case if flooding occurs during excavations. With the application of appropriate mitigation measures as described in section 6.2.4, this impact is not considered to be significant.

Operational impacts: surface water

Once the proposal becomes operational, the potential impacts to water quality would remain unchanged from the existing conditions. Existing and long term risk to water quality would consist of surface runoff from impervious surfaces and concentration of runoff by drains. This can result in the build-up of contaminants on road surfaces, median areas and roadside corridors in dry weather which, during rainfall events, can be flushed into the stormwater drainage, in which case pollutant loads would be discharged to the surrounding watercourses. The contaminants of most concern relating to road runoff are:

- Suspended sediment from the paved surface and landscaped batters over the short-term as the area recovers and the vegetation treatments establish and mature
- Heavy metals attached to particles washed off the paved surface

- Oil, grease and other hydrocarbon products
- Litter from the road corridor.
- Nutrients from biological matter.

Sediment is currently picked up in the grass swales adjacent to the road. These swales slow stormwater discharge and act as a filter to remove pollution and sediments. No extra water quality measures are currently proposed as the grass swales are considered to provide effective filtration for stormwater runoff. As a result there would be no net change from the existing situation. It is considered unlikely that significant sediment or pollution impacts would occur during operation of the proposal.

Operational impacts: flooding

As described above, the road would be less likely to flood as the new and replaced bridges would be built to provide greater flood protection. Despite this being a benefit of the proposal the following operational impacts are still anticipated:

- Scouring and sediment movement at structures, leading to potential undermining and failure of structures. Scour protection measures would be identified and refined during detail design to minimise the above impacts such that any associated scouring and sediment during flooding would not have a notable adverse effect.
- Increased surface water levels in the vicinity of drainage structures and the new bridges over Harris and Williams Creeks. However, hydraulic modelling indicates new road bridges would not have a significant impact on peak flood levels upstream of the road corridor over the full range of flood events analysed, which would mean that any impact would be negligible.

6.2.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Soil and 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	Core standard safeguard SW1 Section 2.1 of QA G38 <i>Soil and Water Management</i>
Soil and water	A site specific Erosion and Sediment Control Plan/s (ESCP) will be prepared and implemented as part of the Soil and Water Management Plan. 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.	Contractor	Detailed design / Pre-construction	Core standard safeguard SW2 Section 2.2 of QA G38 <i>Soil and Water Management</i>
Water Quality	A detailed Environmental Work Method Statement (EWMS) will be prepared and implemented for all works undertaken within waterways. The EWMS will detail measures to avoid or minimise risks from erosion and sedimentation to water quality and biodiversity. It will be prepared in accordance with relevant guidelines including, but not limited to: <ul style="list-style-type: none"> • Roads and Maritime Biodiversity Guidelines - Protecting and managing biodiversity on RTA projects • The Blue Book: Managing Urban Stormwater (MUS): Soils and Construction, Volume 2 (Landcom, 2008). 	Construction contractor	Pre-construction	Additional safeguard SW3

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Water Quality	<p>Consistent with any specific requirements of the approved SWMP and ESCP, control measures will be implemented to minimise risks associated with erosion and sedimentation and entry of materials to drainage lines and waterways. That will include, but not necessarily be limited to:</p> <ul style="list-style-type: none"> • Sediment management devices, such as fencing, hay bales or sand bags • Measures to divert or capture and filter water prior to discharge, such as drainage channels and first flush and sediment basins • Scour protection and energy dissipaters at locations of high erosion risk • Installation of measures at work entry and exit points to minimise movement of material onto adjoining roads, such as rumble grids or wheel wash bays • Appropriate location and storage of construction materials, fuels and chemicals, including bunding where appropriate. 	Construction contractor	Pre-construction	Additional safeguard SW4
Water Quality	<p>The ESCP will also address the following regarding water quality:</p> <ul style="list-style-type: none"> • Identification of catchment areas and the direction of on-site and off-site water flow • The likely run-off from each road sub-catchment • Separation of on-site and off-site water • The direction of run-off and drainage points during each stage of construction • Location and staging of scour protection • Process for monitoring and preparing for wet weather. 	Construction contractor	Pre-construction	Additional safeguard SW5
Water Quality	<p>Instream work would be suspended following high rainfall events. Work would recommence once the work area and ground conditions are stabilised and potential for erosion and sedimentation is minimised.</p>	Contractor	Construction	Additional safeguard SW6
Water Quality	<p>During concreting, cement slurry and other contaminants will be prevented from entering waterways or any drainage lines.</p>	Contractor	Construction	Additional safeguard SW7

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Water Quality	If concreting work is required onsite, concrete washout bays located in bridge work zones would be positioned as far as reasonably practicable from waterways and be emptied on a regularly basis. Any washout of the lines or chute will be in an impervious bunded area	Contractor	Construction	Additional safeguard SW8
Flooding/ Hydrology	Prior to construction commencing, final flood and hydrology assessments will be undertaken to inform detail design measures to minimise risks to the environment	RMS	Detailed Design/Pre-construction	Additional safeguard SW9
Flooding	Scour protection measures will be identified and refined during detail design	RMS	Detailed Design	Additional safeguard SW10
Spills	Emergency wet and dry spill kits would be kept onsite at all times. All staff would be made aware of the location of the spill kit and trained in its use.	Contractor	Construction	Additional safeguard SW11
Spills	All refuelling of vehicles and equipment on site would be undertaken a minimum of 50 metres away from water bodies and surface drains, wherever possible. The refuelling of vehicles would be monitored at all times and spill kits would be available within refuelling vehicles.	Contractor	Construction	Additional safeguard SW12
Spills	Any fuel, oil or other liquids stored onsite would be stored in an appropriately sized impervious bunded area away from water bodies.	Contractor	Construction	Additional safeguard SW13

Other safeguards and management measures specific to potential groundwater impacts, may also address surface water impacts and these are identified in the following section 6.3.

6.3 Groundwater

6.3.1 Methodology

The following documents guided the assessment:

- Code of Practice for Water Management: Roads and Development Management (Roads and Maritime, 1999)
- Guidelines for Assessment and Management of Contaminated Groundwater (DEC, 2007a)
- Guidelines for Construction Water Quality Monitoring (Roads and Maritime, undated)
- Water Policy (Roads and Maritime, undated).

Central to the assessment was assessing the likelihood for the proposal to impact on the local groundwater catchment. Consequently, the assessment considered the value that these resources provide and how these values would be likely affected by the proposal. Exposure, contamination, migration, and change in function/quality were factors referred to in undertaking the assessment. The assessment considers the source of the potential impact, the impact pathway and the receiving environment.

Study area

The study area considered the impacts across the proposal footprint, and within the local surface water and groundwater catchment.

6.3.2 Existing environment

Water quality

During the geotechnical investigations undertaken for the proposal groundwater was encountered between 1.8 metres and 2.2 metres below ground level (BGL) at Harris Creek, at 0.6 metres BGL at about 75 metres north of the railway on the western side of Heathcote Road, and between 2.2 metres and 2.9 metres at Williams Creek (WSP | Parsons Brinckerhoff, 2016). While no assessment of groundwater flow was undertaken as part the above assessment, it can be assumed that the groundwater would typically flow towards the creek lines and Port Hacking to the east of the proposal footprint.

A Sydney Water sewage treatment plant (STP) is also located about 500 metres to the north east of the study area. This may present a risk of groundwater contamination. Section 6.4.3 discusses this further.

6.3.3 Potential impacts

Construction impacts: groundwater quality

Groundwater quality could be affected during the excavations needed for the bridge footings and bored piles at Harris Creek, Williams Creek and the railway line. This would be due to groundwater seepage that may occur where the excavation extends below the groundwater table, with the potential to affect safety and the progress of construction work.

Construction impacts: groundwater resource

Dewatering during excavation and the use of casings when drilling the bored piles would potentially be required, particularly where loose sands are encountered below the water table at Williams Creek and Harris Creek. However, the extent, volume and duration of dewatering would be at the local scale in a groundwater system that operates and recharges regionally. Due to the underlying permeable geology (refer to section 6.4) the groundwater recharge rate is quick. Consequently, there would only be a short-term drawdown of the water table at the point of excavation, with the levels recharging almost immediately. Therefore there would be no anticipated regional effects that would further impact upon nearby groundwater dependent ecosystems associated with Williams Creek or Harris Creek (as discussed in section 6.1 and Appendix G).

Operational impacts

Once the proposal becomes operational, there would be no net change in how the road impacts on groundwater levels, flows, recharge, quality or other values.

6.3.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Groundwater quality	Additional site investigation including the installation and subsequent monitoring of groundwater wells at about 500 metre intervals along the proposal alignment and near Williams Creek and Harris Creek would be undertaken.	Roads and Maritime	Detailed Design/pre-construction	Additional safeguard GW1
Groundwater resource	A dewatering strategy and groundwater management measures for any excavations below the groundwater table will be prepared and implemented as part of the Soil and Water Management Plan. This would focus on the construction of the pier foundations in Harris Creek. Any dewatering activities will be undertaken in accordance with the RTA Technical Guideline: Environmental management of construction site dewatering in a manner that prevents pollution of waters	Roads and Maritime Contractor	Pre-construction Construction	Additional safeguard GW2
Groundwater quality	Shoring and water-tight requirements are to be implemented for foundation excavations	Roads and Maritime	Detailed Design/pre-construction	Additional safeguard GW3
Groundwater resource	Concreting methods that reduce the likelihood of groundwater ingress will be employed for construction of bridge piles and foundations. This will also reduce the likelihood of washing out the cement content.	Contractor	Construction	Additional safeguard GW4

6.4 Soils and geology

6.4.1 Methodology

A desktop assessment of potential site contamination issues has been carried out as part of the REF. The purpose of this was to assess the potential contamination issues that may have arisen from past and/or present activities and to identify the need for further investigation.

The desktop search included a search and review of the:

- NSW EPA Contaminated Land - Record of Notices on 9 March 2016
- NSW EPA List of NSW Contaminated Sites Notified to EPA on 9 March 2016
- NSW EPA List register for any Licences or Notices that have been issued for the Sites under the Protection of the Environment Operations (POEO) Act, 1997
- Department of Defence public register of properties on the Defence Environmental Remediation Program
- Past land uses from historical aerial photographs of the proposal area.

The review of information considered the following State and Commonwealth guidelines:

- Guidelines for Consultants Reporting on Contaminated Sites (EPA, 2011).
- NEPC, 2013. National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1).
- Australian Standard AS 4482.1-2005 Guide to the investigation and sampling of sites with potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds.
- NSW Protection of Environment Operations Act 1997 (as amended).
- NSW Contaminated Land Management Act 1997.
- Acid Sulfate Soils Assessment Guidelines. (Acid Sulfate Soil Management Advisory Committee, 1998)
- Guideline for the Management of Contaminated Land (Roads and Maritime, 2013f).
- Guidelines for the Management of Acid Sulfate Materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze (RTA, 2005).

Study area

The study area considered the impacts across the proposal footprint, and to the underlying soil and geology. Regional characteristics were used to provide wider context and reference.

6.4.2 Existing environment

Soils

The 1:100 000 soil landscape map for Penrith (Bannerman *et al*, 1990) indicates that the majority of the study area is underlain by fluvial soils of the Richmond group. These are broadly described as poorly structured orange to red clay loams and sands, plastic clays are present in drainage lines. There is high erosion potential on terrace edges. The remaining extents of the study area appear to be underlain by residual soils of the Blacktown Group (north) and the Lucas Heights Group (south). The soils are classed as a low erosion hazard in accordance with the Blue Book guidance (Managing urban stormwater: soils and construction (Landcom, 2004)).

Geology

Reference to the 1:100 000 geological sheet for Penrith (Clark *et al*, 1991) indicates that the majority of the study area is underlain by Hawkesbury Sandstone described as medium to very coarse-grained quartz sandstone with minor laminated mudstone and siltstone lenses. From the intersection of Heathcote Road and Infantry Parade, the alignment appears to be underlain by Ashfield shale described as being dark-grey to black claystone-siltstone and fine sandstone-siltstone laminate. The geotechnical investigations undertaken in this area did not reveal the presence of shale, however residual soil encountered in one borehole location between these roads was classified as highly expansive indicating the possibility of underlying shale.

A 'linear feature' crossing the alignment near the T2 Airport Railway Line also occurs within the study area. Although no targeted survey was undertaken, no sign of this feature was observed in boreholes, which were dug to six metres below ground level during geotechnical testing for the proposal. Further investigation into this geotechnical feature would be contingent on final design and construction requirements, however it would be considered unlikely that this feature would impact on the proposal.

Acid Sulfate Soils

Acid sulfate soils (ASS) are divided into actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS). They typically occur in low lying coastal areas. A review of the Australian Soil Resource Information Sydney (ASRIS) (CSIRO, 2016) indicates that there is an "extremely low" probability of ASS occurring across the majority of the study area. There are two exceptions. Along both the Harris Creek and Williams Creek corridor there is a "low probability" of ASS occurring.

6.4.3 Contaminated land

Potentially contaminating historic land uses

Table 6-13 provides an overview of the area's development history focussing on land uses that have associated contamination potential.

Table 6-13: Potentially contaminating historic land uses (taken from aerial imagery)

Year	Description of the site	Description of surroundings
1943	The majority of the site is occupied by a constructed road (Heathcote Road).	There are small settlements and farmland along the road in the Holsworthy area. The other surroundings include vegetated bush land. Drainage lines such as Harris Creek are present.
1956	Heathcote Road is still apparent and many adjoining roads have been constructed. Roads appear wider and several larger intersections and on-ramps are apparent.	Increased expansion of settlement in Holsworthy area, including growth of Holsworthy Barracks. Voyager Point area now developed. Sewerage treatment plant built in between Hammondville and Voyager Point. Treatment tanks and larger pond are also present.
1970	Site appears broadly unchanged. Some roads north of the study area have been changed leading out of Holsworthy Barracks.	Holsworthy development continued. Sewerage treatment plant expanded 500 metres north east of the study area. Harris Creek oval established between alignment and sewerage treatment plant. Surroundings are broadly unchanged.
2014	Heathcote Road constructed along proposed site area.	Urban development surrounds site in Holsworthy area and railway line passes beneath Heathcote Road. Vegetated bush land north of the study area around Williams Creek. Holsworthy Barracks extends to the southern boundary of study area around Williams Creek.

Current potentially contaminating land uses

The NSW Environment Protection Authority maintains a database of sites that are either placed on notice as they are contaminated or are known sites and facilities that hold licences to undertake activities that inherently present a contamination risk. In the case of the study area:

- As of 9 March 2016 there are no sites that are notified as being contaminated within one kilometre of the proposal footprint

- There is one surrendered licenced facility, relating to a pipeline linking Holsworthy sewage treatment plant (STP) to Liverpool STP. The STP is located about 500 metres to the north east of the proposal footprint.

The Sydney Water Holsworthy STP, about 500 metres to the north east of the proposal footprint. The STP or associated pipeline is unlikely to materially impact on the proposal due to the distance from the footprint and likely microbiological contaminants present in the contained sludge. Detectable concentrations of dissolved heavy metals and other contaminants may be present in surface waters and groundwater surrounding STP treatment ponds. Although no specific groundwater or surface quality testing has been undertaken as part of this proposal, it is possible that concentrations may be present and would likely diminish with distance from the STP treatment ponds. Groundwater quality monitoring is planned for the detailed design phase (refer to safeguard GW1).

6.4.4 Department of Defence – Holsworthy Barracks

A search of the publically available Department of Defence Environmental Remediation Program for NSW was undertaken due to the need to work on the Holsworthy Barracks. This is summarised below. Holsworthy Barracks has been a training area and artillery range since World War I and a major base for the permanent component of the Australian Army in NSW. Activities carried out on the site include use of firing ranges, chemical weapons testing, fire training, vehicle maintenance and bulk chemical storage and distribution (mainly fuels and waste oils) from above ground and underground storage tanks. The majority of waste generated from site operations have been disposed of in landfills, however some waste has been disposed of in stockpiles around the site. Known contamination around the barracks, include:

- Fuel/oil related compounds in soil at numerous locations around the barracks – primarily around oil separators, and areas where fuel is stored in above ground or underground storage tanks
- Nutrient and biological contamination of soil around areas where sewerage disposal onto surface soils has occurred
- Heavy metal (copper, lead, mercury, nickel, zinc) and benzo (a) pyrene contamination within some of the fill material tested around the barracks
- Heavy metal contamination (mainly lead, copper, chromium, zinc) in soils around firing range areas. Some elevated concentration of lead has also been found in groundwater at some of the firing range areas
- Isolated areas of asbestos contaminated soil within designated waste disposal areas and in some of the firing range stop butt areas
- Groundwater with elevated levels of ammonia and lead near one of the underground fuel storage tank areas.

Department of Defence provided a risk assessment rating indicating that known contamination have been identified at the property. Further assessment of the nature and extent of these risks has been prioritised by Defence. The risks are actively managed by Defence until further assessment is completed. Other risks from Defence activities, such as unexploded ordnance, are discussed in section 6.11.

A phase one desktop assessment and limited phase two intrusive investigations for soil and groundwater quality (refer to section 6.3) were completed for the property and the need for additional intrusive investigations has been identified but not yet completed. Further detail in regards to the location and severity of these identified contamination areas are limited by defence information sensitivity.

The Holsworthy Barracks area adjacent to the proposal alignment is generally made up of vegetated land in the south around The Avenue, followed by roads, open space and embankments up to the rail line. It is considered unlikely that contamination would be present within the study area, however it cannot be ruled out without further assessment. A request for Department of Defence site investigation reports will be made during detailed design to determine if there are any known contamination issues within 100 metres of the proposal footprint.

6.4.5 Potential impacts

Construction

Potential impacts on soil from construction activities would be primarily associated with soil loss from erosion of exposed soils and stockpiles, and potential sedimentation of surrounding land and waterways, including Harris Creek and Williams Creek. Construction activities with the potential to expose soils and lead to erosion and sedimentation, may lead to the exposure of contaminated soils. These construction activities include:

- Vehicle movements
- Stockpiling
- Excavation
- Importation of fill material
- Vegetation removal
- Grubbing processes
- Landscaping.

The historical land uses associated with the proposal footprint being construction of a roadway, installation of utilities and construction of the adjacent railway have associated profiles that involve activities that used contaminants of concern. Table 6-14 lists the potential contaminants of concern associated with the above land uses.

Table 6-14: Potential contaminants of concern associated with legacy land uses

Activity	Potential contaminants
Fill material	Heavy metals, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene, and xylenes (BTEX), organochlorine pesticides (OCP), polychlorinated biphenyls (PCBs) and asbestos.
Utility conduits	Asbestos
Railways	Hydrocarbons, diesel, lubricating oils, paraffin, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAH), solvents, glycol, creosote, herbicides, heavy metals, asbestos, ash, fill, clinker, and sulphates.

To date no site investigation has taken place to confirm the chemistry of the underlying ground in the proposal footprint or to confirm the presence of any contaminants. Despite this, there remains a residual risk for encountering contaminants of concern while undertaking ground excavation work.

Disruption of contaminated soils could impose health risks to construction workers and enable the spread of contaminants across a larger area, to a range of sensitive receivers, including Harris Creek and Williams Creek if not properly managed. Preliminary sampling and where necessary a detailed (phase two) site investigation would be undertaken along the proposal alignment as required during detailed design. Based on available historical information, contamination is unlikely to represent a significant risk of harm to human health and the environment.

Construction activities, if not properly managed, may also result in soil contamination through accidental spills or fuel and chemical leaks. During construction, there will be a need to store small quantities of fuels, chemicals and other potentially hazardous materials. It is unlikely that large inventories of hazardous materials would be stored onsite. Therefore, the potential for accidental spills are likely to be minor in nature and not result in a significant impact to the receiving environment. With the implementation of the proposed management measures for the storage and handling of hazardous materials potential impacts would be minimised.

Operation

The proposal would increase the area of hardstand. As such there would be a greater area for stormwater runoff. The proposal is to increase the stormwater drainage provisions to manage this while also providing additional protection during and following major storm events. As such, there would be no change with regard to the risk for erosion and scour at the stormwater discharge points or potential for sediment discharge and pollution.

The general operation and maintenance of the road would be managed under similar practices that are used at present to prevent any spillage or contaminant risk. As such, there is expected to be no net change or impact from maintaining the road.

6.4.6 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Contaminated land	<p>A Contaminated Land Management Plan will be prepared in accordance with the Guideline for the Management of Contamination (Roads and Maritime, 2013) and the NSW <i>Contaminated Land Management Act 1997</i> and implemented as part of the CEMP. The plan will include, but not be limited to:</p> <ul style="list-style-type: none"> • Capture and management of any surface runoff contaminated by exposure to the contaminated land • Further investigations required to determine the extent, concentration and type of contamination, as identified in the detailed site investigation (phase two) • Management of the remediation and subsequent validation of the contaminated land, including any certification required • Relevant licenses and approvals to be obtained and relevant notifications to be given under the <i>Contaminated Land Management Act 1997</i> • Measures to ensure the safety of site personnel and local communities during construction. 	Contractor	Detailed design / Pre-construction	<p>Core standard safeguard C1</p> <p>Section 4.2 of QA G36 Environment Protection</p>
Contaminated land	<p>If contaminated areas are encountered during construction, appropriate control measures will be implemented to manage the immediate risks of contamination. All other works that may impact on the contaminated area will cease until the nature and extent of the contamination has been confirmed and any necessary site-specific controls or further actions identified in consultation with the Roads and Maritime Environment Manager and/or EPA. Waste classification and reuse procedures will also be included in the Contaminated Land Management Plan.</p>	Contractor	Detailed design / Pre-construction	<p>Core standard safeguard C2</p> <p>Section 4.2 of QA G36 Environment Protection</p>

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Accidental spill	A site specific emergency spill plan will be developed, and include spill management measures in accordance with the Code of Practice for Water Management (RTA, 1999) and Environmental Guidelines: Preparation of pollution incident response management plans (NSW EPA, 2012). The plan will address measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities (including Roads and Maritime and EPA officers).	Contractor	Detailed design / Pre-construction	Core standard safeguard C3 Section 4.3 of QA G36 Environment Protection
Exposure of acid sulfate soils	Design of drainage lines and infrastructure to minimise the need for deep excavations. Minimise the need for extended dewatering of sediments around drainage lines for construction.	Roads and Maritime	Detailed Design	Additional Safeguard C4
Exposure of acid sulfate soils	ASS testing (field screening and chromium reducible sulfur suite) in soils around Harris Creek and Williams Creek to be undertaken. Other areas of the alignment as required. If ASS are identified, an ASS investigation report to be prepared that identifies areas of ASS, chemistry and liming rates for treatment. The ASS investigation to be undertaken and report verified by a suitably qualified and experienced environmental consultant.	Roads and Maritime	Detailed design /Pre-construction	Additional Safeguard C5
Exposure of acid sulfate soils	An ASS Management Plan (ASSMP) is to be prepared for any excavation of material in the vicinity of Harris Creek and Williams Creek. The plan is to include methods for onsite treatment or offsite disposal of excavated ASS. The plan will make reference to the ASS investigation report findings and be in accordance with the NSW ASSMAC Guidelines (1998).	Construction Contractor	Pre-construction, construction.	Additional Safeguard C6

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Identification of contaminated land	Preliminary site sampling and where necessary a detailed (phase two) site investigation is to be undertaken along the alignment. Assessments are to be undertaken in accordance with guidance made or endorsed by the NSW EPA. The contaminated land investigations are to be undertaken and report verified by a suitably qualified and experienced environmental consultant.	Roads and Maritime	Detailed Design, Pre-construction	Additional Safeguard C7
Identification of contaminated land	Consult with and request information from Department of Defence to determine the presence of any known contamination issues within 100 metres of the proposal alignment.	Roads and Maritime	Detailed Design, Pre-construction, construction.	Additional Safeguard C8
Human and ecological exposure to contaminated land	The Contaminated Land Management Plan will also include awareness training for construction staff to include the procedures for identification, reporting and management of contaminated land.	Contractor	Pre-construction, construction.	Additional Safeguard C9
Accidental spills	The Soil and Water Management Plan will include measures to minimise accidental spills and associated potential impacts such as: <ul style="list-style-type: none"> • Storage of chemicals within an impervious bunded area. • All refuelling of vehicles and equipment would be undertaken off site or within an impervious bunded area at the compound site at least 40 metres from drainage lines. Where this cannot occur, mobile fuel trucks should be equipped with a self bunded tank, spill prevention equipment and spill kits. • Requirement for an emergency spill kit to be kept on site at all times and be easily accessible and staff awareness and training in its use. • Removal of contaminated material (soils, water, clean up materials) offsite by a licensed contractor and disposed of at an appropriately licensed facility. 	Construction contractor	Pre-construction, construction.	Additional Safeguard C10

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Erosion and Sediment	<p>An Erosion and Sedimentation Control Plan (ESCP) shall be developed for the works. The ESCP shall provide for:</p> <ul style="list-style-type: none"> • Prevent sediment moving off-site and sediment laden water entering any water course, drainage lines, or drain inlets. • Reduce water velocity and capture sediment on site. • Minimise the amount of material transported from site to surrounding pavement surfaces. • Erosion and sedimentation controls are to be checked and maintained on a regular basis and records kept and provided on request. • Erosion and sediment control measures are not to be removed until the works are complete or areas are stabilised. • Work areas are to be stabilised progressively during the works • Divert clean water around the site (in accordance with the Landcom/Department of Housing Managing Urban Stormwater, Soils and Construction Guidelines (the Blue Book)). 	Construction contractor	Pre-construction, construction.	Additional Safeguard C11
Erosion and Sediment	The maintenance of established stockpile sites during construction is to be in accordance with the Roads and Maritime Stockpile Site Management Procedures, 2001.	Construction contractor	Pre-construction, construction.	Additional Safeguard C12

Other safeguards and management measures that would address soil and land contamination impacts are identified in sections 6.2.4 and 6.3.4.

6.5 Traffic and transport

This section summarises the traffic, transport and access impacts that are likely to occur when building and operating the proposal. Appendix I contains a supporting technical paper prepared by Bitzios Consulting.

6.5.1 Methodology

A review of previous modelling was undertaken and a number of modelling scenarios and simulations were developed to predict the likely impacts of the operation of the proposal. Models were created to establish:

- The existing 2016 conditions and forecast the future years 2026 and 2036 'Do Minimum' case
- A proposal case model for the years 2016, 2026 and 2036
- Intersection models to assess the future year intersection phasing and timing needs for signalised intersections of Heathcote Road with Infantry Parade, Macarthur Drive, Soldiers Way and The Avenue.

Traffic modelling software VISSIM was used to develop a local network model and SIDRA was used to model individual intersections.

The assessment:

- Identified existing and future traffic, transport and access patterns into, out of and across the study area
- Identified and assessed how traffic, transport and access patterns and provisions would be impacted by building and operating the proposal
- Assessed how road conditions and travel times would be affected by building and operating the proposal
- Identified adverse impacts that would need safeguarding or managing under the proposal.

Study area

The traffic and transport assessment study area considered the proposal's effect on traffic movements, transport provisions and access on Heathcote Road and intersections with Infantry Parade, Macarthur Drive, Soldiers Way and The Avenue.

6.5.2 Existing environment

Road network

Heathcote Road is a major arterial road which joins Heathcote, Lucas Heights and the Sutherland Shire to Liverpool and its surrounding suburbs. It plays an important role in moving traffic between the Illawarra area and the western Sydney areas. The section of Heathcote Road passes through the southern end of Holsworthy, Morningson, Holsworthy Barracks and Voyager Point. These are low-density areas accessed by roads that intersect onto Heathcote Road.

Major intersections along the corridor include:

- Heathcote Road/Infantry Parade, a four-way signalised intersection
- Heathcote Road/Macarthur Drive, a four-way roundabout
- Heathcote Road/Holsworthy Barracks Access, a signalised intersection
- Heathcote Road/The Avenue, a priority seagull intersection.

There are also two minor left-in-left-out accesses within the study area for access to:

- Moorebank Sports Club (its secondary access south of the main access)
- Harris Creek Oval.

There are three existing property accesses within the proposal footprint:

- Immediately to the south of the Macarthur Drive roundabout on the eastern side of Heathcote Road for access to Commonwealth Lands as well as an alternative access point to the Harris Creek Oval
- To the north of the railway line crossing on the eastern side of Heathcote Road, used by Sydney Trains as well as a number of utility service providers including Sydney Water and APA to access their infrastructure
- To the north of the new Barracks Access intersection prior to the railway line crossing on the western side of Heathcote Road also used by Sydney Trains.

A SIDRA model was developed to show the current and future operation of the intersections. The SIDRA model described the current performance of the intersections along Heathcote Road and described the key congestion points and the time and causes for this congestion. The intersection levels of service (LoS) have been assessed based on average delay (refer to Table 6-15).

Table 6-15: Intersection Levels of Service (LoS) for Heathcote Road

Level of Service (LoS)	Average Delay per vehicle (sec/vehicle)	Description
A	Less than or equal to 14	Good operation
B	15 to 28	Good with acceptable delays and spare capacity
C	29 to 42	Satisfactory
D	43 to 56	Operating near capacity
E	57 to 70	At capacity
F	70 and above	Unsatisfactory

The key outputs are shown in Table 6-16 and the following sections.

Table 6-16: Current operating performance of intersections on Heathcote Road

Intersection	Results
Heathcote Road/Infantry Parade	This intersection is performing unsatisfactorily in the morning peak period (LoS F). Conversely the performance is good in the afternoon peak or across the middle of the day on Saturday (LoS B).
Heathcote Road/Macarthur Drive Intersection	This intersection experiences long queues, particularly northbound in the morning peak period due to the merge point north of the roundabout where two lanes merge into one. This often causes queues back into the roundabout reducing the ability for traffic to move through the roundabout uninhibited and increasing congestion for all movements. While this is the case it is not adversely impacting on performance which remains good in the peak periods (LoS B).
Heathcote Road/Holsworthy Barracks Access	This intersection was recently upgraded to a signalised intersection. It performs well with minor delays in the peak periods and on Saturdays (LoS A to LoS B).
Heathcote Road/The Avenue	This intersection causes delays for people entering and leaving the Avenue particularly during the afternoon peak period (LoS C).

Key congestion points

Heathcote Road currently experiences congestion in peak periods associated with the intersections along the road between Infantry Parade and The Avenue. The morning peak period is the critical peak for congestion as northbound traffic conflicts with right turning traffic at Macarthur Drive mostly headed towards Holsworthy Train Station. In addition two traffic lanes merge into one on either side of the intersections at Infantry Parade, Macarthur Drive the Holsworthy Barracks Access and The Avenue which exacerbate queuing at the intersections. These key congestion points are as follows:

- Northbound merge just north of Macarthur Drive: morning peak period
- Macarthur Drive/Heathcote Road roundabout : morning peak period
- Southbound merge just south of Macarthur Drive: afternoon peak period
- Infantry Parade Intersection northbound: morning peak period
- Southbound merge south of Sports Complex Access: afternoon peak period
- Infantry Parade Intersection southbound: afternoon peak period
- Northbound merge just south of rail crossing bridge: afternoon peak period.

Modes of travel

Analysis of data from the Australian Bureau of Transport Statistics Journey to Work (JTW) Survey from the 2011 Census show a heavy reliance on commuting (private) vehicles specific to this area. This is consistent with the low population density of Holsworthy and its surrounds and relatively dispersed trips to employment opportunities across Greater Sydney. Apart from the commuter rail services provided at Holsworthy Train Station, which attract a reasonable level of Park and Ride and Kiss and Ride patronage, public transport services (eg bus) are not used extensively for JTW trips nor are walking and cycling modes.

Network traffic growth

Heathcote Road traffic is growing. With increasing through traffic and local traffic growth associated with land development, as well as increasing demand for Holsworthy Train Station. Intersection movements along the subject section of Heathcote Road are forecast to increase by about 30 per cent between 2016 and 2026 and a further 30 per cent between 2026 and 2036.

Holsworthy Train Station's Park and Ride (PnR) facilities are currently being upgraded from 1191 bays to 1635 bays which is likely to attract further peak period traffic demand to this popular station. A maximum planning capacity also exists in the *Liverpool DCP Part 2.6* for about 8,000 sqm of retail/commercial floor area on the site on the south-west corner of Macarthur Drive and Heathcote Road which will attract more traffic into this area. Also, without any interventions, reportable traffic crashes on the subject section of Heathcote Road are expected to increase from 13 crashes per annum in 2016 to 22 crashes per annum in 2036.

At the above congestion points and along the corridor as a whole, traffic modelling (VISSIM) for the 2016 and 2036 'Do Minimum' case showed that:

- There are expected to be significant increases in delays and queues by 2036 in the peak periods with most intersections assessed expected to be operating over capacity
- By 2036, at least one movement at each intersection is at practical capacity in the AM peak and PM peak with Saturday midday peak conditions also worsening considerably
- Under "do minimum" by 2036 the entire proposal section would be expected to be congested and "covered" with queues in the peak periods.

Public transport

Rail

Holsworthy Train Station provides access to the T2 Airport Railway Line, originating in the city and terminating at Macarthur Station. Transfers at Wollie Creek provide access to the T4 Eastern Suburbs and Illawarra Line, while transfers at Sydenham provide access to the T3 Bankstown Line. Redfern and City Circle stations provide access to the rest of the network.

East Hills Station lies outside the study area but is accessible to Voyager Point via a pedestrian connection.

Buses

The upgrade-proposal section of Heathcote Road is used by the following bus services:

- 901: Liverpool to Holsworthy, via Wattle Grove
- 902: Liverpool to Holsworthy, via Moorebank and Hammondville
- 902X: Sandy Point to Holsworthy, via Pleasure Point and Voyager Point.

These services connect to Holsworthy Train Station and some of the residential areas around the Heathcote Road corridor. They also connect to Liverpool in the northwest, with the 902X servicing part of Sutherland Shire. None of these services stop on the section of Heathcote Road being considered for upgrade. Table 6-17 summarises the services local to the proposal footprint.

Table 6-17: Bus services within the proposal footprint and locality

Route	Service (number)	Operations and frequency	
		Weekday	Weekend
Liverpool to Holsworthy via Wattle Grove	Transdev : 901	About 5:30am to 10pm <i>30 minutes (peak)</i> <i>60 minutes (off peak)</i>	About 7am to 7pm (Saturday) About 8:30am to 7pm (Sunday & Public Holidays) <i>60 minutes</i>
Liverpool to Holsworthy via Moorebank and Hammondville	Transdev : 902	About 5:30am to 10pm <i>30 minutes (peak)</i> <i>60 minutes (off peak)</i>	About 6.30am to 7pm (Saturday) About 8am to 7pm (Sunday & Public Holidays) <i>60 minutes</i>
Sandy Point to Holsworthy via Pleasure Point and Voyager Point <i>School Bus Service</i>	Transdev : 902X	Three services from about 7am to 8.30am and one service about 3:30pm <i>Sandy Point to Holsworthy</i> Four services from about 3:15pm and 6:30pm <i>Holsworthy to Sandy Point</i>	No services

Pedestrian and cycling networks and facilities

There is currently no practical pedestrian link and no continuous, safe cycling route along Heathcote Road from Macarthur Drive to The Avenue. Presently, the only active transport (pedestrian and cyclist) provisions along this section of Heathcote Road are on the western side of the road between Infantry Parade and Macarthur Drive.

Crashes

A total of 59 crashes occurred in the study area in the period January 2009 – June 2015. Of these one was a fatality, 25 incurred injury and 35 were non-casualty crashes. A spatial analysis of the crashes indicates crash clusters at the roundabout at Macarthur Drive and Heathcote Road, at the southern approach to the signals at Heathcote Road/Infantry Parade and at the Heathcote

Road/The Avenue intersection. Of crashes that occurred across the main intersections and sections of Heathcote Road in the study, the data do not show any changing trends in the number of crashes per annum since 2009 or any noticeable changes in the severity of crashes. However, the average crash rate is expected to increase from 13 crashes per annum 2016 to 22 crashes per annum by 2036.

6.5.3 Potential impacts

Construction impacts: network and intersection performance

There would be a temporary extension of the peak periods of congestion and queuing through implementing temporary traffic management controls to build the proposal. This would include lowering of the speed limit through sections of the proposal site under construction.

Delivery of plant and equipment to the site compound may cause some infrequent localised congestion if undertaken during peak periods. In addition, right turns directly out of the site compound would introduce additional traffic delays as the turns would probably need to be undertaken under traffic control.

The staging methodology (refer to section 3.4.1) minimises impacts on traffic flows while providing separation between operational traffic areas and construction work areas to maximise the safety of the workforce. When traffic is required to be switched over to the newly constructed roadway to allow upgrade of the existing, these switches would be expected to occur late at night so as to minimise disruptions. Upgrade of the intersection at Macarthur Drive is likely to be disruptive to traffic in peak periods given the heavy turn volumes at this location that would need to be accommodated during its construction. The relatively wide road reserve surrounding the roundabout could be used in this area to design temporary works to minimise traffic impacts during the construction of this intersection.

The combined effect of these is that network and intersection efficiency, capacity and performance would be temporarily affected. This would lead to minor travel-time delays in periods of heavier traffic.

Construction impacts: access and parking

Access to and from all roads intersecting with the proposal would be maintained while the proposal is being built. There are three accesses between Macarthur Drive and Soldiers Way used by Sydney Trains, and utilities companies that would need access maintained during construction. The lack of existing frontages onto Heathcote Road allows the construction of sections to occur generally without impeding access to property.

Construction impacts: active transport

The ability for people to safely walk or cycle along Heathcote Road would be maintained at the existing shared use path between Infantry Parade and Macarthur Drive. Temporary provisions would be provided in this section when the existing footpath is upgraded.

There is no formal pedestrian or cyclist provisions between Macarthur Drive and The Avenue and any pedestrians or cyclists would be required to use the existing narrow road shoulder in this area. This may be a significant deterrent to its use by these modes during construction.

Heathcote Road is not a heavily used cycle route, however the construction work is likely to require some lane narrowing and use of road shoulders such that cyclist movements could be affected. Alternative provisions may be required for cyclist movements between Macarthur Drive and The Avenue during construction. As the lanes in this section are already narrow no new impacts would be expected to be introduced with construction taking place. Any such impacts to pedestrians or cyclists would be managed as part of the Traffic Management Plan which would support the CEMP.

Construction impacts: public transport

There are no active bus stops located within the proposal. One bus stop is located on Heathcote Road, however the stop does not appear on any routes maps and it is therefore unclear if the stop has been abandoned. Nevertheless, the stop would not be impacted by the work as the kerb in front of the stop is being retained. There would be no service loss in the area, however people travelling by bus through the area may be slightly delayed if traveling during reduced speed zones. No bus service impacts are expected.

Operational impacts: network and intersection performance

The upgrade of Heathcote Road significantly reduces the travel times of all vehicles in peak periods compared to what would be the case if no upgrades were undertaken. Some of the key benefits of the proposal include:

- A reduction of nearly 240 vehicle-hours in the morning peak period in 2026 and about 80 vehicle hours in the afternoon peak period in 2026
- An increase in average travel speeds expected in 2036 from 19 km/h to 20 km/h in the morning peak period and from 20 km/h to 27 km/h in the morning peak period
- A significant increase in mid-block capacity of at least 1,000 vehicles per hour per direction.
- A noticeable reduction in 2036 peak period queue lengths on Heathcote Road, although some edge capacity constraints at the southern and northern extents of the modelled area are observed in 2036
- A significant reduction in expected major crashes in the upgrade section in 2036 from 22 crashes per annum to eight crashes per annum.

Potential adverse impacts from the operation of the proposal include:

- Future year modelling identified continued queues back into Morningside Parade at the Macarthur Drive/Heathcote Road intersection despite the signalisation of the intersection. Further discussions with Liverpool City Council would be required to develop a traffic management strategy for the roundabout
- Potential minor impacts at the three accesses between the Macarthur Drive roundabout and the Soldiers Way which are used by Sydney Trains and utility service providers. Roads and Maritime would need to consult with Sydney Trains and service providers as the proposal evolves.

Operational impacts: freight movements

The proposed upgrade would improve traffic congestion and safety conditions for general traffic, and also introduces benefits for freight movements. The volume of heavy vehicles on this section of Heathcote Road is relatively small at one or two per cent of the total traffic volumes. There is a minimal catchment for heavy vehicles or freight transport off this section of Heathcote Road due to the close proximity to the M5 Motorway and lack of significant industrial development located off Heathcote Road. Nevertheless, freight movements will also benefit from the travel time benefits introduced for cars due to the proposal.

Operational impacts: access

All public and private local and direct access would be preserved and/or improved under the proposal. The Sydney Trains access track located on the southern side of Heathcote Road adjacent to the Holsworthy Army Barracks will be directly affected by the bridge duplication in this area. Alternative arrangements will be determined with Sydney Trains during detailed design.

Operational impacts: active transport

The inclusion of pedestrian and cycle infrastructure introduces significant benefits to pedestrians and cyclists by extending the off road facility currently in place north of Macarthur Drive, further south to The Avenue. This would benefit Voyager Point residents by providing with a safe walking and cycle access to the north and particularly to Holsworthy Train Station and Hammondville Park. The extension of the off road shared use path to The Avenue would also assist cyclists that may be

travelling on Heathcote Road (most likely recreational or sports cyclists) by providing them a safer alternative to sharing the road with general traffic.

Operational impacts: public transport

Buses would also benefit from travel time savings on Heathcote Road. The reduced congestion would also improve service and journey-time reliability and hence result in reduced layover times for trains at Holsworthy Station.

6.5.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Traffic and transport	<p>A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the Roads and Maritime Traffic Control at Work Sites Manual (Roads and Maritime, 2010) and QA Specification G10 Control of Traffic (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	<p>Core standard safeguard TT1</p> <p>Section 4.8 of QA <i>G36 Environment Protection</i></p>

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Construction traffic	<p>Traffic Management Plan (TMP) will also include:</p> <ul style="list-style-type: none"> • Scheduling the delivery of plant, equipment and construction materials to generally occur out of peak traffic periods • Consideration of methods to minimise peak period traffic disruptions during each stage of construction • Roads and Maritime to liaise with utilities providers and Sydney Trains to maintain service accesses to their facilities during construction and following completion of the proposal. <p>The TMP is to ensure the work site and site compound:</p> <ul style="list-style-type: none"> • Includes safe 'sight distances' to allow traffic to leave and enter the given areas • Uses temporary painted road lines to provide delineation • Provides suitable intersection layouts where required • Includes traffic management controls to allow for safe entry and exit. 	Contractor	Pre-construction/ construction	Additional safeguard TT2
Intersection Signalisation	Signal phasing arrangements and timings be reviewed as part of the commissioning of the proposal to determine the coordination arrangements as an extension to the existing conditions.	Roads and Maritime	Construction/ Pre-operation	Additional safeguard TT3
Operation of Macarthur Drive intersection	The operation of the signalised intersection of Heathcote Road and Macarthur Drive should be periodically reviewed to identify if additional Holsworthy Train Station-generated demands are intermittently affecting signal operations and localised congestion. Appropriate signal timing plans to be adopted added if needed.	Roads and Maritime	Operation	Additional safeguard TT4
Operational Monitoring	Monitoring of the queuing and congestion impacts along Macarthur Drive to the Morningside Parade intersection to manage any residual queueing impacts at this location and associated safety impacts.	Roads and Maritime	Operation	Additional safeguard TT5

6.6 Noise and vibration

This section summarises the noise and vibration impacts that are likely to occur when building and operating the proposal. A specialist noise and vibration assessment has been prepared by WSP | Parsons Brinckerhoff (refer to Appendix J).

6.6.1 Methodology

The specialist noise and vibration assessment carried out to assess the impacts of the proposal comprised:

- Identifying noise and vibration sensitive receivers within the study area
- Determining the background noise levels within the study area
- Predicting how building and operating the proposal would impact on noise and vibration-sensitive receivers
- Identifying those adverse impacts that would need safeguarding or managing under the proposal.

Noise monitoring

Both unattended and attended noise monitoring was undertaken to characterise the study area's existing ambient noise environment and establish noise management levels (NMLs) for four locations across the length of the project area.

Short-term attended noise measurements

Short-term attended noise monitoring was undertaken to describe the main contributors to the noise levels within the study area. Data were collected over a 15 minute (averaging) period at four receiver-locations next to the proposal footprint in February and March 2016. The data were sufficient to capture ambient conditions representative of the proposal footprint in 2016. Table 4-1 of Appendix J provides a full list of the monitoring locations and their addresses.

Long-term unattended noise measurements

The above short-term data were supplemented by long-term unattended noise monitoring data collected between 11 February and 19 February at three locations and between 23 February and 2 March 2016 at one location. Collected data were applied to this proposal and were used to describe the average and maximum ambient noise levels over a 24 hour period. Figure 6-4 shows the attended and unattended monitoring locations referred to in this section and Appendix J.

Noise catchment areas

For assessment purposes, NCAs were defined for the study area. The NCAs grouped receivers that were of a similar geographic location and a similar land use classification such as residential or industrial (refer to Table 3-1 and figures in Appendix J).

Noise averaging periods

Noise can be measured over various periods of time. The four 'averaging periods' and one standardised background level used in this REF are described below:

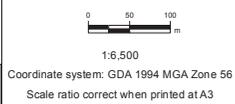
- L_{Aeq} describes an average noise level across a period of time (either day, evening, night, or over a 15 minute period). It accounts for the full range of noise levels encountered in a given area over a given period
- L_{A90} describes the noise level that is exceeded for 90 per cent of the time and therefore describes the background noise level
- L_{A10} describes the noise level that is exceeded for 10 per cent of the time and therefore describes what the environment is like during the noisiest periods
- L_{Amax} describes the average maximum noise level recorded at any point in time
- Rating background (noise) levels (RBLs) describe the ambient noise levels during the day, evening and at night. They represent an overall single-figure background noise level based on the measured L_{A90} in each relevant assessment period as described in detail in the Industrial Noise Policy (INP) (NSW Environment Protection Authority, 2000).



Legend

- NCA
- Non-residential receiver
- Noise monitoring location
- Road Design
- Existing noise barrier

Map: Noise monitoring locations	Author: CM
Date: 1/06/2016	Approved by: CM



Heathcote Road Upgrade
Figure 6.4
Noise monitoring locations

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6.6.2 Criteria

Assessment criteria

The following criteria informed the noise assessment.

Construction noise assessment criteria

The ICNG establishes construction NMLs for a number of sensitive receiver-types. Feasible and reasonable safeguards and management measures should be implemented where NMLs are exceeded either during or outside of the recommended standard hours for construction work. The standard hours cover: Monday to Friday between 7am and 6pm and Saturday between 8am and 1pm. They represent the times of the day when residential receivers are likely to be less sensitive to noise impacts. Consequently, during the recommended standard hours for construction work, the NMLs for residential receivers are less stringent (i.e. higher). For all other receiver-types, the NMLs are based on when the receiver is likely to be used/occupied.

Residential receivers

For residential receivers, two NMLs are established under the ICNG. The first represents the limits above which the receiver is considered likely to be affected by noise (termed 'noise affected'). This is derived from the determined RBL plus an additional permissible level of construction noise. The second, more stringent, NML is an absolute limit above which there is anticipated to be notable affects (termed 'highly noise affected'). Table 6-18 shows the management levels for construction noise on residential receivers and how they are applied to the proposal during standard and non-standard hours for construction work (termed 'out of hours' work). As noted above, due to the density of residential receivers in the study area, representative receiver locations were selected to monitor noise. Calculations were then undertaken to assess a potentially worst-case impact.

Table 6-18: Construction noise management levels for residential receivers and working hours

Time of day	NML $L_{Aeq(15minute)}$ (note 1 & 2)	How they are applied
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise: <ul style="list-style-type: none"> Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

Time of day	NML $L_{Aeq(15\text{minute})}$ (note 1 & 2)	How they are applied
	Highly noise affected 75 dB(A)	<p>The highly noise affected level represents the point above which there may be strong community reaction to noise.</p> <p>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:</p> <ul 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) <p>If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.</p>
Outside recommended standard hours	Noise affected RBL + 5dB	<p>A strong justification would typically be required for works outside the recommended standard hours.</p> <p>The proponent should apply all feasible and reasonable work practices to meet the noise affected level.</p> <p>Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.</p>

Note 1 Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 metres above ground level. If the property boundary is more than 30 metres from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 metres of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Note 2 The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy (EPA 2000).

Non-residential receivers

There are a number of non-residential noise-sensitive receivers in the area where NMLs apply (refer to Figure 6-5). They include:

- Childcare centres: 55 dBA L_{Aeq} (15-minute) as measured inside the building
- Schools: 55 dBA L_{Aeq} (15-minute) as measured inside the building
- Active recreation areas: 65 dBA L_{Aeq} (15-minute) as measured outside the building
- Passive recreation areas: 60 dBA L_{Aeq} (15-minute) as measured outside the building
- Commercial: 55 dBA L_{Aeq} (15-minute) as measured inside the building.

Final criteria

The criteria in Table 6-18 were used in conjunction with the short-term and long-term noise monitoring to determine NMLs for the assessed receivers. Table 6-19 lists the proposal-specific NMLs.

Table 6-19: Noise management levels for the noise catchment areas

NCA	Representative receiver type	NML $L_{eq(15min)}$ dBA			
		Day: standard hours	Day: outside of standard hours	Evening	Night
A	Residential	52	47	44	35
	School sports oval	65	-	-	-
	School playground	60	-	-	-
	School classroom	55	-	-	-
	Child care centre	55	-	-	-
B	Residential	56	51	51	36
C	Commercial*	70	70	70	70
D	Residential	51	46	41	35
E	Residential	46	41	41	35
F	Residential	46	41	41	35
	Active recreation	65	65	65	-
	Commercial	70	70	70	70

Note 1: As the land use inside the military facility is not known, the potential for residential barracks has been included. The NML has been based on the AS2107 recommended maximum design sound level for sleeping areas in barracks near major roads. A 10 dB correction has been applied to convert internal noise levels to external.

Construction noise (sleep disturbance) assessment criteria

The RNP describes a maximum night-time noise level (L_{Amax}) as being the RBL + 15 dB above which sleep disturbance may occur. The RNP then goes on to state that:

- Maximum internal noise levels below 50-55 dBA would be unlikely to result in people's sleep being disturbed
- If the noise exceeds 65-70 dBA once or twice each night the disturbance would be unlikely to have any notable health or wellbeing effects.

The guidance within the RNP indicates that internal noise levels of 50-55 dBA are unlikely to cause people's sleep to be disturbed. Assuming that receivers may have windows partially open for ventilation, a 10 dB outside-to-inside correction has been adopted as indicated in the ICNG. Therefore a sleep disturbance screening criterion of L_{max} 65 dBA has been adopted.

Construction vibration assessment criteria

Construction vibration can have two potential impacts, for which limits have been set:

- Loss of amenity due to human comfort impacts
- Cosmetic damage.

Importantly, cosmetic damage is regarded as minor in nature, it is readily repairable, and it does not affect a building's structural integrity.

Loss of amenity due to human comfort impacts

Assessing Vibration: A Technical Guideline provides values for continuous, transient and intermittent vibration activities that are based on a vibration dose value (VDV) rather than a continuous vibration level. The level and duration of vibration and the number of times it occurs during the day or at night is used to set the VDV. Table 6-20 lists the recommended VDV's for intermittent vibration-generating activities that have been adopted for this assessment.

Table 6-20: Adopted construction vibration goals

Location	Assessment Period	Annoyance VDV goal $m/s^{1.75}$	
		Preferred	Maximum
Critical areas	Day or night	0.10	0.20
Residences	Day	0.20	0.40
	Night	0.13	0.26
Offices, schools, educational institutions, and places of worship	Day or night	0.40	0.80
Workshops	Day or night	0.80	1.60

Notes: $M/s^{1.75}$ represent the standard time period recognised in the assessment criteria. Critical areas include locations such as hospital operating theatres, precision laboratories)

Cosmetic damage

There is currently no Australian Standard that provides guidance for assessing cosmetic building damage caused by vibration. As such, German Standard DIN 4150 Part 3 Structural Vibration - Effects of Vibration on Structures has been adopted. Appendix J provides more detail on the limits adopted to support the REF.

Safe working distances for vibration intensive plant

The propagation of vibration emitted from a source is site-specific. It depends on the vibration energy generated by the source, the vibration frequency, the localised ground conditions and the interaction of structures and features that can dampen vibration. The recommended safe working distances for plant in Table 6-21 are taken from the Transport for NSW Construction Noise Strategy (Transport for NSW, 2012a). Consistent with BS 7385:2-1993 and the Assessing Vibration Guideline, the recommendations are for the practical management of potential vibration to minimise the likelihood of cosmetic damage to buildings and disturbance or annoyance in humans. The safe working distances are conservative. They were developed for activities where the vibration would be from a continuous source and its impact on typical residential buildings.

Table 6-21: Recommended safe working distances for vibration intensive plant

Plant Item	Rating/Description	Safe working distance (m)		
		Residential ¹	Cosmetic damage ¹	Human response ²
Vibratory roller	< 50 kN (typically 1-2 tonnes)	10	15	15 to 20
	< 100 kN (typically 2-4 tonnes)	20	20	20
	< 200 kN (typically 4-6 tonnes)	25	35	40
	< 300 kN (typically 7-13 tonnes)	35	45	100
	< 300 kN (typically 13-18 tonnes)	45	60	100
	> 300 kN (typically > 18 tonnes)	55	75	100
Jackhammer	Hand held	1 (nominal)	5	Avoid contact with structure
Pile bore	≤ 800 mm	2 (nominal)	10	-
Dozer	Typical	10	15	-

Note 1: Referenced from British Standard BS 7385:2-1993 Evaluation and measurement for vibration in buildings Part 2.

Note 2: Referenced from DEC's Assessing Vibration: a technical guideline.

Operational road traffic noise

Residential receivers

The proposal includes the redevelopment of Heathcote Road with intersection upgrades and has the potential to increase noise levels on existing roads. Where an existing road is redeveloped and it changes functional class, it is considered a new road according to the Noise Criteria Guideline (Roads and Maritime, 2015c). Based on a review of the predicted change in traffic volumes, no roads in the study area are considered to be changing functional class and therefore all roads are assessed against the redeveloped criteria. Table 6-22 provides a summary of the criteria for residential receivers applicable to redeveloped roads.

Table 6-22: Operational road traffic noise criteria for residential receivers

Road Category	Type of project/land use	Assessment criteria dBA	
		Day 7am-10pm	Night 10pm-7am
Freeway/arterial/sub-arterial/collector ¹ roads	Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	$L_{eq(15hr)}$ 60 dBA	$L_{eq(9hr)}$ 55 dBA

Note: According to the Noise Criteria Guideline (Roads and Maritime, 2015c), collector roads are considered the same category as sub-arterial roads

Non-residential receivers

There are a number of non-residential receivers in the study area. Table 6-23 provides a summary of the criteria for the applicable non-residential noise sensitive land uses that apply when the premises are in use.

Table 6-23: Road traffic noise assessment criteria for non-residential sensitive land uses

Existing sensitive land use	External Assessment criteria dBA
School classrooms	$L_{eq(1hr)}$ 50
School play areas	$L_{eq(1hr)}$ 55
Open space active use	$L_{eq(15hr)}$ 60
Child care facility sleeping rooms	$L_{eq(1hr)}$ 45
Child care facility indoor play areas	$L_{eq(1hr)}$ 50
Child care facility outdoor play areas	$L_{eq(1hr)}$ 55

The Noise Criteria Guideline (Roads and Maritime, 2015c) states that for existing roads that are affected by more than a 2 dB increase due to the changes introduced under the proposal, feasible and reasonable safeguards and management measures should be investigated for affected sensitive receivers. This criterion applies to the existing roads in the proposal footprint and extends to cover adjacent roads outside of the proposal footprint.

Sleep disturbance during operation

The guidance within the RNP indicates that internal noise levels of 50-55 dBA are unlikely to cause sleep awakenings. Therefore at levels above 55 dBA, sleep disturbance would be considered likely. Assuming that receivers may have windows partially open for ventilation, a 10 dB outside to inside correction has been adopted as indicated in the ICNG. Therefore a sleep disturbance screening criterion of 65 dBA_{L_{max}} has been adopted.

6.6.3 Existing environment

The environment in which the proposal would be built is a combination of urban and bushland. Noise sources in the existing environment are mainly influenced by road traffic noise from Heathcote Road. Table 6-24 and Table 6-25 describes the existing noise environment at various locations along the length of the proposal footprint and at varying times of day. The data shown indicate sound levels collected over a 15 minute (averaging) period ($L_{eq(15min)}$) and RBLs. Table 6-25 also shows the general background noise level at four locations ($L_{90(15min)}$).

Table 6-24: Noise measurement levels

Location ID	Address	Measured noise level dBA					
		Day (7am to 6pm)		Evening (6pm to 10pm)		Night (10pm to 7am)	
		$L_{eq(15min)}$	RBL	$L_{eq(15min)}$	RBL	$L_{eq(15min)}$	RBL
BG1 ¹	23 Sabre Crescent, Holsworthy	55	42	52	39	48	30 ²
BG2	26 Margate Avenue Holsworthy	57	46	58	46	52	31

Location ID	Address	Measured noise level dBA					
		Day (7am to 6pm)		Evening (6pm to 10pm)		Night (10pm to 7am)	
		L _{eq(15min)}	RBL	L _{eq(15min)}	RBL	L _{eq(15min)}	RBL
BG3	3 Punctata Court, Voyager Point	49	36	50	36 ³	46	30 ²
BG4 ¹	23 Willowie Way, Voyager Point	57	41	54	36	52	30 ²

Note 1: Measurements were façade reflected.

Note 2: The RBL at this location was measured to be less than 30 dBA. In accordance with the INP, the RBL has been set to 30 dBA.

Note 3: The measured RBL was higher during the evening than the day. In accordance with the INP Application Notes (EPA, 2013), the evening RBL has been set equal to the day.

Table 6-25: Attended noise monitoring results

Location	Date	Start time	L _{eq(15min)} dBA	L _{90(15min)} dBA	Comments
BG1	16/11/2015	1.45pm	56	51	Noise environment generally controlled by road traffic noise from Heathcote Road with continuous peaks from trucks passing. Noise from planes and bird calls were audible, but the contribution was minimal to the overall L _{eq} .
BG2	11/02/2016	1.45pm	55	46	Background noise was dominated by Heathcote Road to the north, with occasional peaks from trucks passing. Community noise was the other contributing noise source.
BG3	19/02/2016	3.05pm	51	48	Peaks from the rail line were considered dominant, however occur intermittently. Background noise was dominated by Heathcote Road. The traffic noise was generally continuous with occasional peaks from trucks passing. Bird calls occasional audible, but the contribution was considered negligible.
BG4	11/02/2016	4.15pm	62	57	Noise environment generally controlled by road traffic noise from Heathcote Road with occasional peaks from trucks passing. Minor community noise was also audible on occasions. Estimated road traffic noise level is 55 dBA.

Rail traffic noise levels

Measurements of rail pass-bys were also undertaken at a location representative of the receivers on Punctata Court to characterise noise levels from railway activity. The average sound exposure level from rail pass-bys was 82 dBA and noise levels were then calculated for BG3 (3 Punctata Court) as shown in Table 6-26.

Table 6-26: Calculated rail noise level at BG3

Location	Calculated rail noise level $L_{eq, period}$ dBA	
	Day (7am to 10pm)	Night (10pm to 7am)
BG3	56	51

6.6.4 Potential impacts

Construction impacts: equipment noise

Noise-generating equipment would be used to build the proposal (refer to Table 3-7). The noise emissions from a piece of equipment are often published as sound power levels, which represent the maximum rated noise output. Typically however, the equipment is seldom operated or used at its maximum output, therefore the sound power level is rarely reached. By combining the sound power levels from the equipment that would be used to undertake each activity it is possible to predict the worst-case noise emissions from each work activity. From this the need for mitigation is determined. This assumes all the associated equipment to be operating at its maximum output and at its minimum distance from the limit of the proposal footprint and the assessed noise-sensitive receiver or noise catchment area.

Nine scenarios were developed, reflecting the activities described in section 3.4.1 of this REF. Appendix J reports the full detail of the modelling predictions covering the impact on all receivers from undertaking the activities shown in Table 3-7. Table 6-27 and Table 6-28 summarise this by showing:

- The scenarios that would exceed the corresponding NMLs
- The scenarios in which noise levels are predicted to exceed the 75dBA “highly noise affected” levels (shown in bold in the tables, refer to section 5.1 of Appendix J)
- The maximum noise exceedance in the catchment area.

The range of predicted noise levels is only shown for NCAs A, B, D, E and F as NCA C does not contain sensitive receivers.

Table 6-27: Predicted noise level per construction scenario at residential receivers

NCA	NML $L_{eq}(15min)$ dBA				Predicted noise level per scenario $L_{eq}(15min)$ dBA								
	D	O	E	N	1	2	3	4	5	6	7	8	9
A	52	47	44	35	66-35	68-37	69-30	70-31	77-38	69-30	79-38	84-43	73-30
B	56	51	51	36	69-37	71-39	73-42	74-43	81-50	73-42	82-50	87-55	53-31
D	51	46	41	35	64-30	66-32	60-35	61-36	68-43	60-35	77-43	82-48	32-30
E	46	41	41	35	52-30	54-30	62-33	63-30	70-37	62-33	65-40	70-45	37-30
F	46	41	41	35	43-32	45-31	52-32	53-33	60-40	52-32	56-42	61-47	44-34

D: standard hours, O: out of hours, E: evening, and N: night

Table 6-28: Predicted noise level per construction scenario at non-residential receivers

Non-residential Receiver	NCA	Criteria dB(A)	Predicted noise level per scenario $L_{eq(15min)}$ dBA								
			1	2	3	4	5	6	7	8	9
Holsworthy early education and child care centre Holsworthy pre-school Holsworthy Public School	A	55	65	67	56	57	64	56	78	83	58
Holsworthy pre-school	A	55	47	49	54	55	62	54	60	65	48
Holsworthy public school	A	55	62	64	53	54	61	53	75	80	51
Recreational Areas	F	65	42	44	52	53	60	52	55	60	<30

The table confirms that:

- Residents would be affected at some point while the proposal is being built especially where night works are carried out
- The worst case predicted noise levels at residential properties indicated noise levels could be up to 30 dBA above the daytime guidelines levels, 40 dBA during the evening and 50 dBA above the night time noise management levels
- The construction activities that are likely to generate the most noise are the bulk earthworks, bridge works, pavements works and some finishing activities
- The closest receivers in NCA A and B would be highly noise affected during scenarios 5, 7 and 8 which represent bridge, pavement and finishing works
- The closest receivers in NCA D were also predicted to be highly noise affected during scenarios 7 and 8 which represents pavement and finishing works
- The Holsworthy child care centre is predicted to be impacted above the guideline levels for all construction scenarios
- Pupils and teachers at Holsworthy Public School and Holsworthy pre-school and Holsworthy early education and childcare centre would be affected by the noise generated for the majority of construction activities
- The worst case noise levels are predicted to be up to 35 dBA above the external criteria at Holsworthy School. However, large exceedances more than 20 dBA above the criteria only occur during pavement and finishing works. Other exceedances are in the order of 3 to 8 dBA.

In addition it can also be concluded that:

- The residents in noise catchment areas A, B and D would be the worst affected, as they have the highest predicted noise levels which in some cases are above the highly noise affected limit of 75 dBA limit.

Construction impacts: sleep disturbance

As described in section 3.4.2, certain work would need to take place at night to install the bridges and remove the Macarthur Drive Roundabout. As described in the previous section, people's sleep can be potentially disturbed where noise levels are 15 dB above the RBL. In the case of the proposal, a screening criterion of 65 dB was adopted to determine if sleep disturbance would likely occur as a result of working at night. Table 6-29 shows the results of this assessment, which predicts exceedance of the screening criterion when undertaking each of the activities.

Table 6-29: Predicted sleep disturbance noise impacts

NCA	Scenario predicted maximum noise levels $L_{1,1min}$ dBA								
	1	2	3	4	5	6	7	8	9
A	71	73	74	75	82	74	84	89	78
B	74	76	78	79	86	78	87	92	58
D	69	71	65	66	73	65	82	87	37
E	57	59	67	68	75	67	70	75	42
F	48	50	57	58	65	57	61	66	49

Note: Where the sleep disturbance screening criterion is exceeded, text is highlighted in bold.

All noise catchment areas with sensitive receivers have the potential to be affected by sleep disturbance during night time activities. The actual potential cause for sleep disturbance would depend on a number of local factors including people’s current tolerance to the high ambient noise levels at night as a result of traffic using Heathcote Road, where they sleep in the house, and any noise treatments that are already included at people’s properties.

It is possible that people’s sleep maybe disturbed as a result of the work, the effects of which maybe notable if predicted noise levels are reached. Overall however, the scale of the exceedances means that there is the predicted potential for sleep disturbance while the proposal is being built and it is necessary to have safeguards in place such as restrictions on the number of consecutive nights that work can be carried out near residences or the type of work carried out.

Construction impacts: road traffic noise

As described in section 6.5.3, vehicle movements would take place every day to build the proposal, make deliveries, remove material and allow the workers to travel to and from site. These would also include contractor staff arriving and leaving site on the fringes of the peak periods. The number of movements across the extent of the proposal footprint every hour, would vary depending on the work shifts and scheduling requirements. This is in the context of an area that currently transports many thousands of vehicles every hour (refer to section 6.5.3). As such, the impact of additional traffic generated noise is considered to be not significant.

The other consideration is the change in traffic conditions along certain roads while building the proposal. These controls would involve traffic restrictions, potential lane closures and/or the use of stop-go signs or temporary traffic lights. This would likely result in additional temporary traffic queues forming on Heathcote Road, Infantry Parade, Macarthur Drive and The Avenue. While queuing traffic would increase the amount of time adjacent receivers would be exposed to noise, the effects are unlikely to be discernible against the current background.

The proposed site compound would be located near sensitive residential receivers (NCA A). Activities at the compound may cause intermittent noise levels that may affect adjacent receivers. Noise generating activities at the site compound have been assessed to be equally or less noisy than other construction work activities; the impact of which is assessed above.

Construction impacts: vibration

The proposal would likely require the use of a hydraulic hammer, jackhammer, and a pile bore. The extent of impact depends on the equipment size, distance and duration. Based on the guidance in the Construction Noise Strategy (Transport for NSW, 2012a) and BS 7385, it is considered that the two tonne vibratory roller, bore pile, jackhammer and whacker packer could cause cosmetic damage if the recommended mitigation measures are not implemented (see Appendix J). In the case of the vibratory roller up to 13 tonnes, this would need a separation distance of 40 metres away from any building for there to be no vibration impact risk. The two tonne vibratory roller and

up to 13 tonnes vibratory roller would also need a separation distance of 20 metres and 60 metres, respectively from a heritage-listed item for there to be no vibration impact risk. As a result, with the appropriate vibration mitigation impacts implemented (refer to section 6.6.5), vibration impacts are not expected to be significant.

Operational impacts: road traffic noise

Acute residential receivers

The proposal would involve traffic travelling closer to properties adjacent to Heathcote Road, however noise levels typically change by less than 1 dBA as a result of the proposal and would not sufficiently alter the traffic volumes and conditions on Infantry Parade, Macarthur Drive or The Avenue.

In accordance with the NCG, NMG and ENMM, investigation of mitigation should be undertaken for acute residential receivers, of which 24 residential properties have been identified (refer to Table 6-30 and Figure 6-5). These receivers have a dominant contribution from Heathcote Road. Mitigation measures are to be investigated during detailed design in order of preference as follows:

- Lower noise pavement surfaces
- Noise barriers
- At-property treatments (this may include architectural upgrades or at-property screens).

Table 6-30: Summary of number of affected and acutely affected residential receivers

NCA	Number of residential receivers eligible for mitigation ¹	Number of acute residential receivers ²
A	4	4
B	10	10
D	10	10
Total	24	24

Note 1: Receivers are only counted where the proposal causes a receiver to be acute. Receivers that are acute due to non-proposal roads are not eligible for consideration of mitigation as part of this road proposal.

Note 2: The number of receivers shown is counted where there is an exceedance on any façade or floor of a receiver.

The receivers in NCA A and B are the first storey levels and are typically situated above existing barriers. Receivers in NCA D generally have direct line of sight to the road over the existing barrier at the property boundary and the existing barrier provides limited benefit to receivers.

Acute non-residential receivers

The Holsworthy Early Education and Child Care Centre and the classrooms closest to Heathcote Road at Holsworthy Public School are two non-residential receivers that have been identified as eligible for consideration of noise mitigation measures.

Mitigation measures

The feasibility of the above mitigation measures was considered with regard to the 24 residential and two non-residential acute receivers in the NCAs.

Lower noise pavement surfaces

- Modelling results showed that provision of lower noise pavement on the 80 km/h section of Heathcote Road in NCA D would reduce the number of acute receivers in the NCA by two

- For the remainder of the project area, noise levels for some receivers in NCA D and all receivers in NCAs A and B would be unchanged as lower noise pavements are less effective on roads where the speed limit is less than 70 km/h.

Noise barriers

- The provision of a 4.5 metre noise barrier in NCAs B and D would reduce the number of acute receivers to 13 residential and one non-residential receiver
- In NCA B provision of 4.5 metre noise barriers would reduce the number of acute receivers in the NCA from 10 to seven. However on site observations indicated that, behind the front row of houses, the existing barrier would provide adequate protection for external receivers. Additionally the acute receivers in NCA B have double glazing and would be likely to have a façade design capable of providing adequate protection for internal habitable spaces. It therefore may not be considered reasonable to increase the barrier height in NCA B.

At-property treatment

- At-property treatments may be considered for receivers only after considering other mitigation strategies (as above). There are 13 residential receivers across all NCAs that would be eligible for further consideration of at-property treatment. For non-residential receivers, treatments are typically limited to architectural upgrades or at-property screens.

Further investigation of noise mitigation options would be undertaken in detailed design and would consider the following when determining feasible and reasonable mitigation for affected receivers:

- Existing noise mitigation (barriers and architectural treatments) previously applied to any acute receivers
- The specification and implementation of noise mitigation (if any) in recent development applications for identified acute receivers

At two non-residential receivers the predicted operational noise levels exceeded the non-residential criteria identified in section 6.6.2. These non-residential receivers are the Holsworthy Early Education and Child Care Centre at 3A Artillery Crescent and the classrooms closest to Heathcote Road at Holsworthy Public School. It was noted that extension of the existing noise barrier between the child care centre and Heathcote Road would likely reduce the noise level to within the NCG criteria. It is likely that only the closest classroom to Heathcote Road at Holsworthy Public School would be eligible for consideration of at-property treatment. Extension of the existing noise barrier and other mitigation measures would be investigated in consultation with these sensitive receivers during detailed design.

Figure 6-5 shows the residential and non-residential properties which have been considered for mitigation during the operational phase of the project. The requirement for mitigation at these properties will be determined during detailed design together with the type of mitigation.

Operation impacts: road traffic noise (sleep disturbance)

Section 9.7 of the Appendix J describes the potential for the changes introduced under the operational proposal to result in sleep disturbance. The assessment indicates that maximum noise events would not be expected to increase significantly in frequency or noise level as a result of the proposal. Consequently, the proposal would not increase the likelihood of sleep disturbance to the adjacent residents.

310750 311000 311250 311500 311750 312000 312250

6240750

6240500

6240250

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6240500

6240250



Legend

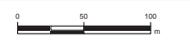
- Residential receiver for mitigation
- Non-residential receiver for mitigation
- Road design
- ▭ NCA

Map: 2113368_GIS_022_A1

Author: RP

Date: 19/08/2016

Approved by: -



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Coordinate system: GDA 1994 MGA Zone 56
Scale ratio correct when printed at A3



**Heathcote Road Upgrade
Figure 6.5**

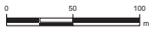
Receivers identified for mitigation in operational phase - North

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Legend

- Residential receiver for mitigation
- Non-residential receiver for mitigation
- Road design
- ▭ NCA

Map: 2113368_GIS_022_A1	Author: RP		 1:4,000 Coordinate system: GDA 1994 MGA Zone 56 Scale ratio correct when printed at A3
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Data source: © Roads and Maritime Services			



Heathcote Road Upgrade
Figure 6.5
Receivers identified for mitigation in operational phase - South

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6.6.5 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Noise and vibration	<p>A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the CEMP. The NVMP will generally follow the approach in the Interim Construction Noise Guideline (ICNG) (DECC, 2009) and identify:</p> <ul style="list-style-type: none"> • All potential significant noise and vibration generating activities associated with the activity • Feasible and reasonable mitigation measures to be implemented taking into account <i>Beyond the Pavement: urban design policy, process and principles</i> (Roads and Maritime, 2014e). • A monitoring program to assess performance against relevant noise and vibration criteria • Arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures • Contingency measures to be implemented in the event of non-compliance with noise and vibration criteria. 	Contractor	Detailed design / pre-construction	<p>Core standard safeguard NV1</p> <p>Section 4.6 of QA G36 Environment Protection</p>
Noise and vibration	<p>All sensitive receivers (e.g. schools, local residents) likely to be affected will be notified at least five days prior to commencement of any works associated with the activity that may have an adverse noise or vibration impact. The notification will provide details of:</p> <ul style="list-style-type: none"> • The proposal • The construction period and construction hours • Contact information for proposal management staff • Complaint and incident reporting • How to obtain further information. 	Contractor	Detailed design / pre-construction	Core standard safeguard NV2

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Noise impacts	<ul style="list-style-type: none"> • Work is undertaken in accordance with the Construction Noise and Vibration Guideline (Roads and Maritime, 2016f) • Orientate stationary and directional noise sources away from sensitive receivers • Utilise vehicles, obstacles and stockpiles on site to provide shielding to receivers, especially for static noise sources • Use equipment that has noise levels equal to or less than the sound power levels in Table 6-2 of Appendix J. 	Contractor	Pre-construction, Construction	Additional Safeguard NV3
Vibration	<ul style="list-style-type: none"> • Condition surveys of areas prior to the commencement of construction where vibration intensive equipment is to be used within the safe working distances. • Where possible, the use of less vibration intensive methods of construction or equipment should be considered where possible to reduce the potential for cosmetic damage. • All equipment should be maintained and operated in an efficient manner, in accordance with manufacturer's specifications, to reduce the potential for adverse vibration impacts. • Site-specific safe working distances are to be established on site prior to the vibration generating works commencing. • Ensure that safe working distances established on site are complied with. • If vibration intensive equipment is to be used within the safe working distances, attended vibration measurements are to be undertaken when work commences to determine site specific safe working distances. • Vibration intensive work should not proceed within the safe working distances unless a permanent vibration monitoring system is installed approximately one metre from the building footprint, to warn operators (via flashing light, audible alarm, SMS etc.) when vibration levels are approaching the peak particle velocity trigger levels. 	Contractor	Pre-construction, Construction	Additional Safeguard NV4

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Potential noise and vibration nuisance and amenity impacts	Develop a community information program before starting work. This would involve identification of a nominated community liaison officer and informing affected community members in advance of starting work through advertisements, flyers and community consultation sessions. Provide a 24-hour community hotline for complaints and queries concerning construction and advertise this ahead of starting any work. Develop a complaints handling procedure and ensure a timely response to complaints. Provide actions and progress towards resolving concerns. Make the work program available to the community and ensure it is routinely updated as work progresses.	Contractor	Pre-construction	Additional safeguard NV5
Construction out of hours work	<p>The Contractor would justify the requirement for out-of-hours work and suitably demonstrate why the work cannot be reasonably undertaken during normal working hours. The Contractor should assess proposed out-of-hours work and take reasonable and feasible steps to mitigate construction noise. The Contractor should seek approval from the Principal to undertake out-of-hours work.</p> <p>Ensure out of hours work is undertaken to comply with quality assurance specification G36: Environmental Management (Roads and Maritime, 2014b) and the Construction Noise and Vibration Guideline (Roads and Maritime, 2016f).</p>	Contractors	Construction	Additional safeguard NV6
Noise and vibration complaints	Undertake attended noise and/or vibration monitoring following a complaint. Report the monitoring results as soon as possible. In the case that exceedances of the management levels are recorded, review the situation and identify means to reduce the impacts to noise and vibration sensitive receivers. This is to include revision to the CNVMP where required.	Contractors	Construction	Additional safeguard NV7

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
The potential for exceedance of the NMLs	<p>Ensure toolbox talks and environmental induction training is provided to include specific construction noise and vibration management including, but not limited to:</p> <ul style="list-style-type: none"> • Avoiding the use of radios outside of standard working hours • Avoiding shouting and slamming doors • Operating machinery at low speeds or powers and switch off equipment when it is not being used • Minimising reversing • Avoiding dropping material from height 	Contractors	Construction	Additional safeguard NV8
Operational noise mitigation	<p>Investigate mitigation measures to minimise operational noise including:</p> <ul style="list-style-type: none"> • Quieter pavement surfaces and suitability of such pavement types for through lanes and areas of acceleration, deceleration and turning movements • Noise barriers • At property treatments for residually affected receivers where feasible and reasonable. • Consideration of existing noise mitigation and any specified mitigation in development applications for acute receivers in NCAs A, B and D (both barriers and architectural) when determining reasonable and feasible mitigation 	Roads and Maritime	Detailed Design	Additional Safeguard NV9
Property treatments	<p>Where at property treatments are identified, consider implementing these at the commencement of construction. These treatments would alleviate any noise concerns/ complaints during the construction period.</p>	Contractors	Construction	Additional Safeguard NV10

6.7 Aboriginal heritage

This section summarises the assessed impacts on Aboriginal heritage values that are likely to occur when building and operating the proposal. Appendix K contains a supporting technical paper.

6.7.1 Methodology

The following sources of information were examined during the assessment:

- The Aboriginal Heritage Information Management System (AHIMS)
- Liverpool Local Environmental Plan 2008
- Roads and Maritime Register
- Sydney Water Heritage Register
- State Heritage Register and State Heritage Inventory
- Commonwealth Heritage List
- National Heritage List
- Australian Heritage Places Inventory
- Register of the National Estate
- Procedure for Aboriginal Cultural and Heritage Consultation and Investigation (PACHCI).

Field investigations

An archaeological survey was conducted in accordance with the Stage 1 of RMS's *Procedure for Aboriginal Cultural and Heritage Consultation and Investigation* (PACHCI) on 5 August 2015. The aim of the survey was to record any Aboriginal archaeological sites or areas with potential to contain Aboriginal objects. Based on the archaeological background and landform context of the study area, the survey team closely inspected any areas of surface exposure for artefacts, evidence of intact soils and any mature trees for evidence of Aboriginal bark removal. Assessments of soil disturbance were also made during the survey.

6.7.2 Existing environment

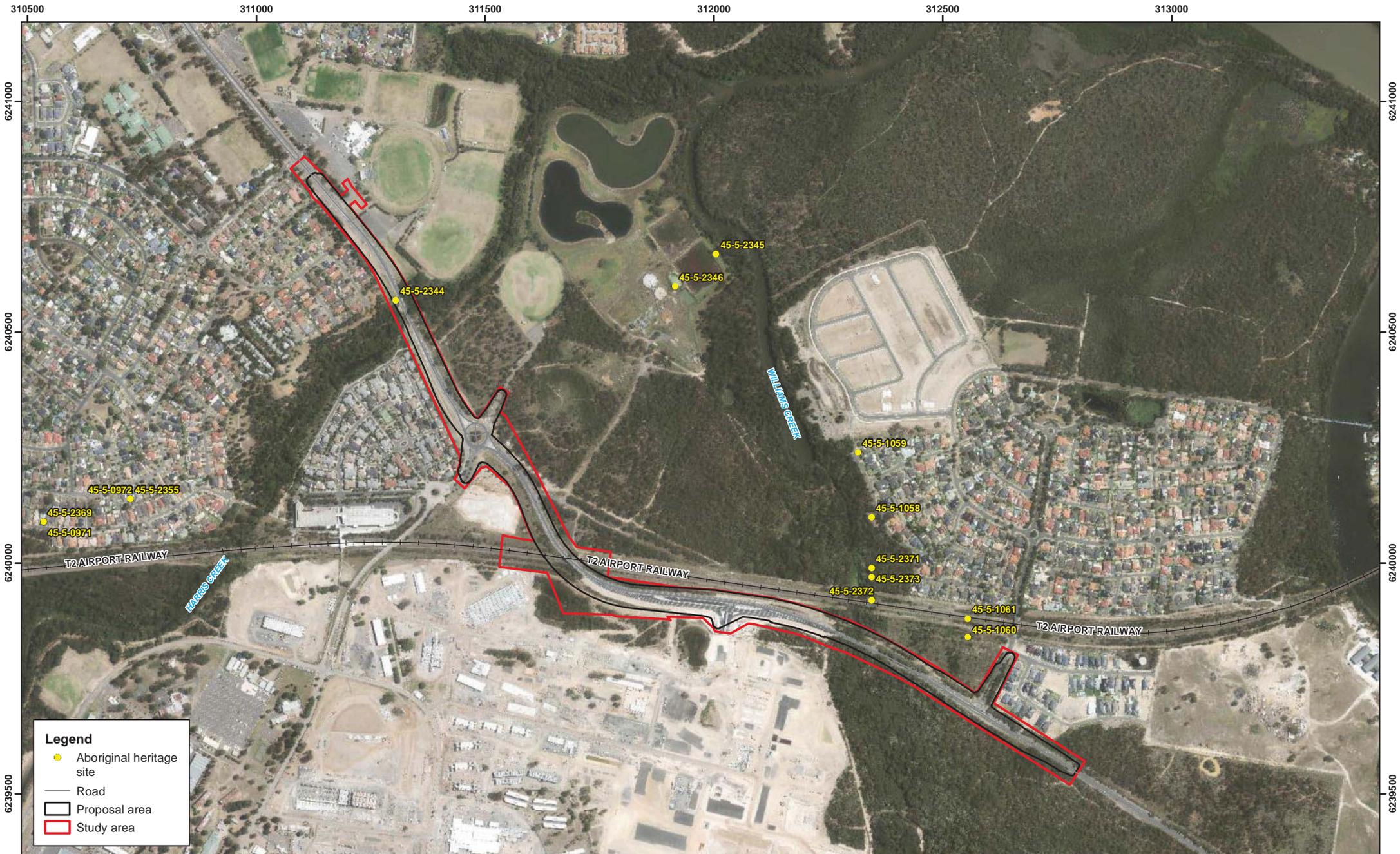
Desktop review

A search of the Aboriginal Heritage Information Management Systems (AHIMS) was conducted on 11 September 2015 applying a one kilometre search radius from the project area, these are shown in Figure 6-6. Fifteen Aboriginal sites were identified; however two of the sites had duplicate recordings. No recorded Aboriginal objects are shown within the proposal footprint. Table 6-31 outlines the sites identified in the search.

Table 6-31: Frequency of site types from results of AHIMS search

Site Feature	Number
Artefact	10
Artefact and Shell	1
Modified tree (Carved or Scarred)	2

The study area contains a portion of the Cubbitch Barta National Estate, a heritage item listed on the Liverpool LEP 2008. The Cubbitch Barta National Estate Area is a listed place on the Commonwealth Heritage List (Place ID 105405) and the Register of the National Estate (Place ID 100633).



Legend

- Aboriginal heritage site
- Road
- Proposal area
- Study area

Map: 2113368_GIS_019_A	Author: RP
Date: 8/09/2016	Approved by: IS





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Coordinate system: GDA 1994 MGA Zone 56
 Scale ratio correct when printed at A3



Heathcote Road Upgrade
Figure 6-6
 Aboriginal heritage AHIMS

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Previous archaeological investigations

A number of previous archaeological investigations have been undertaken around the study area generally in the form of archaeological field studies. Of these surveys, three identified the area as being of low archaeological significance. Four archaeological sites within 100 metres of the study area have been identified by previous investigations. These items are:

- Holsworthy Isolated Find 4 (AHIMS 45-5-2344)
 - Holsworthy Isolated Find 4 comprised one yellow mudstone flaked piece. The artefact was located about 20 metres south of Harris Creek and 10 metres north of the current study area. The area had been heavily disturbed by modern land-use practices including mounds of dumped material and earthworks. The site is listed as destroyed on the AHIMS database.
- Voyager Point 1 (AHIMS 45-5-2372)
 - Voyager Point 1 was a shell midden that was located on the eastern bank of Williams Creek and about 60 metres north of the current study area. The midden comprised rock oyster (*Crassostrea commercialis*) and mud oyster (*Ostrea angasi*) shells within a sandy deposit.
- Voyager Point 2 (AHIMS 45-5-2373)
 - Voyager Point 2 consisted of a culturally modified scribbly gum (*E. sclerophylla*) that was located on the eastern bank of Williams Creek and about 85 metres north of the current study area. A single scar was identified 1.2 metres above the ground on the eastern side of the tree. The scar measured 50 cm in length and 11 cm in width with bark regrowth 7 cm deep.
- Voyager Point ISF 3 (AHIMS 45-5-1060)
 - Voyager Point ISF 3 comprised a single silcrete broken flake. The artefact was located within a disturbed deposit about 20 metres west of The Avenue (formerly Sirius Road) and 95 metres north of the current study area.

The majority of previously recorded artefact scatters were identified on flat to gently sloping landforms near Harris Creek and Williams Creek. These areas were significant waterways and would have provided several resources for past Aboriginal people as indicated by the types of sites recorded. Artefacts present at the sites were predominantly surface scatters of stone tools, however two modified trees and a shell midden have also been recorded.

The preservation of Aboriginal archaeological material in the region has been impacted both by natural processes and land-use practices. These processes disturb subsurface deposits and Aboriginal objects are unlikely to survive in these disturbances.

Field investigations

No Aboriginal archaeological sites, objects or potential deposits were identified within the study area during field investigations.

The artefact identified within the works footprint through the AHIMS search could not be located. This item is an isolated artefact located in a highly disturbed context. The study has concluded that this site exhibits low significance as it offers low research potential and is relatively common.

6.7.3 Potential impacts

The study area contains a portion of the Cubbitch Barta National Estate. The Stage 2 PACHCI report (refer to Appendix K) complies with the requirement to assess the potential impact of the proposal on Aboriginal heritage associated with the Cubbitch Barta National Estate Area. The proposal will not have a significant impact on the Cubbitch Barta National Estate Area.

The study area is a highly disturbed and modified environment exhibiting little potential artefact survivability. No Aboriginal archaeological objects or potential archaeological deposits were identified within the study area and the area was found to be extensively disturbed by natural processes and contemporary land use practices. It is not likely that the construction or operation of the proposal would result in adverse impacts to Aboriginal sites or potential archaeological deposits. Despite this, there remains the potential to discover objects unexpectedly during construction activities, such as earthworks. Therefore, a number of safeguards would be implemented.

6.7.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Aboriginal heritage	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, 2011f) and <i>Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015d) 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 AHMP will be prepared in consultation with all relevant Aboriginal groups.	Contractor	Detailed design / pre-construction	Core standard safeguard AH1 Section 4.9 of QA G36 Environment Protection
Aboriginal heritage	The <i>Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015d) will be followed in the event that an unknown or potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Roads and Maritime does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place. Work will only re-commence once the requirements of that Procedure have been satisfied.	Contractor	Detailed design / pre-construction	Core standard safeguard AH2 Section 4.9 of QA G36 Environment Protection

6.8 Non-Aboriginal heritage

6.8.1 Methodology

This section summarises the assessed impacts on non-Aboriginal heritage values that are likely to occur when building and operating the proposal. Appendix L contains a supporting technical paper prepared by Artefact Heritage.

Significance assessment

Determining the significance of heritage items or a potential archaeological resource in NSW is undertaken by utilising a system of assessment based on the *Burra Charter* (Australia ICOMOS 2013). The principles of the charter are relevant to the assessment, conservation and management of sites and relics. The assessment of heritage significance for sites in New South Wales is outlined through legislation in the Heritage Act and implemented through the *NSW Heritage Manual* and the *Archaeological Assessment Guidelines* (NSW Heritage Office 1996: 25-27).

The Heritage Division specifies assessment using seven heritage criteria (Table 6-32). If an item meets one of the seven criteria, and retains the integrity of its key attributes, it can be considered to have heritage significance. The significance of an item or potential archaeological site can then be assessed as being of Local or State significance. If a potential archaeological resource reaches the local or State significance threshold, then it is a relic as defined and protected by the Heritage Act:

- *State heritage significance*, in relation to a place, building, work, relic, moveable object or precinct, means significance to the State in relation to the historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic value of the item.
- *Local heritage significance*, in relation to a place, building, work, relic, moveable object or precinct, means significance to an area in relation to the historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic value of the item.

Table 6-32: NSW heritage assessment criteria.

Criterion	Description
A	An item is important in the course or pattern of NSW's cultural or natural history (or the cultural or natural history of the local area).
B	An item has strong or special associations with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local area).
C	An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).
D	An item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons.
E	An item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area).
F	An item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area).
G	An item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places; or cultural or natural environments (or a class of the local area's cultural or natural places; or cultural or natural environments).

Impact assessment

The assessment of impact has been undertaken in accordance with the Heritage Division guidelines (Heritage Office & DUAP 2002), and the level of impact is assessed as outlined in Table 6-33.

Table 6-33: Assessed scale of heritage impact

Level of impact	Description
Major	The proposed works would directly impact defining elements inherent to the item's heritage significance such as built fabric, archaeological remains, defining landscape characteristics and/or associated aesthetic elements. This would permanently impact the integrity/intactness of the item and the heritage significance of the item would be lost.
Moderate	The proposed works would impact defining elements inherent to the item's heritage significance such as built fabric, archaeological remains, defining landscape characteristics and/or associated aesthetic elements. Although the integrity/intactness of the item would be impacted, some defining elements of the item would be retained. Therefore, there is potential for the heritage significance of the item to be retained.
Minor	The proposed works would impact defining elements inherent to the item's heritage significance such as built fabric, archaeological remains, defining landscape characteristics and/or associated aesthetic elements. However, these impacts are not considered to detract from the heritage significance of the item.
Nil	The proposed works would not impact defining elements inherent to the item's heritage significance such as built fabric, archaeological remains, defining landscape characteristics and associated aesthetic elements. The works are not considered to detract from the heritage significance of the item.

6.8.2 Existing environment

A search of the above registers and databases identified seven sites of non-Aboriginal heritage within or partially within the study area, some of which are duplicates. Table 6-34 outlines the sites identified in the search, and these are further illustrated in Appendix L.

Table 6-34: Heritage sites identified from desktop review

Item	Listing	Location
Holsworthy Pedestrian Bridge	Liverpool LEP, Roads and Maritime s170 register	Harris Creek and Heathcote Road
Harris Creek Road Bridge	Roads and Maritime s170 register	Heathcote Road
Williams Creek Bridge	Roads and Maritime s170 register	Williams Creek and Heathcote Road
Holsworthy Group	Liverpool LEP	Off Heathcote Road
Old Army/Internment Camp Ground	Commonwealth Heritage List, Register of the National Estate	South of Heathcote Road

Item	Listing	Location
Cubbitch Barta National Estate	Commonwealth Heritage List, Register of the National Estate, Liverpool LEP	Old Illawarra Road
Holsworthy Landscape Conservation Area	Liverpool LEP	Holsworthy, Eckersley
Original Heathcote Road Alignment	Unlisted	Heathcote Road, one section west of Macarthur Drive, one section east of Macarthur Drive

Of these items, four would be directly affected by the proposal and discussed further here. Cubbitch Barta National Estate, while not expected to be directly affected by the proposal is a significant heritage site and is therefore included here.

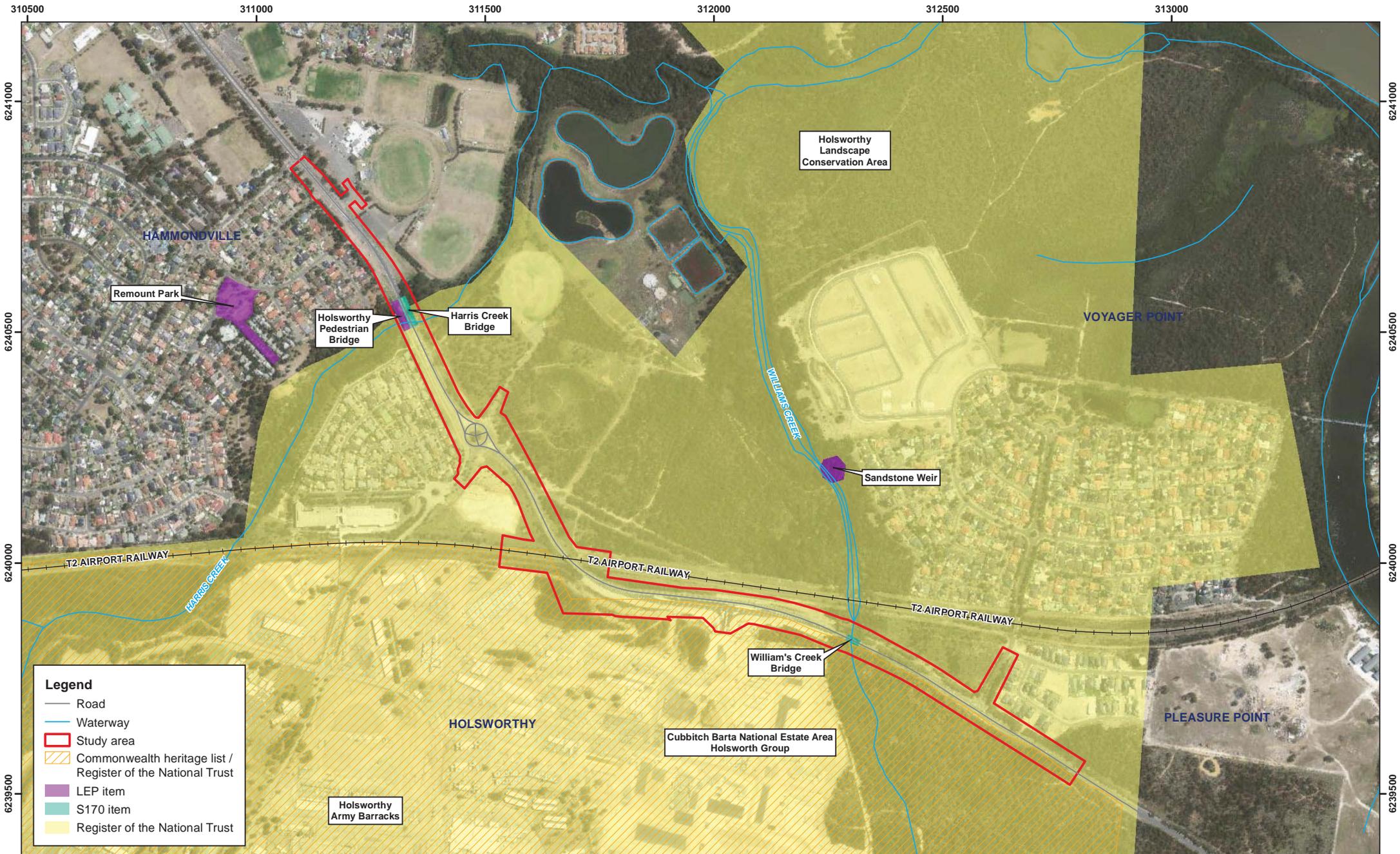
Holsworthy Pedestrian Bridge

Holsworthy Pedestrian Bridge is listed on the Liverpool LEP and Roads and Maritime s170 register (Figure 6-7) and is entirely within the study area. It is also included as part of other heritage listed items:

- Old Army/Internment Camp Group (Commonwealth Heritage List, Register of the National Estate)
- State Heritage Inventory (SHI) Holsworthy Group (Liverpool LEP)
- Holsworthy Landscape Conservation Area (National Trust Register)

The listing for Harris Creek Bridge (Roads and Maritime s170 Register) does not cover the Holsworthy Pedestrian Bridge, but contains the following description of the Bridge:

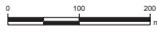
A 3 span structure which is now a combination pedestrian bridge using Bailey Bridging, and pipe bridge. This is supported on two deep steel beams which span between large concrete piers and abutments. It is unclear if the beams are original. The bridge may have seen service as a railway bridge. One pier shows a plaque identifying the construction date as 1917.



Legend

- Road
- Waterway
- ▭ Study area
- ▨ Commonwealth heritage list / Register of the National Trust
- ▭ LEP item
- ▭ S170 item
- ▭ Register of the National Trust

Map: 2113368_GIS_016_A	Author: RP
Date: 8/09/2016	Approved by: IS

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 Coordinate system: GDA 1994 MGA Zone 56
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Heathcote Road Upgrade
Figure 6-7
 Non-Aboriginal heritage sites

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Harris Creek Bridge

Harris Creek Bridge carries Heathcote Road across Harris Creek and the item is entirely within the study area. The bridge was built in association with Heathcote Road and was completed in 1941. The Harris Creek Bridge is listed on the Roads and Maritime S170 Register.

A 2005 study of pre-1948 concrete beam road bridges in RTA (now Roads and Maritime) control in the Sydney, South West and Southern Regions found a total of 78 such bridges (RTA 2006). The majority of these bridges are modest structures crossing minor waterways, and were built to replace earlier bridges on previously existing routes. The 78 bridges form the remnant of a larger number constructed in the period 1907-1948, many of which have since been replaced in order to address increased traffic volumes and speed (RTA 2006). Of the remaining bridges, many have been modified or upgraded, in particular to widen the road and replace the original railings with guard railing.

The Harris Creek Bridge is therefore one of a number of bridges built to a similar design and with similar materials in the period 1907-1948. It is unusual in that it was built during the Second World War as part of an effort to upgrade defence infrastructure, it has remained in place and in use through to the present, and the original railings are still in situ. The railings are a distinctive feature of this bridge, but the structure is otherwise unobtrusive. The superstructure of the bridge allows a clear view of the local setting from the carriageway.

Williams Creek Bridge

Williams Creek Bridge carries Heathcote Road across Williams Creek and is entirely within the study area (Figure 6-6). The bridge was built in association with Heathcote Road and was completed in 1941. The Williams Creek Bridge is listed on the Roads and Maritime S170 Register.

The Williams Creek Bridge is similar to the Harris Creek Bridge in date, function, material, design and setting, as outlined above. However, the original railings of this structure have been replaced with modern crash barrier rails.

Holsworthy Group (LEP)

The LEP curtilage of this item comprises the Holsworthy Military Reserve (Figure 6-7). However, the listing includes the Holsworthy Pedestrian Bridge (remains of a former railway bridge) as part of the Group. The Group is comprised of the following components:

- Collection of early 20th century structures and building remains scattered round the edge of a former parade ground
- Parade ground encircled by macadam paved road
- Tree plantings, both natives and exotics
- Remains of the former Officer's Mess
- Remains of the (former) Corporal's Club
- Powder magazine
- Remains of a former railway bridge
- Parts of the railway line, the ruins of the railway terminus, the railway siding and part of Military Road
- Group of weatherboard buildings directly north of the remains of the Officer's Mess.

Of these items only the Holsworthy Pedestrian Bridge is located within the study area. The remainder are located about 3 kilometres south west of the current study area, in the vicinity of the Old Holsworthy Camp.

Part of the curtilage of this item is within the study area; between Illawarra Road and Macarthur Drive, and the southern part of the Heathcote Road reserve to the east of Macarthur Drive.

Old Army/Internment Camp Group

The Commonwealth Heritage Listing and Register of the National Estate listings for the Old Army/Internment Camp Group does not include a curtilage map, however the listing is likely to

relate to the same curtilage as the Holsworthy Group (outlined above). The Commonwealth Heritage List and Register of the National Estate listings for this item are duplicates.

The Old Army/ Internment Camp Group item consists of a collection of early 20th century buildings related to the Old Army/Internment Camp at Holsworthy. While the curtilage of the group extends over the full extent of the Holsworthy Military Reserve, the Commonwealth Heritage List listing itemises several features:

- Guards' camp buildings
- Former sergeants' mess (or corporals' club)
- Powder magazine
- Ruin of recreation hall
- Federation bungalow
- Ruins of the railway terminus, the railway siding and part of Military road, with possible archaeological remains
- Parade ground area
- Tree plantings from the internment period
- Pedestrian bridge.

Of these items only the Holsworthy Pedestrian Bridge is located within the study area. The remainder are located about 3 kilometres south west of the current study area, in the vicinity of the Old Holsworthy Camp.

While the Commonwealth Heritage listing includes the Holsworthy Pedestrian Bridge, consultation with the Commonwealth Department of Environment, Australian Heritage Information has confirmed that the bridge is neither on the Commonwealth List nor on land owned or managed by the Commonwealth. The bridge is also located outside the Holsworthy Military Reserve. The inclusion of this item in the Commonwealth Heritage List is likely a result of the duplication of the whole listing from the Register of the National Estate. The inclusion of the Bridge in the Register of the National Estate listing is a result of the association of the item with the main Camp group.

Cubbitch Barta National Estate Area (Commonwealth Heritage List, Register of the National Estate, Liverpool LEP)

Cubbitch Barta National Estate Area is listed on the Commonwealth Heritage List, Register of the National Estate and the Liverpool LEP. The curtilage overlaps with that of the Holsworthy Group and Old Army / Internment Camp Group, however this listing recognises distinct heritage values.

The primary values associated with the Cubbitch Barta National Estate Area relate to Aboriginal cultural and natural heritage values, including:

- A diversity of natural landscapes and vegetation species in a relatively unmodified condition.
- Several rare and threatened animal species including the Koala (*Phascolarctos cinereus*), Wallaroo (*Macropus robustus*) and the New Holland Mouse (*Pseudomys novaehollandiae*)
- A large and diverse collection of Aboriginal sites which represent a complex Aboriginal landscape including over 300 rock art sites.

These values are assessed in separate technical reports being undertaken for the proposal.

The listing also recognises the historic heritage of the area as well as Aboriginal / European interactions. These include:

- The Cubbitch Barta National Estate is associated with Governor Macquarie's war against the Aboriginal people of Liverpool, Campbelltown and Appin. Despite efforts to move Aboriginal people away from the region, historical evidence suggests Aboriginal people were visiting the area in the 1830s
- The estate is associated with the development of wine industry and subsistence farming. The Grodno settlement site in particular is associated with early migrants within the Liverpool region.

As with the Holsworthy Group, the curtilage of the Cubbitch Barta National Estate Area includes the entire area of the Holsworthy Military Review (Figure 6-6). Consequently, the corresponding

section of the study area is within the Cubbitch Barta National Estate Area. There are no specific historical features associated with the Cubbitch Barta National Estate Area within the study area.

Significance assessment

In accordance with the methodology outlined in section 6.8.1, the heritage significance of each of the sites within the project area have been assessed as shown in Table 6-35.

Table 6-35: Summary of significance³

Item	Location	Level of significance
Holsworthy Pedestrian Bridge	Within the project area	Local
Harris Creek Bridge	Within the project area	Local
Williams Creek Bridge	Within the project area	Local
Holsworthy Group	Partially within project area	State
Old Army/Internment Camp Group	Partially within project area	Commonwealth
Cubbitch Barta National Estate Area	Partially within project area	Commonwealth ⁴
Holsworthy Landscape Conservation Area	Partially within project area	State
Heathcote Road alignment	Partially within	Local

³Natural heritage and pre-contact Aboriginal cultural heritage values of these items are not assessed in this section.

⁴ Section of the Estate within the project area is not of historical heritage significance.

6.8.3 Potential impacts

Construction

The study area includes part or all of seven listed heritage items, and one unlisted heritage item. Five specific elements relating to these heritage items have been identified within the study area.

The potential heritage impact of the proposed development on each of the sites has been assessed in accordance with the Heritage Division guidelines (see section 6.8.1). The potential impact is outlined below, and summarised in Table 6-36.

Holsworthy Pedestrian Bridge

It is proposed to partially remove Holsworthy Pedestrian Bridge, including removal of the superstructure. The superstructure of the Holsworthy Pedestrian Bridge is a later addition to the former rail bridge and considered of little heritage significance. The piers, iron fixings and the plaque of the pedestrian bridge, which are considered of high heritage significance, will be retained. There would be potential for inadvertent impacts during construction. However, this risk could be managed by adequate site protection measures during construction.

Although aesthetic values or setting are not identified as significant aspects of this item, the visual reference of the bridge is important in conveying its heritage significance and removal of the superstructure would affect the legibility of this item as a bridge. It would therefore be considered that the proposal would have a visual impact resulting in a minor impact on significance. This impact could be mitigated with heritage interpretation which highlighted the significance of the former rail bridge.

As the Holsworthy Pedestrian Bridge forms a part of the Holsworthy Group and Old Army Internment Camp Group the proposed works would also have a minor impact on the heritage significance of these items as discussed in the follow sections.

The statutory protection of this item is provided by the Liverpool LEP, as a result of two listings; for Holsworthy Pedestrian Bridge and for the Holsworthy Group. The Bridge is also included in the Commonwealth Heritage Listing, which ordinarily would provide protection in accordance with the EPBC Act. Section 341C (2) of the EPBC Act states:

A place may be included in the Commonwealth Heritage List only if:

- The place either:
 - Is entirely within a Commonwealth area; or
 - Is outside the Australian jurisdiction and is owned or leased by the Commonwealth or a Commonwealth Authority.

Following consultation with the Commonwealth Department of Environment, Australian Heritage Information it has been confirmed that the bridge is not listed on the Commonwealth Heritage List and is not on land owned or managed by the Commonwealth, as such the provisions of the EPBC Act do not apply.

Harris Creek Bridge

During the concept design phase it was identified that the existing Harris Creek Bridge is subject to flooding and does not meet the proposal's design criteria for flooding. As a result, options to replace this bridge were explored.

It is proposed to duplicate the crossings of Harris Creek and replace the current Harris Creek Bridge. This change will result in removal of the items, and will directly impact the defining elements inherent to the item's significance. This is considered a major impact.

Williams Creek Bridge

Williams Creek Bridge is an item of local heritage significance. The option to retain and duplicate the Williams Creek Bridge was considered during the strategic design phase of the proposal, but was rejected for the following reasons:

- The narrow lanes of the Williams Creek Bridge are unsafe in an 80 km/h speed zone
- The kerb side shoulder of the Williams Creek Bridge would be narrowed to less than 0.5 m, making it unsafe for on-road cyclists
- Retention of the Williams Creek Bridge would result in a broken back curve alignment, which is not ideal for safety reasons.

It is proposed to duplicate the crossing of Williams Creek and replace the current Williams Creek Bridge. This change will result in removal of the items, and will directly impact the defining elements inherent to the item's significance. This is considered a major impact.

Holsworthy Group

Works within the curtilage of this item include widening of Heathcote road along the boundary of the curtilage and partial removal of the Holsworthy Pedestrian Bridge. The Holsworthy Pedestrian Bridge is an identified component of and contributes to the heritage significance of the Group, however partial removal of the later pedestrian bridge superstructure, which is considered of only minor heritage significance, would result in a minor impact to that element. Overall, the proposed works would have a minor impact on the overall significance of the Holsworthy Group.

The statutory protection of this item is provided by the Liverpool LEP, though the bridge is listed separately (refer to section 6.8.2).

Old Army/Internment Camp Group

Works near the curtilage of this item include the widening of Heathcote Road along the boundary of the curtilage. As no heritage items are located along the curtilage boundary the proposal would not have an impact on the heritage values of this item.

The majority of elements comprising the Old Army/Internment Camp Group consist of items associated with the internment camp facility including guard buildings, parade facilities and the mess hall. These elements are located approximately three kilometres outside of the study area. The proposed works would not directly or indirectly affect these items.

The Holsworthy Pedestrian Bridge is included in the Commonwealth Heritage List database description of the Group. However, this item is outside the Commonwealth Heritage List curtilage. Consultation with the Department of Environment has confirmed that the bridge is not on Commonwealth land and not included within the Commonwealth Heritage Listing (refer to section 6.8.3).

Other statutory non-statutory heritage listings recognise the importance of the Holsworthy Pedestrian Bridge within the overall group, referred to as the Holsworthy Group, the Old Army/Internment Camp Group, and the Holsworthy Landscape Conservation Area. Proposed works to the Holsworthy Pedestrian Bridge would retain the original components associated with 1917-1918 construction by German concentration camp detainees. It is therefore considered that the proposed works, in particular to the Holsworthy Pedestrian Bridge, would not result in an impact to the significance of the Commonwealth Heritage Listed item the Old Army / Internment Camp Group.

Cubbitch Barta National Estate Area

Works near the curtilage of this item include the widening of Heathcote Road along the boundary of the curtilage. As no features of historical heritage value are located within the curtilage boundary, the proposal would not have an impact on the heritage values of this item.

6.8.4 Operation

There would be no physical impacts on the area's heritage sites further to those generated during construction. There would be no direct impacts to the Holsworthy Old Army Internment Camp Ground. However the upgrade of the road would affect the context and setting of the site, potentially increasing traffic flow and noise from the road. Potential impacts would have limited effect on the heritage values or the importance of this site.

Table 6-36: Summary of heritage impacts

Heritage Item	Component	Proposed works	Impacts to fabric	Impacts to setting	Impacts to archaeological remains
Holsworthy Pedestrian Bridge	Holsworthy Pedestrian Bridge	Partial removal	Minor Removal of later additions of the superstructure and abutments. Potential inadvertent impacts during construction	Minor Loss of visual reference to the item as a bridge	Nil No archaeological remains are likely to be present
Harris Creek Bridge	Harris Creek Bridge	Replacement	Major Removal of Harris Creek Bridge will have a major impact to the fabric of this item	Negligible	Nil No archaeological remains are likely to be present
Williams Creek Bridge	Williams Creek Bridge	Replacement	Major Removal of Williams Creek Bridge will have a major impact to the fabric of this item	Negligible	Nil No archaeological remains are likely to be present
Cubbitch Barta National Estate	n/a	n/a	Neutral No heritage items will be impacted	Neutral The works will involve upgrades to a road that is already present	Nil No archaeological remains are likely to be present
Holsworthy Group	Holsworthy Pedestrian Bridge	Partial removal	Minor Impact is limited to Holsworthy Pedestrian Bridge element. Negligible impact to significance of the Holsworthy Group	Negligible impact to setting in the context of the whole Group	Nil No archaeological remains are likely to be present

Heritage Item	Component	Proposed works	Impacts to fabric	Impacts to setting	Impacts to archaeological remains
Old Army / Internment Camp Group	Holsworthy Pedestrian Bridge	Partial removal	Moderate Impact is limited to Holsworthy Pedestrian Bridge	Minor The work will result in removal of a contributing element of the group, though overall it would be a minor impact to significance	Nil No archaeological remains are likely to be present.
Holsworthy Landscape Conservation Area	Old Illawarra Road alignment	Compound Upgrade to current road pavement	Nil The significance of the item is related to the alignment only	Nil The work will allow the continuing use of the item as a road	Nil No archaeological remains are likely to be present
	Holsworthy Pedestrian Bridge	Partial removal	Moderate Impact is limited to Holsworthy Pedestrian Bridge	Moderate The work will result in removal of a significant element of the item	Nil No archaeological remains are likely to be present
n/a	Holsworthy Road alignment	Upgrade to current road pavement	Nil The significance of the item is related to the alignment only	Nil The work will allow the continuing use of the item as a road	Nil No archaeological remains are likely to be present

6.8.5 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
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.	Contractor	Detailed design / pre-construction	Core standard safeguard H1 Section 4.10 of QA G36 Environment Protection
Non-Aboriginal heritage	<ul style="list-style-type: none"> The <i>Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015d) 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. 	Contractor	Detailed design / pre-construction	Core standard safeguard H2 Section 4.10 of QA G36 Environment Protection
Non-Aboriginal heritage	A heritage induction will be prepared and implemented as part of the proposal's general induction to raise awareness to construction personnel. The induction will include: <ul style="list-style-type: none"> An outline of the history and heritage values of the study area The relevant requirements of the Heritage Act Description and explanation of the unexpected finds procedure 	Contractor	Pre-construction/ construction	Additional safeguard H3

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Impacts to Holsworthy Pedestrian Bridge	<ul style="list-style-type: none"> • Undertake archival recording and heritage interpretation of the Bridge prior to removal of superstructure. This should be combined with detailed historical research • Conservation of elements of the bridge, such as the piers, iron fixings and plaque • Site protection measures for piers, iron fixings and plaque to be included during construction • Construction of a new footbridge in the same or similar location, with associated footpaths following the original alignment of the former rail line, so far as is possible • Inclusion of a heritage interpretation to be considered. 	Roads and Maritime	Detailed design / pre-construction	Additional safeguard H4
Impacts to Harris Creek Bridge and Williams Creek Bridge	<ul style="list-style-type: none"> • Consultation with the Office of Environment and Heritage should be undertaken prior to impacts to the bridge. This would be in accordance with s170A of the Heritage Act • Archival recording of bridges prior to removal including archival photography and measured drawings • Design of replacement bridges and associated shared paths to balance safety and complement the surrounding landscape character and heritage values, including the consideration of material types and finishes. 	Roads and Maritime	Detailed design / pre-construction	Additional safeguard H5

6.9 Landscape character and visual impacts

6.9.1 Methodology

The following documents guided the assessment:

- The Guidelines for Landscape Character and Visual Impact Assessment (EIA-N04) (Roads and Maritime, 2013).
- Australian Standard (AS) 4282-1997 Control of the Obtrusive Effects of Outdoor Lighting (Australian Standards, 1997)
- Landscape Guideline (Roads and Maritime, 2008)
- Bridge Aesthetic Guidelines, Centre for Urban Design (Roads and Maritime, 2012e)
- Beyond the Pavement (Roads and Maritime, 2014e).

The assessment:

- Characterised the existing regional and local landscape and streetscape character as defined into specific character zones
- Determined regional visual characteristics and the study area's local visual context and setting
- Defined the visual envelope, which represents the theoretical limit from where the proposal would be visible
- Determined the sensitivity of landscape character and visual environment to the changes that would occur during construction and from the final permanent presence of the built proposal
- Considered the lighting impacts on adjacent receivers during construction and operation
- Identified those adverse impacts that would need safeguarding or managing during construction and operation.

Landscape character

The landscape comprises a number of distinct zones that have very specific characteristics that define its value. For instance, a bushland landscape is typically of higher value than a modern industrial landscape, which is typically of ordinary or poor quality. Each zone is also sensitive to change. The default assumption is that more valued landscapes are more sensitive to change. However, there are certain valued landscape zones that are less sensitive to change. For instance, a developed dense urban environment may be of value; however it is accepted that urban areas are constantly undergoing change and therefore less sensitive.

Visual impact

Visual impacts occur over different timeframes; while the proposal is being built, once it is open and then when the landscape has established and matured. The expected effectiveness of any landscaping treatments to mitigate adverse visual impacts is likely to gradually increase from construction (greater visual impact) through to the point of opening (lesser visual impact) and then to future operation (minimal visual impact). This is mainly due to the gradual maturation of planted vegetation and its inherent amenity over this time period.

Study area

Figure 6-8 shows the proposal's visual envelope which defines the study area. The assessment considered the predicted changes in landscape character and visual impacts within this envelope. Regional landscape characteristics were also used to describe the existing environment.

Light spill impacts

The adverse impacts of light spill are influenced by:

- The height of the light source relative to the receiver, where light is considered more obtrusive where the light source is higher than the receiver
- Surrounding landforms and topography, which can shield the light source from the receiver
- Ambient existing light levels and the type of light

- Surrounding land uses; for instance residential receivers are considered more sensitive than commercial and industrial land uses.

Standards for lighting are contained within Lighting for Roads and Public Spaces AS/NZS 1158 standard (Standards Australia/Standards New Zealand, 2010) and mitigation measures will take this into consideration during detailed design.

6.9.2 Existing environment

Regional landscape character

The land around Heathcote Road in the study area is generally flat. Two creeks, Harris Creek and Williams Creek flow from the west of Heathcote Road to the Georges River north east of the study area. Residential development occupies the northern and southern sections of the proposal and a large extent of bushland to the north of Heathcote Road. Heathcote Road passes over the T2 Airport Railway Line. Other prominent features in the study area are the recreational areas at Hammondville Park and the Holsworthy Barracks entrance. This mixture of zones reduces cohesion and connectivity in the landscape.

Local landscape character

The study area can be divided into eight distinct landscape character zones:

- Zone 1: Hammondville Park
- Zone 2: Holsworthy and Morningside residential
- Zone 3: Harris Creek (west of Heathcote Road)
- Zone 4: Bushland (east of Heathcote Road)
- Zone 5: T2 Airport Railway
- Zone 6: Holsworthy Army Barracks
- Zone 7: Bushland (west of Heathcote Road)
- Zone 8: Voyager Point residential.

Table 6-37 describes each zone's characteristics, its quality and its sensitivity to change. Figure 6-8 shows the location of each landscape character zone.

Table 6-37: Landscape character zones

Zone	Sensitivity to change
Zone 1: Hammondville Park	Moderate: Hammondville Park is an area of mown grassland that comprises a number of sports pitches and the Moorebank Sports Club. It is fringed with trees and bordered to the south west by Heathcote Road. Extensive areas of car parking hardstand are located between the sports fields and the road. The land use is principally recreation.
Zone 2: Holsworthy and Morningside residential	Moderate: Holsworthy is a medium density residential area and Morningside a high residential area that comprises a mixture of single and double storey houses. Both areas are fringed with trees and bordered to the north by Heathcote Road. The current streetscape is considered of moderate quality.
Zone 3: Harris Creek (south of Heathcote Road)	High: This zone includes the vegetated corridor surrounding Harris Creek on the southern side of Heathcote Road. The land use largely comprises a riparian zone and a number of endangered and threatened species.
Zone 4: Bushland (north of Heathcote Road)	High: Zone comprises extensive bushland on the northern side of Heathcote Road, south of Hammondville Park. It also includes an access track to service the T2 Airport Railway and a Sydney Water reservoir. The zone comprises a number of endangered and threatened species.

Zone	Sensitivity to change
Zone 5: T2 Airport Railway	Low: This zone comprises the rail corridor servicing the T2 Airport Railway Line. It divides Zones 4 and 6 and generally runs east to west.
Zone 6: Holsworthy Army Barracks	Low: Holsworthy Army Barracks are located on the southern side of Heathcote Road, accessed by Soldiers Way. The site has been developed over the past few years, with the land closest to Heathcote Road having a number of buildings constructed accompanied by new landscaping and a significant upgrade of the intersection with Heathcote Road. The land is used by defence personnel.
Zone 7: Bushland (west of Heathcote Road)	High: This zone comprises extensive bushland on the southern side of Heathcote Road to the east of the Holsworthy Army Barracks. The zone comprises a number of endangered and threatened species.
Zone 8: Voyager Point residential	Moderate: Voyager Point is a low density residential area comprising single and double stories houses. The streetscape is fringed with trees and is boarded to the south by Heathcote Road.

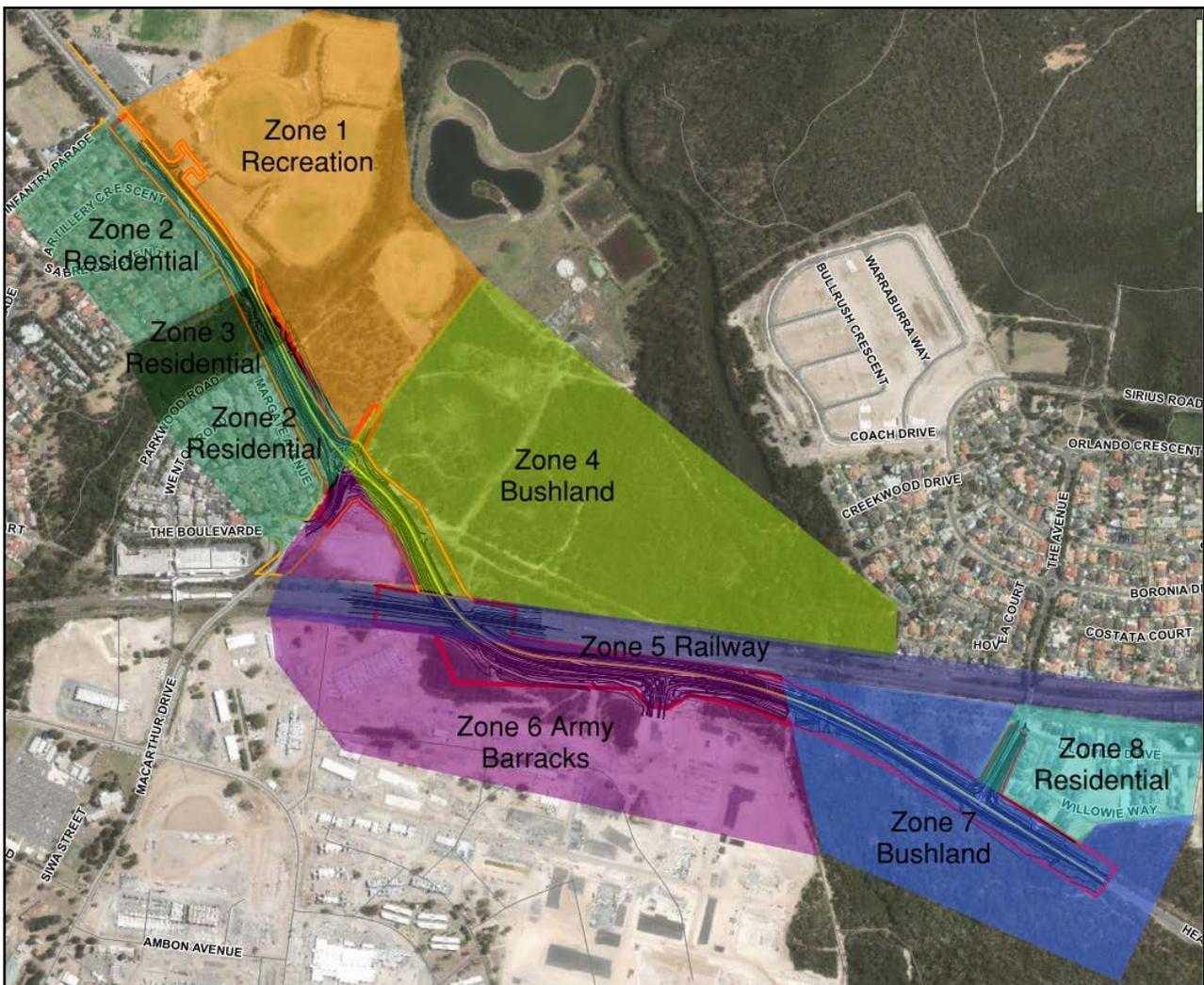


Figure 6-8: Landscape character zones

Visual context

When considering the visual context of the study area, there is an important distinction between the views offered when travelling/walking through the proposal footprint, which are transient, versus the zone of visual influence (referred to as the ‘visual envelope’) exerted by proposal.

Visual envelope

Figure 6-8 shows the proposal’s visual envelope. Its extent has been defined by considering the local topography, built form and the screening provided by the existing planted vegetation. As per the figure, the envelope is largely contained and restricted as a result of the area’s flat topography and linear nature of the proposal. As such, there are limited views of the road beyond the immediate corridor. Table 6-38 describes the visual exposure of the proposal footprint within the envelope by referring back to the landscape character zones defined in Table 6-37.

Table 6-38: Visual exposure of landscape zones

Landscape Character Zone	Exposure
Zone 1: Hammondville Park	Moderate: the land use is principally recreation therefore views are not from permanent receivers
Zone 2: Holsworthy and Mornington residential	Moderate: given that there are receivers that directly overlook the existing road
Zone 3: Harris Creek (west of Heathcote Road)	Negligible: as there are no visual receivers in this zone
Zone 4: Bushland (east of Heathcote Road)	Negligible: as there are no visual receivers in this zone
Zone 5: T2 Airport Railway	Negligible: as the railway crosses below Heathcote Road
Zone 6: Holsworthy Army Barracks	Moderate: as this zone has already been upgraded which limits its exposure to change.
Zone 7: Bushland (west of Heathcote Road)	Negligible: as there are no visual receivers in this zone
Zone 8: Voyager Point residential	Moderate: given that there are receivers that directly overlook the existing road

Visual receivers

The visual receivers in the envelope are those people that would be affected by changes to the landscape character introduced in building and operating the proposal. They are assessed in terms of identifying places where people regularly congregate and include residential property, public buildings, public spaces, heritage items and key businesses. With reference to the proposal, the visual receivers include:

- Occupiers of residential properties adjacent to the proposal footprint
- Passengers, drivers and other road users (e.g. pedestrians) travelling through the proposal footprint and its intersecting roads
- Users of the Hammondville Park recreational facilities.

The sensitivity of each receiver to the landscape changes that would be introduced under the proposal is affected by a combination of whether:

- They would be permanently or temporarily affected (e.g. people that live in the area versus people that work in or routinely visit the area)

- The function and use of each receiver (e.g. a residents versus a recreational user)
- Their location relative to the proposal footprint.

It is not possible to identify each individual property or residence that would be impacted by the proposal. Viewpoints have therefore been selected that best represent groups of receivers. They typically represent points in the visual envelope where the impact is expected to be the greatest. Five viewpoints were selected in the envelope to represent the area's visual receivers. Each viewpoint's sensitivity to change was also determined based on their relativity to one another. Figure 6-9 shows the location of the five representative viewpoints and Table 6-39 describes their location and character.

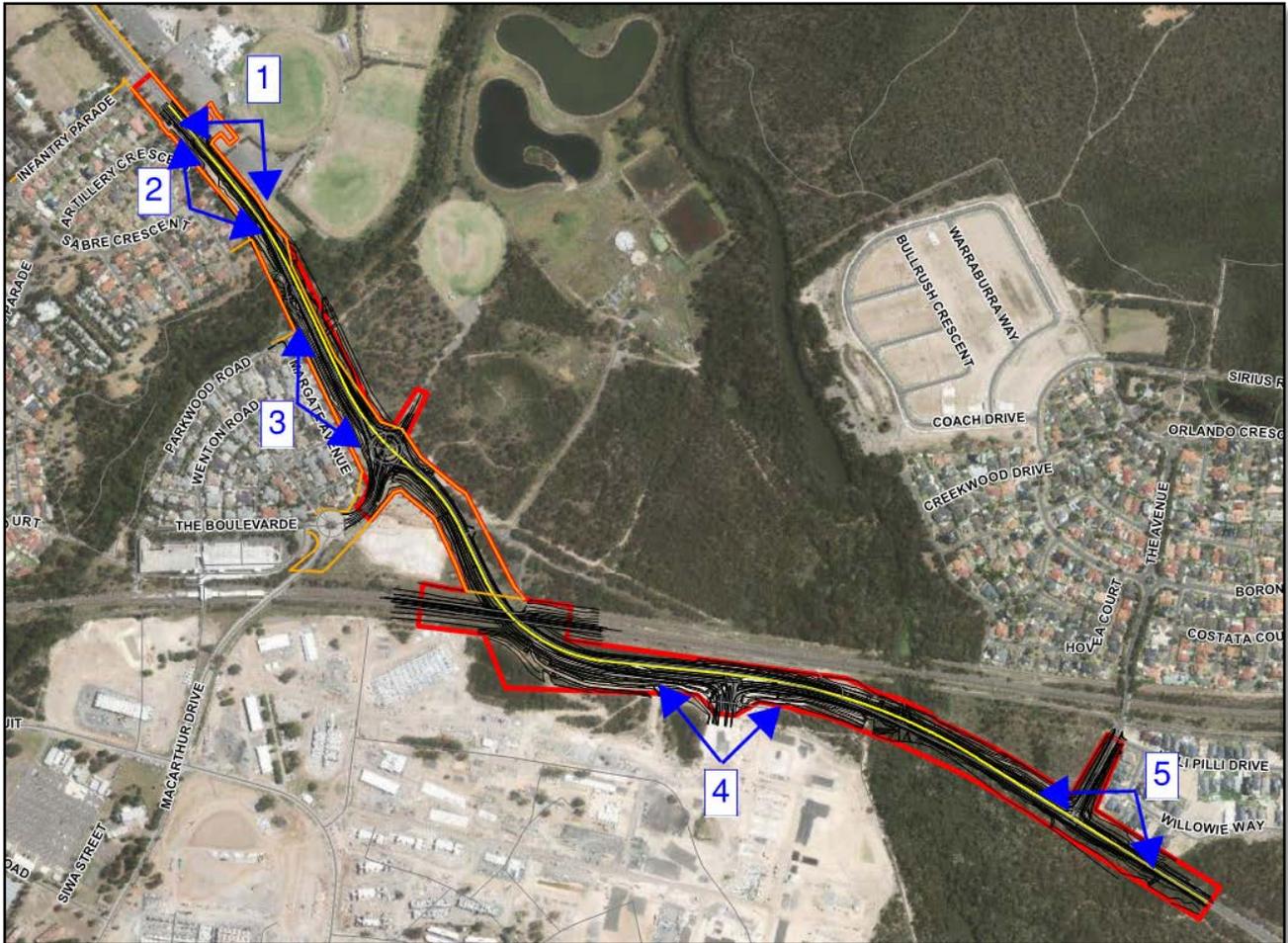


Figure 6-9: Representative viewpoints

Table 6-39: Receiver viewpoint sensitivity

Viewpoint	Receiver representation	Sensitivity to change
Viewpoint 1: looking north and south from Hammondville Park	<ul style="list-style-type: none"> • Existing road users travelling along Heathcote Road • Recreational and sporting users 	<p>Moderate</p> <p>Road users (note 1)</p> <p>Recreational users (note 2)</p>
Viewpoint 2: looking north and south from Sabre Crescent (Holsworthy)	<ul style="list-style-type: none"> • Existing road users travelling along Heathcote Road • Residents in the houses off the western kerb line 	<p>High</p> <p>Residents</p> <p>Moderate</p> <p>Road users</p>

Viewpoint	Receiver representation	Sensitivity to change
Viewpoint 3: looking north and south from Margate Crescent (Mornington)	<ul style="list-style-type: none"> Existing road users travelling along Heathcote Road Residents in the houses off the western kerb line 	<p>High</p> <p>Residents</p> <p>Moderate</p> <p>Road users</p>
Viewpoint 4: looking north and south from Holsworthy Army Barracks Entrance	<ul style="list-style-type: none"> Existing road users travelling along Heathcote Road Military personnel accessing the army barracks 	<p>Moderate</p> <p>Road users</p> <p>Moderate</p> <p>Military personnel (note 3)</p>
Viewpoint 5: looking north and south from Willowie Way (Voyager Point)	<ul style="list-style-type: none"> Existing road users travelling along Heathcote Road Residents in the houses off the eastern kerb line 	<p>High</p> <p>Residents</p> <p>Moderate</p> <p>Road users</p>

Note 1: There is a difference between people that regularly travel along the road (more sensitive to change) and those that only occasionally or rarely travel along the road (less sensitive to change). The assessment however adopts precaution in assessing the more sensitive receivers

Note 2: It is assumed that recreational users are less concerned (and therefore less sensitive) about the views when participating in a sporting activity, and tend not to be affected by the local views in deciding whether to use the type of recreational facility in the area

Note 3: It is assumed that Military personnel are less concerned (and therefore less sensitive) about the views when at work and/or are in training.

Views at night

Street lighting is located on either side of Heathcote Road from Infantry Parade to the Holsworthy Army Barracks intersection and is also present at The Avenue intersection. These light sources contribute to the area's overall light levels and light pollution.

6.9.3 Potential impacts

The proposal's impacts are a result of both the temporary disruption caused while building the proposal and the permanent changes to the landscape, landform and amenity once the proposal is operational. To ensure the proposal enhances the amenity of the streetscape and landscape it has been designed under the principles of Beyond the Pavement (Roads and Maritime, 2014e). This document sets out the processes and approaches to urban (road) design.

Construction impact: landscape character

Temporary landscape impacts would depend on the scale and type of activity taking place in a given location and its duration. Building the proposal would exert an influence locally that would temporarily impact the immediate streetscape. In turn, this would have an indirect impact on the eight identified landscape character zones, affecting those zones fronting the proposal footprint and streetscape more than those further from the work activities. The key activities that would temporarily affect the local landscape character include:

- Stage 1: building the three new bridges and creating the bridge approaches
- Stage 1A: widening the road
- Stage 2: switching the traffic and demolishing and replacing the existing bridges
- Stage 3: upgrading and retaining the existing road and altering the intersections.

In addition to the changes introduced through new structures and removal of existing, visual impacts will be contributed by the day-to-day construction activity. This would include the routine movement of equipment and machinery within the proposal footprint; a temporary increase in traffic congestion; amenity effects such as dust, noise and vibration generation; loading and unloading activities; the presence of construction equipment; and use of bollards, fencing and hoardings.

The utility, drainage, widening, bridge works and intersection improvements would have the greatest temporary impact on the area's landscape values given the scale of the work within the confines of the road corridor.

The impacts would be more notable within landscape character zones 1, 3, 4 and 7 due to the increased sensitivity and amenity value associated with these areas. Overall however, the effects would only be temporary, occurring while the proposal is being built; the impact of which is not significant. However, the impact on the landscape from clearing of vegetation and initial earthworks would be permanent. This would be mitigated in the latter stages of construction when landscaping and finishing works occur. This is discussed below.

Construction impact: visual impacts

Those activities affecting the landscape character would also affect the area's visual amenity. By providing boundary fencing and hoardings around the project area, would screen certain site activities from view at ground level. This would reduce the visual envelope at ground level, therefore partially mitigating impacts. However, there would still be a residual visual impact as a result of traffic accessing and leaving site, the use of equipment onsite, and the mass and scale of the active project area.

The work would also be visible for people that live above ground level as they would not benefit from the screening provided by the hoardings. Residents along Sabre Crescent, Margate Avenue and Willowie Way that back onto Heathcote Road would be affected most while the proposal is being built and in particular when the intersections are being improved and reconfigured. This would be more notable for the two storey residences that overlook Heathcote Road as their views would not be screened.

Residents in Sabre Crescent are also affected by the site compound and Harris Creek Bridge works. Despite the sensitivity of other local receivers, exposure to visual impacts during construction would be intermittent and short-term on the basis that they either work in the area, are only staying for a short period of time, or they are driving through the area. While some receivers that overlook the project area would experience some visual impacts during construction, overall, the impact is not considered significant.

Construction impact: amenity planting

Existing planting and vegetation along the length of Heathcote Road would be removed in order to widen the road. Also, the width of the amenity planting buffer would be reduced to accommodate the widened road. In the short-term this would have a negative impact on the streetscape until landscaping works are undertaken at the later stages of construction. This impact would be unavoidable when building the proposal.

Construction impact: light spill and night time work

As described in section 3.4.2, certain activities can only take place at night given the need to partially or fully close the existing road and/or side roads. Additional site lighting would be needed to undertake any night work for visibility and safety reasons; both for the workers and the public. The introduced light would likely be in the form of high-power site lights and vehicle lights. These lights are typically white in nature and character. They can be shielded and directed to prevent spill and backscatter.

The duration of night work would be temporary and short-term with respite periods determined in accordance with RMS guidelines and community consultation. Light spill from night-time work would be minimised as much as reasonably practicable with priority given to maintaining safe visibility for work personnel. Confirming whether there would be an impact would depend on the location of the light relative to the adjacent receivers identified above in Table 6-39. Given several

receivers are located adjacent to the proposal footprint it is concluded the impact may be significant albeit only occurring for a short duration over the work program.

Operational impact: landscape and streetscape character

The amenity of the area will change over time. At the point of the proposal becoming operational the proposed planting would be unestablished and immature. It would therefore lend less to the area's overall amenity and character. Over time however, as the planting matures, the area's character would improve. Table 6-40 summarises the landscape character impact across the study area. The summary does not directly separate out the impact and benefit at the point of opening versus a point in the future. It simply provides an overview of the long-term changes that would occur under the proposal.

Table 6-40: Permanent landscape character impacts

Zones (sensitivity)	Magnitude of change	Impact
Zone 1: high	<ul style="list-style-type: none"> Negligible: the overall character of a busy road would not change dramatically 	Not significant: the proposal would not materially affect the values of the character of this zone.
Zone 2: moderate	<ul style="list-style-type: none"> Low: the overall character of a busy road would not change dramatically 	Neutral (beneficial): The change would be beneficial in transforming the sense of place in the area.
Zone 3: high	<ul style="list-style-type: none"> Low: there will still be a bridge located in the zone 	Neutral: the proposal would include vegetation removal and removal of the pedestrian bridge, however this would not materially affect the values of the character of this zone.
Zone 4: high	<ul style="list-style-type: none"> Negligible: the overall character of a busy road would not change dramatically 	Neutral (beneficial): the proposal would not materially affect the values of the character of this zone.
Zone 5: low	<ul style="list-style-type: none"> Negligible: the railway overbridge creates a distinct barrier between the proposal and this character zone meaning that it would not be impacted by the proposal. 	Not significant: the proposal would not materially affect the values of the character of this zone.
Zone 6: low	<ul style="list-style-type: none"> Negligible: the overall character of a busy road would not change dramatically 	Not significant: the proposal would not materially affect the values of the character of this zone.
Zone 7: high	<ul style="list-style-type: none"> Negligible: the overall character of a busy road would not change dramatically 	Not significant: the proposal would not materially affect the values of the character of this zone.
Zone 8: moderate	<ul style="list-style-type: none"> Low: the overall character of a busy road would not change dramatically, however the intersection upgrade and provision of the shared use path would be a transformation of the streetscape. 	Neutral (beneficial): The change would be beneficial in transforming the sense of place in the area and enhancing people's journeys.

Overall, it is concluded that the streetscape would not change significantly as it will continue to be dominated by a road.

Operation: visual impacts

The adjacent visually-sensitive receivers (refer to Figure 6-9) would be negatively affected by the increased presence and width of the road corridor, new bridges, upgraded intersections, the associated vegetation and tree removal, and additional bridge structures. However, these receivers would also benefit from the urban design enhancements and amenity planting included throughout the corridor. Table 6-41 summarises the assessed visual impact.

The addition of bridges, the widening of the road for additional lanes, and intersection upgrades would contribute to an increase in paved areas, installation of guardrails and minor reduction of vegetated areas within the proposed project area. This would have a moderate low impact on the visual amenity of the site. Given that the visibility of these changes for the most part would be restricted to motorists, the overall impact of the works is not considered significant.

Table 6-41: Permanent visual impacts

Zones (sensitivity)	Magnitude of change	Impact
<p>Viewpoint 1 Road users: moderate Recreational users: moderate</p>	<ul style="list-style-type: none"> Road users - negligible: due to the limited changes to the amenity and value of the landscape character from a road user’s perspective Recreational users – negligible: As the associated views would be largely unchanged or altered through the proposal 	<p>Road and Recreational Users Negligible: the proposal would be a barely perceptible component, resulting in a minor loss or alteration of amenity values.</p>
<p>Viewpoint 2 Residents: high Road users: moderate</p>	<ul style="list-style-type: none"> Residents - low: the widening would increase the dominance of the road and the shared use path would be a transformation of the streetscape, the overall amenity of a busy road would not change dramatically. Road users - negligible: due to the limited changes to the amenity and value of the landscape character from a road user’s perspective 	<p>Residents Moderate: the proposal would form a distinctive visual component resulting in the partial loss or alteration of amenity values.</p> <p>Road Users Negligible: the proposal would be a barely perceptible component, resulting in a minor loss or alteration of amenity values.</p>
<p>Viewpoint 3 Residents: high Road users: moderate</p>	<ul style="list-style-type: none"> Residents - low: the widening would increase the dominance of the road and the intersection upgrade would be a transformation of the streetscape, the overall amenity of a busy road would not change dramatically. Road users - negligible: due to the limited changes to the amenity and value of the landscape character from a road user’s perspective 	<p>Residents Moderate: the proposal would form a distinctive visual component resulting in the partial loss or alteration of amenity values.</p> <p>Road Users Negligible: the proposal would be a barely perceptible component, resulting in a minor loss or alteration of amenity values.</p>

Zones (sensitivity)	Magnitude of change	Impact
Viewpoint 4 Road users: moderate Military Personnel: low	<ul style="list-style-type: none"> Road users - negligible: due to the limited changes to the amenity and value of the landscape character from a road user's perspective the overall character of a busy road would not change dramatically Military Personnel - negligible 	Road Users and Military Personnel: the proposal would be a barely perceptible component, resulting in a minor loss or alteration of amenity values.
Viewpoint 5 Residents: high Road users: moderate	<ul style="list-style-type: none"> Residents - low: the widening would increase the dominance of the road and the intersection upgrade would be a transformation of the streetscape, the overall amenity of a busy road would not change dramatically. Road users - negligible: due to the limited changes to the amenity and value of the landscape character from a road user's perspective 	Residents Moderate: the proposal would form a distinctive visual component resulting in the partial loss or alteration of amenity values. Road Users Negligible: the proposal would be a barely perceptible component, resulting in a minor loss or alteration of amenity values.

Operation: amenity planting

The urban design strategy and plan would aim to restore disturbed areas with appropriate landscaping treatment and native planting. Once landscaping and planting has been completed and well-established, it is likely that local amenity along the length of Heathcote Road is improved. Ongoing maintenance of amenity planting into the future would be undertaken to also ensure amenity is maintained. Amenity planting is expected to provide a long-term beneficial impact.

Operation: light spill

The lighting design will be confirmed at the detailed design stage. It is likely to involve a contemporary design that may involve the inclusion of high-pressure sodium lighting. This is a white light and design that would direct more of the light onto the road surface. This reduces light spill, back scatter and up scatter. It is assumed that the existing light spill could be improved under the proposal. This is likely to reduce the light spill into adjacent properties despite the light being brighter. As such, this is considered a beneficial impact. Proposed new lighting along the bushland sections of Heathcote Road may result in a minor adverse outcome as it would spread light into previously unaffected areas. There are no sensitive receivers in this location, therefore the overall impact is not considered significant.

6.9.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Landscape character and visual impact	<p>An Urban Design Plan will be prepared to support the final detailed design and implemented as part of the CEMP.</p> <p>The Urban Design Plan will present an integrated urban design for the proposal, providing practical detail on the application of design principles and objectives identified in the environmental assessment. The Plan will include design treatments for:</p> <ul style="list-style-type: none"> • Location and identification of existing vegetation and proposed landscaped areas, including species to be used • Built elements including retaining walls and bridges • Pedestrian and cyclist elements including footpath location, paving types and pedestrian crossings • Fixtures such as seating, lighting, fencing and signs • Details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage • Procedures for monitoring and maintaining landscaped or rehabilitated areas. <p>The Urban Design Plan will be prepared in accordance with relevant guidelines, including:</p> <ul style="list-style-type: none"> • <i>Beyond the Pavement urban design policy, process and principles</i> (Roads and Maritime, 2014e) • <i>Landscape Guideline</i> (RTA, 2008) • <i>Bridge Aesthetics</i> (Roads and Maritime 2012e) • <i>Shotcrete Design Guideline</i> (RTA, 2005). 	Contractor	Detailed design / pre-construction	Core standard safeguard UD1

Other safeguards and management measures that would address landscape character and visual impacts are identified in section 6.1.4.

6.10 Socio-economic

6.10.1 Methodology

The following documents guided the assessment:

- Environmental Impact Assessment Practice Note: Socio-economic assessment: EIA-N05 (Roads and Maritime, 2013h).

The assessment:

- Identified the existing socioeconomic characteristics of the study area through desktop research, reviewing secondary-source quantitative data, undertaking limited primary research, and in particular referring to:
 - Census data (Australian Bureau of Statistics – Census Quick Stats, 2011)
 - Information on local community structure and patterns
 - Business and economic data (as confirmed through a site walkover)
- Determined the community's socioeconomic profile (through census data)
- Reviewed the outcome of other assessments containing relevant socioeconomic themes, namely:
 - Traffic and access (refer to section 6.5)
 - Noise and vibration (refer to section 6.6)
 - Non-Aboriginal heritage (refer to section 6.8)
 - Landscape character and visual impacts (refer to section 6.9)
 - Property and land use (refer to section 6.10)
 - Air quality (refer to section 6.11)
- Identified those adverse impacts that would need safeguarding or management.
- Study area.

The socioeconomic study area considered the demographics, social fabric and economic characteristics within Holsworthy (west of Heathcote Road), Hammondville (east of Heathcote Road) and Voyager Point (east of Heathcote Road), and the wider local government area (LGA) of Liverpool City Council as defined by the Australian Bureau of Statistics (2011).

Note: the Census is being updated in 2016. While the assessment is limited to data that are five years old, it is expected that the factors that have been considered in this report are unlikely to materially affect the assessment conclusions and recommendations.

6.10.2 Existing environment

The proposal is located on Heathcote Road, within Liverpool City LGA. Heathcote Road is an important economic corridor and is the primary road link between south western Sydney and the Sutherland Shire and Illawarra beyond. The Liverpool City LGA covers about 305 square kilometres (km²), about 25 kilometres south-west of Sydney. Its population is about 180,143, an increase of eight per cent since 2006. The LGA is a commercial and industrial centre of south-west Sydney.

The area has historically been used for military and defence purposes. The land to the south of Heathcote Road between Harris Creek and The Avenue consists of Department of Defence land and is occupied by the Holsworthy Barracks. The Barracks have been a training area and artillery range for the Australian Army since World War I and is one of the Army's major barracks in NSW. Department of Defence have recently developed a number of new precincts, including the Barracks entry (Macarthur Drive and Heathcote Road), School of Military Engineering and Holsworthy Physical Fitness Complex.

The Department of Defence also occupies land on the northern side of Heathcote Road between Harris and Williams Creeks which is predominately bushland. Residential properties in the suburb of Holsworthy are located on the southern side of Heathcote Road north of Harris Creek and are the closest residential area to the western end of the proposal.

Population and growth

As of 2011, about 10,220 people lived in Holsworthy (5,600), Hammondville (3,250) and Voyager Point (1,370) (Australian Bureau of Statistics, 2011). This represents about 0.2 per cent of the 4.4 million people that live in the Greater Sydney Metropolitan Area (Greater Sydney). This reflects the area's low population density, large areas of undeveloped land, and the dominance of bushland in the area. It is expected that the resident population would grow by about one per cent each year in line with the State average.

Daily population

As of 2011, about 5,240 people were employed in the three suburbs, about 58 per cent of who travelled to work by car and about 18 per cent who used public transport to travel to work.

Socioeconomic profile

The composition of the population helps provide information about the area's communities and values. It also assists in profiling how adaptable the community is likely be to change. The study area's demography in 2011 could be broadly described as comprising young families, with Hammondville having the greatest proportion of people over 65. Household earnings and rents varied across the three suburbs, with people typically being paid less in Hammondville and have higher rent in Voyager Point. Home loan repayments were consistent across the three suburbs. Table 6-42 summarises the area's social and economic characteristics as of 2011.

Table 6-42: Social and economic profile (Holsworthy, Hammondville and Voyager Point)

Category	Sub-category	Characteristics (as of 2011)
Social characteristics		
Population and demography	Population	<ul style="list-style-type: none"> About 10,220 people lived in the area There was about an equal split of males and females About 38 per cent of the adult population was married, while about 24 per cent had never married, and the remainder were either divorced, separated or widowed.
	Age	<ul style="list-style-type: none"> With an average age of 33 in 2011, this was four years below the national average at the time. (The average age in Holsworthy was 28, nine years below the national average at the time). The resident percentage of children (under 15) was about 24 per cent, and the resident percentage of old people (over 65) was about 3.5 per cent for Holsworthy and Voyager Point and about 20 per cent for Hammondville.
	Cultural diversity	<ul style="list-style-type: none"> About 64 per cent of the resident population in 2011 were born in Australia, followed by India (about four per cent), and the Philippines (about two per cent). About 67 per cent of the resident population in 2011 spoke English only at home, followed by Hindi, Arabic, Bengali, Greek and Tamil. About 36 per cent of the resident population in 2011 spoke two or more languages at home, which is higher than the State and national average at the time Christianity (and its various denominations) was the main religion followed by Hinduism; however 12 per cent of the population claimed no religion.

Category	Sub-category	Characteristics (as of 2011)
Families and housing	Families	<ul style="list-style-type: none"> • There were higher number of families in the area in 2011 compared to State and national average at the time • There were also fewer one-parent families in the area on average compared to the State at the time.
	Housing costs and tenure	<ul style="list-style-type: none"> • The average weekly rent in Holsworthy and Hammondville was about \$350 in 2011, while it was about \$470 in Voyager Point • The average monthly mortgage repayment was about \$2,300 in 2011.
Travel to work	Car travel and public transport travel	<ul style="list-style-type: none"> • The majority of people travelled to work by car in the area (about 58 per cent) and only about 18 per cent use public transport.

Economic characteristics		
Income	Income	<ul style="list-style-type: none"> • On average, people earned about \$850 per week in Holsworthy and Voyager Point and \$590 per week in Hammondville, with the State average being about \$580 at the time • The household income per week was about \$1,900 in Holsworthy, \$1,450 in Hammondville and \$2,550 in Voyager Point, with the State average being about \$1,200 at the time.
	Employment	<ul style="list-style-type: none"> • About 70 per cent of the resident population in 2011 of working age were in full-time employment with about 20 per cent in part-time employment. • The main occupations of the people in the area were professionals, clerical and administration, technicians and trades workers, community and personal service, managers and sales workers.

Source: Adapted from the 2011 Census Quick Stats (ABS, 2011)

Social infrastructure and local business

Social infrastructure refers to the community facilities, services and networks that help individuals, families, groups and communities meet their social needs, maximise their potential for development, and enhance community well-being. It includes such things as: educational facilities; health, emergency and aged-care services; sports, recreational and cultural facilities; community support services; and transport facilities. This infrastructure, along with local business, helps develop the area's socioeconomic profile. Table 6-43 lists the social infrastructure and local businesses in the area.

Table 6-43: Social infrastructure and business

Faculty/service/business	Location/number
Social infrastructure	
Education facilities	
Holsworthy Public school	36 Infantry Parade, Holsworthy
Holsworthy High School	Huon Cres, Holsworthy

Faculty/service/business	Location/number
Hammondville Public School	Walder Rd, Hammondville
Health, emergency and aged care services	
All Care Medical Centre Hammondville	192 Heathcote Rd, Hammondville
Hammond Grove Retirement Community	11/23 Judd Ave, Hammondville
Hammond Care residential aged care	1 Judd Ave, Hammondville
Sport, recreation and cultural facilities	
Moorebank Sports Club	230 Heathcote Road
Holsworthy-Wattle Grove Aquatic Education Centre	2 Huon Cres, Holsworthy
Community support services	
Child care facilities	
Holsworthy Pre-school	2 Light Horse Parade
Holsworthy Early Education and Care Centre	55 Infantry Parade
St George Montessori Long Day Care Centre	13 Walder Rd, Hammondville
Community facilities	
Riverside Anglican Churches	Walder Rd & Stewart Ave, Hammondville
Other – local parks, playgrounds, community halls, scout/guide halls	Throughout
Transport facilities	
A number of bus stops are located throughout Holsworthy serviced by the Transdev bus services 901, 902 and 902X	Holsworthy
Eleven bus stops are located throughout Hammondville serviced by the Transdev bus service 902	Hammondville
Five bus stops are located throughout Voyager Point serviced by the Transdev bus service 902X	Voyager Point
Holsworthy Train Station	The Boulevard Holsworthy

Faculty/service/business	Location/number
Economic characteristics	
Business and industry	
Hammondville Shopping Centre (Note 1)	48 Walder Rd, Hammondville
Wattle Grove Plaza (Note 2)	Village Way Wattle Grove

Note 1: Includes an IGA super market surrounded by local shops including an Australia Post, Bakery, Pharmacy, Florist, Real Estate, Chinese restaurant, Hair Salon, Speciality Tea Room and Liquor Store.

Note 2: This shopping centre is located just outside the study area, and is expected to be used by the people located within the study area, in particular Holsworthy.

Economy

The 5,200 people employed in the area as of 2011 mainly worked in the professional, clerical and administration, labour and trade, community and personal service, and retail sectors, demonstrating the variety of occupations in the local community

Local economy

The local economy is limited to a key flagship store (IGA Supermarket) and the local amenity of shops and services in Hammondville centred on Walder Road. However, the high car ownership in the area coupled with good access, means that people have the means and opportunity to travel to bigger more centralised shopping centres and community facilities. As such, the local economy likely has limited value, creates limited job opportunities or generates limited economic input to the community.

Regional economy

Regional business benefits from access to the M5 Motorway. As such a number of distributions, logistic and warehousing facilities have developed along the Motorway corridor and may account for some of the workforce from this area.

Community values

Community values are those socioeconomic aspects that people hold important to their quality of life and wellbeing. They include physical assets, such as parks and recreational areas, as well as social factors such as a sense of safety and wellbeing, belonging and community diversity. Social infrastructure such as churches, schools, public places and local centres are also valued by the community.

Heathcote Road is a major road through the area. It forms a principal link between Newbridge Road in Liverpool to the Princes Highway in Heathcote. In isolation, it contributes little to the area's community values. However, Heathcote Road is placed within the context of a residential and bushland landscape. The bushland and recreational facilities in the area are valued. The community also values the area for its connectivity to the M5 Motorway. Broadly however, the community values that are likely to remain important to the residents and workers in the area are:

- Retained local character, historic values, landmarks and remnant natural areas
- Local amenity and a sense of place
- Employment provisions for both local workers and residents
- Community safety and security
- Liveability and access to social support and community facilities, noting the likely need for many residents to travel to access these facilities
- Access and connectivity, especially for the high commuting population.

6.10.3 Potential impacts

The proposal serves to upgrade Heathcote Road, which as confirmed in section 6.5, would typically improve travel times and reduce delays. This would have an associated socioeconomic benefit locally and regionally by improving travel times and reducing congestion. This would result in people spending less time commuting and a reduction in crashes (which have associated costs to the community). However, there would also be a range of temporary impacts that would occur while the proposal is being built. These impacts are identified and assessed below.

Construction: socioeconomic profile

Given that the proposal largely comprises building a new section of road across undeveloped land it is assessed as having no material impact on the socioeconomic profile of the area, local government area or Greater Sydney. However, there would be some likely temporary socioeconomic impacts and benefits to the local community from building the proposal:

- *Families:* families with young children may experience minor travel delays during their commute to and from educational and recreational facilities (refer to section 6.5.3). However the scale of the changes is unlikely to affect people's travel or commuting habits.
- *Travel to work:* motorists and other road users may experience minor travel delays (refer to section 6.5.3). However the scale of the changes is unlikely to affect people's travel or commuting habits.
- *Income and employment:* there may be some opportunity for localised employment while the proposal is being built as described below.

Overall, the above impacts to the various components of the area's socioeconomic profile are not significant.

Construction: social infrastructure

There is a commitment to maintain direct access to all properties within the proposal footprint (refer to section 6.5) hence the local community will retain access to homes, services and education, recreational and commercial facilities and retain the ability to travel between these locations.

Congestion and travel delays are expected to occur locally and would be temporary while the proposal is being built (refer to section 6.5.3). For people that use Heathcote Road this would result in potential user frustration and annoyance due to people having to allow more time to travel.

The user enjoyment of certain social infrastructure, namely the outdoor sport and recreational facilities at Hammondville Park and Harris Creek Oval could also decline as a result of reduced visual amenity and traffic disruption, as described above. Building the proposal would also have a temporary impact on the reliability on certain transport facilities as described in section 6.5.3.

Construction: economy

Beneficial and adverse impacts to the local economy would be temporary whilst the proposal is being built. The nature of these impacts would depend on the type of business, its function and its location relative to the project area as discussed below.

Benefits

It is estimated that the NSW Government would invest about \$100 million to build the proposal (refer to section 1.1). The majority of this money would benefit the local and regional economy through the procurement of raw materials and the employment of transportation and logistics businesses, manufacturing and processing industries, construction industries and specialist service providers (such as engineers, utility and drainage companies, signage and lighting companies). Indirectly, the proposal's direct employees are likely to make use of regional amenities and businesses, which would deliver indirect economic benefit. This would be supplemented by a number of indirect jobs such as designers, engineers, drivers and suppliers. The workforce would be most-likely sourced locally, however certain specialists may be employed from across the State.

Impacts

The potential for temporary increased delays while the proposal is being built may affect reliability for delivery and/or logistic businesses. However, it is more likely that such firms businesses would promote using alternative routes or allow more time in their schedules. As such, it would be unlikely that any single business would be materially or quantifiably affected while the proposal is being built. This would be assisted by Roads and Maritime committing to minimising road user disruption during peak periods, consulting and communicating with businesses, and building as much of the proposal offline to minimise its impacts (refer to section 6.5). As such, the impact is likely to be negligible.

Construction: community values

The travel delays along Heathcote Road while the proposal is being built are described above. The local community would be affected by proposal's amenity impacts as a direct result of work activities taking place. However, these impacts would take place across an area where the amenity has been impacted by the existing Heathcote Road corridor. Therefore, it is considered that the proposal would have no material impact on the area's community values with the exception of:

- A temporary loss in character due to building activity taking place in the area
- A slight reduction in liveability due to the increased noise and temporary access restriction due to closure of the rail line for the bridge construction (as discussed in section 6.5 and 6.6).
- Perception of reduced safety due to the temporary increased movement of heavy vehicles.

The above impacts are not significant and the impacts would take place in the context of an urban road environment that is already affected by heavy vehicle traffic.

Operation: socioeconomic profile

Once operational, the proposal is unlikely to affect the area's overall socioeconomic profile given that it would improve the traffic flow and capacity on an existing road. The specific impacts and benefits are:

- *Families and travel to work*: people (including those with families) would benefit from the choice and safety of being provided with a shared use path. Notably, the shared use path would provide travel (to work) choice to and from Holsworthy Train Station.
- *Mobility*: the proposal includes mobility access provisions on the footpaths, accesses and crossings including tactile paving and dropped kerbs
- *Travel to work*: travel times along Heathcote Road would improve under the proposal compared to if the proposal was not built (refer to Table 6-4 and Table 6-5 of Appendix I). This would benefit people travelling through the area to and from work in the morning and afternoon peak periods.
- *Crashes*: the proposal would see a reduction in crashes (refer to section 6.5), an economic benefit to the state and a community benefit.

Operation: social infrastructure

The proposal would have no permanent direct impact on the area's social infrastructure. Once operational, the proposal is unlikely to affect the use, access or enjoyment of any of the infrastructure listed in Table 6-43. Indirectly, the travel time improvements in the area would reduce the community's frustration of driving or travelling through the area to access various social infrastructure. As a result, there may be some beneficial outcome from the proposal, however this would be hard to quantify. The ability for people to walk and cycle through the area provides an alternative means of travel to use the social infrastructure in the area. This is perceived as a beneficial outcome of the proposal.

Operation: economy

As when building the proposal, the local economy would either suffer or benefit once the proposal is operational. Again, this would depend on the type of business, its function and its location relative to the proposal footprint.

The proposal would improve capacity and connectivity for road users while also providing a means for people to walk and cycle. These improvements are unlikely to have any quantifiable direct economic benefit. However, they would as a minimum, maintain network capacity for this arterial road. As such, the proposal is rated as having a beneficial impact on the economy

The proposal would be built entirely on land that is designated as a road reserve. This omits the need for property acquisition, and as such the economic impact is not significant.

Operation: community values

There is unlikely to be any material effect on the area's community values as the proposal involves upgrading an existing road. However, the road would be built to current (urban) design standards as such it may deliver some indirect benefit locally in:

- Improving the area's amenity and character and improving its sense of place
- Providing a means to safely walk and cycle particularly near Holsworthy Train Station and Hammondville Park.

The impact of the above is considered to be beneficial.

6.10.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
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>	Construction contractor	Detailed design / pre-construction	Core standard safeguard SE1
Impacts on businesses and the community during construction	Road users will be informed of changed conditions, including likely disruptions to access during construction.	Construction contractor	Pre-construction and construction	Additional safeguard SE2
Community impacts during construction across the proposal footprint	Consultation will be undertaken with potentially affected residences prior to the commencement of and during works in accordance with the RMS's <i>Community Involvement and Communications Resource Manual</i> . Consultation will include but not limited to door knocks, newsletters or letter box drops providing information on the proposed works, working hours and a contact name and number for more information or to register complaints.	Roads and Maritime/ Construction contractor	Pre-construction and construction	Additional safeguard SE3

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Community impacts during construction across the proposal footprint	<p>A complaint handling procedure and register will be included in the CEMP.</p> <p>The complaints register will be maintained throughout construction.</p>	Construction contractor	Pre-construction, construction	Additional safeguard SE4
Emergency Access	Access for emergency vehicles will be maintained at all times during construction. Any site-specific requirements will be determined in consultation with the relevant emergency services agency.	Construction contractor	Construction	Additional safeguard SE5
Impacts to properties	Consultation will be undertaken with all affected property owners during detailed design and construction to develop and implement measures to mitigate impacts on land use viability, infrastructure and severance.	Roads and Maritime	Detailed Design	Additional safeguard SE6

6.11 Other impacts

This section describes potential impacts and relevant safeguards for environmental factors of lesser importance comparative to those factors described in sections 6.1 to 6.10.

6.11.1 Existing environment and potential impacts

Environmental factor	Existing environment	Potential impacts
Hazard and risk	<p>Hazardous materials and dangerous goods: Storage or handling of such materials does not currently occur within the project area. Fuel and oils spills may occur as a result of vehicle crashes. Unexploded ordnance may occur as a result of historical defence activities.</p> <p>Bushland: The proposal is adjacent to bushland. Therefore the area may be prone to bushfires.</p>	<p>Hazardous materials and dangerous goods: Small quantities and inventories of these materials would be required during construction. Therefore transportation, use and storage of these materials would occur. Potential impacts to soil and water quality, workforce safety may occur should spills or improper storage and handling occurs. Potential impacts are not likely to be significant given the implementation of relevant legislation, National Codes of Practice and Australian Standards for the storage and handling of dangerous goods and materials; and recommended safeguards described in section 6.2.4. Unexploded ordnance, if present, may cause harm and injury to the workforce and potential damage to equipment and property. A safeguard is recommended to further investigate the potential occurrence of unexploded ordnance within the project area during detailed design.</p> <p>Bushland: Bushfires whether they are prescribed burning, wildfire or unintentionally ignited would result in loss of vegetation, fauna habitat and fauna species. If uncontrolled, bushfires can result in property damage; and pose risk to the safety and health of the workforce, road users and local residences due to heat, smoke and ash generation. A safeguard is recommended to manage site activities, such as hot works, and to minimise impacts should a bushfire occur. With such management controls in place, potential impacts are not likely to be significant.</p>

Environmental factor	Existing environment	Potential impacts
Air quality	<p>Information sourced from the NSW Air Quality Index states that the existing ambient air quality of the proposal footprint is heavily influenced by road traffic emissions. Other manmade air pollutant sources locally include the industry of Liverpool and Bankstown to the north. This is supplemented by natural effects such bushfires in the summer. One nearby location where long-term ambient air quality is monitored is in Liverpool. This site is in a mixed residential and commercial area and is representative of the study area. The long-term monitored air quality classification at this location is assessed as 'good-to-very-good' (Office of Environment and Heritage, NSW Air Quality Index, 2016).</p>	<p>Air quality impacts associated with the construction of the proposal include:</p> <ul style="list-style-type: none"> • Dust generation due to the disturbance, movement, storage, loading, transfer and transportation of spoil, mud-tracking and when excavations and exposed surfaces are left open. Uncontrolled dust emissions may result in nuisance impacts to sensitive receivers such as dust deposition on building frontages, domestic laundry, swimming pools, windows and parked cars. This may in turn cause community complaints. Uncontrolled dust may also present as a traffic hazard for passing vehicles. Dust generation can be effectively managed and a safeguard is recommended so that potential impacts are not likely to be significant. • Traffic and equipment emissions during construction will result in a temporary and short-term reduction of local air quality. However the potential impact is unlikely to result in adverse human health impacts. • Odour may be generated from mixing and applying asphalt and line marking. The potential odour impact would affect sensitive receivers in the immediate vicinity next to the road works for about 1 to 2 days. The short-term and temporary impact is not likely to be significant. <p>Air quality impacts associated with the operation of the proposal include:</p> <ul style="list-style-type: none"> • Increase in traffic related gaseous emissions which may slightly reduce the local ambient air quality. • A perceptible change in local air quality, however ambient conditions are notably below the air quality goals, therefore the change would have no significant impact.

Environmental factor	Existing environment	Potential impacts
		<ul style="list-style-type: none"> Calculations of particulate matter (PM10) and nitrogen oxide (NO2) concentrations were undertaken and were found to exceed air quality goals at the kerb south of The Avenue. At 10 metres from the kerb, the concentrations are below air quality goals. Only pedestrians and cyclists would be exposed to traffic related pollutants for a short period of time at this particular location, consistent with people that walk and cycle along busy roads in Sydney. As such this impact would not be considered to be significant.
Greenhouse gas and climate change	<p>Estimates of Australia's greenhouse gas emissions are produced by the Australian Department of Environment. Transport emissions are currently the second largest component of NSW greenhouse gas emissions.</p> <p>The major source of transport emissions is road transport which accounts for 86 per cent of all NSW transport emissions. Road transport includes private passenger vehicles (cars and motorcycles), light commercial vehicles, rigid trucks, articulated trucks and buses. This reflects the importance of motor vehicles for both passenger and freight transport within the state.</p>	<p>Construction of the proposal would generate greenhouse gases from activities including:</p> <ul style="list-style-type: none"> Construction traffic and equipment Material production (termed embodied energy) Electricity-generation in response to the power requirements to service work site requirements Upstream and downstream lifecycle activities (eg fuel extraction, processing, production, transport, disposal) Vegetation clearance and breakdown. <p>However, the proposal is expected to generate small scale greenhouse gas emissions and the scale of these is considered to be minor.</p> <p>Climate change could affect the construction and operation of proposal from the increased severity and frequency of extreme weather events and rainfall. This includes the possibility of localised flooding. The concept design has considered the effects of climate change through flooding and drainage assessment work. Detailed design would consider adaptation and resilience of the proposed road design to better respond to potential climate change impacts.</p> <p>Given the scale of this proposal, minor contribution to greenhouse gas emissions and further consideration of climate change impacts during detailed design, potential impacts are not considered to be significant.</p>

Environmental factor	Existing environment	Potential impacts
Waste management and resource use	Sydney is well-placed to manage waste and to source materials due to its population, its construction industry and its commerce. The major materials required to construct the proposal are likely available or manufactured within the metropolitan area. Equally, there is ample provision within the metropolitan area to reuse and recycle materials, and if required, dispose of restricted and controlled waste.	<p>The proposal would require some amount of vegetation clearing and excavation, producing spoil, during construction works. These activities would generate the largest quantities of waste. Other potential waste streams include:</p> <ul style="list-style-type: none"> • Asphalt, concrete • Excess cut material • Roadside materials (fencing, guard rails etc.) • Chemicals and oils from equipment and plant • General site waste (paper, lunch packaging etc.) • Waste water from wash down and bunded areas • Contaminated material (soil, ASS). <p>Waste generated during construction has the potential to affect the local environment if not managed properly. Potential impacts include:</p> <ul style="list-style-type: none"> • Run-off from stockpile mismanagement, sediment and erosion, waste transfer and spillages • Ground contamination from spillages, leaching from excavated material and incorrect disposal of contaminated materials • Excessive waste being diverted to landfill • Amenity impacts from litter/waste. <p>Operationally the proposal would not be anticipated to generate significant amounts of waste. Small amounts of waste may be generated from maintenance work.</p> <p>Recommended safeguards would be implemented to minimise potential impacts. On this basis and considering the scale of the proposal, impacts are not likely to be significant.</p>

Environmental factor	Existing environment	Potential impacts
Property and land use	<p>Land use and development within the vicinity of the proposal is controlled through the zoning provisions of the Liverpool LEP. The proposal is located entirely within land zoned as SP2 Classified Road. Land use zones adjacent to the proposal include:</p> <ul style="list-style-type: none"> • SP2 (Defence) • SP2 (Railway) • R2 (Low Density Residential) • R3 (Medium Density Residential) • R4 (High Density Residential) • RE1 (Public Recreation) • RE2 (Private Recreation) • B2 (Local Centre) • W1 (Waterway). <p>Roads are permitted with consent in all zones in the study area. However, the provisions of ISEPP prevail over the provisions of the LEP in accordance with clause 8 of the ISEPP. Therefore the proposal is permissible without consent within all land use zones under the provisions of ISEPP.</p>	<p>No property acquisition is required for the proposal. All required construction works would be undertaken entirely with the existing road corridor, zoned as road infrastructure. Access to adjacent properties would be maintained throughout the duration of construction. Emergency access may be required to utilities occurring within the project area. Consultation with service providers would occur to determine their emergency access requirements.</p> <p>The operational proposal would have no impact on the objectives or development controls of the Liverpool LEP or associated DCPs. It would continue to operate as a road as provisioned under the LEP land use zoning and associated development control plans. The proposal would also have no impact on adjacent land use zoning or the existing and future committed development.</p>

6.11.2 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Bushfire	<p>A Bushfire Risk Management Plan (BRMP) will be prepared and implemented as part of the CEMP. The BRMP will include but not be limited to:</p> <ul style="list-style-type: none"> • Fire response equipment such as fire extinguisher and fire blanket to be kept on vehicles at the works and compound sites • The fire rating will be checked at the start of each day • Hot works will not be permitted on total fire ban days • An evacuation plan will be kept onsite and staff will be made aware of this and their responsibilities in the event of a fire • A site for smoking will be established at least 40 metres away from dense vegetation and butt disposal bins will be made available. 	Contractor	Construction	Additional safeguard BF1
Hazard and risk	<p>The occurrence of unexploded ordinance will be further investigated during detailed design by using prequalified specialists on the Defence Environment and Heritage Panel to confirm the presence and/or or absence of unexploded ordinance within the project area.</p> <p>If present, a plan for remediation works would be prepared and implemented prior to construction. Investigations would be undertaken in consultation with the Department of Defence.</p>	<p>Roads and Maritime</p> <p>Contractor</p>	<p>Detailed design</p> <p>Pre-construction</p>	Additional safeguard UXO1
Air quality emissions and dust propagation across the proposal footprint	<p>An Air Quality Management Plan (AQMP) would be prepared as part of the CEMP. The plan would include but not be limited to:</p> <ul style="list-style-type: none"> • A procedure for monitoring dust on site and weather conditions • Identification of dust generating activities and associated mitigation measures • Reducing active earthworks on hot windy days • Stabilise temporary stockpiles and spoil set down locations • Compliance with Stockpile Site Management Guidelines (Roads and Maritime, 2008a) 	Contractor	Pre-construction	Additional safeguard AQ1

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
	<ul style="list-style-type: none"> • Progressive stabilisation plans • Impose speed limits throughout the proposal footprint and in the site compound • Implement additional dust control measures in exposed areas where the wind speed is excessive (including periodic gusts) or produces visible dust • Implement a vehicle, plant and machinery maintenance program to comply with manufacturer's specifications and ensure compliance with the NSW <i>Protection of Environment Operations Act 1997</i> • Prevent equipment idling for an excessive period of time while ideally locating machinery away from adjacent receivers • Prohibit any burning onsite or in the construction compounds • Visually inspect local conditions to ensure management measures are implemented and effective • Routinely sweep areas (at least once a day) to minimise surface dust notwithstanding the requirement to prevent sediment-laden runoff • Cover and sheet all trucks leaving site and ensure methods to remove sediment from truck wheels are implemented • Revise work activities should the dust control measures prove ineffective • Do not carry out emissions-generating activities (ie paint spraying, grout, concrete mixing) during high winds and employ methods to minimise dust dispersion • Do not stockpile fine construction materials in exposed areas • Monitor wind conditions and schedule activities to avoid high-wind periods to avoid impacting on adjacent receivers. 			
Dust deposition impacts	Ensure that the consultation strategy (refer to Chapter 5) includes provision for managing dust nuisance complaints during the work.	Contractor	Construction	Additional safeguard AQ2

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Improving energy efficiency and sustainability	Machinery onsite would be running efficiently to ensure optimal performance, minimise down time and improve fuel efficiency.	Contractor	Construction	Additional safeguard AQ3
Dust deposition impacts	Surface stabilisation would be undertaken within the proposal as each section of work is completed or in areas that are inactive for more 20 days, in accordance with <i>Managing Urban Stormwater – Soils and construction, Volume 2D: Main road construction (Blue Book)</i> .	Contractor	Construction	Additional safeguard AQ4
Manage and reduce fuel consumption	Energy efficiency and related greenhouse emissions would be considered in the selection of vehicle and plant equipment and fuel types (e.g. lower emission fuels such as e10). Vehicles, plant and machinery would be appropriately sized for the task and properly maintained so as to achieve optimum fuel efficiency.	Construction contractor	Construction	Additional safeguard GGC1
Use low embodied energy materials	Consider using recycled or locally sourced materials (where readily available, economic, and fit for purpose) to reduce impacts from transportation emissions, reduce fuel costs and support local economies. Deliveries would be programmed so that the minimum amount of trips is made without compromising site requirements.	Construction contractor	Construction	Additional safeguard GGC2
Use low embodied energy materials	Ensure the detailed design considers opportunities to reduce construction material quantities.	Roads and Maritime	Detailed design	Additional safeguard GGC3
Manage and reduce waste generation	The Roads and Maritime <i>Resource Recovery Exemptions</i> , will be followed to maximise opportunities to reuse construction and demolition materials where feasible and permissible.	Construction contractor	Construction	Additional safeguard GGC4

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Manage the design to accommodate the climate change factors of increased temperature and rainfall events across the whole proposal	<p>Consider options in adopting the latest pavement design to ensure resilience against extreme temperature and rainfall events.</p> <p>Detailed design for rainfall, runoff and waterways to take into consideration the effects of sea level rise, changes to rainfall frequency and/or intensity as a result of climate change as per the Roads and Maritime <i>Technical Guide: Climate Change Adaptation for the State Road Network</i></p>	Roads and Maritime	Detailed design	Additional safeguard GGC5
Manage the design to accommodate the climate change factors of increased temperature and rainfall events across the whole proposal	Detailed design would also consider adaptation and resilience of the proposed road design to better respond to potential climate change impacts (temperature and rainfall).	Roads and Maritime	Detailed design	Additional safeguard GGC6
Emergency road side access during construction	Contact all service providers to determine their emergency access requirements. Include these provisions in the CEMP.	Contractor	Pre-construction/ construction	Additional safeguard PL2

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
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 proposal • 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 <i>Environmental Procedure - Management of Wastes on Roads and Maritime Services Land</i> (Roads and Maritime, 2014f) and relevant Roads and Maritime Waste Fact Sheets.</p>	Contractor	Detailed design / pre-construction	Core standard safeguard W1 Section 4.2 of QA G36 Environment Protection

6.12 Cumulative impacts

This section describes the assessed cumulative impacts that may occur as the combined result of other committed and approved projects near to this proposal.

6.12.1 Study area

The study area for this cumulative impact assessment has been determined by considering the geographical location (spatial) and timing (temporal) extent of any residual impacts identified in section 6.1 to section 6.11 and those residual impacts of nearby projects within the locality. The overlap in timing between this proposal's construction and operational schedule and those of nearby projects has also been identified. Subject to the availability of funding, this proposal could be constructed between 2019 and 2021.

The assessment has only considered projects that were of sufficient scale to create potential cumulative impacts to receiving environments common to this proposal. It is outside the scope of this proposal to consider cumulative impacts to receiving environments not impacted by this proposal.

6.12.2 Other projects and developments

A number of projects are currently being built or are planned to be built near to the proposal over the next few years. These are identified in Table 6-44 and Figure 6-10. These projects are more than two kilometres from the proposal and do not share any common sensitive receivers. Receiving environments impacted by these other projects that are common to this proposal include:

- Traffic
- Biodiversity
- Community impact fatigue.

Due to the absence of common sensitive receivers, cumulative impacts from noise, air quality and amenity are not considered in this assessment. An analysis of each proposal, from publicly available impact assessment information, has been undertaken. This identifies each project's potential impacts that may contribute to cumulative impacts together with this proposal.

Table 6-44: Past, present and future projects and identification of potential cumulative impacts

Potential contribution to cumulative impacts from construction	Potential contribution to cumulative impacts from operational impacts
<p>Moorebank Intermodal Terminal Project</p> <ul style="list-style-type: none"> • 220 ha intermodal freight terminal facility including commercial warehouse infrastructure, a rail link to the Southern Sydney Freight Line • Site situated between the Georges River in the west, M5 South-Western motorway to the north and Moorebank Avenue to the east • The project's concept plan and early works was approved under the EP&A Act in June 2016 and is awaiting approval under the EPBC Act. This is anticipated around end 2016, thereafter construction activities could commence. An EIS is currently being prepared for Stage 2 of the project. The Secretary's Environmental Assessment Requirements (SEARs) for Stage 2 were issued in July 2016. For the purposes of this assessment, it is possible that construction may occur at the same time as the proposal. • The traffic haul routes proposed in the EIS do not include Heathcote Road 	

Potential contribution to cumulative impacts from construction	Potential contribution to cumulative impacts from operational impacts
<p>Construction activities impacting upon common receivers of the Moorebank Intermodal Terminal may include:</p> <ul style="list-style-type: none"> • Construction traffic during earthworks and civil construction phase contributing to congestion on Moorebank Avenue before the road is upgraded • 43-55ha of vegetation clearing including three threatened ecological communities (Castlereagh Scribbly Gum Woodland, Castlereagh Swamp Woodland and River Flat Eucalypt Forest). Both Castlereagh Scribbly Gum Woodland and Castlereagh Swamp Woodland would be affected by this proposal, refer to section 6.1. 	<p>Operational activities impacting upon common receivers of the Moorebank Intermodal Terminal include:</p> <ul style="list-style-type: none"> • Some additional heavy and light vehicle trips along Moorebank Avenue, the M5 Motorway and local road intersections with potential to contribute to congestion during peak hours.
<p>SIMTA Intermodal Facility Project</p> <ul style="list-style-type: none"> • Intermodal terminal facility operating 24/7 with capacity for 250,000 trucks. Includes truck processing and loading areas, rail loading and container storage areas, administration and carpark facilities • Site situated with Moorebank Avenue to the west and an industrial precinct to the north • Recommendation made for approval of State significant development under Section 89E of the <i>Environmental Planning and Assessment Act 1979</i> • Being developed in stages alongside the Moorebank Intermodal Terminal under a whole precinct strategy. The Concept Plan was determined in September 2014. The EIS for Stage 1 of the project is yet to be determined; the Department of Planning and Environment's assessment and recommendations were released in December 2015. The EIS for Stage 1 had indicated a construction start of early 2016, subject to planning approval and a construction duration of 18 months. The Secretary's Environmental Assessment Requirements (SEARs) for Stage 2 were issued in May 2016. For the purposes of this assessment, it is possible that construction may occur at the same time as the proposal. 	
<p>Construction activities impacting upon common receivers of the SIMTA Intermodal Facility may include:</p> <ul style="list-style-type: none"> • Traffic – increased pressure on Heathcote Road and the M5 Motorway due to construction traffic • Biodiversity – clearing of 1.23 ha of native vegetation (Castlereagh Scribbly Gum Woodland, Castlereagh Swamp Woodland, Freshwater Wetlands and River Flat Eucalypt Forest). Both Castlereagh Scribbly Gum Woodland and Castlereagh Swamp Woodland would be affected by this proposal, refer to section 6.1. 	<p>Operational activities impacting upon common receivers of the SIMTA Intermodal Facility include:</p> <ul style="list-style-type: none"> • Traffic – increased heavy road and rail freight traffic across same traffic routes predicted to be impacted by construction.

Potential contribution to cumulative impacts from construction	Potential contribution to cumulative impacts from operational impacts
<p>Glenfield Waste Services Materials Recycling Facility</p> <ul style="list-style-type: none"> • 100 ha Materials Recycling Facility to increase the proportion of recycling undertaken • Bounded to the west by the Southern Sydney Freight Line, to the east by the Georges River and traversed by the T2 Airport Rail Line and Cambridge Avenue • Proponent reviewing submissions to the EIS submitted under Section 89E of the EP&A Act • Glenfield Waste Services Materials Recycling Facility is currently in the early stages of the planning process and as such the construction schedule not available in the Environmental Impact Statement. 	
<p>Construction activities impacting upon common receivers from the Glenfield Waste Services Recycling Facility may include:</p> <ul style="list-style-type: none"> • 9.5 ha of critically endangered Cumberland Plain Shale Woodland and Shale Gravel Transition Forest. This proposal would impact on Shale Gravel Transition Forest, refer to section 6.1 • Five threatened bat species recorded • Truck movements and queuing to and from site. 	<p>Operational activities impacting upon common receivers from the Glenfield Waste Services Recycling Facility may include:</p> <ul style="list-style-type: none"> • Truck movements to and from site along Cambridge Avenue.

6.12.3 Potential impacts

It is anticipated the timing of the projects listed in Table 6-44 and impacts on similar threatened ecological communities may lead to cumulative impacts in combination with the proposal:

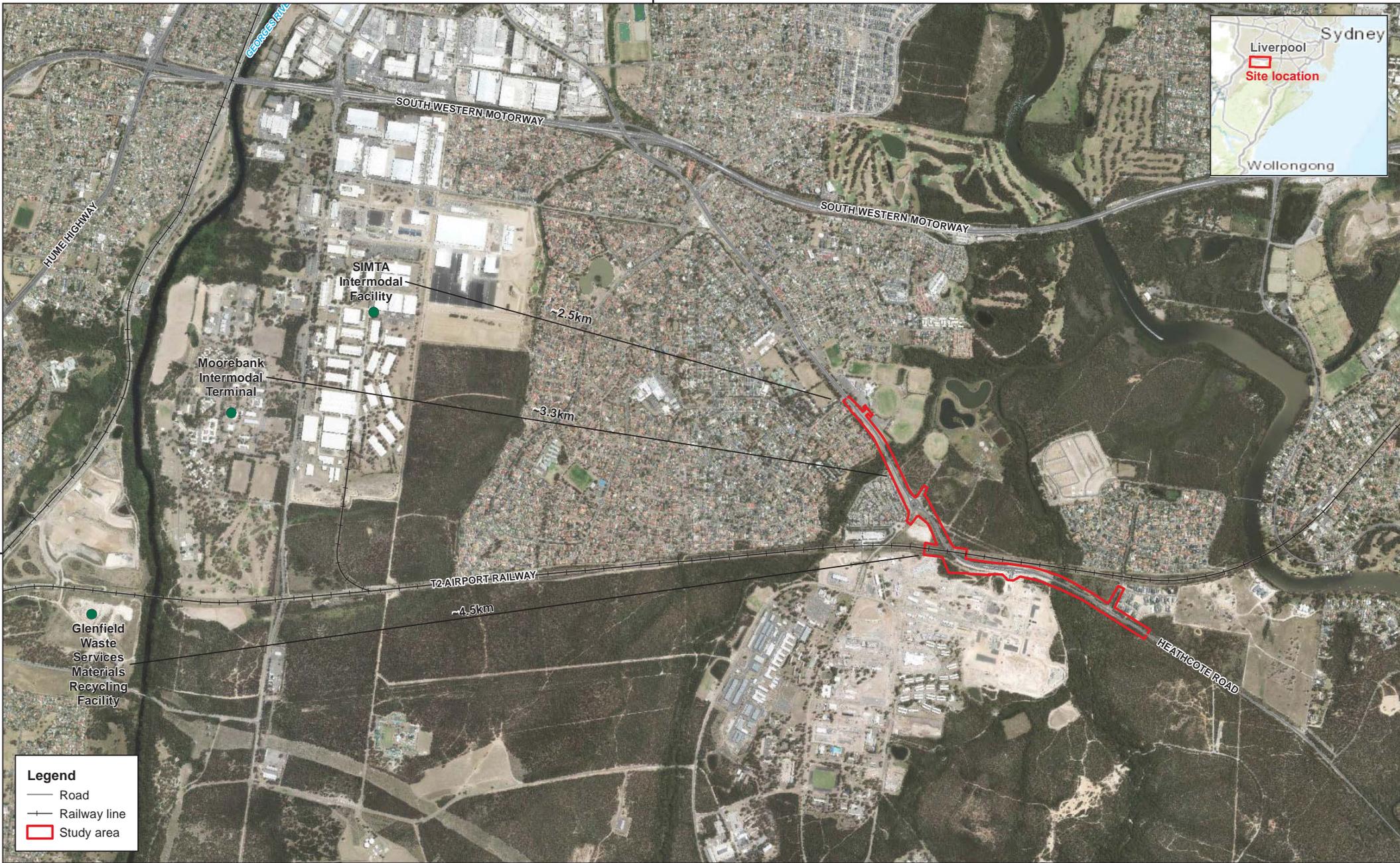
- Biodiversity and impacts to TECs
- Disruption to traffic and to public transport services
- Impact fatigue.

Biodiversity

Construction of the proposal would result in the loss of 3.41 ha of remnant native vegetation, comprising of 2.37 hectares of Castlereagh scribbly gum woodland; 0.77 hectares of Castlereagh shale – gravel transition forest; 0.03 hectares of Castlereagh swamp woodland and 0.24 hectares of Cumberland river-flat forest. The projects above also require the removal of some of these vegetation communities as outlined in Table 6-44. Removal of these vegetation communities would have a negative cumulative impact upon fauna and flora species supported by this vegetation. However, the cumulative impact of this proposal is considered minor in comparison to the Moorebank Intermodal Terminal Project, where up to 55 ha of various vegetation communities is being cleared. The ecological communities impacted by the proposal and these other projects are considered to be part of much larger populations located in more suitable areas outside of the project area (ie the Holsworthy Military army Barracks which comprises up to 18,000 ha of intact vegetation extending south towards Bowral). Additionally none of the communities are considered to be on the verge of meeting the critical thresholds for habitat loss or degradation as such the cumulative effects of these projects would not be expected to significantly affect the biodiversity values of the locality.

Once operational, the impact to the biodiversity of the area would be unlikely to change to those impacts felt during construction.

310000



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6240000

Legend

- Road
- +— Railway line
- ▭ Study area

Map: 2113368_GIS_018_A	Author: RP
Date: 8/09/2016	Approved by: IS




1:20,000
Coordinate system: GDA 1994 MGA Zone 56
Scale ratio correct when printed at A3



Heathcote Road Upgrade
Figure 6-10
Cumulative impacts

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Traffic

Traffic management controls would be installed to build the proposal (refer to section 6.5). It is assumed that these controls may be in place for about two years. The controls would be relaxed during high demand periods (i.e. the morning and afternoon peaks) so as not to affect the area's road network performance (refer to section 6.5.3). For the Moorebank, SIMTA and Glenfield projects, it would not be expected that there would be significant volumes of heavy vehicles using Heathcote Road for access to the Moorebank sites and Glenfield site. Trucks would be predominantly arriving and exiting to Moorebank Avenue from the M5 Motorway.

Once operational, the Heathcote Road proposal would provide capacity for future traffic growth and improved freight access and efficiency. In doing so it would create an operational benefit for the projects listed in Table 6-44 Traffic modelling and assessment for Heathcote Road has taken into account regional growth and development and the resultant traffic impacts and associated noise impacts for the operational phase of the proposal.

None of the other projects have considered Heathcote Road within their traffic modelling and assessment as such it would be considered unlikely to result in significant cumulative impacts to the area as a result of the operation of these projects. Any extra traffic from these projects would be introduced onto roads that currently carry several thousand vehicles per hour every day (refer to Appendix L). As such, the cumulative effect of additional vehicle movements per day would have negligible effect on congestion, network performance or travel delays to all road users, pedestrians and cyclists.

Community impact and fatigue

Impact fatigue is where people and environmental receivers are affected for a longer period of time than it would take to build this individual proposal. This can often happen in areas of high development where the building of several projects overlaps.

In the case of the proposal, it has been assumed that any of the above projects have the potential to be built around the same time as the proposal. Currently there is no information available with regards to the timing of the Moorebank Intermodal Terminal, SIMTA and Glenfield Waste Services. For the purposes of this assessment, it has been considered possible that the projects may occur concurrently or within succession of one another. As such, any of the above impacts could be experienced for a longer period than assessed in the REF which would lead to impact fatigue. However, as the other identified projects are located over two kilometres from the proposal it is considered that community fatigue impacts would be minimal and not considered significant. . Potential impacts would be managed and mitigated through consultation before work starts and safeguards and management measures committed to in this REF would be implemented.

Once operational, community and impact fatigue would not be considered to be an impact above current levels.

6.12.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
Cumulative traffic impacts when building the proposal	<p>If required, modify the proposal's construction traffic management plan on account of any identified cumulative impacts to:</p> <ul style="list-style-type: none"> • Implement traffic management controls in consultation with other project developers to minimise cumulative construction traffic impacts on Heathcote Road • Carefully select appropriate work site access and egress locations • Monitor traffic levels and network performance across the project area and wider locality to consider cumulative effects from other projects. 	Roads and Maritime/ Contractor	Pre-construction/ construction	Additional safeguard CI1
Cumulative impacts	Consult with other developers to obtain information about project timeframes and impacts. Identify and implement appropriate safeguards and management measures to minimise cumulative impacts.	Roads and Maritime/ Contractor	Pre-construction Construction	Additional safeguard CI2
Cumulative impacts	Consult with other developers before starting work to manage the interfaces of the proposal's staging and programming in combination with the other projects occurring in the area.	Roads and Maritime	Pre-construction	Additional safeguard C13
Cumulative impacts	Prepare all environmental management plans (including but not limited to the Construction Noise and Vibration Management Plan and Traffic Management Plan) to consider other developments in the area.	Contractor	Pre-construction	Additional safeguard C14

7 Environmental management

This chapter describes how the proposal will be managed to reduce potential environmental impacts throughout detailed design, construction and operation. A framework for managing the potential impacts is provided. A summary of site-specific environmental safeguards is provided and the licence and/or approval requirements required prior to construction are also listed.

7.1 Environmental management plans (or system)

A number of safeguards and management measures have been identified in the REF in order to minimise adverse environmental impacts, including social impacts, which could potentially arise as a result of the proposal. Should the proposal proceed, these safeguards and management measures would be incorporated into the detailed design and applied during the construction and operation of the proposal.

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

The CEMP will be prepared prior to construction of the proposal and must be reviewed and certified by the Roads and Maritime Environment Officer, Sydney region, prior to the commencement of any on-site works. The CEMP will 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 will be incorporated into the detailed design phase of the proposal and during construction and operation of the proposal, should it proceed. These safeguards and management measures will minimise any potential adverse impacts arising from the proposed works on the surrounding environment. The safeguards and management measures are summarised in Table 7-1.

Table 7-1: Summary of safeguards and management measures

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
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 proposal will implement the identified safeguards outlined in the REF • Issue-specific environmental management plans • Roles and responsibilities • Communication requirements • Induction and training requirements • Procedures for monitoring and evaluating environmental performance, and for corrective action • Reporting requirements and record-keeping • Procedures for emergency and incident management • Procedures for audit and review. <p>The endorsed CEMP will be implemented during the undertaking of the activity.</p>	Contractor / Roads and Maritime project manager	Pre-construction / detailed design	Core standard safeguard
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	Core standard safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
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 proposal. 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 • Threatened species habitat • Adjoining residential areas requiring particular noise management measures 	Contractor / Roads and Maritime project manager	Pre-construction / detailed design	Core standard safeguard
B1	Biodiversity	<p>A Flora and Fauna Management Plan will be prepared in accordance with Roads and Maritime's <i>Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects</i> (RTA, 2011) and implemented as part of the CEMP. It will include, but not be limited to:</p> <ul style="list-style-type: none"> • Plans showing areas to be cleared and areas to be protected, including exclusion zones, protected habitat features and revegetation areas • Requirements set out in the <i>Landscape Guideline</i> (RTA, 2008) • Pre-clearing survey requirements • Procedures for unexpected threatened species finds and fauna handling • Procedures addressing relevant matters specified in the <i>Policy and guidelines for fish habitat conservation and management</i> (DPI Fisheries, 2013) • Protocols to manage weeds and pathogens. 	Contractor	Detailed design / pre-construction	<p>Core standard safeguard</p> <p>Section 4.8 of QA G36 Environment Protection</p>
B2	Biodiversity	Investigate measures to further avoid and minimise the construction footprint and native vegetation or habitat removal.	Contactore	Detailed design / pre-construction	Core standard safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
B3	Native vegetation removal and re-establishment	Minimise native vegetation and habitat removal through detailed design. Harris Creek and Williams Creek to retain fauna passage and connectivity to areas south of Heathcote Road to enable movement for fauna south.	Roads and Maritime	Detailed design	Additional safeguard
B4	Native vegetation removal and re-establishment	A Biodiversity Offset Strategy would be prepared during the detailed design phase to provide offsets equivalent to 145 ecosystem credits. This strategy would be prepared in accordance with the Guidelines for Biodiversity Offsets (Roads and Maritime, 2011h) and the NSW BioBanking Assessment Methodology 2014.	Roads and Maritime	Detailed design	Additional safeguard
B5	General ecological mitigation	Ensure any fauna encountered onsite would be managed in accordance with Biodiversity Guidelines, Guide 9 (fauna handling) (Roads and Maritime, 2016b)	Contractor	Pre-construction	Additional safeguard
B6	General ecological mitigation	In addition to the requirements of Core standard safeguard B1, the Flora and Fauna Management Plan would also include: <ul style="list-style-type: none"> • A site walkover to confirm clearing boundaries and sensitive location before starting work • Identify, in toolbox talks, where biodiversity controls would be included. 	Contractor	Pre-construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
B7	Invasive and noxious weed management	<p>Develop a weed management plan (WMP) in accordance with Biodiversity Guidelines, Guide 6 (Roads and Maritime, 2016b) to include:</p> <ul style="list-style-type: none"> • Identification of the weeds on site (confirm during ecologist pre-clearing inspection) • Weed management priorities and objectives • Sensitive environmental areas within or adjacent to the site • The location of weed infested areas • Weed control methods • Measures to prevent the spread of weeds, including machinery hygiene procedures and disposal requirements • A monitoring program to measure the success of weed management • Communication with local Council noxious weed representative. 	Contractor	Pre-construction	Additional safeguard
B8	Vegetation management	Develop a vegetation management plan for undertaking the work across Harris and Williams Creek in accordance with Greater Metropolitan Regional Environmental Plan No. 2 – Georges River Catchment	Contractor	Pre-construction	Additional safeguard
B9	Risk of pathogen and pest species	If hygiene procedures are required onsite, ensure the Flora and Fauna Management Plan includes hygiene protocols to prevent the introduction and spread of such pathogens as specified in Biodiversity Guidelines: (Roads and Maritime, 2016b). Manage all pathogens (e.g. Chytrid, myrtle rust and phytophthora) in accordance with the Biodiversity Guidelines, Guide 7 (Roads and Maritime, 2016b).	Contractor	Pre-construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
B10	Unexpected blockage of fish passage	<p>A detailed Environmental Work Method Statement (EWMS) will be prepared and implemented for all works undertaken within waterways. The EWMS will detail measures to avoid or minimise risks from erosion and sedimentation to water quality and biodiversity. It will be prepared in accordance with relevant guidelines including, but not limited to:</p> <ul style="list-style-type: none"> • Roads and Maritime Biodiversity Guidelines - Protecting and managing biodiversity on RTA projects • NSW DPI (Fisheries) guidelines Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. • Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management Update 2013 (Department of Primary Industries 2013). 	Contractor	Construction	Additional safeguard
B11	Unexpected discovery of threatened species	<p>If unexpected flora or fauna are discovered stop work immediately and implement the Roads and Maritime Unexpected Threatened Species Find Procedure in the Biodiversity Guidelines, Guide 1 (Roads and Maritime, 2016b).</p>	Contractor	Construction	Additional safeguard
B12	Injury and mortality impacts while building the proposal	<p>Implement the following controls: under the Flora and Fauna Management Plan:</p> <ul style="list-style-type: none"> • Manage fauna in accordance with Biodiversity Guidelines, Guide 9 (Roads and Maritime, 2016b) • Remove any habitat in accordance with Biodiversity Guidelines, Guide 4 (Roads and Maritime, 2016b). 	Contractor	Construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
B13	Native vegetation removal and re-establishment Threatened species habitat and habitat features	Implement the following controls under the Flora and Fauna Management Plan: <ul style="list-style-type: none"> • Undertake pre-clearance checks in accordance with Biodiversity Guidelines, Guide 1 (Roads and Maritime, 2016b) • Create exclusions zones in accordance with Biodiversity Guidelines, Guide 2 (Roads and Maritime, 2016b) • Re-establish native vegetation in accordance with Biodiversity Guidelines, Guide 3 (Roads and Maritime, 2016b) • Reinstate habitat in accordance with Biodiversity Guidelines, Guide 5 and Guide 8 (Roads and Maritime, 2016b). 	Contractor	Construction	Additional safeguard
B14	Aquatic impacts	Protect aquatic habitat in accordance with Biodiversity Guidelines, Guide 10 Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (Roads and Traffic Authority 2011) and section 3.3.2 standard precautions and measures of the Policy Guidelines for Fish Habitat Conservation and Management (NSW Department of Primary Industry (Fisheries), 2013).	Contractor	Construction	Additional safeguard
B15	Aquatic impacts	Watercourse crossings will be designed to ensure that they meet the minimum requirements for fish passage recommended for the classes of 'fish habitat' found at the stream crossings.	Contractor	Construction	Additional safeguard
B16	Wildlife connectivity impacts	Implement connectivity controls in accordance with the Wildlife Connectivity Guidelines for Road Projects (Roads and Maritime, 2016c).	Contractor	Construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
SW1	Soil and 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	Core standard safeguard Section 2.1 of QA G38 Soil and Water Management
SW2	Soil and water	A site specific Erosion and Sediment Control Plan/s (ESCP) will be prepared and implemented as part of the Soil and Water Management Plan. 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.	Contractor	Detailed design / Pre-construction	Core standard safeguard Section 2.2 of QA G38 Soil and Water Management
SW3	Water Quality	A detailed Environmental Work Method Statement (EWMS) will be prepared and implemented for all works undertaken within waterways. The EWMS will detail measures to avoid or minimise risks from erosion and sedimentation to water quality and biodiversity. It will be prepared in accordance with relevant guidelines including, but not limited to: <ul style="list-style-type: none"> • RMS Biodiversity Guidelines - Protecting and managing biodiversity on RTA projects • The Blue Book: Managing Urban Stormwater (MUS): Soils and Construction, Volume 2 (Landcom, 2008). 	Construction contractor	Pre-construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
SW4	Water Quality	<p>Consistent with any specific requirements of the approved SWMP and ESCP, control measures will be implemented to minimise risks associated with erosion and sedimentation and entry of materials to drainage lines and waterways. That will include, but not necessarily be limited to:</p> <ul style="list-style-type: none"> • Sediment management devices, such as fencing, hay bales or sand bags • Measures to divert or capture and filter water prior to discharge, such as drainage channels and first flush and sediment basins • Scour protection and energy dissipaters at locations of high erosion risk • Installation of measures at work entry and exit points to minimise movement of material onto adjoining roads, such as rumble grids or wheel wash bays • Appropriate location and storage of construction materials, fuels and chemicals, including bunding where appropriate. 	Construction contractor	Pre-construction	Additional safeguard
SW5	Water Quality	<p>The ESCP will also address the following regarding water quality:</p> <ul style="list-style-type: none"> • Identification of catchment areas and the direction of on-site and off-site water flow • The likely run-off from each road sub-catchment • Separation of on-site and off-site water • The direction of run-off and drainage points during each stage of construction • Location and staging of scour protection • Process for monitoring and preparing for wet weather. 	Construction contractor	Pre-construction	Additional safeguard
SW6	Water Quality	<p>Instream works would be suspended following high rainfall events. Work would recommence once the work area and ground conditions are stabilised and potential for erosion and sedimentation is minimised.</p>	Contractor	Construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
SW7	Water Quality	During concreting, cement slurry and other contaminants will be prevented from entering waterways or any drainage lines.	Contractor	Construction	Additional safeguard
SW8	Water Quality	If concreting works are required onsite, concrete washout bays located in bridge work zones would be positioned as far as reasonably practicable from waterways and be emptied on a regularly basis. Any washout of the lines or chute will be in an impervious bunded area.	Contractor	Construction	Additional safeguard
SW9	Flooding/ Hydrology	Prior to construction commencing, final flood and hydrology assessments will be undertaken to inform detail design measures to minimise risks to the environment.	Roads and Maritime	Detailed Design/ Pre-construction	Additional safeguard
SW10	Flooding	Scour protection measures will be identified and refined during detail design.	Roads and Maritime	Detailed Design	Additional safeguard
SW11	Spills	Emergency wet and dry spill kits would be kept onsite at all times. All staff would be made aware of the location of the spill kit and trained in its use.	Contractor	Construction	Additional safeguard
SW12	Spills	All refuelling of vehicles and equipment on site would be undertaken a minimum of 50 metres away from water bodies and surface drains, wherever possible. The refuelling of vehicles would be monitored at all times and spill kits would be available within refuelling vehicles.	Contractor	Construction	Additional safeguard
SW13	Spills	Any fuel, oil or other liquids stored onsite would be stored in an appropriately sized impervious bunded area away from water bodies.	Contractor	Construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
GW1	Groundwater	Additional site investigation including the installation and subsequent monitoring of groundwater wells at approximate 500 metres intervals along the proposal alignment and near Harris and Williams Creeks would be undertaken.	Roads and Maritime	Detailed design / Pre-construction	Additional safeguard
GW2	Groundwater	A dewatering strategy and groundwater management plan for any excavations below the groundwater table to be developed, with focus on the construction of the pier foundations in Harris Creek. Any dewatering activities will be undertaken in accordance with the RTA Technical Guideline: Environmental management of construction site dewatering in a manner that prevents pollution of waters.	Roads and Maritime Contractor	Pre-construction Construction	Additional safeguard
GW3	Groundwater	Shoring and water-tight requirements to be implemented for foundation excavations.	Roads and Maritime	Detailed design / Pre-construction	Additional safeguard
GW4	Groundwater	Concreting methods that reduce the likelihood of groundwater ingress will be employed for construction of bridge piles and foundations. This will also reduce the likelihood of washing out the cement content.	Contractor	Construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
C1	Contaminated land	<p>A Contaminated Land Management Plan will be prepared in accordance with the <i>Guideline for the Management of Contamination</i> (Roads and Maritime, 2013f) and the <i>Contaminated Land Management Act 1997</i> and implemented as part of the CEMP. The plan will include, but not be limited to:</p> <ul style="list-style-type: none"> • Capture and management of any surface runoff contaminated by exposure to the contaminated land • Further investigations required to determine the extent, concentration and type of contamination, as identified in the detailed site investigation (Phase 2) • Management of the remediation and subsequent validation of the contaminated land, including any certification required • Relevant licenses and approvals to be obtained and relevant notifications to be given under the <i>Contaminated Land Management Act 1997</i> • Measures to ensure the safety of site personnel and local communities during construction. 	Contractor	Detailed design / Pre-construction	<p>Core standard safeguard</p> <p>Section 4.2 of QA G36 Environment Protection</p>
C2	Contaminated land	<p>If contaminated areas are encountered during construction, appropriate control measures will be implemented to manage the immediate risks of contamination. All other works that may impact on the contaminated area will cease until the nature and extent of the contamination has been confirmed and any necessary site-specific controls or further actions identified in consultation with the Roads and Maritime Environment Manager and/or EPA. Waste classification and reuse procedures will also be included in the Contaminated Land Management Plan.</p>	Contractor	Detailed design / Pre-construction	<p>Core standard safeguard</p> <p>Section 4.2 of QA G36 Environment Protection</p>

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
C3	Accidental spill	A site specific emergency spill plan will be developed, and include spill management measures in accordance with the Roads and Maritime <i>Code of Practice for Water Management</i> (RTA, 1999) and Environmental Guidelines: Preparation of pollution incident response management plans (NSW EPA 2012). The plan will address measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities (including Roads and Maritime and EPA officers).	Contractor	Detailed design / Pre-construction	Core standard safeguard Section 4.3 of QA G36 Environment Protection
C4	Exposure of acid sulfate soils	<ul style="list-style-type: none"> Design of drainage lines and infrastructure to minimise the need for deep excavations. Minimise the need for extended dewatering of sediments around drainage lines for construction. 	Roads and Maritime	Detailed Design	Additional Safeguard
C5	Exposure of acid sulfate soils	ASS testing (field screening and chromium reducible sulfur suite) in soils around Harris Creek and Williams Creek to be undertaken. Other areas of the alignment as required. If ASS are identified, an ASS investigation report to be prepared that identifies areas of ASS, chemistry and liming rates for treatment. The ASS investigation to be undertaken and report verified by a suitably qualified and experienced environmental consultant.	Roads and Maritime	Detailed design/ Pre-construction,	Additional Safeguard
C6	Exposure of acid sulfate soils	An ASS Management Plan (ASSMP) is to be prepared for any excavation of material in the vicinity of Harris Creek and Williams Creek. The plan is to include methods for onsite treatment or offsite disposal of excavated ASS. The plan will make reference to the ASS investigation report findings and be in accordance with the NSW ASSMAC Guidelines (1998).	Construction Contractor	Pre-construction, construction.	Additional Safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
C7	Identification of contaminated land	Preliminary site sampling and where necessary a detailed (phase two) site investigation is to be undertaken along the alignment. Assessments are to be undertaken in accordance with guidance made or endorsed by the NSW EPA. The contaminated land investigations are to be undertaken and report verified by a suitably qualified and experienced environmental consultant.	Roads and Maritime	Detailed Design, Pre-construction	Additional Safeguard
C8	Identification of contaminated land	Consult with and request information from Department of Defence to determine the presence of any known contamination issues within 100 metres of the proposal alignment.	Roads and Maritime	Detailed Design, Pre-construction, construction.	Additional Safeguard
C9	Human and ecological exposure to contaminated land	The Contaminated Land Management Plan will also include awareness training for construction staff to include the procedures for identification, reporting and management of contaminated land.	Contractor	Pre-construction, construction.	Additional Safeguard
C10	Handling and disposal of contaminated materials	The Soil and Water Management Plan will include measures to minimise accidental spills and associated potential impacts such as: <ul style="list-style-type: none"> • Storage of chemicals within an impervious bunded area • All refuelling of vehicles and equipment would be undertaken off site or within an impervious bunded area at the compound site at least 40 metres from drainage lines. Where this cannot occur, mobile fuel trucks should be equipped with a self bunded tank, spill prevention equipment and spill kits • Requirement for an emergency spill kit to be kept on site at all times and be easily accessible and staff awareness and training in its use • Removal of contaminated material (soils, water, clean up materials) offsite by a licensed contractor and disposed of at an appropriately licensed facility. 	Contractor	Construction	Additional Safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
C11	Erosion and Sediment	<p>An Erosion and Sedimentation Control Plan (ESCP) shall be developed for the works. The ESCP shall provide for:</p> <ul style="list-style-type: none"> • Prevent sediment moving off-site and sediment laden water entering any water course, drainage lines, or drain inlets • Reduce water velocity and capture sediment on site. • Minimise the amount of material transported from site to surrounding pavement surfaces • Erosion and sedimentation controls are to be checked and maintained on a regular basis and records kept and provided on request • Erosion and sediment control measures are not to be removed until the works are complete or areas are stabilised • Work areas are to be stabilised progressively during the works • Divert clean water around the site (in accordance with the Landcom/Department of Housing Managing Urban Stormwater, Soils and Construction Guidelines (the Blue Book)). 	Construction contractor	Pre-construction, construction.	Additional Safeguard
C12	Erosion and Sediment	The maintenance of established stockpile sites during construction is to be in accordance with the Roads and Maritime Stockpile Site Management Procedures, 2001.	Construction contractor	Pre-construction, construction.	Additional Safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
TT1	Traffic and transport	<p>A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the Roads and Maritime Traffic Control at Work Sites Manual (Roads and Maritime, 2010) and QA Specification G10 Control of Traffic (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	<p>Core standard safeguard</p> <p>Section 4.8 of QA G36 Environment Protection</p>

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
TT2	Construction traffic	<p>Traffic Management Plan (TMP) will also include:</p> <ul style="list-style-type: none"> Scheduling the delivery of plant, equipment and construction materials to generally occur out of peak traffic periods Consideration of methods to minimise peak period traffic disruptions during each stage of construction Roads and Maritime to liaise with utilities providers and Sydney Trains to maintain service accesses to their facilities during construction and following completion of the proposal. <p>The TM is to ensure the work site and site compound:</p> <ul style="list-style-type: none"> Includes safe 'sight distances' to allow traffic to leave and enter the given areas Uses temporary painted road lines to provide delineation Provides suitable intersection layouts where required Includes traffic management controls to allow for safe entry and exit. 	Contractor	Pre-construction/ construction	Additional safeguard
TT3	Intersection Signalisation	Signal phasing arrangements and timings be reviewed as part of the commissioning of the proposal to determine the coordination arrangements as an extension to the existing conditions.	Roads and Maritime	Construction/ Pre-operation	Additional safeguard
TT4	Operation of Macarthur Drive intersection	The operation of the signalised intersection of Heathcote Road and Macarthur Drive should be periodically reviewed to identify if additional Holsworthy Train Station-generated demands are intermittently affecting signal operations and localised congestion. Appropriate signal timing plans to be adopted added if needed.	Roads and Maritime	Operation	Additional safeguard
TT5	Operational Monitoring	Monitoring of the queuing and congestion impacts along Macarthur Drive to the Morningside Parade intersection to manage any residual queuing impacts at this location and associated safety impacts.	Roads and Maritime	Operation	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
NV1	Noise and vibration	<p>A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the CEMP. The NVMP will generally follow the approach in the <i>Interim Construction Noise Guideline</i> (ICNG) (DECC, 2009) and identify:</p> <ul style="list-style-type: none"> • All potential significant noise and vibration generating activities associated with the activity • Feasible and reasonable mitigation measures to be implemented, taking into account <i>Beyond the Pavement: urban design policy, process and principles</i> (Roads and Maritime, 2014e). • A monitoring program to assess performance against relevant noise and vibration criteria • Arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures • Contingency measures to be implemented in the event of non-compliance with noise and vibration criteria. 	Contractor	Detailed design / pre-construction	<p>Core standard safeguard</p> <p>Section 4.6 of QA G36 Environment Protection</p>
NV2	Noise and vibration	<p>All sensitive receivers (e.g. schools, local residents) likely to be affected will be notified at least five days prior to commencement of any works associated with the activity that may have an adverse noise or vibration impact. The notification will provide details of:</p> <ul style="list-style-type: none"> • The proposal • The construction period and construction hours • Contact information for proposal management staff • Complaint and incident reporting how to obtain further information. 	Contractor	Detailed design / pre-construction	Core standard safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
NV3	Noise impacts	<ul style="list-style-type: none"> • Work is undertaken in accordance with the Construction Noise and Vibration Guideline (Roads and Maritime, 2016f) • Orientate stationary and directional noise sources away from sensitive receivers • Utilise vehicles, obstacles and stockpiles on site to provide shielding to receivers, especially for static noise sources • Use equipment that has noise levels equal to or less than the sound power levels in Table 6-2 of Appendix J. 	Contractor	Pre-construction, Construction	Additional Safeguard
NV4	Vibration	<ul style="list-style-type: none"> • Condition surveys of areas prior to the commencement of construction where vibration intensive equipment is to be used within the safe working distances. • Where possible, the use of less vibration intensive methods of construction or equipment should be considered where possible to reduce the potential for cosmetic damage. • All equipment should be maintained and operated in an efficient manner, in accordance with manufacturer's specifications, to reduce the potential for adverse vibration impacts. • Site-specific safe working distances are to be established on site prior to the vibration generating works commencing. • Ensure that safe working distances established on site are complied with. • If vibration intensive equipment is to be used within the safe working distances, attended vibration measurements are to be undertaken when work commences to determine site specific safe working distances. • Vibration intensive work should not proceed within the safe working distances unless a permanent vibration monitoring system is installed approximately one metre from the building footprint, to warn operators (via flashing light, audible alarm, SMS etc.) when vibration levels are approaching the peak particle velocity trigger levels. 	Contractor	Pre-construction, Construction	Additional Safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
NV5	Potential noise and vibration nuisance and amenity impacts	Develop a community information program before starting work. This would involve identification of a nominated community liaison officer and informing affected community members in advance of starting work through advertisements, flyers and community consultation sessions. Provide a 24-hour community hotline for complaints and queries concerning construction and advertise this ahead of starting any work. Develop a complaints handling procedure and ensure a timely response to complaints. Provide actions and progress towards resolving concerns. Make the work program available to the community and ensure it is routinely updated as work progresses.	Contractor	Pre-construction	Additional safeguard
NV6	Construction out of hours work	The Contractor would justify the requirement for out-of-hours work and suitably demonstrate why the work cannot be reasonably undertaken during normal working hours. The Contractor should assess proposed out-of-hours work and take reasonable and feasible steps to mitigate construction noise. The Contractor should seek approval from the Principal to undertake out-of-hours work. Ensure out of hours work is undertaken to comply with quality assurance specification G36: Environmental Management (Roads and Maritime, 2014b) and the Construction Noise and Vibration Guideline (Roads and Maritime, 2016f).	Contractors	Construction	Additional safeguard
NV7	Noise and vibration complaints while building the proposal	Undertake attended noise and/or vibration monitoring following a complaint. Report the monitoring results as soon as possible. In the case that exceedances of the management levels are recorded, review the situation and identify means to reduce the impacts to noise and vibration sensitive receivers. This is to include revision to the CNVMP where required.	Contractors	Construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
NV8	The potential for exceedance of the NMLs	<p>Ensure toolbox talks and environmental induction training is provided to include specific noise and vibration management including, but not limited to:</p> <ul style="list-style-type: none"> • Avoiding the use of radios outside of standard working hours • Avoiding shouting and slamming doors • Operating machinery at low speeds or powers and switch off equipment when it is not being used • Minimising reversing • Avoiding dropping material from height. 	Contractors	Construction	Additional safeguard
NV9	Operational noise mitigation	<p>Investigate mitigation measures including:</p> <ul style="list-style-type: none"> • Quieter pavement surfaces and suitability of such pavement types for through lanes and areas of acceleration, deceleration and turning movements • Noise barriers • At property treatments for residually affected receivers where feasible and reasonable. • Consideration of existing noise mitigation and any specified mitigation in development applications for acute receivers in NCAs A, B and D (both barriers and architectural) when determining reasonable and feasible mitigation 	Roads and Maritime	Detailed Design	Additional Safeguard
NV10	Property treatments	Where at property treatments are identified, these would be implemented at the commencement of construction. These treatments would alleviate any noise concerns/ complaints during the construction period.	Contractors	Construction	Additional Safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
AH1	Aboriginal heritage	An Aboriginal Heritage Management Plan (AHMP) will be prepared in accordance with the Procedure for Aboriginal cultural heritage consultation and investigation (Roads and Maritime, 2011f) and Standard Management Procedure - Unexpected Heritage Items (Roads and Maritime, 2015d) 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 AHMP will be prepared in consultation with all relevant Aboriginal groups.	Contractor	Detailed design / pre-construction	Core standard safeguard Section 4.9 of QA G36 Environment Protection
AH2	Aboriginal heritage	The <i>Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015d) will be followed in the event that an unknown or potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Roads and Maritime does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place. Work will only re-commence once the requirements of that Procedure have been satisfied.	Contractor	Detailed design / pre-construction	Core standard safeguard Section 4.9 of QA G36 Environment Protection
H1	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.	Contractor	Detailed design / pre-construction	Core standard safeguard Section 4.10 of QA G36 Environment Protection

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
H2	Non-Aboriginal heritage	<ul style="list-style-type: none"> The <i>Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015d) 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. 	Contractor	Detailed design / pre-construction	Core standard safeguard Section 4.10 of QA G36 Environment Protection
H3	Non-Aboriginal heritage	<p>A heritage induction will be prepared and implemented as part of the project's general induction to raise awareness to construction personnel. The induction will include:</p> <ul style="list-style-type: none"> An outline of the history and heritage values of the study area The relevant requirements of the Heritage Act Description and explanation of the unexpected finds procedure. 	Contractor	Pre-construction/ construction	Additional safeguard
H4	Impacts to Holsworthy Pedestrian Bridge	<ul style="list-style-type: none"> Undertake archival recording and heritage interpretation of the Bridge prior to removal of superstructure. This should be combined detailed historical research Conservation of elements of the bridge, such as the piers, iron fixings and plaque Site protection measures for piers, iron fixings and plaque to be included during construction Construction of a new footbridge in the same or similar location, with associated footpaths following the original alignment of the former rail line, so far as is possible Inclusion of a heritage interpretation to be considered. 	Roads and Maritime	Detailed design / pre-construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
H5	Impacts to Harris Creek Bridge and Williams Creek Bridge	<ul style="list-style-type: none"> • Consultation with the Office of Environment and Heritage should be undertaken prior to impacts to the bridge. This would be in accordance with s170A of the <i>Heritage Act 1977</i> • Archival recording of bridges prior to removal including archival photography and measured drawings • Design of replacement bridges and associated shared paths to balance safety and complement the surrounding landscape character and heritage values, including the consideration of material types and finishes. 	Roads and Maritime	Detailed design / pre-construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
UD1	Landscape character and visual impact	<p>An Urban Design Plan will be prepared to support the final detailed proposal design and implemented as part of the CEMP.</p> <p>The Urban Design Plan will present an integrated urban design for the proposal, providing practical detail on the application of design principles and objectives identified in the environmental assessment. The Plan will include design treatments for:</p> <ul style="list-style-type: none"> • Location and identification of existing vegetation and proposed landscaped areas, including species to be used • Built elements including retaining walls and bridges • Pedestrian and cyclist elements including footpath location, paving types and pedestrian crossings • Fixtures such as seating, lighting, fencing and signs • Details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage • Procedures for monitoring and maintaining landscaped or rehabilitated areas. <p>The Urban Design Plan will be prepared in accordance with relevant guidelines, including:</p> <ul style="list-style-type: none"> • <i>Beyond the Pavement urban design policy, process and principles</i> (Roads and Maritime, 2014e) • <i>Landscape Guideline</i> (Roads and Maritime, 2008) • <i>Bridge Aesthetics</i> (Roads and Maritime 2012e) • <i>Shotcrete Design Guideline</i> (Maritime, 2005). 	Contractor	Detailed design / pre-construction	Core standard safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
SE1	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	Core standard safeguard SE1
SE2	Impacts on businesses and the community during construction	Road users will be informed of changed conditions, including likely disruptions to access during construction.	Construction contractor	Pre-construction and construction	Additional safeguard
SE3	Community impacts during construction across the proposal footprint	Consultation will be undertaken with potentially affected residences prior to the commencement of and during works in accordance with the RMS's Community Involvement and Communications Resource Manual. Consultation will include but not limited to door knocks, newsletters or letter box drops providing information on the proposed works, working hours and a contact name and number for more information or to register complaints.	Roads and Maritime	Pre-construction and construction	Additional safeguard
SE4	Community impacts during construction across the proposal footprint	A complaint handling procedure and register will be included in the CEMP. The complaints register will be maintained throughout construction.	Roads and Maritime	Pre-construction, construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
SE5	Emergency Access	Access for emergency vehicles will be maintained at all times during construction. Any site-specific requirements will be determined in consultation with the relevant emergency services agency.	Roads and Maritime	Construction	Additional safeguard
SE6	Impacts to properties	Consultation will be undertaken with all affected property owners during detailed design and construction to develop and implement measures to mitigate impacts on land use viability, infrastructure and severance.	Roads and Maritime	Detailed Design	Additional safeguard
BF1	Bushfire	<p>A Bushfire Risk Management Plan (BRMP) will be prepared and implemented as part of the CEMP. The BRMP will include but not be limited to:</p> <ul style="list-style-type: none"> • Fire response equipment such as fire extinguisher and fire blanket to be kept on vehicles at the works and compound sites • The fire rating will be checked at the start of each day • Hot works will not be permitted on total fire ban days • An evacuation plan will be kept onsite and staff will be made aware of this and their responsibilities in the event of a fire • A site for smoking will be established at least 40 metres away from dense vegetation and butt disposal bins will be made available. 	Contractor	Construction	Additional safeguard
UXO1	Hazard and risk – dangerous goods and explosives	<p>The occurrence of unexploded ordinance will be further investigated during detailed design by using prequalified specialists on the Defence Environment and Heritage Panel to confirm the presence and/or or absence of unexploded ordinance within the project area.</p> <p>If present, a plan for remediation works would be prepared and implemented prior to construction. Investigations would be undertaken in consultation with the Department of Defence.</p>	<p>Roads and Maritime</p> <p>Contractor</p>	<p>Detailed design</p> <p>Pre-construction</p>	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
AQ1	Air quality emissions and dust propagation across the proposal footprint	<p>An Air Quality Management Plan (AQMP) would be prepared as part of the CEMP. The plan would include but not be limited to the following:</p> <ul style="list-style-type: none"> • A procedure for monitoring dust on site and weather conditions • Identification of dust generating activities and associated mitigation measures • Limits on the area that can be opened-up or distributed at any one time • Stabilise temporary stockpiles and spoil set down locations • Compliance with Stockpile Site Management Guidelines (Roads and Maritime, 2008a) • Progressive stabilisation plans • Impose speed limits throughout the proposal footprint and in the site compound • Implement additional dust control measures in exposed areas where the wind speed is excessive (including periodic gusts) or produces visible dust • Implement a vehicle, plant and machinery maintenance program to comply with manufacturer's specifications and ensure compliance with the NSW <i>Protection of Environment Operations Act 1997</i> • Prevent equipment idling for an excessive period of time while ideally locating machinery away from adjacent receivers • Prohibit any burning onsite or in the construction compounds • Visually inspect local conditions to ensure management measures are implemented and effective • Routinely sweep areas (at least once a day) to minimise surface dust notwithstanding the requirement to prevent sediment-laden runoff • Cover and sheet all trucks leaving site and ensure methods to remove sediment from truck wheels are implemented 	Contractor	Pre-construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
		<ul style="list-style-type: none"> • Revise work activities should the dust control measures prove ineffective • Do not carry out emissions-generating activities (ie paint spraying, grout, concrete mixing) during high winds and employ methods to minimise dust dispersion • Do not stockpile fine construction materials in exposed areas • Monitor wind conditions and schedule activities to avoid high-wind periods to avoid impacting on adjacent receivers. 			
AQ2	Dust deposition impacts	Ensure that the consultation strategy (refer to Chapter 5) includes provision for managing dust nuisance complaints during the work.	Contractor	Construction	Additional safeguard
AQ3	Improving energy efficiency and sustainability	Machinery onsite would be running efficiently to ensure optimal performance, minimise down time and improve fuel efficiency.	Contractor	Construction	Additional safeguard
AQ4	Dust deposition impacts	Stabilisation would be undertaken within the proposal as each section of work is completed or in areas that are inactive for more 20 days.	Contractor	Construction	Additional safeguard
GGCC1	Manage and reduce fuel consumption	<p>Consider using biofuels, lower emission fuels (e.g. e10) or fuels that allow the plant to run more efficiently during construction.</p> <p>Vehicles, plant and machinery would be appropriately sized for the task and properly maintained so as to achieve optimum fuel efficiency.</p>	Construction contractor	Construction	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
GGCC2	Use low embodied energy materials	<p>Consider using recycled or locally sourced materials (where readily available, economic, and fit for purpose) to reduce impacts from transportation emissions, reduce fuel costs and support local economies.</p> <p>Deliveries would be programmed so that the minimum amount of trips is made without compromising site requirements.</p>	Construction contractor	Construction	Additional safeguard
GGCC3	Use low embodied energy materials	Ensure the detailed design considers opportunities to reduce construction material quantities.	Roads and Maritime	Detailed design	Additional safeguard
GGCC4	Maintain and reduce vehicle emissions for the whole proposal	The Roads and Maritime <i>Resource Recovery Exemptions</i> , will be followed to maximise opportunities to reuse construction and demolitions materials where feasible and permissible.	Construction contractor	Construction	Additional safeguard
GGCC5	Manage the design to accommodate the climate change factors of increased temperature and rainfall events across the whole proposal	<p>Consider options in adopting the latest pavement design to ensure resilience against extreme temperature and rainfall events.</p> <p>Detailed design for rainfall, runoff and waterways to take into consideration the effects of sea level rise, changes to rainfall frequency and/or intensity as a result of climate change as per the Roads and Maritime <i>Technical Guide: Climate Change Adaptation for the State Road Network</i></p>	Roads and Maritime	Detailed design	Additional safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
GGCC6	Manage the design to accommodate the climate change factors of increased temperature and rainfall events across the whole proposal	Detailed design would also consider adaptation and resilience of the proposed road design to better respond to potential climate change impacts (temperature and rainfall).	Roads and Maritime	Detailed design	Additional safeguard
W1	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 proposal • 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 <i>Environmental Procedure - Management of Wastes on Roads and Maritime Services Land</i> (Roads and Maritime, 2014f) and relevant Roads and Maritime Waste Fact Sheets.</p>	Contractor	Detailed design / pre-construction	Core standard safeguard

No.	Impact	Environmental safeguards	Responsibility	Timing	Standard / additional safeguard
CI1	Cumulative traffic impacts when building the proposal	<p>If required, modify the proposal's construction traffic management plan on account of any identified cumulative impacts to:</p> <ul style="list-style-type: none"> • Implement traffic management controls to respect critical timing requirements of these other projects • Carefully select appropriate work site access and egress locations. <p>Monitor traffic levels and network performance across the proposal footprint and wider area to consider cumulative effects from other projects.</p>	Roads and Maritime/ contractor	Pre-construction/ construction	Additional safeguard
CI2	Cumulative impacts	Consult with other developers to obtain information about project timeframes and impacts. Identify and implement appropriate safeguards and management measures to minimise cumulative impacts.	Roads and Maritime Contractor	Pre-construction Construction	Additional safeguard
CI3	Cumulative impacts	Consult with other developers before starting work to manage the interfaces of the proposal's staging and programming in combination with the other projects occurring in the area.	Roads and Maritime	Pre-construction	Additional safeguard
CI4	Cumulative impacts	Prepare all environmental management plans (including but not limited to the Construction Noise and Vibration Management Plan and Traffic Management Plan) to consider other developments in the area.	Contractor	Pre-construction	Additional safeguard

7.3 Licensing and approvals

Table 7-2 provides a list of licensing and approvals that may be required for the proposal.

Table 7-2: Summary of licensing and approvals required

Instrument	Requirement	Timing
Fisheries Management Act 1994 (s199)	<p>Pursuant to <i>Code Of Practice for Minor works in NSW waterways</i> (RMS 2014) and in accordance with Section 199 of the FM Act, RMS is required to consult with the Minister for Primary Industries regarding dredging or reclamation works within Harris Creek and Williams Creek.</p> <p>Pursuant to Section 199(b), RMS must consider any matters concerning the proposed work that are raised by the Minister within 21 days after the giving of the notice.</p> <p>[Note exemption pursuant to s263A of the <i>Fisheries Management (General) Regulation 2010</i>]</p>	Consultation with the Minister for Primary Industries shall be carried out prior to the commencement of any work within Harris Creek and Williams Creek.
<i>Fisheries Management Act 1994 (s218)</i>	Notification to the Minister for Primary Industries prior to any activities to construct, alter or modify a dam, weir or reservoir on a waterway.	Prior to start of the activity
Fisheries Management Act 1994 (s219)	Permit to obstruct the free passage of fish (temporary or permanent) from the Minister for Primary Industries.	Prior to start of the activity.
Heritage Act 1977 (s60)	Permit to carry out activities to an item listed on the State Heritage Register or to which an interim heritage order applies from the Heritage Council of NSW.	Prior to start of the activity.
Roads Act 1993 (s138)	Road occupancy licence to dig up, erect a structure or carry out work in, on or over a road	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

Strategically, Heathcote Road is an arterial road connecting Liverpool to the Princes Highway at Heathcote. It provides regional access between Sydney's southern suburbs and the motorway network around Liverpool (M5 Motorway, M7 Motorway and M31 Motorway). Locally, the road provides a main arterial route for the suburbs of Holsworthy, Wattle Grove, Hammondville and Voyager Point. It also provides a key link for commuters who drive, walk or cycle to their nearest train station at Holsworthy. The proposal supports these needs by improving freight access and efficiency, enhancing network connectivity and improving pedestrian and cyclist access and connectivity to Holsworthy Train Station and surrounds.

The road provides an important regional and local access function that is currently compromised around Holsworthy due to it only operating with one lane in each direction. As a result, there is notable congestion and resultant delays, especially during the morning peak period due to people wanting to travel to the Holsworthy Army Barracks and Holsworthy Railway Station. Part of this problem was addressed in 2014 through the Commonwealth Department of Defence upgrading the intersection and approaches to the Holsworthy Army Barracks to provide dedicated filter lanes to enter and leave the site. The proposal would ease congestion and reduce travel times along this entire section of Heathcote Road, by upgrading and widening the road either side of the Holsworthy Army Barrack's intersection.

8.1.1 Social factors

As reflected in Chapter 6, Roads and Maritime realise in order to build and operate the proposal there would be a number of changes to the local area. There would also be some short-term disruption while the proposal is being built. Such impacts are consistent with similar road-development proposals in urban areas and would be safeguarded and managed by implementing measures that have been set out in published Roads and Maritime environmental management guidance as being effective in reducing the magnitude, extent, duration and scope of the proposal's impacts. Central to this would be managing and timing the construction work to minimise the disruption as far as is reasonably and feasibly for road users, residents and other affected stakeholders.

In the long-term, the proposal would provide positive social impacts through the significant reduction in expected major crashes, improving travel time reliability and efficiency and increasing road capacity to cater for current and predicted traffic volumes.

8.1.2 Biophysical factors

The majority of the adverse environmental effects would occur while the proposal is being built. These effects would be mainly minor in nature, they would occur as a result of short-term impacts, and they would only be experienced while the proposal is being built.

A key adverse outcome of building the proposal is its effects on biodiversity. It would result in some vegetation and tree loss across an area whose values are protected under State and Commonwealth legislation. It would also have an effect on areas of non-Aboriginal heritage value. This REF and its supporting technical studies have identified the risks and impacts that would occur as a result of building the proposal, and included additional safeguards and controls before work starts to ensure the proposal's residual effect on the environment is not significant.

8.1.3 Economic factors

The proposal selects a design that would provide for the future development of Holsworthy, listed as a targeted growth area in Liverpool City Council's residential strategy. Improved journey time, including improved freight access and efficiency and reduced crashes as a result of the proposal would have regional economic benefits as it would produce productivity through improved travel times and access, and reduce costs associated with crashes. The workforce used to build the proposal would also contribute to the local and regional economy during the construction phase that would see workers use local services and amenity.

8.1.4 Public interest

The proposal recognises the need to improve the road capacity and performance to avoid future increased delays and congestion locally. The proposal would:

- Reduce travel time for people travelling along Heathcote Road especially during the morning peak period
- Ease congestion and providing additional network capacity through providing a specific filter lane for traffic turning into all intersections, in particular the Macarthur Drive intersection
- Improve pedestrian and cycle access, providing people with the choice of being able to walk or cycle to Holsworthy Train Station and Hammondville Park.
- Improve road safety with a reduction in expected major crashes.

Overall, the proposal is believed to be justified in meeting its objectives with few residual impacts and is therefore in the interest of the public interest.

8.2 Objectives of the EP&A Act

Objectives	Comment
5(a)(i) To encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment.	While there would be some impacts to the environment, including vegetation clearing, the proposal would contribute to the continued traffic management in the area. The upgrade has been designed to maintain the environmental values of the surrounding area and while there are some minor exceptions they can be safeguarded against (refer to Chapter 6). It would also provide social infrastructure in the form of a cycleway and pedestrian improvements to assist with offering people greater travel choice. Collectively, this would improve the context and setting of the area in the long-term consistent with this objective.
5(a)(ii) To encourage the promotion and co-ordination of the orderly economic use and development of land.	The project area is contained within the existing road corridor and is consistent with the land use zoning provisions of the local environmental plan (refer to section 4.1).

Objectives	Comment
5(a)(iii) To encourage the protection, provision and co-ordination of communication and utility services.	As described in section 3.6, the proposal would require various above and belowground utilities and infrastructure to be either adjusted or relocated. In planning the proposal, Roads and Maritime has coordinated with the utility providers to ensure there would be minimal service interruption. Roads and Maritime is also committed to continuing to work with these providers to work around their access and maintenance schedules, again to minimise any disruption.
5(a)(iv) To encourage the provision of land for public purposes.	The road is currently provided for public use. By upgrading and widening it, this would ensure there was improvements for people travelling to and from Infantry Parade and The Avenue, in particular travel to Holsworthy Train Station. This is being supplemented by building a cycleway, which would allow people to safely cycle to and from these locations. Both outcomes are consistent with this objective.
5(a)(v) To encourage the provision and co-ordination of community services and facilities.	Once operational, the improvements, including the footpath and cycleway provisions, are considered to provide supplementary community services in the area. They would also provide people with choices as to how they travel between the community services and facilities in the area.
5(a)(vi) To encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats.	The proposal contains specific safeguards and management measures that would protect and manage the environment. These controls are assessed and considered to provide adequate mitigation to protect the environment to an acceptable residual level during construction and once operational (refer to Chapter 7).
5(a)(vii) To encourage ecologically sustainable development.	Ecologically sustainable development is considered in sections 8.21 to 8.2.4 below.
5(a)(viii) To encourage the provision and maintenance of affordable housing.	The proposal would not restrict the future residential growth as outlined in the Liverpool Residential Development Study (refer to section 2.1.3).
5(b) To promote the sharing of the responsibility for environmental planning between different levels of government in the State.	Not relevant to the proposal.

Objectives	Comment
5(c) To provide increased opportunity for public involvement and participation in environmental planning and assessment.	Roads and Maritime has consulted the community and sought feedback before determining whether to build the proposal. It has also committed to continuing its consultation in developing the proposal's design, while planning to build the proposal, while the proposal is being built and once it is operational. Chapter 5 describes the detail of how the public has been consulted and how they will be involved and they have and would participate in the environmental planning and assessment process moving forward.

8.2.1 The precautionary principle

Principle 15 of the United Nations Conference on Environment and Development 1992 (the Rio Summit) defined the precautionary principle: “where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation”. In 2000, a European Union communication further refined the definition to account for action where scientific evidence is “insufficient, inconclusive or uncertain”. Also realised was the responsibility placed on the developer to prove their actions as being safe and act in instances where there is uncertainty.

In all cases impact assessment is a subjective process. It relies on professional judgement and interpretation. Consequently, precaution has been built into the assessment undertaken and reported in this REF. This includes adopting a number of worst-case assumptions, such as all noise-generating equipment operating at its maximum output at the same time in the same location, or the assumption of a worst-case visual impact occurring across specific landscape character zones. It also assumes a worst-case interaction between projects to assess interactive and cumulative effects. In each case, while the likelihood of such impacts to occur is remote the consequence of these impacts could be significant if they happened. Therefore precaution has been employed to remove subjective uncertainty and to ensure the impact on the receiving environment is minimised.

There has also been a responsibility on Roads and Maritime to employ ‘feasible and reasonable’ measures to protect the environment and to do this where there is uncertainty. In the case of the proposal, there are certain impacts that have very low likelihood of occurring, such as there being a major spill onsite. However, Roads and Maritime has still committed to implement measures to safeguard against these risks.

Conversely, there are certain proposed work activities, which when assessed under a worst-case scenario, clearly show there is likely to be an impact. A good example is construction noise and its exceedance of the corresponding noise management levels. Again in reality there would be an exceptionally low likelihood of the conditions modelled in the REF actually occurring onsite. Nonetheless, Roads and Maritime is committed to controlling noise to a worst-case level. This again demonstrates the adoption of precaution where there is uncertainty.

Finally, the concept design will be developed and refined into a detailed design. At this stage there are many aspects of the design that are not detailed (e.g. final finishes, the final ancillary facility requirements). Roads and Maritime has committed to confirming that the impacts reported in this REF are still relevant, accurate and consistent and reflect the proposal's detailed design. Additional environmental assessment would be undertaken where there is an identified inconsistency. This again would ensure that uncertainty is identified, addressed and resolved throughout the proposal's design lifecycle by implementing precaution at all stages.

8.2.2 Intergenerational equity

Establishing intergenerational equity allows for the needs of today to be met without affecting the ability of future generations to meet their own needs, as termed by the World Commission on Environment and Development in 1993 when defining sustainable development. In instances where environmental resources and values are preserved for use by future generations to create 'wealth' this is termed 'weak sustainable development'. Where there is recognition humans cannot replace a degrading environmental resource or value for future generations to benefit from this is termed 'strong sustainable development'.

The proposal would invest in and therefore preserve the established built road environment of Mascot and an established access to the airport for use by future generations. It would also supplement this by encouraging people to walk and cycle. The proposal would have little impact on environmental resources and values other than the required use of a limited amount of natural resources to build the proposal. Roads and Maritime is also committed to its Climate Change Plan and the NSW Greenhouse Gas Plan (refer to section 6.11). Both include priorities to ensure that Road and Maritime reduces its demands on natural resources by conserving energy, reducing the carbon footprint of all developments and accommodating climate change into its designs. Roads and Maritime has committed to these measures in designing this proposal.

8.2.3 Conservation of biological diversity and ecological integrity

Preserving biological diversity and ecological integrity requires that ecosystems, species, and biological diversity are maintained and improved to ensure their survival. It is accepted that this proposal would result in the loss of about 3.4 hectares of Castlereagh scribbly gum woodland, Castlereagh shale – gravel transition forest, Castlereagh swamp woodland and Cumberland river-flat forest, which are legally protected in their own right as well as it providing resource and habitat for other threatened species. The proposal would also result in the loss 46 individuals of the species *Grevillea parviflora* subsp. *parviflora* and 75 individuals of the species *Hibbertia puberula*. The State and Commonwealth has published guidelines to determine if certain actions and activities would have a significant impact on the values and defining features of legally protected ecological values. Central to the guidelines is the consideration if the impacts would have a material impact on biological diversity and ecological integrity to the point of affecting their overall conservation.

In the case of the proposal these assessments, which are reported in Appendix G, conclude that while the impacts are material, meaning they would have an adverse impact on biological diversity and ecological integrity, the impacts are not significant. The proposal's design has also been developed to minimise its ecological impacts, which has been achieved by restricting works, including the location of the ancillary facility within the existing road corridor to reduce its footprint. Providing the safeguard measures in section 6.1.4 are implemented, the loss would not have a material or significant impact on the conservation of the Castlereagh scribbly gum woodland, Castlereagh shale – gravel transition forest, Castlereagh swamp woodland and Cumberland river-flat forest in the area, its biological diversity and its ecological integrity. This extends to include the habitat value and the species the communities support.

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 impacts.

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 and once it is operational. 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 exceptionally unlikely event that it should occur. Consequently, the proposal has adopted the polluter pays principle.

Roads and Maritime has also committed to the purchase of recycled materials and materials with low-embodied energies where feasible and reasonable in their application. These provisions serve to consider the lifecycle demand on natural resources and their conservation. Roads and Maritime has also committed to sourcing the materials from local markets, including primary materials wherever possible. Finally, all materials, staff and equipment, and waste would be obtained and disposed of as close to the proposal footprint as possible (termed the 'proximity principle'). This would reduce the proposal's wider secondary, indirect and lifecycle impacts.

Finally, Roads and Maritime has developed environmental assessment guidance to allow external parties to prepare its environmental assessment documentation. These external parties comprise specialists who are competent in environmental impact assessment and are experienced in identifying cost-effective safeguards and management measures based on a hierarchy of avoidance over mitigation. In addition, Roads and Maritime has its own in-house team of environmental specialists who review all environmental assessments to ensure the safeguards and management measures are cost-effective and achieve the proposal's environmental goals and Roads and Maritime's organisational goals.

8.3 Conclusion

The proposed Heathcote Road upgrade from Infantry Parade at Holsworthy to The Avenue at Voyager Point is subject to assessment under Part 5 of the EP&A Act. The REF has examined and taken into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity.

This has included consideration (where relevant) of conservation agreements and plans of management under the NPW Act, joint management and biobanking agreements under the TSC Act, wilderness areas, critical habitat, impacts on threatened species, populations and ecological communities and their habitats and other protected fauna and native plants. It has also considered potential impacts to matters of national environmental significance listed under the Federal EPBC Act.

A number of potential environmental impacts from the proposal have been avoided or reduced during the concept design development and options assessment. The proposal as described in the REF best meets the proposal objectives but would still result in some impacts including impacts to heritage listed bridges, noise sensitive receivers, traffic due to delays associated with construction works and threatened ecological communities including clearing of 2.37 hectares of Castlereagh scribbly gum woodland for which an offset strategy would be required. Safeguards and management measures as detailed in this REF would ameliorate or minimise these expected impacts. The proposal would also improve safety, improve driving conditions, reduce travel times and provide people with greater travel choice as they could walk and cycle. On balance the proposal is considered justified and the following conclusions are made.

8.3.1 Significance of impact under NSW legislation

The proposal would be unlikely to cause a significant impact on the environment. Therefore it is not necessary for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning under Part 5.1 of the EP&A Act. A Species Impact Statement is not required. The proposal is subject to assessment under Part 5 of the EP&A Act. Consent from Council is not required.

8.3.2 Significance of impact under Australian legislation

The proposal is not likely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*. A referral to the Australian Department of the Environment is not required.

9 Certification

This review of environmental factors provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposal.



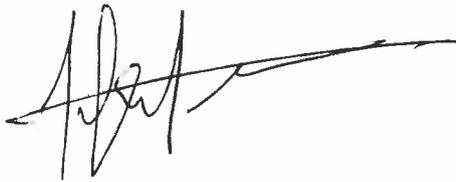
Cara Renshaw

Senior Consultant

WSP | Parsons Brinckerhoff

Date: 12 September 2016

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



Ankur Arora

Project Development Manager

Greater Sydney Program Office

Date: 17/10/2016

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Terms and acronyms used in this REF

Term / Acronym	Description
AASS	Actual acid sulfate soils
ABS	Australian Bureau of Statistics
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal heritage impact permit
AHMP	Aboriginal Heritage Management Plan
Air NEPM	Air Quality National Environmental Protection Measure
AQMP	Air Quality Management Plan
AS	Australian Standard
ASRIS	Australian Soil Resource Information System
ASS	Acid sulfate soils
ASSMAC	Acid Sulfate Soil Management Advisory Committee
ASSMP	ASS Management Plan
AusLink	Mechanism to facilitate cooperative transport planning and funding by Commonwealth and state and territory jurisdictions
CEMP	Construction environmental management plan
CMA	Catchment Management Authority
CP	Communication Plan
BGL	Below ground level
BRMP	Bushfire Risk Management Plan
BTEX	Benzene, toluene, ethylbenzene, and xylenes
ch.	Chainage (distance in metres)
CHL	Commonwealth Heritage List
CMP	Contamination Management Plan
CNVMP	Construction Noise and Vibration Management Plan
CO	Carbon monoxide
dB	Decibel

Term / Acronym	Description
dBA	A-weighted decibel
DCP	Development control plan
EIA	Environmental impact assessment
EIS	Environmental impact statement
ENM	Excavated natural material
ENMM	Environmental Noise Management Manual
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth). Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.
EPI	Environmental planning instrument
EPL	Environmental protection license
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
ESCP	Erosion and Sediment Control Plan
EWMS	Environmental Work Method Statement
FM Act	Fisheries Management Act 1994 (NSW)
Fill	The term used to place material to either in fall a low point in the landscape or raise the road above the surrounding landscape
Heritage Act	Heritage Act 1977 (NSW)
HRMP	Hazard and Risk Management Plan
ICNG	Interim Construction Noise Guidelines 2009 (NSW)
IHO	Interim heritage order
INP	Industrial Noise Policy (NSW)
ISEPP	State Environmental Planning Policy (Infrastructure) 2007
JTW	Journey to work
km/hr	Kilometers per hour
L _{Aeq}	Equivalent continuous sound level – the energy average of the varying noise over the sample period and its equivalent to the level of a constant noise which contains the same energy as the varying noise.

Term / Acronym	Description
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.
mg	milligram (equivalent to 10 ⁻⁶ of a kilogram)
mm	Millimeter
NAHMP	Non-Aboriginal Heritage Management Plan
NCA	Noise Catchment Area
NCG	Noise Construction Guidelines (Roads and Maritime 2015c)
NES	Matters of national environmental significance under the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> .
NMG	Noise Management Guideline (Roads and Maritime, 2016d)
NML	Noise management level
NO ₂	Nitrous oxide
Noxious Weeds Act	Noxious Weeds Act 1993 (NSW)
NPI	National Pollutant Inventory
NPW Act	National Parks and Wildlife Act 1974 (NSW)
NSW DEC	Department of Environment and Conservation (now Office of Environment and Heritage) (NSW)
NSW DECC	Department of Environment and Climate Change (now Office of Environment and Heritage) (NSW)
NSW DECCW	Department of Environment, Climate Change and Water (now Office of Environment and Heritage) (NSW)
NSW DP&E	Department of Planning and Environment (NSW)
NSW DPI	Department of Primary Industries
NSW DUAP	Department of Planning and Urban Affairs (now the Department of Planning and Environment) (NSW)
NSW EPA	Environment Protection Authority (NSW)
NSW OEH	Office of Environment and Heritage (NSW)

Term / Acronym	Description
OCP	Organochlorine pesticides
OEH	NSW Office of Environment and Heritage
PACHCI	Procedure for Aboriginal Cultural Heritage Consultation and Investigation
PAH	polycyclic aromatic hydrocarbons
PASS	Potential Acid Sulfate Soils
PCB	Polychlorinated biphenyls
PM ₁₀	Particulate matter with diameter of 10 microns
PM ₂₅	Particulate matter with diameter of 25microns
PnR	Park and Ride
PPE	Personal protective equipment
The proposal	For the purpose of this report, the proposed design described in this REF due to differences from the original determined REF design.
RBL	Rating background level: for each period this is the median level of the RBL values for the period over all the days measured. There is therefore an RBL value for each period – daytime and night-time.
REF	Review of Environmental Factors: the term used within this document to refer to this document.
RNE	Register of the National Estate
Roads and Maritime	NSW Roads and Maritime Services
RTA	Roads and Traffic Authority (now Roads and Maritime)
SEPP	State Environmental Planning Policy. A type of planning instrument made under Part 3 of the EP&A Act.
SEPP 14	State Environmental Planning Policy No.14 – Coastal Wetlands
SO ₂	Sulphur dioxide
SO _x	Oxides of sulfur
STP	Sewage treatment plant
SWGC	South West Growth Centre
SWMP	Soil and Water Management Plan
TMP	Traffic Management Plan
TSC Act	Threatened Species Conservation Act 1995 (NSW)

Term / Acronym	Description
TSP	Total suspended particles
VDV	Vibration dose value
WMP	Waste Management Plan
WSEA	Western Sydney Employment Area

Appendix A

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

Clause 228(2) Checklist

In addition to the requirements of the *Is an EIS required?* guideline (DUAP 1995/1996) and the *Roads and Related Facilities EIS Guideline* (DUAP 1996) as detailed in the REF, the following factors, listed in clause 228(2) of the *Environmental Planning and Assessment Regulation 2000*, have also been considered to assess the likely impacts of the proposal on the natural and built environment.

Factor	Impact
A. Any environmental impact on a community?	
<p><i>Construction:</i> a number of traffic management controls would be introduced to build the proposal. These controls would cause a temporary increase in congestion and travel delays. The community would also be affected and inconvenienced as result of work activity mainly taking place on the existing section of Heathcote Road, which would have temporary amenity impacts in terms of noise, loss of values, inconvenience, increased traffic, and visual impacts. These impacts would be mitigated with the implementation of recommended safeguards identified in Chapter 6.</p>	Short term minor negative
<p><i>Operational:</i> the proposal would improve access to Holsworthy Train Station. It would also include new pedestrian and cycle facilities to provide the community with travel choices in being able to walk and cycle in particular to and from Holsworthy Train Station. These are considered benefits of the proposal. The only adverse impact on the community would be from widening the kerb-to-kerb distance of the road which would have a negative impact on adjacent receivers. However, the visibility of these changes for the most part would be restricted to motorists.</p>	Long term positive Long term minor negative
B. Any transformation of a locality?	
<p><i>Construction:</i> the proposal would result in short-term disruption during construction leading to noise, amenity and visual impacts. These impacts would be mitigated with the implementation of recommended safeguards identified in Chapter 6.</p>	Short-term minor negative
<p><i>Operation:</i> as described above the character of the locality would change by widening the kerb-to-kerb distance of the road which would have a negative visual impact on adjacent receivers. However, it would be contained within the existing road corridor and the visibility of these changes for the most part restricted to motorists. The proposal would implement an urban and landscaping plan to improve the long term visual amenity of the project area along the length of Heathcote Road.</p>	Long term negative

Factor	Impact
C. Any environmental impact on the ecosystems of the locality?	
<p><i>Construction:</i> the proposal would result in the loss of about 6.24 hectares of habitat, (including 3.41 hectares of Castlereagh scribbly gum woodland, Castlereagh shale – gravel transition forest, Castlereagh swamp woodland and Cumberland river-flat forest), which provides habitat for a range of recorded species and species that are likely to occur in the area, including the threatened flora species <i>Hibbertia puberula</i> subsp. <i>puberula</i> and <i>Grevillea parviflora</i> subsp. <i>parviflora</i>. All are protected either under State and/or Commonwealth legislation. The proposal would also result in the loss of other areas of habitat that (potentially) support a range of native and non-native species that are not legally protected. The proposal also crosses two creeks. Safeguards have been proposed that Roads and Maritime would commit to, in order to minimise the proposal’s ecological impacts.</p>	<p>Long term moderate negative</p> <p>Long term moderate negative</p>
<p><i>Operation:</i> once operational there would be ongoing maintenance and repair risks, plus other operational risks that may result in an impact on the ecological values in the area. These mainly relate to accidental discharges and poor maintenance practices.</p>	<p>Short term minor negative</p>
D. Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?	
<p><i>Construction:</i> the proposal would result in short-term disruption while it is being built, and as discussed above, this would lead to certain amenity impacts. These impacts would mainly occur as result of establishing work sites within the proposal footprint, introducing traffic management controls and the use and movement of equipment and traffic locally. This would be supplemented by the need to undertake occasional night work to build the proposal. The loss of certain ecological values locally, as discussed above, would also have an impact on the area’s environmental and scientific quality. However, in all cases, these impacts would be minimised by including a range of safeguards. These safeguards would also include controls to prevent any unnecessary impacts while minimising any risks to other values locally.</p>	<p>Short term moderate negative</p> <p>Long term negative</p>
<p><i>Operational:</i> as discussed above, the proposal would increase the prominence of the road in its streetscape, which would have a detrimental effect to some receivers adjacent to Heathcote Road.</p>	<p>Long term minor negative</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><i>Construction:</i> the proposal would result in the direct impact on three non-Aboriginal items (Holsworthy Pedestrian Bridge and the road bridges over Harris Creek and Williams Creek).</p> <p>Any heritage values would be either recorded or preserved before the work starts. As such, the impact would be avoided other than impacts on any unexpected finds.</p>	<p>Long term minor to major negative</p>

Factor	Impact
<p><i>Operation:</i> the road would have an effect on the wider setting and context of the area's non-Aboriginal heritage values. Options for adaptive reuse of the bridges would be considered during detailed design to minimise the impacts on heritage values for future generations.</p>	<p>Long term minor negative</p>
<p>F. Any impact on the habitat of protected fauna (within the meaning of the National Parks and Wildlife Act 1974)?</p>	
<p>The proposal would not impact on any ecological values protected under the above Act.</p>	<p>Nil.</p>
<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>As noted under factor [C], the proposal would result in the loss of about 6.4 hectares of habitat that is either known or likely to support an arrangement of species that are endangered or critically endangered at the State and Commonwealth level. This includes about 3.41 hectares of Castlereagh scribbly gum woodland, Castlereagh shale-gravel transition forest, Castlereagh swamp woodland and Cumberland river-flat forest), plus habitat that supports <i>Hibbertia puberula subsp. puberula</i> and <i>Grevillea parviflora subsp. Parviflora</i> and threatened fauna as listed in Tables 6.3 and 6.4.</p>	<p>Long-term moderate negative</p>
<p>H. Any long-term effects on the environment?</p>	
<p>The following long-term permanent impacts would occur as a result of building and operating the proposal:</p> <ul style="list-style-type: none"> • Loss of about 0.77 hectares of Castlereagh shale gravel transition forest, a critically endangered threatened ecological community • Loss of about 6.24 hectares habitat that is known or has the potential to support other legally protected threatened species • Direct impact on three non-Aboriginal items and possible other impacts on heritage values in the area • Change character and setting of Heathcote Road in the receiving environment due to widening the road and its upgrade from two lanes to four lanes. 	<p>Long-term moderate negative</p>
<p>I. Any degradation of the quality of the environment?</p>	
<p>As per Factor D.</p>	
<p>J. Any risk to the safety of the environment?</p>	
<p>There would be negligible risk to environmental safety either when building the proposal or once it was operational as work activities would be managed and the operational asset would be designed to be safe and maintained and repaired to remove any risk. Nonetheless, these risks cannot be fully discounted.</p>	

Factor	Impact
<p><i>Construction:</i> small quantities of hazardous materials would be used to build the proposal. These would be transported to site and stored at the main site compound. These materials would be handled, stored, used, and disposed of in accordance with the relevant procedures. This would minimise the risk of spillage while the proposal is being built. The earthwork volumes are insufficient to create notable erosion and sediment control issues. Also, the proposal crosses two creeks. While working close to a watercourse has an associated risk of impacting on the water quality and ecological values of Harris Creek and Williams Creek, it would be managed using well-practiced published safeguards.</p>	Nil
<p><i>Operation:</i> the road has been designed to ensure it complies with all safety requirements. Its design has also been independently audited to ensure it will be safe once operational. As such, this reduces the impact of any accidents or incidents that may result in pollution, contamination or other environmental safety concerns. While this risk cannot be full discounted it has been reduced to a level that is achievable, feasible and reasonable.</p>	Nil
K. Any reduction in the range of beneficial uses of the environment?	
<p><i>Construction:</i> there is assessed not to be any reduction in the beneficial use of the area while the proposal is being built. That said, the community, road users and pedestrians would be inconvenienced and delayed due to the introduced site management practices and traffic management controls, however this would not fundamentally prevent any activities or uses from taking place.</p>	Nil
<p><i>Operation:</i> the proposal would operate entirely within land already dedicated as a road reserve.</p>	Nil
L. Any pollution of the environment?	
<p><i>Construction:</i> there are two pollution risks.</p> <ul style="list-style-type: none"> • The low potential for an accident or spillage to pollute Harris Creek and Williams Creek given that the volume of harmful polluting material needed to build the proposal would be minimal due to its primary use for equipment maintenance, repair and refuelling away from the creeks • The risk of noise pollution while the proposal is being built. However, while there would be exceedances of management levels this is different from noise pollution, which is not expected to occur as controls would be put in place to limit the magnitude and duration of any impact 	Negligible

Factor	Impact
<p><i>Operation:</i> the road has been designed to ensure it complies with all safety requirements. As such, this reduces the impact of any accidents or incidents that may result in pollution, contamination or other environmental safety concerns. While this risk cannot be full discounted it has been reduced to a level that is achievable, feasible and reasonable. This includes controls to manage the stormwater runoff from the operational site via a water detention system that would include required gross pollutant traps and potentially, settlement ponds and swale and reed systems.</p>	Nil
M. Any environmental problems associated with the disposal of waste?	
<p><i>Construction:</i> the proposal would involve working in an area that has a reasonable potential for encountering pollutants and/or contaminants of concern. Material disturbed, excavated and removed under the proposal would be assessed and sampled before work starts. A waste management plan would be developed following the sampling to ensure that these materials are handled, removed, stored, classified, transported and disposed of in accordance with their classification, by a licenced contractor to a licenced waste-management facility.</p>	Negligible
<p><i>Operation:</i> there would be nominal quantities of waste generated in maintaining and repairing the proposal. All waste would be managed and classified in accordance with the guidance, regulation and procedures described in section 6.11.</p>	Nil
N. Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply?	
<p><i>Construction:</i> the proposal is small scale. It would not affect any resources that are, or likely to become, in short supply. It also includes opportunities to use recycled materials and materials with a low embodied energy.</p>	Nil
<p><i>Operation:</i> there would be nominal resources used to maintain and repair the proposal. Again these materials would not be in short supply.</p>	Nil
O. Any cumulative environmental effect with other existing or likely future activities?	
<p><i>Construction:</i> there are a small number of committed and approved developments that would be built or would operate at the same time as the proposal (refer to section 6.12). A risk of cumulative impacts to occur would only be confirmed once the schedules and timing of work activities and operations associated with the above projects is known. However, there is the potential for cumulative increase in construction traffic movements with other projects using Heathcote Road as a haul route.</p>	Short-term minor negative
<p><i>Operation:</i> there are no committed or approved developments that are likely to have a cumulative impact during the operation of the proposal.</p>	Nil

Factor	Impact
P. Any impact on coastal processes and coastal hazards, including those under projected climate change conditions?	
The proposal would not impact on coastal processes or coastal hazards.	Nil

Matters of National Environmental Significance

Under the environmental assessment provisions of the *Environment Protection and Biodiversity Conservation Act 1999*, the following matters of national environmental significance and impacts on Commonwealth land are required to be considered to assist in determining whether the proposal should be referred to the Australian Government Department of the Environment.

A referral is not required for proposed actions that may affect nationally listed threatened species, populations, endangered ecological communities and migratory species. Impacts on these matters are still assessed as part of the REF in accordance with Australian Government significant impact criteria and taking into account relevant guidelines and policies.

Factor	Impact
<p><i>Any impact on a World Heritage property?</i></p> <p>The proposal would have no impact on a world heritage property (refer to section 6.8).</p>	Nil
<p><i>Any impact on a National Heritage place?</i></p> <p>The proposal would have no impact on a national heritage place (refer to section 6.8).</p>	Nil
<p><i>Any impact on a wetland of international importance?</i></p> <p>The proposal would have no impact on a wetland of international importance (refer to section 6.1)</p>	Nil
<p><i>Any impact on a listed threatened species or communities?</i></p> <p>The proposal would result in the following confirmed impacts:</p> <ul style="list-style-type: none"> • Loss of about 0.77 hectares of Castlereagh shale-gravel transition forest, a critically endangered threatened ecological community • The loss of about 6.24 hectares of habitat capable of supporting: 11 threatened (vulnerable and endangered) plant species and 30 threatened (vulnerable and endangered) animal species. <p>Appendix G includes the assessment of impacts on threatened species that are either known or have a high likelihood of occurring in the area. The assessment was prepared in accordance with Significant Impact Guidelines 1.1: Matters of National Environmental Significance (Australian Government Department of Environment, 2013). As summarised in Table 6-12, in all instances, the proposal's impact on the defining features and overall value provided by the above communities, habitat and species is assessed as non-significant within the meaning and definition of the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i></p>	Not significant
<p><i>Any impacts on listed migratory species?</i></p> <p>Twelve bird species protected under Commonwealth legislation have a moderate or higher potential of migrating over the area, based on the recorded habitats (refer to section 6.1). Given the relative small area of habitat likely to be affected and its marginal quality as habitat, the proposal is unlikely to significantly affect the migration of these species.</p>	Nil
<p><i>Any impact on a Commonwealth marine area?</i></p> <p>The proposal would have no impact on a Commonwealth marine area.</p>	Nil

Factor	Impact
<p><i>Does the proposal involve a nuclear action (including uranium mining)?</i></p> <p>The proposal does not involve a nuclear action.</p>	<p>Nil</p>
<p><i>Additionally, any impact (direct or indirect) on Commonwealth land?</i></p> <p>The proposal would have no impact on a Commonwealth land (refer to section 4.4).</p>	<p>Nil</p>

Appendix B

Statutory consultation checklists

Infrastructure SEPP

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	Liverpool City Council	ISEPP cl.13(1)(a)
Traffic	Are the works likely to generate traffic to an extent that will <i>strain</i> the existing road system in a local government area?	No	Liverpool City 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	Liverpool City Council	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	Liverpool City Council	ISEPP cl.13(1)(d)
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	Liverpool City Council	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	Liverpool City Council	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? If yes, does a heritage assessment indicate that the potential impacts to the item/area are more than <i>minor</i> or <i>inconsequential</i> ?	Yes	Liverpool City Council	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?	Yes	Liverpool City Council	ISEPP cl.15

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 1974</i> ?	No	Office of Environment and Heritage	ISEPP cl.16(2)(a)
Marine parks	Are the works adjacent to a declared marine park under the <i>Marine Parks Act 1997</i> ?	No	Department of Planning and Environment	ISEPP cl.16(2)(b)
Aquatic reserves	Are the works adjacent to a declared aquatic reserve under the <i>Fisheries Management Act 1994</i> ?	No	Office of Environment and Heritage	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	Department of Planning and Environment	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	Rural Fire Service	ISEPP cl.16(2)(f)

Appendix C

Detailed Proposal Overview Figures

Appendix D

Design Criteria

Design criteria

Aspect	Design criteria
General specification	
Horizontal alignment	Describes the route of the road
	<ul style="list-style-type: none"> Road: typically northwest to southeast
Vertical alignment	Describes the height of the road relative to the surrounding land. It describes where the road would be built below (cutting) or above (fill) the surrounding land
	<ul style="list-style-type: none"> Bridges: up to 6.5 metres above ground level Road: up to 1 metre above ground level (fill) Road: up to 1 metre below ground level (cut)
Engineering specification	
Cross section	Describes the width of the road. Figure 3.2 shows a typical cross section
	<ul style="list-style-type: none"> Main road: typically 23 metres wide Intersections: up to 60 metres wide Formation (main road): one shared use path, four traffic lanes and a median Formation (bridges): as above, however no median
Lane width	<ul style="list-style-type: none"> Traffic lanes: 3.5 metres wide Turning lanes: 3.3 metres wide
Shoulder width	Describes the space between the solid white line and the inside and outside kerb
	<ul style="list-style-type: none"> Infantry Parade to Macarthur Drive: 1.5 metres outside and 0.5 metres inside Macarthur Drive to The Avenue: 2.0 metres outside and 0.5 metres inside
Grade (cross fall)	Describes the slope on the road to allow stormwater to run from the inside kerb to the stormwater drains on the outside kerb
	<ul style="list-style-type: none"> Typically about 3 per cent from the inside kerb to the outside kerb Maximum of 7 per cent from the inside kerb to the outside kerb
Footways	Describes the area of the road corridor between the kerb and the batter slopes or retaining wall
	<ul style="list-style-type: none"> Over bridges: 3.6 metres wide Main road alignment: 20 metres wide

Aspect	Design criteria
Shared use path	Describes a shared area of pavement separated from the traffic lanes where people can walk and cycle
	<ul style="list-style-type: none"> • West of Macarthur Drive to Infantry Parade: 3 metres wide on the southern side of the road. • East of Macarthur Drive to Soldiers Way: 3 metres wide on the southern side of the road • Soldiers way to The Avenue: 3 metres wide on the northern side of the road and 2.5 metres shared use path at The Avenue • Bridges: 3.6 metres wide • The Avenue, Heathcote Road to Lilli Pili Drive 2.8 metres wide
Intersections	<ul style="list-style-type: none"> • Two existing intersections (unchanged): Infantry Parade and Soldiers Way • Two existing intersections (to be upgraded): Macarthur Drive and The Avenue
Tie-ins	Describes the points where a new road joins an existing road
	<ul style="list-style-type: none"> • Infantry Parade: existing intersection • Macarthur Drive: existing intersection • Soldiers Way: existing intersection • The Avenue: existing intersection • Heathcote Road: existing road
Pavement type (road surface)	Describes the material used to construct a new road surface (pavement)
	<ul style="list-style-type: none"> • New sections of road: composite pavement • Resurfaced sections of road: flexible pavement • Typical composite composition: <ul style="list-style-type: none"> • Pavement: About 175 millimetres (mm) of asphalt • Sub base: About 300 mm of selected material and 200 mm of concrete • Typical flexible composition: <ul style="list-style-type: none"> • Pavement: About 315 mm of asphalt • Sub base: About 300 mm of sealed material and 300 mm of gravel
Barriers	<ul style="list-style-type: none"> • Main road: wire rope about 0.5 metres high on the inside of the traffic lanes from Soldiers Way to The Avenue • Retaining wall: concrete barriers about 0.6 metres high • Bridges (inside): concrete barriers about 0.6 metres high • Bridges (outside): concrete barriers about 0.6 metres high • Main road: W beam barrier: outer edges of main alignment from Macarthur Drive to the Avenue and at approaches to bridges
Design specification	
Speed	<ul style="list-style-type: none"> • Infantry Parade to the Rail Bridge: posted speed of 80km/h • Rail Bridge to The Avenue: posted speed of 60km/h
Vehicle type	<ul style="list-style-type: none"> • Design capacity: 19.5 metre long semi-trailer (26 metre long B double traffic if necessary)
Stopping sight distance	Describes the distance people would need to see along the road to safely stop
	<ul style="list-style-type: none"> • On the approach to the intersections: 100 metre visibility

Aspect	Design criteria
Ancillary design specification	
Utilities	<ul style="list-style-type: none"> • Protection: measures to identify, mark-out and avoid above or belowground utilities • Adjustment: move the alignment and/or depth/height of an above or belowground utility broadly in its current location • Relocation: move the alignment and/or depth/height of an above or belowground utility to a new location • Installation: utilities placed in a new location above or belowground.
Drainage	<ul style="list-style-type: none"> • Longitudinal drains comprising drains, pits and pipes • Cross drains comprising box or pipe culverts • Bridge drainage comprising scuppers • Swales.
Batters and retaining walls	<ul style="list-style-type: none"> • Batter slopes: typically an increase of one metre in height for every four horizontal metres (1-in-4), steepened to a maximum of 2:1 where space is limited (such as westbound approach to the bridge over the railway) • Retaining walls: typically formed of precast concrete base, concrete panels and facing treatments. The retaining wall at the Avenue typically is 2.5 metres high and to the west of the rail bridge is typically 6 metres high.
Traffic signals	<ul style="list-style-type: none"> • Existing traffic lights: timing adjustments: Infantry Parade and Soldiers Way • New traffic lights: Macarthur Drive and The Avenue • Electrical cabling and conduits (provisions included however actual lights excluded).
Street lighting	<ul style="list-style-type: none"> • Heathcote Road: installation of white lights on both sides of the road • Bridges: installation of white lights on both sides of the bridge • Intersections: installation of white lights around the intersection. <p>Note: the configuration, specification, height, and spacing would be confirmed during the detailed design.</p>

Appendix E

Government Agency Consultation

Government agency consultation

Issue raised	Response / where addressed in REF
Department of Defence (DoD)	
<p>With regard to the access tracks on the north of Heathcote Road:</p> <ul style="list-style-type: none"> DoD requires access for light vehicles 	<ul style="list-style-type: none"> Three designs were considered for realignment of the northern access road. Option 2 was selected as the preferred option as it reduces impacts on utilities but will increase impacts to DoD land.
Sydney Trains	
<p>With regard to the access track on the north of Heathcote Road:</p> <ul style="list-style-type: none"> Sydney Trains requires access for a 9.5mFTR900 <p>With regard to the access tracks on the south of Heathcote Road:</p> <ul style="list-style-type: none"> Sydney Trains requires access for a 9.5mFTR900 <p>With regard to rail corridor management and rail systems interface:</p> <ul style="list-style-type: none"> Sydney Trains has different waiver standards to Roads and Maritime Sydney Trains major works would like to be considered first to do electrical relocation works as they are accredited and it is their asset 20% concept design to be sent to Sydney Trains <p>Sydney Trains potentially affected include:</p> <ul style="list-style-type: none"> overhead wiring HV transmission lines signalling assets drainage combined services routes lineside maintenance access and corridor access 	<ul style="list-style-type: none"> Three designs were considered for realignment of the northern access road. Option 2 was selected as the preferred option as it reduces impacts on utilities but will increase impacts to DoD land. Two designs were considered for realignment of the southern access road. Option 2 was selected as the preferred option but will require land or negotiated access rights with DoD. Electrical and asset issues discussed and noted

Appendix F

Utility Adjustments and Consultation

Utility adjustments and consultation

Utility adjustments, realignments and installation

Utility	Location	Relocation, installation, protection or removal
Sydney Water		
Water main	Infantry Parade to Macarthur Drive, located on the northern side of Heathcote Road	Relocation - to the southern side of Heathcote Road, adjacent to the project boundary and under-bored beneath Harris Creek
Water main	Infantry Parade to Macarthur Drive, located on the southern side of Heathcote Road	Relocation - adjacent to the project boundary, including a new crossing of Heathcote Road east of the Macarthur Drive intersection and under-boring beneath Harris Creek
Water main	Chainage 500 to Macarthur Drive, located on the northern side of Heathcote Road	Relocation - to the southern side of Heathcote Road, adjacent to the project boundary, including a new crossing of Heathcote Road, east of the Macarthur drive intersection
Water main	Chainage 500 to Macarthur Drive, located on the northern side of Heathcote Road	Relocation - to the southern side of Heathcote Road, adjacent to the project boundary, including a new crossing of Heathcote Road, east of the Macarthur drive intersection
Water main	From the Holsworthy Army Barracks intersection to The Avenue, located on the northern side of Heathcote Road	Relocation - adjacent to the project boundary, where it will be under-bored beneath Williams Creek
Two sewer mains	Holsworthy Pedestrian Bridge	Relocation - to a new service bridge over Harris Creek (to be confirmed during detailed design)
Two sewer pipes	Williams Creek at Chainage1600	Replace - existing crossing with new sewer pipes
Jemena		
Gas main	On the northern side of Heathcote Road from Infantry Parade to Macarthur Drive intersection where it crosses Heathcote Road and continues south along Macarthur Drive	Relocation - to the southern side of Heathcote Road continuing along the boundary towards the Macarthur Drive intersection where it will cross Macarthur Drive and continue within the shared user path, crossing to the northern side of Heathcote Road at Ch700 to tie back into the existing pipe.

Utility	Location	Relocation, installation, protection or removal
Gas main	Northern side of Heathcote Road at the new army barracks access continuing east to The Avenue	Relocation - into the shared use path where it is impacted by the road upgrade and will tie back into the existing pipe at Ch1800. At the proposed Williams Creek Bridge, space will be allocated to allow for the gas pipe to be laid within the superstructure
Telstra		
Optical fibre	Southern side of Heathcote Road from the railway bridge to the new army barracks intersection	Relocation - adjacent to the Sydney Trains access road
Optical fibre	Crossing Heathcote Road, south of Infantry Parade (Chainage 180)	Lowered beneath the finished road surface level
Optical fibre and empty conduits	Two road crossings at the southern side of the Macarthur Drive intersection	Lowered from the existing location to a greater depth beneath the finished road surface level
Conduits (empty)	North of the Macarthur Drive intersection, three existing Telstra crossings	Lowered from the existing location to a greater depth beneath the finished road surface level
Conduits (empty)	Two P100 conduits cross Heathcote Road at the new army barracks intersection	Lowered from the existing location to a greater depth beneath the finished road surface level
Optus		
Optical fibre	Crossing Heathcote Road, south of Infantry Parade at Chainage 200	Protection – to be confirmed during detailed design, and provision of a new conduit, adjacent to the existing crossing
Powertell		
Inter-capital cable	Contained within the rail corridor	Replacing - the galvanised steel trough section at the rail bridge abutment with a buried route. Once clear of the new bridge abutment, the buried route will connect into a new set of pits. The route will tie back into the existing cable routes, near the top of the embankment on the southern side of the new road bridge

Utility	Location	Relocation, installation, protection or removal
Endeavour Energy		
Underground and overhead services (low and high voltage)	Throughout the length of the project and the northern and southern side of Heathcote Road.	Relocation – to be confirmed during detailed design
APA Group		
Ethane gas pipeline	On the northern side of the railway, within the rail corridor, crossing below Heathcote Road	Protection - with a piled concrete slab spanning the pipeline
NBN Co		
Optical fibre	Southern side of Heathcote Road from the railway bridge to the new army barracks intersection	Relocation - adjacent to the Sydney Trains access road
Department of Defence		
Private water main	Northern side of Heathcote Road from Infantry Parade to Macarthur Drive	Relocation - into Department of Defence land

Utility communication

Issues Raised	Comments
Telstra	
<ul style="list-style-type: none"> Cable crossing Heathcote Road west of the Macarthur Drive roundabout, is not indicated on the Telstra dial before you dig plans 	<ul style="list-style-type: none"> To be investigated further as this may not be a Telstra cable
<ul style="list-style-type: none"> A number of Telstra crossings are required to be realigned 	<ul style="list-style-type: none"> The realignments are as described Table 3.10
<ul style="list-style-type: none"> Telstra requirements and conditions to be incorporated into the design 	<ul style="list-style-type: none"> Standard cover for Telstra conduits is 300 mm below subgrade with a 100 mm cap No requirement for extra conduits for future proofing Estimated detailed design (by Telstra) would require 6-8 weeks to complete
Sydney Water	
<ul style="list-style-type: none"> Ownership of the private water main between Macarthur Drive intersection and Infantry Parade 	<ul style="list-style-type: none"> Sydney Water confirmed that this main is owned by the Department of Defence

Issues Raised	Comments
<ul style="list-style-type: none"> Sydney Water requirements and conditions to be incorporated into the design 	<ul style="list-style-type: none"> Boring of water mains under creeks is Sydney Water preferred method of construction Relocated water mains should maintain suitable clearance from intersections as to not impact intersection and traffic signals
<ul style="list-style-type: none"> The proposal is located in bushfire prone zone 	<ul style="list-style-type: none"> All hydrants and valves to remain visible
Powertel	
<ul style="list-style-type: none"> Feasibility of relocation of intercapital cable located in the railway corridor of road bridge 	<ul style="list-style-type: none"> Powertel to provide inputs and design requirements
Optus	
<ul style="list-style-type: none"> Confirmation sought that Optus crossing of Heathcote Road contains fibre optic cable feeding a mobile tower 	<ul style="list-style-type: none"> Confirmed
<ul style="list-style-type: none"> New conduit is required adjacent to the existing crossing and Optus requirements and conditions to be incorporated into the design 	<ul style="list-style-type: none"> New conduit to be installed via directional drilling During detail design stage, Optus requires three quotes for carrying out relocation works Optus require 6-8 weeks of lead time to allow for network outage All civil construction and replacement fibre must be completely installed before an outage can be requested/scheduled
<ul style="list-style-type: none"> Future requirements for the Optus network in project area 	<ul style="list-style-type: none"> No future requirements are known at this stage
<ul style="list-style-type: none"> Standard for minimum clearance values on roadways 	<ul style="list-style-type: none"> Minimum depth of one metre clearance from finished road surface level
Department of Defence (DoD)	
<ul style="list-style-type: none"> DoD requirements and conditions to be incorporated into the design for the relocation of the private water main running from Infantry Parade to Macarthur Drive roundabout 	<ul style="list-style-type: none"> DoD will engage and provide input to the design and relocation of utilities Sydney Water standards for clearances, offsets, minimum depths etc are acceptable
<ul style="list-style-type: none"> Confirm that the water main is currently operational and that the service is required to be maintained 	<ul style="list-style-type: none"> Confirmed, this main is the water supply for the Holsworthy Barracks and needs to be maintained.

Issues Raised	Comments
<ul style="list-style-type: none"> Advice on shut down and isolation periods that would need to be taken into account in planning for relocation 	<ul style="list-style-type: none"> There are no planned shutdowns for this equipment Repairs are conducted on a reactive basis, if and when needed. The pumps are timed to pump between 1100 – 0500 when called by the telemetry system due to lower water levels in the reservoirs located on base. The reservoirs cater for approximately a weeks' worth of water during normal consumption periods, although this varies during the seasons. The reservoirs also provide all of the Fire water supply on base as well. It would be preferred if any works were to be conducted outside of the peak Bushfire season.
Endeavour Energy	
<ul style="list-style-type: none"> Requested confirmation of provision for ducting, transmission and distribution cables for a future substation in the proposed design 	<ul style="list-style-type: none"> Actioned and logged to be considered in the design process
NBN Co	
<ul style="list-style-type: none"> Location of NBN optical fibre 	<ul style="list-style-type: none"> Confirmed to be within Telstra conduits between Infantry parade and the new Holsworthy Barracks intersection
<ul style="list-style-type: none"> Responsibility for relocation of the NBN fibre 	<ul style="list-style-type: none"> Confirmed to be carried out by Telstra
<ul style="list-style-type: none"> Impact to the NBN conduits under new Macarthur Drive intersection to The Avenue on the southern side of Heathcote Road 	<ul style="list-style-type: none"> Confirmed to be no impact
APA	
<ul style="list-style-type: none"> Details for the ethane gas pipeline including - condition assessment, As-Built drawings, advice on pipe materials and sizing, design standards, exclusion zones for the pipe, design and approval process for protection measures and requirement for APA personnel during construction were requested. 	<ul style="list-style-type: none"> APA require a referral for an engineering assessment for the project. Design approval and relevant information from APA would be granted following the assessment.

Appendix G

Biodiversity Assessment

Appendix H

Hydrology Assessment

Appendix I

Traffic and Transport Assessment

Appendix J

Noise and Vibration Assessment

Appendix K

Aboriginal Heritage Assessment

Appendix L

Non-Aboriginal Heritage Assessment



rms.nsw.gov.au



contactus@rms.nsw.gov.au



Customer feedback
Roads and Maritime
Locked Bag 928,
North Sydney NSW 2059



Transport
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