

Kings Hill Interchange

Review of Environmental Factors

Roads and Maritime Services | September 2019

Chapters 1-5



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Review of Environmental Factors

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Prepared by



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Approval and authorisation

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Dated:	XX

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Executive summary

The proposal

Roads and Maritime Services (Roads and Maritime) proposes a to design and construct a new grade separated interchange (the proposal) over the Pacific Highway at Kings Hill (four kilometres north or Raymond Terrace). The proposal is required to enable safe and efficient access and egress from the proposed Kings Hill Urban Release Area (URA), a residential development that adjoins the Pacific Highway and is proposed to support 3,500 residential dwellings.

The main features of the proposal are:

- A new overpass across the Pacific Highway (about one kilometre north of Irrawang Spillway)
- A new road (the East-West Link road) that would connect the Kings Hill Urban Release Area (Kings Hill URA) to the proposed interchange. It would run in an east-west direction from the future Kings Hill town centre intersection (which falls outside the scope of this proposal)
- Two northbound (entry and exit) and two southbound (entry and exit) ramps that would connect the East-West Link road and the Pacific Highway and enable all northbound and southbound movements
- A roundabout that would connect the East-West Link road to the interchange
- Relocation of the existing Hunter Water maintenance track access point
- Relocation of existing utilities
- Drainage infrastructure (e.g. swales or pipes) that would convey surface flows from the interchange into detention basins, which would discharge into existing culverts located beneath the Pacific Highway.

Need for the proposal

In 2010, the New South Wales Government rezoned land at Kings Hill, located north of Raymond Terrace within the Port Stephens Local Government Area (LGA). Previously rural land, this rezoned land would support a mix of general residential, mixed use and local centre land use zones and is expected to yield in excess of 3,500 residential dwellings over a 25-year period.

Kings Hill Development Pty Ltd (KHD) is the majority landowner of this rezoned land known as Kings Hill URA, where KHD proposes residential, mixed use and commercial development.

Before granting development consent to any development application for subdivision of the rezoned land, Port Stephens Council (Council) requires satisfactory arrangements be made under the *Port Stephens Local Environmental Plan 2013* (Port Stephens LEP) including suitable vehicular access from the Kings Hill URA to the Pacific Highway. As such, access and egress to the new residential subdivision development is proposed from the Pacific Highway via the proposed interchange.

Proposal objectives

The objectives of the proposal are to:

- Provide suitable vehicular access from the Kings Hill URA to the Pacific Highway, for future traffic associated with the Kings Hill URA, without impeding the safe and efficient operation of the Pacific Highway as part of the national highway network
- Deliver a proposal that is sympathetic with the surrounding landscape and future surrounding land uses, minimises impacts on the natural and built environment and is compatible with the Pacific Highway urban design principles and objectives

- Provide Kings Hill URA with flood-immune access to the Pacific Highway for a 1 in 20-year event.

Options considered

Three options were considered:

- Option 1: do nothing.
- Option 2: provide a northbound access and egress via a left turn from the Pacific Highway into Kings Hill URA, and left turn out of Kings Hill URA onto the Pacific Highway, on the eastern boundary of Kings Hill URA
- Option 3: provide a full 'all-movements' interchange at the Pacific Highway on the eastern boundary of Kings Hill URA.

Option 3 has been selected as the preferred option as it best meets the proposal objectives, by providing for the long-term traffic capacity needs of the 3,500 residential dwellings that are proposed to be constructed at Kings Hill, and providing safe and efficient vehicular access from the Kings Hill URA to the Pacific Highway.

Option 3 involves the provision of a new grade separated 'all-movements' interchange for the Pacific Highway. This interchange would allow residents of Kings Hill to access both the northbound and southbound carriageway of the Pacific Highway, and for users of the northbound and southbound carriageway of the Pacific Highway to access Kings Hill.

This option would have the highest capital expenditure and would require the removal of a larger area of vegetation than options 1 or 2. Drainage infrastructure (e.g. swales, pipes, detention and/or water quality treatment basins) would be required to manage surface flows from the interchange. Option 3 would also have temporary traffic impacts on users of the Pacific Highway during construction.

Statutory and planning framework

Roads and Maritime are seeking approval under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The proposal is categorised as development for the purpose of a road and is being carried out by Roads and Maritime. Clause 94 of the *State Environmental Planning Policy (Infrastructure) 2007* 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. Therefore, the proposal is permissible without consent. The proposal is not State Significant Infrastructure, State Significant Development or Designated Development. Development consent under Part 4 of the EP&A Act from Council is not required.

Roads and Maritime is the determining authority for the proposal. This REF has been prepared in accordance with Roads and Maritime REF guidelines and fulfils Roads and Maritime's obligation under Section 5.5 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.

The proposal is not located on land reserved under the *National Parks and Wildlife Act 1974* and does not affect land or development regulated by *State Environmental Planning Policy (State and Regional Development) 2011* or *State Environmental Planning Policy (State Significant Precincts) 2005*.

This REF fulfils the requirements of Section 5.5 of the EP&A Act and has been prepared in line with clause 228 of the *Environmental Planning and Assessment Regulation 2000*. It has also considered the *Biodiversity Conservation Act 2016* (BC Act), the *Fisheries Management Act 1994* (FM Act), and the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The proposal would be unlikely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the EPBC Act. A referral to the Australian Department of the Environment and Energy is not required.

Community and stakeholder consultation

Extensive consultation has been undertaken for the development of the proposal with multiple stakeholders since 2014, including:

- Hunter Water
- Council
- Roads and Maritime
- Dams Safety Committee
- Telstra
- Ausgrid
- Affected landowners
- Worimi Local Aboriginal Land Council representatives.

The REF will be placed on public exhibition for a minimum of 30 days. During this time, the community, government agencies and other interested parties are invited to make written submissions on the proposal. Roads and Maritime would then prepare a submissions report to respond to the issues raised in the submissions.

If the proposal is determined by way of approval, Roads and Maritime will continue to consult with government agencies, affected residents and other relevant stakeholders before and during construction. Roads and Maritime would also continue to consult with service and utility providers to ensure the design adheres to their requirements and that no services are inadvertently impacted by the proposal.

Environmental impacts

The proposal would have some temporary and permanent environmental impacts. A number of detailed technical investigations have been completed to assess impacts of the proposal and to identify mitigation and management measures. The most prominent impacts of the proposal are summarised below.

Traffic and access

During construction, road users of the Pacific Highway would experience the following impacts:

- Increased traffic due to construction vehicles
- Reduced speed limits
- Temporary lane closures.

A Traffic Management Plan (TMP) will be prepared as part of the Construction Environment Management Plan (CEMP) during detailed design of the proposal and implemented during construction of the proposal. The CTMP will describe how impacts during construction would be managed, to minimise delays and disruptions to the local road network. The CTMP will demonstrate how the mitigation measures proposed will enable acceptable traffic operations and level of service on the Pacific Highway and other haulage roads during construction.

During operation, the proposal would provide safe and efficient access and egress from the Kings Hill URA. Access to the Pacific Highway via Six Mile Road could potentially be removed by the closure of Six Mile Road at the Pacific Highway. This closure would occur only after suitable alternative access to the proposal, via the Kings Hill internal road network, is established.

The relocated access point for the Hunter Water Grahamstown Dam maintenance access track would connect to the Pacific Highway at a point between the existing access track and the proposal, on the south bound entry ramp to the highway. This location was determined in consultation with Hunter Water and Roads and Maritime.

Existing direct vehicular access to the Pacific Highway from the Riding for the Disabled property (3217 Pacific Highway) would be maintained in its current condition until the proposal is operational. Upon opening of the proposal to traffic, direct access to Riding for the Disabled from the Pacific Highway would be closed, and access would be provided via a connection to the Kings Hill internal road network to the proposal. Current direct access to the Pacific Highway for the residential property at 3385 Pacific Highway would be maintained in its existing condition during operation of the proposal.

Biodiversity

The biodiversity assessment determined that the proposal would require the removal of 27.64 hectares of various types of vegetation, of which 12.00 hectares conforms to the Plant Community Type (PCT) Spotted Gum - Broad-leaved Mahogany – Red Ironbark Shrubby Open Forest. This PCT is not commensurate with a Threatened Ecological Community. Other vegetation occurring in the study area does not conform to the definition of a PCT.

The proposal would result in the removal of potential habitat for four threatened flora species and 25 threatened fauna species known to occur in the study area, or that have a Moderate or High likelihood of occurring in the study area. Three threatened fauna species were recorded from within the study area during surveys by Arcadis in 2017 and 2019:

- Koala (*Phascolarctos cinereus*) (Vulnerable – BC Act, Vulnerable Population – EPBC Act)
- Little Lorikeet (*Glossopsitta pusilla*) (Vulnerable – BC Act)
- Grey-Headed Flying-Fox (*Pteropus poliocephalus*) (Vulnerable – BC Act and EPBC Act).

Fauna habitat to be removed includes:

- A total of 20 hollow-bearing trees that offer sheltering and breeding habitat to hollow-dependant fauna, including threatened microbats, birds and gliders
- Up to 12.00 hectares of Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest containing varying abundances of koala feed trees.

Assessments of significance were undertaken for all relevant threatened species, populations and communities listed under the BC Act that were recorded. Significant impact assessments were undertaken for the threatened species and communities listed under the EPBC Act that were recorded or for which habitat occurs in the biodiversity study area. The proposal is not likely to significantly impact threatened species, populations or ecological communities or their habitats, within the meaning of the BC Act or the (FM Act) and therefore a Species Impact Statement is not required. The proposal is not likely to significantly impact threatened species, populations, ecological communities or migratory species, within the meaning of the EPBC Act.

The proposal would not affect habitat critical to the survival of the species and would not substantially interfere with the recovery of the species. As such, the proposal is unlikely to have a significant impact on the Koala in accordance with Figure 1 of the *EPBC Act Referral Guidelines for the vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)* (DoE, 2014). An EPBC Referral is not considered necessary.

The biodiversity assessment prescribes a number of safeguards and compensatory measures, in accordance with *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA 2011), to be implemented to avoid, reduce and minimise potential impacts on biodiversity of the study area.

A Flora and Fauna Management Plan (FFMP) will be prepared and implemented as part of the Construction Environmental Management Plan (CEMP). The FFMP will identify all reasonably foreseeable risks relating to biodiversity values of the study area and describe how these risks will be addressed during construction.

Soil, contamination and water

During construction (particularly earthworks), there is a high risk of dispersal of sediments and water pollutants, and adverse impacts on downstream water quality, particularly in proximity to the dam foreshore in the northern extent of the proposal.

Dispersal of sediments and water pollutants may result in soil erosion, siltation and off-site movement of eroded sediments by wind and/or stormwater into receiving waters, and ultimately downstream environments such as Grahamstown Dam and Irrawang Swamp (located within a Coastal Wetland listed under the *State Environmental Planning Policy (Coastal Management) 2018*). If unmanaged, construction activities could adversely affect downstream water quality, by resulting in an increase in levels of turbidity and sediment deposition, a decrease in dissolved oxygen, and changes to pH levels in receiving waters. Accidental fuel and chemical spills and contaminated runoff from construction vehicles, plant, equipment or chemical storage areas have the potential to reach receiving waters or infiltrate into the groundwater.

These potential impacts are proposed to be managed by implementing standard construction soil erosion and sediment controls designed and constructed in accordance with *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004; DECC, 2008). In addition, A Soil and Water Management Plan (SWMP) will be prepared and implemented as part of the Construction Environmental Management Plan (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.

Operational impacts on downstream environments would be mitigated by the effective stormwater management infrastructure, such as table drains, detention basins and/or water quality treatment basins. Treated stormwater would then flow to the proposed stormwater channel (concurrent proposal subject to separate assessment and approval) and ultimately south to Irrawang Spillway. It has been determined that the various stormwater treatments prior to water discharging into Irrawang Spillway would not adversely impact water quality within Irrawang Swamp, as a result of the operation of the proposal. It has been determined that even major rainfall events would not result in a significant increase in water levels in Irrawang Swamp. In the event that the proposed stormwater channel is not constructed, alternative drainage infrastructure that would be required to treat and discharge surface flows would be developed during detailed design of the proposal.

A preliminary waste classification of material expected to be excavated within the impact areas of the proposed interchange and stormwater channel (concurrent proposal) was undertaken by Douglas Partners. The results show that the majority of soils tested are classified as Virgin Excavated Natural Material (VENM) and would be suitable for re-use on site. This material is proposed to be used for the construction of the entry and exit ramp embankments. It would also act as a barrier to future exposure and disturbance of any existing contamination present.

Soil testing prior to or during construction would be required to confirm the presence or absence of contamination. If contaminated areas are encountered during construction, appropriate control measures will be implemented to manage the immediate risks of contamination. If acid sulfate soils are encountered, they would be managed and disposed in accordance with the *Acid Sulfate Soils Manual* (Acid Sulfate Soils Management Advisory Committee, 1998). Any contaminated soils would be disposed off-site in accordance with the *NSW Waste Classification Guidelines* (EPA, 2014).

Justification and conclusion

This REF has found that the environmental impacts of the proposal are not likely to be significant and therefore it is not necessary for an Environmental Impact Statement (EIS) to be prepared and approval to be sought for the proposal from the Minister for Planning under Division 5.2 of the EP&A Act. The proposal is unlikely to significantly affect threatened species, populations or ecological communities or their habitats, within the meaning of the BC Act or FM Act, and therefore a species impact statement is not required. The proposal is also unlikely to significantly affect Commonwealth land or have a significant impact on Matters of National Environmental Significance.

The proposal would meet its objectives and would be consistent with the requirements of Council, NSW Government planning and transport policies, and relevant strategic planning and transport policies. The proposal has been designed in line with Roads and Maritime road design guidelines, safety and traffic efficiency requirements. The proposal would deliver substantial road safety and road user benefits, by providing suitable and safe vehicular access from the Kings Hill URA to the Pacific Highway.

Display of the review of environmental factors

This REF is on display for comment between [date and date]. You can access the documents in the following ways:

Internet

The documents are available as pdf files on the Roads and Maritime website at [insert website address] [if applicable add the 'Have your say' website]

Printed copies

The documents can be viewed at the following locations:

[List exhibition venues, including street address (with floor level if required) and provide other details where necessary, eg this location will be staffed between 10am to 2pm, etc. Locations could include the local library, Roads and Maritime office and Council office.]

Copies by request

Printed and electronic copies are available by contacting [add contact name and number], noting that there may be a charge for hard copies, CD or USB.

Staffed displays

[Day/ date / times / locations]

How can I make a submission?

To make a submission about this proposal, please send your written comments to:

[Mail]

[Email]

Submissions must be received by [day/date]. Submissions will be managed in accordance with the Roads and Maritime Services Privacy Statement which can be found here [X] or by contacting [XX] for a copy.

What happens next?

Roads and Maritime will collate and consider the submissions received during public display of the REF.

After this consideration, Roads and Maritime will determine whether or not the proposal should proceed as proposed and will inform the community and stakeholders of this decision.

If the proposal is determined to proceed, Roads and Maritime will continue to consult with the community and stakeholders prior to and during construction.

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- Appendix B Clause 228 Checklist and Matters of National Environmental Significance
- Appendix C Pacific Highway Interchange at Kings Hill-Revised Concept Design: Updated Traffic Modelling and Assessment (Hyder Consulting, 2014)
- Appendix D Kings Hill REF Construction Route Assessment Technical Note (Arcadis, 2019)
- Appendix E Kings Hill Interchange and Drainage Channel: Traffic and Construction Noise Assessment (Wilkinson Murray, 2017)
- Appendix F Aboriginal and Cultural Heritage Consultation and Investigation: Kings Hill Interchange and Stormwater Channel (Myall Coast Archaeological Services, 2019)
- Appendix G Kings Hill Grade Separated Interchange Urban Design Memo (Spackman Mossop and Michaels 2013)
- Appendix H Kings Hill Interchange Biodiversity Assessment (Arcadis, 2019)
- Appendix I Assessment of the Kings Hill development impacts on Irrawang Swamp ecology (Alluvium, 2019)
- Appendix J Flood Study for Proposed Stormwater Diversion Channel (Northrop, 2016)
- Appendix K Report on Preliminary Geotechnical Investigation Proposed Grade Separated Interchange Kings Hill Development (Douglas Partners, 2015)
- Appendix L Water Quality Report for Proposed Stormwater Diversion Channel Kings Hill Urban Release Area (Northrop, 2017)

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

1.1.1 Description of the proposal

Roads and Maritime Services (Roads and Maritime) proposes to build a new grade separated interchange (the proposal) over the Pacific Highway at Kings Hill. The main features of the proposal are:

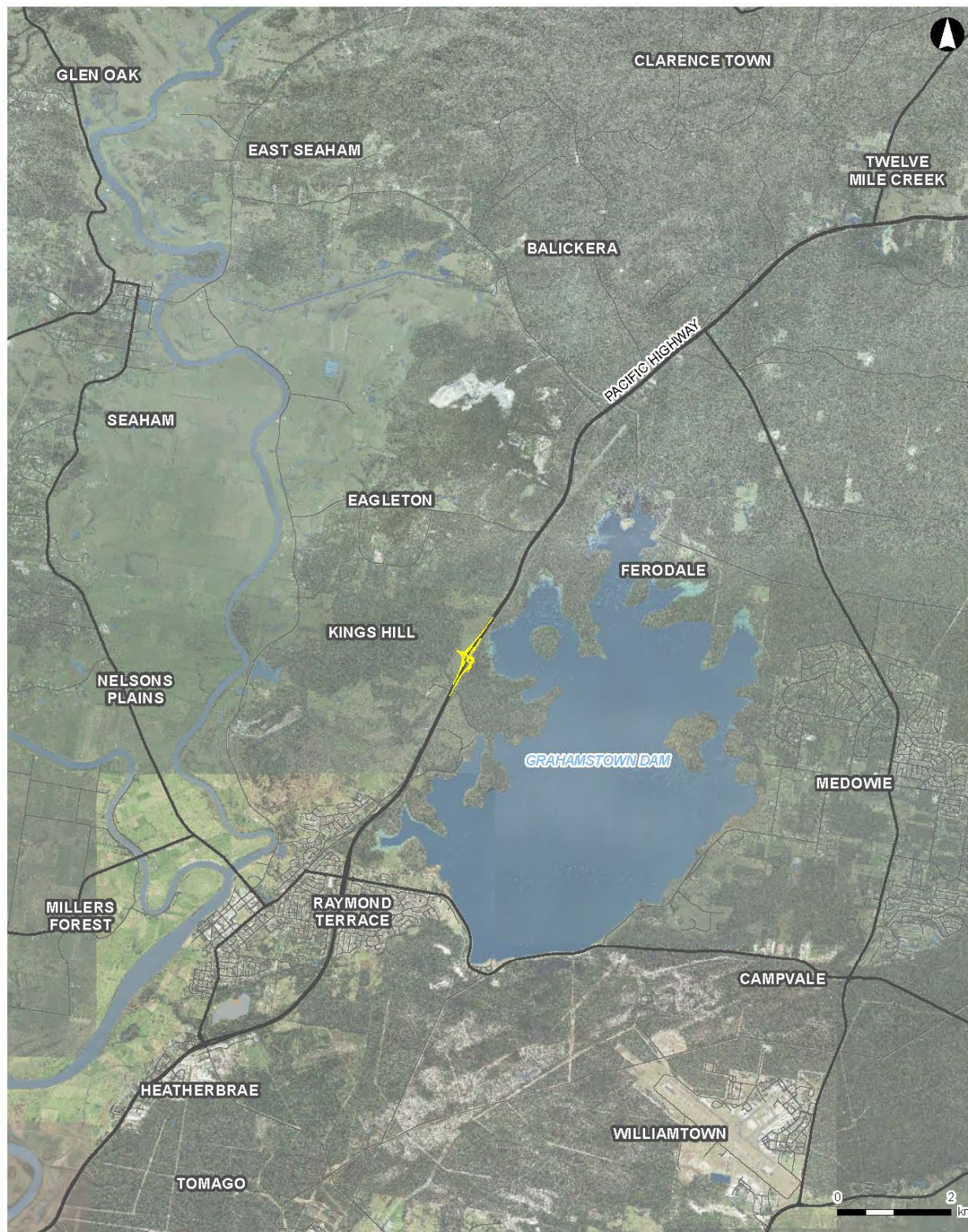
- A new overpass across the Pacific Highway (about one kilometre north of Irrawang Spillway)
- A new road (the East-West Link road) that would connect the Kings Hill Urban Release Area (Kings Hill URA) to the proposed interchange (Figure 2-2). It would run in an east-west direction from the future Kings Hill town centre intersection (which falls outside the scope of this proposal)
- Two northbound (entry and exit) and two southbound (entry and exit) ramps that would connect the East-West Link road and the Pacific Highway and enable all northbound and southbound movements
- A roundabout that would connect the East-West Link road to the interchange
- Relocation of the existing Hunter Water maintenance track access point
- Drainage infrastructure (e.g. swales or pipes) that would convey surface flows from the interchange into detention basins, which would discharge into existing culverts located beneath the Pacific Highway.
- Establishment of temporary ancillary facilities for the duration of construction; including access tracks and compound areas that would support site offices, workforce parking, plant storage, laydown areas and material stockpiling areas. Temporary ancillary facilities would be rehabilitated at completion of construction of the proposal.

The proposal has been developed to a concept level and would be further refined during the detailed design phase.

Construction of the proposal would also require the relocation of three types of essential services that are currently situated in (and therefore conflict with) the impact area:

- Ausgrid 11kV overhead power line
- Telstra underground Optic Fibre and Copper communication lines
- Hunter Water Corporation 33kV overhead power line.

The location of the proposal in a regional context is provided in **Error! Reference source not found.** Section **Error! Reference source not found.** and Figure 3-1 describes the proposal in more detail.



LEGEND

- Proposed interchange
- Major road
- Minor road

Coordinate System: GDA 1994 MGA Zone 56
Date issued: September 17, 2019
Aerial imagery supplied by NSW LPI

1:100,000 at A4



Figure 1-1 Location of the proposal

1.1.2 Background to the proposal

In 2010, the New South Wales Government rezoned land at Kings Hill, located north of Raymond Terrace within the Port Stephens Local Government Area (LGA). Previously rural land, this rezoned land would support a mix of general residential, mixed use and local centre land use zones and is expected to yield in excess of 3,500 residential dwellings over a 25-year period.

Kings Hill Development Pty Ltd (KHD) is the majority landowner of this rezoned land known as Kings Hill URA, where KHD proposes residential, mixed use and commercial development.

Before granting development consent to any development application for subdivision of the rezoned land, Port Stephens Council (Council) requires satisfactory arrangements be made under the *Port Stephens Local Environmental Plan 2013* (Port Stephens LEP) including suitable vehicular access from the Kings Hill URA to the Pacific Highway. As such, access and egress to the new residential subdivision development is proposed from the Pacific Highway via the proposed interchange.

1.2 Proposal location

The proposal is located at Kings Hill within the Port Stephens LGA, approximately four kilometres north of Raymond Terrace, 25 kilometres north of Newcastle and 135 kilometres north of Sydney. The proposal is within the Roads and Maritime Hunter and Central Coast region.

The proposal would be located on land owned by Roads and Maritime and KHD known as:

- The Pacific Highway road reserve
- Lot 41 DP 1037411
- Lot 31 and 32 DP 1185385.

During construction, additional land would also be impacted, including:

- Lot 113 DP 733181
- Lot 4821 and 4822 DP 852073
- Lot 481 DP 804971
- Lot 5 DP 234521.

Impacted lots are shown in Figure 1-2.

The surrounding landscape comprises a mosaic of large tracts of native vegetation within private and publicly owned land, patches of cleared land used for agricultural purposes (primarily grazing) and rural-residential properties. Kings Hill, to the west of the proposal (across the Pacific Highway), comprises of land that was rezoned by the New South Wales Government in 2010, from rural land to General Residential, Mixed Use and Local Centre land use zones. This land is currently used for cattle grazing and further west, native vegetation covers the slopes and natural ridge line of Kings Hill. This vegetated area has been rezoned as E2 Environmental Conservation.

A more detailed description of the existing environmental context is presented in Section 6 of this REF.



Figure 1-2 Impacted lots

1.2.1 Study area

For the purpose of this assessment, the study area covers 53.6 hectares and comprises a 50-metre buffer of the proposed interchange and compound areas (Figure 1-3). The study area also covers two proposed stormwater detention basins and the proposed 3.1-kilometre alignment of the Telstra optic fibre cable that is required to be relocated. The study area encompasses the existing Pacific Highway, land to the east and west of the highway (including the western shore of Grahamstown Dam) and land currently owned and managed by Hunter Water Corporation (Hunter Water) adjacent to the Grahamstown Dam (the Hunter's largest drinking water supply dam).

1.2.2 Impact area

For the purpose of this assessment, the impact area covers 33.8 hectares and comprises of land that would be directly impacted by construction of the proposal (Figure 1-3). This includes a 20-metre buffer on the interchange footprint, a 10-metre buffer on compound areas, a 5-metre buffer on proposed access tracks and a 2.5 metre buffer of proposed access to the proposed Telstra optic fibre alignment. Existing access tracks would be excluded in the impact area as no direct works would be undertaken in these areas.

1.3 Purpose of the report

This review of environmental factors (REF) has been prepared by Arcadis Australia Pacific Pty Ltd (Arcadis) on behalf of Roads and Maritime. For the purposes of these works, Roads and Maritime is the proponent and the determining authority under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The purpose of the REF is to describe the proposal, to document the likely impacts of the proposal on the environment, and to detail mitigation and management measures to be implemented.

The description of the proposed work and assessment of associated environmental impacts has been undertaken in the context of Clause 228 of the *Environmental Planning and Assessment Regulation 2000*, the *Biodiversity Conservation Act 2016* (BC Act), the *Fisheries Management Act 1994* (FM Act), and the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In doing so, the REF helps to fulfil the requirements of Section 5.5 of the EP&A Act including that Roads and Maritime examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity.

The findings of the REF would be considered when assessing:

- Whether the proposal is likely to have a significant impact on the environment and therefore the necessity for an Environmental Impact Statement to be prepared and approval to be sought from the Minister for Planning under Division 5.2 of the EP&A Act
- The significance of any impact on threatened species as defined by the BC Act and/or FM Act, in Section 1.7 of the EP&A Act and therefore the requirement for a Species Impact Statement or a Biodiversity Development Assessment Report
- The significance of any impact on nationally listed biodiversity matters under the EPBC Act, including whether there is a real possibility that the activity may threaten long-term survival of these matters, and whether offsets are required and able to be secured
- The potential for the proposal to significantly impact any other matters of national environmental significance or Commonwealth land and the need, subject to the EPBC Act strategic assessment approval, to make a referral to the Australian Government Department of the Environment and Energy for a decision by the Commonwealth Minister for the Environment on whether assessment and approval is required under the EPBC Act.

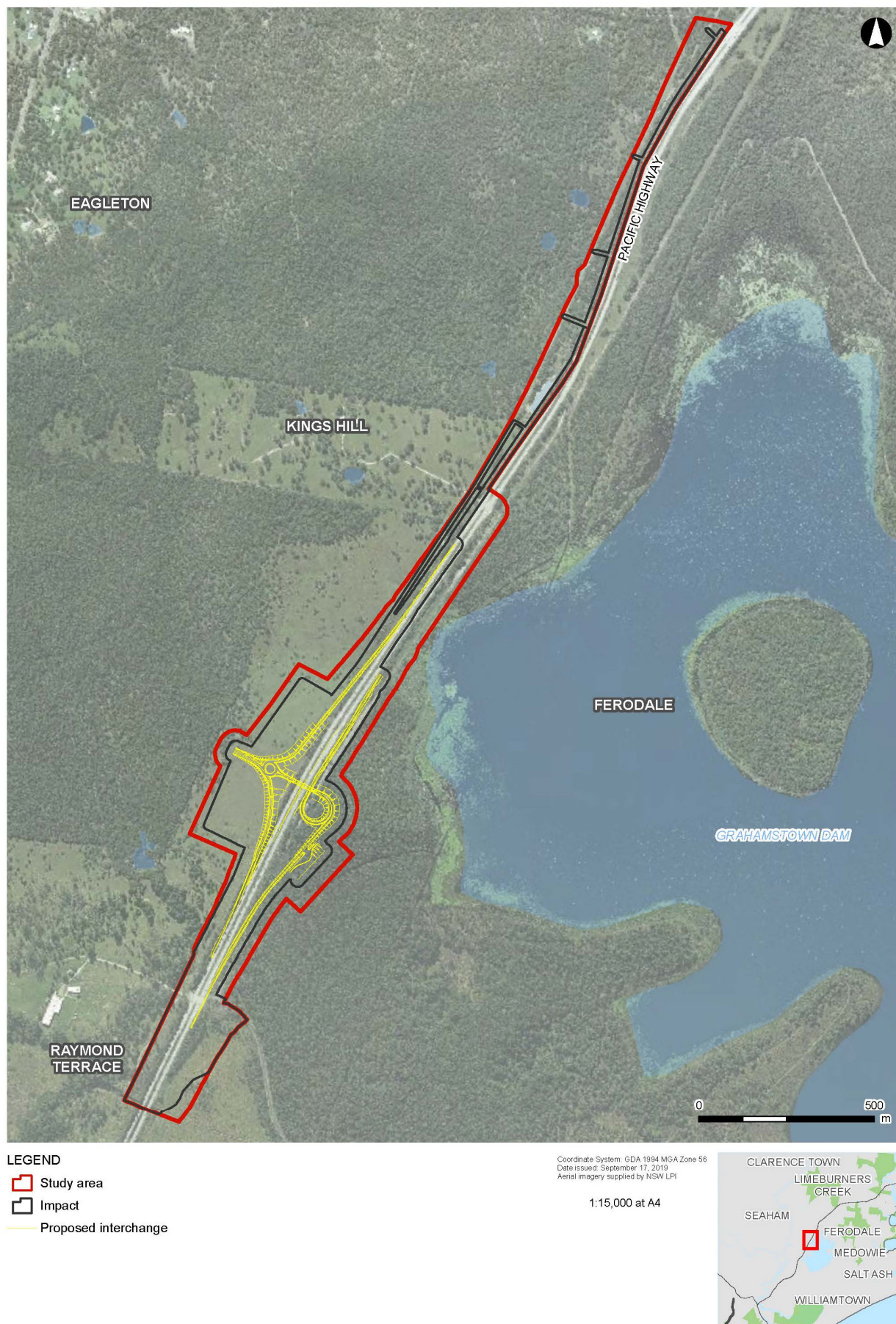


Figure 1-3 Study area and impact area

1.4 Concurrent proposal

The existing Pacific Highway is elevated slightly above the eastern-most extent of Kings Hill URA and acts as a major hydraulic control for runoff discharging downslope towards the Grahamstown Dam. There are existing culverts that convey stormwater flows from the western side of the Pacific Highway, under the Pacific Highway and towards the Grahamstown Dam.

Hunter Water requires that should development at Kings Hill occur, runoff from the eastern catchment area of the URA would need to be prevented from entering the Grahamstown Dam. To comply with this requirement, Roads and Maritime proposes to construct a stormwater channel on the eastern side of the Pacific Highway, between the road corridor and the Grahamstown Dam. The stormwater channel would convey post development flows, treated at source within the URA on the west of the Pacific Highway, and prevent stormwater entering into the Grahamstown Dam for any rainfall event up to the 0.2% Annual Exceedance Probability (AEP).

The stormwater channel would be about 3.5 kilometres in length, parallel to the Pacific Highway between a point 80 metres south of the Pacific Highway and Six Mile Road intersection and the proposed discharge point at Irrawang Spillway.

A separate REF has been prepared for the proposed stormwater channel, that will be subject to assessment and approval by Council (as the determining authority for that infrastructure). While these are separate standalone proposals, there are aspects that may overlap and have the potential for cumulative impacts. In particular, some of the temporary ancillary facilities (e.g. compound areas and access tracks) are proposed to be shared during construction of the stormwater channel and interchange, if both proposals are constructed concurrently. Therefore, engineering constraints (Section 3.2.2) and cumulative impacts of the interchange and stormwater channel (Section 6.12) have been considered in this REF.

2. Need and options considered

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

2.1 Strategic need for the proposal

This section describes the compatibility of the proposal with key strategic planning and policy documents. The documents relevant to the proposal are:

- *NSW 2021 Plan* (Department of Premier and Cabinet, 2011)
- *State Infrastructure Strategy 2018* (iNSW, 2018)
- *Hunter Regional Transport Plan* (Transport for NSW (TfNSW), 2014)
- *NSW Long Term Transport Masterplan* (TfNSW, 2012)
- *Hunter Regional Plan 2036* (Department of Planning and Environment (DPE), 2016)
- KHD URA Revised Concept Development Application – Stage 1 (DA 16-2018-772-1)
- *Port Stephens Local Environmental Plan 2013* (refer to Section 4.1.4)

These documents are discussed in the following sections.

2.1.1 NSW 2021 plan

The Premier of NSW has announced 12 key priorities of the NSW Government that will grow the economy, deliver infrastructure, protect the vulnerable, and improve health, education and public services across NSW.

The priorities relevant to the proposal are:

- Delivering infrastructure: Key metropolitan, regional and local infrastructure projects to be delivered on time and on budget
- Making housing more affordable: Deliver 61,000 housing completions on average per year to 2021
- Creating jobs: 150,000 new jobs by 2019.

The proposal would support these priorities by providing local infrastructure for future residents of Kings Hills, specifically, safe vehicular access to and from Kings Hill and the Pacific Highway. Provision of this safe vehicular access will allow for the development of housing at Kings Hill, which is expected to yield in excess of 3,500 residential dwellings over a 25-year period.

Construction of the interchange would contribute to building a locally skilled workforce by creating jobs for the construction sector, and ultimately would support the growth of Kings Hill, activate local economies (e.g. in Kings Hill town centre and surrounding centres such as Raymond Terrace and Newcastle) and improve accessibility to Kings Hill.

2.1.2 State Infrastructure Strategy

The *State Infrastructure Strategy 2018* (iNSW, 2018) identifies proposals and reforms which will accelerate growth and deliver benefits to the NSW community.

With regard to geographic infrastructure directions, the NSW Government's responses relevant to the proposal include improving transport connections to key markets, upgrades to social infrastructure in regional hubs and supporting regional hubs to act as effective centres serving their surrounding regional populations. The proposal would support the strategy's strategic objectives by connecting future development to the existing Pacific Highway enabling connections to a new regional hub.

2.1.3 Hunter Regional Transport Plan

The *Hunter Regional Transport Plan* (TfNSW, 2014) was prepared to support the *NSW Long Term Transport Masterplan* (TfNSW, 2012), as the Hunter is one of 10 regional centres in NSW that has specific local transport needs and priorities, which require specific consideration and planning. The *Hunter Regional Transport Plan* outlines specific actions to address transport challenges such as:

- An increase in travel demand as the population increases
- An increase in demand to travel for healthcare, medical as the population ages
- Need for more specialist transport services to cater for limited mobility and to reduce social isolation
- An increase in for improved public transport connections
- An increase in demand and congestion on strategic and local road network during peak holiday travel periods
- An increase in freight growth requiring delivery of the right network capacity and configuration.

The proposal would provide a safe vehicular connection between Kings Hill and the Pacific Highway, without impeding the safe and efficient operation of the Pacific Highway as part of the national highway network, including during peak holiday travel periods. The proposal would provide residents of Kings Hill with access to surrounding centres such as Raymond Terrace and Newcastle, that offer healthcare and medical services.

2.1.4 NSW Long Term Transport Masterplan

The *NSW Long Term Transport Masterplan* (TfNSW, 2012) sets the direction for transport planning and delivery for the next two decades. It aims to ensure the State's infrastructure priorities, including the *State Infrastructure Strategy*, are taken forward in an integrated manner.

The plan also identifies the Newcastle – Tweed Heads Pacific Highway corridor as having strategic value in supporting economic development and population and employment growth. Keeping these corridors open and performing well in moving both people and freight efficiently is important to the broader regional and NSW economies. The proposal would improve connectivity and accessibility to the future development at Kings Hill without constraining or compromising the performance of the Pacific Highway as a strategic economic corridor.

2.1.5 Hunter Regional Plan 2036

The *Hunter Regional Plan 2036* (DPE, 2016) is a 20-year blueprint for the future of the Hunter. The Plan's vision is to create a leading regional economy in Australia, with a vibrant metropolitan city at the heart through the achievement of four goals: a leading regional economy in Australia; a biodiversity-rich natural environment; thriving communities; and greater housing choice and jobs.

The Plan identifies the Kings Hill URA as one of the three future housing opportunities for the Port Stephens Local Government Area (LGA). The proposal would provide safe vehicular access for these residents to and from Kings Hill and the Pacific Highway. It would also support the growth of Kings Hill; development of its town centre would provide local jobs, while providing access to surrounding centres such as Raymond Terrace and Newcastle. The proposal is infrastructure that is critical to the development of land at Kings Hill and therefore is considered consistent with the Plan.

2.1.6 KHD URA Concept Development Application

The *KHD Revised Concept Development Application* (DA 16-2018-772-1) Concept Development for future Residential Subdivision and Stage 1 Subdivision (Initial Site Preparation) is not a statutory document but defines the key elements of the physical structure of the Kings Hill site and outlines proposed development for the site, including number of lots, access and collector roads, open spaces, stormwater catchments and

environmentally sensitive zones. The proposal is located east of the junction of the East-West Collector Road and North-South Collector Road. Primary access to Kings Hill would be provided by the proposal.

The KHD Revised Concept Development Application was submitted to council on 23 November 2018 and placed on public exhibition from 6 June 2019 to 11 July 2019. It is currently under assessment by Council and the Joint Regional Planning Panel (JRPP). The proposal is infrastructure that is critical to the development of Kings Hill URA.

2.2 Existing infrastructure

While native vegetation has been historically cleared from low-lying land on the western side of the Pacific Highway for agricultural purposes (primarily cattle grazing), there are no internal roads or residential or commercial properties on land owned by KHD at Kings Hill. Existing infrastructure includes:

- Ausgrid 11kV overhead power line that is currently located within KHD-owned land on the western side of the Pacific Highway
- Telstra underground Optic Fibre and Copper communication lines, located within KHD-owned and Gwynvill Trading Pty Ltd (Gwynvill) owned land on the western side of the Pacific Highway
- Hunter Water 33kV overhead power line, located within KHD-owned land on the western side of the Pacific Highway, crosses to the eastern side of the Pacific Highway (in the middle of the proposal footprint), where it continues north on the eastern side of the Pacific Highway.

The Pacific Highway at Kings Hill is a dual carriageway with a plain concrete pavement. The northbound and southbound carriageways each have two lanes with a speed limit of 110 kilometres per hour. A revegetated median approximately seven metres wide separates the carriageways. A guardrail is provided alongside the northbound and southbound carriageways where Irrawang Spillway is located beneath the highway, south of the proposal.

Six Mile Road, located two kilometres north of Kings Hill, is an unsealed rural road with a speed limit of 80 kilometres per hour, which connects the Pacific Highway to Newline Road in the west. There are no other public roads in proximity to the proposal.

A chain-link, floppy-top fauna fence is located on the eastern side of the Pacific Highway, that extends from an existing Hunter Water maintenance track access point into the Grahamstown Dam, located 350 metres north of Irrawang Spillway, to beyond the northern extent of the study area.

2.3 Proposal objectives

The objectives of the proposal are to:

- Provide suitable vehicular access from the Kings Hill URA to the Pacific Highway, for future traffic associated with the Kings Hill URA, without impeding the safe and efficient operation of the Pacific Highway as part of the national highway network
- Deliver a proposal that is sympathetic with the surrounding landscape and future surrounding land uses, minimises impacts on the natural and built environment and is compatible with the Pacific Highway urban design principles and objectives
- Provide Kings Hill URA with flood-immune access to the Pacific Highway for a 1 in 20-year event.

2.4 Alternatives and options considered

To meet the proposal objectives, several options that could provide suitable vehicular access from the Kings Hill URA were developed. Development of these options was informed by:

- *Port Stephens Council Report for Kings Hill Residential Lands Rezoning Traffic and Transport Study* (GHD, 2013). GHD was commissioned by Council to undertake a high level, strategic traffic and transport study. The study investigated the capability of the existing road and transport network, calculated the future traffic generated by the development of Kings Hill, identified development-related trigger points for road infrastructure improvement and developed future traffic scenarios for the road network surrounding Kings Hill (including an assessment of network performance)
- *Pacific Highway Interchange at Kings Hill: Updated Traffic Modelling and Assessment* (Hyder Consulting, 2014a). This report, prepared for Roads and Maritime by Arcadis (formerly Hyder Consulting), examined the traffic performance of the interchange design, following feedback on the initial interchange design provided by Roads and Maritime in May 2014
- *Technical Note: Kings Hill Development, Infrastructure Upgrade Needs without the Interchange* (Hyder, 2014b). This technical note described preliminary findings from a scenario where the interchange was not constructed, based on traffic data reported in *Kings Hill Residential Lands Rezoning Traffic and Transport Study*
- Extensive consultation with Roads and Maritime since 2014 (refer to Section 5.4).

Three options were considered:

- Option 1: do nothing.
- Option 2: provide a northbound access and egress via a left turn from the Pacific Highway into Kings Hill URA, and left turn out of Kings Hill URA onto the Pacific Highway, on the eastern boundary of Kings Hill URA
- Option 3: provide a full 'all-movements' interchange at the Pacific Highway on the eastern boundary of Kings Hill URA

2.4.1 Option 1: Do nothing

Under Option 1, development of the interchange would not occur. However, Council requires satisfactory arrangements be made under the Port Stephens LEP including suitable vehicular access from the Kings Hill URA to the Pacific Highway (as described in Section 2.1). The proposal is required to enable development at Kings Hill and facilitate future traffic travelling between Kings Hill and the Pacific Highway. Without suitable vehicular access from the Kings Hill URA to the Pacific Highway, development of Kings Hill URA could not proceed beyond 400 lots with access and egress only to occur off Newline Road. Development beyond the 400 lots would result in unacceptable levels of service at the intersection of Six Mile Road and Pacific Highway, which is likely to impact the safety and efficiency of the Pacific Highway during peak periods.

This option was not considered viable and was not considered further.

2.4.2 Option 2: Provision of northbound access and egress

Option 2 involves the provision of a left turn into Kings Hill URA from the northbound carriageway of the Pacific Highway, and a left turn out of Kings Hill URA onto the northbound carriageway of the Pacific Highway. Traffic wanting to access Kings Hill URA from the southbound carriageway would be required to travel south to the Pacific Highway at Richardson Road, turn around using the roundabout and travel north on the northbound carriageway. Traffic wanting to access the southbound carriageway from Kings Hill URA

would be required to travel north to Six Mile Road, carry out a U-turn and travel south on the southbound carriageway.

The main benefit of this option is that it would have significantly lower capital expenditure than Option 3, while still providing vehicular access to Kings Hill URA. This option would be sympathetic to the surrounding landscape by minimising the impacts on the natural environment. This includes removal of roadside vegetation from the western margin of the Pacific Highway only. This option would have temporary traffic impacts on users of the Pacific Highway during construction, however construction times would be shorter than Option 3, thereby minimising impacts on Pacific Highway users.

The left turn into the Kings Hill URA was considered to be acceptable however the left out access onto the Pacific Highway at this location was concluded by Roads and Maritime to not be acceptable on safety grounds due to the U-turn manoeuvre required at Six Mile Road to enable southbound travel. Without this, traffic exiting the URA would be required to travel via Newline Road in a northerly direction and rely upon the existing Six Mile Road intersection with the Pacific Highway. Accordingly, Option 2 would be a temporary solution, and a left turn into Kings Hill URA would not be sufficient after 400 lots at Kings Hill were developed. Option 2 is not considered a viable alternative to solve the long-term traffic capacity needs of the 3,500 residential dwellings that are proposed to be constructed at Kings Hill, and therefore this option was not considered further.

2.4.3 Option 3: Provision of an 'all-movements' interchange

Option 3 involves the provision of a new grade separated 'all-movements' interchange for the Pacific Highway. This interchange would allow residents of Kings Hill to access both the northbound and southbound carriageways of the Pacific Highway, and for users of the northbound and southbound carriageways of the Pacific Highway to access Kings Hill.

This option would have the highest capital expenditure and would require the removal of a larger area of vegetation than Options 1 or 2, as vegetation would also be required to be removed from the eastern side of the Pacific Highway. Drainage infrastructure (e.g. swales, pipes, detention and/or water quality treatment basins) would be required to manage surface flows from the interchange and provide flood-immune access to Kings Hill URA. Option 3 would also have temporary traffic impacts on users of the Pacific Highway during construction.

However, Option 3 best meets the proposal objectives, by providing for the long-term traffic capacity needs of the 3,500 residential dwellings that are proposed to be constructed at Kings Hill and providing safe and efficient vehicular access from the Kings Hill URA to the Pacific Highway. The design of Option 3 would be compatible with the Pacific Highway urban design principles and objectives, as it would be similar in appearance and functionality to other interchanges in the area (e.g. Newcastle Interchange, Buchanan Interchange (Roads and Maritime, 2013a)).

This option would provide significant traffic and road safety benefit to Pacific Highway road users. For example, the provision of the 'all-movements' interchange would improve traffic performance and safety to the Pacific Highway/Six Mile Road intersection, as less vehicles would be utilising the road. The existing direct access to Riding for the Disabled on the Pacific Highway would be closed and access would be provided via the internal road network of Kings Hill URA (refer to Section 3.1.6), therefore improving the safety of entering and exiting the facility. These changes would have direct benefit to the Pacific Highway in the longer term by providing a full grade separated interchange to allow safe access and egress for future increases in traffic due to development of the Kings Hill URA.

2.5 Preferred option

Option 3 best meets the proposal objectives, while also providing for the long-term traffic capacity needs of the 3,500 residential dwellings that are proposed to be constructed at Kings Hill and enabling the safe and efficient operation of the Pacific Highway as part of the national highway network.

The preferred option would have construction and operational environmental impacts, as discussed in Section 6 of this REF. These impacts have been taken into consideration when selecting the preferred option and would be managed using the measures summarised in Section 7 and further considered during the detailed design stage of the proposal.

The preferred option is described in detail in Section 3.

2.5.1 Design refinements

The initial design for the preferred option was developed by Arcadis (formerly Hyder Consulting) in early 2014. This design is presented in Figure 2-1.

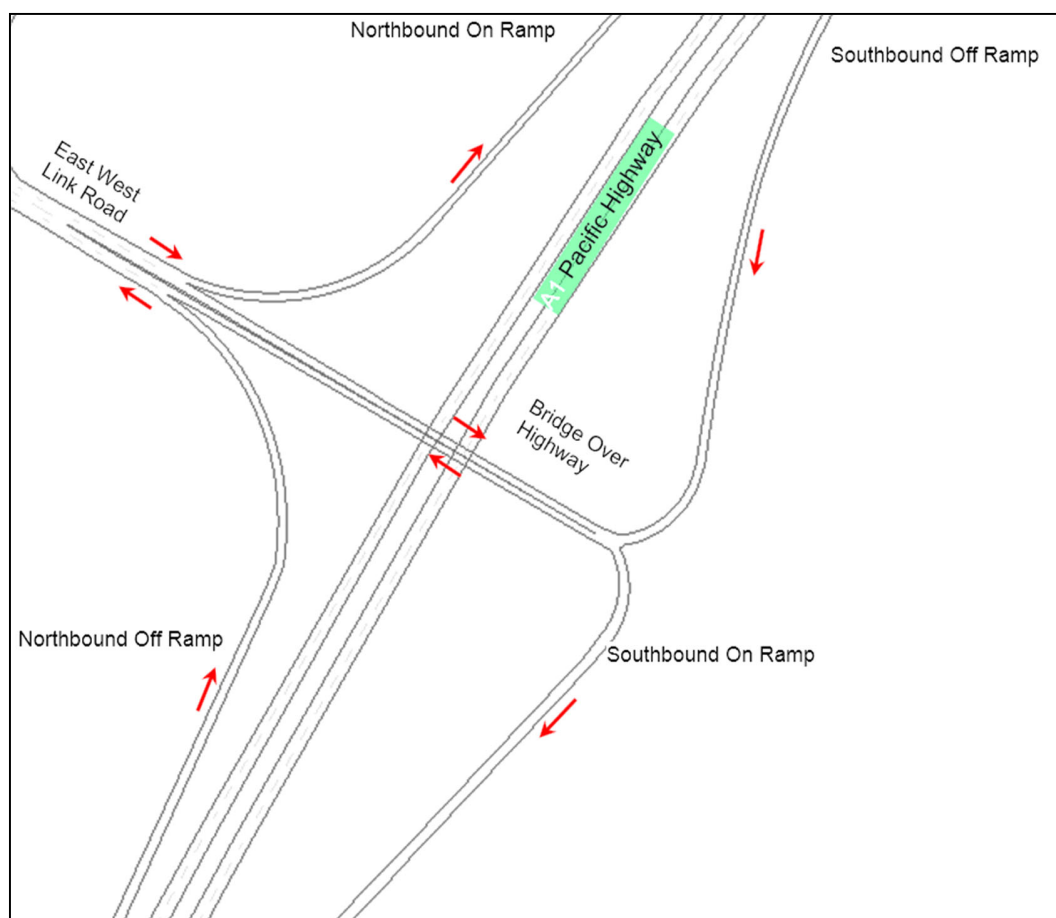


Figure 2-1 Initial design of the preferred option (Source: Hyder Consulting, 2014a)

In May 2014, Roads and Maritime reviewed the initial concept design and provided feedback to enhance free flow movement to northbound and southbound traffic to and from the Kings Hill URA. In November 2014, this feedback was incorporated into a strategic concept design for the proposal. The resultant strategic concept design for a grade separated interchange was supported by Roads and Maritime on the grounds of functionality, level of service and safety. The strategic concept design is presented in Figure 2-2. A detailed description of the refinements made is presented in Table 2-1. In late 2017, the strategic concept design was advanced to a concept design, which was completed in June 2018.

The East-West link road between the interchange roundabout and the town centre of Kings Hill, leads up to a proposed signalised intersection which does not form part of the proposal, and would be built separately as part of the Kings Hill URA local road network.

Table 2-1: Design refinements made to initial concept design

Proposal Element	Initial Concept	Refined Concept
Southbound on/off-ramps	T-intersection, with major movement as southbound on-ramp	Trumpet shape arrangement, with free-flow movements on and off
Northbound on/off-ramps	Free-flow movements for on and off ramps	Interchange Roundabout. The proposed roundabout would have substantial safety benefits allowing vehicles to safely perform weaving manoeuvres on approach to town centre roundabout.

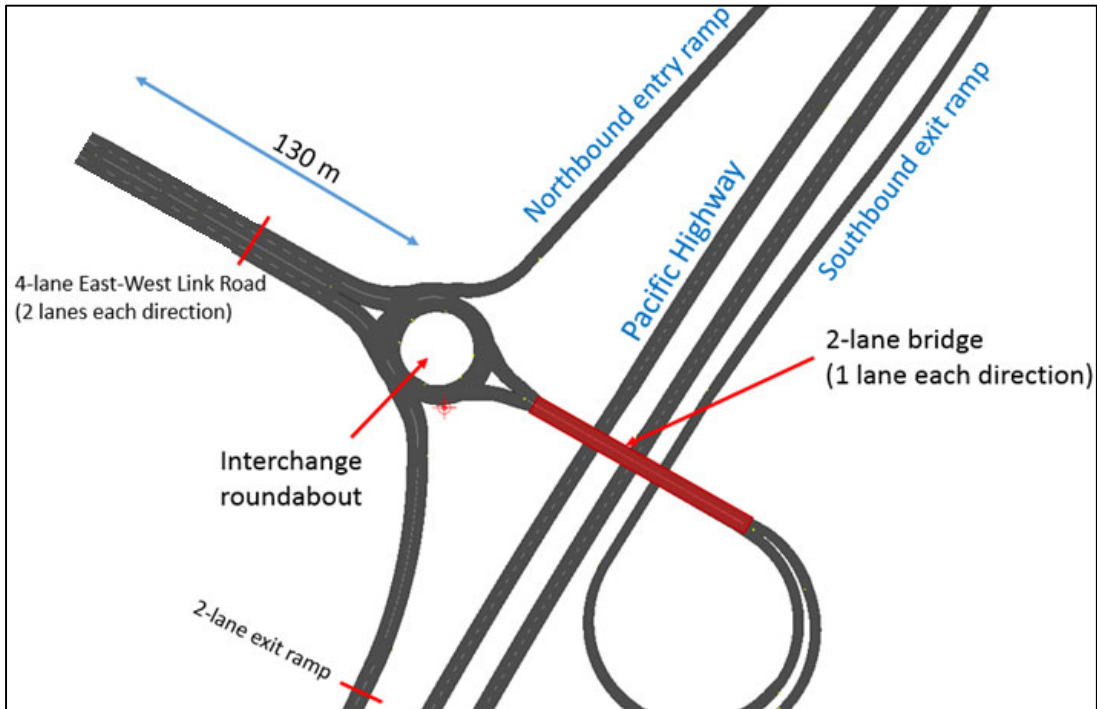


Figure 2-2 Refined design of the preferred option (Source: Hyder Consulting, 2014b)

2.6 Hunter Water Grahamstown Dam maintenance track

Following the selection of the preferred option for the proposal, various options for the relocation of the existing Hunter Water maintenance track access point were considered in consultation with Hunter Water and Roads and Maritime.

Hunter Water-owned land on the eastern side of the Pacific Highway has an existing access from the Pacific Highway, that is used on occasion by Hunter Water staff to access the Grahamstown Dam. This existing access point would be impacted by the proposed alignment of the interchange southbound entry ramp. As Hunter Water require this access to be maintained or re-instated, alternative locations for this access that would not conflict with the proposal were considered. The locations considered were:

- Option 1: Connection on southbound entry ramp, south of the loop

- Option 2: Connection on southbound entry ramp, immediately east of the bridge
- Option 3: Connection on southbound exit ramp, just north of the bridge
- Option 4: Connection on southbound exit ramp, at northern end of ramp
- Option 5: Connection at existing location, southern extent of the southbound entry ramp
- Option 6: Connection north of the interchange, directly onto the Pacific Highway.

These options are shown in Figure 2-3. These options were compared against safety, road user accessibility (specifically, Hunter Water access requirements for variously sized vehicles) and cost, as shown in Table 2-2. In consultation with Hunter Water and Roads and Maritime (refer to Section 0), it was determined that the Option 1 is the preferred location for Hunter Water access. Additional recommendations and requirements of both Hunter Water and Roads and Maritime regarding the alignment and geometry of the access (refer to Section 3.2.1) have been incorporated into its design.



LEGEND

- Proposed interchange
- ① Access connection option

Coordinate System: GDA 1994 MGA Zone 56
Date issued: September 20, 2019
Aerial imagery supplied by NSW LPI

1:10,000 at A4

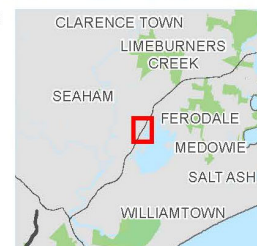


Figure 2-3 Options for the relocation of the Grahamstown Dam access point

Table 2-2: Options considered for the relocation of the Grahamstown Dam access point
(Note: Option advantages and disadvantages are shown with a '+' and '-' respectively)

Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Safety - Vehicles entering Hunter Water land					
+ Hunter Water vehicles entering the access point from up the ramp would be entering from a lower speed environment than the Motorway + Public users have good sight distance to the entry point. + Hunter Water users can slow down in the widened shoulder	+ Entry is from a low speed environment - Entry would be left-in only so as not to impact traffic coming up the loop ramp	+ Access point sufficiently off the highway to decelerate completely on the exit ramp - Public vehicles that do not slow down would be potentially travelling at high speed	- Access point may require Hunter Water vehicles to partially slow down on highway in a higher speed environment	- Hunter Water vehicles would be slowing down when all other vehicles are accelerating - Public vehicles would be looking to their right to merge with highway traffic, but the Hunter Water vehicles would be slowing down on the left - Not satisfactory for an M-class motorway	- Similar to Option 5. - Not satisfactory for an M-class motorway + The location would provide for good sight distance as the highway is fairly flat on a large radius curve
Safety - Vehicles exiting Hunter Water land					
+ Vehicles would exit in a relatively low speed environment and have time to accelerate to a substantial proportion of highway speed before merging onto the highway (for cars, approximately 80 km/h by the gore area) + Vehicles would have more room for an off-road area to park the vehicle, whilst locking the gate behind them + Vehicles would have to turn left onto the southbound entry ramp (i.e. not allowed to turn right back across the	+ Vehicles would exit in a relatively low speed environment and have time to accelerate to full highway speed before merging onto the highway + Vehicles would have to turn left onto the southbound entry ramp (i.e. not allowed to turn right back across the bridge)	+ Vehicles leaving the access would have good sight distance down the ramp - Vehicles leaving the access are almost at the start of the climb up the loop, they would not achieve a high speed and so may be more prone to a rear end crash	- Vehicles exiting would be competing with vehicles trying to slow down on the exit ramp and may be prone to rear end type accidents	- Vehicles exiting have very limited room to accelerate prior to connecting to the highway - Vehicles would have to compete with both ramp traffic and highway traffic - Sight distance down the highway would be reduced from the current situation due to construction of the interchange	- Vehicles exiting would have very limited room to accelerate prior to connecting to the highway, similar to existing access conditions - Acceleration would be on the highway only, under A-class conditions

Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
bridge)					
Safety - Highway and interchange road users					
- Vehicles exiting the Hunter Water land may not achieve full highway speed before they merge onto highway + Vehicles going considerably quicker than the existing access scenario here a standing start directly onto the highway is required. - Vehicles on the southbound exit ramp may have to slow down for Hunter Water vehicles entering and exiting the access, and they then may not achieve highway speed along the ramp.	+ No impact to highway traffic. - Vehicles travelling east over the bridge may have to slow down or stop for Hunter Water vehicles entering and exiting the access	- Traffic on the exit ramp would have to slow down and potentially stop for Hunter Water vehicles using the facility. + None to minimal impact to highway traffic + Low traffic volumes on the southbound exit ramp	- Traffic on the exit ramp would have to slow down and potentially stop for Hunter Water vehicles using the facility - If traffic on the highway that is going to use the exit ramp sees a vehicle entering the Hunter Water access they may slow down before they reach the ramp and so start to slow down on the highway. + Low traffic volumes on the southbound exit ramp	- Vehicles exiting the Hunter Water land would not achieve highway speed before they merge onto highway and so highway traffic may have to slow down. + Traffic accelerating on the southbound entry ramp would have good sight distance to the access - Traffic accelerating on the southbound entry ramp may have to slow down or stop for Hunter Water vehicles entering and exiting the access and so would also not be able to accelerate to highway speed.	- Vehicles on the highway would potentially have to slow down or stop for Hunter Water vehicles entering and exiting the access. - It would be similar to existing conditions in an A-class environment
Hunter Water requirements (based on consultation)					
+ Vehicles coming from both the south and north can use exit ramps and overpass to enter site - Vehicles exiting the access must travel south towards Newcastle. If they wish to travel north, they need to travel down southbound carriageway	+ Vehicles from both the south and north can use the exit ramps and overpass to enter site + Vehicles have dedicated left-in / left-out access just east of the bridge prior to loop ramp - Vehicles exiting the access would travel south	- Vehicles from the south must do a highway U-turn north of the interchange at Six Mile Road, or if that gets closed then Ringwood Road + Dedicated access on exit ramp in a relatively low speed environment as it would be near to where	- Vehicles from the south have to do a highway U-turn north of the interchange at Six Mile Road, or if that gets closed then Ringwood Road - Dedicated access on exit ramp close to highway and public vehicles may	+ Vehicles from the south or north can use the exit ramps and overpass to enter site. - Vehicles exiting the access would travel south towards Newcastle. If they wish to travel north, they need to do a U-turn down the highway.	- Vehicles from the south have to do a highway U-turn north of the interchange at Six Mile Road, or if that gets closed then Ringwood Road + Vehicles exiting can continue south past the interchange, or use the

Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
until they can safely make a turn to travel north. + Hunter Water Depot located south of Interchange, most of the traffic would be heading south + Closest to existing access point	towards Newcastle. If they wish to travel north, they need to travel down southbound carriageway until they can safely make a turn to travel north. - A more cumbersome entry and exit point for Hunter Water.	public vehicles have to slow down anyway for the loop ramp + Vehicles exiting the access can travel either south or north by utilising the interchange. - A more cumbersome entry and exit point for Hunter Water.	not have decelerated right down to stop + Vehicles exiting the access can travel either south or north by utilising the interchange - A more cumbersome entry and exit point for Hunter Water.		interchange to turn around and travel north up the highway (not critical to Hunter Water).
Capital and maintenance cost					
- Build widened shoulder - Minor additional earthworks - About 400 metres of paved access track + associated Infrastructures	- Substantial volume of additional earthworks and potential batter stabilisation or retaining walls required - A robust pavement for portion of access road on steep embankment is likely to be required for truck access - About 700 metres of access track + associated Infrastructures	- Build widened shoulder - Additional earthworks - About 700 metres of access track + associated Infrastructures	- Build widened shoulder - Additional earthworks - About 1,000 metres of access track + associated Infrastructures	- Build widened shoulder - Would require relocation for future M-class upgrade	- Potentially use another existing access point on highway with minimal cost; or - Highway shoulder connection would need to be built for access - Additional earthworks - About 1,600 metres of access track + associated Infrastructures - Would require relocation for future M-class upgrade

3. Description of the proposal

This section describes the proposal and provides descriptions of existing conditions, the major design features, design and engineering constraints, the construction method and associated activities. The proposal has been developed to a concept design level, and further refinements to the proposal would be made during the detailed design phase.

3.1 The proposal

An overview of the main elements of the proposal are presented in Figure 3-1. Other elements of the proposal, such as lighting, roadside furniture and signage would be developed during detailed design. These elements would be contained within the impact area assessed in this REF.

3.1.1 Overpass

The overpass would cross the Pacific Highway about one kilometre north of Irrawang Spillway and would extend from the southbound ramps on the eastern side of the Pacific Highway to the interchange roundabout, west of the highway.

The overpass would comprise two spans. One span would be about 29 metres in length, positioned above the highway northbound carriageway, and the second span would be about 36 metres in length, positioned above the highway southbound carriageway. The total length of the overpass would be about 65 metres.

The length of the spans would allow for future widening of the highway to three lanes in each direction and would cater for the interchange southbound exit loop ramp. The minimum vertical clearance of the bridge would be approximately 5.3 metres over the carriageways.

The overpass would be constructed of super-T girders with a reinforced concrete deck and asphalt overlay. It would have a central pier in the highway median and spill through abutments at either end.

The overpass would support a 10-metre wide road with two 3.5-metre wide lanes (one in each direction), two 1.5-metre wide shoulders and two bridge barriers.

There would be no provision for cyclist or pedestrian access on the overpass. The requirement for a safety “throw” screen to be erected on the overpass would be determined during detailed design, in consultation with Roads and Maritime.

3.1.2 Ramps

Four single lane ramps would connect the interchange to the Pacific Highway and enable all in and out south and north movements; an exit ramp from and an entry ramp to the northbound carriageway, and an exit ramp from and an entry ramp to the southbound carriageway.

The northbound exit, northbound entry and southbound entry ramps would be designed as standard diagonal type of ramps. The southbound exit ramp would be designed as a loop which would travel beneath the bridge overpass. The southbound entry ramp would provide access to the Hunter Water Grahamstown Dam maintenance track. This ramp would have a widened shoulder with sufficient deceleration room for vehicles entering the access point.

The ramps design would allow appropriate room for acceleration to, and deceleration from, highway speeds. The ramps would tie into the Pacific Highway, requiring the pavement layers of the ramps to match existing levels at the tie in point, as well as new line markings, new road barriers and road signage. The

final alignment and gradients would be determined during detailed design in accordance with all relevant design and safety requirements (refer to Section 3.2.1).

3.1.3 East-West Link road

The proposed East-West Link road would connect the Kings Hill development to the proposed interchange. It would run in an east-west direction from a signalised intersection within the Kings Hill town centre (which falls outside the scope of this proposal), through the interchange roundabout, and over the overpass.

The road west of the interchange, between the signalised interchange and the interchange roundabout, would consist of four 3.5-metre wide lanes (two in each direction) with 1.5-metre wide shoulders, one metre wide verges and a median marked line.

3.1.4 Interchange roundabout

The interchange roundabout would be a single-lane roundabout and would connect the northbound exit ramp and northbound entry ramp to the East-West Link road. It would separate westbound traffic on the overpass (from the southbound exit ramp) and traffic on the northbound exit ramp.

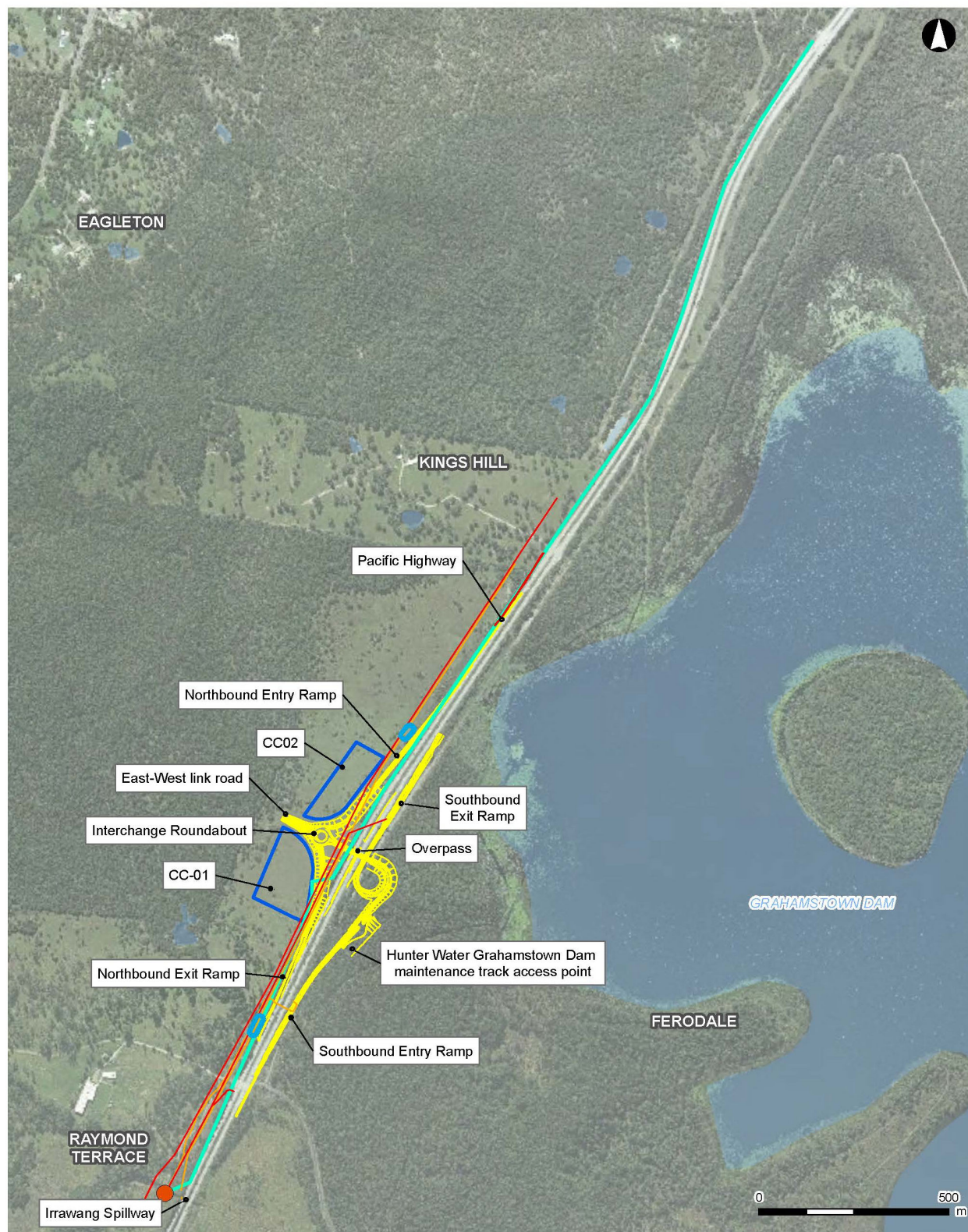
3.1.5 Drainage infrastructure

The proposal includes two permanent stormwater detention/treatment basins, one located in proximity to the western margin of the northbound exit ramp and one in proximity to the western margin of the northbound entry ramp. These basins would be appropriately sized to capture stormwater run-off from the western portion of the proposed interchange. The size and location of these basins would be refined during detailed design. Detailed design of the proposal may also determine that basins are required on the eastern side of the proposed interchange. This possibility has been somewhat mitigated by assuming all vegetation would be removed from within a 20-metre buffer of the concept design footprint (discussed in further detail in Section 6.7).

It is anticipated that surface flows would be conveyed to basins by pits and pipes or table drains. The basins would function as both detention basins and water quality treatment basins. From the basins located on the western side of the interchange, stormwater would be discharged into existing culverts located beneath the Pacific Highway.

If the proposed stormwater channel is constructed, these culverts would be extended (culvert extensions would form part of proposed stormwater channel scope of works and is not on scope for this proposal) to allow for treated stormwater to discharge into the channel, and ultimately flow south to Irrawang Spillway. The proposed stormwater channel would prevent any stormwater entering Grahamstown Dam, and would be suitably sealed to prevent groundwater entering the channel and to prevent stormwater from the channel migrating to the Grahamstown Dam.

Surface flows from the Pacific Highway are currently conveyed into the existing culverts and are discharged into the receiving environment on the eastern side of the Pacific Highway. In the event that the proposed stormwater channel is not constructed, treated stormwater from the interchange would likely be discharged from the existing culverts into stormwater detention infrastructure, either detention basins or table drains. This would allow the gradual infiltration of stormwater into the surrounding environment. Drainage infrastructure that would be required to treat and discharge surface flows, in the absence of the proposed stormwater channel on the eastern side of the Pacific Highway, would be developed during detailed design of the proposal.



LEGEND

- | | |
|---------------------------------------|----------------------------------|
| Compound area | Electrical infrastructure |
| Proposed interchange | Telecommunication infrastructure |
| Detention basin (indicative location) | Existing Telstra pit |
| Proposed optical fibre relocation | |

Coordinate System: GDA 1994 MGA Zone 56
Date issued: September 20, 2019
Aerial imagery supplied by NSW LPI

1:15,000 at A4



Figure 3-1 Main elements of the proposal

3.1.6 Changes to property access

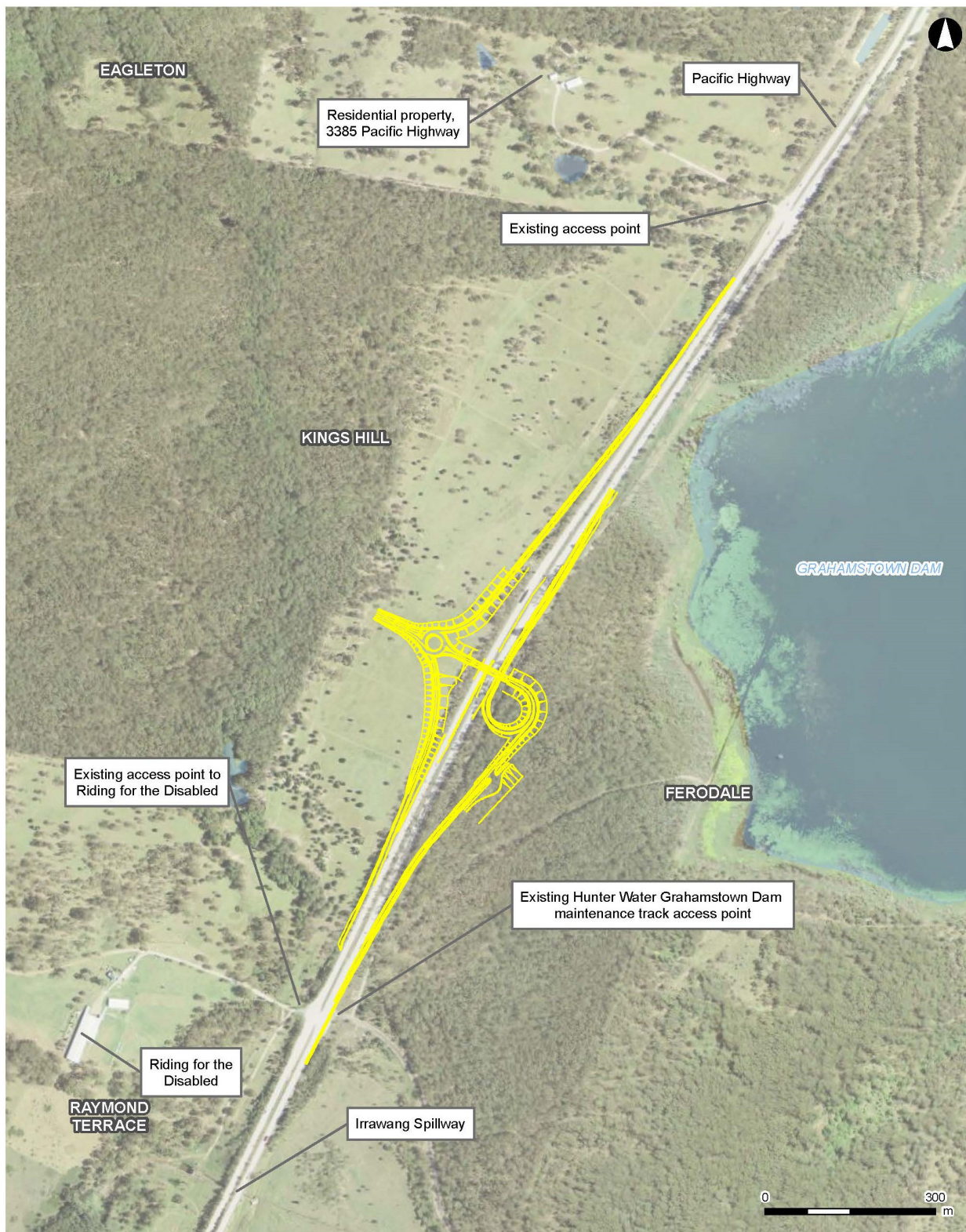
In addition to KHD-owned land, two privately-owned properties are located in proximity to the proposal; a residential property at 3385 Pacific Highway and a recreational facility, Riding for the Disabled at 3217 Pacific Highway (Figure 3-2).

Existing direct vehicular access to the Pacific Highway from Riding for the Disabled (3217 Pacific Highway) would be maintained in its current condition until the proposal is operational. Upon opening of the interchange to traffic, direct access to Riding for the Disabled from the Pacific Highway would be closed, and access would be provided via a connection to the Kings Hill URA internal road network (outside the scope of this REF, and subject to Council consent for internal road works). The existing crossing across the Pacific Highway median would also be closed to the public. Removing the direct access to the Pacific Highway from Riding for the Disabled would deliver safety benefits to Pacific Highway road users by providing safer all-movements access from and to the Pacific Highway via the proposed interchange.

Current direct access to the Pacific Highway for the residential property at 3385 Pacific Highway would be maintained in its existing condition during operation of the proposal. The existing crossing across the Pacific Highway median at this location would be closed to the public.

Both existing crossing across the Pacific Highway median would be closed to the public by the installation of bollards. These bollards could be temporarily removed on the occasion that over-height vehicles are required to travel south on Pacific Highway. Over-height vehicles would be required to bypass the overpass by utilising the northbound ramps of the interchange. Over-height vehicles travelling south on the southbound carriageway would cross the median north of the overpass, travel up the northbound entry ramp, through the interchange roundabout, down the northbound exit ramp, and would cross back over to the southbound carriageway at the crossing point south of the interchange.

Potential access to the Pacific Highway via Six Mile Road by future Kings Hill residents would be limited to the capacity of that intersection by a limitation placed on the number of lots able to be approved before the proposal is operational. If determined necessary by way of traffic study after the proposal is operational, the Six Mile Road intersection may need to be modified to allow left-in / left-out movements only, but this is not likely. Any such modification of this intersection would be subject to a separate assessment and approval.



LEGEND

— Proposed interchange

Coordinate System: GDA 1984 MGA Zone 56
Date issued: September 17, 2019
Aerial imagery supplied by NSW LPI

1:10,000 at A4



Figure 3-2 Existing property accesses near the proposal

3.1.7 Hunter Water maintenance track access point

Hunter Water-owned land on the eastern side of the Pacific Highway has an existing access point from the Pacific Highway that would conflict with the proposed alignment of the interchange southbound entry ramp (Figure 3-2). In the event that the interchange was not constructed, the existing access point would remain in its current location.

The current at-grade access allows for left-in / left-out movements with the Pacific Highway southbound carriageway. Whilst it is positioned adjacent to a U-turn facility on the motorway, no formal right-turn movements can currently be performed to and from the northbound carriageway.

Hunter Water requires this access to be maintained or re-instated for use as follows:

- By a light vehicle (ute) approximately once per week
- By a rigid type truck on rare occasions (for example to manually open the dam's sluice gates should the need arise)
- By a 14.5-metre coach for infrequent tourist coach visits to the dam.

As part of the proposed stormwater channel scope of works, a new four-metre wide maintenance access track would be located within Hunter Water-owned land and would provide vehicular access along the entire length of the proposed stormwater channel, to allow for Hunter Water monitoring and maintenance activities. With the exception of the relocated access point, the specifications of this maintenance access track form part of the proposed stormwater channel design and scope of works, subject to separate assessment and approval.

The location of the Hunter Water access point to the Grahamstown Dam maintenance track would be relocated about 465 metres north of its existing location, and would interface with the interchange southbound entry ramp (Figure 3-3).

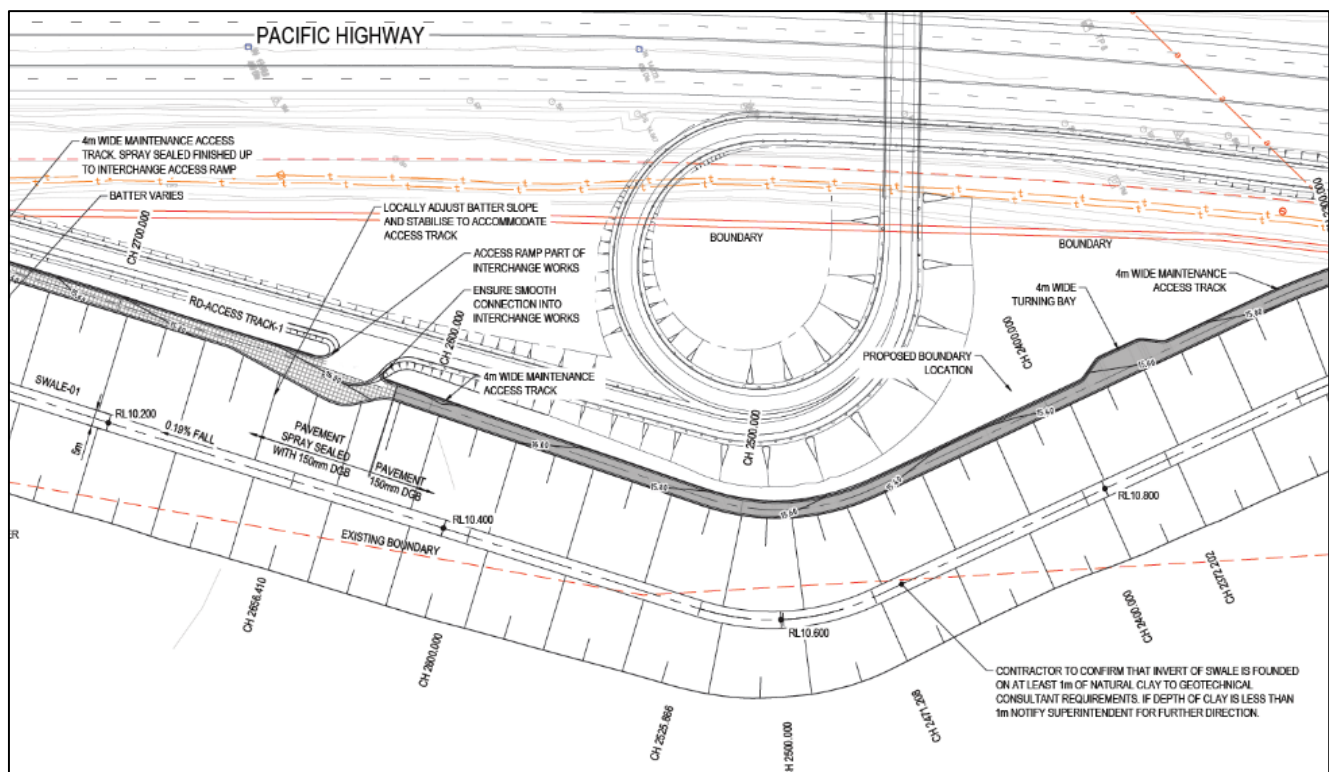


Figure 3-3 Location of proposed Hunter Water access point (extracted from civil engineering design drawings of the proposed stormwater channel)

3.2 Design

3.2.1 Design criteria

Engineering design criteria

The proposal would be designed generally in accordance with the relevant Australian Standards, Austroads design standards, and Roads and Maritime standards including:

- *Austroads Guide to Road Design* (Austroads, 2016)
- *Roads and Maritime Supplements to the Austroads Guide* (Roads and Maritime, 2015a)
- *Austroads Guide to Traffic Management* (Austroads, 2015)
- *AS1742 Manual of Uniform Traffic Control Devices* (Standards Australia, 2014a) and Roads and Maritime Supplements
- *Austroads Guide to Pavement Technology Part 2: Pavement Structural Design* (2012) and *Roads and Maritime Austroads Guide* (2015)
- *AS5100 Bridge Design* (Standards Australia, 2014b).

Urban Design Policy Procedures and Design Principles

Roads and Maritime has developed nine fundamental principles, applicable to all projects, for designing road and maritime infrastructure in a manner which achieves both engineering and urban design outcomes. The principles, outlined in *Beyond the Pavement: Urban Design Policy Procedures and Design Principles* (Roads and Maritime, 2014a) to achieve integrated engineering and urban design are:

1. Contributing to urban structure and revitalisation
2. Fitting into the built fabric
3. Connecting modes and communities
4. Fitting with landform
5. Responding to natural pattern
6. Incorporating heritage and cultural contexts
7. Designing an experience in movement
8. Creating self-explaining road environments
9. Achieving integrated and minimal maintenance design.

Pacific Highway Urban Design Principles

The Pacific Highway Urban Design Framework 2013: Urban Design Vision, Objectives and Design Principles for the Upgrade of the Pacific Highway from Hexham to Tweed Heads (Roads and Maritime, 2013b) defines six urban design objectives to help achieve the urban design vision outlined in the framework, specifically “The upgrade should be a sweeping, green highway providing panoramic views to the Great Dividing Range and the forests, farmlands and coastline of the Pacific Ocean; sensitively designed to fit into the landscape and be unobtrusive; and characterised by simple and refined road infrastructure”.

The six objectives are:

1. Flowing and responsive: Provide a flowing road alignment that is responsive and integrated with the landscape

2. Well-vegetated and natural: Provide a well-vegetated, natural road reserve
3. Enjoyable journey: Provide an enjoyable interesting highway with varied views and vistas of the landscape and pleasant restful places to stop
4. Community benefit: Value the communities and towns along the road
5. Consistency with variety: Provide consistency with variety in road elements
6. Simple, refined and unobtrusive: Provide a simplified and unobtrusive road design.

The framework is intended to inform urban designers, engineers and project managers working on Pacific Highway projects and should be adopted on all projects whether at planning, design or construction stages. Aiming to meet these objectives would help Roads and Maritime to continue to create a high-quality Pacific Highway.

Hunter Water maintenance track access point design criteria

The following criteria was considered and agreed in developing the design of the Hunter Water access location.

Entry into Hunter Water access from southbound entry ramp

The design speed of vehicles on the entry ramp that are going to enter the access was assessed, as it impacts:

- Length of deceleration lane (in the form of a widened shoulder on the ramp)
- Sight distance to the access.

The design vehicle will dictate the pavement area required for vehicles to enter the access road (e.g. rigid truck turn paths).

Exit from Hunter Water access onto southbound entry ramp

The design speed of ordinary vehicles on the entry ramp that exiting traffic will need to compete with was assessed, as it impacts:

- Intersection sight distance requirements with reference to Austroads Guide to Road Design Part 4a Section 3.2
- The speed at which exiting traffic will be competing with.

The design vehicle will dictate the pavement area required for vehicles to exit the access road (e.g. rigid truck turn paths).

Exit from Hunter Water access with consideration for entry onto Pacific Highway

The speed at which vehicles need to enter the Pacific Highway Motorway, with reference to Austroads Guide to Road *Design* Part 4c and Upgrading the Pacific Highway Guidelines, was assessed.

As such the minimum safe stopping distance required by Roads and Maritime from the access exit movements to the merge location with vehicles on the ramp has been agreed with Roads and Maritime and considered in the access location.

Design Vehicle Swept Paths

Swept paths representing an 8.8-metre rigid truck and a 14.5-metre coach were assessed using industry standard software (AutoTurn) to assess the vehicle movements into and out of the proposed access location.

The geometry of the entry/exit point allows for all vehicles to enter and exit the maintenance access track in a single manoeuvre (Figure 3-4). Vehicles would enter the maintenance access track by turning left from southbound entry ramp, requiring vehicles to first drive through the interchange from either northbound or

southbound carriageway of the Pacific Highway before entering the southbound ramp. Vehicles exiting the maintenance access track would be required to turn left onto the southbound entry ramp and continue travelling on the southbound carriageway of the Pacific Highway. Vehicles wanting to travel on the northbound carriageway would be required to first travel on the southbound carriageway until a suitable intersection allows vehicles to safely turn around.

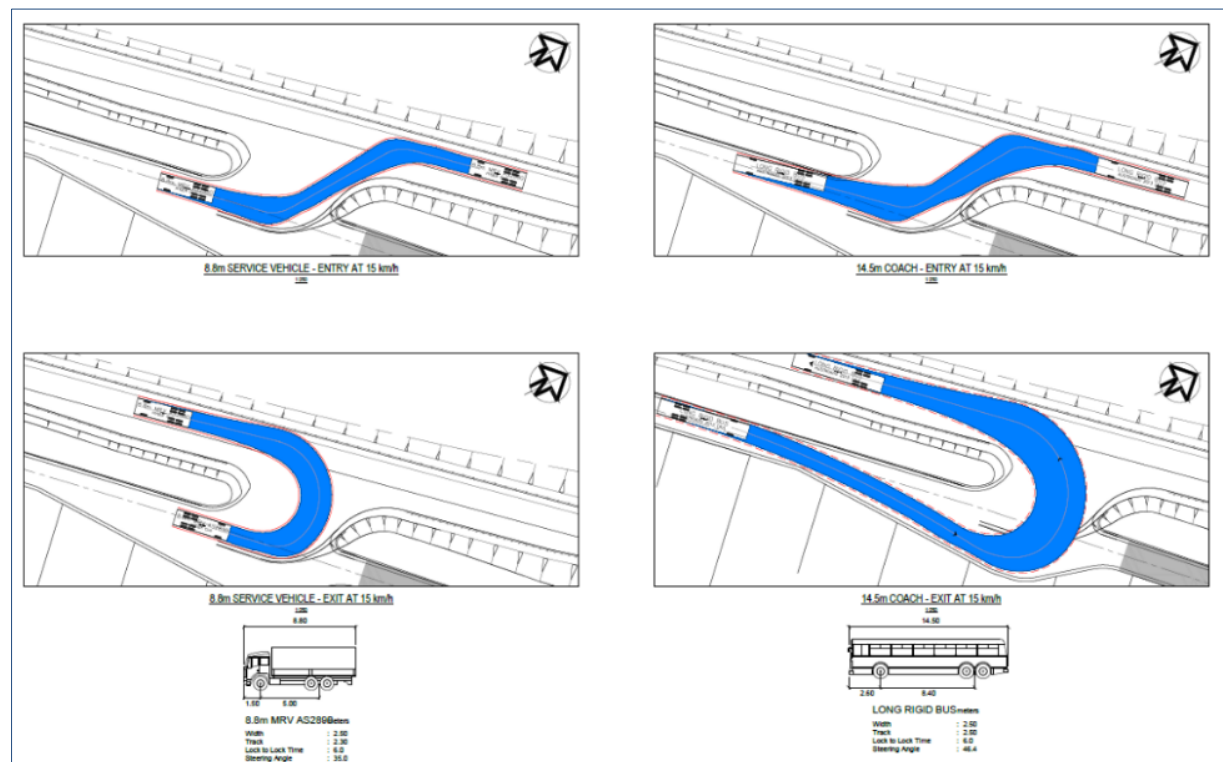


Figure 3-4 Turning paths of service vehicles and coaches, into the Hunter Water access point from the southbound entry ramp, and out of the Hunter Water access point onto the southbound entry ramp

3.2.2 Engineering constraints

The design and construction of the proposal has considered a number of engineering issues and constraints. The main issues and constraints are discussed below.

Soil conditions

The loads imposed by the bridge structure would be significant, and therefore the bridge would likely need to be supported on deep piled footings socketed into rock. Piles founded in medium strength or stronger bedrock may be suitable, however, the presence of mudstone and coal encountered in one bore may require bored piles to be found within the high strength bedrock below this seam (Appendix K).

Some portions of the proposal footprint exhibit wet subgrade conditions, particularly where the proposal is located in proximity to the Grahamstown Dam foreshore (Appendix K). Further detail regarding soil conditions is provided in Section 6.9.

Location of proposed stormwater channel

The design of the proposal has considered the proposed stormwater channel. A number of possible alignments for the proposed stormwater channel were investigated, with the preferred option for the proposal located between the Grahamstown Dam and the Pacific Highway, running generally parallel to the Pacific Highway.

The development of both the proposed stormwater channel and proposed interchange designs have occurred concurrently to date, so that both forms of infrastructure are contained within the land available between the Grahamstown Dam and the Pacific Highway. The proposed stormwater channel is subject to separate environmental assessment and approval. The construction and operation of the proposed interchange does not rely on the proposed stormwater being developed.

Tie-in to existing Pacific Highway

The proposal has been designed so that the two northbound (entry and exit) and two southbound (entry and exit) ramps would tie in to the existing Pacific Highway. Further issues would require consideration during detailed design of the ramps, including:

- Vertical geometry
- Stopping sight distance
- Surface flow drainage paths
- Interface with existing road infrastructure
- Pavement design compatibility
- Lengths of acceleration/deceleration lanes

Design of the loop off-ramp to ensure correct exit speed and loop geometry, and associated barrier treatments.

Utilities

Utilities currently located in the proposal footprint would require relocation. Construction of the proposed interchange would require the relocation of three types of essential services that are currently situated in (and therefore conflict with) the impact area:

- Ausgrid 11kV overhead power line
- Telstra underground Optic Fibre and Copper communication lines
- Hunter Water 33kV overhead power line.

Refer to Section 3.5 for more details on utility infrastructure relocations.

3.3 Construction activities

This section describes how the proposal would be built. The methodology presented in this section is subject to further refinement during the detailed design stage of the proposal.

3.3.1 Work methodology

The general construction phases and activities required for the proposal are described in Table 3-1. Further details of particular construction activities (i.e. those in bold) is given below.

Table 3-1 General construction activities

Construction phase	Activities
Phase 1: Pre-construction work	• Installation of pre-construction work erosion and sediment controls • Utilities relocation • Installation of boundary fencing • Pre-clearing biodiversity surveys • Upgrade of minor access roads

Construction phase	Activities
	• Installation of fauna exclusion fencing to prevent fauna accessing the impact area and the Pacific Highway • Vegetation clearing and grubbing.
Phase 2: Site establishment	• Temporary removal of fencing that conflicts with the construction work zone • Mobilisation and establishment of compound areas and site accesses Temporary traffic management arrangements • Installation of erosion and sediment controls • Other activities determined by the environmental representative (construction contractor or Roads and Maritime) to have minimal environmental impact • Construction of diversion drains and sedimentation control measures (where required) • Clearing of vegetation and processing of materials • Relocation of Hunter Water maintenance track access point • Temporary upgrade work for existing local roads and intersections.
Phase 3: Interchange construction	• Construction roadwork at off-line areas, including: - Construction of embankments for on and off-ramps - Diversion drains and sedimentation basins - Bridge foundation, abutments and piers • Lifting of the overpass bridge super-T girders into place • Laying of asphalt layers, including surfacing • Construction of verges and batters.
Phase 4: Finishing works	• Tying in the proposal with the existing Pacific Highway, including grade correction asphaltting or asphalt tie-in • Installation of pavement markings, signposting and other road furniture • Progressive landscaping and tree planting • Reinstatement of fencing • Site clean-up and demobilisation, including restoration of ancillary facilities and temporary access roads (where required).

Phase 1: Pre-construction work

Utility relocations

Utility infrastructure impacted by the proposal would be relocated. Utility infrastructure relocation and protection requirements are detailed in Section 3.5.

Phase 2: Site establishment

Mobilisation and establishment of compound areas and site accesses

Two compound areas would be established to enable the construction of the proposal and nine access points from the Pacific Highway would be established to enable vehicular access from and to the site. Temporary traffic control on the Pacific Highway would be required during the establishment of compound areas and site accesses. Compound areas and vehicular access arrangements are described in Section 3.4 and Section 3.3.5, respectively, and are shown in Figure 3-5.

Relocation of Hunter Water maintenance track access point

The existing Hunter Water Grahamstown Dam maintenance track access point, which provides Hunter Water with vehicular access to the Grahamstown Dam on the eastern side of the Pacific Highway, would be

obstructed by the proposal construction; specifically, construction of the southbound entry ramp. Alternate temporary access to the Grahamstown Dam (during construction) would be established before the construction on the eastern side of the Pacific Highway starts. The location of this temporary access point would be determined during detailed design.

Phase 3: Interchange construction

Construction roadwork at off-line areas

Road construction for all off-line areas would begin after the existing utilities and site establishment works described in Phase 1 and 2 have been completed.

The mass haul arrangement, based on current knowledge of the site geotechnical conditions, is largely a cut to fill operation whereby excess material yielded from the proposed basins would be utilised for roadwork general fill locations. Cut volumes from the excavation for the proposed stormwater channel may also be utilised for roadwork general fill locations. This possibility described further in Section 3.3.4.

Diversion drains and sedimentation basins

This construction task comprises excavating sedimentation basins and diversion drains necessary to manage surface water from the proposal.

Bridge foundation, abutments and piers

The central pier construction method would be defined during detailed design stage, but it is likely the central pier would be constructed utilising a spread footing or piled footing arrangement. The spread footing arrangement would require lane reconfiguration to both the southbound and northbound carriageways of the highway as well as the installation of pinned concrete barriers on both sides.

This scenario presents the worst traffic impact to the highway hence it has been considered as part of this assessment. It is acknowledged that lesser traffic management control measures would be needed if the bridge design requires less space for the construction of the central pier, for example by the adoption of a piled footing or increasing the girder span above the southbound carriageway.

The construction of the abutments and associated piles, headstocks and other bridge elements would start after some of the temporary traffic management controls have been established (e.g. temporary concrete unpinned barriers behind the existing gutters).

The central pier and footing construction would be likely to require:

- Lane width modifications to both carriageways. Modified lane widths would be defined in the construction traffic management plan to be prepared as part of the Construction Environmental Management Plan (CEMP) (refer to Section 6.1.4). Preliminary assessment indicates there is insufficient working width in the median to cater for width modification and dynamic deflection of a temporary barrier. Temporary barriers are likely to be pinned to the existing road surface
- Reduction in speed zone to 80 kilometres per hour.

During Phase 3 of the works, bridge construction would be advanced up until the supporting structure is ready to accept the lifting of girders into place.

Lifting of the overpass bridge super-T girders into place

The lifting of the girders would require the temporary closure of the Pacific Highway carriageway. There are two options for undertaking this work:

- Closing one side of the highway and implementing a contraflow arrangement at night. This would require the construction of a temporary crossover both before and after the bridge central pier. Speed limits during this operation would be lowered to at least 40 kilometres per hour. The temporary road surface would be removed before proposal completion

- Implement a detour of one direction of the carriageway, either utilising Richardson Road or Medowie Road. The detour/contraflow would be expected to be in operation only during night-time hours and on two separate occasions. This option would require an assessment of potential impacts of the detour on receivers located in proximity to Richardson Road or Medowie Road, if it were to be selected.

After the girders are placed, the bridge deck, surfacing works and street furniture would be completed during finishing works.

Phase 4: Finishing works

Tying in the proposal with the existing Pacific Highway

The final major construction activity to occur would be to complete the tie-in roadworks to the Pacific Highway. Temporary traffic control would be required to complete any grade corrections. This may necessitate the through lanes being reduced to one during night-time hours along with speed zone reductions. Tie-in works are required where each of the four ramps connect to the highway and would involve matching the new pavement layers of the ramps to existing levels at the tie in point, new line markings, new road barriers and road signage.

3.3.2 Construction hours and duration

Construction timing

A construction program for the proposal has not yet been confirmed. However, it is expected that construction would take about 14 months, with preliminary utility relocations potentially commencing in 2021.

Ideally, Phase 3 of the proposal would be constructed at the same time as the proposed stormwater channel (subject to separate environmental assessment and approval) is constructed. This would enable the use of suitable material excavated from the proposed stormwater channel to be used in the construction of ramps, reducing the need to stockpile, import or export material, and associated costs (refer to Section 3.3.4).

Construction hours

The proposed working hours for construction activities (including the delivery of plant and equipment) would be limited to within the hours described in *Construction Noise and Vibration Guidelines* (Roads and Maritime, 2016a), wherever feasible and reasonable. These standard construction hours are:

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

Construction hours for activities with impulsive or tonal noise emissions are:

- Monday to Friday: 8am to 5pm
- Saturday: 9am to 1pm
- Sunday and public holidays: No work.

There would be certain activities that would need to be carried out outside of standard working hours, such as lifting of the bridge girders. These 'out of hours' periods would be needed to reduce disruption for the Pacific Highway users. Any work outside standard hours would be carried out in accordance with Roads and Maritime *Construction Noise and Vibration Guideline* (Roads and Maritime, 2016a).

The *Interim Construction Noise Guideline* (DECC, 2009) has been developed by a number of NSW Government agencies to provide guidance on managing noise from construction work. Section 2.3 of the guideline provides details on the five categories of work that might be carried out outside the recommended standard hours. These categories are:

- The delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads.
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm.
- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours.
- Public infrastructure works that shorten the length of the proposal and are supported by the affected community.
- Works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

Of these five categories, two categories are likely to be applicable to the proposal: the delivery of oversize plant (i.e. large earthmoving vehicles and/or equipment) to the construction site, in accordance with TfNSW requirements for overside and/or overmass vehicles and loads, and works that justify operating outside the recommended standard hours (i.e. the lifting of bridge girders).

In addition, the guideline states that public infrastructure works are one of the five categories of works that might be undertaken outside the recommended standard hours. This need is typically based on a requirement to sustain the operational integrity of public infrastructure, as work to restore operation of the infrastructure provides a benefit to the greater community (that is, more than just local residents).

Construction activities for the proposal that fall under the above categories include:

- Relocating utilities to avoid and minimise disruptions for utility customers
- Establishment of compound area operations to support any activities that may be undertaken out of hours
- Refuelling activities and plant maintenance.

Works that would occur outside of standard working hours have been considered as part of the noise assessment (Section 6.2 and Appendix E). Confirmation of works occurring outside of standard working hours would be determined at detailed design.

3.3.3 Plant and equipment

Table 3-2 provides details of construction activities and the type of plant and equipment to be used and gives an indication on the duration each construction activity is expected to take therefore providing an indication of the intensity and scale of the construction effort. Ultimately the exact equipment and plant profile would be determined by the construction contractor. Where possible, the proposal would be constructed in conjunction with the stormwater channel, with plant and equipment shared.

Table 3-2 Construction activities, likely plant and equipment and approximate duration

Activity	Plant and equipment required	Duration (months)
Mobilisation and site establishment	Plant: Small cranes and lifting equipment, excavators, front end loaders, road trucks, light vehicles Equipment: Fences, portable sheds, portable ablutions, fuel storage, generators, waste tanks	1-2

Activity	Plant and equipment required	Duration (months)
Relocation and protection of existing services	Plant: Small cranes, excavators, backhoes, front end loaders, trenching machines, dump trucks, road trucks, light vehicles, agitator trucks Equipment: Jack hammers, concrete saws and other small handheld equipment	2-3
Clearing, grubbing and topsoil stripping	Plant: Excavators, bulldozers, graders, water carts, front end loaders, dump trucks, fuel trucks, road trucks, scrapers, light vehicles	<1
Bulk earthworks and materials haulage including sedimentation basins and diversion drains	Plant: Excavators, bulldozers, graders, water carts, front end loaders, vibratory rollers, dump trucks, road trucks, scrapers, fuel trucks, light vehicles Equipment: Hand-held compactors	8-10
Road surface construction	Plant: Excavators, bulldozers, graders, water carts, front end loaders, Bomags, road sweepers, fuel trucks, asphalt pavers, bituminous spray sealing trucks, vibratory rollers, road trucks, line marking machines, light vehicles Equipment: Hand-held compactors, jack hammers, concrete saws and other small handheld equipment	1-3
Drainage structures construction (if required)	Plant: Underborers, excavators, mobile cranes, front end loaders, vibratory rollers, road trucks, light vehicles Equipment: Hand-held compactors and other small tooling	2-3
Bridge construction works including heavy vehicle deliveries of over-size loads	Plant: Excavators, elevated work platforms, mobile cranes, agitator trucks, pile drivers, concrete pumps, vibratory rollers, road trucks, light vehicles Equipment: Hand-held compactors and other small tooling	10-12
Signposting	Plant: Excavators, elevated work platforms, mobile cranes, agitator trucks, road trucks, light vehicles Equipment: Hand-held compactors, jack hammers and other small tooling	<1
Lighting and roadside furniture installation	Plant: Excavators, elevated work platforms, mobile cranes, agitator trucks, road trucks, light vehicles Equipment: Hand-held compactors and other small tooling	1-2
Landscaping, waste disposal and rehabilitation of	Plant: Excavators, bulldozers, water carts, front end loaders, graders, road trucks, light vehicles Equipment: Small tooling	1-2

Activity	Plant and equipment required	Duration (months)
disturbed areas with no future use		

3.3.4 Source and quantity of materials

Construction materials

Typical materials that would be used for the construction of the proposal and estimated quantities are presented in Table 3-3 and Table 3-4.

Table 3-3 Typical construction materials and approximate quantities

Material	Approximate quantity
Select fill material (imported)	500 to 10,000 cubic metres
Drainage backfill	500 to 1,000 cubic metres
Asphalt	2,500 to 3,000 tonnes
Topsoil	2,000 to 3,000 cubic metres
Concrete	5,000 to 10,000 cubic metres
Steel	200 to 400 tonnes

Table 3-4: Approximated cut and fill volumes for the proposal

Proposal element	Approximate cut (cubic metres)	Approximate fill (cubic metres)
Northbound exit ramp	Negligible	30,000
Northbound entry ramp		50,000
Southbound exit ramp		20,000
Southbound entry ramp		40,000
Basins immediately north of interchange western side of highway	50,000	7,000
Total estimate	50,000	147,000

Material sources

Earthwork materials

Material to be excavated from the proposed stormwater channel would be considered for re-use for the proposal, such as for entry and exit ramp embankments. A Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the *Protection of the Environment Operations (Waste) Regulation 2014* for excavated natural material would be required to meet the conditions for excavated natural material that is, or is intended to be, for use in earthworks for the proposal.

Approximately 85,200 cubic metres of excess material would be produced from excavation of the proposed stormwater channel. However, construction of the proposal does not rely upon the material that would be excavated from the proposed stormwater channel; in the event the proposed stormwater channel is not constructed, the required volume of earthwork materials would be imported. Potential quarries to source earthwork materials include:

- Boral Quarry, Seaham (about 12 kilometres from the proposal site)
- Hunter Quarry, Karuah (about 25 kilometres from the proposal site)
- Stockrington Quarry, Stockrington (about 32 kilometres from the proposal site).

It is possible that several of these quarries would be used to optimise material quality and cost. Extraction rates at all the quarries are sufficient to achieve the assumed required production rates.

If material to be excavated from the proposed stormwater channel is re-used for the proposal, the volume of earthwork materials required would likely comprise a mixture of excavated material and imported material. The volume of excavated material that could be used would be dependent on the quality of material removed from the proposed stormwater channel. The quality of excavated material would be determined in-situ as part of more detailed geotechnical investigations for the proposal.

The results of geotechnical investigations carried out in the stormwater channel alignment in 2015, including drilling of test pits and bores, determined that residual soils may be suitable for re-use within the embankments, although mixing of the excavated bedrock and overlying residual soils would be required.

Further testing was undertaken in September 2019 by Douglas Partners (Appendix A). The purpose of this preliminary investigation was to classify the material expected to be excavated within the impact areas of the proposed interchange and stormwater channel, with a focus on areas likely to be suitable for classification as Virgin Excavated Natural Material (VENM). The results show the majority of soils tested (excluding topsoils) are classified as VENM for reuse on another site or for direct disposal to a licenced landfill (if required). Further detail is provided in Section 6.8 and Appendix A.

Any material excavated from the proposed stormwater channel which cannot meet the requirements of *QA Specification R44: Earthworks* (Roads and Maritime, 2014) and as such is unsuitable for use as general fill, may be incorporated into landscaping (for example, earth mounds for visual or acoustic screening, where and if appropriate) on the western side of the Pacific Highway or disposed of in accordance with the provisions of *Protection of the Environment Operations Act 1997*.

Asphalt pavement materials

An existing batch plant facility at Thornton (about 22 kilometres from the proposal site) would be a potential primary source in lieu of haulage from a greater distance.

Reinforced steel

Reinforcing steel for structures would be sourced from suppliers throughout Australia. The construction contractor would select a source that conforms to the quality and performance requirements of the proposal.

Concrete

Concrete for the bridge, pavement sub-bases and other proposal elements would be sourced from local batch plant facilities with agitator trucks delivering to the work fronts. A number of batch plants exist in the Hunter region.

3.3.5 Traffic management and access

Construction access and circulation

Proposed construction access points are described in Table 3-5 and shown in Figure 3-5.

Table 3-5 Construction access points

Access point	Proposed access arrangement
AP-00	The preferred haulage route for movements from one side of the Pacific Highway to the other. This route passes under the Pacific Highway via the existing disused Irrawang Spillway.
AP-01	Pacific Highway northbound carriageway first entry point. AP-01 would be the primary access point for construction works on the western side of the highway and or getting to construction compounds CC-01 and CC-02.
AP-02	The existing Hunter Water maintenance track access point would be converted into a construction access point for both northbound and southbound Pacific Highway access.
AP-03	Pacific Highway northbound carriageway entry point into the median to support the construction of the central bridge pier. It is anticipated this access point would cater for a limited number of vehicles.
AP-04	Pacific Highway southbound carriageway exit point for vehicles requiring access into the median for construction of the central bridge pier.
AP-05	Pacific Highway northbound carriageway exit point from the median to support the construction of the central bridge pier. It is anticipated this access point would cater for a limited number of vehicles.
AP-06	Pacific Highway southbound carriageway entry point for vehicles requiring access into the median for construction of the central bridge pier.
AP-07	Southbound Pacific Highway construction access point to the eastern side of the Pacific Highway.
AP-08	Northbound and southbound access point for the western side of the Pacific Highway via Six Mile Road.

Eight access points from the Pacific Highway are proposed to support general site access, vehicle movement and materials deliveries. For movements requiring material to be taken from one side of the highway to the other, vehicles, including trucks, would most likely utilise the disused Irrawang Spillway (AP-00). This would be the preferred option as it would minimise truck movements both within the construction area and on the Pacific Highway and would not require traffic management measures on the Pacific Highway. The Spillway has been previously utilised as a haulage route and therefore it is assumed for the purpose of this assessment that it is structurally sound and able to accommodate truck movements under the Pacific Highway.

A visual inspection report of the spillway prepared by Arcadis in 2018 provided high level recommendations for repairing concrete spalls and part of the concrete wall, as well as suggested further structural investigations to better assess the remaining life of the structure. These further investigations would be carried out as part of detailed design.

Should it be determined the Spillway is not a suitable haulage route, either due to being found structurally unsound during detailed design or wet weather prevents safe movement under the Pacific Highway, the following haulage routes would be utilised:

- East-to-west movement option 1: vehicles would exit southbound onto the Pacific Highway at AP-07, travel approximately 1.6 kilometres and turn right at AP-01 using the existing right-hand turn lane
- East-to-west movement option 2: vehicles would exit southbound onto the Pacific Highway at AP-02, travel approximately 3.5 kilometres south to the Richardson Road exit, perform a U-turn at the roundabout to gain access to the northbound carriageway, travel back 3.5 kilometres north and turn left at AP-01
- West-to-east movement option 1: vehicles would turn right southbound onto the Pacific Highway at AP-08, and turn left at AP-07 or AP-02

West-to-east movement option 2: vehicles would exit northbound onto the Pacific Highway at AP-01, travel approximately 4.1 kilometres north to Ringwood Road, perform a U-turn at the existing U-turn bay to gain access to the southbound carriageway, travel south and enter at either AP-07 or AP-02.

Temporary traffic management measures would be implemented at various stages of the proposal in accordance with the *Traffic Control at Worksites Manual - Version 4* (Roads and Maritime, 2010) and AS1742. It is anticipated the construction of the central overpass bridge pier would require the greatest effort in terms of temporary traffic controls.

Temporary traffic management measures would be detailed by the construction contractor as part of the construction traffic management plan (refer to environmental management measures in Section 6.1.4). Access to existing properties would be maintained at all times until the interchange is operational, at which point access to certain properties as noted in Sections 3.1.6 and 3.1.7 would be altered.

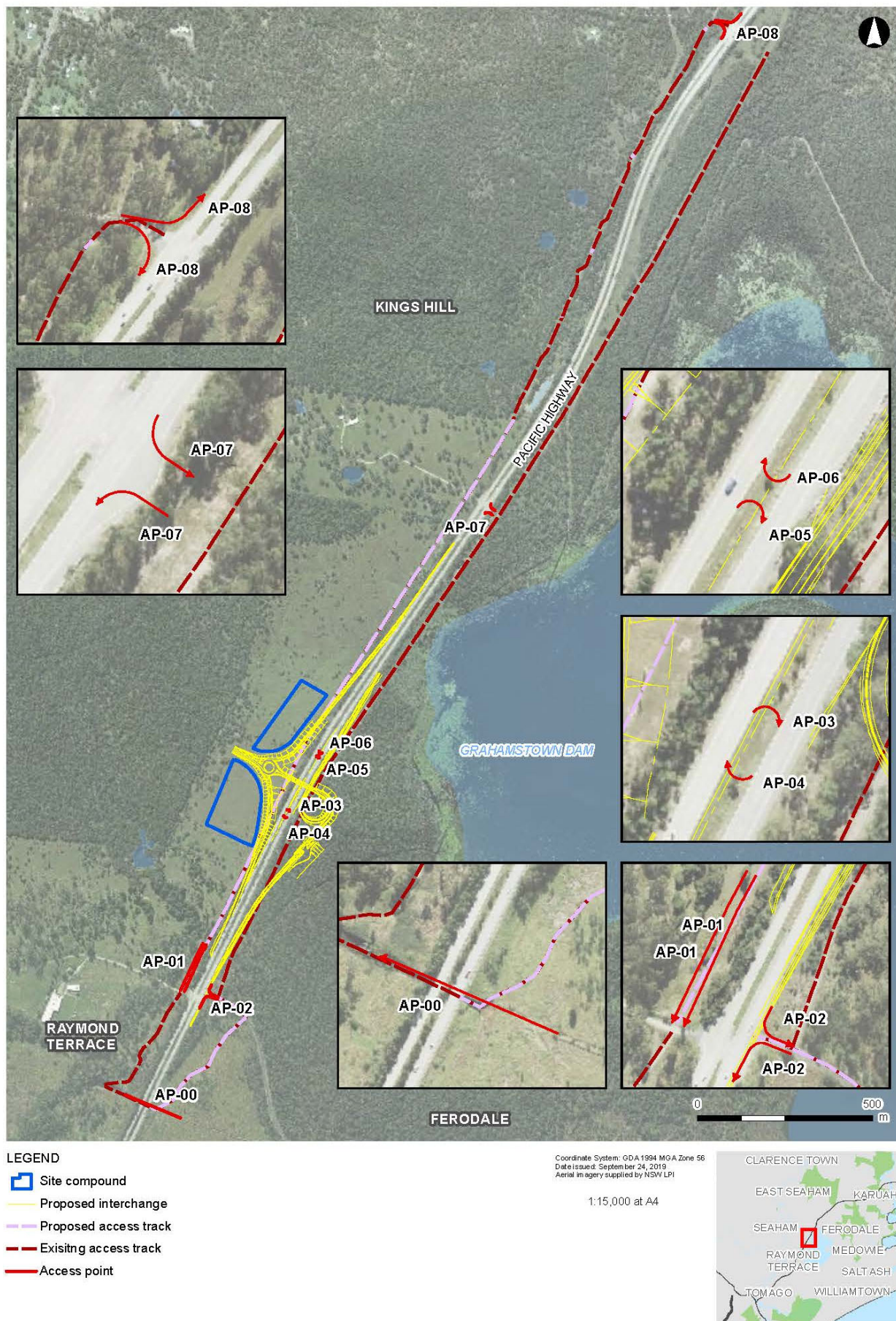


Figure 3-5 Construction access points and compound areas

3.4 Ancillary facilities

3.4.1 Compound areas

Temporary compound areas would be required for construction of the proposal, and would support site offices, workforce parking, plant storage, laydown areas and material stockpiling areas. Temporary compound areas would be rehabilitated at completion of construction.

Construction of the proposal would require two compound areas, nominated as CC-01 and CC-02 in Figure 3-5. Both compounds would be located in proximity to the proposal design footprint, on land that is devoid of native vegetation; establishment of both compounds would require the removal of exotic grassland only (currently used for cattle grazing). CC-01 would cover approximately 2.4 hectares, while CC-02 would cover approximately 1.8 hectares.

Both compounds would be accessed from the northbound carriageway of the Pacific Highway via a temporary access road. CC-01, CC-02 and temporary (likely gravel) access tracks would be remediated upon completion of construction. The size and location of compounds may be refined, and the alignment of any associated temporary access tracks would be determined during detailed design of the proposal.

CC-01 would also be utilised for the construction of the proposed stormwater channel (concurrent proposal).

3.4.2 Temporary material stockpiling

Temporary material stockpiling would be required during construction to allow for material handling and stockpiling of topsoil between its excavation from the proposed stormwater channel and its placement on proposal ramp embankments (if determined to be suitable for re-use). Stockpiles would be located within the compound areas. Any identified and additional locations proposed for temporary stockpiling would be required to implement appropriate traffic, erosion and sediment and environmental protection measures. Temporary material stockpiles would not be located in vegetated areas. Any material which is not considered suitable for re-use would be transferred off site. All material to be transferred off site would be tested and deposited at a suitable collection facility based on its determined category.

Stockpile management would be carried out in accordance with *Stockpile Site Management Guideline* (Roads and Maritime, 2015b). Temporary stockpiles will be located within the impact area according to the following criteria:

- Be located at least 5 metres clear of all areas of possible concentrated water flow
- Be located at least 10 metres from a waterway (except mulch)
- Mulch stockpiles are to be located more than 20 metres from a watercourse (if in place for greater than one month)
- Be located on land with slopes less than 10 per cent
- Have ready access to the road network or direct access to the construction corridor
- On land that does not require the removal of threatened species, Endangered Ecological Communities (EECs) or roosting habitat for listed threatened fauna species or native vegetation clearing beyond what is already required for the proposal
- Be located in areas of low heritage conservation significance (including identified Aboriginal cultural value) and not impact on heritage sites beyond those already impacted by the proposal.

3.5 Public utility adjustment

Phase 1 of construction of the proposal would involve the relocation of three types of essential services that are currently situated in (and therefore conflict with) the impact area. Indicative alignments of the relocated utilities are described below and have been assessed in this assessment (Figure 3-1). The final alignment of relocated utilities would be determined during detailed design of the proposal in consultation with the relevant asset owners.

3.5.1 Ausgrid 11kV overhead power line

Currently located within KHD-owned land on the western side of the Pacific Highway, Ausgrid 11kV overhead power line would be diverted in two stages. Stage 1 of this work would be an aboveground relocation out of the impact area of the proposal. Stage 2 would see the line undergrounded and located within the Pacific Highway road reserve. This would not require clearing of native vegetation. A new unsealed shared access track would be established adjacent to the Stage 1 aboveground alignment, that would allow for maintenance of the overhead powerline, as well as future monitoring and maintenance of any drainage infrastructure associated with the proposal that is located on the western side of the proposal (i.e. detention/treatment basins).

3.5.2 Telstra underground optic fibre and copper communication lines

Currently located within KHD-owned land on the western side of the Pacific Highway, the Telstra optic fibre line would be relocated to within the Pacific Highway road reserve, approximately 1.5 metres outside of KHD's boundary, and would extend approximately 3.1 kilometres from an existing pit immediately south of Irrawang Spillway to an existing pit on KHD-owned land near Six Mile Road. This would be done via trenching, which would require the removal of approximately 2.2 hectares of vegetation that occurs along the western margin of the Pacific Highway road reserve.

Currently located on both side of the Pacific Highway, the underground copper services would be relocated to be further inside the Pacific Highway road reserve. This would be done via underboring.

3.5.3 Hunter Water 33kV overhead power line

Currently located within KHD-owned land on the western side of the Pacific Highway, the Hunter Water overhead power line crosses to the eastern side of the Pacific Highway (in the middle of the proposal impact area), where it continues north on the eastern side of the Pacific Highway. This utility would be relocated from where it conflicts with the proposal impact area. This would be done via underboring the Pacific Highway to the south of the proposal, running a line along the eastern margin of the proposal and then connecting to the first existing pole on the east side of the Pacific Highway (west of the maintenance access track that would be adjacent to the western margin of the proposed stormwater channel).

Further relocation works would be required on the eastern side of the Pacific Highway where the existing infrastructure intercepts the proposed stormwater channel. This stage of relocation works would be considered in the proposed stormwater channel REF and is not in scope for this assessment.

3.6 Property acquisition

The proposal would be almost entirely contained within the Pacific Highway road reserve, and on land owned by KHD and Gwynvill on the eastern and western side of the Pacific Highway.

A portion of land (Lot 31 DP 1185385) on the eastern side of the Pacific Highway has been acquired by KHD from Hunter Water to accommodate the south bound entry and exit ramps of the interchange, as well as a small component of the proposed stormwater channel. The ownership of the land occupied by the proposal would be transferred to Roads and Maritime on completion of construction as this land would become part of the Pacific Highway road reserve. Any residual land to the east of the proposal southbound entry and exit ramps would be transferred back to Hunter Water.

4. Statutory and planning framework

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

Roads and Maritime is seeking project approval under Part 5 of the EP&A Act. The proposal is not located on land reserved under the *National Parks and Wildlife Act 1974* and does not affect land or development regulated by *State Environmental Planning Policy (State and Regional Development) 2011* or *State Environmental Planning Policy (State Significant Precincts) 2005*.

Part 2 of the *State Environmental Planning Policy (Infrastructure) 2007* (ISEPP) contains provisions for public authorities to consult with local councils and other public authorities before the commencement of certain types of development. Consultation, including applicable ISEPP consultation requirements, is discussed in Section 5 of this REF.

4.1 Environmental planning instruments

4.1.1 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 grade-separated interchange and is to be carried out by Roads and Maritime, it can be assessed under Part 5 of the EP&A Act. Development consent from Council is not required.

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 Section 5 of this REF.

4.1.2 State Environmental Planning Policy No 44 – Koala Habitat Protection (SEPP 44)

State Environmental Planning Policy 44 – Koala Habitat Protection (SEPP 44) aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure that permanent free-living populations are protected in their present range, and to reverse the current trend of population decline. The policy applies to the Port Stephens LGA via the *Port Stephens Comprehensive Koala Plan of Management 2002* (CKPoM). As the proposal does not require development consent in accordance with ISEPP, the CKPoM does not apply to the proposal. Regardless, this document has been considered when assessing potential impacts on koalas and koala habitat, as part of the biodiversity assessment documented in Section 6.7.

4.1.3 State Environmental Planning Policy (Coastal Management) 2018

State Environmental Planning Policy No 14 – Wetlands was repealed and replaced by *State Environmental Planning Policy (Coastal Management) 2018* on 3 April 2018.

The aim of the *State Environmental Planning Policy (Coastal Management) 2018* (Coastal Management SEPP) is to promote an integrated and co-ordinated approach to land use planning in the coastal zone in a manner consistent with the objects of the *Coastal Management Act 2016* by:

- a) Managing development in the coastal zone and protecting the environmental assets of the coast

- b) Establishing a framework for land use planning to guide decision-making in the coastal zone
- c) Mapping the 4 coastal management areas which comprise the NSW coastal zone, in accordance with the definitions on the Coastal Management Act 2016.

The mapping associated with the Coastal Management SEPP shows that a Coastal Wetland is located adjacent to the southern extent of the impact area. The impact area does not overlap with the mapped Coastal Wetland (Figure 4-1).

Surrounding this wetland is a 100-metre wide “Proximity Area”. Some elements of the proposal are located within this area, namely the relocation of the Telstra optic fibre cable. The purpose of the “Proximity Area” is to ensure that development near the Coastal Wetland considers downstream effects. Development which satisfies the requirements outlined in Clause 11 of the Coastal Management SEPP is permitted in areas mapped as Proximity Area for Coastal Wetlands.

The relocation of the Telstra optic fibre cable would require running an optic fibre cable above the Irrawang Spillway and connecting at an existing pit location directly south of the Irrawang Spillway.

Measures to avoid, minimise and mitigate potential impacts on this coastal wetland are described in the biodiversity assessment (Appendix H) and Section 6 of this REF.



LEGEND

- Impact area
- Proposed interchange
- Watercourse
- NSW Coastal Management SEPP (2018):
- Coastal Wetlands
- Coastal Wetlands Proximity Area

Coordinate System: GDA 1994 MGA Zone 56
Date issued: September 27, 2019
Aerial imagery supplied by NSW LPI

1:10,000 at A4



Figure 4-1 The proposal and the Coastal Management SEPP Coastal Wetland

4.1.4 Port Stephens Local Environmental Plan 2013

The *Port Stephens Local Environment Plan 2013* (Port Stephens LEP) establishes land zonings for the local government area, with information on applicable land use and development in each of the described zone as well as clauses relating to development assessment under Parts 5, 6 and 7 of the Port Stephens LEP that must be considered (where applicable) prior to determining a Development Application. As shown in **Error! Reference source not found.**, the majority of land occupied by the proposal is zoned SP2 Classified Road with a small portion zoned SP1 Hunter Water Corporation. The proposal also occupies land zoned B4 Mixed Use, B2 Local Centre, R1 General Residential and E2 Environmental Conservation.

In accordance with the provisions of the Port Stephens LEP, the proposal would be permitted without development consent in the SP2 zone. The proposal would be permitted with development consent in zones B2, B4 and R1. The proposal would be prohibited within SP1 and E2 zones, however Clause 94 of the ISEPP permits Roads and Maritime as a public authority to carry out development for the purpose of a road and/or road infrastructure facilities on any land without consent. As a result, consent from Council would not be required for the proposal. An assessment of the impact on land uses is documented in Section 6.3.

The proposal overlaps with land mapped as “Wetland” on the Port Stephens LEP Wetlands Map. As prescribed by Clause 7.9 of the Port Stephens LEP, development consent must not be granted unless the consent authority is satisfied that:

- a) the development is designed, sited and will be managed to avoid any significant adverse environmental impact, or
- b) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or
- c) if that impact cannot be minimised—the development will be managed to mitigate that impact.

The aim of this clause is to ensure that wetlands are preserved and protected from the impacts of development.

Measures to avoid, minimise and mitigate potential impacts on this wetland are described in the biodiversity assessment (Appendix H) and Section 6 of this REF.

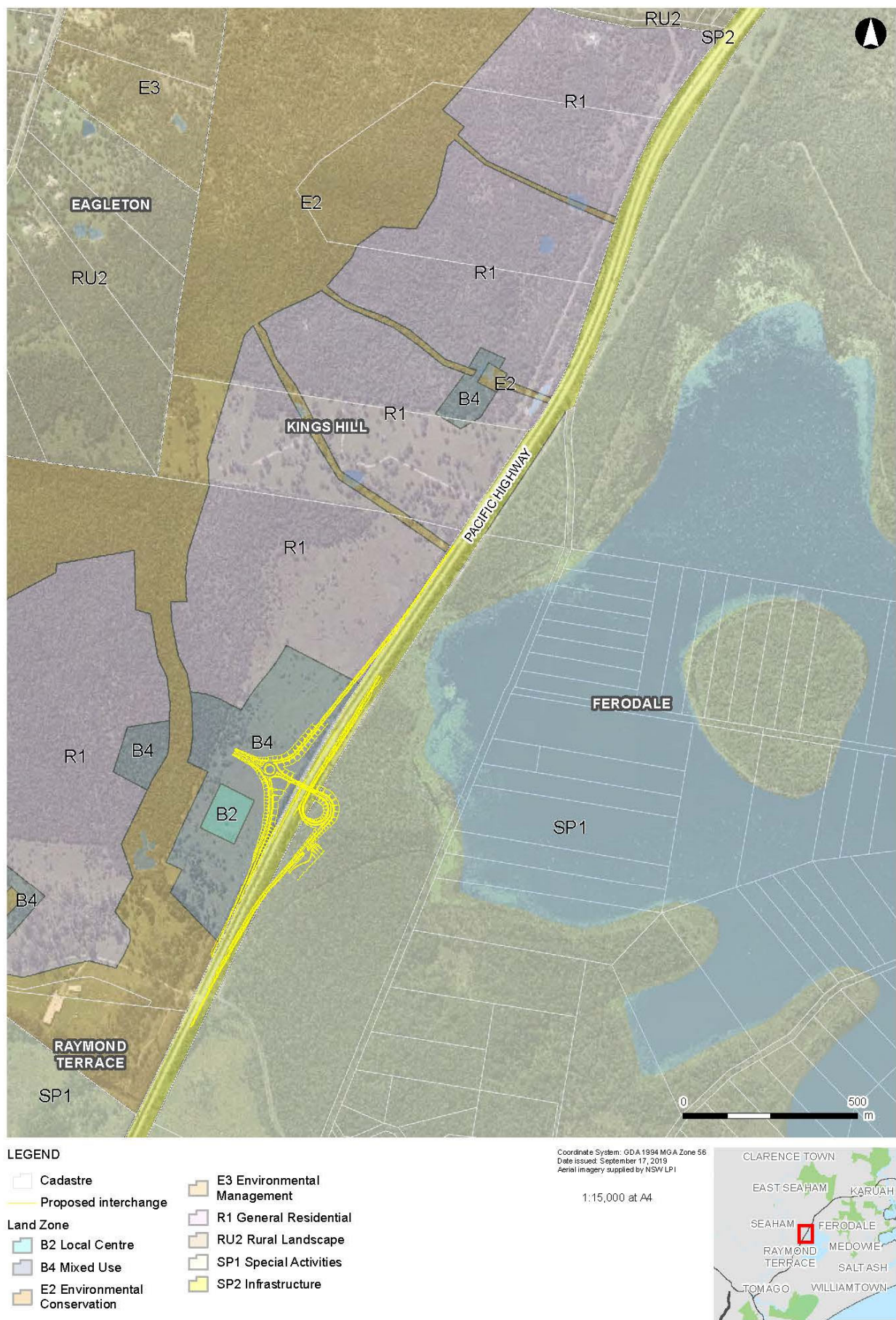


Figure 4-2 Zoning as per Port Stephens Local Environment Plan 2013

4.1.5 Port Stephens Development Control Plan 2014

Port Stephens Development Control Plan 2014 (the DCP) aims to facilitate development in accordance with the Port Stephens LEP. Although the proposal does not require development consent from Council, consideration has been given to parts of the DCP that would be otherwise relevant to the proposal. These are Part B2, Part B3, Part B4, Part B9 and Part D14.

Consideration of the DCP is presented in Table 4-1.

Table 4-1 Port Stephens DCP relevant clauses

Clause / relevance	Consideration given
Part B2 Natural Resources The proposal is located within 500 metres of land that contains threatened species / communities, has the potential to impact biodiversity The proposal is located on or in proximity to land identified as koala habitat (refer section 6.7)	• A flora and fauna assessment has been undertaken for this REF and is documented in Section 6.7. The assessment includes field surveys and koala habitat assessment. • Potential impacts on Koala Habitat were assessed as part of the ecology assessment undertaken. Mitigation measures has been developed.
Part B3 Environmental management The proposal involves earth works and would be undertaken on an area with a low risk of acid sulfate soils (refer section 6.9)	• Environmental management measures are proposed to manage impacts from earthworks. These measures are outlined in Section 6.8 and 6.9 and would be implemented in accordance with the <i>Managing Urban Stormwater: Soils and Construction</i> (Landcom, 2004; DECC, 2008). • Acid sulfate soil management measures and disposal methods would be in place in accordance with the Acid Sulfate Soils Manual (Acid Sulfate Soils Management Advisory Committee, 1998) • Impacts on the Aboriginal heritage have been assessed in this REF (refer to Section 6.4)
Part B4 Drainage and Water Quality The proposal would increase impervious surfaces and would drain to the public drainage system (should the proposed stormwater channel be constructed).	• Detention basins have been incorporated into the proposal design to capture and treat runoff before entering the public drainage system, ensuring water quality targets prescribed by the DCP are achieved • Management measures would be implemented for the duration of construction in accordance with the <i>Managing Urban Stormwater: Soils and Construction</i> (Landcom, 2004; DECC, 2008) to ensure water quality is protected and maintained.
Part B9 Road Network and Parking The proposal would impact the existing road network.	• Traffic impacts on the existing road network have been considered in this REF • A Traffic Management Plan would be incorporated into the Construction Environmental Management Plan.
D14 Kings Hill – Raymond Terrace The proposal would be located on land identified as Kings Hill	• D14.B – The proposal (i.e. the Pacific Highway interchange) would be the primary access point to the Kings Hill URA • D14.D – The detention basins incorporated into the proposal design contribute to ensuring environmentally sustainable water management.

4.2 NSW Legislation

4.2.1 Environmental Planning and Assessment Act 1979

The objects of the *Environmental Planning and Assessment Act 1979* (EP&A Act) are:

- a) to encourage:
 - i. 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,
 - ii. the promotion and co-ordination of the orderly and economic use and development of land,
 - iii. the protection, provision and co-ordination of communication and utility services,
 - iv. the provision of land for public purposes,
 - v. the provision and co-ordination of community services and facilities, and
 - vi. the protection of the environment, including the protection and conservation of native animals and plants, including threatened species and ecological communities, and their habitats, and
 - vii. ecologically sustainable development, and
 - viii. the provision and maintenance of affordable housing, and
- b) to promote the sharing of the responsibility for environmental planning between the different levels of government in the State, and
- c) to provide increased opportunity for public involvement and participation in environmental planning and assessment.

In accordance with Part 5, Subdivision 2, Section 5.5, for the purpose of attaining the objects of the EP&A Act relating to the protection and enhancement of the environment, a determining authority (i.e. Roads and Maritime) in its consideration of an activity (i.e. construction and operation of the proposed interchange) shall, notwithstanding any other provisions of this Act or the provisions of any other Act or of any instrument made under this or any other Act, examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity.

4.2.2 Hunter Water Act 1991

A portion land that would be occupied during the construction of the proposal is located on a designated gazetted special area (i.e. Grahamstown Catchment area) pursuant to Section 53 of the *Hunter Water Act 1991* (HW Act).

Under Section 51 of the HW Act, Roads and Maritime may notify Hunter Water of the proposal as it is located in a special area and in close proximity to the Grahamstown Dam.

4.2.3 Hunter Water Regulation 2015

The *Hunter Water Regulation 2015* provides for restrictions of water use in special areas including the engagement in aquaculture, intensive livestock or agriculture; installation or operation of sewage disposals; and the pollution of waters. The Schedule specifies offences as penalty notice offences and prescribes authorized officers for the purposes of issuing penalty notices.

Clause 10 of the *Hunter Water Regulation 2015* prohibits polluting any waters in a special area. Appropriate erosion and sediment controls would be implemented during construction to mitigate impacts on the Grahamstown Dam Catchment area.

4.2.4 Roads Act 1993

Section 138 of the *Roads Act 1993* requires consent from the relevant roads authority (Roads and Maritime) for the erection of a structure, or the carrying out of work in, on or over a public road, or the digging up or disturbance of the surface of a road. The proposal construction would require partial Pacific Highway closures. The highway is a classified road and requires consent from the road authority to proceed.

NSW Traffic Management Centre approval would be sought for a road occupancy licence for the closure of traffic lanes and the movement of over-sized vehicles during the construction.

4.2.5 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) establishes a regulatory framework for the protection and restoration of the environment. It provides a mechanism for licensing for certain activities, listed in Schedule 1 of the POEO Act.

The reuse of Excavated Natural Material (ENM) does not require an Environment Protection Licence in accordance with Section 19 of Schedule 1 of the POEO Act, provided that the conditions of the resource recovery order and exemption for ENM are met.

A Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the *Protection of the Environment Operations (Waste) Regulation 2014*, for excavated natural material from the proposed stormwater channel, would be required to meet the conditions for excavated natural material that is, or is intended to be for use in earthworks for the proposed interchange (concurrent proposal subject to separate assessment).

If approved, the construction and operational stages of the proposal would need to comply with the POEO Act provisions related to prevention of pollution and waste classification, management and disposal.

Section 19 of Schedule 1 of the POEO Act states land-based activities involving the extraction, processing or storage of more than 30,000 tonnes per year of extractive materials (e.g. clay, sand, soil, stone, gravel, rock and sandstone) require an environment protection licence. If approved, the construction and operational stages of the proposal would need to comply with the POEO Act provisions related to prevention of pollution and waste classification, management and disposal.

4.2.6 Biosecurity Act 2015

The primary objective of the *Biosecurity Act 2015* is to provide a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, dealing with biosecurity matter, carriers and potential carriers, and other activities that involve biosecurity matter, carriers or potential carriers. Division 2 of the Act defines local control authorities for weeds and Schedule 1 outlines special provisions relating to weeds, including the duty of land occupiers to control and manage weeds.

4.2.7 Land Acquisition (Just Terms Compensation) Act 1991

The *Land Acquisitions Act 1991* (LA Act) applies to the acquisition of land (by agreement or compulsory process) by a public authority authorised to acquire the land by compulsory process. It provides a guarantee that, when a public authority requires the acquisition of land, the amount of compensation will not be less than the market value of the land. Land acquisition requirements for the proposal are discussed in Section 3.6.

4.2.8 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act) provides for the conservation and management of nature and objects, places and features of cultural value. It is the primary legislation for the protection of Aboriginal cultural heritage in NSW. Part 6 of the NPW Act provides protection for all Aboriginal objects and Aboriginal places in NSW. Under Section 90 of the Act, an Aboriginal Heritage Impact Permit (AHIP) is required before the disturbance of Aboriginal objects or places. No AHIP is required for the proposal. An assessment of impact on Aboriginal heritage is presented in Section 6.4.

4.2.9 Biodiversity Conservation Act 2017

The purpose of the *Biodiversity Conservation Act 2017* (BC Act) is to maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future, consistent with the principles of ecologically sustainable development. The BC Act replaced and repealed the *Threatened Species Conservation Act 1995* (TSC Act) on 25 August 2017. The BC Act incorporates broadly similar objectives to those identified in the TSC Act, and additionally seeks to establish a framework for assessment and offsetting of development impacts as well as investment in biodiversity conservation. The NSW Biodiversity Offsets Scheme (BOS) is established under Part 6 of the BC Act and the Biodiversity Assessment Method (BAM) is established under section 6.7 of the BC Act. The purpose of the BAM is to prescribe requirements for the assessment of certain impacts on threatened species and Threatened Ecological Communities (TECs), and their habitats, and the impact on biodiversity values, where required under the BC Act.

Section 7.3 of the BC Act provides a test for determining whether proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats. Where a significant impact is likely, a Species Impact Statement must be prepared. Alternatively, Roads and Maritime could elect to enter into the BOS as an alternative to preparing a Species Impact Statement. The significant impact test has been applied to several threatened entities (refer to Section 6.7 and Appendix H).

4.2.10 Crown Lands Act 1989

The *Crown Lands Act 1989* (CL Act) ensures that Crown land is managed for the benefit of the people of New South Wales and set up requirements for granting a relevant interest over a Crown Reserve including licences, permits, easements or rights of way. Crown land would not be impacted by the proposal.

4.2.11 Water Management Act 2000

General water management principles are listed under Part 1, Division 1, Section 5 of the *Water Management Act 2000* (WM Act). Of relevance to the proposal, water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded.

There is potential for groundwater to be intercepted during construction of the proposal, therefore aquifer interference approval would be sought from the NSW Office of Water prior to the start of construction if required.

4.3 Commonwealth legislation

4.3.1 Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) proposed 'actions' that have the potential to significantly impact on matters of national environmental significance or the environment of Commonwealth land, or are being carried out by a Commonwealth agency, must be referred to the Commonwealth Government. If the Commonwealth Minister for the Environment determines that a referred proposal is a "controlled action", the Commonwealth Minister's approval of the proposal would be required in addition to approval from the NSW Minister for Planning.

The assessment of the proposal's impact on Matters of National Environmental Significance (MNES), and Commonwealth land found that there is unlikely to be a significant impact on MNES (other than biodiversity matters) or on Commonwealth land. Accordingly, the proposal has not been referred to the Australian Government Department of the Environment and Energy under the EPBC Act.

The assessment of the proposal's impact on nationally listed threatened species, populations, endangered ecological communities and migratory species (refer to Section 6.7 and Appendix H) concluded that there is unlikely to be a significant impact on biodiversity related MNES. While the proposal would result in the loss of approximately 12.00 hectares of native vegetation that offers habitat to threatened species listed under the EPBC Act (specifically, Grey-headed Flying Fox and Koala), it was determined that the proposal is unlikely to have a significant impact on these threatened species.

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

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

Although not required for strategic assessments, assessments of significance of impacts to MNES have been included in this report. These assessments are provided to 'address and consider potential impacts on MNES' as required by the strategic assessment.

4.4 Confirmation of statutory position

Roads and Maritime are seeking approval under Part 5 of the EP&A Act. The proposal is categorised as development for the purpose of a road and is being carried out by Roads and Maritime. Under clause 94 of the ISEPP the proposal is permissible without consent. The proposal is not State significant infrastructure, State significant development or Designated development. Development consent under Part 4 of the Act from Council is not required.

Roads and Maritime is the determining authority for the proposal. This REF has been prepared in accordance with Roads and Maritime REF guidelines and fulfils Roads and Maritime's obligation under Section 5.5 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.

5. Consultation

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

The consultation objectives for the proposal are to:

- Identify all potentially interested stakeholders and provide opportunities to include and engage them in the project development process
- Obtain input from the community during the key development phases of the project
- Build relationships and resolve issues during planning
- Provide good information to assist the community to understand the planning process, including public display of the REF.

5.1 Community involvement

There are four landowners directly affected by the proposal: KHD, Hunter Water, Gwynvill Trading Pty Ltd and Riding for the Disabled. As a part of development process, KHD and its representatives have consulted with affected landowners with regard to the concept design of the proposal. To date, all stakeholders have indicated their support for the proposal.

Consultation with the affected landowners is ongoing. The proposal has been developed to ensure that appropriate access to the affected landowners' properties would be maintained at all times during and post-construction.

5.2 ISEPP consultation

In relation to the consultation requirements set out in Part 2, Division 1 of the ISEPP, it is noted the proposal would not impact on:

- Council-related infrastructure or services (refer to Section 3.5)
- The local heritage (refer to Section 6.4 and 6.5)
- Flood liable land (refer to Section 6.8).

Hence Council consultation requirements set out in the ISEPP would not be triggered by the proposal.

Further, the proposal does not fall into the definition of 'specified development' pursuant to Section 16 of the ISEPP. Hence it is considered the proposal does not trigger public authority consultation requirements outlined under the ISEPP.

5.3 Aboriginal heritage consultation

Aboriginal Heritage Due Diligence Assessment: Kings Hill interchange and drainage channel Raymond Terrace, NSW (Myall Coast Archaeological Services, 2015) was prepared to support the assessment of potential impacts of the proposal on Aboriginal heritage. This due diligence was informed by a previous Aboriginal Heritage assessment across the Kings Hill URA, which involved full consultation with the Aboriginal Community.

More recently, an Aboriginal heritage assessment (Appendix F) was carried out in accordance with Roads and Maritime's *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI) (RTA, 2011a).

As part of the PACHCI Stage 2, Roads and Maritime's Aboriginal Cultural Heritage Officer (Southern Region) carried out a site inspection across the proposal footprint on 24 May 2019. The Aboriginal Cultural Heritage Officer was accompanied by a Roads and Maritime Environment Officer, representatives from KHD and representatives from the Worimi Local Aboriginal Land Council (LALC). This facilitated on-site consultation regarding the interchange and channel proposals, construction methodologies and operational issues such as stormwater management. The results of the PACHCI Stage 2 are described in Section 6.4.

5.4 Government agency and stakeholder involvement

Various government agencies and stakeholders have been consulted about the proposal, including:

- Hunter Water
- Council
- Roads and Maritime
- Dams Safety Committee
- Telstra,
- Landowners

Issues that have been raised as a result of consultation with these agencies and stakeholders are outlined below in Table 5-1.

Table 5-1 Issues raised through stakeholder consultation

Stakeholder	Activity	Issue/feedback received	Where addressed in this REF
NSW Department of Planning, Industry and Environment	Ongoing since 2014 Meetings and correspondence regarding funding, proposal timing and coordination of processes and approvals	Approval framework	Section 4
		Reasonable and Proportionate Funding mechanisms Expected timing	Section 3.3
Port Stephens Council	April 2015 Meeting with Council's working group Various meetings and correspondence as part of the overall Kings Hill development	Interchange ownership	Section 3.6
		Property adjustment and acquisition requirements Stormwater management system arrangements Drinking catchment / Irrawang Swamp water quality impacts	Section 3.6 Section 3.1.5 and Section 6.8 Section 3.1.4 and Section 6.8
	March 2017 Workshop with Hunter Water, Council	Access arrangements into Grahamstown Dam for Hunter Water personnel Relocation of utilities Irrawang Swamp (existing environment, potential	Section 3.1.7 Section 3.5

Stakeholder	Activity	Issue/feedback received	Where addressed in this REF
		operational impacts, mitigation measures)	Section 6.7 and Section 6.8
	April 2017 Meeting with Council's Natural Resource Coordinator and Senior Environmental Scientist	Proposed stormwater channel biodiversity discussions	N/A
	July 2017 Meeting with Council to discuss status of Stormwater Channel REF prior to lodgement	Water quality impacts on downstream environments Channel-related material	Section 6.8 N/A
	August 2017 Workshop with environmental representatives, maintenance staff and environmental planners from Council, Hunter Water and Umwelt	Workshop to discuss results of third-party review of draft REF (i.e. by Umwelt on behalf of Port Stephens Council) Cumulative impacts of the interchange and proposed stormwater channel, particularly the loss of native vegetation and threatened species habitat	Throughout Section 6.12
	February 2019 Correspondence	Approval from Council on Koala Hub Assessment scope for the Kings Hill URA	N/A
	September 2018 Meeting	Kings Hill URA Pre-Development Application (DA) lodgement meeting Mention of proposal as key infrastructure	N/A
	February 2019 Meeting with Council, ANU, RPS	Kings Hill URA biodiversity discussions: Koala habitat, wetlands, corridors, Koala DNA work, cumulative impacts, mitigation and offsetting, Species Impact Statement (SIS) submission	N/A

Stakeholder	Activity	Issue/feedback received	Where addressed in this REF
		Kings Hill URA lodgement, assessment and referral process	
	May 2019 Meeting	Pre-DA lodgement meeting with Council for the Kings Hill Water and Wastewater Infrastructure (subject to separate environmental assessment and approval) Minor mention of the status of the Interchange REF	N/A
Hunter Water	May 2015 Meeting with Hunter Water staff at the Newcastle offices and correspondence	Impacts on the Hunter Water Grahamstown Dam maintenance access track; proposed relocation of the track	Section 3.3.2 and Section 6.1
		Stormwater discharge arrangements and avoidance of discharge into the Grahamstown Dam	Section 6.8
		The relocated Grahamstown Dam access road should be trafficable on a 0.2%AEP rainfall.	Section 6.8
		New drainage channel (which falls outside the scope of this proposal) to cater for the critical 0.2% percent annual exceedance probability rainfall event to prevent water entering Grahamstown Dam. Relocation of power lines running parallel to Pacific Highway	Section 1.4 Section 3.5
	March 2017 Workshop with Hunter Water and Council	As described for Port Stephens Council (refer to above)	As identified above
	May 2019 Meeting	Meeting with Hunter Water to discuss the Kings Hill Water and Wastewater Infrastructure (subject to separate environmental assessment and approval)	N/A

Stakeholder	Activity	Issue/feedback received	Where addressed in this REF
		Minor mention of the status of the Interchange REF	
Roads and Maritime	Ongoing since 2014 Correspondence; face to face meetings with Roads and Maritime Hunter Region staff	In principle support for the proposal Feedback on initial design for preferred option Options considered for the location of the Grahamstown Dam service road connection Impacts on Pacific Highway / classified road network Overpass bridge clearance and impacts on the highway lane widths Ramps length to allow for appropriate deceleration/acceleration Methodology of noise assessment Requirement for stand-alone biodiversity assessment in accordance with <i>Environmental Impact Assessment Practice Note – Biodiversity Assessment</i> (EIAN06) guideline (Roads and Maritime Services, 2016)	Section 5.4 Section 2 Section 2.6 and Section 3.1.7 Section 6.1.3 Section 3.1.1 Section 3.1.2 Section 6.2.1 Section 6.7
	March 2017 On-site meeting with Roads and Maritime Environment Officer and Aboriginal Cultural Heritage Officer	Interchange footprint and design features, with focus on drainage arrangements, biodiversity issues and Aboriginal heritage issues, and context with regard to proposed stormwater channel footprint	Section 6.4.1 and Section 6.12
	August 2017 Workshop with Roads and Maritime Hunter Region staff	Interchange geometry and design, including overpass height and shoulder width on overpass Relocation of utilities: timing, methodology and proposed alignments Proposed drainage infrastructure and stormwater management, with and without construction of the	Section 3 Section 3.5 Section 3.1.5

Stakeholder	Activity	Issue/feedback received	Where addressed in this REF
		proposed stormwater channel east of the interchange	
	May 2019 Meeting with Roads and Maritime Hunter Region staff	Aboriginal heritage assessment requirements – PACHCI Stage 2 Legislative updates Confirmed comments from March 2017 Workshop with Hunter Water and Port Stephens Council are to be addressed	Section 6.4 Throughout Throughout
	July 2019 Meeting with Roads and Maritime Hunter Region staff	Verification of proposal description and consideration of construction traffic movements Confirmation of study area	Section 3 and Section 6.1 Section 1.2.1
Telstra	August 2014 Correspondence and phone discussions	Impact on Telstra copper communication cables	Section 3.5
	July 2019 Correspondence	Relocation of Telstra optic fibre cable	Section 3.5
Ausgrid	August 2017	Relocation of 11Kv overhead powerline	Section 3.5
Gwynvill Trading Pty Ltd	August 2016 Correspondence	All details related to the proposal provided to landowner Information was reviewed and concurrence and support confirmed	N/A
Riding for the Disabled Association	June 2019 Meeting with committee members	Details related to the proposal provided to the Association Discussion of operational and access requirements	Section 3.1.6 and Section 6.1
Stephen Phillips Managing Director / Principal	September 2017	Significance of impacts of the proposal on koalas, mitigation measures to be implemented to reduce impacts on koalas, and measures to provide for habitat connectivity into and	Section 6.7

Stakeholder	Activity	Issue/feedback received	Where addressed in this REF
Research Scientist		through the proposal footprint and surrounding landscape.	
Biolink Ecological Consultants	September 2017 Meeting with Arcadis, KHD, JW Planning, BIOCM	Significance of impacts of the proposal on koalas, mitigation measures to be implemented to reduce impacts on koalas, and measures to provide for habitat connectivity into and through the proposal footprint and surrounding landscape.	Section 6.7
	March and May 2018 Meetings	Kings Hill URA Hub Assessment outputs, recommendations and updates Kings Hill URA Koala corridor	N/A
	Ongoing 2019 Correspondence	Ongoing discussions surrounding Koala habitat, Koala land bridge, mitigation measures, etc.	Section 6.7
Department of the Environment and Energy	October 2017	Discussions regarding the potential for the proposal to trigger an EPBC Referral due to cumulative impacts associated with the adjacent proposed URA development	Section 6.7.3
Department of Planning, Industry and Environment (formerly Office of Environment and Heritage, OEH)	April 2018 Meeting	Consultation regarding DGRs, offsetting, SIS, approach for future DAs, approach to Koala impacts (related to Kings Hill URA)	N/A
	August 2018 Meeting	Kings Hill URA Pre-SIS consultation	N/A
	February 2019 Meeting with OWAD, RPS, JW Planning, ANU	Kings Hill URA Pre-DA lodgement consultation	N/A

5.5 Ongoing and future consultation

This REF will be placed on public exhibition by Roads and Maritime for a minimum of 30 days. As a minimum it will be available for viewing at **XX [Drafting note: Roads and Maritime to confirm exhibition details]**

During the REF exhibition, the community, government agencies and other interested parties are invited to make written submissions on the proposal.

Following the submissions period, Roads and Maritime will collate submissions. After consideration of community comments Roads and Maritime will determine whether the proposal should proceed as proposed, or whether any alterations to the proposal are necessary.

If the proposal is determined by way of approval, Roads and Maritime will continue to consult with government agencies, affected residents and other relevant stakeholders before and during construction. Roads and Maritime would also continue to consult with service and utility providers to ensure the design adheres to their requirements and that no services are inadvertently impacted by the proposal.

5.5.1 Consultation with NSW government agencies

NSW Government agencies including the Department of Planning, Industry and the Environment (DPIE) and the Environmental Protection Authority (EPA) would be consulted during the public display period of the REF. Roads and Maritime would seek comments on the proposal by these agencies, and would respond to these comments in the Response to Submissions Report.

5.5.2 Changes to the approved proposal

Any changes to the approved proposal that would result in increased environmental impacts would require consultation with Roads and Maritime's Aboriginal Cultural Heritage Officer to determine if a revised assessment of potential impacts on Aboriginal cultural heritage is required. Further consultation with relevant agencies would be undertaken as required.

6. Environmental assessment

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

- Potential impacts on Matters of National Environmental Significance (MNES) 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 B.

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

6.1 Traffic and transport

This section presents an assessment of the potential impacts of the proposal on traffic and access and identifies safeguards and management measures to avoid or minimise these impacts. The assessment presented in this section draws on information provided in *Pacific Highway Interchange at Kings Hill- Revised Concept Design: Updated Traffic Modelling and Assessment* (Appendix C) and *Kings Hill REF Construction Route Assessment Technical Note* (Appendix D). Where relevant, *Port Stephens Council Report for Kings Hill Residential Lands Rezoning Traffic and Transport Study* (GHD, 2013) has also been referenced.

6.1.1 Methodology

Preliminary traffic modelling was carried out by Arcadis (formerly Hyder Consulting) in February 2014, based on the initial concept design (as described in Section 2.6 and illustrated in Figure 2-1). After this design was refined, additional traffic modelling was carried out in November 2014, based on the current concept design (i.e. the proposal, as described in Section 3).

The following tasks were undertaken for this assessment:

- Review of existing road network and existing pedestrian and cyclist access and public transport services
- Review existing traffic volumes from traffic studies relevant to the proposal (GHD, 2013, Hyder, 2014a and 2014b). The level of service (LoS) criteria used in the traffic studies followed the *Guide to Traffic Generating Developments* (RTA, 2002) (Table 6-1) and is presented in **Error! Reference source not found.**
- Review of Roads and Maritime average annual daily traffic data
- Review of Roads and Maritime Crash Statistics Database between 2013 and 2017
- Determination of future traffic performance using Paramics modelling software (Hyder 2014a and 2014b). The model was set up with the following assumptions:
 - Kings Hill site would be fully developed by 2036 and comprising of 3,500 residential dwellings and 7.5 hectares of mixed-use/retail land-uses
 - A self-containment trips factor of 25 per cent was assumed within the subdivision
 - Traffic access from the Kings Hill site to the external road network would be 80 per cent via the proposed interchange and 20 per cent via the Newline Road
 - Six Mile/Pacific Highway intersection and Riding for the Disabled access road to the Pacific Highway would be closed and replaced with access via the proposed interchange
 - Introduction of a priority-controlled T intersection with Newline Road to provide access for the Kings Hill traffic
 - Background traffic growth to 2036 on the Pacific Highway is assumed to be 2 per cent per annum and for other roads background growth is assumed to be 1 per cent per annum.
- Identification of mitigation and management measures to avoid and minimise impacts of the proposal on traffic and access.

Table 6-1 Level of service (LoS) criteria (Source: RTA, 2002)

LoS	Average delay per vehicle (seconds)	Traffic signals and roundabouts	Give way and stop signs
A	Less than 15	Good operation	Good operation

LoS	Average delay per vehicle (seconds)	Traffic signals and roundabouts	Give way and stop signs
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	28 to 42	Satisfactory	Satisfactory, but accident study required
D	42 to 56	Operating near capacity	Near capacity, accident study required
E	56 to 70	At capacity, excessive delays; roundabout requires other control mode	At capacity; requires other control mode
F	Greater than 70	Unsatisfactory; requires additional capacity	Unsatisfactory; requires other control mode

6.1.2 Existing environment

Road network

The existing road network surrounding the proposal is presented in Figure 6-1. The main roads relevant to the proposal are:

- Pacific Highway, the major coastal route between Sydney and Brisbane. The Pacific Highway has four lanes (two in each direction) at the point where it would intersect the proposal site. The highway provides direct connections at Adelaide Street in Raymond Terrace for northbound traffic, via a grade separated interchange at Richardson Road, and an at-grade intersection at Six Mile Road
- Grahamstown Dam maintenance track (no public access road) allows access from the Pacific Highway to the dam and foreshore areas. The service road connects to the Pacific Highway southbound carriageway via two at-grade access points (AP-02 and AP-07, identified in **Error! Reference source not found.**) that allow for left-in / left-out movements with the highway. There are locked gates at both access points and access to the service road is limited to Hunter Water authorised personnel. It is understood the two service road access points are used infrequently, around once per week. While the southern-most of the service road access points is positioned next to a U-turn facility on the highway, no formal right-turn movements can currently be performed to and from the northbound carriageway into the northern-most access point.
- Six Mile Road, a two lane (one in each direction) road running east-west and connecting the Pacific Highway and Newline Road. It is controlled in the east via a seagull intersection arrangement at Pacific Highway and an uncontrolled intersection in the west at Newline Road. A portion of Six Mile Road is unsealed. Portions of Six Mile Road are subject to flooding during major storm events.
- Newline Road, a two lane (one in each direction) sealed road running north-south parallel to the Williams River, connecting rural residential areas to Raymond Terrace. Newline Road provides an alternate route from Raymond Terrace to Seaham via Eagleton and forms the western boundary of the Kings Hill URA. Newline Road is subject to flooding during major storm events.

Average Daily Traffic counts, collected from the southbound carriageway of Pacific Highway at Twelve Mile Creek (Station T0482), located nine kilometres north of the study area, have been obtained from Roads and Maritime Traffic Volume Viewer (Table 6-2).

Table 6-2 Traffic data collected from Station T0482

Year	Light vehicles (average monthly count)	Heavy vehicles (average monthly count)
2015	8525	526
2016	8995	645
2017 (to date)	9501	695

Property access

In addition to KHD-owned land, two privately-owned properties are located in proximity to the proposal, on the western side of the Pacific Highway:

- A residential property at 3385 Pacific Highway located on the western side of the Pacific Highway, north of the proposal. Access is currently provided via a left-turn lane from the northbound carriageway, into an unsealed driveway. Traffic leaving this property may turn left on the northbound carriageway and travel north, or travel across the northbound carriageway to a right-turn lane in the median, to turn right into the southbound carriageway to travel south. The location of this property is shown on Figure 3-2.
- Riding for the Disabled (3217 Pacific Highway), located on the western side of the Pacific Highway (but does not directly adjoin the Pacific Highway), south of the proposal. Access is currently provided via a left-turn lane from the northbound carriageway, into an unsealed driveway. Traffic leaving Riding for the Disabled may turn left on the northbound carriageway and travel north, or travel across the northbound carriageway to a right-turn lane in the median, to turn right into the southbound carriageway to travel south. The location of this property is shown on Figure 3-2.

Pedestrian and cyclist network

The section of the Pacific Highway section that transects the proposal does not have designated bicycle route or pedestrian footpaths. The closest designated bicycle routes and footpaths are located in Raymond Terrace.



Figure 6-1 Existing road network

Public transport

A number of public bus services operate on the Pacific Highway and Raymond Terrace. These are listed in Table 6-3. There are no bus stops, taxi ranks or train services within or next to the proposal.

Table 6-3 Existing public transport (Source: Busways, 2015; Hunter Valley Buses, 2015; Port Stephens Coaches, 2015; Transport for NSW, 2017)

Company	Bus route	Frequency
Busways	150, 151 and 152 Newcastle - Taree	Daily. Up to four times a day on weekdays
Hunter Valley Buses	136 Stockton to Raymond Terrace 137 Raymond Terrace to Lemon Tree Passage 140 Newcastle to Raymond Terrace	Daily. Regular service
NSW Train Link	135 Raymond Terrace to Taree	Daily. Once a day
Port Stephens Coaches	130 and 135 Nelson Bay to Raymond Terrace	Monday to Friday. Twice a day

Road safety

Roads and Maritime's Crash Statistics Database provided crash data for the main roads surrounding the proposal site for the period January 2013 to 2017. Accidents captured by the database during this period are shown in Figure 6-2.

A total of 38 crashes were reported along the Pacific Highway with one fatality. The primary crash type was vehicle to object crashes (60 per cent), followed by vehicle to vehicle crashes (34 per cent) and animal strike (5 per cent). The data shows a reduction in the crash rate between 2013 and 2017.

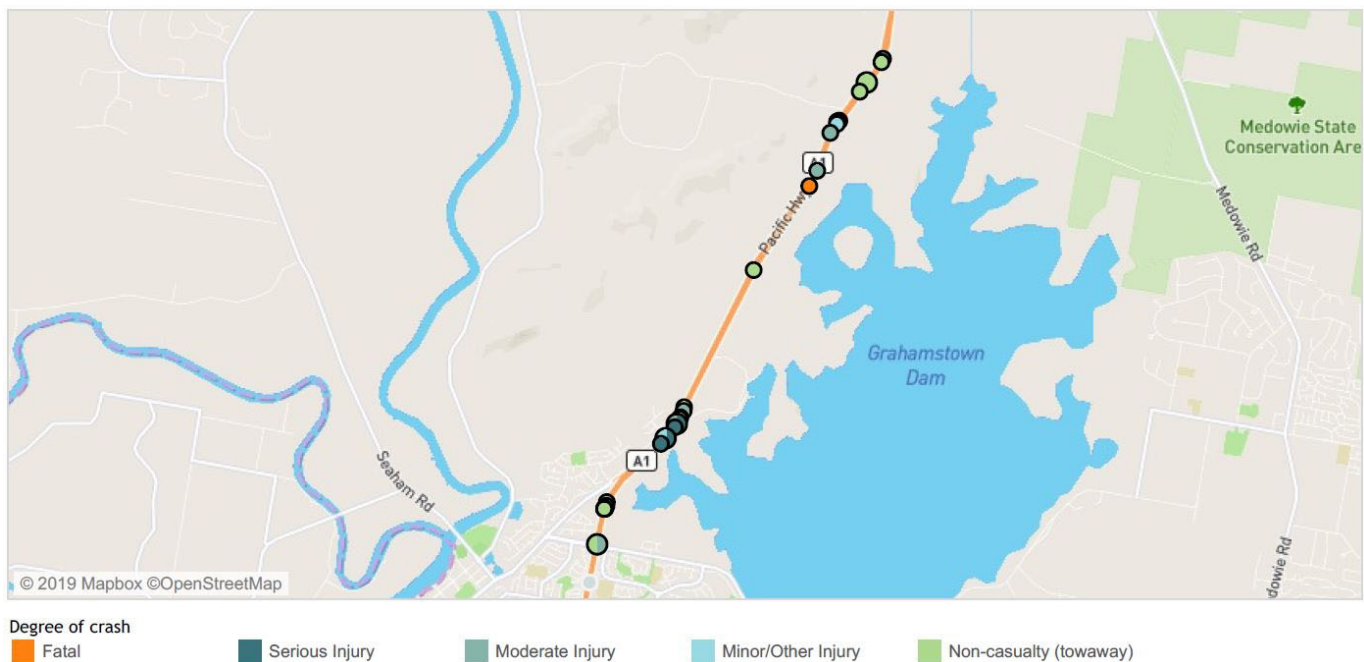


Figure 6-2 Crash statistics database records 2013 to 2017 (Source: Roads and Maritime Crash Statistics Database, 2019)

Existing traffic demand

An analysis of the levels of service provided at key intersections and at mid-block of key roads was undertaken by GHD (2013) based on 2012 surveyed traffic flows. The LoS observed are presented in Table 6-4.

Table 6-4 2012 levels of service at key intersections and mid-block roads (GHD, 2013)

Location	Levels of service	
	AM peak	PM peak
Intersections		
William Bailey Street/Newline Road	A	B
Beaton Avenue/Newline Road	A	A
Six Mile Road/Newline Road	A	A
Six Mile Road/Pacific Highway	D	D
Waste Access Road/ Newline Road	A	A
Mid-block (worst-case direction)		
Newline Road (north of William Bailey Street)	A	B
William Bailey Street (east of Newline Road)	C	F
Pacific Highway (south of Kings and north of Adelaide Street)	A	A
Six Mile Road (west of Pacific Highway)	A	A

Intersections investigated operated well during peak periods with the exception of the Six Mile Road/Pacific Highway intersection which was found to operate near capacity. The mid-block analysis found that during the PM peak, William Bailey Street experienced unsatisfactory levels of service.

6.1.3 Potential impacts

Construction

Construction traffic

The average number of trips per working day would be about 35 two-way trips for the 14-month duration of construction of the proposal. These trips would be generated by the workforce, materials haulage, and deliveries to the proposal site. Based on the average monthly vehicle counts (Table 6-2), the additional movements generated by the construction of the proposal would not cause adverse impacts on the Pacific Highway or its users. Construction deliveries would be timed to occur outside peak traffic periods when feasible and reasonable, to minimise impacts on the road network (refer to Section **Error! Reference source not found.** for traffic management measures to be implemented).

As described in Section **Error! Reference source not found.**, Irrawang Spillway would most likely be utilised as the main haulage route for the duration of the construction period (Figure 6-3). Two alternative east-west movement routes and two alternative west-east movement routes (and their corresponding access points) have been proposed should the spillway be determined unsuitable as a haulage route:

- East-to-west movement option 1: vehicles would exit southbound onto the Pacific Highway at AP-07, travel approximately 1.6 kilometres and turn right at AP-01 using the existing right-hand turn lane (Figure 6-4)
- East-to-west movement option 2: vehicles would exit southbound onto the Pacific Highway at AP-02, travel approximately 3.5 kilometres south to the Richardson Road exit, perform at U-turn at the roundabout to gain access to the northbound carriageway, travel back 3.5 kilometres north and turn left at AP-01 (Figure 6-5)
- West-to-east movement option 1: vehicles would turn right southbound onto the Pacific Highway at AP-08, and turn left at AP-07 or AP-02 (Figure 6-6)
- West-to-east movement option 2: vehicles would exit northbound onto the Pacific Highway at AP-01, travel approximately 4.1 kilometres north to Ringwood Road, perform a U-turn at the existing U-turn bay to gain access to the southbound carriageway, travel south and enter at either AP-07 or AP-02 (Figure 6-7).

These alternative routes were assessed by Arcadis in 2019 (**Error! Reference source not found.**) to determine if they would be viable for the transport of materials, equipment and workforce. Route viability scores were derived based on the number of pinch point impacts relative to the number of impact items assessed under each route option and are provided in Table 6-5. All routes are considered to be viable. The preferred route (i.e. utilising the spillway) would be expected to generate the least impact, as vehicles would not enter onto the Pacific Highway.

Table 6-5 Route viability scores

Route option	Score
Utilising Irrawang Spillway	92%
East-to-west movement option 1	83%
East-to-west movement option 2	90%
West-to-east movement option 1	86%
West-to-east movement option 2	95%

The assessment determined that the existing Safe Intersection Sight Distance (SISD), Minimum Gap Sight Distance (MGSD) and Approach Sight Distance (ASD) at the proposed access points are greater than the minimum required distances and would maintain safe sight distance standards as provided in *Austroads Guide to Road Design – Part 4A: Unsignalised and Signalised Intersections* (Austroads, 2010) and *Austroads Guide to Road Design Part 3: Geometric Design* (Austroads, 2016). Access points would be upgraded and/or formalised in accordance with *Austroads Guide to Road Design – Part 4A: Unsignalised and Signalised Intersections Manual* to ensure safe and efficient vehicle movement throughout construction.

The Pacific Highway provides access to vehicles classified as General Access Vehicles (GAV), as well as 10-metre B-doubles and 4.6-metre-high vehicles, and therefore is suitable as a haulage route during construction of the proposal.

Most of the construction work would occur away from the Pacific Highway and local public roads, and the spillway would be the preferred haulage route. Notwithstanding this, should the alternative haulage routes be utilised, only about 35 trips per day would be expected. Hence impacts on the road network is considered minor.

Traffic management measures would be included in the Traffic Management Plan to ensure that the safety and efficiency of the Pacific Highway is not compromised, and existing traffic operations and level of service are maintained.

Impacts on the Pacific Highway and local roads

The construction of the overpass central pier would require temporary lane width modifications and reduction in the current speed zone on both carriageways of the Pacific Highway. The lifting of the bridge girders would likely involve the temporary closing of one carriageway of the Pacific Highway at night and implementing a contraflow arrangement with reduced speed zone.

The construction of ramps and roads tie-ins would require temporary reduction in lanes available to traffic (i.e. temporary closure of one lane), along with speed limit reductions in proximity to construction activities. Other local roads are unlikely to be impacted during construction. Although the Pacific Highway would remain operational at all times (although at times with traffic modifications required for construction of the overpass, as described above), temporary impacts on the level of service of the highway are anticipated during construction, due to the reduced speed limit and temporary closure of traffic lane(s).

To address these issues, detailed traffic analysis would be carried out during detailed design of the proposal, to quantify the impact on level of service at the Pacific Highway, Six Mile Road and other local roads during these critical construction periods, once the haulage routes and construction sequence are finalised.

Measures would be developed to ensure that the safety and efficiency of the Pacific Highway is not compromised and enable acceptable traffic operations and level of service. Traffic control measures would be determined on a site-by-site basis and could include a combination of temporary lane closures, realignments, or detours, along with temporary fencing, visual barriers, traffic controllers and signage. These measures would be included in the Traffic Management Plan (refer to Section 6.1.4).

Road users and the local community would be informed via signage and the Roads and Maritime website [drafting note: Roads and Maritime to confirm their community notification procedure] prior to commencement of any construction work that would impact on the traffic conditions of the road network.

Impacts on public transport

Impacts on the Pacific Highway are likely to result in temporary minor delays in some bus services due to changes in traffic conditions. This impact is considered minor and short term in nature and would not impact the overall levels of service provided by bus routes in the area. Bus companies would be informed of construction works impacting any of their service routes.

Impacts on access to other properties

Access to private properties along the Pacific Highway in proximity to the proposal (i.e. Riding for the Disabled and residential property at 3385 Pacific Highway) would be maintained in their current condition during construction. Temporary controlled access to private properties along the Pacific Highway may occur during the construction of the north bound ramps and drainage system.

Impacts on Grahamstown Dam property access

The two existing access points to the Hunter Water Grahamstown Dam maintenance access track would be removed during construction with the access point at the southern extent of the proposal becoming a construction access point (see construction access point AP-02 in Figure 3-5).

A temporary alternative access point would be constructed as part of the early stage of construction, with the aim of maintaining access at all times throughout construction. The relocation and design of the service road would be further developed in consultation with Hunter Water and Roads and Maritime during the detailed design stage.

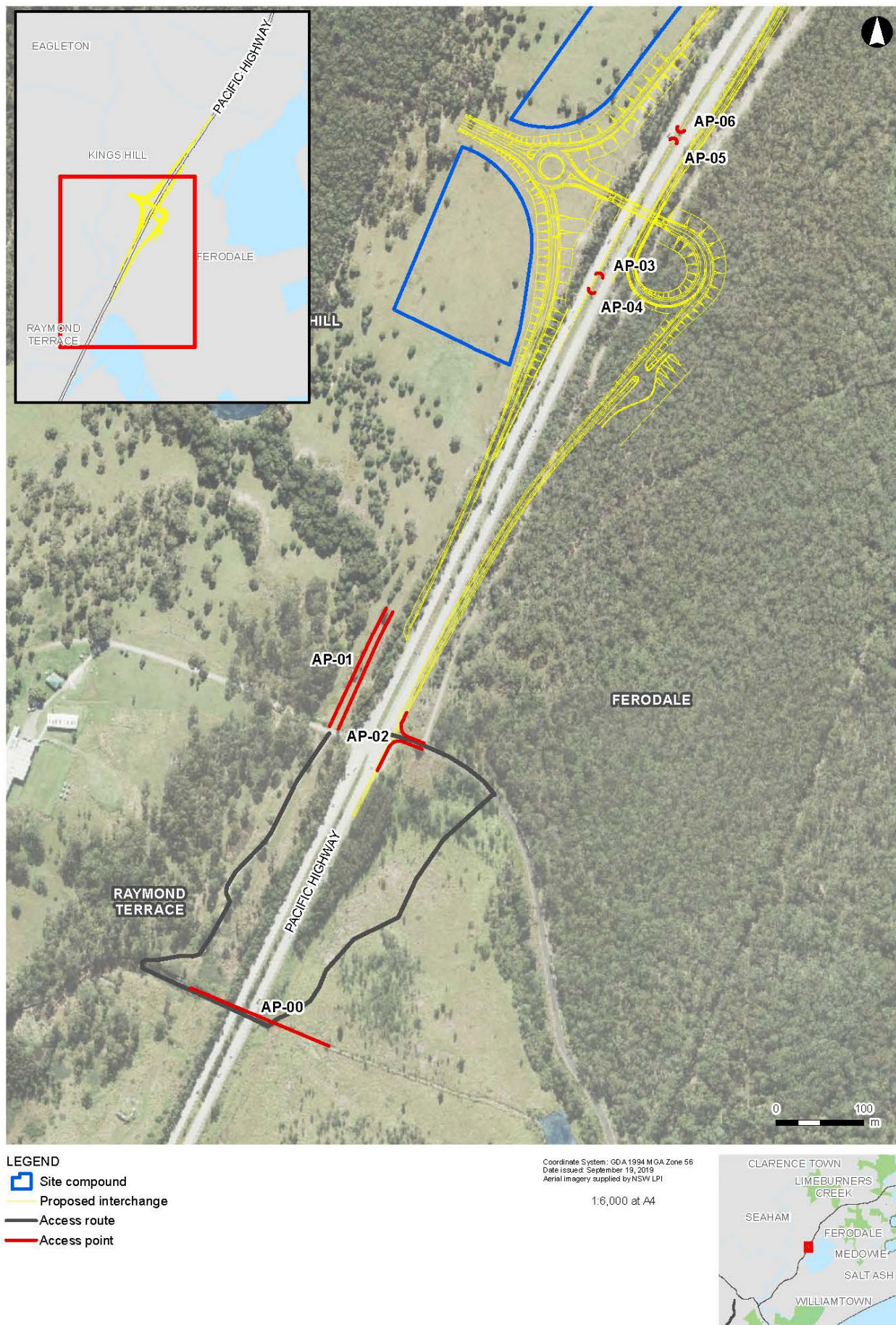


Figure 6-3 Preferred haulage route utilising Irrawang Spillway



LEGEND

- Site compound
- Proposed interchange
- Access route
- Proposed access track
- Existing access track
- Access point

Coordinate System: GDA 1994 MGA Zone 56
Date issued: September 19, 2019
Aerial imagery supplied by NSW LPI

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Figure 6-4 East-to-west movement option 1

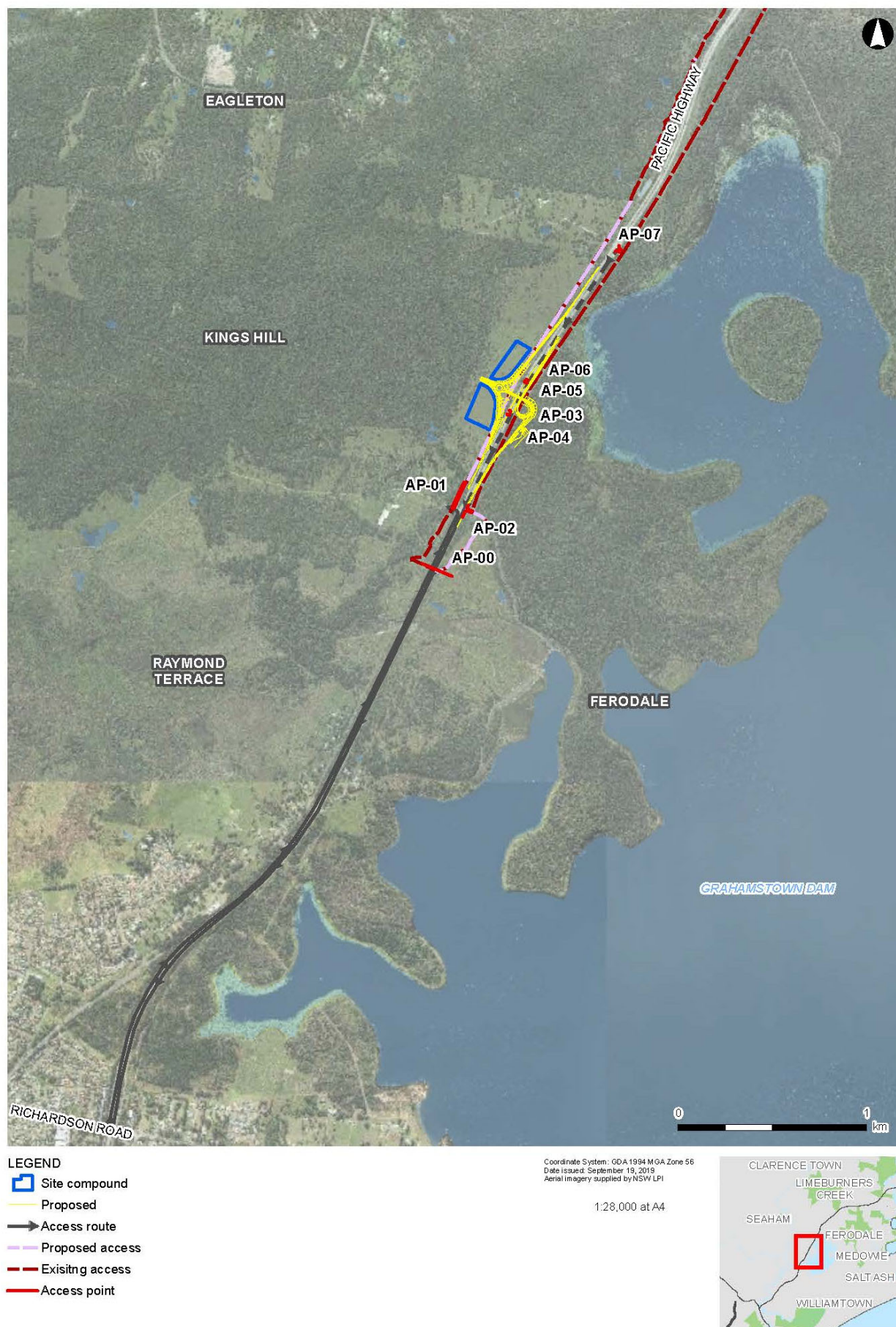
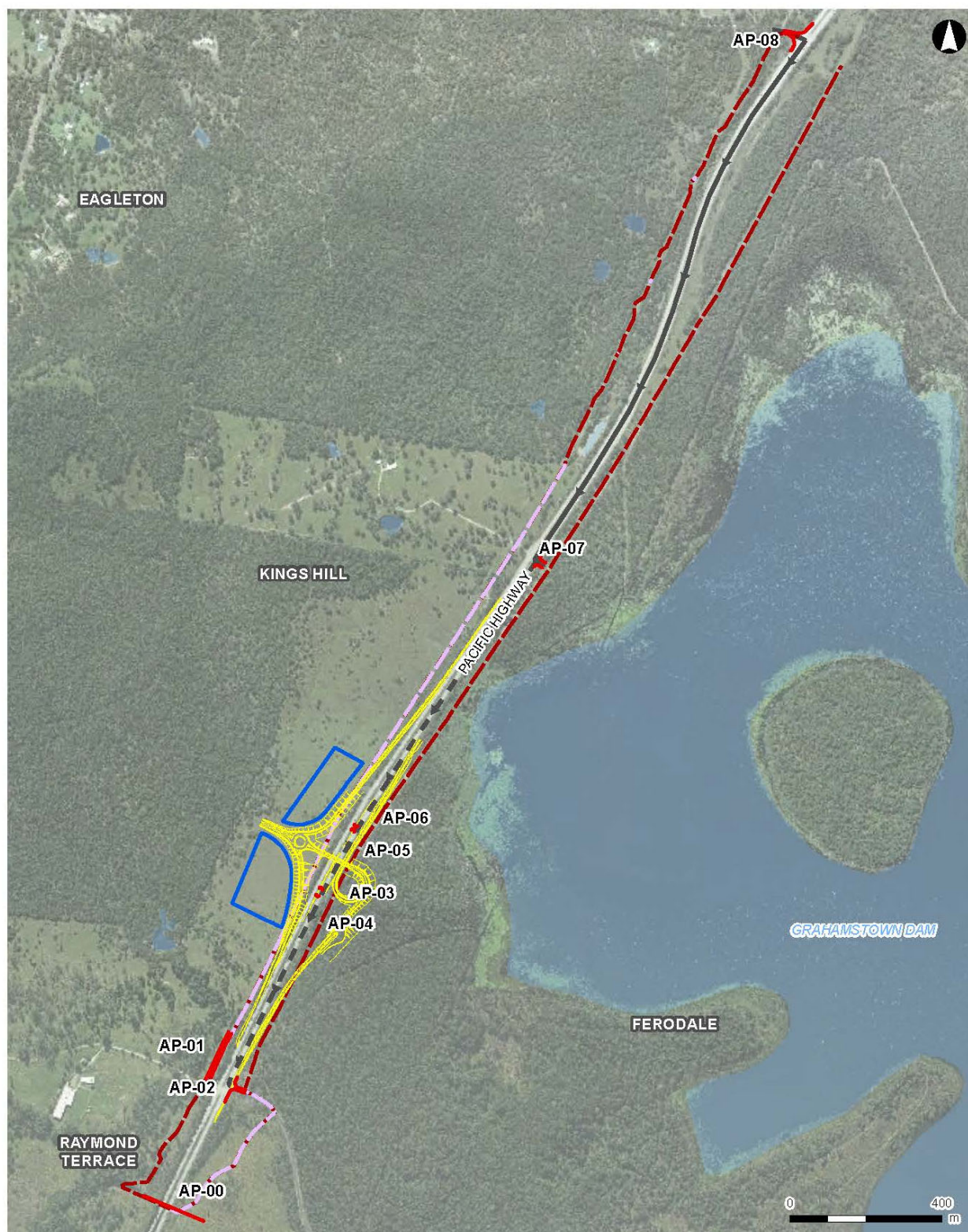


Figure 6-5 East-to-west movement option 2



LEGEND

- Site compound
- Proposed interchange
- Access route
- Proposed access track
- - Existing access track
- Access point

Coordinate System: GDA 1994 MGA Zone 56
Date issued: September 19, 2019
Aerial imagery supplied by NSW LPI

1:15,000 at A4



Figure 6-6 West-to-east movement option 1



LEGEND

-  Site compound
-  Proposed stormwater channel
-  Access route
-  Proposed access track
-  Existing access track
-  Access point

Coordinate System: GDA 1994 MGA Zone 56
Date issued: September 19, 2019
Aerial imagery supplied by NSW LPI

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Figure 6-7 West-to-east movement option 2

Operation

Future turning movements

The future turning volumes at full development for 2036 have been forecast for the interchange for both AM and PM peak periods (Hyder 2014b). The future traffic volumes at the town centre intersection are also shown. Figure 6-8 and Figure 6-9 show AM and PM peak turning movement volumes associated with Kings Hill URA.

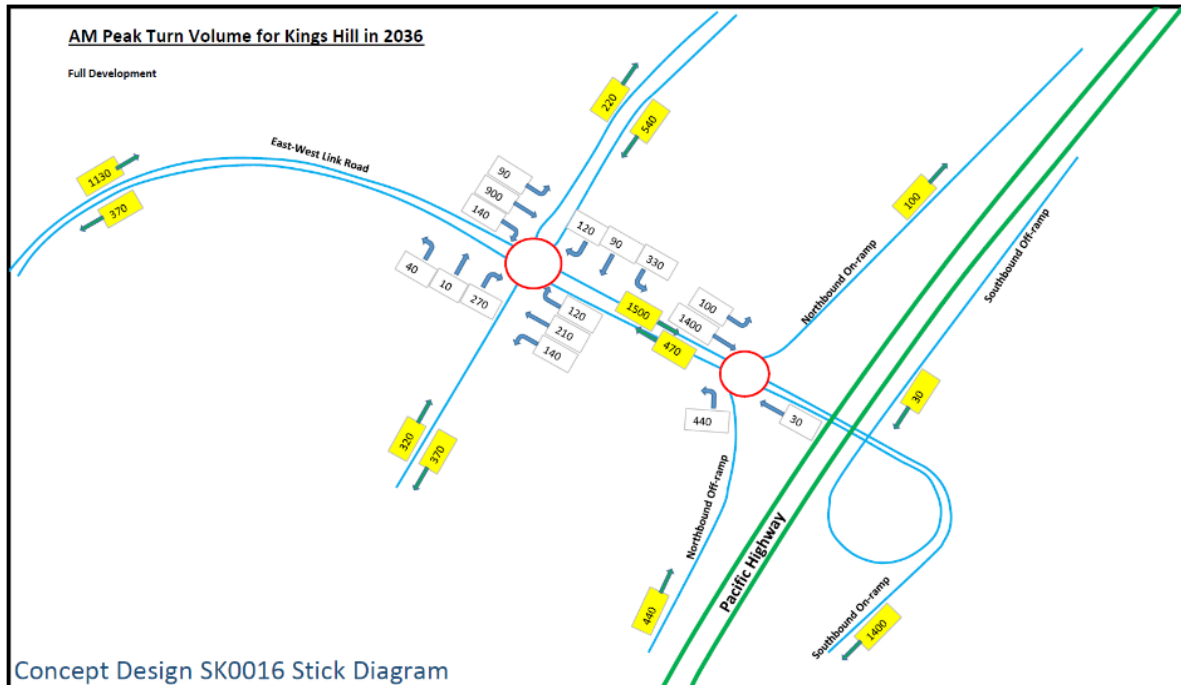


Figure 6-8 Turning movement volumes 2036 AM peak (Hyder 2014b)

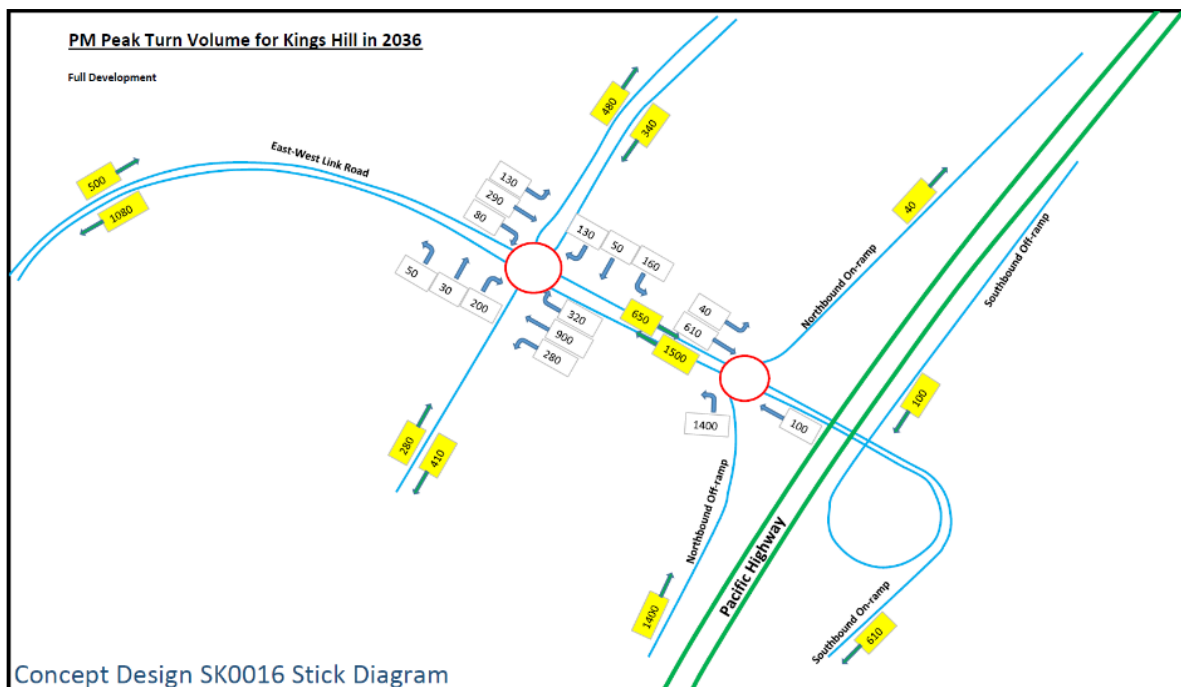


Figure 6-9 Turning movement volumes 2036 PM peak (Hyder 2014b)

Interchange performance

Once in operation, the interchange would provide access to and from the Kings Hill URA. GHD (2013) calculated the future traffic generation for the Kings Hill URA (Table 6-6), based on a trip generation rate of 0.85 peak hour trips per dwelling, and assuming a development rate of 200 dwellings per year.

Table 6-6 Number of trips

Year	No. Dwellings	Total no. trips	Total no. trips with 25% containment*	AM		PM	
				Arrivals	Departures	Arrivals	Departures
2014	0	0	0	0	0	0	0
2016	400	340	340	68	272	272	68
2021	1400	1190	1190	238	952	952	238
2026	2400	2040	2040	408	1632	1632	408
2031	3400	2890	2168	434	1734	1734	434
2036	4300	3655	2741	548	2193	2193	548

*It has been assumed that 25% of generated trips would be self-contained within Kings Hill by 2031, following the development of the local centre and school, and would not impact on the external road network

Impacts on local roads

Access to the Pacific Highway via Six Mile Road could potentially be removed by the closure of Six Mile Road at the Pacific Highway. This closure would occur only after suitable alternative access to the proposal, via the Kings Hill internal road network, is established. Additional traffic assessment would be carried out during detail design, to determine potential operational impacts on the surrounding road network, relating to the closure of Six Mile Road at the Pacific Highway. Six Mile Road would remain open at Newline Road.

Impacts on public transport

Existing bus routes and service frequency would not be impacted by the proposal. The proposal would facilitate bus services to the Kings Hill URA should bus operators choose to extend their services to this area.

Impacts on the Hunter Water maintenance access track

A four-metre-wide maintenance access track is proposed along the western side of the proposed stormwater channel. The access track would connect to the Pacific Highway at a point between the existing Grahamstown Dam maintenance access track and the proposal, on the south bound entry ramp to the highway. This location was determined in consultation with Hunter Water and Roads and Maritime (refer to Section 6 for further details).

Further assessment of this new access point would be carried out during detailed design. Issues to be considered by this future traffic assessment include:

- The speed differential between traffic entering/exiting the Hunter Water access and the entry ramp and Pacific Motorway
- Traffic entering/exiting the Hunter Water access having to compete with traffic streams from both the Pacific Motorway and the entry ramp
- Hunter Water's requirements including safety for workers and an access that provides ease of use.

Impacts on access to other properties

Existing direct vehicular access to the Pacific Highway from the Riding for the Disabled property (3217 Pacific Highway) would be maintained in its current condition until the proposal is operational. Upon opening of the proposal to traffic, direct access to Riding for the Disabled from the Pacific Highway would be closed, and access would be provided via a connection to the Kings Hill internal road network to the proposal. Removing the existing at-grade crossing at Riding for the Disabled would deliver safety benefits to Pacific Highway road users by providing a safer all-movements access from and to the Pacific Highway via the proposal.

Current direct access to the Pacific Highway for the residential property at 3385 Pacific Highway would be maintained in its existing condition during operation of the proposal.

6.1.4 Safeguards and management measures

Proposal-specific safeguards and management measures have been developed (Table 6-7) with the aim of minimising or mitigating, as far as practical, traffic impacts.

Table 6-7 Environmental management measures for traffic impacts

Impact	Environmental safeguards	Responsibility	Timing	Reference
Traffic and transport	A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the <i>Roads and Maritime Traffic Control at Work Sites Manual</i> (RTA, 2010) and <i>QA Specification G10 Control of Traffic</i> (Roads and Maritime, 2008). The TMP will include (where applicable): • 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	Contractor	Detailed design / Pre-construction	Section 4.8 of QA G36 <i>Environment Protection</i>

Impact	Environmental safeguards	Responsibility	Timing	Reference
	- 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.			
Road safety audit	A road safety audit will be conducted as part of detailed design to identify and address potential safety issues associated with the operation of the proposal	Roads and Maritime	Detailed design	
Impacts on private property	Consultation with the private dwelling at 3385 Pacific Highway and the Riding for the Disabled property at 3217 Pacific Highway will be undertaken for the design of the property access driveways, where they would connect to the Kings Hill internal road network	Roads and Maritime	Detailed design	
Construction traffic impacts	Construction deliveries will be timed to occur outside peak traffic periods when feasible and reasonable, to minimise impacts on road network	Construction contractor	Pre-construction	

6.2 Noise and vibration

This section presents an assessment of the potential noise impacts of the proposal and identifies safeguards to minimise and reduce these impacts. The assessment draws on information in *Kings Hill Interchange and Drainage Channel: Traffic and Construction Noise Assessment* (Wilkinson and Murray, 2017), prepared to inform this REF (Appendix E).

As the nearest receivers are located at least 300 metres from the proposal, no vibration impacts resulting from construction or operation of the proposal are anticipated, and vibration has not been considered in the assessment.

6.2.1 Methodology

Kings Hill Interchange and Drainage Channel: Traffic and Construction Noise Assessment

(Appendix E) was prepared in 2015 and updated in 2017 to incorporate Roads and Maritime's most recent guidelines and to include the results of attended noise measurements that were recorded in October 2017. Methodology for assessing noise impacts involved:

- Identification and classification of receivers located near the proposal
- Characterisation of the existing noise environment based on attended noise measurements at receivers near the proposal
- Modelling to predict traffic noise levels at receivers
- Determination of noise management levels in accordance with relevant guidelines
- Determination of construction and operational noise levels associated with the proposal
- Identification of mitigation measures to minimise construction noise impacts
- Identification of the need for further noise monitoring at receivers located near the proposal.

The construction noise assessment was carried out in accordance with and/or has considered:

- Construction Noise and Vibration Guideline (CNVG) (Roads and Maritime, 2016a)
- Noise Criteria Guideline (NCG) (Roads and Maritime, 2015c)
- The Interim Construction Noise Guideline (ICNG) (DECC, 2009)
- NSW Road Noise Policy (RNP) (DECCW, 2011)
- NSE Industrial Noise Policy (INP) (EPA, 2000).

6.2.2 Existing environment

Receivers

There are two receivers near the proposal (Figure 6-10) that may be impacted by noise generated by the construction and operation of the proposal:

- Receiver 1 (R1), an existing residence located at 3385 Pacific Highway Eagleton. This is a one storey house located approximately 450 meters from the proposal
- Receiver 2 (R2), "Riding for the Disabled", located at 3217 Pacific Highway, Raymond Terrace. This is non-residential property supporting a one-storey administration building and facilities associated with the riding school. This property is located approximately 300 metres from the proposal.



LEGEND

- Proposed interchange
- Sensitive receiver

Coordinate System: GDA 1994 MGA Zone 56
Date issued: September 17, 2019
Aerial imagery supplied by NSW LPI

1:10,000 at A4



Figure 6-10 Receivers located near the proposal

Construction noise assessment

Sources of noise that are likely to influence background noise levels are limited to road traffic noise associated with the existing Pacific Highway and aircraft noise associated with Newcastle Airport and Williamstown RAAF Base.

To characterise the existing ambient noise environment for the proposal, and to establish background noise levels on which to base the construction NMLs, short-term attended background noise monitoring was undertaken on Tuesday 10 October 2017. The result of this monitoring is provided in Table 6-8. Background noise levels were recorded at both R1 and R2. The Rating Background Level (RBL) was calculated based on this noise monitoring.

Table 6-8 Results of attended noise monitoring

Receiver	Timing of attending monitoring	Background LA90 noise level measured	Background LA90 noise level used to inform NMLs
R1	Three consecutive 15-minute periods, between 10.45am and 11.45am	50 dBA 51 dBA 52 dBA	50dBA
R2	12.10pm and 12.25pm	52dBA	52dBA

Construction noise management levels

Airborne noise would be generated by construction of the proposal, mainly associated with vegetation clearing, earthworks and construction of the various elements of the interchange.

The ICNG prescribes the method for carrying out a quantitative assessment for predicting noise levels at sensitive receivers and comparing them with the relevant NML specified for that type of receiver. The ICNG provides an approach for determining LAeq(15minute) Noise Management Levels (NMLs) at residential receivers, by applying the measured LA90 (15minute) background noise levels, as defined in Table 6-9. ICNG also defines NMLs at other sensitive land uses, based on the principle that the characteristic activities for each of these land uses should not be unduly disturbed. Table 6-10 lists the NML relevant to R2, Riding for the Disabled.

Table 6-9 Determination of NMLs for residential receivers (i.e. R1)

Time of day	Noise Management Level LAeq15 min	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise affected RBL + 10dB(A)	- The noise affected level represents the point above which there may be some community reaction to noise - Where the predicted or measured LAeq,15min is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise - 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	Noise Management Level LAeq15 min	How to apply
	Highly noise affected 75dB(A)	- The highly noise affected level represents the point above which there may be strong community reaction to noise - Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noisy such as before and after schools, or midmorning or mid-afternoon for works near residences - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dBA	- A strong justification would typically be required for works outside the recommended standard hours. - The proponent should apply all feasible and reasonable work practices to meet the noise affected level. - Where all feasible and reasonable practices have been applied and noise is more than 5dBA above the noise affected level, the proponent should negotiate with the community.

Table 6-10 Determination of NMLs for active recreation areas (i.e. R2)

Land use	NML LAeq(15minute) (Applied when the land use is in use)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)

Operational noise assessment

Noise modelling was carried out in 2015 to assess the proposal's potential operational road traffic noise impacts. Forecast traffic flow data for the 'no build' (also known as 'future existing') and the 'build' scenarios for the then assumed year of opening (2017) and 10 years after opening (2027) were applied to the noise model to predict the road traffic noise levels for each scenario.

Noise levels from the existing and proposed road alignments were calculated using procedures based on the Calculation of Road Traffic Noise (CoRTN) prediction algorithms using SoundPlan noise modelling software.

Noise modelling inputs are outlined in Appendix E.

Operational noise criteria

Noise levels generated by the operation of the proposal were predicted at R1 and R2. The noise level predictions were made both for daytime (7am to 10pm) and night-time (10pm to 7am) for two future scenarios: without the proposal and with the proposal.

The RNP defines criteria to be used in assessing the impact of noise from new road projects and road redevelopment projects. Noise policy criteria relevant to R1, as defined by the RNP, are presented in Table 6-11. The RNP also provides criteria for open space (active use) which is appropriate for R2 (Table 6-12).

Table 6-11 Noise policy criteria for the proposal (DECCW 2011)

Road Category	Type of project/land use	Assessment criteria-dBA	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	LAeq, (15 hour) ⁶⁰ (external)	LAeq, (9 hour) ⁵⁵ (external)
	2. Existing residences affected by additional traffic on existing freeways/arterial/ sub-arterial roads generated by land use developments		

Table 6-12 Assessment criteria for non-residential receivers

Existing Sensitive Land Use	Assessment criteria-dBA	
	Day (7am-10pm)	Night (10pm-7am)
Open space (active use)	LAeq, 15hr 60 (external) when in use	-

6.2.3 Potential Impacts

Construction

The NMLs for R1 and R2 during standard working hours and outside of standard working hours are listed in Table 6-13. If construction noise levels are predicted to be above the NML, safeguards and management measures will be implemented to minimise noise emissions.

Sources of noise during construction of the proposal would be generated by plant and machinery required for various construction activities, as described in Section 3.1. Construction noise levels for three construction zones (Figure 6-11) have been predicted. The construction zones are:

- Zone A: construction of the southbound entry and exit ramps
- Zone B: construction of the overpass, East West Link Road and interchange roundabout
- Zone C: construction of the northbound entry and exit ramps.

The predicted noise levels during recommended standard hours are provided in

Table 6-14, while predicted noise levels outside standard recommended hours (which would be required for construction of the overpass, such as lifting of the bridge girders) are provided in Table 6-15.

Table 6-13 Noise Management Levels calculated for receivers near the proposal

Receiver	Background Level Recommended Standard Hours LA90 dBA	Background Level Outside Recommended Standard Hours LA90 dBA	Noise Management Levels LAeq dBA		Criteria LAmax dBA
			Recommended Standard Hours	Outside Recommended Standard Hours	Night Time
R1	50	30*	60	35	45
R2	52	-	65	65	-

* a conservative background noise level of 30dBA has been adopted for the outside recommended standard hours. In accordance with Section 3.1.2 of INP, where the rating background level is found to be less than 30 dBA, then it is set to 30 dBA

Table 6-14 Predicted Construction Noise Levels during Standard Recommended Hours

Construction Activity	Total LAeq,15min Sound Power Level (SWL)	Zone	Predicted LAeq,15min	
			R1	R2
Establishment Clearing Paving, Landscaping	110 SWL dB(A)	A	31	44
		B	35	37
		C	42	32
Earthworks	116 SWL dB(A)	A	37	48
		B	41	41
		C	48	36
Hydraulic Hammering (for construction of overpass)	122 SWL dB(A)	A	-	-
		B	47	52
		C	-	-
Piling Sawcutting	115 SWL dB(A)	A	36	52
		B	40	45
		C	47	40
Noise Management Levels LAeq,15min (dBA)			60	60

Table 6-15 Predicted Construction Noise Levels Outside of Standard Recommended Hours

Construction Activity	Sound Power Level (SWL)	Predicted Noise Levels (dBA)	
		R1	R2
Construction of the overpass such as lifting of the bridge girders (Zone B only)	LAeq,15min 110 SWL	35	37
	LAmix 116 SWL	41	Not applicable
Noise Management Levels (dBA)	LAeq,15min	35	65
	LAmix	45	Not applicable

No construction activities during Standard Recommended Hours are predicted to generate noise that exceeds the Noise Management Levels for either R1 or R2. No construction activities outside of Standard Recommended Hours are predicted to generate noise that exceeds the Noise Management Levels for either R1 or R2. Confirmation of works occurring outside of standard working hours would be determined at detailed design. Any work outside standard hours would be carried out in accordance with Roads and Maritime Construction Noise and Vibration Guideline (Roads and Maritime, 2016).



Figure 6-11 Construction zones

Operation

Operation of the proposal would result in noise impacts generated by the traffic using the interchange. Predicted operation noise levels are based on traffic volumes for two scenarios:

- No Build: the proposal is not constructed, Kings Hill URA is not developed, and background traffic growth on the Pacific Highway is assumed to be 2% per annum
- Build: the proposal is constructed in 2017, Kings Hill URA is fully developed by 2027 (and supports 3,500 dwellings) and background traffic growth on the Pacific Highway is assumed to be 2% per annum.

Predicted noise levels for 2017 & 2027 “No Build” and “Build” Options, with regard to the noise criteria determined by NCG, are provided in Table 6-16.

Table 6-16: Predicted Noise Levels for 2017 & 2027 “No Build” and “Build” Options

Year	Receiver	Assessment Criteria		“No Build”		“Build”		Difference in Noise Levels between “Build” and “No Build”		Consider Noise Mitigation?
		LAeq,15hr Day	LAeq,9hr Night	LAeq,15hr Day	LAeq,9hr Night	LAeq,15hr Day	LAeq,9hr Night	LAeq,15hr Day	LAeq,9hr Night	
2017	R1	60	55	57.6 Noise levels do not exceed criteria	52.6 Noise levels do not exceed criteria	57.3 Noise levels do not exceed criteria	52.3 Noise levels do not exceed criteria	-0.3	-0.3	No
	R2	60	-	59.9 Noise levels do not exceed criteria	54.9 Criteria not applicable	60.3 Noise levels do exceed criteria	55.2 Criteria not applicable	0.4	0.3	No
2027	R1	60	55	58.3 Noise levels do not exceed criteria	53.3 Noise levels do not exceed criteria	58.3 Noise levels do not exceed criteria	53.3 Noise levels do not exceed criteria	0.0	0.0	No
	R2	60	-	60.7 Noise levels do exceed criteria	55.6 Criteria not applicable	62.3 Noise levels do exceed criteria	57.5 Criteria not applicable	1.6	1.7	No

Table 6-16 indicates that neither R1 nor R2 would experience exceedances of the noise criteria defined by NCG. Accordingly, these receivers do not require any permanent noise mitigation as the RNP, NCG and NMG requirements have been satisfied.

6.2.4 Safeguards and management measures

Proposal-specific safeguards and management measures have been developed (Table 6-17) with the aim of minimising or mitigating, as far as practical, the construction noise impacts identified in Section 6.2.3.

Table 6-17 Environmental management measures for noise impacts

Impact	Environmental safeguards	Responsibility	Timing	Reference
Construction noise	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 <i>Construction Noise Guideline</i> (ICNG) (DECC, 2009) and identify: • All potential significant noise and vibration generating activities associated with the activity • Feasible and reasonable mitigation measures to be implemented, taking into account <i>Beyond the Pavement: urban design policy, process and principles</i> (Roads and Maritime 2014) • A monitoring program to assess performance against relevant noise and vibration criteria • Arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures • Contingency measures to be implemented in the event of non-compliance with noise and vibration criteria.	Construction contractor	Detailed design / pre-construction	Section 4.6 of QA G36 <i>Environment Protection</i>
Noise and vibration	Receivers R1 and R2 will be notified prior to commencement of any construction works associated with the activity that may have an adverse noise or vibration impact. The notification will provide details of: • the proposal • the construction period and construction hours • contact information for proposal management staff • complaint and incident reporting how to obtain further information.	Construction contractor	Detailed design / pre-construction	

Impact	Environmental safeguards	Responsibility	Timing	Reference
Construction noise	Workers and contractors will be inducted and trained (such as through toolbox talks) in the use of construction equipment in ways that minimise noise.	Construction contractor	Construction	
Construction noise impacts	The following approaches to reduce the impact of construction noise during outside recommended standard hours would be applied by the construction contractor where feasible and reasonable: • Equipment selection • Site noise planning • Operator instruction • Plant noise audit • Localised barrier • Respite periods • Community liaison.	Construction contractor	Construction	

6.3 Socio-economic and land use

This section assesses the social, economic and land use impacts of the proposal on the local community, businesses and industry.

6.3.1 Methodology

A desktop assessment was undertaken in accordance with *Environmental Planning and Impact Assessment Practice Note: Socio-economic Assessment* (Roads and Maritime, 2013c). The following tasks were undertaken:

- Desktop review of demographic, travel patterns, economic and social infrastructure information relevant to the proposal
- Review of property ownership and existing and future land uses
- Characterisation of existing socio-economic environment relevant to the proposal
- Identification and assessment of impacts on access and connectivity, local amenity, health and safety, property, business and social infrastructure impacts, and impacts on community values
- Identification of management measures to enhance, proposal benefits and avoid or reduce potential adverse impacts.

6.3.2 Existing environment

Property and land use

The proposal would be located on the following land parcels (as shown in Figure 1-2):

- The Pacific Highway road reserve
- Lot 41 DP 1037411
- Lot 31 and 32 DP 1185385.

During construction, additional land would also be impacted, including:

- Lot 113 DP 733181
- Lot 4821 and 4822 DP 852073
- Lot 481 DP 804971
- Lot 5 DP 234521.

The majority of the proposal falls within land zoned SP2 Classified Road under Port Stephens LEP, being the Pacific Highway road reserve.

The eastern portion of the proposal falls on land known as Lot 31 DP 1185385, zoned SP1 Hunter Water Corporation under Port Stephens LEP. This lot is now under the ownership of KHD (refer to Section 3.6) and supports remnant native vegetation.

Social infrastructure

There is one social infrastructure facility located in proximity to the proposal. Riding for the Disabled (3219 Pacific Highway, Raymond Terrace) is a volunteer organisation providing equine-assisted activities for people with disabilities to develop and enhance abilities. In January 1980, the President of Riding for the Disabled negotiated with Hunter District Water Board and BMG Pty Ltd, to obtain the use of 30 acres of land on the Pacific Highway, north of Raymond Terrace, known as Irrawang Park. Riding sessions began in

February 1980, and the facility continues to operate today. Access to this property is located on the western side of the Pacific Highway towards the southern end of the proposal. This access point would be used during construction (AP-01 in **Error! Reference source not found.**).

Other social infrastructure and services are located further away from the proposal in the Raymond Terrace urban area, approximately five kilometres south-west of the proposal. These services include:

- Various childcare, pre-school and early learning centres, four primary schools and one high school
- GP super clinic, pathology collection centre and various health centres and dental practices
- The King Park Sporting Complex (23 Newline Road), the Raymond Terrace Athletics Club (Vi Barnett Field), the Raymond Terrace Leisure Centre (Sturgeon Street), the YMCA Lakeside Leisure Centre (3 Leisure Way) and the Raymond Terrace Ten Pin Bowling club (1 Leisure Way)
- The Raymond Terrace Senior Citizens Hall (17E Irrawang Street)
- Public and active transport infrastructure including bus stops, taxi ranks and bicycle routes.

Population and demography

The proposal area falls in the Eagleton Australian Bureau of Statistics (ABS) 2016 Census area, however, geographically the nearest ABS urban centre area is Raymond Terrace.

The Eagleton area had a population of 211 people in 2016 from which 50 per cent were females, 45 per cent were aged between 20 and 54 years, 4 per cent were Aboriginal and/or Torres Strait Islander people and 3 per cent were people with need of assistance.

The Raymond Terrace area had a population of 12,820, of which 51 per cent were females, 45 per cent were aged between 20 and 54 years, 6 per cent were Aboriginal and/or Torres Strait Islander people and 3 per cent were people with need of assistance.

Kings Hill is expected to support general residential, mixed use and local centre land use zones and is expected to yield in excess of 3500 residential dwellings over a twenty-five-year period.

Travel to work

At the time of the 2016 census, 96 per cent households at Eagleton and 93 per cent of households at Raymond Terrace reported to have at least one motor vehicle.

According to the results of the 2016 census, 69 percent of people travelling to work from Eagleton (49 per cent of the population) used private motor vehicles (either as a driver or passenger) as the mode of transport. In Raymond Terrace, 94 per cent of people travelling to work (34 per cent of the population) used motor vehicles (either as a driver or passenger) as the mode of transport. Walking and bus were the second and third preferred to travel to work methods used by three and one per cent of the population, respectively, in Raymond Terrace.

Income, business and employment

The ABS 2016 census reported that the median household income in 2016 for Eagleton and Raymond Terrace were \$1,625 and \$1,486 per week respectively.

The biggest industries of employment in Eagleton and Raymond Terrace in 2016 were manufacturing, construction, wholesale and retail trade. Public administration and safety also employed a significant number of people in Raymond Terrace. Only 7 per cent of people in Eagleton and 4 per cent of people in Raymond Terrace aged 15 years and over reported to be unemployed and looking for work at the time of the census.

Community values

Community consultation undertaken by Council in October and November 2012 as part of the *Port Stephens Council Community Strategic Plan 2013-2023* identified matters that are considered valuable by the community living the LGA. Matters that are relevant to the proposal are listed in Table 6-18. These matters are deemed to be community values for the purposes of this assessment.

Table 6-18 Port Stephens community values relevant to the proposal (Source: Port Stephens Council 2013 (modified))

Aspect	Value
Roads and traffic	• State of the road network (including state and regional roads) • Increased traffic due to increased population and holiday seasonality impact • Public Transport / Lack of connectivity • Access to services (frequency, routes etc) • Special needs transport.
Infrastructure	• Concentrate on fixing roads, drains • Infrastructure to go along with development • Footpaths/cycleways.
Natural environment	• Tension between development and retention of natural bushland • Illegal dumping • Noxious weeds • Loss of habitat – birds, koalas • Overpopulation and urban encroachment • Foreshore erosion • Sea level rise/climate change • Community education • Waste management.
Development	• Population pressures dictating built environment options – over-development • Raymond Terrace development / No development without infrastructure • Development and noise affected areas • Retention of rural nature of some areas • Development and threats to natural environment • Traffic pressures • Productive agricultural land • Infill development vs urban sprawl • Housing stock.
Community safety	• Increased traffic • Lack of youth activities leading to crime

Aspect	Value
	• Police presence • Impressions of safety and crime vary across LGA • Graffiti and vandalism • Street lighting.

Future growth

As outlined in Section 2.1.5, the *Hunter Regional Plan 2036* (DPE, 2016) outlines priorities and provides a direction for regional planning decisions. It focuses on new housing and jobs and targets growth in strategic centres and renewal corridors close to transport to deliver social and economic benefits.

The plan identifies the Kings Hill URA as one of the three future housing opportunities for the Port Stephens LGA. In 2016, Port Stephens LGA was reported to support a population of 74,100 people. This population is expected to increase by 18,550 people to reach a population of 92,650 people by 2036. The number of dwellings across the LGA is expected to increase from 36,900 in 2016 to 47,950 dwellings in 2036.

6.3.3 Potential impacts

Construction

Impacts on properties and land use

Lot 31 DP 1185385 has been acquired by KHD from Hunter Water for the proposal. Acquired land would become part of the Pacific Highway road reserve upon completion.

There would be minimal impact to privately owned land due to the construction of the proposal, namely access to Hunter Water-owned land, the residential property at 3385 Pacific Highway and the Riding for the Disabled facility. An assessment of impacts to property access during construction is provided in Section 6.1.

Impacts on public utility infrastructure

The proposal would be constructed adjacent to Hunter Water owned land that contains the Grahamstown Dam. However, no portion of the proposal would be constructed on Hunter Water owned land nor in close proximity to Grahamstown Dam. The existing Hunter Water track to the east of the Pacific Highway would be utilised for the duration of construction.

If unmanaged, dispersal of sediments and water pollutants from construction activities (described in Section 3.3) may result in soil erosion, siltation and off-site movement of eroded sediments by wind and/or stormwater into the surrounding environment, and ultimately the Grahamstown Dam. Measures to mitigate these potential impacts are described in Section 6.9.4.

Impacts on social infrastructure

The proposal would not impact on existing social infrastructure or community services during construction. Access to Riding for the Disabled would be maintained at all times during construction.

Impacts on local amenity and local community

Local amenity and local community impacts that may result from the construction of the proposal would relate to traffic, noise, visual amenity and air quality, as discussed in Sections 6.1, 6.2, 6.6 and 6.10, respectively.

As discussed in Section 3.3, the proposal would take about 14 months to construct. Over that time, the expected average workforce would be about 55 people. As is typical of other road infrastructure proposals, the construction contractor is likely to bring in key workers for the duration of the construction phase. The existing labour force in the Eagleton / Raymond Terrace area would have some of the skills needed for the proposal. There may be direct employment opportunities during the construction phase, and this would depend on the skills needed by the construction contractor.

There would also be additional demand for temporary hotel and motel accommodation on a short-term basis. Additional employment associated with the construction of the proposal could decrease the availability or increase the price of short-term accommodation or on labour prices.

In addition, potential impacts on community values relating to construction of the interchange are outlined in:

- Section 6.1.3 for values pertaining road and traffic, including access, footpaths and cycleways
- Section 6.2.3 for values pertaining to development, specifically noise
- Section 6.7.3 for values pertaining to the natural environment.

Operation

Impacts on properties and land use

The proposal would connect the Kings Hill URA to the transport network. Once operational, the internal Kings Hill URA road network would provide safe and efficient access to Riding for the Disabled property. Access to the residential property at 3385 Pacific Highway would be maintained in its current condition. Further detail regarding property access during operation is discussed in Section 6.1.3.

The operation of the proposal would eventually offer improved and closer property access to goods and services offered by future non-residential development at the Kings Hill URA.

Impacts on public utility infrastructure

Drainage infrastructure associated with the proposal (as discussed in Section 3.1.5) would prevent stormwater and associated pollutants from entering the Grahamstown Dam, with or without the proposed stormwater channel. Therefore, no operational impacts of the proposal on the Grahamstown Dam are expected.

Impacts on social infrastructure and services

The operational stage of the proposal would not adversely impact existing community services or social infrastructure. Operation is expected to improve access to existing social services in Raymond Terrace and enable access to any future social infrastructure and services at the Kings Hill URA.

Impacts on local community and community values

The proposal operation would not result in the relocation or displacement of members of the community nor impact on the population and demography of Eagleton or Raymond Terrace.

In addition, potential impacts on community values relating to operation of the proposal are outlined in:

- Section 6.1.3 for values pertaining road and traffic, including access, footpaths and cycleways
- Section 6.7.3 for values pertaining to the natural environment

- Section 6.2.3. for values pertaining to development, specifically noise.

Impacts on local amenity

The main types of amenity impact that may result from the operation of the proposal would relate to access, noise, visual amenity and air quality. These impacts are assessed in Sections 6.1, 6.2, 6.6 and 6.10, respectively.

Economic impacts

Improved levels of connectivity to existing and future land uses, social infrastructure and services can provide economic benefits to businesses served by these connections, and social benefits to their employees (through reduced travel time). Better connectivity can also contribute to the economic development of the Eagleton and Raymond Terrace areas. The proposal would provide these connections by facilitating the safe and efficient movement of people and goods between the future Kings Hill URA and existing land uses at Eagleton and Raymond Terrace.

6.3.4 Safeguards and management measures

Recommended strategies to manage socio-economic impacts during the construction stage of the proposal are detailed in Table 6-19. No management measures are required or recommended for the operational stage.

Table 6-19 Environmental management measures for socio-economic impacts

Impact	Environmental safeguards	Responsibility	Timing	Reference
Socio-economic	A Communication Plan will be prepared and implemented as part of the CEMP to help provide timely and accurate information to the community during construction. The plan will include (as a minimum): • mechanisms to provide details and timing of proposed activities to affected residents, including changed traffic and access conditions • contact name and number for complaints. The plan will be prepared in accordance with the <i>Community Involvement and Communications Resource Manual</i> (RTA, 2008a).	Construction contractor	Detailed design / pre-construction	
Local amenity	Ongoing and timely communication will be maintained with nearby private properties and Hunter Water about construction work. This will include notice on timing and duration of activities and potential localised impacts.	Construction contractor	Pre-construction	

Impact	Environmental safeguards	Responsibility	Timing	Reference
	The wider community will be notified of any construction activities outside standard construction working hours. Management measures to reduce construction noise impacts would be required and would be implemented as identified in Section 6.2.4 of this REF.			

6.4 Aboriginal Heritage

This section presents an assessment of the Aboriginal heritage impacts of the proposal and identifies safeguards to minimise and reduce these impacts. The assessment draws on information outlined in *Aboriginal and Cultural Heritage Consultation and Investigation: Kings Hill Interchange and Stormwater Channel* (Myall Coast Archaeological Services (MCAS), 2019) (Appendix F), prepared for this REF.

6.4.1 Methodology

The assessment was undertaken to identify whether Aboriginal objects are, or are likely to be, present in the proposal impact area, determine whether the proposal would be likely to harm Aboriginal objects (if present) and determine whether an Aboriginal Heritage Impact Permit (AHIP) application is required.

The assessment was carried out in accordance with Roads and Maritime's *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI) (RTA, 2011). PACHCI involves four stages of consultation and investigation that assess known or potential impacts to Aboriginal cultural heritage. Proposals that can avoid impacts to Aboriginal cultural heritage may only be required to complete some stages of this procedure. However, proposals that would harm Aboriginal objects or places are required to complete all stages.

A PACHCI Stage 2 assessment was undertaken for the proposal. This involved a desktop risk assessment as well as a field survey with specific Aboriginal stakeholders and an archaeologist to assess the proposal's potential to harm Aboriginal cultural heritage and determine whether formal Aboriginal community consultation and an Aboriginal cultural heritage assessment report (ACHAR) is required.

Desktop risk assessment

The following was undertaken for the desktop risk assessment:

- A review of past assessments in the area, including:
 - *Archaeological Survey of Grahamstown Dam. Grahamstown Dam Augmentation Environmental Impact Statement* (Paton, 1992)
 - *Archaeological Survey for Aboriginal Sites -Pacific Highway Upgrade Raymond Terrace to Karuah* (Brayshaw, 1997)
 - *Aboriginal Cultural Heritage Assessment and Constraints Management Plan Various Lands North Raymond Terrace* (Roberts, 2003)
 - *Aboriginal Heritage Due Diligence Assessment: Kings Hill interchange and drainage channel* (MCAS, 2015). This assessment was completed in consideration of the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (DECCW, 2010)
 - A search of the Aboriginal Heritage Information Management System (AHIMS) and a review of any results returned
- Combined map search for Aboriginal Places and State Heritage Register items, available online at <https://www.environment.nsw.gov.au/heritageapp/heritagesearch.aspx>
- A review of heritage items listed under Schedule 5 of the Port Stephens LEP.

Field survey

A field survey was undertaken on 24 May 2019. The survey was conducted by an archaeologist from Myall Coast Archaeological Services, with representatives of the Worimi Local Aboriginal Land Council (LALC) and Roads and Maritime (including the Roads and Maritime Aboriginal Cultural Heritage Officer). The field

survey was conducted on foot on both sides of the Pacific Highway within the study area identified in



- LEGEND
- Proposed interchange
 - Proposed stormwater channel
 - PACHCI Stage 2 Assessment area

Coordinate System: GDA1994 MGA Zone 56
Date issued: September 24, 2019
Aerial imagery supplied by NSW LPI

1:16,000 at A4



Figure 6-12. The study area covers the extent of both the proposed interchange and stormwater channel, as well as an alternative stormwater channel option on the western side of the Pacific Highway.

This study area was confirmed with Roads and Maritime during a meeting held on 10 May 2019. It includes the existing Pacific Highway, land owned by KHD to the east and west of the highway (within the Kings Hill URA) and land currently owned and managed by Hunter Water to the east of the highway. The western shore of Grahamstown Dam, the Hunter's largest drinking water supply dam, is located in close proximity to the eastern boundary of the study area.

6.4.2 Existing environment

Previous disturbances

As specified under Clause 80B (4) of the *National Parks and Wildlife Regulation 2009*, and in accordance with *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (DECCW, 2010), disturbed land is defined as "Land that has been previously subjected to any activity that has resulted in clear and observable changes to the land's surface". Examples of disturbed land include ploughing, construction of rural infrastructure (such as dams and fences), construction of roads, trails and tracks (including fire trails and tracks and walking tracks), clearing vegetation, construction or installation of utilities and other similar services (such as above or below ground electrical infrastructure, water or sewerage pipelines, stormwater drainage and other similar infrastructure) and construction of earthworks.

The study area has been subjected to many of these activities, relating to:

- The construction of the Pacific Highway
- The clearing of vegetation for grazing purposes on the western side of the Pacific Highway
- The construction of access tracks on Hunter Water-owned land on the eastern side of the Pacific Highway
- The construction and more recent augmentation of Grahamstown Dam
- The construction of fencings on both sides of the Pacific Highway
- The installation of below and above-ground utilities (including overhead powerlines and Telstra underground Optic Fibre and Copper communication lines).

Analysis of historical imagery of the study area and surrounding land from 1958 and from 2005 (provided in Appendix F) shows clear and observable changes of the lands surface.

AHIMS search

Two Aboriginal sites were returned in an AHIMS search conducted on 8 May 2019.

One site is a series of rock shelters that are located within Kings Hill URA. Kings Hill and its associated ridgeline (where these caves and rock shelters are located) is considered to be of high Aboriginal significance. This location is outside of the study area for this assessment.

The second site relates to an isolated artefact in the Pacific Highway road reserve within the study area. This artefact was found during investigations for the Pacific Highway upgrade in 1997. The area where the artefact was found was disturbed and there appeared to be no potential for any intact archaeological deposit in the area. Consent to destroy was given on the NPWS site recording form.

Field survey results

No Aboriginal objects were identified during the field survey, and the presence of subsurface evidence was deemed unlikely based on the landscape features present within the study area (Table 6-20).



LEGEND

- Proposed interchange
- Proposed stormwater channel
- PACHCI Stage 2 Assessment area

Coordinate System: GDA 1994 MGA Zone 56
 Date issued: September 24, 2019
 Aerial imagery supplied by NSW LPI

1:16,000 at A4



Figure 6-12 Aboriginal heritage assessment study area

Table 6-20 Landscape features that indicate the likely existence of Aboriginal objects (DECCW, 2010)

Is the proposal:	Response
Within 200 metres of waters?	Yes The proposal is within 200 metre of water, however the watercourses (the Grahamstown Dam and a channel linking the Williams River) manmade. During construction, no artefacts were identified, therefore there is no archaeological potential of Aboriginal objects.
Located within a sand dune?	No
Located on a ridgetop, ridgeline or headland?	No
Located within 200 metres below or above a cliff face?	No
Within 20 metres of or in a cave, rock shelter or a cave mouth?	No

6.4.3 Potential impacts

The proposal was assessed as having a low potential to have an impact on Aboriginal cultural heritage. No further stages of PACHCI are required to be completed. Formal Aboriginal heritage consultation and an ACHAR is not required.

Construction

There is the potential for unexpected Aboriginal objects to be discovered during construction of the proposal. Procedures would be in place to deal with any unexpected findings.

Operation

Operation of the proposal would not impact Aboriginal cultural heritage.

6.4.4 Safeguards and management measures

Management measures outlined in Table 6-21 are proposed in the event of an unanticipated Aboriginal heritage object discovery. No mitigation measures are proposed for the operational stage of the proposal.

Table 6-21 Aboriginal heritage safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Aboriginal heritage	<i>The Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015d) will be followed in the event that an unknown or potential Aboriginal	Construction contractor	Detailed design Pre-construction	Section 4.9 of QA G36 <i>Environment Protection</i>

Impact	Environmental safeguards	Responsibility	Timing	Reference
	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.			
Aboriginal heritage	A heritage induction will be provided to workers before construction begins. It will inform them of exclusion zones and guidelines to follow if unexpected heritage items or deposits are located during the work.	Construction contractor	Pre-construction	

6.5 Non-Aboriginal heritage

This section presents an assessment of the impacts of the proposal on non-Aboriginal heritage and identifies mitigation and management measures to minimise and reduce these impacts.

6.5.1 Methodology

A non-Aboriginal heritage desktop assessment was completed, which involved:

- Review of relevant historical information for Raymond Terrace and surroundings and past reports of relevance, including Environmental Impact Statements relating to various Grahamstown Dam Environment Impact Statements
- Review of statutory and non-statutory heritage registers as follows:
 - The National Heritage List and the Commonwealth Heritage List under the *Environmental Protection and Biodiversity Act 1999*
 - State Heritage Register including Section 170 Heritage and Conservation Registers under the *NSW Heritage Act 1977*, for the following government agencies:
 - Roads and Maritime
 - DPIE (formally OEH)
 - Transport for NSW
 - Hunter Water
 - Water NSW
- Heritage listings under Schedule 2 and heritage mapping in the *Port Stephens Local Environmental Plan 2013*
- National Trust of Australia
- Combined map search for Aboriginal Places and State Heritage Register items, available online at <http://www.environment.nsw.gov.au/heritageapp/heritagesearch.aspx>
- Assessment of heritage impacts in accordance with *NSW Heritage Manual and the Archaeological Assessment Guidelines* (NSW Heritage Office, 1996)
- Identification of safeguards to manage impacts.

The assessment of potential impacts of the proposal on non-Aboriginal heritage has considered Clause 5.10 of Port Stephens LEP, which relates to Heritage conservation. The objectives of this clause are as follows:

- a) to conserve the environmental heritage of Port Stephens;
- b) to conserve the heritage significance of heritage items and heritage conservation areas, including associated fabric, settings and views;
- c) to conserve archaeological sites; and
- d) to conserve Aboriginal objects and Aboriginal places of heritage significance.

6.5.2 Existing environment

Historical context

Raymond Terrace

The Raymond Terrace and District Historical Society (2008) reported that the first documented European settlement at the Raymond Terrace area occurred in 1801. Lt. Colonel Paterson took the survey vessel "Lady Nelson" from Sydney to investigate and report on coal outcrop and other natural resources on the north and camped just before a junction of the Hunter and Williams rivers.

In 1812, 1818 & 1821, Governor Macquarie took parties to the Hunter and used the name 'Raymond Terrace' for a location on the riverbanks where Colonel Paterson made camp in 1818.

Land grants east and west of the Hunter and Williams rivers were made available in the 1820s. Raymond Terrace became a growing port of call, leading to a village being developed and recognised in 1837. This included warehouses and shops located on the eastern bank of the river.

Good quality sandstone was quarried close to the town and used in the 1860s for construction of the town's Anglican and Catholic churches, some houses and stores.

Throughout the 1900's, factories were established that contributed to growth in the area, including:

- A butter factory established in 1902, which prospered, and later led to the large OAK factory being established at Hexham
- The Masonite Factory opened in 1939, employing 150 people
- The Courtaulds Factory began making yarns for motor tyres in the 1950's, 150 houses were built, and British families were brought out to live and help staff the factory
- The French-owned Tomago Aluminium Smelter started up in 1983.

The RAAF Base (established in 1942), and more recently the Newcastle Airport at Williamstown, have contributed greatly to Raymond Terrace's development. Raymond Terrace is today an administrative centre for the popular, extensive, and varied tourist region of Port Stephens.

Kings Hill and surrounds

Hunter Water (2010) notes the Irrawang Pottery Site is one of the earliest potteries in Australia, and was established by James King, an early Scottish entrepreneur who arrived in NSW in 1827. The site is located south of the Riding for the Disabled property, within the Grahamstown Dam operational area. Operating from 1833 to the sale of the land in 1855, James King's Irrawang Pottery Manufactory produced glazed earthenware.

In 2015, Council proposed to create a new suburb named Kings Hill. Council informed the Geographical Names Board of NSW that the new locality name would be adopted from the geographical high point 'Kings Hill', located within the proposed suburb. Pursuant to the provisions of Section 8 of the *Geographical Names Act 1966*, the Geographical Names Board (GNB) amended the locality boundaries between Raymond Terrace and Eagleton to allow for the creation of Kings Hill.

Heritage register searches

A search on the various statutory and non-statutory heritage registers (refer to Section 6.5.1) was conducted on 5 August 2019. One heritage site is located adjacent to the impact area – the Grahamstown Dam – as described below. No other heritage-listed items were identified within 500 metres of the impact area. The nearest listed heritage items found are described below.

Grahamstown Dam

Grahamstown Dam is listed as SHI 3630054 on the Hunter Water S170 register.

Grahamstown Dam is located to the east of the proposal.

Constructed between 1955 and 1964, the Grahamstown Dam scheme involved drawing fresh water from the Williams River near Seaham and conveying it by open canals and a tunnel to the storage dam constructed on Grahamstown moors, formed by constructing an embankment across the natural depression. The Grahamstown Water Supply Scheme was officially opened on 11th July 1964 by the then Premier of NSW. Several augmentations of the dam have occurred since 1964, generally involving increases to capacity and new spillways; the most recent augmentation works in 2005 involved an increase in the Full Supply Level to 12.8 metres and provided 50 per cent more storage capacity. These works also included construction of a larger spillway at Irrawang (known as the Grahamstown Dam Spillway) and discharge channel under the Pacific Highway. Today, Grahamstown Dam is the Hunter's largest drinking water supply dam.

Irrawang Pottery archaeological site

The Irrawang Pottery archaeological site is listed under Schedule 5 of the Port Stephens LEP (identified as Archaeological Item A4) as being of Local Significance, and as SHI 3630109 on the Hunter Water S170 register.

The Irrawang Pottery archaeological site located at 70 Rees James Road in Lot 113 DP733181, about one kilometre south of the proposal, east of the Pacific Highway and south-east of Grahamstown Spillway, on land owned and managed by Hunter Water.

The Irrawang Pottery site was established by James King in the early 1830s, and was operation until his death in 1856, after which the site became farmland. No structural remains are currently visible above ground and the site is now overgrown with dense vegetation.

Excavations by the University of Sydney at the Irrawang Pottery site were carried out between 1967 and 1976. During excavations, the types and shapes of ceramics made at the pottery, and much about the layout of the Irrawang estate itself was revealed.

Grahamstown Canal

Grahamstown Canal is listed as SHI 3630118 on the State Government S170 register.

Constructed between 1957 and 1964, Grahamstown Canal is an open canal cut into the surrounding pastureland with earthen embankments at the sides. It is located five kilometres north-east of the proposal area. The canal connects to the Williams River through concrete flood gates at one end and enters Balickera Pumping Station thorough a series of intake pipes at the other. Part of its length includes the 1.2-kilometre Balickera Tunnel, cut through the ridge between the Williams River extraction point and the Balickera Pumping Station.

Balickera Pumping Station

Balickera Pumping Station is listed as SHI 3630048 on the Hunter Water S170 register and is considered to be of local significance.

Constructed between 1957 and 1965, Balickera Pumping Station is the major pumping station for the Grahamstown Scheme, the last major expansion of the Hunter Water supply. It is located about six kilometres north of the proposal area and is accessed via Italia Road. Balickera Pumping Station is two storey rectangular industrial building constructed with a metal frame and clad in corrugated metal (Hunter Water, 2010).

Archaeological potential

The area that would be occupied by the proposal has been heavily disturbed from construction of the Pacific Highway, Grahamstown Dam, existing drainage lines and farm dams, optical fibre and electricity infrastructure. Due to this previous disturbance, the proposal area has low archaeological potential.

6.5.3 Potential impacts

Construction

There are no heritage-listed items within, or within 500 metres of, the impact area.

The closest item, Irrawang Pottery Site (located about one kilometre south of the proposal) will not be directly impacted by the proposal, as it is located outside the impact area. As Irrawang Pottery Site is not located downstream of the proposal (Irrawang Pottery Site is separated from the proposal by Grahamstown Spillway and an expanse of grassy and forested vegetation), the proposal would not indirectly impact Irrawang Pottery Site during construction (such as sedimentation or erosion impacts).

Therefore, no items of non-Aboriginal heritage would be impacted during construction of the proposal. The construction activities related to the proposal are consistent with the objectives of Clause 5.10 of Port Stephens LEP, as the activities would not impact upon the conservation of environmental heritage, heritage items and areas, archaeological sites or Aboriginal objects and places (Aboriginal heritage is discussed in Section 6.4).

Operation

Operation of the proposal would not impact on any items of non-Aboriginal heritage. Operational activities would be confined to the impact area described in Section **Error! Reference source not found.** The operation of the proposal is consistent with the objectives of Clause 5.10 of Port Stephens LEP, as the activities described above would not impact upon the conservation of environmental heritage, heritage items and areas, archaeological sites or Aboriginal objects and places (Aboriginal heritage is discussed in Section 6.4).

6.5.4 Safeguards and management measures

Proposal-specific management measures outlined in Table 6-22 are proposed in the event of an unanticipated Non-Aboriginal heritage items or skeletal remains discovery. No mitigation measures are proposed for the operational stage of the proposal.

Table 6-22 Non-Aboriginal heritage safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Non-Aboriginal heritage	A heritage induction will be provided to workers before construction begins. It will inform them of exclusion zones and guidelines to follow if unexpected heritage items or deposits are located during the work.	Contractor	Pre-construction	
Non-Aboriginal heritage	<i>The Standard Management Procedure - Unexpected Heritage Items</i> (Roads and Maritime, 2015d)	Contractor	Detailed design / pre-construction	Section 4.10 of QA G36

Impact	Environmental safeguards	Responsibility	Timing	Reference
	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.			<i>Environment Protection</i>

6.6 Landscape character and visual amenity

This section presents an assessment of the landscape character and visual amenity impacts of the proposal and identifies safeguards to minimise and reduce these impacts. The assessment draws on information in the *Kings Hill Grade Separated Interchange Urban Design Memo* (Spackman Mossop and Michaels, 2013) prepared for this REF (Appendix G).

6.6.1 Methodology

The assessment of landscape and visual impacts were undertaken with reference to the *Environmental Impact Assessment Practice Note EIA-N04 Guideline for Landscape Character and Visual Impact Assessment* (Roads and Maritime, 2014b) and the *Pacific Highway Urban Design Framework 2013: Urban Design Vision, Objectives and Design Principles for the Upgrade of the Pacific Highway from Hexham to Tweed Heads* (Roads and Maritime, 2013b).

The assessment was informed by the landscape context, urban design principles and objectives and urban design recommendations developed (Appendix G), and involved the following tasks:

- Review of the proposal description (both construction and operation) and design
- Conducting a site visit, reviewing relevant investigations and analysing aerial photographs and topographic maps to understand the study area
- Review of the Kings Hill URA Revised Concept Development Application (DA 16-2018-772-1)
- Identification and description of landscape character zones relevant to the proposal. A qualitative assessment was carried out for each landscape character zone that would be potentially impacted by the proposal. The assessment used 'sensitivity', 'magnitude' and 'impact' parameters, which were scored on a qualitative basis using a scale from 'negligible' to 'high'. The resulting impact is the combination of the 'magnitude' and 'sensitivity' rating in accordance to the impact assessment grading matrix shown in Table 6-23
- Identification of the visual catchment of the proposal, selecting viewpoints within the visual catchment representing a range of different sensitive receivers. A visual impact assessment was undertaken to determine the areas from where the proposal would be visible and key viewpoints to and from the proposal. The assessment was based on the 'magnitude' of change to existing views and the 'sensitivity' of the viewer. The resulting impact is the combination of the 'magnitude' and 'sensitivity' rating in accordance to the impact assessment grading matrix shown in Table 6-23
- Identification of urban design recommendations and strategies to mitigate adverse impacts.

Table 6-23 Landscape character and visual impact grading matrix (Source: Roads and Maritime, 2014)

Sensitivity	Magnitude			
	High	Moderate	Low	Negligible
High	High impact	High-Moderate	Moderate	Negligible
Moderate	High-Moderate	Moderate	Moderate-Low	Negligible
Low	Moderate	Moderate-Low	Low	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

6.6.2 Existing environment

Existing landscape character

The proposal site and surroundings were categorised into five landscape character zones generally determined through the combination of existing land uses, topography and vegetation coverage. These landscape character zones are described in Table 6-24 and locations shown in Figure 6-13.

Table 6-24 Description of landscape character zones

Zone	Commentary	Photo
LCZ1 - Moderately undulating forests	LCZ1 is comprised of heavy vegetated forest with undulating topography. The zone contains Aboriginal heritage items and the Kings Hill Ridge Song Trail cultural site of high significance for the Aboriginal community (refer to Section 6.4 for assessment of impacts on Aboriginal heritage). Areas within LCZ1 are undeveloped and mostly zoned E2 Environmental Conservation under the Port Stephens LEP.	
LCZ2 - Riparian corridors	LCZ2 is comprised of a network of ephemeral water courses and Irrawang Spillway, running west-east and west-southeast direction and their associated riparian vegetation. The topography of this zone is undulating to the west and relatively flat to the east. Slopes generally run towards east and south east. Areas within LCZ2 are largely undeveloped although some of these riparian corridors are crossed by existing road and utility infrastructure, such as Irrawang Spillway.	
LCZ3 - Rural hinterland	LCZ3 is located between moderately undulating forests (LCZ1) and the Pacific Highway. The topography of this zone is relatively flat and with slope of less than 10 degrees generally running towards east and south east. The landscape character is that of paddocks and mature trees with intermittent rural residential properties located along Six Mile Road and the western side of the Pacific Highway. LCZ2 also has a strip of high voltage electricity lines running parallel to the Pacific Highway.	

Zone	Commentary	Photo
LCZ4 - Road corridor / reserve	LCZ4 is comprised of land occupied by the Pacific Highway road reserve, zoned SP2 (Classified Road) under the Port Stephens LEP. The topography of this zone is relatively flat. The road reserve is well vegetated with native plantings to the verge, and a narrow median of mown grass, native grasses and, occasionally, shrubs and small trees. Vegetated areas provide a sense of separation from adjoining areas. Glimpses of the broader landscape can be experienced to the west by Pacific Highway users.	
LCZ5 - Grahamstown Dam and foreshore	LCZ5 is comprised of land occupied by the Grahamstown Dam and a relatively narrow strip of heavily vegetated foreshore area, both zoned SP2 (Hunter Water Corporation) under the Port Stephens LEP. The topography of this zone is relatively flat and with slope of less than 10 degrees generally running towards the dam. The landscape character is that of a dam used for water supply purposes and surrounded by dense forest with some patches of low vegetation. The zone is considered to have significant scenic values. Access to the general public to this zone is restricted.	

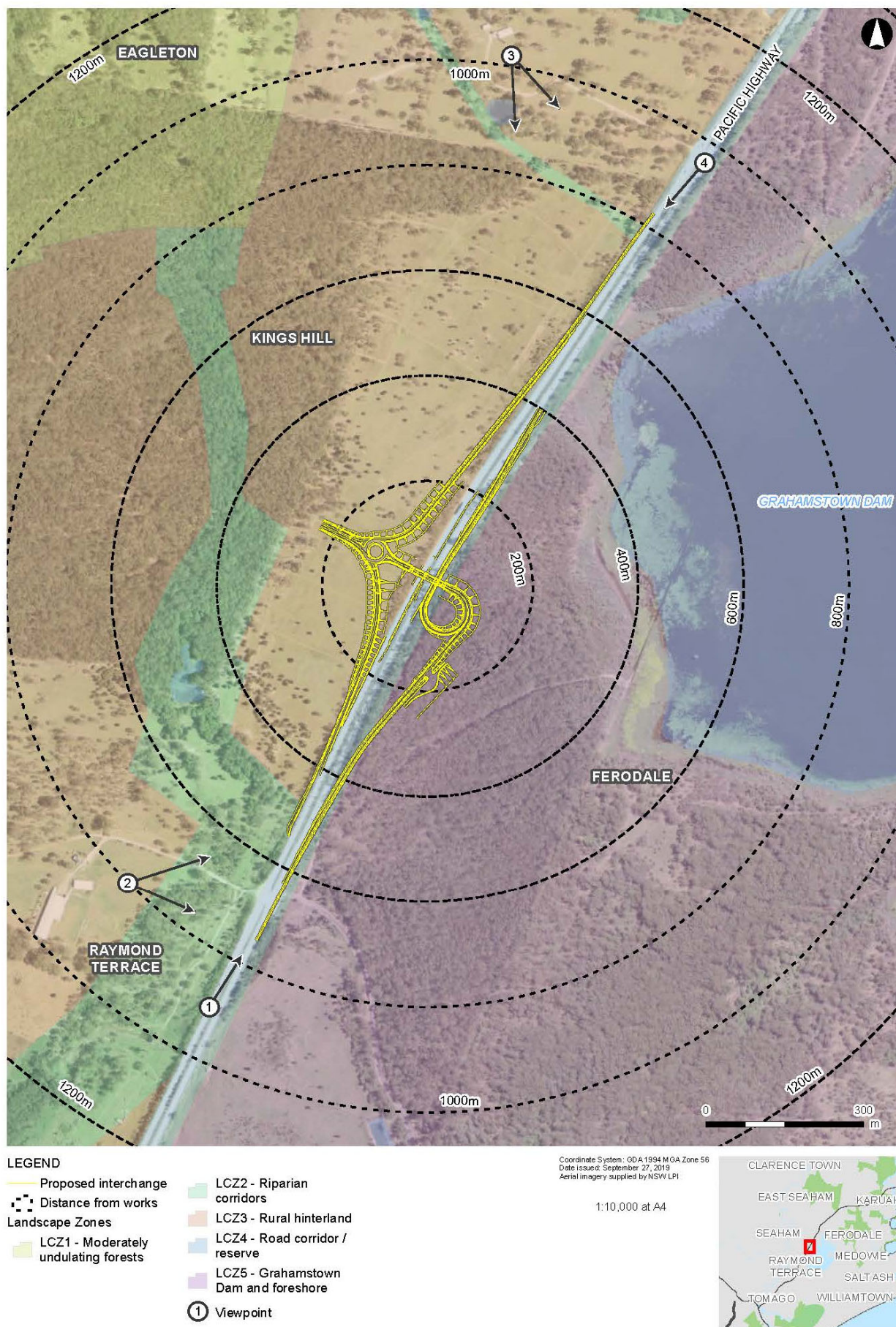


Figure 6-13 Location of landscape character zones

Visual catchment and viewpoints

The extent from which the proposal would be visible from adjoining areas varies and is mainly influenced by vegetation and topography.

Most of the potential views of the proposal would be screened by existing vegetation and the natural slope of the land. Views to the proposal would be generally restricted to the Pacific Highway road corridor and rural land immediately to the west of the highway.

A desktop assessment and site visit were utilised to determine the viewpoints from which the proposal would be visible. Four key viewpoints were identified. These are described in Table 6-25 and are illustrated in Figure 6-13.

Table 6-25 Viewpoints and visual receivers

No	Representative view	Visual receiver
1	Foreground view of Pacific Highway and surrounds for highway users travelling north	Motorists.
2	Foreground view of Pacific Highway and surrounds	Customers and residents of the Riding for the Disabled property at 3217 Pacific Highway.
3	Foreground view of Pacific Highway and surrounds	Residents of the rural residential property at 3385 Pacific Highway. This view is considered representative of other existing properties along the western side of the highway which are owned by the proponent.
4	Foreground view of Pacific Highway and surrounds for highway users travelling south	Motorists.

6.6.3 Potential impacts

Construction

Landscape character impacts

As detailed in Table 6-26, moderate to high adverse impacts are predicted for LCZ3 (rural hinterland), LCZ4 (road reserve) and LCZ5 (Grahamstown Dam and foreshore). This would result from the removal of trees and vegetation and general construction work activities.

During construction, there would be moderate adverse impacts on the moderately undulating forests (LCZ1) and riparian corridors (LCZ2) landscape character zones due to the presence of compound areas and construction activities (Table 6-26).

Table 6-26 Landscape character construction impact assessment

Zone	Magnitude (and rationale)	Sensitivity (and rationale)	Overall impact
LCZ1 - Moderately	Negligible	High	Moderate

Zone	Magnitude (and rationale)	Sensitivity (and rationale)	Overall impact
undulating forests	Construction would be located away from this landscape character zone and would not change or impact the character of the existing dense forest.	Landscape character zone with natural environment and cultural heritage values that are considered high by the Aboriginal community.	
LCZ2 -Riparian corridors	Moderate Construction would involve the removal of trees, establishment of a temporary access track and general construction activities related to utilities relocation.	High Landscape character zone with natural environment values.	High-moderate
LCZ3 - Rural hinterland	High Construction would involve the removal of trees, establishment of a compound area and general construction activities	Moderate Views from current properties would be impacted.	High-moderate
LCZ4 - Road reserve	High As in LCZ4, construction would involve the removal of trees, establishment of a compound area and general construction activities.	Negligible Proposal elements would fit well with the Pacific Highway infrastructure hence this zone has now sensitivity to the proposed changes.	Moderate
LCZ5 - Grahamstown Dam and foreshore	High Construction of the proposal would remove vegetation and introduce construction activities and plant in an area currently covered by vegetation	High Part of Hunter Water's water supply system. The dam and associated foreshore areas are considered to have good scenic qualities.	High

Visual impacts

During construction, there would be moderate to high adverse visual impacts to motorists travelling along the Pacific Highway as they are likely to see compound areas and construction activities. There would be low to moderate visual impacts to the Riding for the Disabled property at 3217 Pacific Highway, the rural residential property at 3385 Pacific Highway and other rural residential properties along the western side of

the highway from construction traffic and activities associated with the access track and drainage channel. These visual impacts are described in Table 6-27.

Mitigation measures are proposed to manage these impacts (refer to Section 6.6.4).

Table 6-27 Visual construction impact assessment

Viewpoint	Magnitude (and rationale)	Sensitivity (and rationale)	Overall impact
1	High Motorists would be likely to see the compound areas and construction activities	Low Motorists would focus on driving and would have a low sensitivity in this highway environment	Moderate
2	Moderate Construction would be visible from the Riding from the Disabled property due to the shared use of the driveway for access to the compound area. The compound area would be partial visible through existing vegetation.	Low There would be minimal alteration of existing view. Landscaping of ramp batter slopes with vegetation would further reduce the magnitude of this impact.	Moderate-low
3	Low Construction would be visible from the residential property at 3385 Pacific Highway as the proposed access route crosses the driveway adjacent to the Pacific Highway. However, there would be a distance of about 375 metres from the property to the track, so visual impact would be low.	Low There would be minimal alteration of existing view. Landscaping of ramp batter slopes with vegetation would further reduce the magnitude of this impact.	Low
4	High Motorists would be likely to see the compound areas and construction activities	Low Motorists would focus on driving and would have a low sensitivity in this highway environment	Moderate-low

Operation

Landscape character impacts

A qualitative assessment of the magnitude, sensitivity and resulting impact for each of the landscape character zones to the proposal is presented in Table 6-28. Overall, the assessment found moderate potential impacts in three of the five of the landscape character zones.

Potential impacts on the Grahamstown dam and foreshore landscape character zone are considered to be high-moderate due to the increased scale of infrastructure, which may reduce the scenic value of the dam.

Table 6-28 Landscape character operational impact assessment

Zone	Magnitude (and rationale)	Sensitivity (and rationale)	Overall impact
LCZ1 - Moderately undulating forests	Negligible The proposal is located away from this landscape character zone and would not change or impact the character of the existing dense forest.	High Landscape character zone with natural environment and cultural heritage values that are considered high by the Aboriginal community.	Moderate
LCZ2 -Riparian corridors	Low The proposal would increase the scale of road infrastructure which crosses some of the drainages. However, the increased infrastructure would fit within existing road reserve and would have little impact on riparian vegetation or the integrity of the corridors.	High Landscape character zone with natural environment values.	Moderate
LCZ3 - Rural hinterland	Moderate The proposal would increase the scale of road infrastructure due to the East-West Link Road and sediment basins likely to be built in land within this zone. The proposal would result in safe access to the highway for existing properties with this zone.	Moderate Views from current properties would be impacted.	Moderate
LCZ4 - Road reserve	Negligible	Negligible	Negligible

Zone	Magnitude (and rationale)	Sensitivity (and rationale)	Overall impact
	The proposal would increase the scale of road infrastructure by adding a service road, roundabout, overbridge and ramps to the exiting highway. However, proposal elements are consistent with the landscape character of this zone.	Proposal elements (i.e. culvert extensions) would fit well with the Pacific Highway infrastructure hence this zone has no sensitivity to the proposed changes.	
LCZ5 - Grahamstown Dam and foreshore	Moderate The proposal would increase the scale of road infrastructure. Sections of the southbound entry and exit ramps would be located within this landscape character zone.	High Part of Hunter Water's water supply system. The dam and associated foreshore areas are considered to have good scenic qualities.	High-moderate

Visual impacts

A qualitative assessment of the magnitude, sensitivity and resulting visual impact for each of the viewpoints to the proposal is presented in Table 6-29. Moderate-low impacts are predicted for Pacific Highway users (motorists) and for the receivers located to the west of the Pacific Highway.

Table 6-29 Visual operational impact assessment

Viewpoint	Magnitude (and rationale)	Sensitivity (and rationale)	Overall impact
1	Moderate Overpass and ramps would be prominent and would be seen by motorists travelling to the north.	Low Motorists would be focused on driving and would likely have a low sensitivity in this highway environment. Similar infrastructure is located on the Pacific Highway north of the proposal at Tarean Road interchange and Limeburners Creek Road overpass, Karuah. Landscaping of ramp batter slopes with vegetation would further	Moderate-low

Viewpoint	Magnitude (and rationale)	Sensitivity (and rationale)	Overall impact
		reduce the magnitude of this impact.	
2	Low Proposal elements likely to be visible would include northbound exit and southbound entry ramps which would be partially screened by existing vegetation that is retained between the proposal and the receiver.	Low There would be minimal alteration of existing view. The new view of the new northbound exit and southbound entry ramps would be consistent with existing visual character of the highway. Landscaping of ramp batter slopes with vegetation would further reduce the magnitude of this impact.	Low
3	Moderate There would moderate alteration of existing views as a result of potential sediment basins and drainage infrastructure (to be determined during detailed design). Other proposal elements likely to be visible would include northbound entry and southbound exit ramps which would be partially screened by existing vegetation to be retained between the proposal and the receiver.	Low There would be minimal alteration of existing view. The new view of the new northbound exit and southbound entry ramps would be consistent with existing visual character of the highway. Landscaping of ramp batter slopes with vegetation would further reduce the magnitude of this impact.	Moderate-low
4	Moderate Overpass and ramps would be prominent and would be seen by motorists travelling to the south.	Low Motorists would be focused on driving and would likely have a low sensitivity in this highway environment. Similar infrastructure is located on the Pacific Highway north of the proposal at Tarean Road interchange and Limeburners Creek	Moderate-low

Viewpoint	Magnitude (and rationale)	Sensitivity (and rationale)	Overall impact
		Road overpass, Karuah. Landscaping of ramp batter slopes with vegetation would further reduce the magnitude of this impact.	

6.6.4 Safeguards and management measures

Safeguards and management measures to be considered during construction are presented in **Error! Reference source not found.**Table 6-30.

Table 6-30 Landscape character and visual amenity safeguards and mitigation measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Landscape character and visual impact	An Urban Design Plan will be prepared to support the final detailed proposal design and implemented as part of the CEMP. The Urban Design Plan would present an integrated urban design for the proposal, providing practical detail on the application of relevant design principles. The Plan will include design treatments for: - location and identification of existing vegetation and proposed landscaped areas, including species to be used - built elements including retaining walls, bridges and noise walls - 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	Roads and Maritime	Detailed design / pre-construction	

Impact	Environmental safeguards	Responsibility	Timing	Reference
	- procedures for monitoring and maintaining landscaped or rehabilitated areas. The Urban Design Plan will be prepared in accordance with relevant guidelines, including: - Beyond the Pavement urban design policy, process and principles (Roads and Maritime, 2014) - Landscape Guideline (RTA, 2008) - Bridge Aesthetics (Roads and Maritime, 2012) - Shotcrete Design Guideline (RTA, 2005).			
Landscape character and visual impact	Detailed design stage of the proposal would incorporate the urban design recommendations and maintenance considerations outlined in <i>Kings Hill Grade Separated Interchange Urban Design Memo</i> (Appendix G), such as: - Selection of plant species that are robust, non-invasive and not fire promoting - Use of local provenance plant material for native revegetation plantings - Exclusion of all species on weed lists applicable to the local area. Placement and species selection for planting within the Pacific Highway road reserve to be in accordance with clear zone and sight stopping distance requirements.	Design contractor	Detailed design	
Construction impacts	Construction compound areas will occupy the minimum area practicable for the intended use. Suitable barriers will be erected to screen views from impacted sensitive receivers where feasible and reasonable. Trees to be retained within construction areas will be identified, protected and maintained.	Contractor	Construction	

Impact	Environmental safeguards	Responsibility	Timing	Reference
Construction impacts	Once construction is complete – or progressively throughout the work, where feasible and reasonable – the ancillary facilities will be returned to at least their pre-construction state.	Construction contractor	Construction	
Construction impacts	Opportunities will be identified to retain existing trees within the ancillary facilities.	Construction contractor	Construction	

6.7 Biodiversity

This section presents an assessment of the potential impacts of the proposal on biodiversity and identifies safeguards to minimise and reduce these impacts. The assessment presented in this section draws on information provided by the *Kings Hill Stormwater Interchange Biodiversity Assessment* (Appendix H) undertaken for the proposal by Arcadis.

6.7.1 Methodology

A study area was identified for the purposes of identifying potential direct and indirect impacts associated with the construction and operation of the proposed interchange. Flora and fauna surveys were restricted to the study area which covers an area of 53.6 hectares and comprises a 50-metre buffer of the interchange design footprint and compound areas, as well as an access track on the western side of the Pacific Highway north of the proposal and south of the proposal through the Irawang Spillway. The study area also covers two proposed stormwater detention basins and the proposed 3.1-kilometre alignment of the Telstra optic fibre cable that is required to be relocated.

The biodiversity assessment involved the following tasks:

- Background research, database searches and literature review
- Flora and fauna surveys carried out by Arcadis in April, May and June 2017, and July/August 2019, which included:
 - 13 vegetation integrity plots, conducted in accordance with the *Biodiversity Assessment Method* (BAM) (OEH, 2017)
 - Parallel transects carried out in accordance with *NSW Guide to Surveying Threatened Plants* (OEH, 2016), targeted locally recorded threatened flora species
 - Targeted searches for threatened flora species within 15 vegetation plots
 - Diurnal bird surveys at 15 locations across an adjacent to the study area, by area searches (fixed time) and transect surveys
 - Hollow-bearing tree survey, to determine the number and type of tree hollows occurring within the study area
 - Stag-watching of hollow trees, to identify the presence of threatened hollow-dependant fauna
 - Deployment of eight remote cameras across and adjacent to the study area for a period of 13 consecutive nights, to identify the presence of threatened arboreal mammals, including Brush-tailed phascogale and Squirrel glider
 - Spot Assessment Technique (SAT) surveys, to identify the presence and activity levels of koalas, and consideration of the *Port Stephens Council Comprehensive Koala Plan of Management* (CKPoM) (Port Stephens Council, 2002)
 - Spotlighting transects throughout the study area, to identify the presence of nocturnal fauna species
- Incorporation of previous flora and fauna survey results, carried out across the study area and wider Kings Hill URA between 2012 and 2016 by PEA Consulting (where relevant)
- Incorporation of the findings from ecological assessments of Irawang Swamp, carried out by BIOCM in January 2017 (BIOCM, 2017) and Alluvium in May 2019 (Appendix I)
- Characterisation of the existing environment relevant to the proposal based on information from the background research and the flora and fauna surveys
- Identification of the presence or likelihood of occurrence of threatened species, populations and ecological communities listed under the BC Act and the EPBC Act within the study area

- Identification and assessment of direct and indirect impacts, including loss of native vegetation and fauna habitat, impacts on threatened species, aquatic habitat impacts, fauna mortality, introduction and spread of weeds and cumulative impacts
- Identification of environmental management measures to avoid, minimise and mitigate potential impacts.

6.7.2 Existing environment

The study area is located in a landscape that comprises a mosaic of large tracts of native vegetation, within private and publicly-owned land, patches of cleared land used for agricultural purposes (primarily grazing) within rural-residential properties. Native vegetation of the study area to the east of the Pacific Highway has been somewhat fragmented by Hunter Water vehicle access tracks and an overhead powerline easement. In addition, this vegetation and has been disturbed by past logging activities and edge effects resulting from past upgrades of the Pacific Highway and more recently, Grahamstown Dam augmentation works in 2005. Irrawang Swamp, a Coastal Wetland under the Coastal Management SEPP, is downstream of the proposal.

Flora

Vegetation Types

The native vegetation in the study area is consistent with PCT 1590: Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest and is present in a range of structure and condition classes. The areas of each of these classes are listed in Table 6-31. In addition to Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest, five other vegetation types that do not conform to the definition of any PCTs were also recorded in the study area (Table 6-31). The location of each vegetation type within the study area is shown in Figure 6-14.

Table 6-31 Vegetation identified in the study area

Vegetation Type	Structure/ condition class	Threatened ecological community?	Area (ha) in study area
Plant Community Type			
Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest (PCT 1590)	Shrub/grass understorey	No	11.41
	Grassy understorey		0.75
	Dense paperbark shrub layer		1.07
	Disturbed grassy understorey		0.54
	Road verge (native understorey)		3.78
	Road verge (exotic understorey)		0.86
	Scattered trees over grazed grassland		3.75
Total PCT vegetation			22.16

Vegetation Type	Structure/ condition class	Threatened ecological community?	Area (ha) in study area
Other vegetation types			
Planted Casuarinas	N/A	No	0.61
Disturbed road verge – exotic species dominant	N/A	No	1.25
Dam foreshore	N/A	No	0.95
Cleared land – exotic grassland and tracks	N/A	No	21.01
Total all vegetation types			46.28

Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest occurs across the study area. This PCT is characterised by a canopy of *Corymbia maculata* (Spotted Gum) with varying co-dominance by Ironbarks, mainly *Eucalyptus fibrosa* (Red Ironbark) and *Eucalyptus siderophloia* (Grey Ironbark), *Eucalyptus moluccana* (Grey Box) *Eucalyptus punctata* (Grey Gum) and *Eucalyptus acmenoides* (White Mahogany). *Eucalyptus tereticornis* (Forest Red Gum), *Eucalyptus umbra* (Broad-leaved White Mahogany), *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Angophora costata* (Sydney Red Gum) were also present in lower frequencies.

The midstorey includes regenerating canopy species and a diversity of melaleucas including *Melaleuca styphelioides* (Prickly-leaved Tea Tree), *Melaleuca nodosa* (Ball Honey Myrtle) and less commonly, *Melaleuca linariifolia* (Flax-leaved Paperbark). The Midstorey is variable across the distribution of this PCT, being at its densest in the areas closest to Grahamstown Dam.

The shrub layer supports scattered occurrences of *Leucopogon juniperinus* (Prickly Beard-heath), *Daviesia ulicifolia* (Gorse Bitter Pea), *Breynia oblongifolia* (Coffee bush), *Acacia ulicifolia* (Prickly Moses) and *Bursaria spinosa* (Native Blackthorn).

The grassy ground layer supports a high diversity of native species, such as *Entolasia stricta* (Wiry Panic), *Imperata cylindrica* (Blady Grass), *Cymbopogon refractus* (Barbed Wire Grass), *Lomandra longifolia* (Spiky-headed Mat-rush) and *Themeda triandra* (Kangaroo Grass). Other frequently recorded ground layer species include *Dichondra repens* (Kidney Weed), *Pratia purpurascens* (Whiteroot), *Dianella revoluta* (Blueberry Lily), *Brunoniella pumilio* (Dwarf Blue Trumpet), and *Cheilanthes sieberi* (Rock Fern). Commonly recorded vines and creepers include *Parsonsia straminea* (Common Silkpod), *Geitonoplesium cymosum* and *Hardenbergia violacea* (False Sarsparilla).

Exotic species are present in low abundance within most areas of Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest in the study area, except for disturbed areas and cleared edges such as the Pacific Highway road verges, where weedy exotic grasses including *Andropogon virginicus* (Whiskey Grass), *Chloris gayana* (Rhodes Grass), *Eragrostis curvula* (African Love Grass), *Sporobolus africanus* (Parramatta Grass) and *Hyparrhenia hirta* (Coolatai Grass) are sometimes abundant. *Lantana camara* (Lantana) occurs frequently throughout the study area, with a scattered patchy occurrence in most areas except for some parts of the road verge (Pacific Highway) where it dominates the midlayer. There is occasional occurrence of exotic groundcovers such as *Bidens pilosa* (Cobblers pegs), *Plantago lanceolata* (Ribwort) and *Senecio madagascariensis* (Fireweed). Patches of this PCT are fragmented by maintenance

and access tracks used to service the Grahamstown Dam and the electrical easement located on the eastern side of the Pacific Highway.

The vegetation structure and condition of Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest is variable across the study area; seven vegetation zones have been identified and mapped for this PCT.

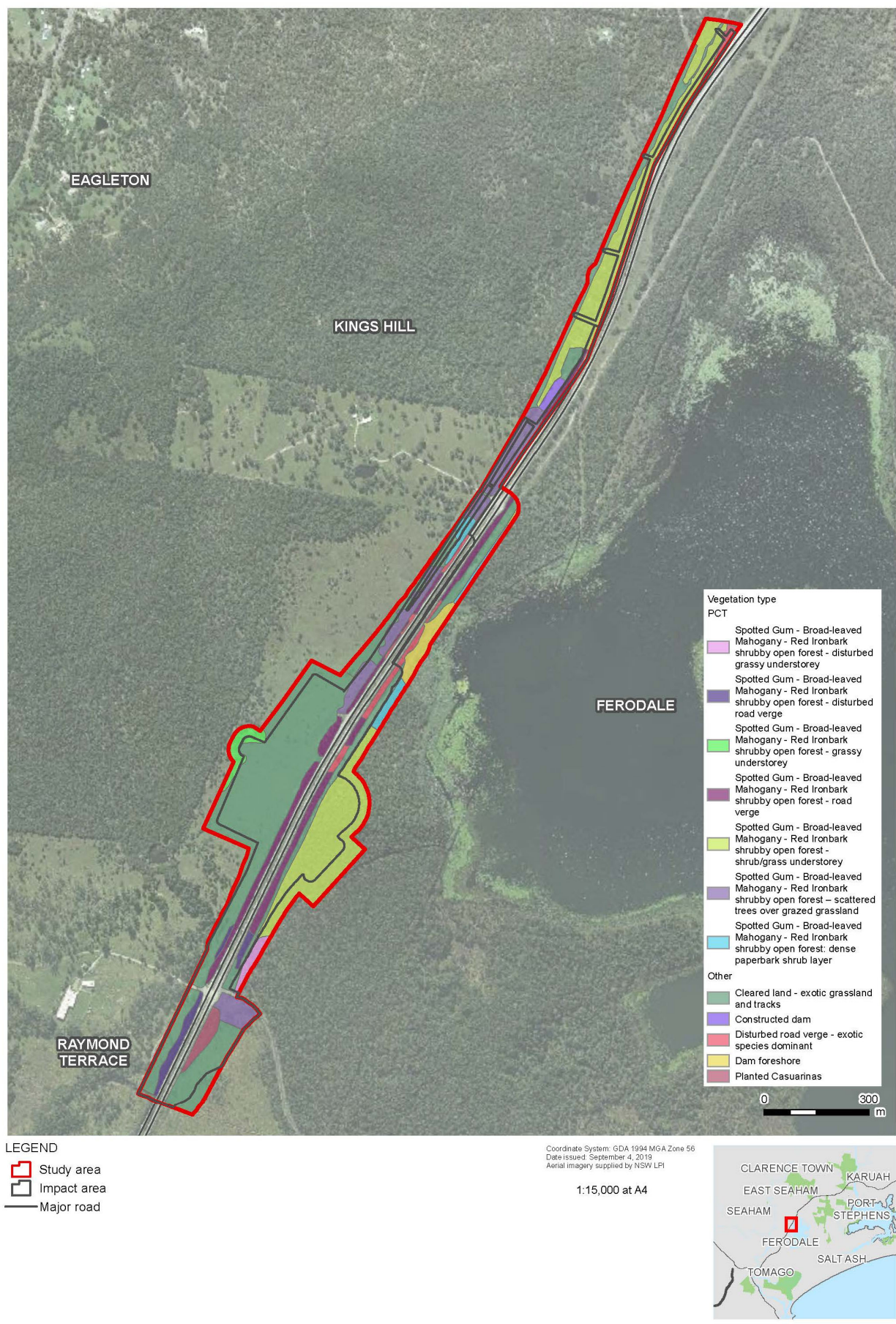


Figure 6-14 Distribution of PCTs and vegetation types

Threatened flora

No threatened flora species or populations listed under the BC Act or EPBC Act were identified in the study area. It was determined that four threatened flora species listed under the BC Act have a Moderate likelihood of occurrence in the study area. These are discussed in Table 6-32.

Table 6-32: Threatened flora species known or likely to occur in the study area

Scientific name	Common Name	Status		Potential occurrence
		BC Act	EPBC Act	
<i>Callistemon linearifolius</i>	Netted Bottlebrush	Vulnerable	Not listed	Moderate. Species not identified during flora surveys across the study area. Study area supports potential habitat for the species and there are recent records nearby.
<i>Corybas dowlingii</i>	Red Helmet Orchid	Endangered	Not listed	Moderate. Species not identified during flora surveys across the study area. Study area supports potential habitat for the species and there are recent records nearby – RPS (2019) have recorded a population of this species in the Kings Hill Development proposal footprint.
<i>Maundia triglochinoides</i>	-	Vulnerable	Not listed	Moderate. Species not identified during flora surveys across the study area. Study area supports some small areas of potential habitat for the species in drainage soaks and at the edge of Grahamstown Dam. There are recent records nearby – RPS (2019) have recorded a population of this species in the Kings Hill Development proposal footprint.
<i>Pterostylis chaetophora</i>	-	Vulnerable	Not listed	Moderate. Species not identified during flora surveys across the study area, however targeted seasonal surveys for this species were not conducted within the portion of the study area to the east of the Pacific Highway.

Scientific name	Common Name	Status		Potential occurrence
		BC Act	EPBC Act	
				Study area supports potential habitat for the species and there are recent records nearby – RPS (2019) have recorded a population of this species in the Kings Hill Development proposal footprint, and there is another population to the east and north-east in the Grahamstown Dam catchment.

Exotic flora

Of the 38 exotic species recorded in the study area, seven are listed as Priority Weeds under the NSW *Biosecurity Act 2015* for the hunter region, which includes the Port Stephens LGA. Three species are also listed as Weeds of National Significance (WoNS) under the National Weeds Strategy. Priority weed species and WoNS identified are detailed in Table 6-33.

Table 6-33 Priority weed species and WoNS identified within the study area

Scientific Name	Weed status	Biosecurity duty (<i>Biosecurity Act 2015</i>)
<i>Bryophyllum</i> species (Mother of Millions)	Priority weed	Regional Recommended Measure: Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be bought, sold, grown, carried or released into the environment.
<i>Cortaderia selloana</i> (Pampas Grass)	Priority weed	Study area is located within core infestation area. Core infestation area: Land managers should mitigate spread from their land. Land managers to reduce impacts from the plant on priority assets.
<i>Hyparrhenia hirta</i> (Coolatai Grass)	Priority weed	Regional Recommended Measure: Land managers should mitigate the risk of the plant being introduced to their land. Land managers should reduce impacts from the plant on priority assets. Land managers should prevent spread from their land where feasible. The plant or parts of the plant are not traded, carried, grown or released into the environment.
<i>Lantana camara</i> (Lantana)	Priority weed WoNS	Prohibition on dealings: Must not be imported into the State or sold.
<i>Olea europaea</i> subsp. <i>cuspidata</i> (African Olive)	Priority weed	Regional Recommended Measure: Land managers should mitigate the risk of the plant being introduced to their land. Land managers should reduce impacts from the plant on priority assets. Land managers should prevent spread from their land where feasible. The plant or parts of the plant are not traded, carried, grown or released into the environment.
<i>Rubus fruticosus</i> species aggregate	Priority weed WoNS	Prohibition on dealings: Must not be imported into the State or sold.

Scientific Name	Weed status	Biosecurity duty (<i>Biosecurity Act 2015</i>)
(Blackberry)		
<i>Senecio madagascariensis</i> (Fireweed)	Priority weed WoNS	Prohibition on dealings: Must not be imported into the State or sold.

Fauna

Threatened fauna

A total of three threatened fauna species were recorded from within the study area during surveys by Arcadis in 2017 and 2019:

- Koala (*Phascolarctos cinereus*) (Vulnerable – BC Act, Vulnerable Population – EPBC Act)
- Little Lorikeet (*Glossopsitta pusilla*) (Vulnerable – BC Act)
- Grey-Headed Flying-Fox (*Pteropus poliocephalus*) (Vulnerable – BC Act and EPBC Act).

PEA Consulting has previously recorded 12 threatened fauna species within or near the study area.

The current assessment has determined that a total of 25 threatened fauna species have been recorded, or are considered to have a Moderate or High likelihood of occurrence in the study area (Table 6-34).

The location of all threatened fauna species recorded during surveys by Arcadis and PEA Consulting are shown in Figure 6-15.

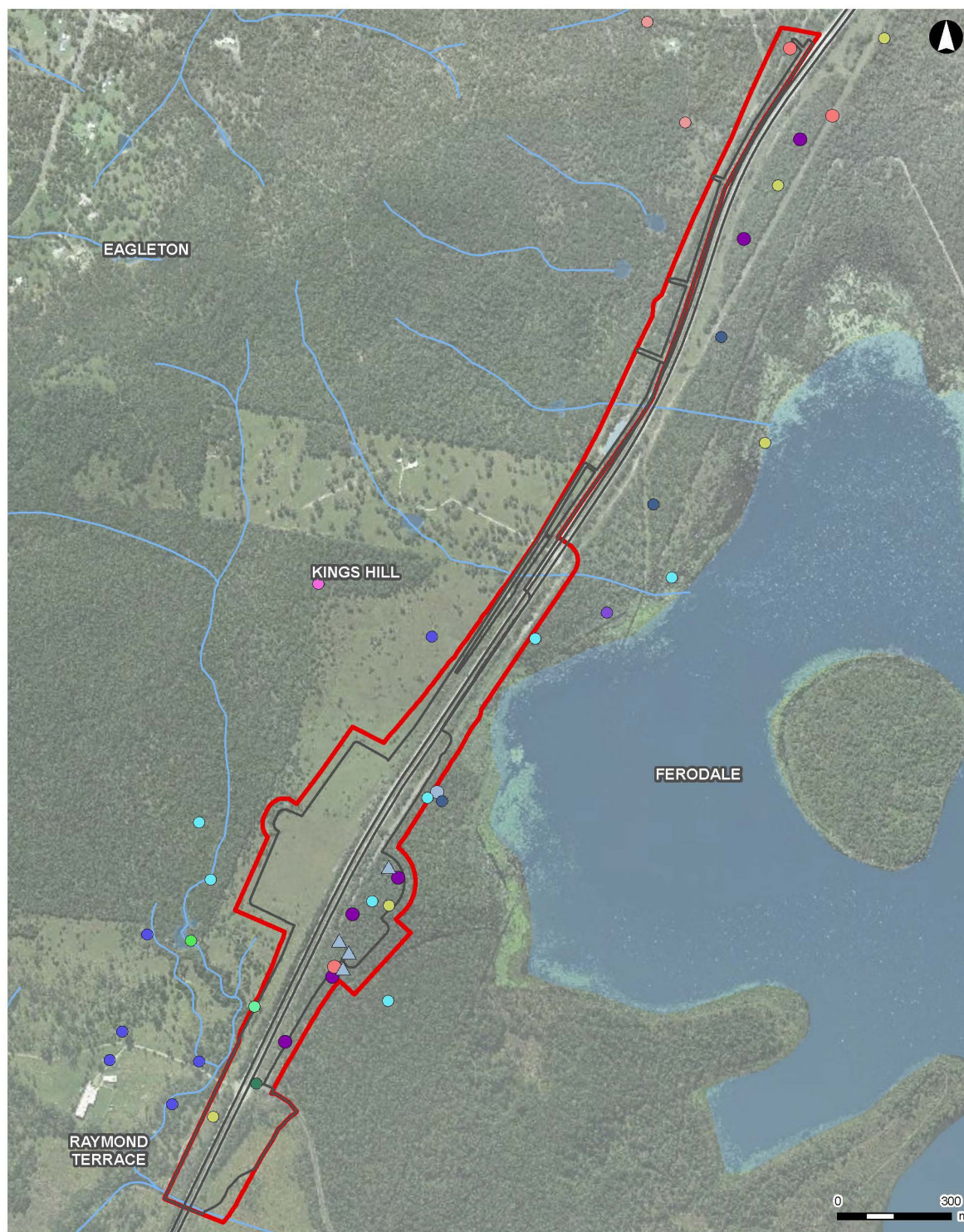
Table 6-34: Threatened fauna species known or likely to occur within the study area

Scientific name	Common Name	Status		Likelihood of occurrence
		BC Act	EPBC Act	
<i>Anthochaera phrygia</i>	Regent Honeyeater	Critically Endangered	Critically Endangered	Moderate Study area offers potential habitat and recent records from the locality
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow	Vulnerable	-	Moderate Study area offers potential habitat and recent records from the locality
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	Vulnerable	-	High Recorded from adjacent to the study area during surveys for the Kings Hill SIS (RPS 2019). Study area offers potential habitat and recent records from the locality
<i>Circus assimilis</i>	Spotted Harrier	Vulnerable	-	Moderate Study area offers potential habitat and recent records from the locality
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	Vulnerable	-	Moderate Study area offers potential habitat and recent records from the locality
<i>Daphoenositta chrysoptera</i>	Varied Sittella	Vulnerable	-	High Study area offers potential habitat and recent records from the locality
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	Vulnerable	-	Recorded Recorded previously by PEA Consulting Study area offers potential habitat and recent records from the locality
<i>Glossopsitta pusilla</i>	Little Lorikeet	Vulnerable	-	Recorded

Scientific name	Common Name	Status		Likelihood of occurrence
		BC Act	EPBC Act	
				Several small flocks observed throughout the study area during surveys by Arcadis in 2019 Study area offers suitable habitat and additional recent records from the locality
<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	Vulnerable	-	Moderate Study area offers potential habitat and recent records from the locality
<i>Lathamus discolor</i>	Swift Parrot	Endangered	Critically Endangered	Moderate Study area offers potential habitat and recent records from the locality
<i>Lophoictinia isura</i>	Square-tailed Kite	Vulnerable	-	Moderate Study area offers potential habitat and recent records from the locality
<i>Micronomus norfolkensis</i>	Eastern Coastal Free-tailed Bat	Vulnerable	-	High Recorded previously by PEA Consulting from adjacent to the study area. Study area offers potential habitat and recent records from the locality
<i>Miniopterus australis</i>	Little Bent-winged Bat	Vulnerable	-	High Recorded previously by PEA Consulting from adjacent to the study area. Study area offers potential habitat and recent records from the locality
<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	Vulnerable	-	Recorded Recorded previously by PEA Consulting Study area offers potential habitat and recent records from the locality
<i>Myotis macropus</i>	Southern Myotis	Vulnerable	-	Moderate Study area offers potential habitat and recent records from the locality

Scientific name	Common Name	Status		Likelihood of occurrence
		BC Act	EPBC Act	
<i>Ninox strenua</i>	Powerful Owl	Vulnerable	-	Moderate Study area offers potential habitat and recent records from the locality
<i>Petaurus norfolcensis</i>	Squirrel Glider	Vulnerable	-	High Recorded by PEA Consulting to the west of the study area Study area offers potential habitat and recent records from the locality
<i>Petroica boodang</i>	Scarlet Robin	Vulnerable	-	Moderate Study area offers potential habitat and recent records from the locality
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	Vulnerable	-	High Recorded by PEA Consulting from adjacent to the study area Study area offers potential habitat and recent records from the locality
<i>Phascolarctos cinereus</i>	Koala	Vulnerable	Vulnerable	Recorded One individual observed by Arcadis within the study area in 2019 Scats and scratches recorded throughout the study area during previous and current surveys by PEA Consulting and Arcadis
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler	Vulnerable	-	High Recorded by PEA Consulting from adjacent to the study area Study area offers potential habitat and recent records from the locality
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Vulnerable	Vulnerable	Recorded This species was observed foraging in the canopy of Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest by Arcadis during the April/May 2017 survey period Study area offers foraging habitat No roosting or breeding habitat present within the study area. Nearest known camp is at Raymond Terrace

Scientific name	Common Name	Status		Likelihood of occurrence
		BC Act	EPBC Act	
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat	Vulnerable	-	Moderate Study area offers potential habitat and recent records from the locality
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	Vulnerable	-	High Recorded previously by PEA Consulting from adjacent to the study area. Study area offers potential habitat and recent records from the locality
<i>Tyto novaehollandiae</i>	Masked Owl	Vulnerable	-	Recorded Recorded previously by PEA Consulting from a roadkill specimen near the Irrawang Spillway. Study area offers potential habitat and recent records from the locality



LEGEND

- Study area
- Impact area
- Major road
- Watercourse

Threatened Fauna Species (Arcadis)

- ▲ Koala (scat)
- Koala (sighting)
- Little Lorikeet
- Grey-headed Flying Fox

Threatened Fauna Species (PEA Consulting 2012-2015)

- Brush-tailed Phascogale
- Eastern Coastal Free-tailed Bat
- Eastern False Pipistrelle
- Greater Broad-nosed Bat
- Grey-crowned Babbler
- Koala
- Koala (Potential)
- Large Bent-winged Bat
- Little Bent-wing Bat
- Masked Owl

Coordinate System: GDA 1994 MGA Zone 56
Date issued: September 2, 2019
Aerial imagery supplied by NSW LPI

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Figure 6-15 Threatened fauna species

Koala

A single Koala was identified in a *Corymbia maculata* (Spotted Gum) in the study area, just south of Grahamstown Dam by Arcadis during field surveys in 2019. Evidence of Koala was identified in different parts of the study area opportunistically and during SAT surveys carried out by Arcadis in 2017 and 2019. Koala scats were identified during SAT surveys carried out by Arcadis in Spotted Gum – Broad-leaved Mahogany – Red Ironbark shrubby open forest in the north and south of the study area. Koala surveys carried out by PEA Consulting in 2013 recorded Koala scats and scratches in the study area.

Koala movements on the western side of Grahamstown Dam may be higher than in other areas of habitat surrounding the dam, due to the installation of Koala floppy-top fencing alongside the eastern margin of the Pacific Highway.

Studies undertaken in the adjacent Kings Hill URA (Ford and Youngentob, 2019) determined that Spotted Gum – Broad-leaved Mahogany – Red Ironbark shrubby open forest across the study area contains varying abundances of ‘high’ and ‘moderate’ value Koala feed trees. Forest Red Gum and Grey Gum have both been recorded throughout the study area, however vegetation within the study area does not support a high abundance of these tree species. The most commonly occurring ‘moderate’ value Koala feed tree is Grey Box. Narrow-leaved Ironbark, Red Ironbark and Broad-leaved Mahogany occur in relatively low abundance in the study area.

Koala surveys undertaken for the SIS (RPS, 2019) recorded a total of 10 individual Koalas (four females and six males) from within the SIS study area. Mapping provided in the SIS (RPS, 2019) shows records for four Koalas (three males and one female) adjacent to the study area for the current assessment.

Grey-headed flying fox

The Grey-headed Flying-Fox is listed as Vulnerable under the BC Act. This species was observed during stag-watching and spotlighting surveys, foraging in the canopy of flowering eucalypts within the study area.

The Grey-headed Flying-Fox is known to forage on blossoms and fruit from a wide range of native and exotic trees and shrubs. The range of flowering trees recorded in Spotted Gum – Broad-leaved Mahogany – Red Ironbark shrubby open forest within the study area provide suitable foraging resources for the Grey-headed Flying-Fox.

No Grey-headed Flying-fox camps (occupied roosting habitats) have been recorded from within the study area, and the study area does not support rainforest or mesic riparian vegetation that would provide suitable habitat for future camps. The nearest Nationally Important Flying Fox camp is mapped by *National Flying-fox monitoring viewer* (DotEE, 2019) at Raymond Terrace (Camp ID 265), located approximately 4.5 kilometres south-west of the study area, which has typically supported up to approximately 10,000 flying foxes in recent years.

It is considered most likely that individual Grey-headed Flying-foxes foraging within the study area are from the known camp at Raymond Terrace.

Little Lorikeet

The Little Lorikeet is listed as Vulnerable under the BC Act. This species was recorded from within the study area during surveys by Arcadis in July/August 2019.

Spotted Gum – Broad-leaved Mahogany – Red Ironbark shrubby open forest within the study area offers suitable, albeit limited, foraging habitat for the Little Lorikeet. Small hollows in living smooth-barked hollow-bearing trees may also provide suitable breeding habitat for this species.

The study area provides only a small area of suitable forage habitat compared to the much larger areas of higher-quality habitat protected within large reserves in the locality. It is therefore unlikely that the habitat available within the study area would be significant for the Little Lorikeet.

Other Species

A number of species were recorded within or adjacent to the study area by PEA Consulting in addition to those recorded by Arcadis, including:

- Brush-tailed Phascogale
- Eastern Coastal Free-tailed Bat
- Eastern False Pipistrelle
- Greater Broad-nosed Bat
- Grey-crowned Babbler
- Large Bent-winged Bat
- Little Bent-winged Bat
- Masked Owl.

Further detail of these species is given in the biodiversity assessment (Appendix H).

Fauna habitat

Terrestrial habitat

Vegetation of the study area offers an abundance of flowering and fruiting plants. Eucalypts, Corymbias, Angophoras and Melaleucas offer foraging resources to nectivorous birds, arboreal mammals and the threatened Grey-headed Flying Fox. Blossom-dependent threatened fauna may occasionally forage within the study area during blossoming periods for preferred forage trees.

Fruiting plants offer a foraging resource to frugivorous birds such as Olive-backed oriole (*Oriolus sagittatus*) as well as the threatened Grey-headed Flying Fox. *Allocasuarina littoralis* (Black she-oak), a preferred food resource of the Glossy Black-Cockatoo (NPWS, 1999c, DEC, 2004), is patchily distributed throughout the study area.

The abundance of rough-barked trees offers preferred habitat to insectivorous birds that forage for invertebrates on tree trunks and branches. Shrubs, including dense thickets of Lantana, offer sheltering and foraging habitat to small birds.

The vegetation present supports a diversity of ground layer habitat features. Dense ground layer vegetation and well-developed leaf litter is common, as is small ground timber. Larger logs occur occasionally. These features offer foraging and sheltering habitat to reptiles and small terrestrial mammals. Rocky features are absent from the study area.

Hollow-bearing trees

A total of 38 hollow-bearing trees were observed within the study area (Figure 6-16). While extensive surveys for hollow-bearing trees were not undertaken outside of the study area, the abundance of hollow-bearing trees in adjacent and continuous habitat appear to be similar. Given most hollow-bearing trees were recorded in Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest this equates to a density of approximately 1.7 hollow-bearing trees per hectare.

Several hollow-dependent species occur in the study area, including Laughing Kookaburra (*Dacelo novaeguineae*), Rainbow Lorikeet (*Trichoglossus moluccanus*), Yellow-tailed Black-Cockatoo (*Calyptorhynchus funereus*), Common Brushtail Possum (*Trichosurus vulpecula*) and Sugar Glider (*Petaurus breviceps*). Small hollows (< 5cm diameter), cracks and fissures offer potential roosting habitat to microbats.

Hollow-bearing trees offer potential breeding and/or roosting habitat to locally occurring threatened species including; Dusky Woodswallow, Glossy Black-Cockatoo, Brown Treecreeper, Little Lorikeet, Powerful Owl, Masked Owl, Squirrel Glider, Brush-tailed Phascogale and hollow-roosting microbats.

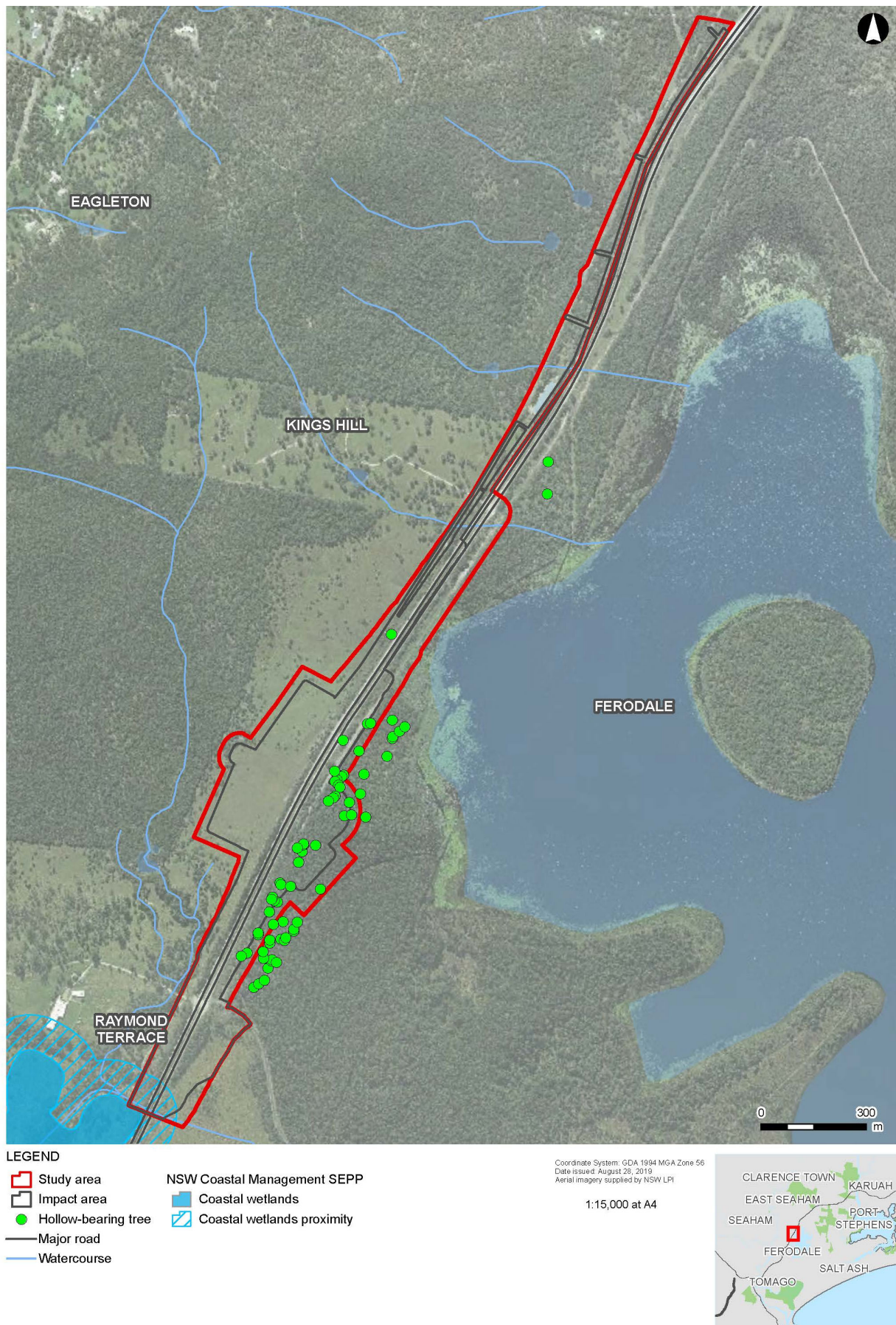


Figure 6-16 Hollow-bearing trees

Koala habitat

Tree species from the study area have been identified as Koala food trees in the *North Coast Koala Management Area for the Approved Koala Recovery Plan* (DECC, 2008) and by Marsh and Youngentob (2019). Vegetated areas of the western portion of the study area are mainly 'potential habitat' or 'unsuitable' Koala habitat, with small areas of 'suitable Koala habitat' mapped (RPS, 2019). No 'suitable Koala habitat (high value)' was mapped as occurring within or near the study area.

PCT 1590 across the study area contains varying abundances of Primary and Secondary Koala feed trees. Forest Red Gum and Grey Gum have both been recorded throughout the study area, however vegetation within the study area does not support a high abundance of these tree species. The most commonly occurring Secondary Koala feed tree is Grey Box.

Ecotone (2011) and Kings and Winning (2004) consider that the preferred food tree of the Koala at Grahamstown Dam is Forest Red Gum, particularly where it occurs in proximity to the water's edge. Further, leaf analysis on the Kings Hill URA also shows Forest Red Gum as a likely preferred feed tree along with a number of other eucalypt species. However, the study area does not encompass native forest that occurs along the dam foreshore and as such, the study area does not support a high abundance of Forest Red Gum. Of the Koala feed trees listed in Table 6-35, Grey Box occurs most commonly in the study area.

Under SEPP 44, potential koala habitat is defined as:

"an area of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component".

Koala feed trees listed under Schedule 2 that occur in the study area are listed in Table 6-35.

Table 6-35: Trees of importance to koalas identified in the study area

Species	Significance to Koalas	Occurrence in study area
<i>Eucalyptus tereticornis</i> (Forest Red Gum)	Listed as a Koala feed tree under Schedule 2 of SEPP 44	Uncommon
	Listed as a Primary feed tree in the Approved Recovery Plan (DECC 2008)	
	A 'high' value Koala food tree species for the locality of the study area in the Kings Hill URA (Marsh and Youngentob 2019)	
<i>Eucalyptus punctata</i> (Grey Gum)	Listed as a Koala feed tree under Schedule 2 of SEPP 44	Uncommon
	Listed as a Secondary feed tree in the Approved Recovery Plan (DECC 2008)	
	A 'high' value Koala food tree species for the locality of the study area in the Kings Hill Development SIS (RPS 2019)	
<i>Eucalyptus moluccana</i> (Grey Box)	Listed as a Secondary feed tree in the Approved Recovery Plan (DECC 2008)	Common
	A 'moderate' value Koala food tree species for the locality of the study area in the Kings Hill Development SIS (RPS 2019)	

Under SEPP 44, core Koala habitat is defined as an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population. It is likely that the study area and adjacent lands would constitute core Koala habitat in accordance with this definition due to the presence of a single individual on the eastern side of the study area and several individuals known to occur on or near the western side of the study area.

The Koala habitat assessment tool provided in EPBC Act Referral Guidelines for the vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) (DotEE, 2014) has been utilised to determine the sensitivity, value and quality of habitat within the study area, and, therefore, whether it contains habitat critical to the survival of the Koala. A habitat score of 10 has been calculated (further detail provided in Appendix H).

Aquatic habitat

Key Fish Habitat (as defined under the FM Act) is mapped at the southern extent of the study area is on a disturbed open grassland, the modified concrete channel at Irrawang Spillway and a small tributary to the north of Irrawang Swamp. The channel, spillway and tributary are highly modified with minimal fish habitat features, poorly defined channel and banks and ephemeral flow. The spillway is disused and flow from Grahamstown Dam is directed to the Grahamstown Spillway further south, severing fish habitat connectivity between the channel feeding into the Irrawang Spillway and Grahamstown Dam. It is considered Type 3 – Minimally sensitive key fish habitat and Class 3 – Minimal key fish habitat in accordance with DPI's Policy and guidelines for fish habitat conservation and management (2013 update) (DPI, 2013).

Key Fish Habitat is also mapped to the east of the study area, in the Grahamstown Dam. At this location, the dam contains aquatic, floating and emergent vegetation, and snags that could provide foraging and breeding habitat for fish, though is poor quality relative to other areas of the foreshore with high cover of the exotic grass *Panicum repens* (Torpedo Grass) and lower vegetative diversity and cover. At the time of survey in July/August 2019, the easternmost extent of this part of the study area comprised a bare mud flat as the dam level was relatively low.

No critical habitat for threatened fish species is known to occur in proximity to the study area. No named creeks or rivers transect the study area. To the west of the study area, a third-order stream flows towards Irrawang Spillway.

Low-lying damp and inundated areas in addition to the grassy foreshore of Grahamstown Dam support a high abundance of commonly occurring frogs, such as Common Eastern Froglet (*Crinia signifera*) and Striped Marsh Frog (*Limnodynastes peroni*). Grahamstown Dam also offers habitat to aquatic birds such as White-faced Heron *Ardea novaehollandiae*, Australian Pelican (*Pelecanus conspicillatus*) and Pacific Black Duck (*Anas superciliosa*).

Downstream and outside of the study area, Irrawang Swamp offers additional habitat to aquatic flora and fauna species.

Habitat connectivity

The study area is located in a landscape that comprises a mosaic of large tracts of native vegetation, within private and publicly owned land, patches of cleared land used for agricultural purposes (primarily grazing) within rural-residential properties. The installation of floppy-top fauna fencing alongside the eastern margin of the Pacific Highway aims to prevent terrestrial fauna accessing the highway, thereby reducing mortality resulting from vehicle strikes. However, this fencing also acts as a barrier to fauna movement, preventing the movement of fauna to habitat west of the Pacific Highway. Terrestrial fauna movement is restricted to the north/south direction, between the fauna fence and the dam foreshore.

The absence of native vegetation between the western foreshore of Grahamstown Dam and the floppy-top fauna fence adjacent to the Pacific Highway has created a 300-metre-wide gap between patches of Spotted Gum-Ironbark Forest occurring to the north and south. The absence of vegetation can be attributed to past clearing activities for the electricity easement (located parallel to the Pacific Highway) and from die-

back following permanent inundation resulting from the dam augmentation works. This gap may be perceived as a barrier to the movement of some cover-dependant fauna species.

The movement of arboreal mammals including Brush-tailed phascogale and threatened gliders is also likely adversely impacted by habitat fragmentation. The gap between the low (10-metre-high) canopy of Disturbed road verge vegetation occurring along the western margin of the Pacific Highway and taller canopy (16-18 metres) of Disturbed road verge vegetation occurring along the western margin of the Pacific Highway is on average 35 metres wide. Gaps between trees greater than 35 metres wide are considered a potential barrier to Squirrel Glider crossings (Goldingay & Taylor, 2009). Smaller gliders such as Sugar Gliders would be unlikely to successfully cross the Pacific Highway.

The corridor of Cleared land – exotic grassland and tracks to the east of the Pacific Highway, associated with the electricity easement and Hunter Water maintenance track, created a wider gap between patches of fauna habitat. The existing gap between the canopy of disturbed road verge vegetation and Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest varies from 10 metres to 15 metres. Larger gliders would most likely be able to successfully cross these gaps.

A series of 17, four-metre-high timber vertical refuge poles have been installed along the eastern existing Hunter Water maintenance track, after the storage capacity of the Grahamstown Dam was increased in 2005. The purpose of the poles was to mitigate the potential increase in habitat fragmentation, associated with die-back of foreshore trees following permanent inundation (resulting from the dam augmentation works). Each koala refuge pole located along the western foreshore of Grahamstown Dam was inspected by Arcadis ecologists for signs of koala use. No scratches were identified on any of the poles.

Irrawang Swamp

Ecological surveys of Irrawang Swamp, located downstream of the proposal, were carried out by BIOCM in January 2017 (Appended to the biodiversity assessment, Appendix H) and Alluvium in May 2019 (Appendix I). The findings of the assessments are summarised below. Irrawang Swamp is located downstream and south-west of the southern extent of study area and is characterised by a mosaic of ephemeral freshwater wetland, semi-permanent freshwater wetland, *Casuarina glauca* (Swamp Oak) Forest and wet pasture, from which native vegetation has been largely cleared for livestock grazing. Water bodies within the Irrawang Swamp do not hold water continuously, and Irrawang Swamp hydrology is currently dominated by surface runoff inflows from the local catchments.

Three vegetation types, including two Threatened Ecological Communities (TECs), were identified by BIOCM (2017):

- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions Endangered Ecological Community (EEC)
- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions EEC
- Wet pasture.

Alluvium (2019), with reference to Kleinfelder (2018), identified the following vegetation communities:

- Swamp Meadow Complex (Perennial, Seasonal and Transient Swamp Meadows) – equivalent to Freshwater Wetlands EEC (recorded by BIOCM)
- Swamp Oak Woodland – equivalent to Swamp Oak Floodplain Forest EEC (recorded by BIOCM)
- Paperbark Woodland – equivalent to Swamp Sclerophyll Forest EEC (not recorded by BIOCM).

6.7.3 Potential impacts

Construction

Clearing of vegetation

Clearing of native vegetation is required for the proposal. The areas of Spotted Gum – Broad-leaved Mahogany – Red Ironbark shrubby open forest and other vegetation type to be cleared from the impact area are listed in Table 6-36. The total impact area covers 33.80 hectares, of which 27.64 hectares has been mapped as vegetation.

Table 6-36 Vegetation to be cleared

Vegetation Type	Structure/ condition class	Area to be cleared from the impact area
Spotted Gum - Broad-leaved Mahogany – Red Ironbark Shrubby Open Forest (PCT 1590)	Shrub/grass understorey	4.79
	Grassy understorey	0.11
	Dense paperbark shrub layer	0.26
	Disturbed grassy understorey	0.04
	Road verge (native understorey)	3.22
	Road verge (exotic understorey)	0.86
	Scattered trees over grazed grassland	2.72
	Total PCT 1590	12.00
Other vegetation types	Planted Casuarinas	0.61
	Disturbed road verge – exotic dominant	0.92
	Dam Foreshore	0
	Cleared land – exotic grassland and tracks	14.08
Total all vegetation types		27.64

Removal of threatened fauna habitat

A total of 12.00 hectares of fauna habitat would be cleared from the impact area. Threatened species habitat to be removed is comprised of 12.00 hectares of Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest. The 0.61 hectares of Planted Casuarinas, 0.92 hectares of Disturbed road verge – exotic dominant and 14.08 hectares of Cleared land – exotic grassland and tracks are not considered to provide suitable habitat for any threatened flora or fauna species.

A total of 20 hollow-bearing trees would be cleared from the impact area which has the potential to impact hollow-dependent fauna including threatened fauna species.

Potential impacts of the proposal on threatened species are summarised in Table 6-37.

Table 6-37 Potential impacts on threatened species

Scientific Name	Common Name	Potential occurrence	Impact of proposal
Flora			
<i>Callistemon linearifolius</i>	Netted Bottlebrush	Moderate	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Corybas dowlingii</i>	Red Helmet Orchid	Moderate	Loss of potential habitat offered by 5.20 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Maundia triglochinosides</i>		Moderate	Loss of small (unmapped) areas of potential habitat in ephemeral pools and at the fringes of Grahamstown Dam
<i>Pterostylis chaetophora</i>	-	Moderate	Loss of potential habitat offered by 5.20 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
Fauna			
<i>Anthochaera phrygia</i>	Regent Honeyeater	Moderate	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow	Moderate	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest Loss of 20 hollow-bearing trees that offer potential nesting habitat.
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	High	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest Loss of 20 hollow-bearing trees that offer potential nesting habitat.
<i>Circus assimilis</i>	Spotted Harrier	Moderate	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	Moderate	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest Loss of 20 hollow-bearing trees that offer potential roosting habitat.

Scientific Name	Common Name	Potential occurrence	Impact of proposal
<i>Daphoenositta chrysoptera</i>	Varied Sittella	High	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	Recorded	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest Loss of 20 hollow-bearing trees that offer potential roosting habitat.
<i>Glossopsitta pusilla</i>	Little Lorikeet	Recorded	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest Loss of 20 hollow-bearing trees that offer potential nesting habitat.
<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	Moderate	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Lathamus discolor</i>	Swift Parrot	Moderate	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Lophoictinia isura</i>	Square-tailed Kite	Moderate	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Micronomus norfolkensis</i>	Eastern Coastal Free-tailed Bat	High	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest Loss of 20 hollow-bearing trees that offer potential roosting habitat.
<i>Miniopterus australis</i>	Little Bent-winged Bat	High	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	Recorded	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Myotis macropus</i>	Southern Myotis	Moderate	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest Loss of 20 hollow-bearing trees that offer potential roosting habitat.

Scientific Name	Common Name	Potential occurrence	Impact of proposal
<i>Ninox strenua</i>	Powerful Owl	Moderate	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest Loss of 20 hollow-bearing trees that offer potential roosting, nesting and foraging habitat.
<i>Petaurus norfolcensis</i>	Squirrel Glider	High	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest Loss of 20 hollow-bearing trees that offer potential roosting habitat.
<i>Petroica boodang</i>	Scarlet Robin	Moderate	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	High	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest Loss of 20 hollow-bearing trees that offer potential roosting habitat.
<i>Phascolarctos cinereus</i>	Koala	Recorded	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler	High	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Recorded	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail bat	Moderate	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest Loss of 20 hollow-bearing trees that offer potential roosting habitat.
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	High	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest Loss of 20 hollow-bearing trees that offer potential roosting habitat.

Scientific Name	Common Name	Potential occurrence	Impact of proposal
<i>Tyto novaehollandiae</i>	Masked Owl	Recorded	Loss of potential habitat offered by 12.00 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest Loss of 20 hollow-bearing trees that offer potential roosting, nesting and foraging habitat.

Removal of koala habitat

The potential for adverse effects on Koalas, and the subsequent requirement for a referral, has been determined in accordance with the flowchart illustrated in Figure 2 of *EPBC Act referral guidelines for the vulnerable Koala* (Table 6-38).

Table 6-38 Potential impacts on Koala habitat

Flow chart question	Response
Does your impact area contain habitat critical to the survival of the Koala (habitat score ≥ 5)?	The study area has been determined to support Koala habitat with a score of 10.
Do the area(s) proposed to be cleared contain known Koala food trees?	Yes. Koala feed trees, predominantly <i>Eucalyptus moluccana</i> (Grey Box), and to a lesser extent <i>Eucalyptus tereticornis</i> (Forest Red Gum) and <i>Eucalyptus punctata</i> (Grey gum) occur within 12 ha of Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest that will be cleared.
Are you proposing to clear ≤ 2 ha of habitat containing known Koala food trees in an area with a habitat score of 5?	No. 12 ha of Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest will be cleared.
Are you proposing to clear ≥ 20 ha of habitat containing known Koala food trees in an area with a habitat score of ≥ 8 ?	No. 12 ha Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest would be cleared.
Will your action adversely affect habitat critical to the survival of the Koala?	No. 12 ha of Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest vegetation to be cleared from the study area does not comprises a significant area of koala habitat that occurs in the surrounding locality. Koala feed trees present in the study area are: Forest Red Gum – SEPP 44 and Primary feed tree Grey Gum – SEPP 44 and Secondary feed tree Grey Box – Secondary feed tree

Flow chart question	Response
	The study supports only a low abundance of the two SEPP 44 feed trees listed above. Only one Koala was sighted within the study area during surveys. Surveys did not record any evidence of breeding (i.e. females with young or juveniles) or resident Koalas and activity levels identified from SAT surveys were low. Given the low levels of Koala activity recorded and the narrow, linear shape of habitat present, the study area is unlikely to provide significant habitat for a large number of Koalas East-west connectivity for Koalas is limited by the Koala fence along the eastern side of the Pacific Highway reducing its value as a corridor. Given the above factors, it is unlikely that the study area provides significant or important habitat for the Koala considered to be critical to its survival. As such the proposal will not affect habitat critical to the survival of the Koala.
Could your action interfere substantially with the recovery of the Koala? Impacts which are likely to substantially interfere with the recovery of the Koala may include one or more of the following: 1. Increasing Koala fatalities in habitat critical to the survival of the Koala due to dog attacks to a level that is likely to result in multiple, ongoing mortalities. 2. Increasing Koala fatalities in habitat critical to the survival of the Koala due to vehicle-strikes to a level that is likely to result in multiple, ongoing mortalities. 3. Facilitating the introduction or spread of disease or pathogens for example <i>Chlamydia</i> or <i>Phytophthora cinnamomi</i>, to habitat critical to the survival of the Koala, that are likely to significantly reduce the reproductive output of Koalas or reduce the carrying capacity of the habitat. 4. Creating a barrier to movement to, between or within habitat critical to the survival of the Koala that is likely to result in a long-term reduction in genetic fitness or access to habitat critical to the survival of the Koala.	The proposal would not interfere substantially with the recovery of the Koala as follows: 1. The proposal will not introduce dogs to the area or facilitate an increase in dog abundance. The proposal is unlikely to contribute to any increase in Koala mortality does to dog attacks 2. The existing fauna fence will be retained next to the Pacific Highway or reinstated along the proposed interchange sections, which, when properly maintained by the asset owner, restricts Koala access to the highway and prevent vehicle strikes. Therefore, the proposal is unlikely to contribute to an increase in vehicle strikes. 3. Mitigation measures outlined in Section 5 aim to minimise the risk of introducing disease or pathogens to the study area during construction/operation of the proposal. Therefore the proposal is unlikely to significantly reduce the reproductive output of Koalas or reduce the carrying capacity of the habitat. 4. The proposal would not increase the gap between patches of habitat located of the north and south of where Grahamstown Dam encroaches the study area. The proposal would not create any additional barriers to north-south movement. 5. Run-off from the URA would be directed towards and contained within the stormwater channel.

Flow chart question	Response
5. Changing hydrology which degrades habitat critical to the survival of the Koala to the extent that the carrying capacity of the habitat is reduced in the long-term.	Accordingly, habitat adjoining the proposal footprint is unlikely to be subject to increased volume or velocity of run-off. Changes to hydrology are unlikely to degrade habitat.

The proposal would not affect habitat critical to the survival of the species and would not substantially interfere with the recovery of the species. As such, the proposal is unlikely to have a significant impact on the Koala in accordance with Figure 1 of the *EPBC Act Referral Guidelines for the vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)* (DoE, 2014).

Impacts on aquatic habitat

Aquatic habitats are associated with the Grahamstown Dam and low-lying damp and inundated areas, including the Irrawang Spillway at the southern end of the impact area. Downstream and outside of the impact area, Irrawang Swamp offers additional habitat to aquatic flora and fauna species. No named creeks or river transect the impact area. The proposal would not require direct removal of aquatic habitat along the foreshore of the Grahamstown Dam. Though the dam is considered highly sensitive fish habitat, the quality of fish habitat within the study area poor relative to the rest of the dam. No impacts to threatened fish are anticipated.

The proposal would not directly impact on the disused Irrawang Spillway located at the southern end of the study area. The Telstra access pit located on the southern edge of the disused spillway would be accessed via the existing Hunter Water track. No works are proposed to occur within the disused spillway for the proposal. Further, the existing aquatic habitat in the disused spillway is largely disturbed grassland in a poorly defined channel. Fish passage would not be altered from the existing conditions given the spillway is currently disused and unlikely to provide fish passage during periods of flow.

Indirect impacts to aquatic habitats could arise from run-off adversely affecting water quality in the Grahamstown Dam and/or Irrawang Swamp. Additional potential impacts include spills or leaks of road construction materials including fuels, lubricants and hydraulic oils from construction plant and equipment.

Erosion and sediment control measures would need to be in place to avoid potential impacts on the Grahamstown Dam and the downstream Irrawang Swamp. Provided the implementation of these measures, it is considered the proposal would not have a significant impact on aquatic habitats.

Fauna injury and mortality

Fauna injury or mortality may occur during vegetation clearing activities (particularly during the felling of hollow-bearing trees) or may result from collisions with work vehicles or plant, or accidental entrapment in plant, trenches or other works.