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M1 Pacific Motorway extension to Raymond Terrace

Environmental impact statement – Chapter 12: Aboriginal cultural heritage

Transport for NSW | July 2021

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12. Aboriginal cultural heritage

This chapter describes the potential Aboriginal cultural heritage impacts that may be generated by the construction and operation of the project and presents the approach to the management of these impacts.

The desired performance outcomes for the project relating to Aboriginal cultural heritage, as outlined in the SEARs, are to:

- Ensure that the design, construction and operation of the project facilitates, to the greatest extent possible, the long term protection, conservation and management of the heritage significance of items of environmental heritage and Aboriginal objects and places
- Ensure the design, construction and operation of the project avoids or minimises impacts, to the greatest extent possible, on the heritage significance of environmental heritage and Aboriginal objects and places.

Table 12-1 outlines the SEARs that relate to Aboriginal cultural heritage and identifies where they are addressed in this EIS. The full assessment of Aboriginal cultural heritage impacts is provided in the Aboriginal Cultural Heritage Assessment Report (ACHAR) (**Appendix L**).

Table 12-1 SEARs (Aboriginal cultural heritage)

Secretary's requirement	Where addressed
13. Heritage	
1. The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of:	The cumulative Aboriginal cultural heritage impacts of the project are assessed in **Chapter 23** (cumulative impacts).
(a) Aboriginal places and objects, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines;	Impacts on the heritage significance of Aboriginal places and objects are assessed in **Section 12.5**.
(b) Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan;	There are no Aboriginal places of heritage significance within the construction footprint listed on the Newcastle Local Environmental Plan 2012 or the Port Stephens Local Environmental Plan 2013. Refer to **Section 12.4.3**. There are no project related direct or indirect impacts on Aboriginal Heritage outside of the study area.
(c) environmental heritage, as defined under the *Heritage Act 1977*; and	There are no Aboriginal places of heritage significance defined as environmental heritage within the study area. Refer to **Section 12.4.3**. Non-Aboriginal heritage is discussed in **Chapter 17** (non-Aboriginal heritage).
(d) items listed on the National and World Heritage lists.	No heritage items relevant to the project are listed on the National and World Heritage lists (refer to **Section 12.4.3** and **Section 17.3.2**).
3. Where archaeological investigations of Aboriginal objects are proposed these must be conducted by a suitably qualified archaeologist, in accordance with section 1.6 of the Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW (DECCW 2010). In the event that harm to existing archaeological relics cannot be avoided, a Research Design and Excavation Methodology should be prepared to guide excavation works.	Archaeological investigations previously carried out for the project are described in **Section 12.2.6** and **Section 12.2.7**. A Research Design and Excavation Methodology will be prepared and included in the Aboriginal Cultural Heritage Management Plan for the project (refer to Chapter 9 of the ACHAR (**Appendix L**)).

Secretary’s requirement	Where addressed
4. Where impacts to Aboriginal objects and/or places are proposed, consultation must be undertaken with Aboriginal people in accordance with the current guidelines. The significance of cultural heritage values for Aboriginal people who have a cultural association with the land must be assessed.	**Section 12.3** outlines consultation that must be carried out with Aboriginal people. **Section 12.4.4** identifies areas of cultural significance. Future consultation is described in **Section 6.4**.
3. Noise and vibration – structural	
1. The Proponent must assess construction and operation noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	Surface and subsurface artefacts (Aboriginal heritage) are not subject to potential noise or vibration impacts (refer to **Section 12.5.1** and **Section 12.5.2**). Statements of heritage impact (non-Aboriginal heritage) which consider noise and vibration impacts from the project during construction and operation are provided in **Section 17.4.2**.
4. Consultation	
1. The project must be informed by consultation, including with relevant local, State and Commonwealth government agencies, infrastructure and service providers, special interest groups (including Local Aboriginal Land Councils, Aboriginal stakeholders, and pedestrian and bicycle user groups), affected landowners, businesses and the community. The consultation process must be undertaken in accordance with the current guidelines.	**Section 12.2.2** outlines the guidelines used for the consultation process. **Section 12.3** summarises the consultation carried out to inform this chapter.
2. The Proponent must document the consultation process and demonstrate how the project has responded to the inputs received.	**Section 12.3**
3. The Proponent must describe the timing and type of community consultation proposed during the design and delivery of the project, the mechanisms for community feedback, the mechanisms for keeping the community informed, and procedures for complaints handling and resolution.	**Section 12.3**
11. Visual amenity	
1. The Proponent must assess the visual impact of the project and any ancillary infrastructure (including noise barriers) on: (c) heritage items including Aboriginal places and environmental heritage	Visual impacts on Aboriginal places are discussed in **Section 12.5.1**. Statements of heritage impact (non-Aboriginal heritage) which consider impacts, such as visual impacts of the project, are provided in **Section 17.4.2**.

12.1 Policy and planning setting

The Aboriginal cultural heritage assessment was prepared to assess the potential impacts of the project in accordance with the following relevant legislation, policy and guidelines:

- NSW legislation:
  - *Environmental Planning and Assessment Act 1979* (EP&A Act)
  - *National Parks and Wildlife Act 1974* (NPW Act)
  - *National Parks and Wildlife Amendment Act 2010*
  - *Native Title Act 1994*
  - *Aboriginal Land Rights Act 1983.*

- Commonwealth legislation:
  - *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
  - *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
  - *Native Title Act 1993.*
- Policy and guidelines:
  - Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW (OEH 2011)
  - Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW (the Code) (DECCW 2010e)
  - Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales 2010 (DECCW 2010f)
  - Aboriginal Cultural Heritage Consultation Requirements for Proponents (ACHCRP) 2010 (DECCW 2010a)
  - Procedure for Aboriginal cultural heritage consultation and investigation (PACHCI) (Roads and Maritime Services 2011b).

Further detail on the above legislation, policies and guidelines and how they apply to the project is provided in the ACHAR (**Appendix L**).

Details regarding legislation, policies and guidelines that apply to historical archaeology and heritage and how they apply to the project are provided in **Chapter 17** (non-Aboriginal heritage) and the Non Aboriginal Heritage Working Paper (**Appendix Q**).

12.2 Assessment methodology

12.2.1 Overview

The assessment of Aboriginal cultural heritage was conducted by a suitably qualified heritage consultant in accordance with the guidance documents in **Section 12.1**. The Aboriginal cultural heritage assessment involved:

- A review of previous archaeological assessments relevant to the project
- A desktop assessment of the study area to develop a predictive model
- Predictive modelling to determine the archaeological sensitivity of various landforms in the study area
- Archaeological survey to identify any archaeological objects, or areas with the potential to contain archaeological objects (PADs)
- Archaeological assessment of the study area, including archaeological surveys conducted in 2015 and 2020 to identify any archaeological objects, or areas with the potential to contain PADs
- Consultation with Aboriginal community representatives in accordance with PACHCI and ACHCRP
- Archaeological test excavation program to characterise and determine the extent of any potential areas of Aboriginal archaeological significance
- Identification of Aboriginal sites through consultation and desktop reviews
- Significance assessment of Aboriginal sites within the study area in accordance with The Australia ICOMOS Burra Charter (Australia ICOMOS 2013)
- Impact assessment to determine type and degree of impacts to Aboriginal cultural heritage items as a result of the project
- Development of management measures in accordance with relevant legislation and guidelines to avoid impacts and/or secondarily to mitigate impacts to Aboriginal cultural heritage items.

12.2.2 PACHCI and consultation

The PACHCI is a four-stage process for investigating potential impacts to Aboriginal cultural heritage as a result of Transport road planning, development, construction and maintenance activities. It includes a process of community consultation that aims to ensure that the role, function and views of Aboriginal people are adhered to by Transport. The PACHCI process is summarised as:

- Stage 1: A desktop assessment to identify if any Aboriginal objects or potential archaeological deposits are present, identifying if further assessment is necessary
- Stage 2: Carrying out further desktop assessment and survey with Local Aboriginal Land Council (LALC) representatives (if necessary)
- Stage 3: Formal consultation based on Stage 2 results and the preparation of a cultural assessment report. Consultation is carried out in accordance with ACHCRP. This stage may also include archaeological test excavations
- Stage 4: Post-approval implementation of management recommendations identified in the Stage 3 assessment and consultation.

Engagement with Aboriginal stakeholders was carried out to address the requirements of PACHCI, which provides an opportunity for Aboriginal people to participate in decision making about the management of cultural heritage. The consultation activities carried out in accordance with each stage of the PACHCI are detailed in **Section 12.3** and are detailed further in the ACHAR (**Appendix L**).

12.2.3 Study area

The study area for this assessment is about 15 kilometres in length and has a varying width between 150 to 400 metres in order to accommodate for project features such as interchanges with existing roads, proposed drainage features and the construction footprint, including the proposed ancillary areas.

The study area for this assessment is shown in **Figure 12-1**. The study area in 2015 incorporated a larger area than the 2020 study area. This is because the original assessment in 2015 identified certain areas that did not require further assessment, due to their highly disturbed nature. Both the 2015 and 2020 study areas are shown in **Figure 12-1**. For the purposes of the EIS, the ‘study area’ referred to in the rest of the chapter relates to the 2020 study area.

A broader study area was also used for discussion of Aboriginal cultural heritage values and background research into the archaeological nature of the study area. This has allowed the characterisation and assessment of the entire construction footprint. The impact assessment focusses on those heritage items within or next to the construction footprint.

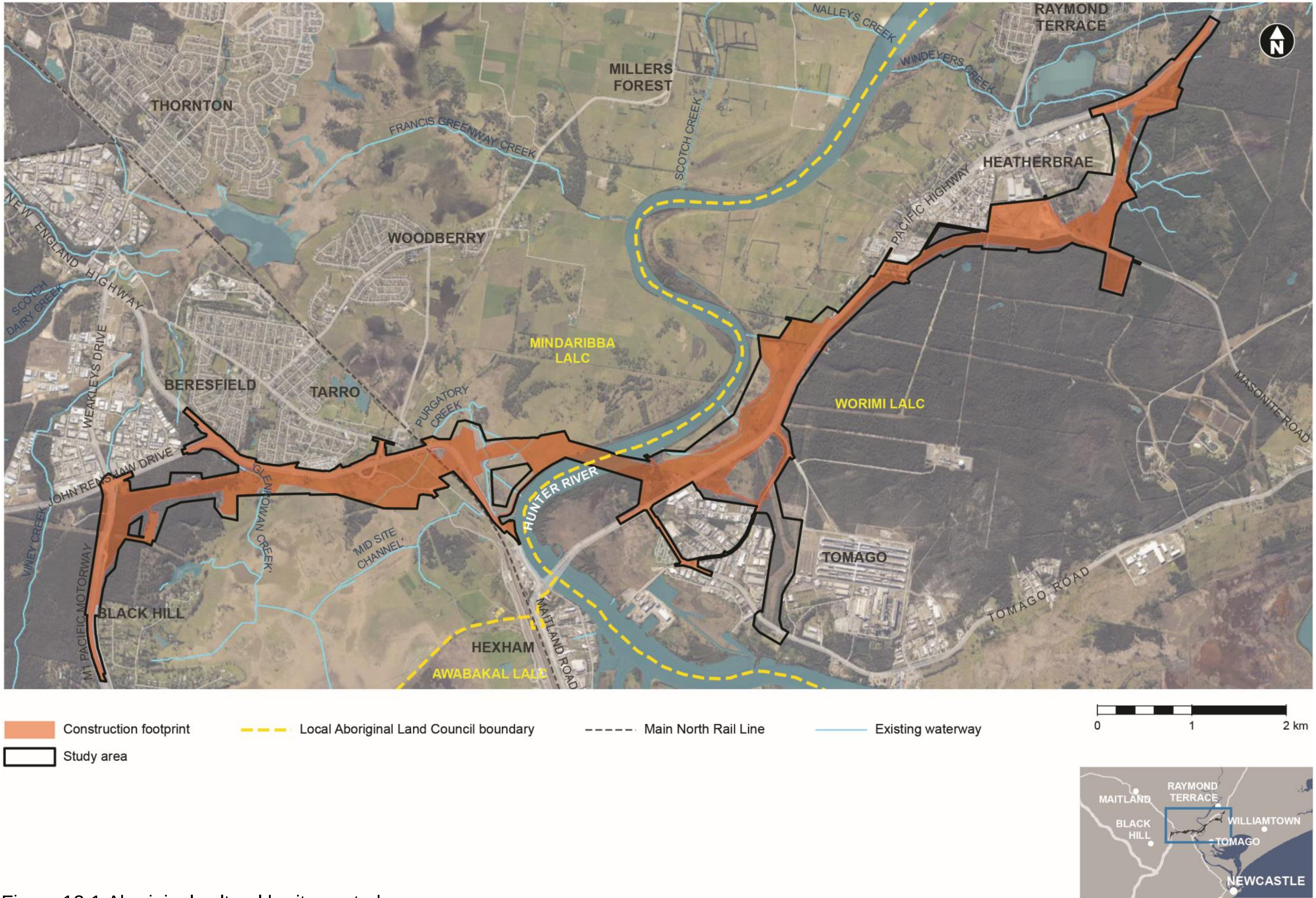

Figure 12-1 Aboriginal cultural heritage study area

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12.2.4 Review of previous archaeological work

A review of previous archaeological work was carried out to provide an archaeological and cultural context for the study area. The review of work was used to inform the following:

- Development of a predictive model for Aboriginal cultural heritage relevant to the project
- Assessment of archaeological significance for any identified Aboriginal cultural heritage with the potential to be impacted by the project.

The archaeological work reviewed included fieldwork and consultation previously conducted for the concept design as well as any previous archeological assessments carried out in the locality of the area. A list of the previous archaeological work reviewed by the project is provided in the ACHAR (**Appendix L**).

12.2.5 Desktop assessment and predictive modelling

The desktop assessment involved collating relevant heritage and spatial data. This data included Aboriginal Heritage Information Management System (AHIMS) sites, aerial imagery, relevant legislation, local environmental plans, soil landscape data and contour data. Spatial data was used to determine the areas likely to be of archaeological sensitivity and require further assessment in the form of archaeological surveys.

Existing data sets were then used in conjunction with predictive modelling to determine the Aboriginal archaeological sensitivity of landforms in the study area. The predictive model is based on a 'land system' or 'archaeological landscape' model of site location. The predictive model was reviewed on the basis of:

- A review of previous models developed for the area
- An assessment of the results of the previous archaeological assessments reviewed
- The interpretation of the distribution patterns of known sites from AHIMS
- A study of previous impacts within the study area and the potential effects of these impacts on the archaeological record.

This type of modelling enables the prediction of site location based on known patterns of site distribution in similar landscape regions or archaeological landscapes. The outcomes of the predictive model were used to inform the archaeological survey.

12.2.6 Archaeological survey

The archaeological survey involved assessing the study area to identify any archaeological objects, or areas with the potential to contain archaeological objects (PADs). This included the inspection of any registered Aboriginal sites located within the study area.

The archaeological survey adopted a sampling strategy with targeted survey on each distinct landform within a given soil landscape. The following directives applied to the sampling strategy:

- Areas of higher visibility and exposures of the ground surface were targeted for particular scrutiny for the presence of midden material or stone artefacts
- All mature trees in the study area were inspected for cultural modification and scarring
- Any areas with potential to contain rocky outcrops close to waterways were inspected for grinding grooves, waterholes and wells.

The methodology for the archaeological survey consisted of:

- Pedestrian survey with nominated site officers from the LALCs, carried out in about 40 to 100 metre wide transects, covering as much as the study area as practicable. In many areas, access and visibility was severely limited by long grass or other vegetation
- Mapping Aboriginal sites and PADs identified, and survey transects into a Geographic Information System database
- Recording the following details for each surveyed area:
  - Landform
  - Ground surface exposure and nature of exposure
  - Visibility as a result of vegetation
  - Degree of disturbance
  - Nature of current and historical land use.

Archaeological surveys were carried out in 2015 and 2020. In the 2015 archaeological survey, four Aboriginal sites were identified, and three previously registered sites were inspected. Eight new areas of PAD were also identified, and four previously identified areas of PAD were reinspected and confirmed. Further archaeological survey was carried out in 2020 to survey areas not previously assessed. No new Aboriginal sites were identified during the 2020 archaeological survey, however five previously registered sites were identified as being impacted due to a change in the study area. These previously registered sites located within the study area were re-inspected to assess the current condition of the sites.

The identified Aboriginal sites and PAD areas are discussed in **Section 12.4**.

12.2.7 Archaeological test excavation

In accordance with Stage 2 of the PACHCI, a test excavation archaeological methodology was developed to describe how further investigations would be conducted. This methodology included:

- Investigation of areas of PAD identified within the study area
- A small number of control investigations outside areas of PAD to confirm areas of low archaeological potential and test predictions of PAD occurrence
- A description of how geotechnical investigation locations were assessed for potential impacts upon Aboriginal cultural heritage values.

The test excavation archaeological methodology was reviewed by all project Registered Aboriginal Parties (RAPs) and the Office of Environment and Heritage (OEH, now Heritage NSW), in accordance with Stage 3 of the PACHCI. The methodology was then updated and finalised based on any comments received.

The test program identified a further three PADs to the initial 12 Aboriginal site locations identified in the archaeological survey. In total, 15 locations underwent sub-surface testing as part of the test excavation program, comprising of about 446 test pits. Of the 15 locations for test excavation, sub-surface cultural deposits were identified at 11 of these locations. The results of the test excavation are discussed in **Section 12.4.3**.

The full excavation program was completed with the exception of a small area within the Hexham M12RT 1 site due to contamination issues. However, as the testing carried out was adequate to characterise the nature and extent of the archaeological deposits, no further sub-surface testing is considered to be required.

12.2.8 Aboriginal cultural values

Cultural significance can be associated with or attached to any place, places, and objects by any individual, group or groups of people. It is embodied in the place itself; its fabric, setting, use, associations, meanings, records, connected places and objects. The cultural values assessment identified locations of Aboriginal cultural significance relevant to the project. The methodology comprised:

- Reviewing archaeological fieldwork and consultation previously conducted for the concept design
- Reviewing literature relevant to the project and the surrounding landscape
- Consultation with knowledge holders for the region during Aboriginal Focus Group (AFG) meetings
- Consultation with knowledge holders at arranged meetings (e.g. oral history recording and site visits with knowledge holders)
- Consulting with Aboriginal site officers during field work regarding Aboriginal objects and cultural values.

The information provided has contributed to an understanding of the cultural value of the broader landscape within which the project is located. Knowledge holders have provided information about the traditional presence of Aboriginal people in the landscape, ceremonial sites and the impact of European land management practices on their traditional land, and subsequently their culture.

12.2.9 Significance assessment

The significance assessment is made up of several criteria that attempt to define why a site is important and form its basis of management. The assessment of Aboriginal cultural heritage in this assessment is based upon the four values of the Australia ICOMOS Burra Charter (Australia ICOMOS 2013). These values include social values, historic significance, scientific significance and aesthetic significance. The significance assessment for the project included:

- Assessing each value for Aboriginal cultural heritage items newly identified as part of the project, then assigning an overall significance based on the average across the values
- Assessing Aboriginal cultural significance from consultation with the nominated site officers for the relevant RAPs during and following field assessments
- Determining historic, scientific and aesthetic significance
- Determining scale of significance at a state, regional or local level by comparing against sites investigated in the region.

The results of the significance assessment are discussed in **Section 12.4.5**.

12.2.10 Impact assessment

The impact assessment was used to determine the potential impact of the project to Aboriginal sites located within the construction footprint. The methodology included:

- Determining the overall significance of each site, assessed in the significance assessment
- Assessing the type of impact expected to each site by considering the construction activities that would occur near it
- Assessing the degree of impact expected to each site by calculating the area of each site within the construction footprint.

The results of the impact assessment are discussed in **Section 12.5**.

12.3 Aboriginal community consultation

Aboriginal stakeholder consultation has been completed in accordance with the ACHCRP. **Table 12-2** provides a summary of the consultation carried out to date the process and its outcomes are detailed further in the ACHAR (**Appendix L**).

Table 12-2 Consultation activities carried out during each of the PACHCI stages

PACHCI stage	Required actions	Activities and outcomes
Stage 1	Desktop risk assessment to determine whether the project would potentially impact Aboriginal cultural heritage, and if further assessment or investigation would be required.	The desktop assessment determined that the project may impact Aboriginal cultural heritage. This result triggered the following actions under Stage 2.
Stage 2	A further desktop assessment and consultation with relevant Aboriginal parties to determine the projects potential to harm Aboriginal cultural heritage.	The following activities were carried out as part of Stage 2: • A search of the National Native Title Register (NNTR) and the Register of Aboriginal Owners was carried out to identify key Aboriginal stakeholders for the project. Key stakeholders identified include the Awabakal, Guringai and Wonnarua Traditional Custodians as well as Mindaribba LALC and Worimi LALC • Site officers for Mindaribba LALC and Worimi LALC participated in archaeological surveys carried out in February, July and October 2015 to advise on Aboriginal cultural heritage issues that may arise as a result of the project. They were requested to provide a cultural survey heritage report to Roads and Maritime Services (now Transport).
Stage 3	Formal consultation based on Stage 2 results and the preparation of a Aboriginal cultural heritage report.	The following activities were carried out as part of Stage 3: • Correspondence sent on 13 January 2015 to government agencies and organisations: Newcastle OEH (now Heritage NSW), NSW Aboriginal Land Council, Mindaribba LALC, Worimi LALC, Awabakal LALC), The Registrar appointed under the *Aboriginal Land Rights Act 1983*, The National Native Title Tribunal (NNTT), The Native Title Services Corporation Limited, Newcastle City Council (now City of Newcastle), Port Stephens Council and Hunter Local Land Services. The correspondence requested details of Aboriginal people who may have an interest in the project and hold potential cultural knowledge. A list of 78 Aboriginal groups or people with potential cultural knowledge was compiled • Letters and advertisements inviting Aboriginal people with cultural knowledge to register were sent out in February 2015. Advertisements were placed in the Koori Mail, Indigenous Times, Newcastle Herald, Maitland Mercury, Port Stephens Examiner, and Cessnock Advertiser. Letters were sent to all Aboriginal persons and groups identified as potential cultural knowledge holders (detailed further in the ACHAR (**Appendix L**)). RAPs for the project were registered for subsequent consultation • A draft archaeological survey report and archaeological methodology were issued to RAPs for review • A survey was carried out with site officers for all RAPs on 11 and 12 November 2015, in response to comments received at the initial AFG • A further search of the NNTL was carried out in November 2015 at the request of the RAPs

PACHCI stage	Required actions	Activities and outcomes
		• Further survey with all RAPs was carried out on 22 and 23 July 2020 to survey areas previously not assessed • A total of five AFG meetings were held for the project: - Initial AFG was held on 15 October 2015 following the public display of the project - Two AFGs followed on 17 December 2015 and 1 September 2016 to discuss the test excavation archaeological methodology - Fourth AFG was held on 20 September 2018 where overview of project, text excavation results and proposed management measures were discussed - Fifth AFG was held on 1 December 2020 where overview of final study area and results of 2020 survey were discussed. A review of all impacts and proposed mitigation and management measures were discussed. • The draft of the ACHAR and Archaeological Assessment Report was provided to the RAPs for review and input. Responses received are provided in the in the ACHAR (**Appendix L**).

12.4 Existing environment

12.4.1 Landscape context

The project passes through three primary landscape regions which include the East Maitland Hills (about 20 per cent of the project), Hexham Swamp and the Hunter River Floodplain (about 40 per cent of the project) and the Tomago Sands (about 40 per cent of the project).

The East Maitland Hills region is characterised by undulating low hills and rises on Permian sediments. These hills reach up to 50 metres in elevation with slopes of around 13 to 15 per cent. The project within this region transverses broad low ridges and low gradient spurs that descend from Black Hill towards Hexham Swamp and the Hunter River floodplain. The East Maitland Hills region contains partially cleared tall open-forest comprising Spotted Gum, Ironbark, Grey Gum and Stringybark.

Hexham Swamp and the Hunter River Floodplain primarily consist of two distinct soil landscapes which include broad swampy Quaternary estuarine floodplain at the lower Hunter River delta, and Quaternary Holocene alluvial floodplain at either bank of the Hunter River. These landscapes are generally low relief and close to sea level, and are all subject to flooding, seasonal waterlogging and have permanently high-water tables. Hexham Swamp consists primarily of sedgeland with open woodland on swamp margins containing Swamp Oak and Paperbark. The Hunter River Floodplain consists primarily of cleared tall open-forest containing Swamp Oak, Paperbark, Tuckeroo and occasionally Cabbage Gum.

Tomago Sands consists of broad, irregular sandy rises and Aeolian deflation basins, with local relief rarely above one metre and slope gradients less than five per cent. Within this region, the project transverses a number of low rises and gullies, although two higher rises are located immediately west of Masonite Road. On the Tomago Sands the drier ridges and sandy rises primarily support dry heath comprising Red Bloodwood, Wallum Banksia, Geebung and Bracken. The poorly drained areas support a wet heath understorey (including Paperbark, Grass Tree and Red Bottlebrush) with a well-developed tree canopy comprising Smooth-barked Apple, Swamp Mahogany, Paperbark, Grey Gum and Scribbly Gum. The Holocene lake shore deposits have predominantly been cleared for pastoralism. Occasional species include She-oak, Swamp Oak, Paperbark, Cabbage Tree palms and Swamp Mahogany.

Various levels of human disturbance have occurred in the Lower Hunter Valley region. Industrial precincts are found at either side of the Hunter River at Hexham and Tomago, and further industrial and residential areas are found on either side of the Pacific Highway at Heatherbrae and Raymond Terrace. The remainder of the Lower Hunter Valley has largely been cleared and drained for the purpose of agricultural and pastoral activities, however native vegetation at Heatherbrae and south of Black Hill have been retained for the Hunter Region Botanic Garden. Land clearance and subsequent development is likely to have affected the archaeological integrity in this region.

12.4.2 Historical Aboriginal land use

Difficulties exist in determining tribal boundaries within the study area, largely due to 200 years of dislocation caused by European settlement. There were two native title claims before the NNTT that intersected the project which were the Wonnarua Traditional Custodians and the Awabakal and Guringai People. These claims have since been either discontinued by the claimant group or have been dismissed by the NNTT. However, the project is thought to traverse the boundaries of three tribal groups: the Awabakal, Worimi and Wonnarua.

Aboriginal people of the Lower Hunter region traditionally used a wide variety of natural resources present within this fertile landscape. Modification of the landscape by Aboriginal people took place through the use of fire farming and reed planting/weir development, but little evidence of such activities is likely to have been preserved in the archaeological record due to the perishable nature of the materials used and the historical alteration of the landscape.

Similarities existed amongst regional tribal groups in their use of traditional material culture. Many of the project region’s material culture (shields, spears, boomerangs, clubs, digging sticks, canoes, containers, shelters, and woven nets and bags) were made from wood or other vegetative material that is rarely preserved in the archaeological record. Scarred trees, which were used in the production of items such as canoes, containers, shelters and bowls have the potential to be present within the region as do carved trees associated with ceremonial sites, although much rarer. Other sites, such as grinding grooves, stone quarries, burials and ceremonial grounds (bora rings, stone arrangements) are much rarer, however, have the potential to be present.

12.4.3 Identified sites

As detailed in **Section 12.2**, sites within the study area were identified by reviewing previous archaeological work, carrying out a desktop assessment and using a predictive model, and carrying out an archaeological assessment comprising archaeological survey and test excavation. The sites identified are detailed below.

Review of previous archaeological assessment

A review of existing archaeological assessments within the vicinity of the project show the East Maitland Hills landscape region to contain considerable amounts of archaeological material of very high sensitivity and cultural significance. These assessments suggest a nearly continuous distribution of artefacts across the elevated areas within the Black Hill area, with higher densities likely to occur closer to the swamp margin, at the break of slope. In the Tomago Sands, sites located within or near the study area consisted of surface artefact scatters containing reasonably high numbers of stone artefacts and hearth remnants. There is therefore moderate potential for substantial sub-surface archaeological deposits in Tomago Sands. The Hunter River Floodplain and Hexham Swamp area has an extremely low number of sites identified and has been assessed as containing low archaeological potential. However, slightly elevated areas near the margins of the swamp may be of slightly higher potential.

Predictive modelling

Predictive modelling was able to note specific predictive points for East Maitland Hills, Hexham Swamp and the Hunter River Floodplain and The Tomago Sands. Results of the predictive model are shown in **Table 12-3**.

Table 12-3 Predictive model based on landscape regions for the identification of areas of high, moderate and low archaeological sensitivity

Landscape region	Specific landscape characteristics within the broad landscape units	Sensitivity rating	Issues relating to assigning sensitivity ratings
East Maitland Hills	Basal slopes and crests of ridges/spurs bordering the wetlands.	High	Many known sites are recorded within this landform unit. Sites are likely to be of shallow nature.
	Upper and mid slopes of ridges/spurs greater than 100m from water.	Moderate	Known sites of low–moderate significance located in these areas.
Hexham Swamp and the Hunter River Floodplain	Low lying areas.	Low	Previous flooding, damp soils.
	Elevated, well drained areas adjacent to the margins of or within the swamp.	Moderate	A handful of sites are recorded within this landform unit. Sites are likely to be heavily disturbed or consist of imported material.
The Tomago Sands	Elevated landforms associated with remnant swamps and drainage lines.	Moderate	Several known sites of high archaeological and cultural significance are recorded within this landform unit.
	Low lying areas.	Low	Previous flooding, damp soils.

Sites identified during desktop assessment

Within the study area, there are no Aboriginal places of heritage significance listed on the World Heritage List, National Heritage List, Newcastle Local Environmental Plan 2012, Port Stephens Local Environmental Plan 2013 or defined as environmental heritage under the *Heritage Act 1977*.

Searches of the AHIMS were carried out with a two kilometre buffer around the study area to inform the desktop assessment by examining a wider archaeological context, with the most recent search carried out on 4 February 2021. The search resulted in 180 Aboriginal sites within the search area. This included 142 artefact scatters, isolated finds or open camp sites, 23 untested or partially tested PADs, 11 middens, three scarred trees and one art site. The desktop assessment also identified one area of potential archaeological sensitivity (PAS) within the study area which was not registered on the AHIMS.

A total of 24 Aboriginal sites, PADs or PAS were identified within the study area based on a desktop assessment.

Sites identified during archaeological survey and the test excavation program

Following archaeological survey and test excavation, a total of 26 Aboriginal sites, PADs and PAS were identified within the study area, comprising:

- Five artefact scatters
- Four isolated artefacts
- Twelve subsurface artefact sites (confirmed PADs) and one extra AHIMS record combining two of these sites (i.e. a total of 12 subsurface artefact sites)
- Four artefact scatters with subsurface artefacts (confirmed PADs).

One PAS not registered on AHIMS was not able to form part of the archaeological survey due to contamination risks associated with the former mineral sands processing site.

The 26 Aboriginal sites, PADs and PAS are described in **Table 12-4** and shown on **Figure 12-2**.

During the test excavation program a total of 3,026 stone artefacts were recovered and later analysed. Of these, 2,123 artefacts were recovered from the south side of the Hunter River, principally in the East Maitland Hills landscape region at Black Hill and a Pleistocene dune bordering the Hexham Swamp at Beresfield. The remaining 903 artefacts were recovered from the north side of the Hunter River principally from the Tomago Sands.

Subsequent to the 2020 archaeological survey, four new sites containing Aboriginal objects were identified through review of the recent archaeological assessment for the Newcastle Power Station (ERM 2019). These sites form part of an existing site, Hexham M12RT 1, which was inspected during the 2015 archaeological survey for this project. These four sites have been included as part of Hexham M12RT 1 for this assessment.

The findings of the archaeological assessment are presented in **Table 12-4**.

Table 12-4 Summary of Aboriginal sites, PADs and PAS within the study area

No.	AHIMS ID	Site name	Site type	AHIMS validity status	Initial description	Results of archaeological investigations
1	38-4-0464	Site 5; Beresfield	Artefact scatter	Valid	Three tuff artefacts identified within a vehicle track. Assessed as having low potential for sub surface artefacts.	Area overgrown. Site area could not be reidentified during survey. Site condition was not able to be determined.
2	38-4-0465	Site 6; Beresfield	PAD	Partially destroyed	PAD associated with artefact scatter (1 tuff flake, 2 silcrete flakes). Artefacts have been partially salvaged and reburied at Chichester Trunk Gravity Main (CTGM) Beresfield East artefacts (38-4-1689). Located on mid slope of a ridge.	5 test pits were excavated during testing within the PAD outside the water pipeline. No subsurface artefacts were identified. Site in poor condition, with a low likelihood of further subsurface artefacts.
3	38-4-0466	Site 7; Beresfield	Isolated artefact	Valid	Isolated artefact (1 silcrete flake) was located on the crest of a ridge. Moderate potential for associated sub–surface deposits (Thomas 2008).	Artefacts not reidentified during survey.
4	38-4-0467	Site 8; Beresfield	PAD (artefact component salvaged)	Valid	PAD associated with an isolated artefact (1 indurated tuff flake). Artefact that was located on the crest of a ridge was salvaged and reburied at CTGM Beresfield East artefacts (38-4-1689) by Hunter Water Corporation.	10 test pits were excavated during test excavation. 3 artefacts were identified.
5	38-4-0468	Site 9; Beresfield	Artefact scatter	Valid	Surface artefacts (1 silcrete flake, 1 tuff flake, 1 tuff blade core). Located on basal slope. High potential for associated sub–surface deposits (Thomas 2008).	Artefacts not reidentified during survey.
6	38-4-0471	Site 10; Beresfield	Artefact scatter	Valid	Surface artefacts (1 indurated tuff flake, 4 silcrete flakes/flaked pieces). Located on basal slope bordering wetland. High potential for associated sub–surface deposits (Thomas 2008).	Surface site could not be reidentified during survey. 38-4-0471 area included within M12RT Black Hill 3 (38-4-1747) PAD extent.

No.	AHIMS ID	Site name	Site type	AHIMS validity status	Initial description	Results of archaeological investigations
7	38-4-0473	Site 2; Beresfield	Isolated artefact	Valid	Isolated artefact (1 silcrete flake). Located on the crest of a ridge. Moderate potential for associated sub–surface deposits (Thomas 2008).	Hearth identified during test excavation.
8	38-4-0358	Glenrowan*	Artefact scatter	Partially destroyed	Unspecified number of stone artefacts found eroding out of an 'Early Holocene' foredune bordering Hexham Swamp in 1991.	16 surface artefacts identified during 2015 survey. PAD tested as a part of 38-4-0837 Beresfield 4 area
9	38-4-0837	Beresfield 4*	PAD	Partially destroyed	PAD identified in 2014 across sandy rise upon which Glenrowan Homestead is located. The PAD incorporates the Glenrowan artefact scatter 38-4-0358.	Extensive subsurface testing carried out. 1,687 artefacts identified.
10	38-4-1214	Beresfield WP AS 1	PAD (artefact scatter component salvaged)	Partially destroyed	Surface artefacts (2 indurated tuff flakes, 1 silcrete flake) and associated PAD. PAD identified on the lower-mid slope of a ridge. Site salvaged as part of CTGM Beresfield East artefacts by Hunter Water Corporation.	10 pits excavated as a part of testing. No subsurface artefacts were identified. Site has a low likelihood of further subsurface artefacts.
11	38-4-1217	CTGM PAD2	PAD (artefact scatter component salvaged)	Partially destroyed	PAD assigned to the length of the CTGM pipeline replaced by Hunter Water Corporation in 2010. Artefacts salvaged and reburied on Country. Remaining PAD extent Site 6, Beresfield (38-4-0465) and Site 8, Beresfield (38-4-0467).	Remaining PAD extent includes Site 6, Beresfield (38-4-0465) and Site 8, Beresfield (38-4-0467).
12	38-4-1709	TB IF 1	Isolated artefact	Valid	Isolated artefact (1 silcrete core). Located on the crest of a ridge.	Artefacts not relocated during survey.
13	38-4-1962	TB2	Artefact scatter	Valid	34 silcrete artefacts in a heavily disturbed area overlooking a drainage line down to Hexham Swamp (Kennedy et al. 2014).	3 silcrete artefacts identified during 2015 survey.

No.	AHIMS ID	Site name	Site type	AHIMS validity status	Initial description	Results of archaeological investigations
14	38-4-1810	Hunter River Isolated Find 1	Isolated find, PAD	Valid	A single weathered mudstone flake identified on a vehicle track located on the Hunter River bank.	Site could not be reidentified during survey in 2020. The access track the site was initially recorded on is located on the top of a levee constructed from introduced fill. Site condition is poor.
15	38-4-1811	Hunter River PAD	PAD	Valid	PAD identified in a slightly elevated section of the Hunter River bank.	The area is elevated as a result of its position on introduced fill (the flood plain is naturally a wetlands area). It is located in proximity to silos and a large area of gravel, concrete, pavers and other building rubble; within an area of fill reportedly the previous location of a wharf in the past. The area is assessed as not PAD but introduced fill and therefore unlikely to include subsurface deposits.
16	39-4-1834	Black Hill Power Artefact 1	Isolated find	Valid	One silcrete core. Located on an access track within high voltage electricity easement.	Site identified during 2015 survey. Area reinspected during 2020 survey, artefact could not be reidentified.
17	38-4-1745	M12RT Black Hill 1	PAD	Valid	Located on upper mid slope within the East Maitland Hills landscape region. High likelihood of subsurface deposits.	Site identified during 2015 survey. 48 pits excavated during testing. 16 artefacts identified.
18	38-4-1747	M12RT Black Hill 3	PAD	Valid	Located on upper mid slope within east Maitland Hills landscape region. High likelihood of subsurface deposits.	Site identified during 2015 survey. 124 pits excavated during testing. 409 artefacts were identified.
19	38-4-1751	Hexham M12RT 1	Artefact scatter and PAD	Valid	A total of 14 surface artefacts (silcrete and tuff flakes and cores) identified at six locations during survey. Elevated terrace and crest of rise within East Maitland Hills outlier landscape region. High likelihood of subsurface deposits.	Site identified during 2015 survey. 120 pits excavated during testing. 549 artefacts identified.

No.	AHIMS ID	Site name	Site type	AHIMS validity status	Initial description	Results of archaeological investigations
	38-4-2020	NPS01 (located in Hexham M12RT 1)	Artefact scatter	Valid	Site recorded after 2015 survey of area and test excavation of Hexham M12RT 1 during assessment for the Newcastle Power Station (ERM 2019).	Located within Hexham M12RT 1 (38-4-1751) PAD area.
	38-4-2021	NPS02 (located in Hexham M12RT 1)	Artefact scatter	Valid	Site recorded after 2015 survey of area and test excavation of Hexham M12RT 1 during assessment for the Newcastle Power Station (ERM 2019).	Located within the area subject to test excavation as a part of Hexham M12RT 1 (38-4-1751) PAD area. No subsurface artefacts were identified within this area. Located outside revised (as a result of test excavation results) PAD area.
	38-4-2022	NPS03 (located in Hexham M12RT 1)	Artefact scatter	Valid	Site recorded after 2015 survey of area and test excavation of Hexham M12RT 1 during assessment for the Newcastle Power Station (ERM 2019).	Located within the area subject to test excavation as a part of Hexham M12RT 1 (38-4-1751) PAD area. No subsurface artefacts were identified within this area. Located outside revised (as a result of test excavation results) PAD area.
	38-4-2038	NPS04 (located in Hexham M12RT 1)	Artefact scatter	Valid	Site recorded after 2015 survey of area and test excavation of Hexham M12RT 1 during assessment for the Newcastle Power Station (ERM 2019).	Located within Hexham M12RT 1 (38-4-1751) PAD area.
20	38-4-1750	Heatherbrae M12RT 3	Artefact scatter and PAD	Valid	An area of PAD on upper slopes and crest of dune overlooking Windeyers Creek. Moderate to high likelihood of subsurface deposits.	Site identified during 2015 survey. 27 pits excavated during testing. 245 artefacts identified. A hearth was also identified at the site location.
21	38-4-1835	Heatherbrae M12RT 4	PAD	Valid	An area of PAD on a crest of a dune within the Tomago sands landscape region. Moderate to high likelihood of subsurface deposits.	Site identified during 2015 survey. 4 pits excavated during testing. 5 artefacts identified. A hearth was also identified at the site location.

No.	AHIMS ID	Site name	Site type	AHIMS validity status	Initial description	Results of archaeological investigations
22	38-4-1749	Heatherbrae M12RT 2	Artefact scatter and PAD	Valid	A tuff flake identified and an associated area of PAD on a crest of a dune within the Tomago sands landscape region. Moderate to high likelihood of subsurface deposits.	Site identified during 2015 survey. 17 pits excavated during testing. 33 artefacts identified.
23	38-4-1833	Black Hill M12RT 4	PAD	Valid	Three silcrete artefacts comprising one angular fragment, one core, and one flake. Ex situ (heavily disturbed fill). This site was identified via test excavation of the Black Hill M12RT 1 (38-4-1745) PAD but has been interpreted as a separate site.	Site identified during 2015 survey. 3 artefacts located within one pit excavated during testing. Disturbed soil profile.
24	38-4-1838	Windeyers Creek 1	PAD	Valid	Subsurface site identified during test excavation within three control test pit locations. Upper slope of dune overlooking Windeyers Creek.	Site identified during 2015 survey. 21 pits excavated during testing. 33 artefacts identified.
25	38-4-1836	Purgatory Creek 1	PAD	Valid	This location was identified for inclusion in the test excavation program due to its landform features when seen during the control pit program.	Site identified during 2015 survey. 10 pits excavated during testing. 121 artefacts identified.
26	Not an AHIMS site	Former mineral sands processing site	PAS	N/A	Elevated landform in proximity to the Hunter River and wetland that cannot be accessed currently due to contamination issues.	Assessed as PAS beneath the concrete slab through desktop assessment.

*Glenrowan (38-4-0358) and Beresfield 4 (38-4-0837) PAD only are separate AHIMS registrations for what is in essence a single site.\

Figure 12-2 Aboriginal sites, PADs and PAS within the study area (map 1 of 2)

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Figure 12-2 Aboriginal sites, PADs and PAS within the study area (map 2 of)

Figure has been redacted for public exhibition due to the sensitivity of the image

12.4.4 Areas of cultural significance

Locations of Aboriginal cultural value relevant to the project were identified through consultation, field surveys and during the test excavation program. Within this assessment the wider region surrounding the study area is considered in the discussion of Aboriginal cultural heritage values as it is a part of a cultural landscape which must be considered as a part of this assessment.

Four locations of Aboriginal cultural values of local significance were identified. The three locations within the study area are a part of the identified 26 Aboriginal sites, PADs and PAS. Details of each of these cultural values and their locations are listed in **Table 12-5**.

Table 12-5 Aboriginal cultural values near or within the study area

Cultural value name (AHIMS ID)	Within or next to study area	Description
Black Hill M12RT 1 & 3 (38-4-1745 & 38-4-1747)	Within	• Part of cultural pathway/song line described by Wonnarua claimant group in the Hunter Valley as well as the Gomeroi claimant group in the Upper Hunter • Story place • Ridge line significant • Place of spiritual significance.
Glenrowan (38-4-0358)/ Beresfield 4 (38-4-0837)*	Within	• Landform with cultural sensitivity for burials • Songline from Black Hill to Mount Sugarloaf intersects this area • Story place.
Hexham M12RT 1 (38-4-1751)	Within	• Landform with cultural sensitivity for burials/ significant site • Place of spiritual significance.
Black Hill ochre quarry (not registered)	Next to	• Ochre quarry to the north of Hunter Water Corporation compound • Precise location unknown.

* Glenrowan (38-4-0358) and Beresfield 4 (38-4-0837) PAD only are separate AHIMS registrations for what is in essence a single site.

The statement of cultural significance and cultural value on behalf of the Awabakal and Guringai Traditional Owners emphasize the importance of the Hexham and Black Hill area. There is a high cultural value and significance of the area as a whole to the Awabakal and Guringai Traditional Owners as the landforms and resources fulfilled not just the basic needs of these People, but also many aspects of their cultural foundations.

The Statement for the Wonnarua Traditional Custodians is limited due to specific cultural information being confidential. However, it can be stated that the Beresfield 4 and Black Hill site areas are significant due to the stories they contain as well as being the last remaining landforms of their type in the area.

Contemporary cultural values were also associated with the large established fig tree on the western bank of the Hunter River by RAPs that participated in the field surveys. RAPs requested that the tree be protected from impact (potentially by a fence) and those working on the construction of the project should be made aware of the tree's significance.

12.4.5 Significance assessment summary

A summary of the significance assessment of the 26 Aboriginal sites, PADs and PAS located within the study area is presented in **Table 12-6**. These were developed in consultation with the RAPs and been provided for their review and feedback. Note the table does not provide a significance rating for the area of PAS at the former mineral sands processing site as contamination risks at the former mineral sands processing site restricted any sub-surface testing from occurring.

Table 12-6 Summary of the significance assessment for Aboriginal sites

No.	Name	Social significance	Historical significance	Scientific significance	Aesthetic significance	Overall significance (scale of significance)
1	Site 5; Beresfield (38-4-0464)	High	N/A	Low-moderate	N/A	**Moderate (local)**
2	Site 6; Beresfield (38-4-0465)	High	N/A	Low	N/A	**Low (local)**
3	Site 7; Beresfield (38-4-0466)	High	N/A	Low	N/A	**Low (local)**
4	Site 8;Beresfield (38-4-0467)	High	N/A	Low	N/A	**Low (local)**
5	Site 9; Beresfield (38-4-0468)	High	N/A	Low	N/A	**Low (local)**
6	Site 10; Beresfield (38-4-0471)	High	N/A	Moderate-high	Moderate	**Moderate-high (local)**
7	Site 2;Beresfield (38-4-0473)	High	N/A	Moderate-high	Low	**Moderate-high (local)**
8 9	Glenrowan (38-4-0358) / Beresfield 4 (38-4-0837)*	High	Moderate	High	Moderate	**High (local)**
10	Beresfield WP AS 1 (38-4-1214)	High	N/A	Low	N/A	**Low (local)**
11	CTGM PAD 2 (38-4-1217) Umbrella site only areas remaining post CTGM Salvage – Site 8;Beresfield (38-4-0467) and Site 6; Beresfield (38-4-0465)*	High	N/A	Low	N/A	**Low (local)**
12	TB IF 1 (38-4-1709)	High	N/A	Low	N/A	**Low (local)**

No.	Name	Social significance	Historical significance	Scientific significance	Aesthetic significance	Overall significance (scale of significance)
13	TB2 (38-4-1962)	High	N/A	Low	N/A	**Low (local)**
14	Hunter River Isolated Find 1 (38-4-1810)	High	N/A	Low	N/A	**Low (local)**
15	Hunter River PAD (38-4-1811)	Low	N/A	Low	N/A	**Low (local)**
16	Black Hill Power Artefact 1 (38-4-1834)	High	N/A	Low	N/A	**Low (local)**
17	Black Hill M12RT 1 (38-4-1745)	High	N/A	Low-moderate	Low	**Low-moderate (local)**
18	Black Hill M12RT 3 (38-4-1747) Includes – Site 10; Beresfield (38-4-0471)*	High	N/A	Moderate-high	Moderate	**Moderate-high (local)**
19	Hexham M12RT 1 (38-4-1751)* Includes – NPS01 (38-4-2020), NPS02 (38-4-2021), NPS03 (38-4-2022) and NPS04 (38-4-2038)	High	N/A	High	High	**High (local)**
20	Heatherbrae M12RT 3 (38-4-1750)	High	N/A	High	Moderate	**High (local)**
21	Heatherbrae M12RT 4 (38-4-1835)	High	N/A	High	Moderate	**High (local)**
22	Heatherbrae M12RT 2 (38-4-1749)	High	N/A	Moderate-high	Moderate	**Moderate-high (local)**
23	Black Hill M12RT 4 (38-4-1833)	High	N/A	Low	N/A	**Low (local)**
24	Windeyers Creek 1 (38-4-1838)	High	N/A	High	Moderate	**High (local)**
25	Purgatory Creek 1 (38-4-1836)	High	N/A	Low	Low	**Low (local)**
26	Former mineral sands processing site (not an AHIMS site)	N/A	N/A	N/A	N/A	N/A

12.5 Assessment of potential impacts

12.5.1 Construction

During project development, design and alignment refinements were made and the location of ancillary facilities were selected to avoid impacts to Aboriginal sites where possible, while considering engineering, environmental, social and economic requirements. The design has also placed the alignment as close as practicable to existing development and infrastructure to limit regional fragmentation impacts and to avoid impacts on less disturbed areas. Ancillary facilities in the Black Hill area were located and sized to align with existing disturbed areas to avoid adjacent undisturbed areas in this landform.

For the purpose of the impact assessment, it has been assumed that Aboriginal sites occurring within the construction footprint would be directly impacted by construction activities. A total of 26 Aboriginal sites, PADs and areas of PAS are located within the construction footprint, and would be directly impacted by the project, including visual impacts. The potential impact to Aboriginal sites, PADs and PAS recorded is summarised in **Table 12-7**.

Table 12-7 Impact assessment for Aboriginal sites, PADs and PAS

No.	Heritage item name	Heritage item type	Overall significance	Type of impact	Degree of impact	Description
1	Site 5 Beresfield (38-4-0464)	Artefact scatter	Moderate	Direct	Whole	The site is located in the construction footprint and will be directly impacted. The project would result in removal of the entire site and irreversible impact to its heritage values.
2	Site 6 Beresfield (38-4-0465)	PAD	Low	Direct	Whole	The remaining portions of this PAD are within the construction footprint. The PAD was tested within the study area with no Aboriginal objects identified. The project would result in removal of the entire PAD and irreversible impact to heritage values (if any). The area of PAD within the construction footprint has previously been impacted during the construction of the CTGM pipeline and associated access track and is unlikely to retain heritage values.
3	Site 7 Beresfield (38-4-0466)	Isolated find	Low	Direct	Whole	The site is located in the construction footprint and will be directly impacted. The project would result in removal of the entire site and irreversible impact to its heritage values.
4	Site 8 Beresfield (38-4-0467)	PAD	Low	Direct	Whole	The remaining portions of this PAD are within the construction footprint. The PAD was tested within the study area with no Aboriginal objects identified. The project would result in removal of the entire PAD and irreversible impact to heritage values (if any). The area of PAD within the construction footprint has previously been impacted during the construction of the CTGM pipeline and associated access track and is unlikely to retain heritage values.
5	Site 9;Beresfield (38-4-0468)	Artefact scatter	Low	Direct	Whole	The site is located entirely within the construction footprint and would be directly impacted. The project would result in removal of the entire site and irreversible impact to its heritage values.
6	Site 10; Beresfield (38-4-0471)*	Artefact scatter	Moderate-high	Direct	Whole	The site is located entirely within the construction footprint and will be directly impacted. The project would result in removal of the entire site and irreversible impact to its heritage values.
7	Site 2;Beresfield (38-4-0473)	Isolated artefact and hearth	Moderate-high	Direct	Partial	The site is partially located within the construction footprint and this component will be directly impacted. The project would result in the removal of about 90% of the site area and irreversible impact to its heritage values.

No.	Heritage item name	Heritage item type	Overall significance	Type of impact	Degree of impact	Description
8 9	Glenrowan (38-4-0358)/ Beresfield 4 (38-4-0837)	Artefact scatter	High	Direct	Partial	The site is partially located within the construction footprint and this component will be directly impacted. The site is likely to extend beyond the study area. The project would result in removal of about 65% of the currently known construction footprint and irreversible impact to its heritage values.
10	Beresfield WP AS 1 (38-4-1214)	PAD	Low	Direct	Whole	The site is located entirely within the construction footprint and would be directly impacted. The area of PAD within the construction footprint area has previously been impacted during the construction of the CTGM pipeline and associated access track and is unlikely to retain heritage values.
11	CTGM PAD2 (38-4-1217) Note: Site consists of Site 6 Beresfield (38-4-0465) and Site 8; Beresfield (38-4-0467)	PAD	Low	Direct	Whole	The remaining portions of this PAD are within the construction footprint. The PAD was tested within the study area with no Aboriginal objects identified. The project would result in removal of the entire PAD and irreversible impact to heritage values (if any). The area of PAD within the construction footprint has previously been impacted during the construction of the CTGM pipeline and associated access track and is unlikely to retain heritage values.
12	TB IF 1 (38-4-1709)	Isolated find	Low	Direct	Whole	The site is located entirely within the construction footprint and will be directly impacted. The project would result in removal of the entire site and irreversible impact to its heritage values.
13	TB2 (38-4-1962)	Artefact scatter	Low	Direct	Whole	The site is located entirely within the construction footprint and will be directly impacted. The project would result in removal of the entire site and irreversible impact to its heritage values.
14	Hunter River Isolated Find 1 (38-4-1810)	Isolated find	Low	Direct	Whole	The site is located entirely within the construction footprint and will be directly impacted. The project would result in removal of the entire site and irreversible impact to its heritage values.
15	Hunter River PAD (38-4-1811)	PAD	Low	Direct	Whole	The site is located entirely within the construction footprint and will be directly impacted. The site was identified during survey to be located entirely on fill and is unlikely to have heritage values.

No.	Heritage item name	Heritage item type	Overall significance	Type of impact	Degree of impact	Description
16	Black Hill Power Artefact 1 (38-4-1834)	Isolated artefact	Low	Direct	Whole	The site is located entirely within the construction footprint and will be directly impacted. The project would result in removal of the artefact yet would have no additional impact to its heritage values as it is an ex-situ context.
17	Black Hill M12RT 1 (38-4-1745)	Artefact scatter	Low-moderate	Direct	Partial	The site is located in the construction footprint and will be directly impacted. The project would result in the removal of about 50% of the site area and irreversible impact to its heritage values.
18	Black Hill M12RT 3 (38-4-1747) Note: Includes Site 10; Beresfield (38-4-0471)	Artefact scatter	Moderate-high	Direct	Partial	The site is partially located within the construction footprint and this component will be directly impacted. The site is likely to extend beyond the construction footprint. The project would result in removal of about 50% of the currently known site area and irreversible impact to its heritage values.
19	Hexham M12RT 1 (38-4-1751) Note: Includes NPS01 (38-4-2020), NPS02 (38-4-2021), NPS03 (38-4-2022) and NPS04 (38-4-2038)	Artefact scatter and PAD	High	Direct	Whole	The site is located entirely within the construction footprint and will be directly impacted. The project would result in removal of the entire site and irreversible impact to its heritage values.
20	Heatherbrae M12RT 3 (38-4-1750)	Artefact scatter	High	Direct	Partial	The site is partially located within the construction footprint and this component will be directly impacted. The site is likely to extend beyond the construction footprint. The project would result in removal of about 75% of the currently known site area and irreversible impact to its heritage values.
21	Heatherbrae M12RT 4 (38-4-1835)	Artefact scatter	High	Direct	Whole	The site is located entirely within the construction footprint and will be directly impacted. The project would result in removal of the entire site and irreversible impact to its heritage values.
22	Heatherbrae M12RT 2 (38-4-1749)	Artefact scatter	Moderate-high	Direct	Whole	The site is located entirely within the construction footprint and will be directly impacted. However, this site is currently subject to an AHIP (C0003580 and C0005569) for its salvage and destruction as a part of an industrial development.

No.	Heritage item name	Heritage item type	Overall significance	Type of impact	Degree of impact	Description
23	Black Hill M12RT 4 (38-4-1833)	Artefact scatter	Low	Direct	Whole	The site is located in the construction footprint and will be directly impacted. The project would result in removal of the entire site and irreversible impact to its heritage values.
24	Windeyers Creek 1 (38-4-1838)	Artefact scatter	High	Direct	Whole	The site is located entirely within the construction footprint and will be directly impacted. The project would result in removal of the entire site and irreversible impact to its heritage values.
25	Purgatory Creek 1 (38-4-1836)	Artefact scatter	Low	Direct	Whole	The site is located entirely within the construction footprint and will be directly impacted. The project would result in removal of the entire site and irreversible impact to its heritage values.
26	Former mineral sands processing facility	PAS	N/A	Direct	Whole	The area of PAS identified in the desktop assessment (access not possible due to contamination) is located entirely within the study area and will be directly impacted. The project would result in removal of the entire area and irreversible impact to its heritage values (if any).

The impacts in **Table 12-7** cannot be avoided and environmental management measures to minimise and mitigate impacts are provided in **Section 12.6** and further detailed in the ACHAR (**Appendix L**).

Construction for the project includes indirect (visual) impacts caused by the project and any ancillary infrastructure (including noise barriers).

An examination of potential indirect (visual) impacts in relation to the identified Aboriginal sites and Aboriginal places has demonstrated that there would be no indirect (visual) impacts. There are no Aboriginal places, as defined under the relevant legislation, planning instruments or heritage lists, within or adjacent to the study area. Therefore, there would be no indirect visual or noise and vibration impacts on Aboriginal places as a result of construction of the project.

Surface and subsurface artefacts (Aboriginal heritage) are not subject to potential noise or vibration impacts. Therefore, noise and vibration generated during construction is not expected to result in indirect impacts to the structural integrity and/or heritage significance of any Aboriginal heritage items identified in this assessment.

Direct impacts of noise barriers are discussed in **Chapter 8** (noise and vibration) while visual impacts are assessed in **Chapter 15** (urban design, landscape and visual amenity).

12.5.2 Operation

No impacts on Aboriginal cultural heritage, both direct and indirect, are expected during the operation of the project. Impacts to Aboriginal sites located within the construction footprint will occur during the construction phase with no further impact during operation. Aboriginal sites that include areas that extend outside the construct footprint will have those portions conserved during construction and will not be impacted during the operation of the project.

As there are no Aboriginal places defined under the relevant legislation, planning instruments or heritage lists within the study area there would be no indirect visual or noise and vibration impacts on Aboriginal places during operation of the project.

Noise and vibration during operation would not result in indirect impacts to the structural integrity and/or heritage significance of any Aboriginal heritage items identified in this assessment.

12.6 Environmental management measures

The environmental management measures that will be implemented to minimise the Aboriginal cultural heritage impacts from the project, along with the responsibility and timing for those measures, are presented in **Table 12-8**.

Table 12-8 Environmental management measures (Aboriginal cultural heritage)

Impact	Reference	Management measure	Responsibility	Timing
Impacts on known Aboriginal sites	AH01	An Aboriginal Cultural Heritage Management Plan (ACHMP) will be prepared in accordance with the Procedure for Aboriginal cultural heritage consultation and investigation (Roads and Maritime Services 2011b) and Standard Management Procedure – Unexpected Heritage Items (Roads and Maritime Services 2015f). The ACHMP will be prepared in consultation with all relevant Aboriginal groups. The ACHMP will include: • Details of investigations completed or planned to be carried out and any associated approvals required • Mapping of areas of Aboriginal heritage value and identification of protection measures to be applied during construction • Procedures to be implemented if previously unidentified Aboriginal objects, including skeletal remains, are discovered during construction • An induction program for construction personnel on the management of Aboriginal heritage values • Opportunities for on-going Aboriginal community engagement in the project.	Transport/ Contractor	Prior to construction
	AH02	Archaeological salvage excavation, surface collection and exclusion fencing as detailed in Table 9-1 of the Aboriginal Cultural Heritage Assessment Report must be carried out in accordance with the methodology specified in the Chapter 9 of the Aboriginal Cultural Heritage Assessment Report (**Appendix L**).	Contractor/ Transport	Prior to construction/ construction

Impact	Reference	Management measure	Responsibility	Timing
Other relevant management measures				
Non-Aboriginal heritage impacts	NA01	A Non-Aboriginal Heritage Management Plan (NAHMP) would be prepared prior to construction in consultation with Heritage NSW. As a minimum, the NAHMP would include the following: • A list, plan and maps with GIS layers showing the location of identified heritage items both within, and near, the construction footprint • Procedures to be implemented during construction to avoid or minimise impacts on items of heritage significance including protective fencing • The Unexpected Heritage Items Procedure (Transport for NSW 2019b) which will be followed in the event that unexpected heritage finds are uncovered during construction • A procedure for the unexpected discovery of human skeletal remains as per the Skeletal remains: guidelines for the management of human skeletal remains (NSW Heritage Office 1998).	Transport/ Contractor	Prior to construction
Aboriginal cultural heritage	UD06	The project detailed design will incorporate relevant Aboriginal cultural heritage elements of Beyond The Pavement (Transport for NSW 2020a) and Designing With Country (GANSW 2020), where practical.	Transport/ Contractor	Prior to construction/ construction

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Environmental impact statement – Chapter 13: Socio-economic

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13. Socio-economic

This chapter describes the potential socio-economic impacts that may be generated by the construction and operation of the project and presents the approach to the management of these impacts.

The desired performance outcomes for the project relating to the socio-economic assessment as outlined in the SEARs, are:

- The project minimises adverse social and economic impacts and capitalises on opportunities potentially available to affected communities
- The project minimises impacts to property and business and achieves appropriate integration with adjoining land uses, including maintenance of appropriate access to properties and community facilities, and minimisation of displacement of existing land use activities, dwellings and infrastructure
- Effective engagement is undertaken with stakeholders during project design and delivery.

Table 13-1 outlines the SEARs that relate to the socio-economic assessment and identifies where they are addressed in this EIS. The full assessment of socio-economic impacts is provided in the Socio-economic Working Paper (**Appendix M**).

Table 13-1 SEARs (socio-economic, land use and property)

Secretary's requirement	Where addressed
12. Socio-economic, Land use and Property	
1. The proponent must assess social and economic impacts in accordance with the current guidelines (including cumulative ongoing impacts of the project).	Relevant guidelines are discussed in **Section 13.1**. Assessment methodology are discussed in **Section 13.2**. Assessment of social and economic construction and operational impacts are discussed in **Section 13.4**. Cumulative social and economic impacts are discussed in **Chapter 23** (cumulative impacts).
2. The proponent must assess impacts from construction and operation on potentially affected properties, businesses, Crown land, Council assets and services, recreational users, and land and water users (including recreational and commercial fishers, and oyster and aquaculture farmers), including property acquisitions/adjustments, access, amenity and relevant statutory rights.	Relevant impacts on businesses, commercial fishers (including oyster and aquaculture farmers), Council assets and services, recreational users, land and water users and amenity from construction and operation are discussed in **Section 13.4**. Relevant impacts on potentially affected properties and Crown land, including property acquisition / adjustments, access and relevant statutory rights from construction and operation are discussed in **Chapter 14** (land use and property).
7. A draft Community Consultation Framework must be prepared identifying relevant stakeholders, procedures for distributing information and receiving/responding to feedback and procedures for resolving stakeholder and community complaints during the design, construction and operation of the project. Key issues that must be addressed in the Framework include, but are not limited to: (a) traffic management (including property, cyclists and pedestrian access) (b) landscaping/urban design matters (c) hydrology and flooding (d) staging and timing of construction activities including out of hours work and utility relocations (e) noise and vibration mitigation and management (f) soil erosion and water quality management (g) interaction with existing land uses.	A draft Community Consultation Framework is provided in **Appendix E**. Additional details on community consultation are provided in **Chapter 6**.

13.1 Policy and planning setting

The socio-economic assessment was prepared to assess the potential impacts of the project in accordance with the following relevant policy, plans and strategies:

- Hunter Regional Plan 2036 (DPE 2016)
- Hunter Regional Transport Plan 2014 (NSW Government 2014a)
- Greater Newcastle Metropolitan Plan 2036 (DPE 2018)
- Aboriginal Participation in Construction Policy (NSW Procurement 2018)
- Port Stephens Council strategies:
  - Port Stephens Community Strategic Plan 2018-2028 (Port Stephens Council 2018a)
  - Port Stephens Economic Development and Tourism Strategy 2018-2020 (Port Stephens Council 2018b)
  - Raymond Terrace and Heatherbrae Strategy 2015-2031 (Port Stephens Council 2015).
- City of Newcastle strategies:
  - Newcastle 2030 Community Strategic Plan (City of Newcastle 2018a).

Further detail on the above policy and planning framework, and how it applies to the project, is provided in **Chapter 3** and the Socio-economic Working Paper (**Appendix M**).

13.2 Assessment methodology

The socio-economic assessment was carried out in accordance with the Environmental Impact Assessment Practice Note – Socio-economic Assessment, January 2020 (Transport for NSW 2020c) to address the socio-economic matters outlined in the SEARs. The Environmental Impact Assessment Practice Note – Socio-economic assessment, January 2020 updates the previous version of the socio-economic practice note released in 2013.

Key steps in the assessment included:

- Scoping the likely range of potential socio-economic impacts and identifying communities likely to be affected by the project
- Describing existing socio-economic characteristics, values and conditions in the study area, including NSW Government and local government policies and strategies, population and demographic data, business and industry, existing social infrastructure and community values
- Identifying and evaluating the significance of potential impacts on and changes to socio-economic conditions and values in the study area as a result of the construction and operation of the project
- Identifying measures to avoid, minimise or mitigate socio-economic impacts that would arise from the construction and operation of the project.

The development of design options included consideration of social and economic values in the study area and opportunities to avoid or minimise potential impacts on these values, where possible.

Further detail on the assessment methodology is provided below and in the Socio-economic Working Paper (**Appendix M**).

13.2.1 Study area

The socio-economic study area is shown on **Figure 13-1**. The study area has been based on those communities that may experience changes to socio-economic conditions due to the location of the project, construction activities and changes in movement patterns for residents, workers and visitors.

It includes the Australian Bureau of Statistics (ABS) Statistical Areas Level 2 (SA2) geographies of:

- Beresfield-Hexham SA2, which includes the suburbs of Woodberry, Beresfield, Tarro, part of Black Hill, Lenaghan and Hexham
- Raymond Terrace SA2, which includes the suburbs of Eagleton, Kings Hill, Raymond Terrace, Heatherbrae and Tomago.

The project's benefits and impacts may also be experienced by communities in the wider area, such as surrounding LGAs and the Hunter Region. The socio-economic assessment considers impacts on communities and businesses in the LGAs of City of Newcastle and Port Stephens Council, through which the project passes, Maitland City Council located to the north of the project, Cessnock City Council located to the west of the project, and the wider Hunter Region, where relevant.

13.2.2 Data sources

The existing environment described in **Section 13.3** principally draws on information from the ABS Census of Population and Housing 2016, supplemented with information and data from:

- Government agencies such as the NSW Department of Planning, Industry and Environment (DPIE), Department of Primary Industries and Destination NSW
- City of Newcastle and Port Stephens Council publications, reports, guidelines and websites
- Observations made during a site visit to the study area in 2016
- A survey of local businesses in the study area and car parking surveys at key locations within Heatherbrae and Beresfield
- Community and stakeholder consultation carried out for the project, including information on existing community values and key issues raised about the project.

13.2.3 Local business surveys

A survey of local business owners/managers and a car park survey were conducted in September 2016 to gather information on local businesses in the study area. It was proposed to conduct updated surveys in 2020, however, in response to the COVID-19 pandemic, a range of restrictions were introduced impacting on the movements of residents, tourists and businesses within NSW and interstate. It is expected that these restrictions would have caused changes to the business environment and shopper behaviour. As a result, it was considered that an updated survey would not provide an accurate representation of usual business conditions.

A desktop review of businesses in the study area in July 2020 indicates that there has not been a substantial change to the type or nature of businesses in the study area since 2016. As such, it is considered that the feedback collected through the 2016 surveys remains relevant to this assessment.

Survey of local business owners and managers

A business survey was carried out to gather information on the type and nature of businesses, business operations, and business owners' perceptions of potential benefits and impacts during construction and operation of the project. Surveys were conducted with owners and managers of retail and service-related businesses within Heatherbrae and Beresfield. These locations were selected as they are a focus for retail and service-related businesses in the study area and businesses that are more likely to rely on passing motorists for their trade. A total of 42 surveys were distributed with 26 surveys completed.

Car park (number plate) survey

The car park survey involved recording vehicle number plates at four locations at Heatherbrae and Beresfield to gather information on the origin of business customers. Information was provided by Transport at a suburb level only to ensure anonymity. The surveys were conducted over two days and number plates were recorded at each location about every two hours. A total of 792 unique number plates were collected in Heatherbrae, and 217 in Beresfield.

13.2.4 Community and stakeholder consultation

A range of engagement strategies were used by Transport to consult with the community and other stakeholders since investigations started in 2004 and have formed an integral part of the project development. In addition, Transport has carried out ongoing community and stakeholder consultation throughout the development of the refined concept design and environmental assessment including:

- Public display of the revised concept design in October 2015
- Public display of concept design changes in August 2016
- Community update on further design updates in November 2020
- Targeted consultation with business owners affected by the project from 2016 through to 2019 and 2020
- Consultation with directly affected land owners.

Further details of the consultation carried out as part of the project development can be found in **Chapter 6**. The socio-economic assessment was informed by the outcomes of this consultation, including the identification of existing features and values important to communities in the study area.

Key issues relevant to the socio-economic assessment raised by communities and stakeholders during consultation for the project are provided in **Chapter 6** and the Socio-economic Working Paper (**Appendix M**).

13.2.5 Evaluation of significance

An evaluation matrix was used to evaluate the significance of potential negative socio-economic impacts associated with the construction and operation of the project. This was based on the evaluation framework developed as part of the Environmental Impact Assessment Practice Note – Socio-economic Assessment (Transport for NSW 2020c). The matrix assesses the levels of sensitivity of receptors and the magnitude of the proposed work and is presented in the Socio-economic Working Paper (**Appendix M**).

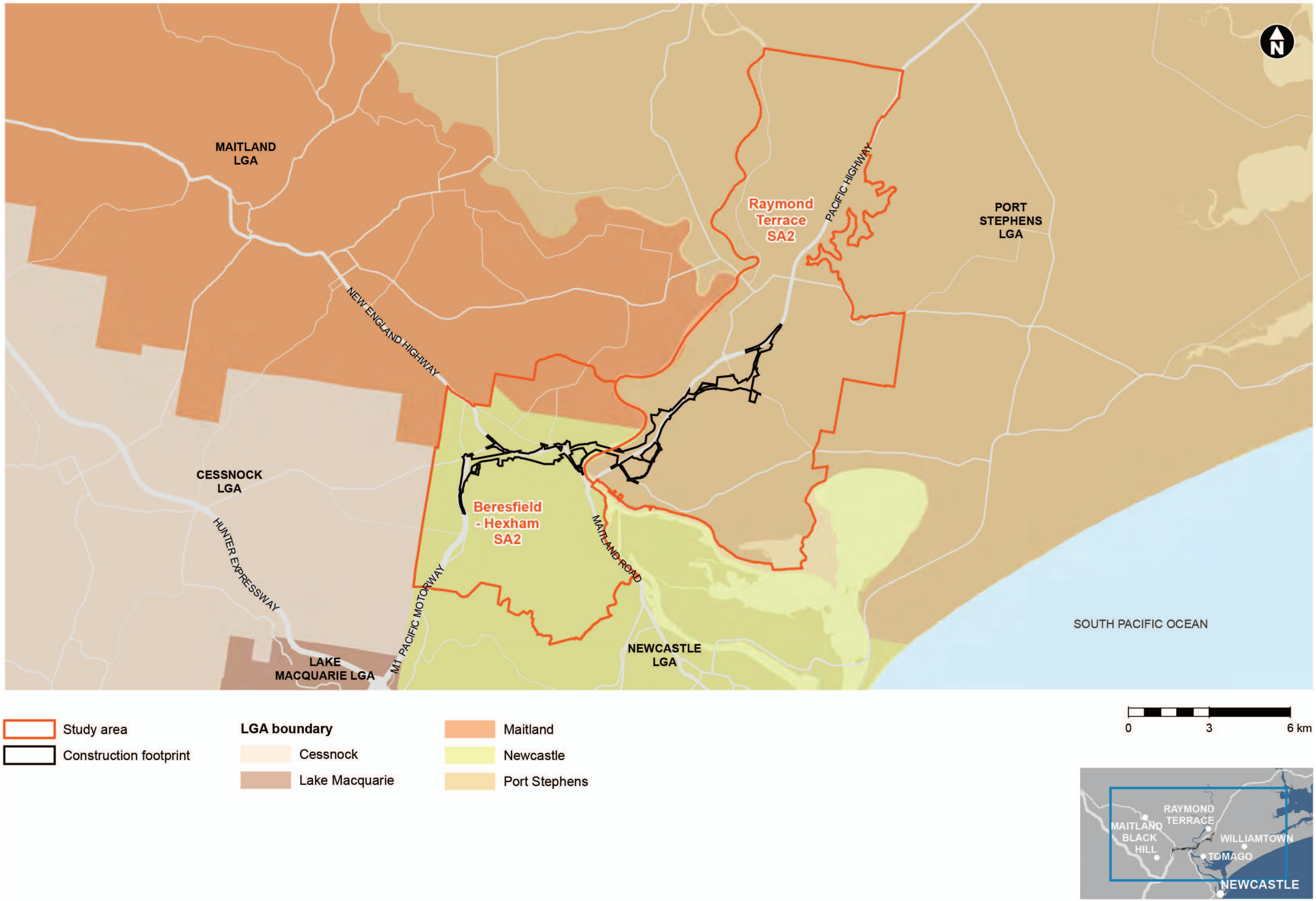

Figure 13-1 Study area used for the socio-economic assessment

13.3 Existing environment

13.3.1 Regional context

The project is located within the City of Newcastle LGA and the Port Stephens Council LGA.

The City of Newcastle is predominantly a residential and industrial area, with agricultural land uses located in the north west. Newcastle is the economic, administrative and cultural centre of the Hunter. In 2019, the City of Newcastle has an estimated resident population of about 165,571 people, with this projected to increase to 199,680 people by 2041. The City of Newcastle supports about 102,800 jobs and has an annual economic output for $35.7 billion, of which manufacturing generates the largest output. Key commercial centres in the study area include Black Hill, Tarro and Beresfield. Major features in the City of Newcastle LGA include the Newcastle central business district, the Port of Newcastle, major community facilities such as The University of Newcastle and John Hunter Hospital, Newcastle Art Gallery and Newcastle Museum, and natural areas such as the Hunter River. The Port of Newcastle is Australia's largest coal export port by volume and is a growing multi-purpose cargo hub.

The Port Stephens Council LGA had an estimated resident population of 73,481 people at June 2019, with this projected to increase to 82,068 people by 2041. The Port Stephens Council LGA supports about 27,346 jobs and has an annual economic output of $12.3 billion, of which manufacturing makes the greatest contribution. Newcastle Airport and Williamtown RAAF base are key features and economic drivers for Port Stephens Council LGA and wider Hunter. Key commercial centres within the study area include Tomago, Heatherbrae and Raymond Terrace. Heatherbrae is located south of Raymond Terrace and has been identified as an 'enterprise corridor' and destination for bulky goods retail.

13.3.2 Community profile

Population size, growth and mobility

The study area had an estimated resident population of 22,484 people in June 2019. The Raymond Terrace SA2 had a larger resident population with 13,994 people, compared to 8490 people in the Beresfield-Hexham SA2. The population of the study area generally remained the same between 2009 and 2019, decreasing by about 110 people. Between 2009 and 2019 the population of City of Newcastle and Port Stephens Council LGAs grew at an average of about one per cent annually, which was below the average rate of growth for NSW, at 1.5 per cent.

The City of Newcastle and Port Stephens Council LGAs are expected to grow at a lower rate than NSW as a whole over the 25 years to 2041. By 2041, the combined population of the City of Newcastle and Port Stephens Council LGAs is projected to increase by about 49,900 people to about 281,748 people. Most of the population growth is expected to occur within the City of Newcastle LGA (about 38,973 people).

Communities in the study area generally had lower levels of population mobility compared to the NSW and City of Newcastle and Port Stephens Council LGAs. This likely reflects the older population and more rural nature of the Beresfield-Hexham area.

Age profile

The study area had a slightly older population compared to the NSW average, with a higher median age and higher proportion of older people. The study area also had proportions of children aged 14 years or younger above the NSW average. While Beresfield-Hexham has an older population, Raymond Terrace reported a median age the same as NSW and a higher proportion of children and lower proportion of older people.

Cultural diversity

Overall, communities in the study area had lower levels of cultural diversity compared to NSW.

The study area had a relatively high proportion of Indigenous people, with about 7.6 per cent of people who reported as being Aboriginal and/or Torres Strait Islander, more than double the NSW average. At the same time, the study area had lower proportions of people who were born overseas and people who speak a language other than English at home compared to the NSW average.

The study area had relatively low proportions of people who speak a language other than English. Levels of English proficiency in the study area were generally high, with less than one per cent of the population only indicating that they did not speak English well or at all, compared to 4.5 per cent in NSW.

Households and families

There were 8,214 households in the study area in 2016. Family households were the predominant household type, representing nearly 70 per cent of households in the study area. The study area had a higher proportion of lone person households and a lower proportion of group households compared to NSW.

There were about 5,886 families in the study area, of which about 38.3 per cent comprised families with children aged under 15 years. Overall, the study area had higher proportions of families with children and lower proportions of couple only families compared to NSW and the City of Newcastle and Port Stephens Council LGAs.

Housing

The study area had the following housing and vehicle ownership profile:

- About 92.6 per cent of the 8,870 dwellings in the study area were occupied on Census night
- Separate houses were the predominant dwelling type, accounting for about 78.1 per cent of dwellings in the study area, which was above the proportion of separate houses in NSW and City of Newcastle and Port Stephens Council LGAs
- Levels of owner-occupied houses were below the NSW average, although this was mainly due to very low proportions of houses that were owned outright or owned with a mortgage in Raymond Terrace
- Relatively high proportion of houses being rented compared to the NSW average, with 34.3 per cent of occupied private houses in the study area being rented, compared to 31.8 per cent in NSW. In Raymond Terrace, 38 per cent of occupied private houses are being rented. The study area had a relatively high proportion of houses being rented from a state authority, with this more than double the NSW average
- Relatively low housing costs, with median weekly rent and monthly mortgage costs below City of Newcastle and Port Stephens Council LGAs and NSW medians
- Lower levels of housing stress related to mortgage costs compared to NSW, although some households experienced levels of rental housing stress with proportions of households paying 30 per cent or more of household income on rental costs similar to or above the NSW average.

Socio-economic disadvantage and need for assistance

Some areas near the project demonstrated higher levels of relative disadvantage in general when measured using the ABS Socio-Economic Indexes for Areas index. Communities near Tomago and Heatherbrae generally indicated a relative lack of economic resources in general, while communities in Beresfield, Tarro and Woodberry generally displayed moderate levels of economic resources (ABS 2016a).

Overall, the study area had relatively high levels of people needing assistance compared to averages for NSW and City of Newcastle and Port Stephens Council LGAs. About 7.8 per cent of people in the study area indicated they have a need for assistance with self-care, mobility or communication. This is compared to 5.4 per cent in NSW (ABS 2016a).

13.3.3 Economic profile

Income and employment

Communities in the study area generally had lower incomes compared to NSW and the City of Newcastle and Port Stephens Council LGAs. The study area also had higher proportions of households with an income of less than $650 per week and lower proportions of households with an income of more than $2500 per week.

The study area had a labour force participation rate of 53.1 per cent (about 9,444 people). This is below the proportion of people who were participating in the labour force in NSW as a whole (59.2 per cent). The study area had a relatively high rate of unemployment, with 10.5 per cent of the study area's labour force unemployed. Key industries of employment for residents in the study area include:

- Health care and social assistance (13.2 per cent)
- Retail trade (11.7 per cent)
- Manufacturing (10.5 per cent)
- Construction (9.3 per cent)
- Accommodation and food services (7.8 per cent).

The proportion of people employed in each of these industries was above the NSW averages.

Vehicle ownership

The study area had lower proportions of households with access to a motor vehicle and households with two or more vehicles in the study area was slightly below the NSW average.

Worker population profile

There were about 16,663 people who worked within the study area, of which about 60 per cent worked in the Raymond Terrace SA2, reflecting employment areas such as Tomago industrial area and Heatherbrae and Raymond Terrace commercial areas (ABS 2016b).

Manufacturing was the main industry of employment for people working in the study area, employing 23 per cent of workers. Other key industries of employment for people working in the study area included construction (12.2 per cent of workers), retail trade (7.8 per cent of workers), transport, postal and warehousing (5.8 per cent of workers), and public administration and safety (5.2 per cent of workers).

About 84.5 per cent of people working in the study area used a car for all or part of their commute to work, compared to 63.5 per cent in NSW. A further 1.3 per cent of workers either walked or cycled to work, well below the NSW average at 4.6 per cent. Workers in the study area had an average commuting distance of 23.6 kilometres between their home and work, compared to 16.1 kilometres in NSW.

13.3.4 Local business and industry

Businesses in the study area

There were 1,521 registered businesses in the study area in 2019, of which just over half were non-employing businesses (that is, sole traders or partnerships with no employees in addition to the business owners). Construction related business accounted for the highest proportion of businesses in the study area (at about 20.8 per cent), which is above the proportion of these businesses in NSW. Rental, hiring and real estate services comprised the second largest proportion of businesses (at 12.2 per cent), followed by manufacturing (8.9 per cent) and transport, postal and warehousing (8.7 per cent). The proportion of these businesses in the study area were all above the average for NSW.

Businesses near the project

A range of businesses at Beresfield, Hexham, Tomago and Heatherbrae have the potential to experience impacts from the project's construction and operation due to their location near the project or along the New England Highway and Pacific Highway. These include businesses that service the needs of local and regional communities as well as travelling motorists, such as:

- Service stations
- Accommodation services (including motel accommodation and caravan park)
- Food services (takeaway bakeries, cafes and restaurants)
- Retailers (including recreational goods, household and electrical goods, hardware, building and garden supplies, pet supplies, caravans, clothing and footwear)
- Manufacturers (including metal products, machinery and equipment)
- Wholesalers (including building products)
- Construction services (such as machinery and equipment hire, repair and maintenance).

Businesses located near the project or with a frontage to the New England Highway and Pacific Highway are shown on **Figure 13-2**. Commercial and industrial uses are also located within the Tomago Industrial Precinct and Beresfield industrial area.

A train support facility for Aurizon coal trains is also located at Hexham, west of the Main North Rail Line. The facility services Aurizon's Hunter Valley coal freight business and alleviates capacity pressures in the coal supply chain.

Overall, Beresfield, Tomago and Heatherbrae have differing business environments. Beresfield comprises mainly light industrial, freight and logistics and manufacturing businesses. Tomago mainly comprises major industrial and manufacturing uses within the Tomago Industrial Precinct. The majority of businesses in Beresfield and Tomago are considered 'destination uses', which are likely to attract customers from a wide catchment and who deliberately plan to use a particular business due to specific goods and services being offered.

Heatherbrae comprises a mix of business uses, including retail and service uses, light industrial and manufacturing uses. The customer base for businesses in Heatherbrae would include a mix of customers who have deliberately planned to use a particular business and customers who access a business because they refer to it while they are driving past ('passing trade').

Findings of business and car park surveys

Heatherbrae and Beresfield have established business environments, with most businesses surveyed indicating they had operated for more than ten years, with seven businesses indicating they had been operating for more than 20 years. The number of people employed by businesses surveyed varied, with six businesses employing between two to five people, and seven businesses employing between 21 and 50 people. Two businesses indicated they employed more than 50 people.

Most businesses surveyed indicated that the business services a wide catchment, including the Newcastle, Maitland, Port Stephens, Lake Macquarie and Greater Sydney regions. Some businesses, for example accommodation providers, also indicated that their catchment includes interstate and overseas customers.

Customers from suburbs within the 2324 postcode (16 suburbs identified) comprised 20.8 per cent of cars surveyed at businesses within Heatherbrae, with most coming from Raymond Terrace. Unlike Heatherbrae, Beresfield did not demonstrate any specific postcode as its primary customer base, which may reflect the types of businesses used for the car park survey in this location (e.g. service station, takeaway). However, the surrounding suburbs within the 2322 postcode (seven suburbs identified) comprised the highest proportion of cars surveyed (8.3 per cent). Both Heatherbrae and Beresfield recorded smaller proportions of customers as being from across NSW and interstate compared to local suburbs. Further information on the suburbs identified within each postcode is provided in the Socio-economic Working Paper (**Appendix M**).

Passing trade was identified as important to numerous businesses surveyed at Heatherbrae and Beresfield, although perceptions about the importance of passing trade varied between individual businesses and was not consistent between similar business types. In general, businesses such as service stations and food outlets estimated that 50 to 75 per cent of their customers were associated with passing trade.

Feedback from the business surveys indicated that many businesses experience increased trade during peak holiday periods, with this generally being associated with motorists travelling along the Pacific Highway. Some businesses also identified that the distance from Sydney and location on the Pacific Highway made Heatherbrae and Beresfield important stopping points for motorists travelling along the Highway. The location of businesses was also identified as important in attracting local workers on their way to work.

Future business growth and development

The transitioning of Heatherbrae into a key regional destination for bulky goods is likely to result in changes to the types of businesses in the area, such as an increase in wholesaling and retailing in homewares, furniture and white goods. This is expected to result in a business environment that is less reliant on passing trade.

The Greater Newcastle Metropolitan Plan 2036 (DPE 2018) recognises Beresfield, Black Hill and Tomago as catalyst areas and major employment and trading hubs within Greater Newcastle. Beresfield and Black Hill are proposed to be a freight and logistics hub, with complementary manufacturing and light industrial activity.

Tomago is proposed to be an advanced manufacturing and industrial area. Local planning for the Tomago Industrial Precinct will look to enable the efficient movement of goods by protecting freight routes connecting Tomago to Newcastle Airport and Port of Newcastle. The Tomago Shipbuilding Precinct located next to the Hunter River is identified as a location to promote the development of shipbuilding industries.

Figure 13-2 Businesses near the project (map 1 of 5)

Construction footprint

Business

- Accommodation
- Equipment hire
- Manufacturing / industrial

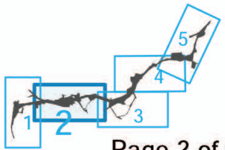

Figure 13-2 Businesses near the project (map 2 of 5)

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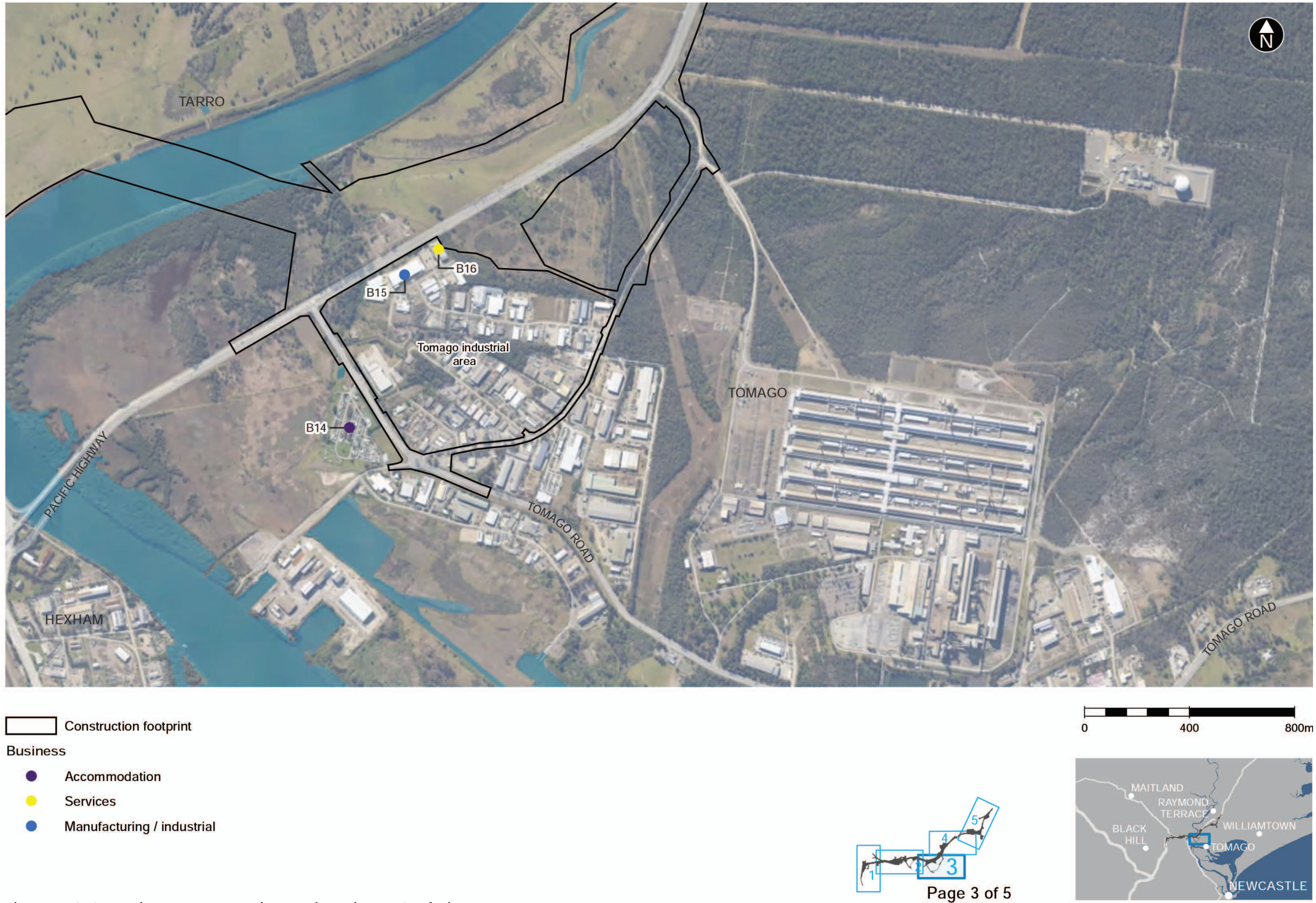
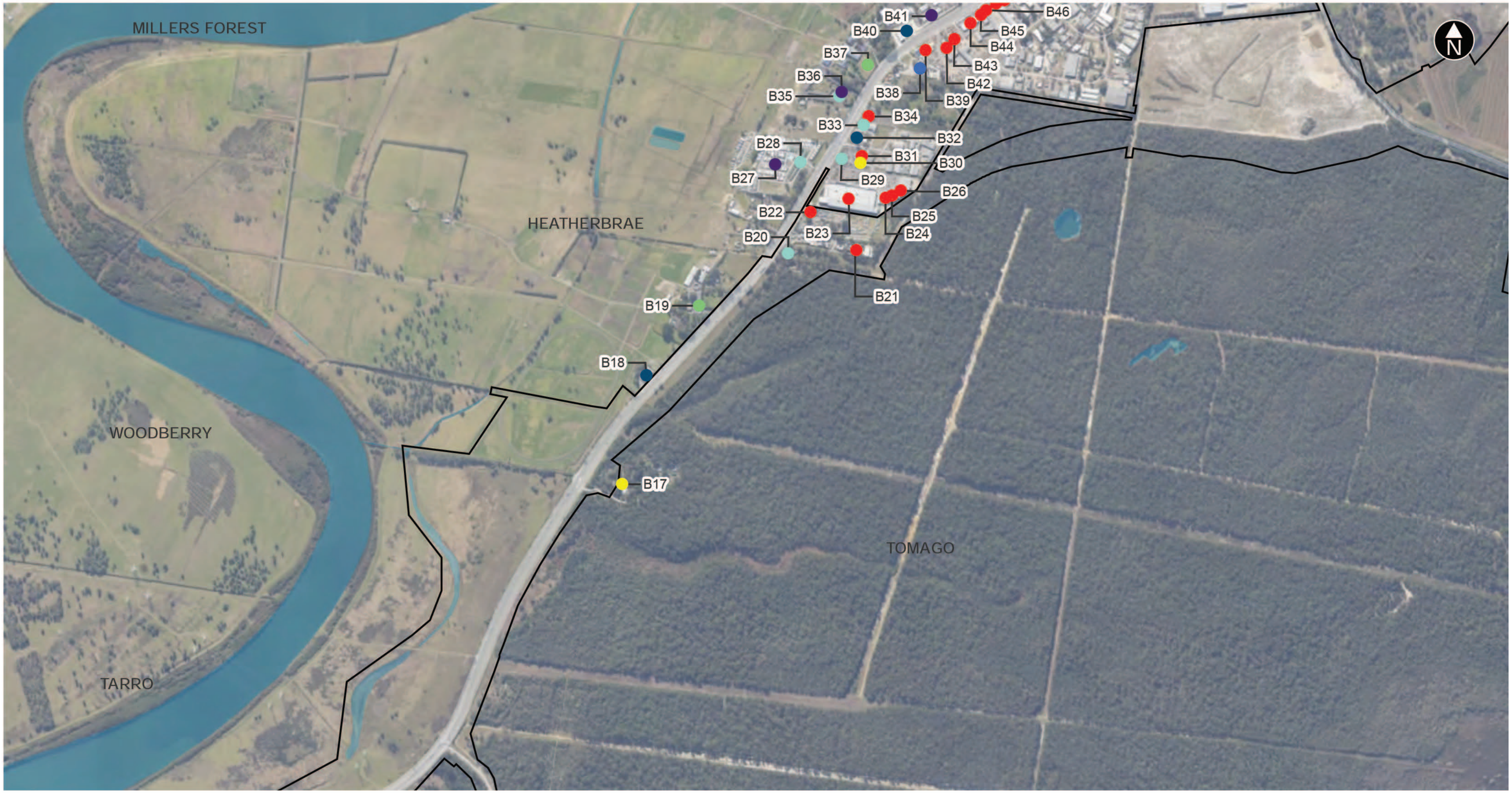


Figure 13-2 Businesses near the project (map 3 of 5)



Construction footprint

Business

- Accommodation
- Agriculture – horse breeding/ training
- Services
- Cafe / restaurant / take-away
- Manufacturing / industrial
- Retail
- Service stations

0 400 800m

Page 4 of 5

Figure 13-2 Businesses near the project (map 4 of 5)

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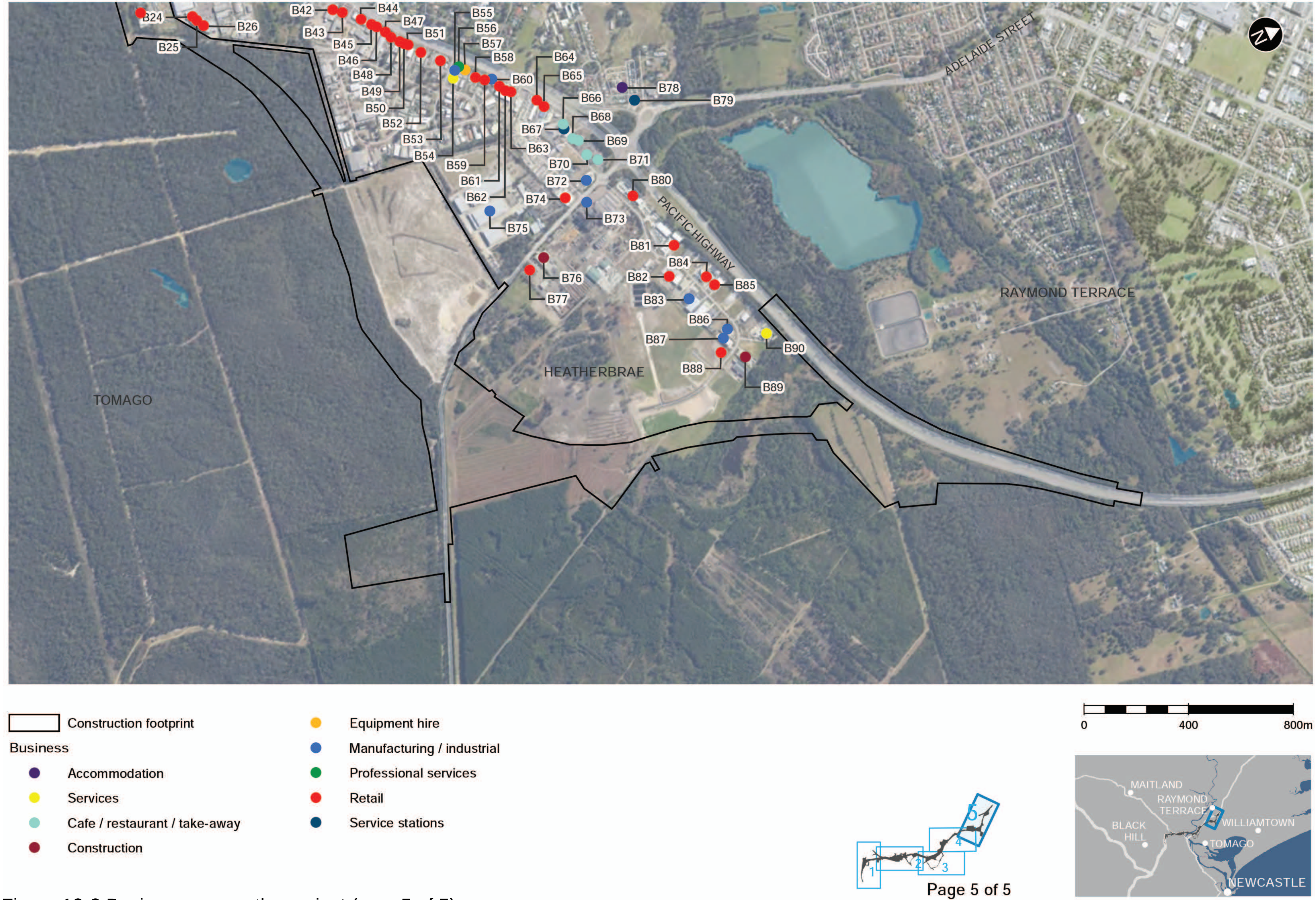


Figure 13-2 Businesses near the project (map 5 of 5)

Commercial and recreational fishing

Commercial fishing and aquaculture farmers

Areas of the Hunter River near the project that are available or used for commercial fishing are located to the north of the Hexham Bridge, which are fishing grounds for prawn trawling with a primary season between October and May each year.

The Hunter River estuary forms part of the Eastern Prawn Trawl Fishery, which also includes the estuaries of the Clarence and Hawkesbury Rivers. Access to the fishery is limited to shareholders and/or their nominated fisher, with 22 shareholders operating in the Hunter River Estuary Prawn Trawl. The primary markets for these prawns are Sydney and regional centres (DPI 2017).

Consultation by Transport with the Commercial Fisherman's Co-operative in 2016 and 2020, indicated that trawlers are about 20 metres wide and would need a minimum clearance of 32 metres. Other considerations raised by the Co-operative during consultation included:

- Trawling occurs close to the shores on the south-western side of the Hunter River and concerns that earthworks on the banks or construction of the pylons may inhibit the ability to trawl in this location
- The bridge spans for the project should be no narrower in the main channel than the existing (Pacific Highway) bridge spans
- Meshing (gill netting) is used in the Hunter River outside of the prawn season for species such as mullet, bream and jewfish and that the new bridge should not impact these activities
- Potential for construction to occur over the winter months to avoid impact on trawlers
- The nets used for trawling have a span of about 15 metres. Issues currently exist within the Hunter River in relation to not being able to pass through one span of the existing (Pacific Highway) bridge due to snags that rip nets
- Need to ensure that no metal, rubbish etc from construction activities enters the Hunter River as this may rip nets.

Aquaculture production in the Hunter Region (excluding Newcastle) is primarily focused on oysters and barramundi (with the latter occurring outside of the study area). The Hunter River also contains oyster leases located away from the project near Stockton Bridge, about 13 kilometres downstream of the project, which are held by a small number of permit holders who mainly cultivate Sydney Rock Oysters.

Recreational fishing

Coastal, estuarine and fresh waters in the Hunter Region, including the Hunter River, are popular locations for recreational fishing. The NSW/ACT Recreational Fishing Survey – 2013/2014 (DPI 2015) found that the majority of recreational fisher days in the Hunter fishing zone were by local or nearby residents from the Hunter Region, Newcastle and Lake Macquarie and about half of these fisher days were boat-based with about 63 per cent within the estuarine waters.

The Hunter River is subject to various fishing closures at certain times of the year. In particular, the section of the Hunter River near the project is closed to hand-hauled prawn nets and push/scissor nets from June to October annually. Access to the Hunter River near the project is provided by boat ramps at Tomago Road, Tomago (downstream of Hexham Bridge) and Riverside Park and King Park Sporting Complex at Raymond Terrace. These are outside of the construction and operational footprints for the project.

Tourism

Regional tourism

In 2019, about 4.63 million people visited the City of Newcastle LGA in 2019. At the same time, the Port Stephens Council LGA had about 1.57 million visitors, the Maitland City LGA had about 801,000 visitors and the Cessnock City LGA had about 1.05 million visitors. Domestic day trippers comprised the largest visitor group, representing about 66.4 per cent of visitors in the City of Newcastle LGA, 51.6 per cent in Port Stephens Council LGA, 78.4 per cent in the Maitland City LGA and 57.2 per cent in the Cessnock City LGA. International visitors represented the smallest visitor group, representing less than 2.5 per cent of visitors in each LGA.

Holidaying and visiting family and friends were the top reasons for visiting the City of Newcastle, Port Stephens Council, Maitland City and Cessnock City LGAs. Business related travel was also a key reason for visitors to the City of Newcastle LGA. Staying with family and friends was a population accommodation option for overnight visitors, accounting for about 2.7 million visitor nights in the City of Newcastle LGA, about 673,000 visitor nights in the Port Stephens Council LGA, about 462,000 visitor nights in the Maitland City LGA and about 264,000 visitor nights in the Cessnock City LGA. Hotel accommodation accounted for about 19 per cent of visitor nights in the City of Newcastle LGA, 23 per cent of visitor nights in the Port Stephens Council LGA and about 37 per cent of visitor nights in the Cessnock City LGA. Commercial camping/ caravan parks were also a popular accommodation option for visitors to Port Stephens, accounting for about 376,000 visitor nights.

In 2019, there were 1,972 tourism related businesses within the City of Newcastle LGA, 638 tourism related businesses in the Port Stephens Council LGA, 662 tourism businesses in the Maitland City LGA and 505 tourism-related businesses in the Cessnock City LGA. The majority of tourism related businesses in each LGA comprised ‘non-employing’ businesses (for example, sole traders) (Tourism Research Australia 2019).

For the year ending in June 2016, there were 26 hotels, motels and serviced apartments with 15 rooms or more in the City of Newcastle LGA, 18 establishments in the Port Stephens Council LGA, eight establishments in the Maitland City LGA and a further 24 establishments in the Cessnock City LGA.

Local tourism

The study area is a key tourism service centre, with businesses that cater for overnight and day-trip visitors as well as motorists travelling along the Pacific Highway. The Hunter Region Botanic Gardens (HRBG) attracts visitors from the surrounding region and beyond.

A range of tourism related businesses are located at Beresfield and Heatherbrae, that provide services for visitors and motorists, including:

- Motel and caravan park accommodation providers such as Tomago Village Van Park, Pacific Gardens Van Village, Sir Francis Drake Inn, Country Comfort Motto Farm Motel and Bellhaven Caravan Park
- Cafes, restaurants and take-away food outlets at Beresfield and Heatherbrae, including fast-food outlets, restaurants with accommodation providers (for example, Golden Terrace Chinese and Golden Hind restaurants), and cafes such as Heatherbrae Pies.

A number of businesses at Heatherbrae also provide services and facilities for self-drive tourists such as caravan retailers and repairs.

13.3.5 Community values

Community values include those values or features held as important to communities for quality of life and well-being. The identification of community values for this assessment has been informed by the review of existing literature from City of Newcastle and Port Stephens Council, outcomes of consultation carried out for the project, and observations.

Local amenity and character

The amenity and character in the study area is influenced by a range of land uses, including:

- Rural land uses, including land used for grazing and horse training at Beresfield, Tarro, Woodberry and Heatherbrae
- Industrial and utilities uses at Black Hill, Beresfield and Tomago
- Commercial, light industrial and large-scale retail uses at Heatherbrae
- Urban residential uses at Beresfield, Tarro, Heatherbrae and Raymond Terrace
- Environmental features including the Hunter River, Hunter Wetlands National Park at Hexham and Tomago Sandbeds
- Major transport infrastructure, including major roads such as the M1 Pacific Motorway, Pacific Highway and New England Highway, and the Main North Rail Line.

Several areas near the project are undergoing change, with Raymond Terrace identified in the Greater Newcastle Metropolitan Plan 2036 (DPE 2018) as an emerging city centre and location of local housing and job opportunities. Beresfield and Black Hill are also transitioning from mainly rural uses to a major employment and trading hub, with a mix of industrial uses. This future development would offer residents access to new residential and urban uses and local employment opportunities. It will also result in changes to the rural landscape in some parts of the study area.

Existing noise levels vary across the study area, with residential areas mostly influenced by road traffic noise and noise from nearby commercial and industrial areas.

The Indigenous and non-Indigenous heritage and history of the study area also contributes to the character and identity of communities. The protection and promotion of the region’s heritage is recognised in the community strategic plans for the City of Newcastle and Port Stephens Council LGAs. Further information is provided in **Chapter 12** (Aboriginal cultural heritage) and **Chapter 17** (non-Aboriginal heritage).

Community cohesion

Community and social networks in the study area are likely to be associated with social infrastructure such as schools, churches and sporting clubs. The HRBG also fosters a strong level of community cohesion and shared values, offering environmental, education and landscape amenity values that are important to local communities, visitors and volunteers.

Community health and safety

Maintaining road safety and provision of a safe, reliable and efficient road network is important to communities in the study area.

During business surveys carried out for the project, some business owners/ managers indicated that customers were concerned about accessing businesses in Heatherbrae from the Pacific Highway during peak traffic periods, with customers scheduling visits around low traffic periods. Large traffic volumes, including heavy vehicles, along the Pacific Highway would also likely affect existing amenity for these business owners. Feedback from consultation for the project identified general support for the project in addressing existing concerns with the road network.

Health risks to the community also include noise and air quality impacts. These are discussed further in **Chapter 8** (noise and vibration), **Chapter 18** (air quality) and **Chapter 22** (safety and risk).

Natural environment

The Hunter River and floodplain supports a range of commercial activities such as fishing, farming and industry and provides access for local and regional communities to informal recreation opportunities such as boating, fishing, kayaking and birdwatching. Downstream of the project, the Hunter River splits into two main channels, separated by the Ramsar-protected Kooragang Wetlands. The Tomago Sandbeds are also an important natural resource providing a drinking water resource for the Lower Hunter, particularly during periods of drought.

The study area provides a variety of land and water-based habitats and foraging areas for a range of species and is home to several threatened species. Protection and conservation of flora and fauna is important to communities in the study area reflected in the Newcastle and Port Stephens Community Strategic Plans and consultation with the community. Further information on biodiversity values within the study area are provided in **Chapter 9** (biodiversity).

13.3.6 Social infrastructure

Regional and state level community services and facilities are located within the City of Newcastle and Port Stephens Council LGAs that cater for communities in the study area as well as in the broader Hunter, including:

- Hospitals, such as the John Hunter Hospital, Hunter Valley Private Hospital, Calvary Mater Newcastle, Newcastle Private Hospital, Lingard Private Hospital and James Fletcher Hospital
- Tertiary education facilities, including the University of Newcastle with campuses in Newcastle and at Callaghan and Hunter TAFE which is located in Hamilton
- Regional, state and national sport and recreation facilities, such as Hunter Stadium
- Major entertainment facilities, such as Newcastle Entertainment Centre
- Major retail, commercial uses, cultural and community support facilities.

A range of social infrastructure is located within about one kilometre of the project that have potential to experience changes during construction and operation due to access changes. Social infrastructure within one kilometre of the project are shown on **Figure 13-3**.

The study area also includes a range of community facilities and services that mainly cater for communities in the study area and surrounding region. Community facilities and services within 400 metres of the project that have potential to experience direct or indirect impacts due to the siting of project infrastructure, construction activities or operation include:

- Sport, recreation and leisure facilities, such as bowling clubs and golf courses, including:
  - Hunter Valley Equestrian Centre (S01)
  - Hunter Valley Traditional Archers (S02)
  - Pasadena Crescent Reserve soccer fields (S03)
  - Fiona John Park (S14)
  - Tarro Recreation area (S22)
  - HRBG (S25).
- Education facilities, including schools and an early education centre, including:
  - Our Lady of Lourdes Primary School / Aspect Hunter School (S17/S18)
  - Tarro Public School (S21).
- Cultural facilities, including churches and cemeteries, including:
  - Tarro General Cemetery (S15)
  - Tarro Uniting Church of Australia (S16).

- Other social infrastructure including:
  - Tarro Fire Station (S19)
  - Tarro Community Hall (S20).

Further information on social infrastructure located within 400 metres of the project is provided in the Socio-economic Working Paper (**Appendix M**).

13.3.7 Access and connectivity

Transport infrastructure and facilities

The M1 Pacific Motorway is part of the key north-south National Land Transport Network (NLTN) corridor linking Sydney to Brisbane and to Newcastle and the Hunter Region. The corridor provides key connections to employment areas in Tomago, Newcastle Airport and the Williamtown RAAF Base. Other key roads servicing the study area include the New England Highway / Maitland Road corridor, the Hunter Expressway, John Renshaw Drive, Weakleys Drive, Old Punt Road and Tomago Road.

The rail network in the study area consists of the Main North Rail Line, which provides access for freight and passenger services. Regional passenger services in the study area are provided on the Hunter Line. The study area is also serviced by long distance passenger services operated by NSW TrainLink.

The bus network in the study area consists of local buses and long-distance coach services. Local bus services near the project provide connections to Newcastle, Raymond Terrace, Newcastle Airport, Nelson Bay and Maitland, and mainly use local roads.

There are limited pedestrian facilities in the study area, particularly along the NLTN and state roads, due to the relatively low demand. There are various footpaths and associated facilities in the key residential catchment areas (e.g. Tarro and Beresfield) and limited footpaths and facilities within industrial and employment areas at Beresfield, Tomago and Heatherbrae. Signalised pedestrian crossings are provided at the following intersections:

- Pacific Highway/Tomago Road: across the eastern leg of the intersection
- Pacific Highway/Hank Street: across all approaches to the intersection.

There are no existing dedicated cycle paths within the study area with cyclists using the shoulders of the existing road network. Inter-regional cycle movement is facilitated by on-road shoulders on the M1 Pacific Motorway, New England Highway/Maitland Road and Pacific Highway and are classified by the Cycleway Finder V3 (Transport for NSW 2020b) as high difficulty routes. Weakleys Drive, John Renshaw Drive and Tomago Road are also designated as high difficulty on-road routes. Anderson Drive through Beresfield and Tarro is designated as a low difficulty on-road route.

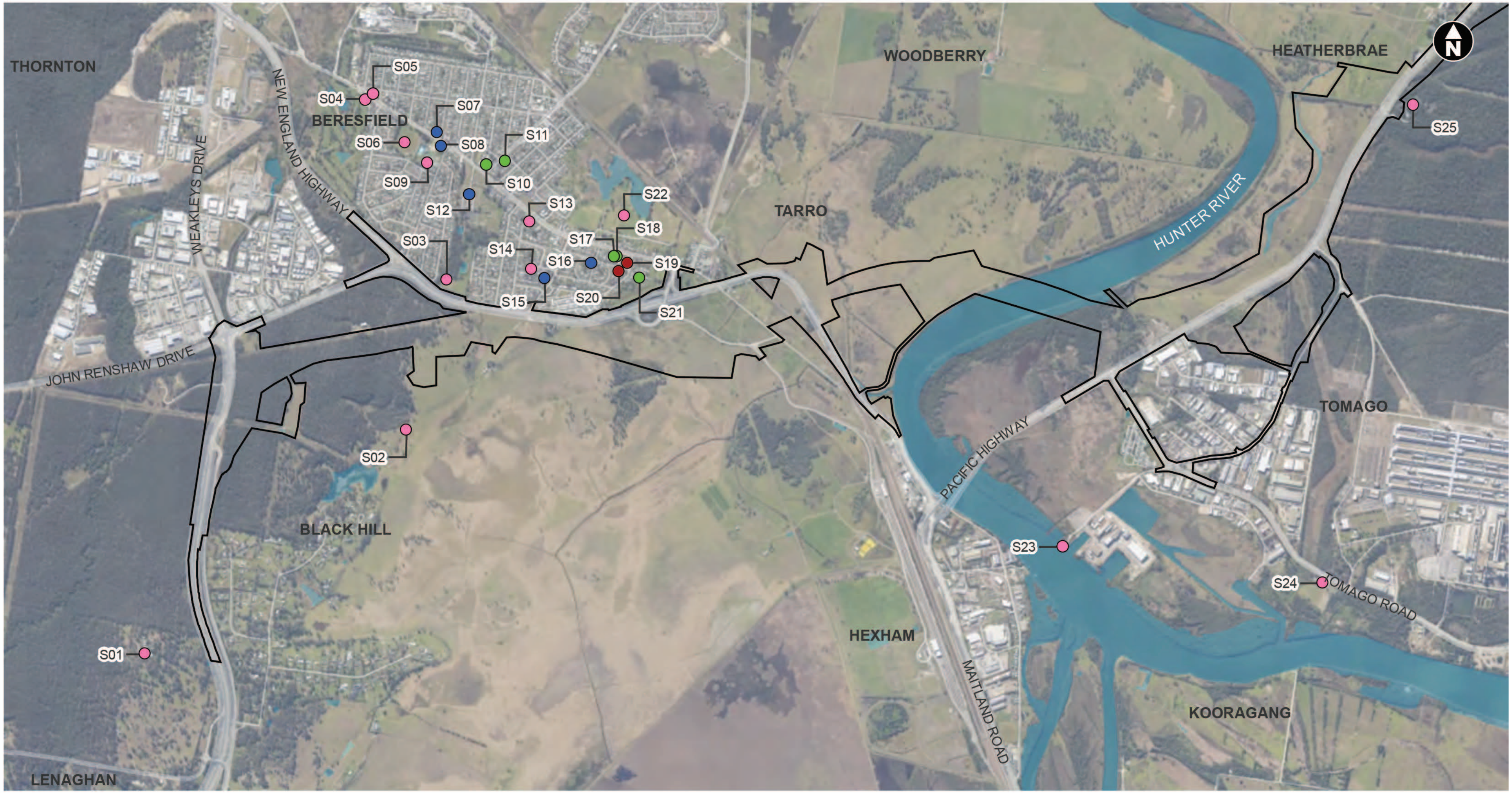
Newcastle Airport is located in Williamtown, about 15 kilometres north of Newcastle. The airport is owned by City of Newcastle and Port Stephens Council on land leased from the Department of Defence. The airport runway is shared with the Williamtown RAAF Base.

Journey to work

Car travel was the predominant mode of travel to work for residents in the study area, with about 79.2 per cent of people using a car for all or part of their journey to work (either as driver or as passenger). This is above the averages for NSW and the City of Newcastle and Port Stephens Council LGAs and is likely to reflect limited public transport access in parts of the study area. Less than one per cent of residents in the study area as a whole used a train for all or part of their journey to work, compared to about 11.2 per cent in NSW. This was closer to two per cent of people in the Beresfield-Hexham area reflecting the location of train stations at Thornton, Beresfield, Tarro and Hexham.

About 1.1 per cent of people in the study area used the bus for all or part of their commute to work. This is well below the proportion of bus commuters in NSW (6.2 per cent) and is likely to reflect limited public transport access and longer commuting distances residents in the study area are required to travel. Compared to NSW, the study area had lower proportions of people who worked from home and higher proportions of people who did not go to work.

Residents in the study area generally travel longer commuting distances. In 2016, the average commute for residents was 19 kilometres, compared to 16.3 kilometres for residents across NSW.



Construction footprint

Social infrastructure

- Education facilities
- Sport, recreation and leisure facilities
- Cultural facilities
- Other facilities

Data source: LPI 2020

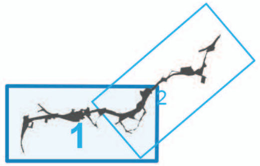


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Figure 13-3 Social infrastructure within one kilometre of the project (map 1 of 2)

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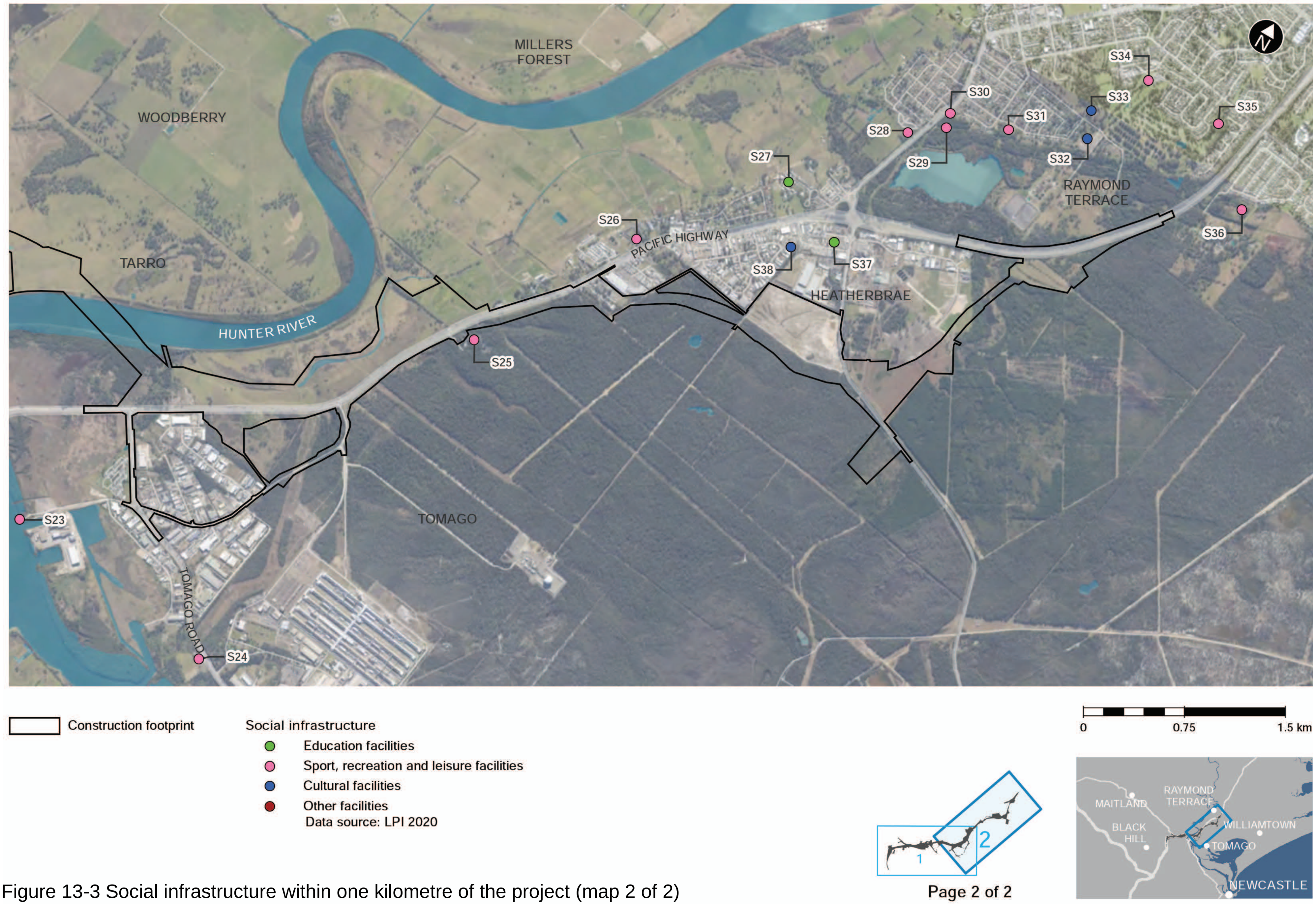

Figure 13-3 Social infrastructure within one kilometre of the project (map 2 of 2)

13.4 Assessment of potential impacts

13.4.1 Construction impacts

Population and demography

Construction of the project is not expected to change population and demography in the study area, including age and gender profiles given effects on population and demography of infrastructure projects would mainly relate to such things as the relocation of residents due to acquisition or the influx of workers for construction. In relation to the project workforce, it is anticipated that workers would generally be sourced from across the Hunter and or from areas in Greater Sydney that are within commuting distance of the project. As such, most construction workers would commute from their homes and changes to population and demography in the study area from the influx of construction workers would be relatively minor.

Employment and training

Effects on employment and training would mainly relate to direct and indirect employment and training opportunities offered by the project.

During construction, the project would impact positively on employment, creating an average of about 2700 direct and indirect employment opportunities annually. The size of the construction workforce would fluctuate over the four year construction period, although on average the project would create direct employment for about 1050 workers per year, including construction workers and professional and administrative staff. It is expected that on average, the project would also create 1650 indirect jobs per year with businesses that supply goods and services to support construction activities.

These benefits would be realised by local and regional communities, with construction workers expected to be sourced from across the Hunter and Greater Sydney regions. The level of benefit for residents in the study area and surrounding LGAs would be dependent on the availability of appropriately skilled and qualified workers.

Construction of the project is likely to provide benefits for groups such as young people, unemployed, women and Aboriginal people. In particular, the project's construction would provide training opportunities and apprenticeships, allowing young people to gain skills in the construction industry. The construction phase would provide opportunities to increase the participation of women in the construction industry and trade-related work, consistent with NSW Government initiatives. The implementation of the NSW Government's Aboriginal Participation in Construction policy would also provide employment and training opportunities for Aboriginal people in the Hunter Region. Transport is currently preparing a strategy to assess current Aboriginal business capabilities in the region and identify gaps in training and employment, to assist in meeting the targeted participation requirements for the project.

From 1 January 2021, the Aboriginal Participation in Construction Policy will merge with the Aboriginal Procurement policy to form a new Aboriginal Procurement Policy. The new policy would require agencies to include minimum requirements for 1.5 per cent Aboriginal participation in all contracts valued at $7.5 million or above (NSW Treasury 2020).

Employment and training opportunities associated with the project would support improved social and economic outcomes for individuals, through skills development, income, and enhanced opportunities for future employment.

Business and industry

Impacts on businesses in the study area

During construction, potential impacts on businesses in the study area are expected to be associated with:

- Increased expenditure by construction workers on local goods and services, resulting in positive impacts for some businesses
- Required goods and services for construction, such as earth moving contractors, transport operators and equipment hire, resulting in positive impacts for some businesses
- Changes in access to businesses due to temporary road changes, disruptions and delays near to construction work
- Increased noise and dust from construction activities, impacting on amenity at businesses near the project
- Temporary disruptions to utility supplies due to short-term shutdowns during utility work.

The construction phase may have a positive effect on some local businesses through increased trade in response to day-to-day needs of construction workers and supply of goods and services to construction. Opportunities to maximise the use of local businesses during the construction phase was identified as important by business owners during the business survey. Any opportunities for local businesses would be considered prior and during construction of the project.

Access to businesses for customers, staff and deliveries would be maintained. Where temporary changes are required, these would be determined in consultation with affected businesses to ensure that any potential impacts are appropriately managed. Much of the project would be constructed away from existing roads, with impacts on the existing roads mainly occurring where the project connects with the existing road network. Traffic flow would also be maintained during construction along with existing speed limits, where possible. While short-term delays and disruptions due to roadwork may inconvenience some business customers these are generally expected to be manageable and are not expected to impact on customer levels for businesses in the study area.

The project would directly impact on the access road to the Aurizon Hexham Train Support Facility, requiring permanent realignment of the access road however the new access road would be constructed early in the construction phase to ensure continued access.

Businesses located near the project may experience temporary impacts on amenity due to noise and dust from construction activities, particularly for businesses in Beresfield near construction work. Some businesses in Tomago and Heatherbrae may also experience noise impacts during noisy work (refer to **Chapter 8** (noise and vibration)).

The effect of temporary impacts on amenity due to noise and dust from construction activities would depend on the nature and type of business but could impact on customer interaction in outdoor areas or a decline in general business ambience. Cafes and restaurants with outdoor dining areas are mainly located away from the project and are generally not expected to be impacted by changes to amenity. The exception to this would be the café within the HRBG. Dust from construction activities was identified through the business survey as a concern for businesses such as caravan dealerships at Heatherbrae.

The sensitivity of businesses to changes from the construction of the project is likely to have increased since the survey was conducted in September 2016 given the impact of COVID-19 on businesses in the study area and wider region. The need to maximise local business opportunities from the construction of the project is also expected to have increased in importance.

Fishing and aquaculture

Construction of the project would not directly impact on areas leased for oyster aquaculture in the Hunter River with these located near Stockton Bridge about 13 kilometres downstream of the project. The implementation of measures to manage surface water impacts within the Hunter River would help to minimise potential for indirect impacts on oyster aquaculture. The construction process for the portion of the viaduct that crosses the Hunter River is discussed in **Chapter 5**.

During the construction phase, access for commercial and recreational vessels using the Hunter River would generally be maintained. Potential impacts on commercial and recreational fishing would mainly be associated with:

- Temporary, short-term closures to access for vessels using the Hunter River during some work over the river
- Access restrictions within the construction footprint for areas outside of the main channel (for example, restrictions on access to the shoreline)
- Navigational restrictions, for example limits on speeds, near construction work for safety
- Restrictions on trawling for prawns along the shoreline within the construction footprint, requiring changes to trawling practices, such as nets being pulled in.

Consideration of prawn trawling activities would be given in detailed construction planning to minimise impacts on commercial fishing operations, although it is likely that construction within the Hunter River would occur during at least one trawling season.

Following construction, all temporary work in the riverbed (for example temporary piles and wharves) would be removed.

Tourism

Potential impacts on regional and local tourism would mainly be associated with:

- The use of some of the available, under-utilised tourist accommodation for the construction workforce, resulting in economic benefits for accommodation owners
- Traffic changes resulting in potential delays and disruptions to travelling motorists using the Pacific Highway and other major roads in the study area
- Amenity impacts for tourist accommodation near to proposed work.

It is expected that construction workers would generally be sourced from across the Hunter and Greater Sydney regions. There is potential, however, that some construction workers from outside of the surrounding region may choose to stay locally during their working week. This may increase demand for short-term visitor accommodation in the study area. The use of some of the available, under-utilised tourist accommodation for the construction workforce would provide economic benefits for accommodation businesses through increased revenue.

There is potential that some motorists may choose alternate routes to avoid construction activities, although it is likely that many would continue to use the Pacific Highway as the main route serving coastal towns in Central and Northern NSW. Where possible, the timing of major construction activities that have potential to cause increased traffic impacts would be scheduled considering the timing of major holiday periods such as Christmas and Easter to minimise potential impacts on travelling motorists.

The project would impact on the visitor car park at the HRBG used by staff, volunteers or visitors, requiring management of parking during construction. Access to HRBG for visitors, staff, volunteers and deliveries would be maintained during construction. Noise, dust and traffic from construction activities may temporarily reduce amenity for visitors, staff and volunteers at HRBG, potentially detracting from the use and enjoyment of the facilities.

Community values

Local amenity and character

Communities that are most likely to be affected by changes to local amenity from construction activities include residential communities at Beresfield and Tarro, and residential uses and commercial uses at Heatherbrae. Adverse changes to local amenity for communities and areas near to construction work, construction compounds and haulage routes would mainly result from:

- Noise, vibration, dust and traffic from construction activities
- Changes in visual amenity due to the removal of established vegetation and presence of construction work and infrastructure
- Light spill from night-time construction work near to residential uses.

Changes to local amenity resulting from increased noise and dust from construction activities may temporarily impact on individuals' use and enjoyment of their homes, businesses and community facilities.

Communities that are most likely to be affected by changes to local amenity from construction activities include:

- Residential communities at Beresfield and Tarro
- Residential uses including visitor accommodation, at Heatherbrae
- Commercial uses at Heatherbrae.

Changes to local amenity resulting from increased noise and dust from construction activities may temporarily impact on individuals' use and enjoyment of their homes, businesses and community facilities. While most construction activities would be carried out during day-time hours, some work may need to be carried out during the evening and at night to minimise potential impacts on regional road networks. A list of activities likely to require evening or night-time work is provided in **Chapter 5**.

Access would be maintained to the Hunter River during construction, helping to minimise potential impacts on commercial and recreational users. While this may impact on some commercial fishing operations in areas near the construction work as described above, navigational restrictions are not expected to impact on the general use of the river.

During construction, direct and indirect impacts on non-Aboriginal heritage items such as the Glenrowan Homestead and Aboriginal sites within the construction footprint, have potential to affect community values relating to heritage and history in the study area. Further discussion on potential impacts on non-Aboriginal and Aboriginal values is provided in **Chapter 12** (Aboriginal cultural heritage) and **Chapter 17** (non-Aboriginal heritage).

Community cohesion

Potential impacts on community cohesion would mainly be associated with temporary disruptions to the use of some social infrastructure and meeting places. In particular, actual or perceived impacts on the HRBG due to temporary changes to access for motorists and public transport users, and noise and dust from construction activities, may detract from the enjoyment of the gardens for some volunteers. This may temporarily impact on volunteering levels and disrupt social networks and relationships associated with the HRBG. These impacts are likely to be temporary and are not expected to impact on the participation of volunteers following construction activities in the vicinity of the gardens.

Construction activities on roads in the study area may result in temporary delays or disruptions and may discourage some people from making some trips. Perceptions about road conditions during construction may also influence people's decisions around local travel. These changes may impact on some people's access to meeting places and participation in local activities, although any potential impacts on community cohesion are likely to be minor.

Community health and safety

Noise, light spill and dust from construction activities have potential to impact on the health and wellbeing of some residents closest to construction work. This impact is most likely to occur where night-time work results in sleep disturbance over extended periods of time or where construction activities create extended periods of high noise or dust levels.

Night work and lighting during construction would be managed in accordance with relevant statutory requirements and guidelines to avoid unacceptable lighting impacts and minimise the potential for adverse impacts on the health and well-being of residents near to construction works. Construction lighting procedures and management measures would be documented in the Construction Environmental Management Plan and may include consideration of such things as lighting levels, projection angles, direction and length of frequency of exposure. Further discussion about potential impacts of construction lighting is in **Chapter 15** (urban design, landscape and visual amenity). Further discussion about the potential for construction noise to cause sleep disturbance is also provided in **Chapter 8** (noise and vibration).

An increase in construction traffic and heavy vehicles on roads within the study area and changes to local traffic and access during construction may impact on community perceptions relating to road safety. Further discussion about potential impacts of construction on access and connectivity within the study area is provided below.

Natural environment

Construction of the project would require the removal of established vegetation within the construction footprint including at Black Hill, Tomago and Heatherbrae, and riparian habitat adjacent to the Hunter River. The clearing of established vegetation for the project is likely to be a concern for some community members, impacting on values relating to ecology, landscape, scenic amenity and the Hunter River. Following construction, areas impacted by construction work that are not required for permanent infrastructure would be rehabilitated.

Social infrastructure

During construction, impacts on social infrastructure in the study area may result from:

- Increased noise, dust and construction traffic, impacting on amenity for users and workers
- Changes in local access and traffic disruptions and delays due to construction activities.

Adverse changes to local amenity and disruptions due to road access changes are most likely to affect social infrastructure located closest to construction activities, although changes to road access may also cause disruption for users of social infrastructure located further from the project, for example sport and recreation facilities and churches at Beresfield and Heatherbrae.

Access changes and increased construction traffic on roads that connect to or are crossed by the project, or that are used for construction access have potential to cause temporary delays and disruptions for users of social infrastructure at Beresfield, Tarro, Heatherbrae and Raymond Terrace. These include facilities such as schools, sport and recreation grounds, and cultural facilities. While these impacts may inconvenience some users, this is not expected to impact on the overall use of these facilities.

Potential impacts on specific social infrastructure within 400 metres of the project construction work are discussed in detail in **Table 13-2**. The location of social infrastructure is shown in **Figure 13-3**.

Table 13-2 Summary of impacts on social infrastructure within 400 metres of the project

Facility (ID / name)		Summary of impacts during construction
S01	Hunter Valley Equestrian Centre	Construction noise and dust has potential to impact on the amenity for users of the facility, but any impacts are expected to be minor given the main facilities (for example, arenas, stables, accommodation, etc) are located at least 300m from the construction footprint and further from the main construction work for the Black Hill interchange. Potential amenity impacts on the equestrian centre are expected to be manageable and the significance of impacts is expected to be negligible with the implementation of management measures.
S02	Hunter Valley Traditional Archers	Temporary impacts on amenity may occur for users of the archery club due to construction noise and dust, potentially impacting on the use and enjoyment of the club for members and visitors. Club events are mainly held on Sundays, which are outside of standard construction hours and any potential impacts would mainly be associated with out of hours work. Potential amenity impacts on the Archers club are expected to be manageable and the significance of impacts is expected to be negligible with the implementation of management measures. The project would close the access currently used by the club from the M1 Pacific Motorway. Future access to the club site facilities would require agreement between the club and the private property owner but would be available via the new access being provided by the project to the property. Potential impacts on the Archers club are expected to be manageable and the significance of impacts expected to be low.
S03	Pasadena Crescent Reserve Soccer Fields	The construction footprint would impact on the landscape buffer between the soccer fields and New England Highway. This would not impact on the use of the soccer fields however temporary impacts on amenity may occur for users of the soccer fields due to construction noise and dust. This may impact on the use of the fields for some events, particularly if they coincide with noise and dust intensive construction activities. Increased dust from construction activities also has potential to influence community perceptions relating to health and wellbeing for some users of the soccer fields, particularly as this facility is used by children. Overall, the significance of impacts on the soccer fields are expected to be low with the implementation of standard management measures and consultation and communication with managers and users of the facility.
S14	Fiona John Park	The park is located about 190m from the construction work for the New England Highway and impacts on amenity if any, are expected to be minor. The significance of potential impacts on the park are considered negligible.
S15	Tarro General Cemetery	The cemetery is now closed but provides passive recreation opportunities. The cemetery is located about 130m from the construction work for the New England Highway and impacts on amenity if any, are expected to be minor. The significance of potential impacts on the cemetery are considered negligible.
S16	Tarro Uniting Church of Australia	During construction, potential impacts would mainly be associated with temporary disruptions for some users due to local road changes at the New England Highway and Anderson Drive. The significance of potential impacts on the church are considered negligible.
S17/ S18	Our Lady of Lourdes Primary School / Aspect Hunter School	During construction, students, teachers and visitors to the school may experience temporary reductions in amenity from construction activities. These impacts are not expected to impact on classroom areas and any impacts on outdoor teaching and recreation areas are likely to be minor. An increase in construction traffic and heavy vehicles using Anderson Drive near the school may result in temporary traffic delays and disruptions for students and teachers and present possible safety risks for students, potentially impacting on community perceptions about student safety. These impacts are most likely to occur during school drop-off and pick-up times. Overall, the significance of potential impacts is expected to be low.

Facility (ID / name)		Summary of impacts during construction
S19	Tarro Fire Station	During construction, potential impacts would mainly be associated with local road changes at the New England Highway and Anderson Drive. Traffic management measures would be implemented during construction, which would assist in managing any potential impacts on the Tarro Fire Station. The significance of potential impacts on the fire station are expected to be moderate-low.
S20	Tarro Community Hall	During construction, potential impacts would mainly be associated with temporary disruptions for some users due to local road changes at the New England Highway and Anderson Drive. There is potential for noise and dust to impact on the amenity of the hall when it is in use, although impacts if any, are expected to be minor. The significance of potential impacts on the hall are considered negligible.
S21	Tarro Public School	During construction, students, teachers and visitors to the school may experience temporary reductions in in amenity due to noise and dust from construction activities. These impacts are likely to have the greatest effect on outdoor teaching and recreation areas and may disrupt the use of these areas during construction activities that generate high noise or dust levels. Potential impacts may also be experienced within some classrooms, with noise levels from some construction activities expected to be clearly audible. Increased dust from construction activities also has potential to influence community perceptions relating to health and wellbeing, particularly for children using outdoor recreation and play areas. The significance of potential impacts on the school during construction are expected to be moderate.
S22	Tarro Recreation Area	The closest sporting fields are located about 330m from the construction work for Tarro interchange. As such, impacts on amenity for users of the facility, if any, are expected to be minor. Access to the recreation area is provided from Anderson Drive, which is proposed to be used for construction access. An increase in construction traffic and heavy vehicles using Anderson Drive may present possible safety risks for users of the recreation area, particularly children. This may impact on community perceptions about children's safety. The significance of potential impacts on the recreation area are considered negligible.
S25	HRBG	During construction, the visitor car park at the entrance to the HRBG would be within the construction footprint for the project, possibly impacting on the availability of this car parking for use by staff, volunteers or visitors. Alternative on-site car parking for the construction phase would be identified in consultation with the HRBG's management. Access for visitors, staff, volunteers and deliveries would be maintained during construction, although access changes would be required during construction of the new access road and bridge (B09) on the main alignment. Traffic management measures would be implemented for the entry / exit to the gardens to maintain road safety for users. Construction of the bridge over the access road would require short-term closure of the HRBG access road to allow lifting of girders however these works would be managed in consultation with HRBG. Noise, dust and traffic from construction activities may temporarily reduce amenity for visitors, staff and volunteers at the gardens, potentially detracting from their use and enjoyment of HRBG and diminishing perceptions of peacefulness and tranquillity in some areas. In particular, some construction activities are likely to generate noise considered to be intrusive, potentially disrupting interactions between visitors, staff and volunteers in some areas. Overall, the significance of construction impacts on the gardens are expected to be moderate, with the implementation of management measures.

Access and connectivity

During construction, potential impacts on local access and connectivity would generally result from:

- Increased construction traffic on roads within the study area that provide construction access, including heavy vehicles and construction worker vehicles, impacting on road users
- Temporary changes to road conditions near to construction work (for example, where the project connects to or crosses existing roads), including reductions in speed limits, temporary traffic lane closures, and temporary diversions and access changes
- Potential changes to bus services, including changes to road conditions and the temporary relocation of some bus stops near to construction work for safety, impacting public transport users
- Changes to pedestrian and cycle access near to construction work, resulting in temporary disruptions or safety risks for users
- Construction activities over the Main North Rail Line, although track possessions would be carried out during per-defined periods of track work, helping to minimise impacts on passenger and freight rail services
- Work within the Hunter River, resulting in navigational restrictions on access for commercial and recreational vessels
- Changes to property access for some properties at Black Hill, Tarro, Tomago and Heatherbrae.

Much of the project would be constructed away from existing major roads and transport networks, helping to minimise potential impacts for road users. The function and capacity of the road network near to construction work would be generally maintained during the construction phase and access would be maintained for motorists, including oversize overmass vehicles.

During construction, potential impacts on emergency services would mainly be associated with temporary road changes where the project ties into the existing road network at Black Hill, Beresfield, Tarro, Tomago and Raymond Terrace or where the project crosses the existing road network (for example, the viaduct crossing of the New England Highway). Traffic management measures would be implemented during construction, which would assist in managing any potential delays or disruptions. This is discussed in **Section 13.5**.

13.4.2 Operational impacts

Population and demography

Property acquisition for the project would require removal of at least two dwellings and possibly one dwelling within the site of the proposed power station at Tomago. While the relocation of residents associated with the removal of dwellings for the project may result in minor localised changes to population, these changes would represent a very small proportion of the study area's population and would not change the population and demography of the study area. Property acquisition is discussed in **Chapter 14** (land use and property).

Employment and training

During operation, potential impacts on employment and training would generally result from:

- Improved access to key employment areas such as Beresfield, Black Hill, Tomago and the Port of Newcastle, resulting in enhanced access to employment for residents and workers in the wider Hunter Region
- Improved travel times and travel reliability, resulting in positive impacts on workers and residents within the study area who use a private vehicle for their commute to work
- Acquisition of commercial properties, resulting in potential loss of local employment.

Improved access and connectivity to the M1 Pacific Motorway and Pacific Highway provided by the project would also support future employment and population growth at Raymond Terrace and growth and development of employment precincts at Tomago and Thornton, Beresfield and Black Hill. This would improve access to new employment opportunities for residents and workers in the study area and wider region, supporting improved social and economic outcomes for individuals.

Improvements in travel times and travel reliability provided by the project would impact positively on workers and residents, helping to reduce commuting times and increasing access to employment within convenient commuting times.

The project would directly impact on three properties at Heatherbrae owned by Transport that currently accommodate existing businesses. Some loss of local employment may occur if these businesses choose to cease operations, possibly resulting in loss of income for affected employees and business owners. Potential impacts on employment due to the relocation of businesses to alternate sites are likely to be dependent on the businesses' new location and individual circumstances of employees, for example the ability of individual employees to travel to the new business location.

Business and industry

Directly affected businesses

The project would directly impact on three properties at Heatherbrae owned by Transport that currently accommodate existing businesses. In addition, partial acquisition would also be required for five businesses at Tarro, Tomago and Heatherbrae.

Potential impacts on individual businesses directly affected by the project are discussed in **Table 13-3.**

Table 13-3 Impacts on directly affected businesses

Business name and number	Summary of impact
Total acquisition	
Sandy's Famous Seafoods, Heatherbrae (B20)	The project would directly impact this business, requiring relocation of the business to an alternate premise prior to construction. It is likely that suitable alternate sites are available locally, although temporary disruptions to business operations are likely as the business re-establishes. Transport currently own and lease this property to the business owner.
Royal Wolf Shipping Containers, Heatherbrae (B21)	Total acquisition would require this business to relocate to an alternate premise prior to construction. It is likely that the business would be able to relocate to an alternate site locally, particularly as the nature of the business is likely to be less dependent on locational requirements.
7th Street Caravans, Heatherbrae (B22)	The project would directly impact this business, requiring relocation of the business to an alternate premise prior to construction. It is likely that suitable alternate sites are available locally, although temporary disruptions to business operations are likely as the business re-establishes. Transport currently own and lease this property to the business owner.
Partial acquisition	
Palm Valley Village, Tarro (B12)	The project would require the partial acquisition of a small area of unused land that forms part of the property occupied by this business. The affected area is outside the fence line and is used for water treatment and drainage. Acquisition of this land would not impact on the ongoing use or functioning of this business for residential accommodation. The project would remove third-party advertising signage located on the affected land.

Business name and number	Summary of impact
Hexham Train Support Facility, Hexham (B14)	The access road for this facility at Hexham would be impacted by the Tarro interchange. Access would be maintained to this facility by a new access road under the main alignment, which would be constructed early in the construction phase to ensure that continued access is provided to the facility during construction of the Tarro interchange and main alignment. As such, ongoing impacts on the use or functioning of this business are not expected.
Tomago Village Van Park, Tomago (B15)	The upgrade of the intersection of the Pacific Highway and Tomago Road would require the partial strip acquisition of land owned by this business. The affected area is generally outside of the area used for the caravan park and would not impact on the ongoing use or functioning of this business.
HRBG, Heatherbrae (B18)	The project would require the partial acquisition of a strip of vegetated land located along the existing Pacific Highway fronting the gardens and an area of car parking. This would require amendments to car parking. Entry to the HRBG would be provided via a new access road and signalised intersection with the Pacific Highway. These changes are not expected to impact on the ongoing operation of the HRBG. Consultation would be carried out with HRBG to ensure that any impacts to the ongoing operation of the business are minimised.
Evergreen Stud Farm, Heatherbrae (B20)	The project would require the partial acquisition of land used for a training track and associated railings and fencing, requiring modifications to the training track and adjustments to the fencing and railings. Any modifications or adjustments required for the project would be carried out in consultation with the property owner to ensure that any impacts on the ongoing functioning of this business are minimised.

Impacts on businesses in the study area

During operation, potential impacts on businesses in the study area would mainly result from improved access to the motorway network for businesses in Beresfield, Tomago and Heatherbrae. Within the City of Newcastle LGA, Port Stephens Council LGA and the wider Hunter, the project would have beneficial impacts on business and industry through improved access and connectivity.

Businesses in Beresfield and Heatherbrae

During operation, potential impacts on businesses in Beresfield and Heatherbrae would mainly result from diverting traffic from the existing New England Highway and Pacific Highway along the new M1 Pacific Motorway, bypassing the towns. Interchanges along the Motorway would allow motorists travelling in both directions to easily exit the project to access existing businesses and services and re-enter the project, although the project would reduce through traffic using John Renshaw Drive at Beresfield and the Pacific Highway through Heatherbrae.

Most businesses in Beresfield comprise ‘destination uses’, which are likely to attract customers from a wide catchment and who deliberately plan to use a particular business. These businesses are likely to be less affected by the bypass of Beresfield and are likely to benefit from improved access and travel conditions provided by the project. The business environment in Heatherbrae is more mixed and includes a large proportion of retail and service related uses that have a high reliance on passing motorists. These businesses, as well as the service station and associated eateries in Beresfield, would potentially be impacted by the reduction in traffic using the Pacific Highway through Beresfield and Heatherbrae. Feedback from business owners in the business survey included concerns about the potential loss of passing trade and loss of customers due to changes in access as a result of the project. Businesses surveyed that felt most at risk from a reduction in traffic included service stations, fast food outlets and some retail and accommodation businesses. Consideration will be given to signage at all interchanges along the project in accordance with Transport signage policy to inform the travelling public about services in Heatherbrae and Beresfield.

While Beresfield and Heatherbrae will continue to service motorists using the M1 Pacific Motorway, the function of these centres is expected to change. Beresfield and Black Hill are proposed to be a freight and logistics hub, with complementary manufacturing and light industrial activity while Heatherbrae is expected to transition into a key destination for bulky goods within the Hunter consistent with the Raymond Terrace and Heatherbrae Strategy 2015-2031 (Port Stephens Council 2015).

Increased commercial development in Heatherbrae and the residential growth proposed for surrounding areas has the potential to offset loss of trade experienced by local business owners due to the project. Increased commercial activity, particularly for wholesaling and retailing, is likely to also result in businesses becoming less reliant on passing trade and allow Heatherbrae to become a destination in itself.

A reduction in through traffic at Heatherbrae and Beresfield, particularly heavy vehicles, would help to enhance business amenity and improve local access. Reduced through traffic and improved road safety provided by the project was identified as a benefit for customer access by some business owners in the survey, particularly for elderly customers. Other potential benefits as a result of the project identified by local business owners included an increased local catchment of customers.

Fishing and aquaculture

The project would be designed to allow the passage of commercial fishing vessels along the Hunter River, although the placement of pylons would limit the ability to trawl along the shoreline near the viaduct. The project would require changes to trawling practices near to the bridge, with trawling nets required to be pulled in to pass under the bridge.

The project is located away from existing boat ramps at Tomago and Raymond Terrace and would not impact on access for recreational fishers.

Operation of the project is not expected to impact on areas leased for oyster aquaculture in the Hunter River.

Tourism

During operation, potential impacts on tourism would mainly result from improved travel time and reliability along the M1 Pacific Motorway and Pacific Highway, John Renshaw Drive and the New England Highway, resulting in better connections for tourists travelling between Sydney and Brisbane. This would have positive impacts on access to tourism destinations in the Hunter, and City of Newcastle and Port Stephens Council LGAs.

During operation, access for visitors to the HRBG would be available from the new signalised intersection at the Pacific Highway. Interchange arrangements either side of the site would allow tourists travelling along the main alignment to exit at either Tomago or Raymond Terrace and travel along the Pacific Highway to access the HRBG. While the changed access arrangements may affect the number of visitors who decide to visit the HRBG, it is likely that many visitors deliberately plan to visit and impacts of these access changes on this tourist destination are not expected to be major.

Access for visitors using public transport would be maintained via the bus stops fronting the HRBG. The signalised intersections would allow safer access for pedestrians, particularly those accessing the site from the bus stops.

Community values

Local amenity and character

During operation, potential impacts on local amenity and character include:

- Changes in traffic noise for communities along the alignment
- Lighting from the project resulting in changes to the night-time amenity for residential properties closest to major interchanges
- Changes in visual amenity from the introduction of new infrastructure.

Changes in road traffic noise from the project are expected to be barely perceptible (less than 2dB(A)) at most sensitive receivers along the project. However, traffic noise impacts may be experienced at some sensitive receivers due to traffic from the project moving closer to residential uses or other sensitive uses or increasing the exposure to more traffic lanes, at Black Hill, Beresfield, Tarro, Heatherbrae and Raymond Terrace. Operational impacts on residential uses and other sensitive uses in the study area and proposed management measures are discussed further in **Chapter 8** (noise and vibration). The reduction in traffic using the Pacific Highway would help to reduce traffic noise in parts of Heatherbrae, particularly at night-time, and improve safety, making it easier and more attractive for people to walk, cycle and drive.

The project would include lighting at interchanges, ramps and roads in the vicinity of interchanges, resulting in potential changes to the night-time environment at some locations. Overall, impacts from lighting are expected to be low as much of the project is located within or near existing infrastructure, although operational lighting may represent a notable change where the project is located in rural areas at Black Hill, Tarro and across the Hunter River and its floodplain. Lighting for the project would be designed in accordance with relevant Australian Standards. Potential light spill from the project would mainly be confined to the operation footprint (refer to **Chapter 15** (urban design, landscape and visual amenity)).

Community cohesion

The project would support improved travel and accessibility to work, business and leisure activities in the study area and wider Hunter. This is likely to facilitate community interaction and enhanced access to economic and social opportunities, with some people making trips that they may have avoided due to unacceptable travel times. Travel time savings provided by the project would also help to increase time available to individual and families for leisure pursuits, impacting positively on social relationships and local networks.

Community health and safety

As indicated in **Section 13.3**, maintaining road safety is important to communities in the study area, with feedback from business owners identifying concerns from some customers about accessing businesses from the Pacific Highway during peak traffic periods. The project would support enhanced road safety and driving conditions by providing a motorway standard of road. Reduced traffic volumes on John Renshaw Drive and the New England Highway at Beresfield and the Pacific Highway at Heatherbrae would also support enhanced safety for road users, including motorists, pedestrians and cyclists.

Natural environment

Where possible, the project has been designed to avoid or minimise potential impacts on environmental values within the study area, although potential biodiversity impacts would be associated with removal of vegetation, loss of habitat for fauna species, and localised disturbance and loss of riparian habitat near the crossings of the Hunter River. This is likely to be a concern for some community members and impact on community values relating to the natural environment. Management measures to mitigate biodiversity impacts during operation of the project are discussed in **Chapter 9** (biodiversity).

Social infrastructure

Directly affected social infrastructure

During operation, potential direct impacts on social infrastructure would mainly result from:

- Reduced traffic on the Pacific Highway, resulting in safer and easier access to the HRBG for visitors, volunteers and staff
- Partial acquisition of land accommodating the HRBG, resulting in impacts on native vegetation
- Changed access to the HRBG, which may affect the number of customers who decide to visit the gardens because they are passing.

Direct access to the HRBG is currently provided via dedicated right turn and left turn lanes on the Pacific Highway. The project realigns the Pacific Highway to the west, near the HRBG, requiring a new access road. This would be provided via a signalised intersection from the Pacific Highway, with the access road passing under the bridge (B09) on the main alignment.

The project is not expected to impact on the operation of the HRBG. Change in access arrangements (i.e. via the new Raymond Terrace interchange or Tomago interchange) may affect the number of customers who decide to visit the HRBG because they are passing, although it is likely that many visitors to the HRBG include people who deliberately plan to visit.

During operation, traffic noise from vehicles using the project has potential to reduce amenity for some visitors, staff and volunteers of the HRBG. This is most likely to impact on users of outdoor areas, including outdoor dining for the café, and would potentially detract from the use and enjoyment of facilities for some people and diminish perceptions of peacefulness and tranquillity in some locations within the site.

Access for public transport users would be maintained via the northbound and southbound bus stops on the Pacific Highway, near the HRBG. Pathways connecting the relocated bus stops would be provided to maintain safe and easy access for visitors, staff and volunteers.

The project may result in minor increases in flooding levels at the Hunter River wetlands, however this is not expected to have any material impact on the community wetland health.

Impacts on social infrastructure in the study area

During operation, potential impacts on social infrastructure in the study area would mainly result from:

- Improved access and connectivity to regional level social infrastructure in the study area, City of Newcastle and Port Stephens Council LGAs, and wider Hunter Region resulting in positive impacts for local and regional communities
- Access changes associated with the bypass of Beresfield and Heatherbrae, resulting in some people traveling different routes to access facilities in the study area.

Any potential impacts associated with access changes would generally be balanced by quicker and more reliable travel times and is not expected to adversely impact on the overall use and demand for facilities.

A summary of potential operational impacts on social infrastructure within 400 metres of the project is provided in **Table 13-4**. The location of social infrastructure is shown in **Figure 13-3**.

Table 13-4 Summary of impacts on social infrastructure within 400 metres of the project

Facility (ID / name)		Summary of impacts during operation
S01	Hunter Valley Equestrian Centre	Operation of the project is not expected to impact on the ongoing operation of the equestrian centre. Any changes in traffic noise levels from the current situation would generally not be perceptible and are not expected to result in amenity changes for users of the centre.
S02	Hunter Valley Traditional Archers	The project would close the access currently used by the club from the M1 Pacific Motorway. Future access to the club site facilities would require agreement between the club and the private property owner but would be available via the new access being provided by the project to the property.
S03	Pasadena Crescent Reserve Soccer Fields	Operation of the project is not expected to impact on the ongoing operation of the soccer fields.
S14	Fiona John Park	Operation of the project is not expected to impact on the ongoing use of the park.
S15	Tarro General Cemetery	Operation of the project is not expected to impact on the ongoing use of this facility for passive recreation.
S16	Tarro Uniting Church of Australia	Operation of the project is not expected to impact on the ongoing use of the church. Any changes in traffic noise levels from the current situation would generally not be perceptible and are not expected to result in impacts for church users.
S17/ S18	Our Lady of Lourdes Primary School / Aspect Hunter School	During operation, changes in road traffic noise at the school are not expected to be perceptible by people using the school grounds. Overall traffic noise levels from the operation of the project would result in some classrooms being eligible for consideration of at-property treatments, although this would be confirmed through further investigation carried out by Transport as detailed design progresses (refer to management measures in **Chapter 8** (noise and vibration)).
S19	Tarro Fire Station	Operation of the project is not expected to impact on the ongoing use of the fire station.
S20	Tarro Community Hall	Operation of the project is not expected to impact on the ongoing use of the community hall. Any changes in traffic noise levels from the current situation would generally not be perceptible and are not expected to result in amenity changes for users of the hall.
S21	Tarro Public School	During operation, changes in road traffic noise at the school are generally not expected to be perceptible by people using the school grounds. Overall traffic noise levels from the operation of the project would result in some classrooms being eligible for consideration of at-property treatment, although this would be confirmed through further investigation carried out by Transport as detailed design progresses (refer to the management measures in **Chapter 8** (noise and vibration)).
S22	Tarro Recreation Area	Operation of the project is not expected to impact on the ongoing use of this recreation area.
S25	HRBG	Refer to discussion in section above.

Access and connectivity

During operation, the project would have the following impacts and benefits on access and connectivity:

- Enhanced travel times and travel reliability for motorists, bus services and emergency services, resulting in positive impacts for local and regional communities, business and industry, including substantially reduced travel times on the Black Hill to Raymond Terrace, New England Highway to Pacific Highway and Pacific Highway to the New England Highway routes for all modelled future scenarios (refer to **Chapter 7** (traffic and transport))
- Access by higher productivity vehicles (for example, truck and trailer combinations) along the M1 Pacific Motorway and Pacific Highway between Sydney and Brisbane, resulting in the facilitation of substantial interstate freight movements between NSW and Queensland
- Reduced through traffic in Beresfield and Heatherbrae, supporting safer and easier access for road users to homes, businesses and facilities in these locations and surrounding areas. In particular, a reduction in through traffic in Heatherbrae would allow safer and easier access to properties in Heatherbrae that have a frontage to the Pacific Highway
- Improved connectivity for cyclists through the provision of new and upgraded cycle facilities, including signalised crossings at the northern approach of the Tomago Road / Pacific Highway intersection and the southern approach of the M1 Pacific Motorway / John Renshaw Drive intersection and wider road shoulders. This would provide alternative transport options for residents and workers and potentially encouraging increased use of cycling for commuting and other trips.

Once operational, the project would enhance travel times and travel reliability for motorists using the M1 Pacific Motorway and Pacific Highway between Black Hill and Raymond Terrace, as well as for motorists using John Renshaw Drive and the New England Highway. This would result in improved connections and links to employment and growth areas in the study area as well as to destinations across NSW and interstate.

Interchanges from the M1 Pacific Motorway to the existing road network at Black Hill, Tarro, Tomago and Raymond Terrace would allow access and connectivity to these locations to be maintained. Motorists would have the choice to use the project via one of the connections or continue to use the existing road network.

The project has been designed to maintain continued use of the Hunter River by maritime traffic, including commercial and recreational fishers.

Operation of the project would also not affect any existing bus routes. Northbound and southbound bus stops would be maintained on the Pacific Highway, near the HRBG. Pathways would be provided to maintain access with the relocated bus stops.

Operation of the project would not impact on the function of the Main North Rail Line or Hexham Train Support Facility. Existing access arrangements would be retained to railway stations in the study area at Thornton, Beresfield, Tarro and Hexham and Australian Rail Track Corporation (ARTC) assets.

Further information on impacts and benefits for access and connectivity from the operation of the project is provided in **Chapter 7** (traffic and transport) and the Traffic and Transport Working Paper (**Appendix G**).

13.4.3 Evaluation of significance

Socio-economic impacts of the project were evaluated based on the sensitivity of receivers and magnitude of the potential impacts. Further detail is provided in the Socio-economic Working Paper (**Appendix M**).

During construction, it is likely that most negative impacts would be appropriately managed with the implementation of management measures relating to noise, vibration, air quality and traffic. The aspects likely to have socio-economic impacts during construction would generally relate to:

- Business and industry, including changed business access due to changes in road conditions near to construction work and changes to commercial fishing operations within the construction footprint
- Social infrastructure near to construction activities, including Tarro Public School, Tarro Fire Station and HRBG
- Community values relating to local amenity, environmental values and community perceptions of road safety
- Access and connectivity, including temporary changes to road conditions, changes to pedestrian and cycle access, and increased construction traffic on roads in the study area.

Potential negative impacts associated with operation have been managed through the implementation of design features, for example design of connections to the local road network. Impacts likely to have residual socio-economic impacts would generally relate to:

- Business and industry, including acquisition of commercial land, bypass of Heatherbrae and impacts on commercial fishing operations
- Changed access arrangements for HRBG and the Hunter Valley Traditional Archers
- Impacts on community values relating to local amenity and environmental values.

13.5 Environmental management measures

The environmental management measures that will be implemented to minimise the socio-economic impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 13-5**.

Table 13-5 Environmental management measures (socio-economic)

Impact	Reference	Management measure	Responsibility	Timing
Community consultation	SE01	A Community Communication Strategy (CCS) will be prepared for the project to facilitate communication with the community and stakeholders including relevant Government agencies, Councils, adjoining affected landowners and businesses, residents, motorists and other relevant stakeholders that may be affected by the project. The strategy will: • Identify people or organisations to be consulted during the delivery of the project • Set out procedures and mechanisms for the regular distribution of information about the project • Outline mechanisms to keep relevant stakeholders updated on site construction activities, schedules and milestones • Outline avenues for the community to provide feedback (including a 24-hour, toll free project information and complaints line) or to register complaints and through which Transport will respond to community feedback • Outline a process to resolve complaints and issues raised.	Transport/ Contractor	Prior to construction
Business impacts	SE02	Signage will be provided in accordance with Transport signage policy to inform the travelling public about services in Beresfield and Heatherbrae.	Transport	Construction/ prior to operation
Other relevant management measures				
Landscape character and visual impacts including during construction	UD02	Disturbed areas outside the operational footprint and within the construction footprint will be revegetated following completion of construction activities.	Contractor	Construction
Property access	TT02	Existing accesses to properties and businesses will be maintained during construction. Where this is not feasible or reasonable, temporary alternative access arrangements will be provided following consultation with the affected property and business owners.	Transport / Contractor	Detailed design/ prior to construction/ construction
	TT03	Access will be maintained to rail infrastructure facilities along Aurizon access road. Transport will liaise with Aurizon and ARTC during detail design and construction.	Transport / Contractor	Detailed design/ prior to construction/ construction

Impact	Reference	Management measure	Responsibility	Timing
Emergency vehicle access	TT05	Where possible, access for emergency vehicles will be maintained at all times during construction. Any site-specific requirements will be determined in consultation with the relevant emergency services agency.	Contractor	Construction
Maritime impacts	TT06	A navigational channel would be provided during construction within the Hunter River	Contractor	Construction
General construction noise and vibration	NV01	A Construction Noise and Vibration Management Plan (CNVMP) would be prepared for the project to mitigate and manage noise and vibration impacts. The CNVMP would include: • All potential significant noise and vibration generating activities associated with the activity • Measures to be implemented during construction to minimise noise and vibration impacts, such as restrictions on working hours, respite periods, staging, placement and operation of ancillary facilities, temporary noise barriers, haul road maintenance, and controlling the location and use of vibration generating equipment • A monitoring program to assess performance against relevant noise and vibration criteria • Process for the implementation of respite periods to provide residents with respite from ongoing impact • Arrangements for consultation with affected receivers, including notification and complaint handling procedures • Contingency measures to be implemented in the event of noncompliance with noise and vibration criteria.	Contractor	Prior to construction/ construction
	NV02	Where reasonable and feasible, implementation of recommended operational noise mitigation would be carried out within 12 months of construction activities commencing.	Transport / Contractor	Prior to construction/ construction
Operational road traffic noise impacts	NV07	Operational noise and vibration mitigation measures would be identified in an Operational Noise and Vibration Review (ONVR). Requirements for mitigation measures, including quieter noise pavements, noise barriers, and at-property treatments, would be reviewed as part of the ONVR and as the detailed design progresses. Detailed information on floorplans and facade construction for school classrooms, places of worship and childcare centres determined to exceed the applicable Noise Criteria Guideline (NCG) (Roads and Maritime Services 2015c) internal noise criteria will be obtained during design development. The implementation of treatments would be carried out in accordance with the Noise Mitigation Guideline (NMG) (Roads and Maritime Services 2015d).	Transport / Contractor	Detailed design/ construction/ prior to operation

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M1 Pacific Motorway extension to Raymond Terrace

Environmental impact statement – Chapter 14: Land use and property

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14. Land use and property

This chapter describes the potential land use and property impacts that may be generated by the construction and operation of the project and presents the approach to the management of these impacts.

The desired performance outcomes for the project relating to land use and property, as outlined in the SEARs, are to:

- Minimise impacts to property and businesses and achieves appropriate integration with adjoining land uses, including maintenance of appropriate access to properties and community facilities, and minimisation of displacement of existing land use activities, dwellings and infrastructure
- Effectively engage with stakeholders during project design and delivery.

Table 14-1 outlines the SEARs that relate to land use and property and identifies where they are addressed in this EIS. The full assessment of land use and property impacts is provided in the Land Use and Property Working Paper (**Appendix N**).

Table 14-1 SEARs (land use and property)

Secretary's requirement	Where addressed
12. Socio-economic, Land use and Property	
2. The proponent must assess impacts from construction and operation on potentially affected properties, businesses, Crown land, Council assets and services, recreational users, and land and water users (including recreational and commercial fishers, and oyster and aquaculture farmers), including property acquisitions/adjustments, access, amenity and relevant statutory rights.	**Section 13.4**. Impacts to businesses, commercial fishers (including oyster and aquaculture farmers), Council assets and services, recreational fishers, land and water users and amenity from construction and operation are discussed in **Chapter 13** (socio-economic).
3. The proponent must assess impacts on: (a) any operating mines, extractive industries or known mineral or petroleum resources (b) exploration activities in the vicinity of the project (c) access for future exploration areas.	Impacts of the project on operating mines, extractive industries, known resources, exploration activities and future exploration in the area is assessed in **Section 14.4**.
4. The design, construction and operation of the project should address and minimise (existing and future) land use conflicts and operations (including existing and ongoing agricultural activities). Siting of project elements should be located in a way that functional, contiguous areas of residual land and land uses are maximised.	Impacts of the project on existing and future land uses is assessed in **Section 14.4**.
5. The Proponent must undertake an assessment of biosecurity risks and management measures relating to the potential for spread of pests, disease or weeds, in accordance with the 'general biosecurity duty' under the *Biosecurity Act 2015*.	The potential for weeds and pests to impact on rural land uses is described in **Section 14.4.2**. A detailed discussion and assessment of impacts associated with the potential spread of pests, disease or weeds, and the 'general biosecurity duty' is provided in **Section 9.4**.
6. The Proponent must assess potential impacts on utilities (including communications, electricity, gas, and water and sewerage) and the relocation of these utilities.	Utility relocations, adjustments and protection are described and assessed in **Section 14.4.5**. **Section 5.3.1** also describes utilities.

Secretary's requirement	Where addressed
7. A draft Community Consultation Framework must be prepared identifying relevant stakeholders, procedures for distributing information and receiving/responding to feedback and procedures for resolving stakeholder and community complaints during the design, construction and operation of the project. Key issues that must be addressed in the Framework include, but are not limited to: (a) traffic management (including property, cyclists and pedestrian access) (b) landscaping/urban design matters (c) hydrology and flooding (d) staging and timing of construction activities including out of hours work and utility relocations (e) noise and vibration mitigation and management (f) soil erosion and water quality management (g) interaction with existing land uses.	A draft Community Consultation Framework is provided in **Appendix E**. Additional details on community consultation are provided in **Chapter 6**.
17. Safety and risk	
2. The proponent must assess the biosecurity risk of the project to minimise the inadvertent spread of disease and pathogens affecting agricultural activities, native vegetation and threatened fauna.	The biosecurity risk of the project is discussed in **Section 14.4.2**. Further information on potential for spread of pests, disease or weeds, and the 'general biosecurity duty' is provided in **Chapter 9** (biodiversity) and **Chapter 22** (safety and risk)

14.1 Policy and planning setting

The land use and property assessment was prepared to assess the potential impacts of the project in accordance with the following relevant legislation, policy and guidelines:

- Hunter Regional Plan 2036 (DPE 2016)
- Greater Newcastle Metropolitan Plan 2036 (DPE 2018)
- State Environmental Planning Policy (Infrastructure) 2007
- Local Environmental Plans:
  - Port Stephens Local Environmental Plan 2013
  - Newcastle Local Environmental Plan 2012.
- Port Stephens Council Strategies:
  - Port Stephens Local Strategic Planning Statement (Port Stephens Council undated)
  - Raymond Terrace and Heatherbrae Strategy 2015-2031 (Port Stephens Council 2015).
- City of Newcastle Strategies:
  - City of Newcastle Local Strategic Planning Statement (City of Newcastle 2020).
- Land use conflict risk assessment (LUCRA) guide (DPI 2011)
- Infrastructure proposals on rural land (DPI 2013b).

Further detail on the above legislation, policies and guidelines, and how they apply to the project, is provided in the Land Use and Property Working Paper (**Appendix N**).

14.2 Assessment methodology

The methodology for the land use and property assessment involved:

- Reviewing existing information relevant to land use and property within the study area, including:
  - Existing NSW Government and local government strategic planning policies, strategies and guidelines relevant to the study area
  - Spatial information and aerial photography to identify existing land uses and tenure
  - Outcomes of community and stakeholder consultation carried out for the project, including with property owners, local community and key stakeholders.
- Describing existing land use and property characteristics in the study area, including property and tenure and future land uses and development areas
- Assessing potential land use and property impacts during construction and operation, including impacts associated with property acquisition and temporary lease of land during construction, impacts on property access and amenity, and impacts on existing and future land uses
- Evaluating the potential risk for land use conflicts between the project and adjoining rural land uses based on the risk matrix presented in the Land Use Conflict Risk Assessment Guide (DPI 2011)
- Describing potential cumulative land use and property impacts that may arise from the interaction of construction and operation of the project, and other approved or proposed projects in the area
- Identifying measures to avoid, minimise or mitigate land use and property impacts arising from the project's construction and operation.

Further detail on the assessment methodology is provided below and in the Land Use and Property Working Paper (**Appendix N**).

14.2.1 Study area

The study area for the land use and property assessment is shown on **Figure 14-1** and includes the construction footprint and a buffer of at least one kilometre around the construction footprint. This area was selected to capture key land uses in the suburbs of Beresfield, Tomago and Heatherbrae. In addition, the assessment also considers potential impacts on regional land use and development within the City of Newcastle and Port Stephens Council LGAs.

14.2.2 Data sources

The existing environment described in **Section 14.3** draws on information and data from:

- NSW Government and local government strategic planning documents and websites including regional planning strategies and LEPs for City of Newcastle and Port Stephens Council LGAs
- Spatial information and data from the NSW government relating to existing land uses, based on the state-wide NSW Landuse 2017 dataset (v1.2) (DPIE 2020e), land use zoning, utilities and property including land tenure
- Data from the Bureau of Meteorology, Australian Groundwater Explorer, WaterNSW groundwater database and WaterNSW water register were used to identify groundwater works and water licences
- Data from the NSW Department of Planning, Industry and Environment MinView database for mining, extractive industries and exploration activities.

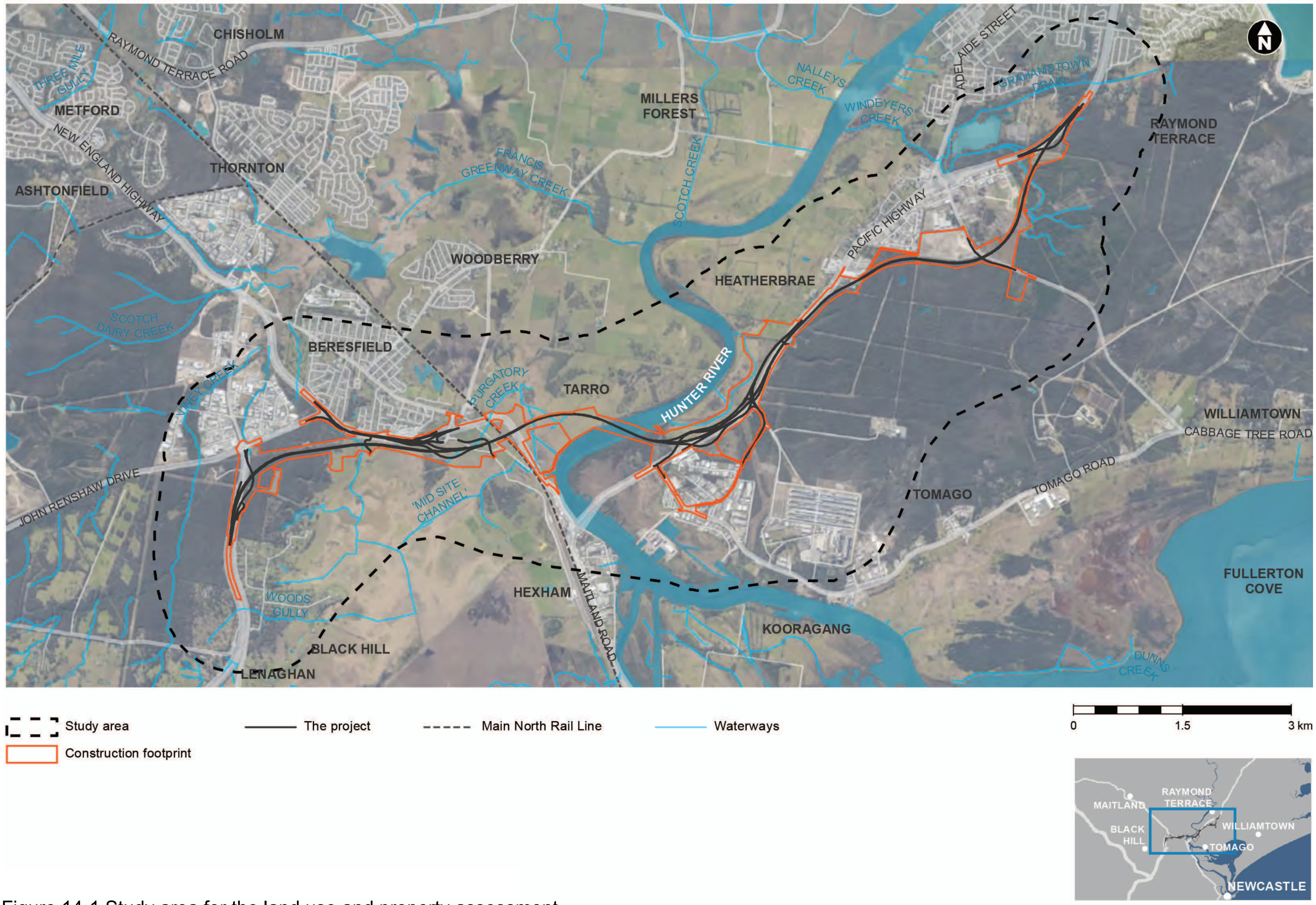

Figure 14-1 Study area for the land use and property assessment

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14.3 Existing environment

14.3.1 Regional land use

The project is located within the City of Newcastle and Port Stephens Council LGAs in the Hunter region. The Hunter is the largest regional economy in Australia in terms of economic output and drives around 28 per cent of regional NSW's total economic output. The Hunter is also the largest regional contributor to the State's gross domestic product (DPE 2016).

Key regional land uses within the Hunter include:

- Manufacturing and industrial uses, including at Beresfield, Black Hill, Tomago and Heatherbrae, Cardiff, Port of Newcastle and surrounding port lands, and at Kooragang Island located downstream of the project
- Agricultural and rural uses, including wine making, thoroughbred horse breeding and major beef cattle production
- Environmental uses, including the Hunter Wetlands National Park, Hunter River, and Hunter Region Botanic Gardens at Heatherbrae
- Tourism, associated with agricultural activities and wine growing
- Defence services, with defence establishments at the Royal Australian Air Force Base in Williamtown, Lone Pine Barracks in the Singleton Military Area and Myambat Logistics Company near Denman
- Newcastle Airport at Williamtown, which is a key global gateway to the Hunter and focus for technology, defence and aerospace industries
- Major health care and education services, including within Newcastle and Maitland
- Mining and power generation within the Upper Hunter.

The M1 Pacific Motorway is a key north-south corridor linking Sydney to the Central Coast, Newcastle and Hunter region. The New England Highway and the Pacific Highway also facilitate significant freight movements between NSW, Victoria and Queensland, as well as between Sydney, the Hunter region and northern NSW.

14.3.2 Property

Property within the study area comprises:

- Privately owned property
- Land owned by the City of Newcastle and Port Stephens Council
- State-owned land.

Transport has been progressively acquiring land for the project with about 43 per cent of property affected by the construction footprint (about 152.6 hectares) owned by Transport.

Land tenure in the study area comprises (**Figure 14-2**):

- Freehold land, which makes up the majority of the land in the study area
- Crown land (land owned and managed by the NSW Government) which is within the construction and operational footprints on either side of the Hunter River, and at Tomago and Heatherbrae
- Local government land at Beresfield next to the construction and operational footprints
- Commonwealth owned land within the study area comprises residential uses at Raymond Terrace owned by Defence Housing Australia, and the Australia Post delivery centre at Heatherbrae. These Commonwealth owned properties would not be affected by the project.

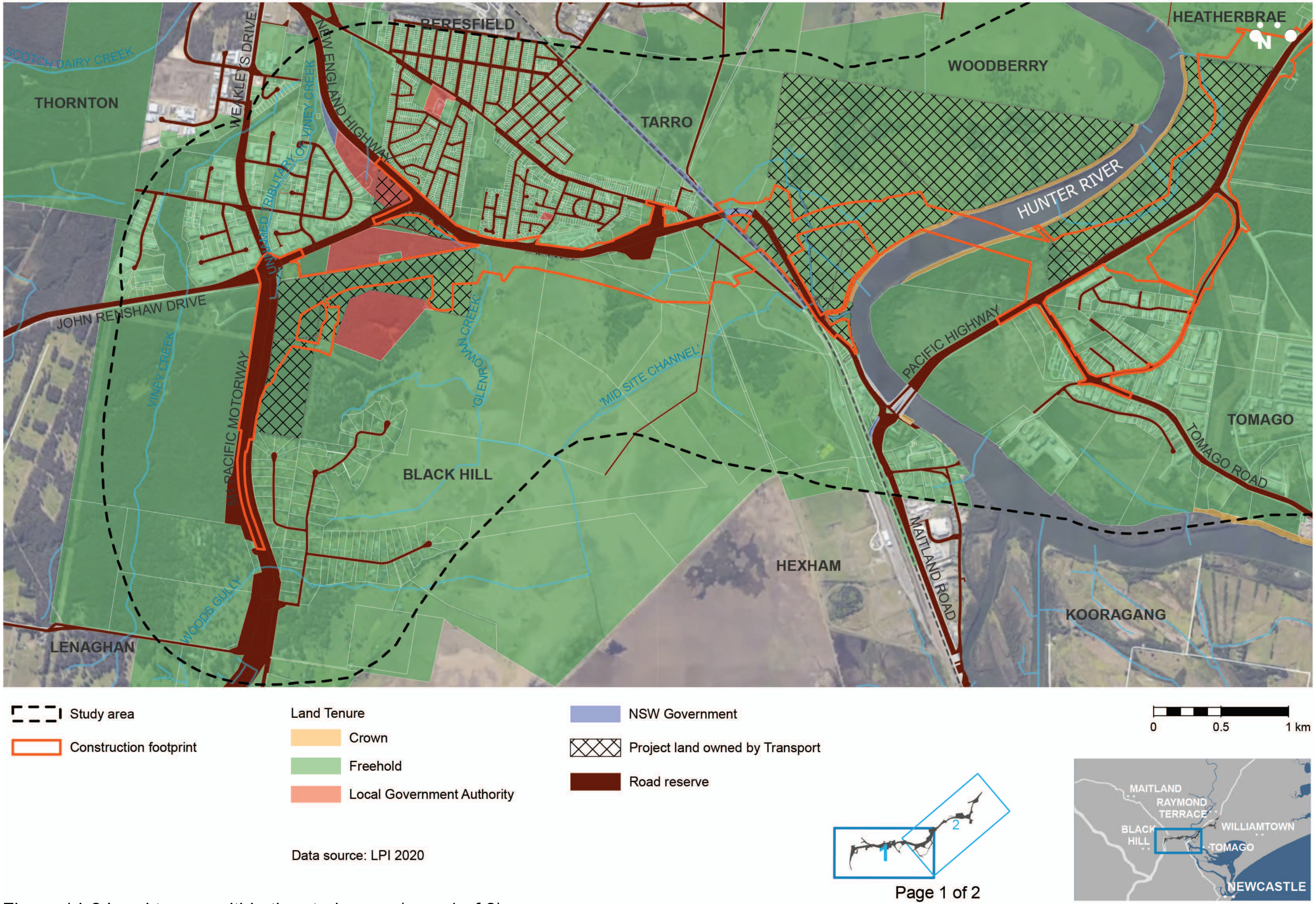

Figure 14-2 Land tenure within the study area (map 1 of 2)

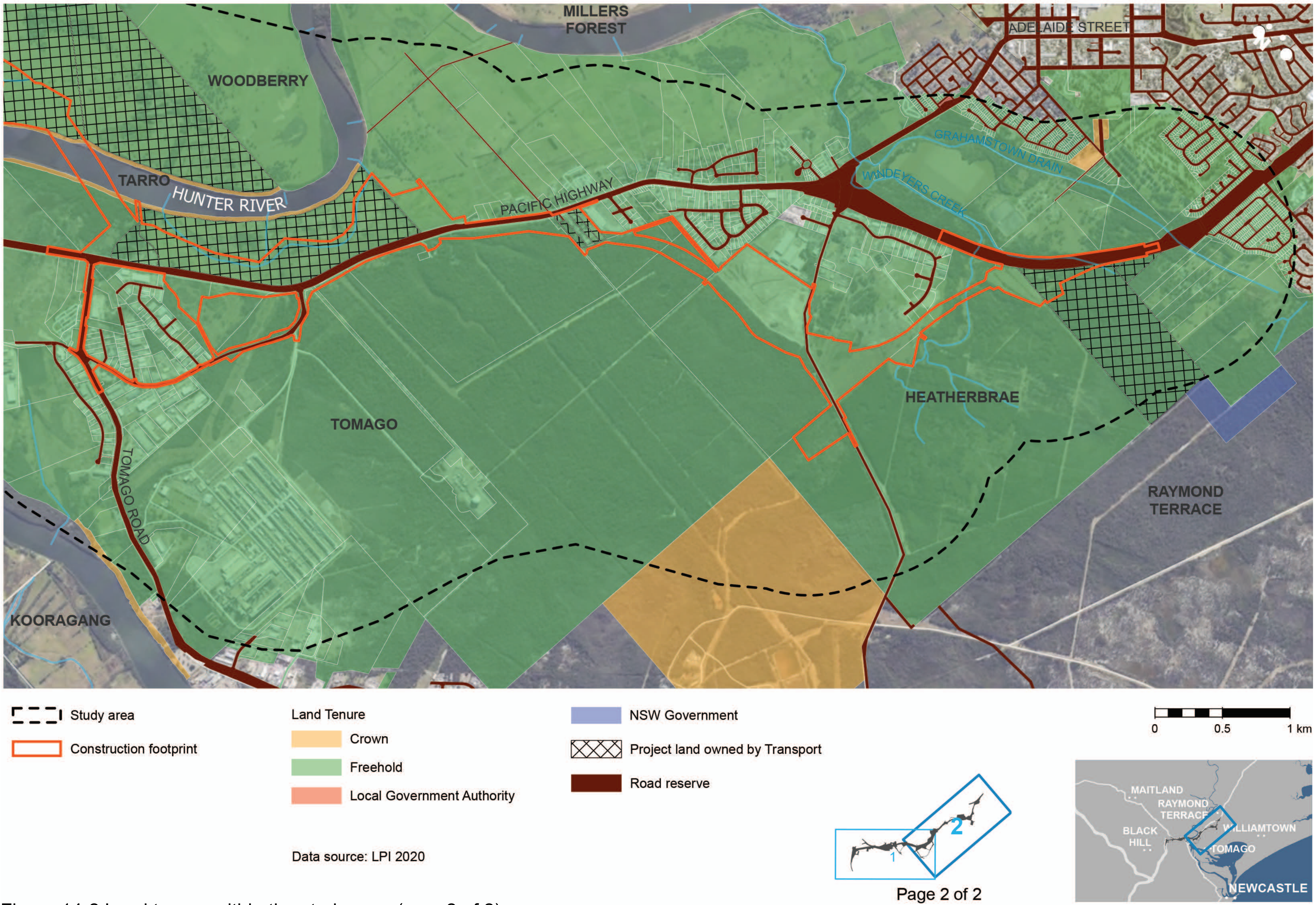

Figure 14-2 Land tenure within the study area (map 2 of 2)

14.3.3 Existing land use

Land within the study area is used for a range of urban, rural and environmental uses. Key land uses in the study area, based on the land use categories from the NSW Landuse 2017 dataset (v1.2) (DPIE 2020e), are shown on **Figure 14-3** and described in **Table 14-2**. Land used for grazing comprises the largest area of land within the study area, with managed resource protection and services uses the next largest land use types. A full list of land uses in the construction and operation footprints is presented in the Land Use and Property Working Paper (**Appendix N**).

Table 14-2 Key land uses within the study area

Key land uses	Description
Primary production	Most of the primary production land in the study area is land used for grazing at Black Hill, Tarro, Woodberry, Tomago, Heatherbrae, and Raymond Terrace. Other primary production uses in the study area include horticultural uses, plantation forests, cropping and 'land in transition' (for example, degraded land, abandoned land, and land under rehabilitation). Other primary production uses such as horticultural uses and irrigated cropping are located away from the project and would not be affected by the project. Land within the study area used for plantation forests uses mainly comprises privately owned land at Heatherbrae, however some of this land has been developed for commercial and industrial uses or is identified for future industrial uses.
Intensive uses	Land mapped for intensive uses mainly comprise urban uses at Beresfield, Tarro, Tomago, Heatherbrae and Raymond Terrace. Intensive uses comprise the second largest area of land in the study area, with this mainly comprising residential uses, manufacturing and industrial uses, and services uses such as commercial, recreation and cultural services. The study area also includes a range of infrastructure uses, including transport infrastructure. About 240 hectares of land in the study area is used for existing transport infrastructure, including roads and highways, local roads and rail corridors. 'Other intensive uses' in the study area comprise mining and resources uses at Black Hill, and intensive animal production at Heatherbrae for horse stud farms and the agistment of horses.
Conservation and natural environments	Land in the study area mapped for conservation and natural environment uses includes land used for nature conservation, managed resource protection (for example, surface water and groundwater supplies) and other minimal uses such as residual native cover and rehabilitated land. More than half of the land area covered by conservation and natural environment uses comprises land used for 'managed resource protection' associated with Hunter Water Corporation's assets such as the Tomago Sandbeds and Grahamstown Dam in Heatherbrae. Land identified as 'other minimal use' comprises the next largest area of conservation and natural environment uses and includes residual native vegetation at Black Hill and rehabilitated land and residual native vegetation at Tomago. Areas identified as nature conservation in the study area include the Hunter Wetlands National Park at Hexham. An existing BioBanking Agreement is located around the Hunter Region Botanic Gardens east of the existing highway which comprises two areas, one north of the Hunter Region Botanic Gardens (about 44 hectares) and one to the south (about 62 hectares).
Water	Land mapped for water uses in the study area includes water bodies such as the Hunter River, Windeyers Creek, Viney Creek, Purgatory Creek and lakes, dams, drainage channels and water pipelines at Black Hill, Tarro, Tomago, Woodberry, and Heatherbrae, and marsh and wetland uses associated with the Hunter River floodplain. About half of the land mapped for water uses is land covered by the Hunter River.

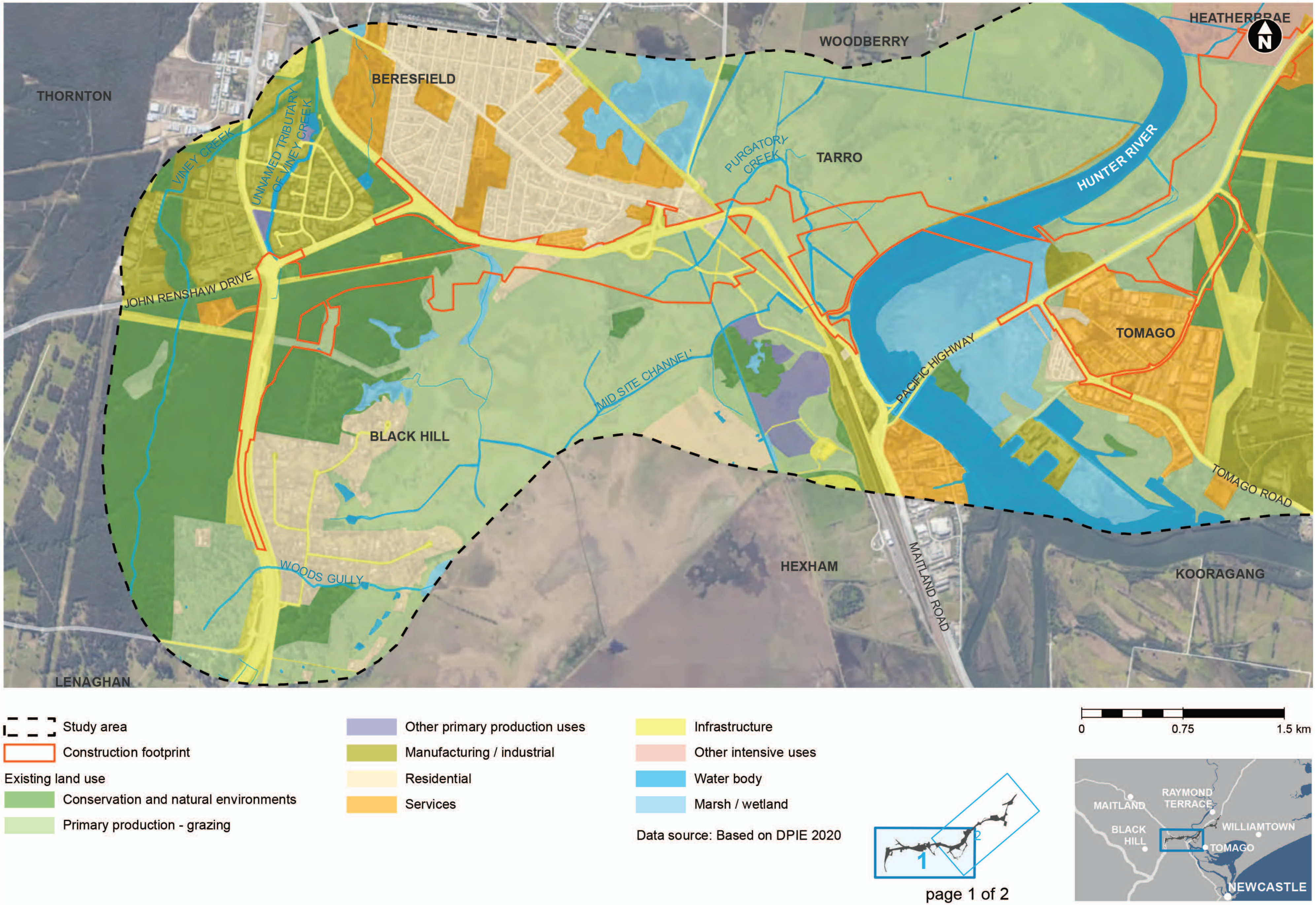

Figure 14-3 Existing land use within the study area (map 1 of 2)

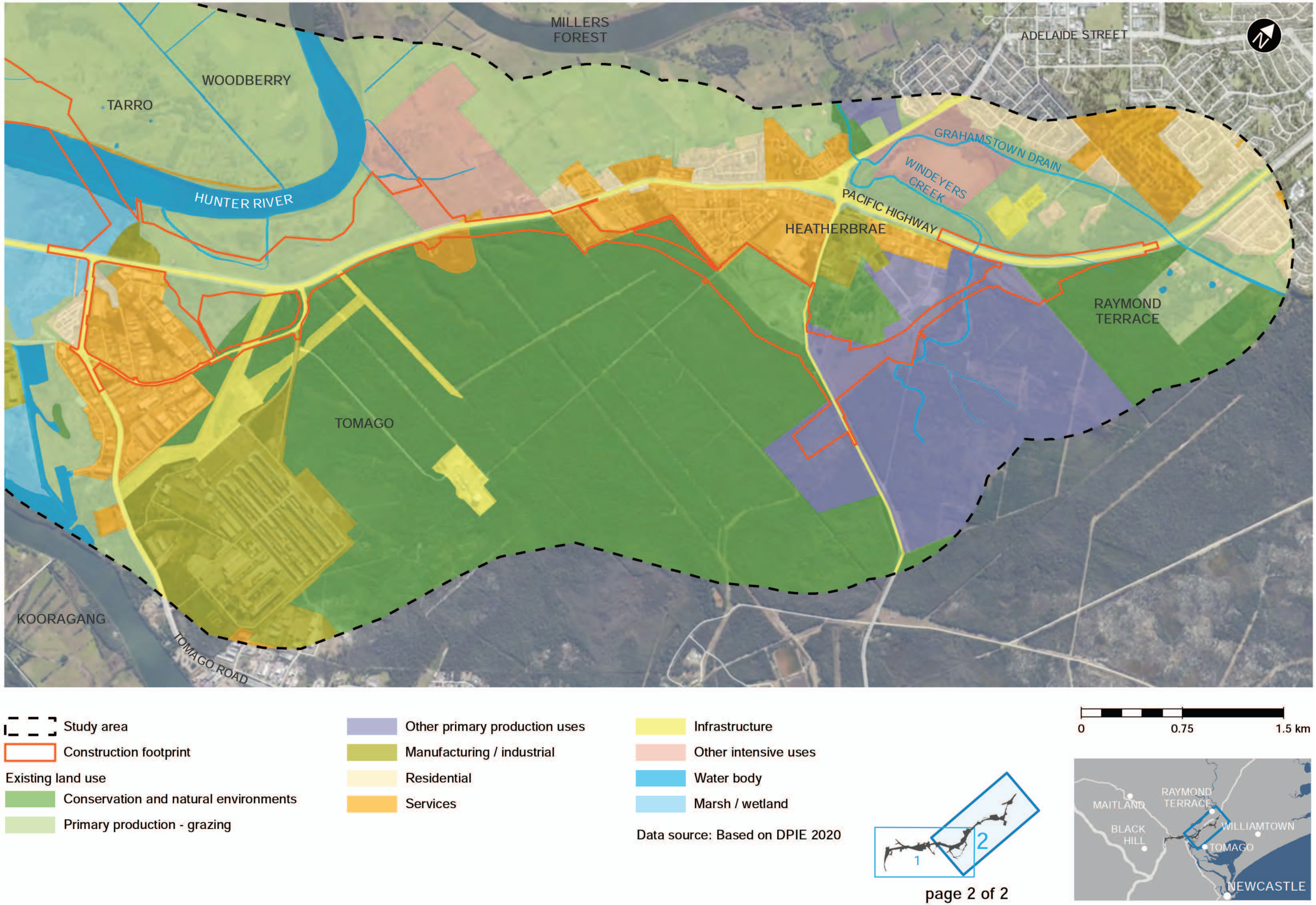

Figure 14-3 Existing land use within the study area (map 2 of 2)

14.3.4 Land use zoning

As identified in the City of Newcastle and Port Stephens Council LEPs, the study area is covered by a range of land uses, including environmental, industrial, business, residential, recreation, primary production, rural, special activities, infrastructure and waterways. The main land use zones in the study area are as follows:

- Environmental protection zones cover the largest area of land in the study area, with this mainly comprising land zoned environmental conservation (E2) at Black Hill, Tarro, Tomago and Heatherbrae. Land zoned for environmental living (E4) is also located at Black Hill and Tarro
- Industrial zones cover the second largest land area, with this mainly comprising general industry zoning (IN1) at Tomago and Heatherbrae. Other land zoned for industrial uses is located at Beresfield and Black Hill (zoned light industrial) and Hexham (zoned heavy industrial)
- Land zoned for special purposes includes:
  - Special activities (SP1) such as the Hunter Water Corporation land, including the Hunter Region Botanic Gardens in Heatherbrae and Raymond Terrace Wastewater Treatment plant at Raymond Terrace
  - Infrastructure (SP2) which includes roads within the study area, the Main North Rail Line at Tarro and Newcastle Memorial Park at Beresfield.
- Rural zones mainly comprise rural landscape zoning (RU2) at Heatherbrae and Raymond Terrace.

As described in **Section 4.2.2**, a road corridor for the project was reserved in the City of Newcastle and Port Stephens Council LEPs in 2010. Within the City of Newcastle LGA, the gazetted road corridor extends from the M1 Pacific Motorway at Beresfield, south of John Renshaw Drive to the New England Highway, crossing the Hunter River next to Hexham Bridge. Within the Port Stephens Council LGA, the gazetted road corridor generally follows the Pacific Highway and main alignment east of Heatherbrae. Land use zoning in the study area is shown on **Figure 14-4**.

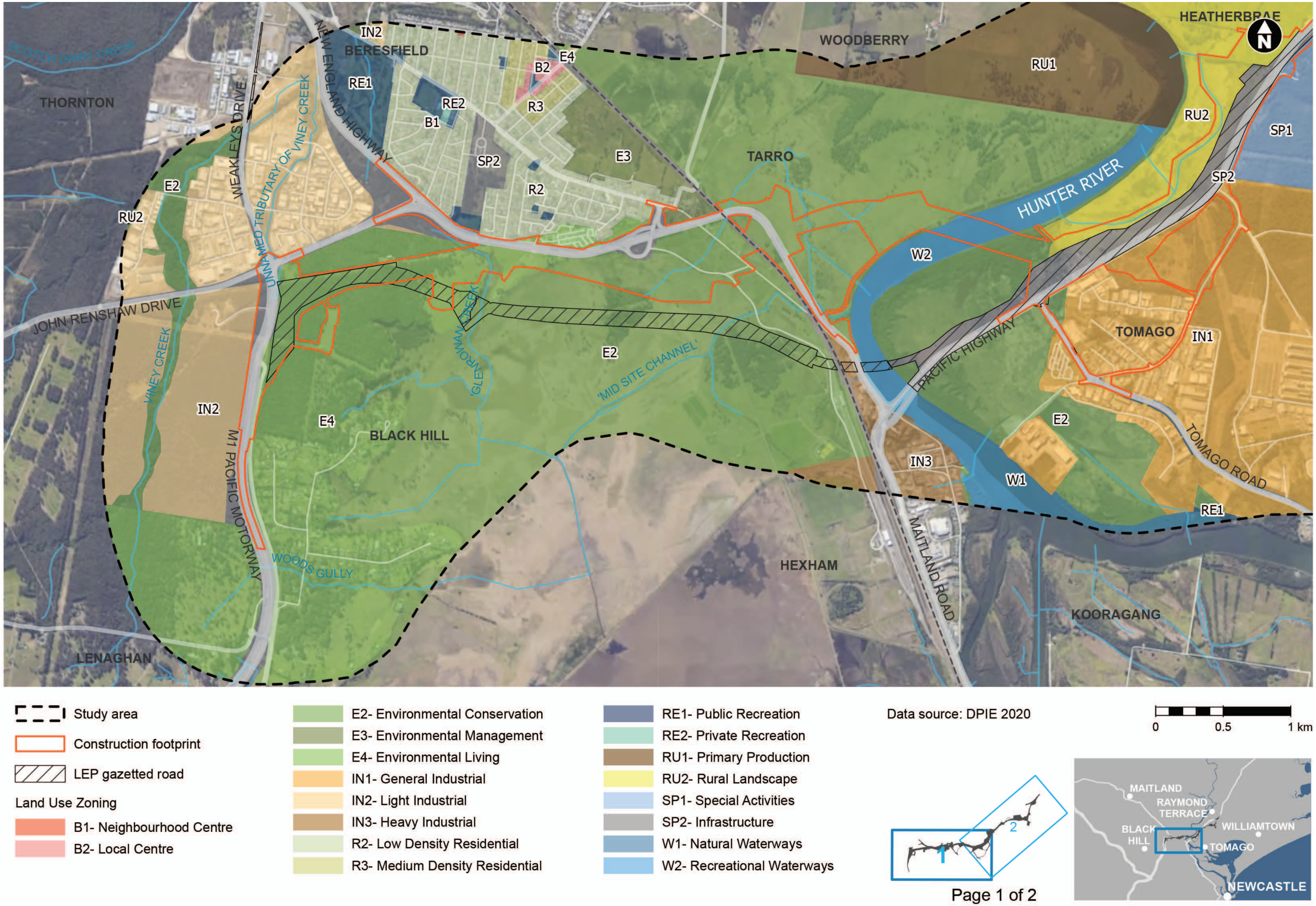

Figure 14-4 Land use zones within the study area (map 1 of 2)

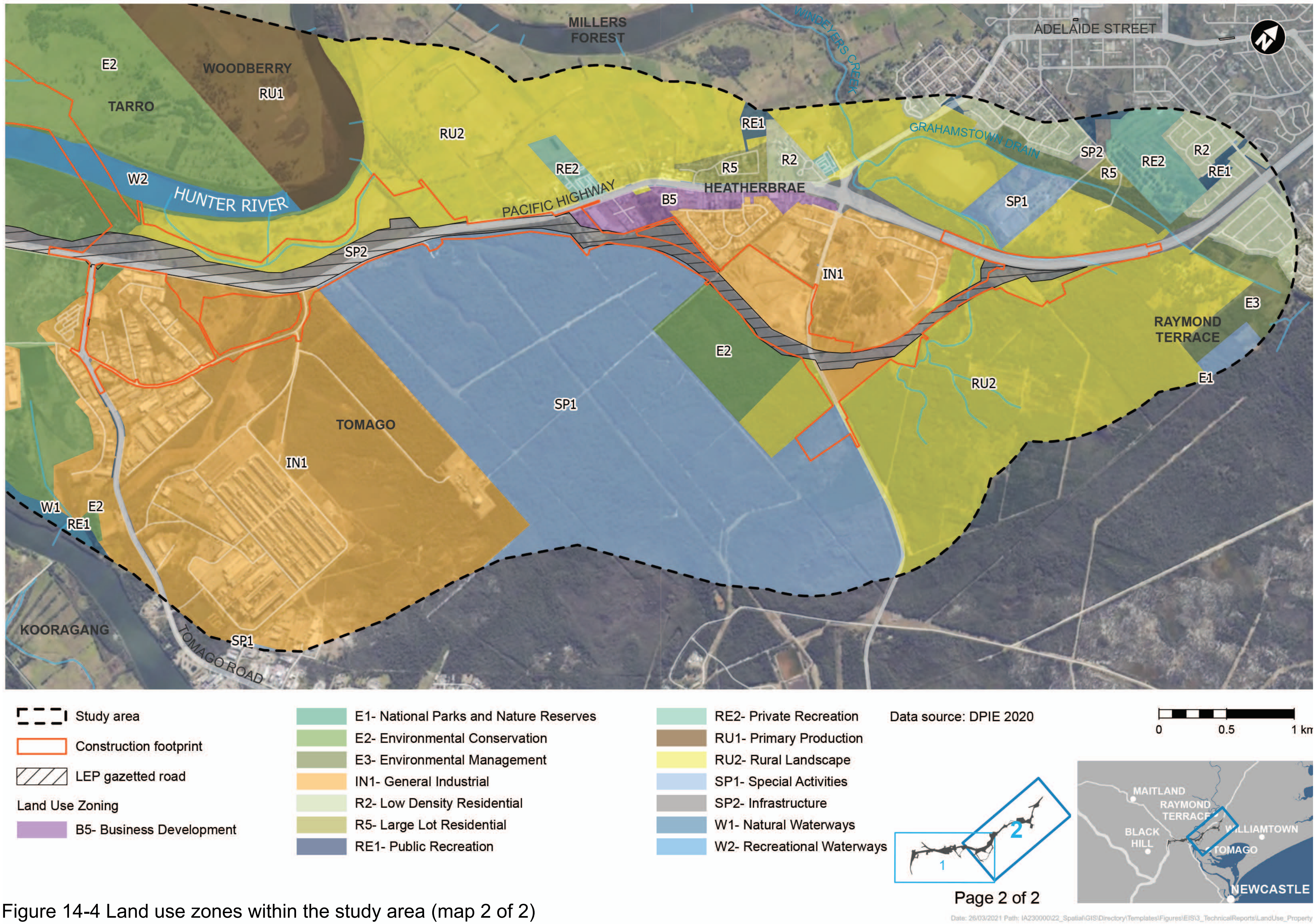

Figure 14-4 Land use zones within the study area (map 2 of 2)

14.3.5 Mining

One Mining Lease (ML) and one Exploration Licence (EL) were identified within or near the study area (refer to **Figure 14-5**):

- ML1618, held by Donaldson Coal Pty Ltd, covers the Abel underground coal mining operation at Black Hill, which is located west of the M1 Pacific Motorway and southwest of Beresfield. The Abel underground coal mine was placed in care and maintenance in 2016
- EL5497, which is also held by Donaldson Coal Pty Ltd, expired on 21 July 2019 but renewal of this licence has been sought.

The study area is also covered by an assessment lease (ALA71, refer to **Figure 14-5**) held by Donaldson Coal Pty Ltd which allows the lease holder to maintain an authority over a potential area and continue exploration to assess the viability of commercial mining.

In addition, the Black Hill Mine Subsidence District is located within the study area, as described in **Chapter 22** (safety and risk) and shown in **Figure 14-5**.

14.3.6 Utilities

As described in **Section 5.3.15**, several utilities and associated infrastructure are located within or near the construction footprint, including:

- Electricity supply and street lighting: TransGrid (high voltage transmission lines) and Ausgrid
- Telecommunications: Telstra, Optus, NBN and Nextgen optic fibre and telephone cables
- Gas: Jemena and AGL
- Water and sewer services and infrastructure: Operated by Hunter Water Corporation and includes the Chichester Trunk Gravity Water Main.

AGL also proposes to construct a 250 megawatt gas fired power station within the study area at Tomago with gas pipelines and electricity transmissions lines (the proposed power station). The proposed power station is due to be operational prior to the commencement of construction of the project. The site for the proposed power station is located between the Pacific Highway and Old Punt Road, north of the Tomago industrial area.

14.3.7 Water users

No water access licenses are located within the construction footprint. Five water access licenses are registered within the study area. These provide water for irrigation, industrial uses, drainage, dewatering and at the Hunter Region Botanic Gardens.

The Tomago Sandbeds are located in the vicinity of the project and extend from Tomago to Port Stephens within land owned by Hunter Water Corporation. The Tomago Sandbeds are also located within the Tilligerry State Conservation Area and a designated ‘Special Area’ in the *Hunter Water Act 1991* protected as a public drinking water supply by Hunter Water Corporation (Hunter Water 2020). The Tomago Sandbeds provide about 20 per cent of the Lower Hunter’s drinking water (Hunter Water 2019).

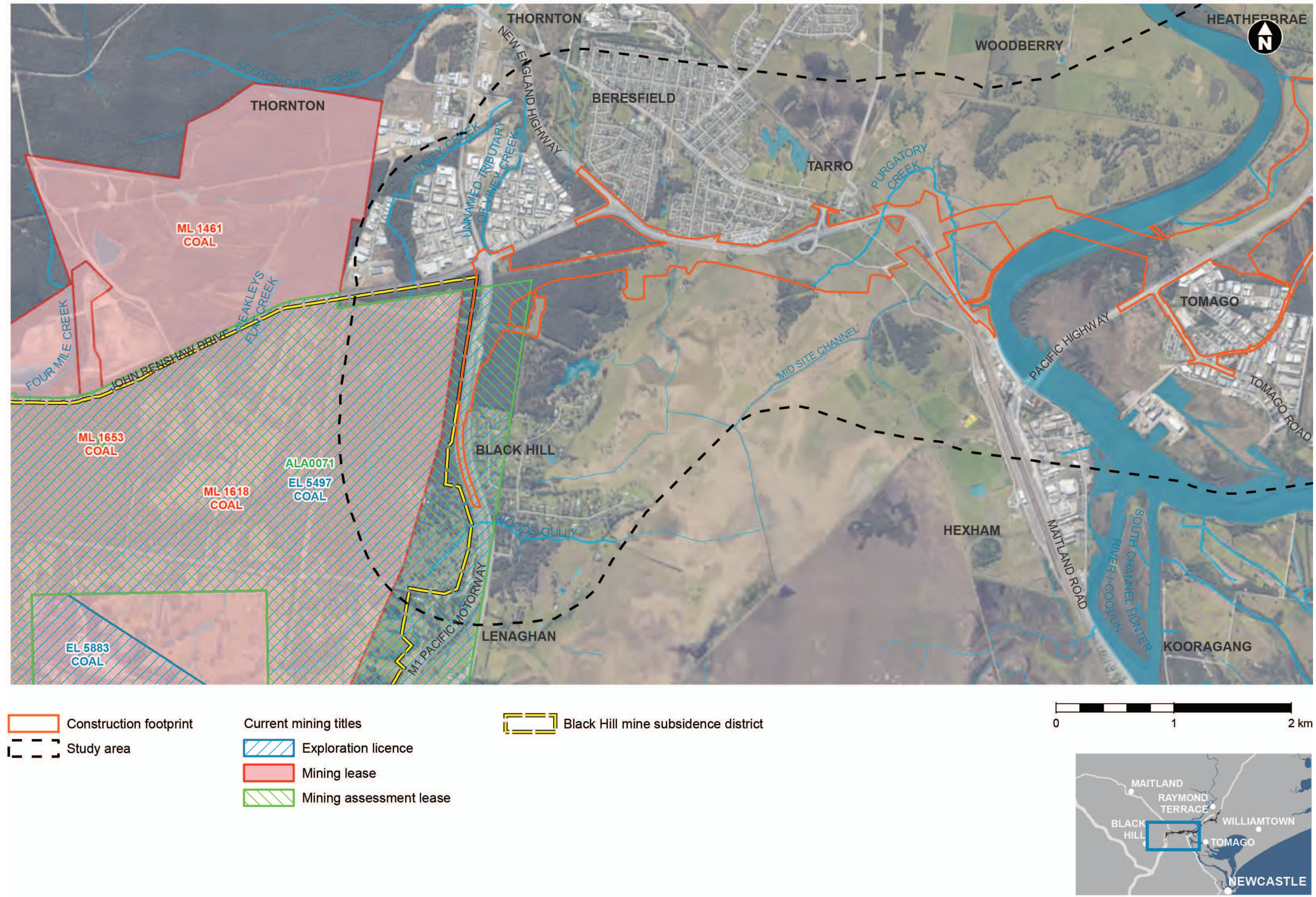

Figure 14-5 Mining activities within the study area

14.3.8 Future land use

The study area is covered by the Hunter Regional Plan 2036 (DPE 2016) and Greater Newcastle Metropolitan Plan 2036 (DPE 2018), which outline the future land use vision for the Hunter and Greater Newcastle areas and provide frameworks for land use planning priorities and decisions.

Raymond Terrace will be the focus of population and employment growth over the next 20 years. Tomago, Heatherbrae and the convergence of the national road network around Thornton, Beresfield and Black Hill are identified as significant employment precincts. The Greater Newcastle Metropolitan Plan (DPE 2018) also identifies Beresfield, Black Hill and Tomago as major employment precincts and trading hubs.

Beresfield and Black Hill are proposed to be a freight and logistics hub, with complementary manufacturing and light industrial activity. Three precincts are identified within this location, including:

- Beresfield Precinct, which will support freight and logistics, manufacturing, and other light industrial uses
- Emerging Black Hill Precinct, located west of the M1 Pacific Motorway, which is proposed to be the subject of a master plan that considers freight and logistic uses, the adjoining mine site and road access to John Renshaw Drive
- Thornton Precinct, which is proposed to support expanded business and light industrial uses.

Tomago is proposed to be an advanced manufacturing and industrial area, and local planning for the Tomago Industrial Precinct will look to enable the efficient movement of goods. Further, the Tomago Shipbuilding Precinct is identified as a location to promote the development of shipbuilding industries.

14.4 Assessment of potential impacts

14.4.1 Property

As described in **Chapter 4**, the project development has been an iterative process. The following key refinements were made to the project design to address property and land use issues:

- Property severance impacts:
  - Reducing the area of property acquisition and severance of agricultural land in Black Hill and Tarro by moving the main alignment next to existing road infrastructure
  - Locating the main alignment next to existing road infrastructure north of Tomago to minimise impacts to property and vegetated areas
  - The viaduct across the Hunter River floodplain allows access and use of land either side of the project.
- Access impacts:
  - Maintaining access to property through the provision of new accesses (where required) including at the Hunter Region Botanic Gardens
  - Development of an oversize overmass (OSOM) strategy to allow for large freight movements for adjoining employment and heavy industry land uses.
- Impacts on future development:
  - Widening of the bridge at the Black Hill Interchange to allow for future development
  - Consolidation of the Tomago and Heatherbrae interchanges into a single interchange to minimise impacts on the proposed power station
  - Maintaining the main alignment on the approach to the Raymond Terrace Interchange behind the industrial estate to minimise impacts to the industrial development.

- Other property impacts:
  - Moving the main alignment at Tarro to the south to avoid directly impacting a dwelling
  - Raising the height of the motorway through the Hunter Water Corporation land in the Tomago Sandbeds Catchment Area to aid in avoiding future water quality impacts on the catchment area.

The following residual property impacts are detailed in the sections below.

Directly affected properties

Transport have progressively purchased 43 lots for the project, comprising several properties, held by private landowners and local councils.

A total of 36 lots held by 18 property owners would need to be acquired for the project, in addition to those previously purchased by Transport. The project would also require temporary agreements with landowners to accommodate ancillary construction facilities such as worksites, bridge construction support, compounds, laydown areas and parking area. Details on the properties subject to property acquisition or temporary lease are provided in **Table 14-3** and shown in **Figure 14-6**.

Ownership of land directly affected, needing property acquisition or temporary agreements by the project comprises:

- Fifteen properties that are privately owned, including nine properties that are owned by a company
- Three properties owned by the City of Newcastle
- One property owned by the rail operator Aurizon
- Two properties owned by the energy provider AGL
- Five properties owned or managed by government agencies such as Hunter Water Corporation and Crown Land.

A strip of Crown land temporarily and permanently impacted by the project is located along the banks of the Hunter River.

Land within the Main North Rail line corridor owned by Transport and maintained by the Australian Rail Track Corporation (ARTC) would also be directly affected by the project, although this would not impact on the ongoing operation of the rail line.

Land use

Most land directly affected by the project comprises rural uses, utilities infrastructure and areas of native vegetation, however some properties subject to acquisition or temporary lease are comprised of dwellings, vacant land associated with a residential village, commercial uses and social infrastructure.

Partial acquisition of land may also result in severance or fragmentation of some rural properties, particularly larger land holdings comprising multiple lots. Access to residual property parcels would be maintained via existing local roads or new service roads constructed as part of the project. The viaduct across the Hunter River floodplain would also allow access to be maintained within and between properties located either side of the project.

Properties identified for temporary lease during construction generally comprise areas of rural land, and industrial and commercial uses. The property owner’s use of, and access to, land subject to temporary lease arrangements would be disrupted during the construction period. Following construction, these areas would be reinstated to pre-construction use, including the reinstatement of any affected infrastructure such as fencing, as agreed with the property owner. Rehabilitation of rural land subject to temporary lease would be carried out in accordance with relevant guidelines to minimise the potential for ongoing risks to rural land uses, for example increased erosion.

Table 14-3 Summary of properties to be acquired or leased

Property ID	Lot/ DP (Bold to be acquired)^	Ownership	Land use*	Total property area (ha)	Property within operational footprint (ha) (per cent of total area)†	Additional property required for construction (ha) (per cent of total area)†	Infrastructure affected
1	10/DP1186448	City of Newcastle	Vacant / vegetated land	1.55	–	1.47 (94.3%)	–
2	**102/DP846451**, **1617/DP1153099**	Hunter Water Corporation	Access track / electricity transmission line easement	1.91	0.04 (1.9%)	1.88 (98.1%)	–
3	13/DP553141, 12/DP553141	City of Newcastle	Landscaped buffer for Pasadena Crescent Reserve Soccer Fields	2.64	–	0.25 (9.5%)	–
4	52/DP551256	City of Newcastle	Utilities infrastructure	0.41	–	0.41 (100%)	Council facility, including fencing and sheds
5	**1/DP1181217**	Private – company	Unused land (Palm Valley Village covering remainder of property)	2.34	0.27 (11.6%)	–	–
6	**2/DP873320, 4/DP735235**	Private	Rural land with dwelling	203.26	14.61 (7.2%)	2.15 (1.1%)	Dwelling, business signage, fencing, stock yards, access tracks
7	**103/DP1084709, 1/DP735456, 101/DP1084709, 32/DP234979, 9/DP842856**	Private	Rural land (grazing), electricity transmission line easement	21.01	18.30 (87.1%)	–	Fencing, dam
8	**1/DP128309**	Hunter Water Corporation	Underground water pipeline easement	2.44	0.68 27.9%)	0.32 (13.2%)	Fencing

Property ID	Lot/ DP (Bold to be acquired)^	Ownership	Land use*	Total property area (ha)	Property within operational footprint (ha) (per cent of total area)†	Additional property required for construction (ha) (per cent of total area)†	Infrastructure affected
9	**102/DP1084709, 10/DP735235, 2/DP735456**, 104/DP1084709, 5/DP227556, 6/DP227556, 13/DP842856	Aurizon Operations Limited	Access road for Hexham Train Support Facility, rural land	47.50	12.20 (25.7%)	5.24 (11.0%)	Fencing, access tracks
10	12/DP842856	Hunter Water Corporation	Water utilities infrastructure	0.01	–	0.01 (100%)	Pipeline infrastructure
11	**100/DP1044020**	Private	Rural land with dwelling	8.30	0.95 (11.4%)	3.89 (46.9%)	–
12	11/DP1149091, 1/DP520550	Private	Rural land with dwelling	53.68	–	2.23 (4.1%)	Fencing, signage, water channel
13	1/DP1165954	Private	Rural land, access track	0.21	–	0.01 (6.5%)	–
14	**7300/DP1163794, 7310/DP1165716**	Crown land	Riverbank of Hunter River	15.15	1.36 (9.0%)	0.55 (3.7%)	–
15	**102/DP1038663**	Private – company	Vegetated land / wetland	32.60	9.97 (30.6%)	–	–
16	**43/DP558481**	Private	Vacant land (part of larger property accommodating Tomago Village Van Park)	1.81	0.32 (17.9%)	–	–
17	1/DP32464	Private – company	Commercial use	0.28	–	0.28 (100%)	Shed
18	**2/DP1043561, 3/DP1043561**	AGL Macquarie Pty Ltd	Rural land with dwelling (site of proposed power station)	27.91	6.89 (24.7%)	3.01 (10.8%)	Dwelling

Property ID	Lot/ DP (Bold to be acquired)^	Ownership	Land use*	Total property area (ha)	Property within operational footprint (ha) (per cent of total area)†	Additional property required for construction (ha) (per cent of total area)†	Infrastructure affected
19	**1203/DP1229590**	AGL Energy Limited	Gas pipeline easement (Newcastle Gas Storage Facility)	7.47	0.42 (5.6%)	–	Access track
20	**4/DP1043561, 202/DP1173564**	Private – company	Vegetated land, electricity transmission line easement, access road for Tomago Aluminium smelter	231.85	3.06 (1.3%)	0.83 (0.4%)	–
21	1/DP450444, **1/DP748716, 18/DP1082495**, **2/DP748716, 2/DP830246, 2/DP450444, 211/DP1103169**, **1/DP830246**	Hunter Water Corporation	Vegetated land, electricity transmission line easements, Hunter Region Botanic Gardens	655.84	16.98 (2.6%)	11.07 (1.7%)	–
22	**905/DP1256183**	Private – company	Vegetated land	459.01	18.65 (4.1%)	31.33 (6.8%)	–
23	**1/DP1169886**	Private – company	Evergreen Horse Stud (training track and paddocks)	171.32	1.43 (0.8%)	8.34 (4.9%)	Training track, fencing, horse paddocks, access tracks
24	**B DP163470**	Private – company	Commercial use	1.46	1.46 (100%)	–	Shed
25	**1/DP1187992**	Private – company	Landscaped buffer for commercial use	4.65	0.39 (8.5%)	–	–
26	**906/DP1256183**	Private – company	Commercial use, forestry plantation	63.29	9.92 (15.7%)	9.90 (15.6%)	–

Notes: *land use based on the review of aerial photography, † '–' no area of property within the operational footprint / requiring additional land for construction. '–' ^Lot/DP in bold are those currently identified for acquisition.

Construction footprint

Operational footprint

Properties impacted by acquisition or leasing have a unique property ID number and may include more than one lot

Project land owned by Transport

Waterways

0 150 300 m

Note: Sections of the properties that are impacted by acquisition are shown in unique full colour and sections of the properties impacted by lease arrangements are shown in the same colour at 30% transparency.

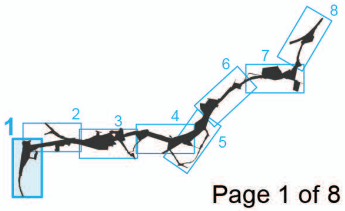

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Figure 14-6 Properties impacted by acquisition or temporary lease (map 1 of 8)

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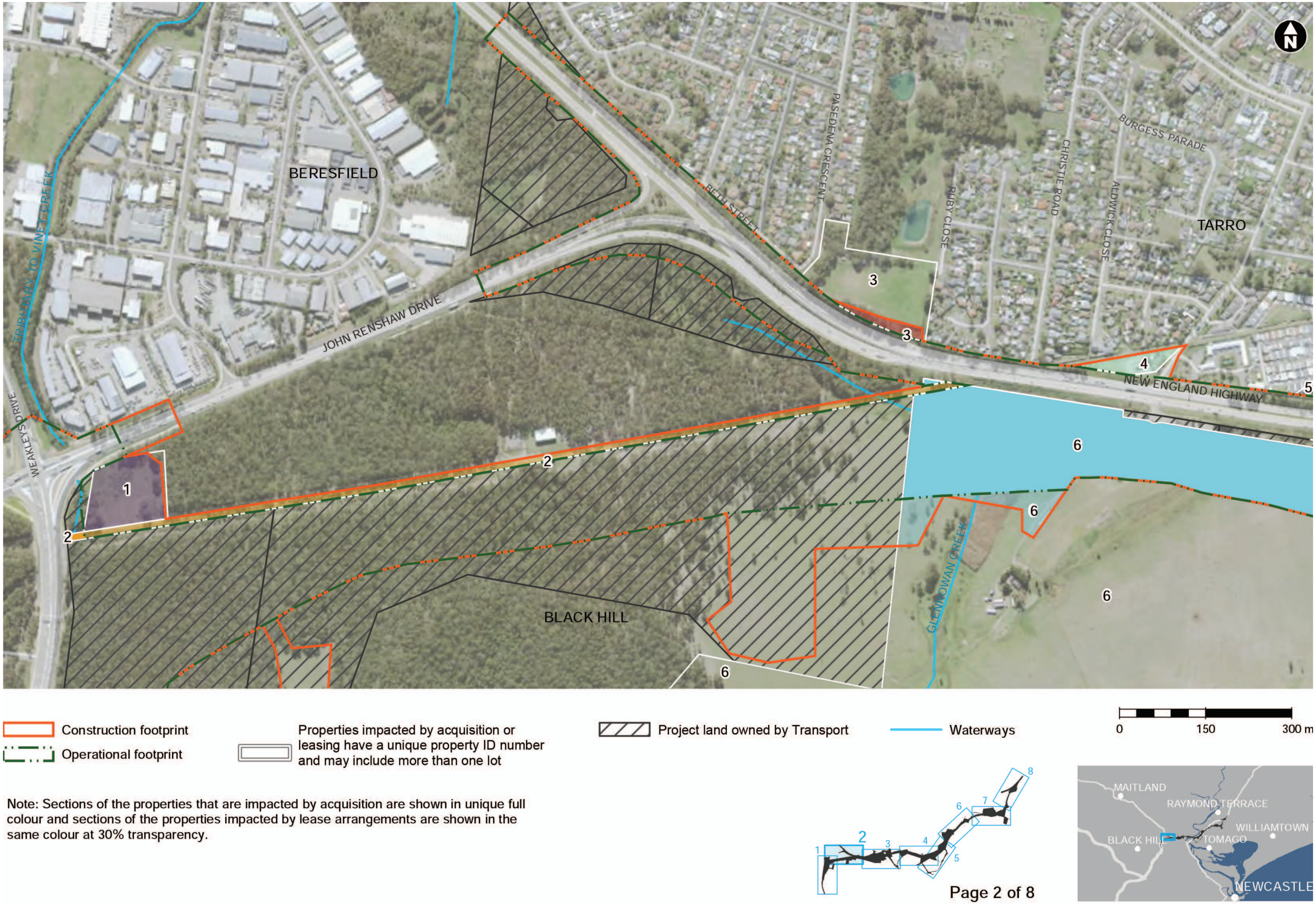
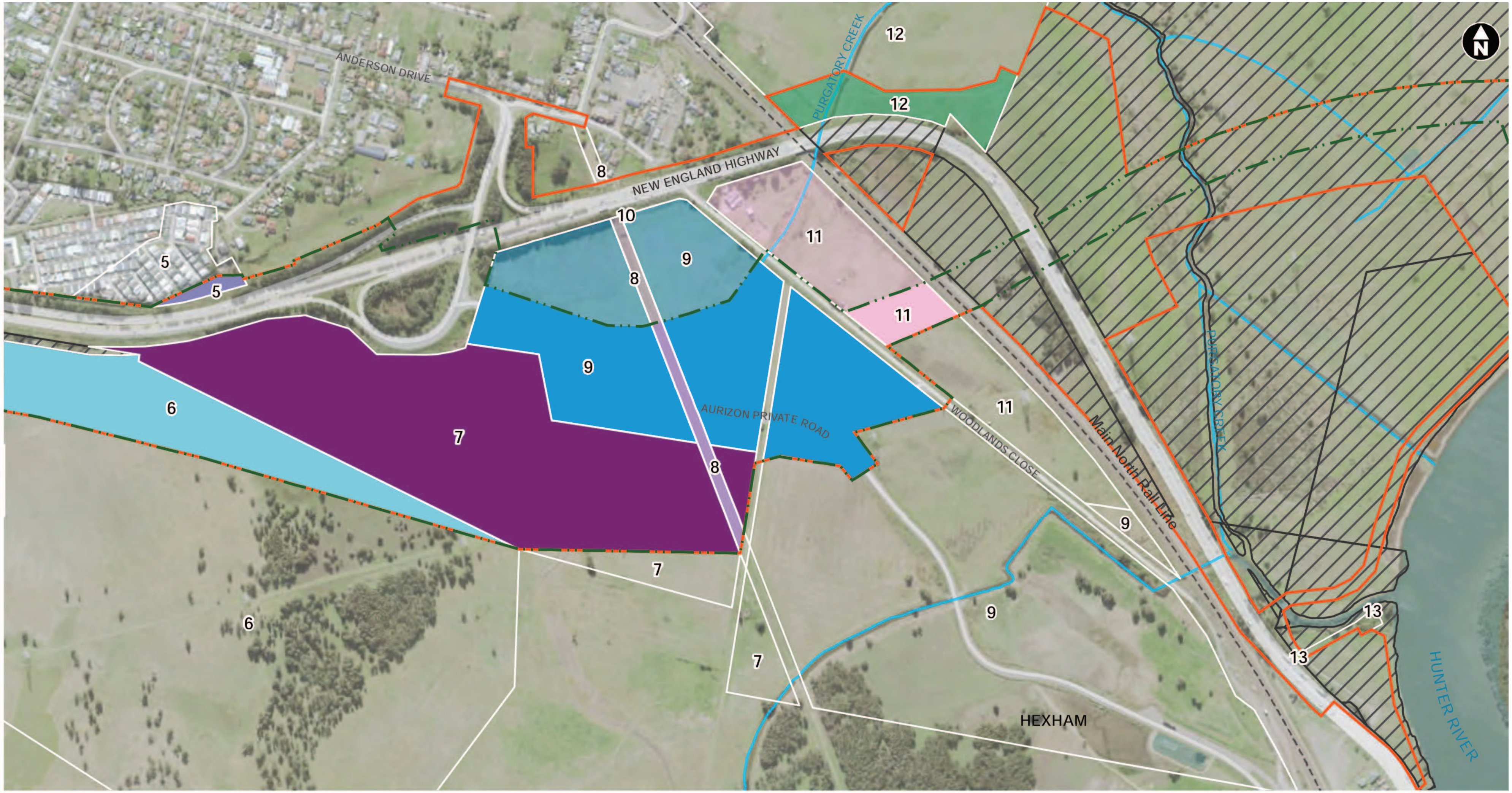


Figure 14-6 Properties impacted by acquisition or temporary lease (map 2 of 8)



Construction footprint

Operational footprint

Properties impacted by acquisition or leasing have a unique property ID number and may include more than one lot

Project land owned by Transport

Waterways

0 150 300 m

Note: Sections of the properties that are impacted by acquisition are shown in unique full colour and sections of the properties impacted by lease arrangements are shown in the same colour at 30% transparency.

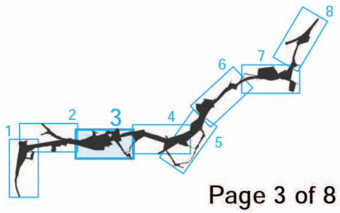


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Figure 14-6 Properties impacted by acquisition or temporary lease (map 3 of 8)

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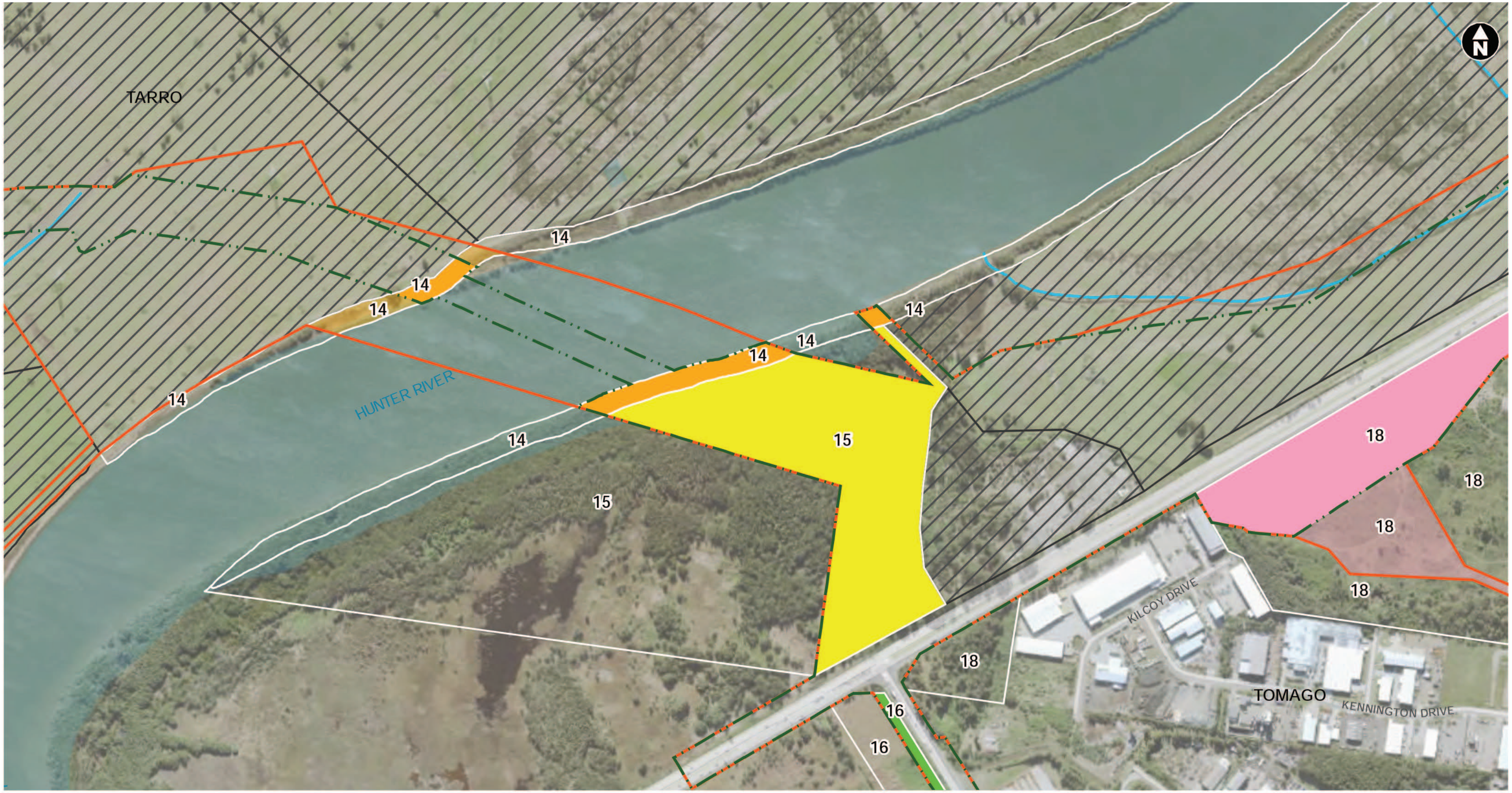

Construction footprint

Operational footprint

Properties impacted by acquisition or leasing have a unique property ID number and may include more than one lot

Project land owned by Transport

Waterways

0 150 300 m

Note: Sections of the properties that are impacted by acquisition are shown in unique full colour and sections of the properties impacted by lease arrangements are shown in the same colour at 30% transparency.

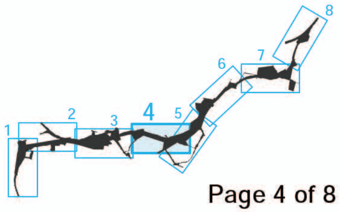

Figure 14-6 Properties impacted by acquisition or temporary lease (map 4 of 8)

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Construction footprint

Operational footprint

Properties impacted by acquisition or leasing have a unique property ID number and may include more than one lot

Project land owned by Transport

Waterways

0 150 300 m

Note: Sections of the properties that are impacted by acquisition are shown in unique full colour and sections of the properties impacted by lease arrangements are shown in the same colour at 30% transparency.

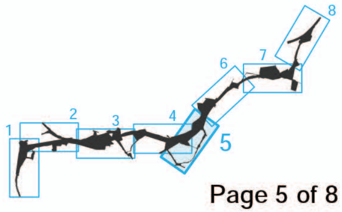

Figure 14-6 Properties impacted by acquisition or temporary lease (map 5 of 8)

Construction footprint

Operational footprint

Properties impacted by acquisition or leasing have a unique property ID number and may include more than one lot

Project land owned by Transport

Waterways

0 150 300 m

Note: Sections of the properties that are impacted by acquisition are shown in unique full colour and sections of the properties impacted by lease arrangements are shown in the same colour at 30% transparency.

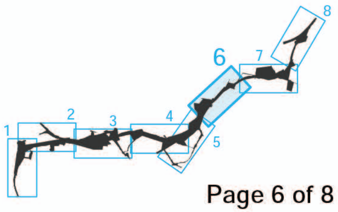

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Figure 14-6 Properties impacted by acquisition or temporary lease (map 6 of 8)

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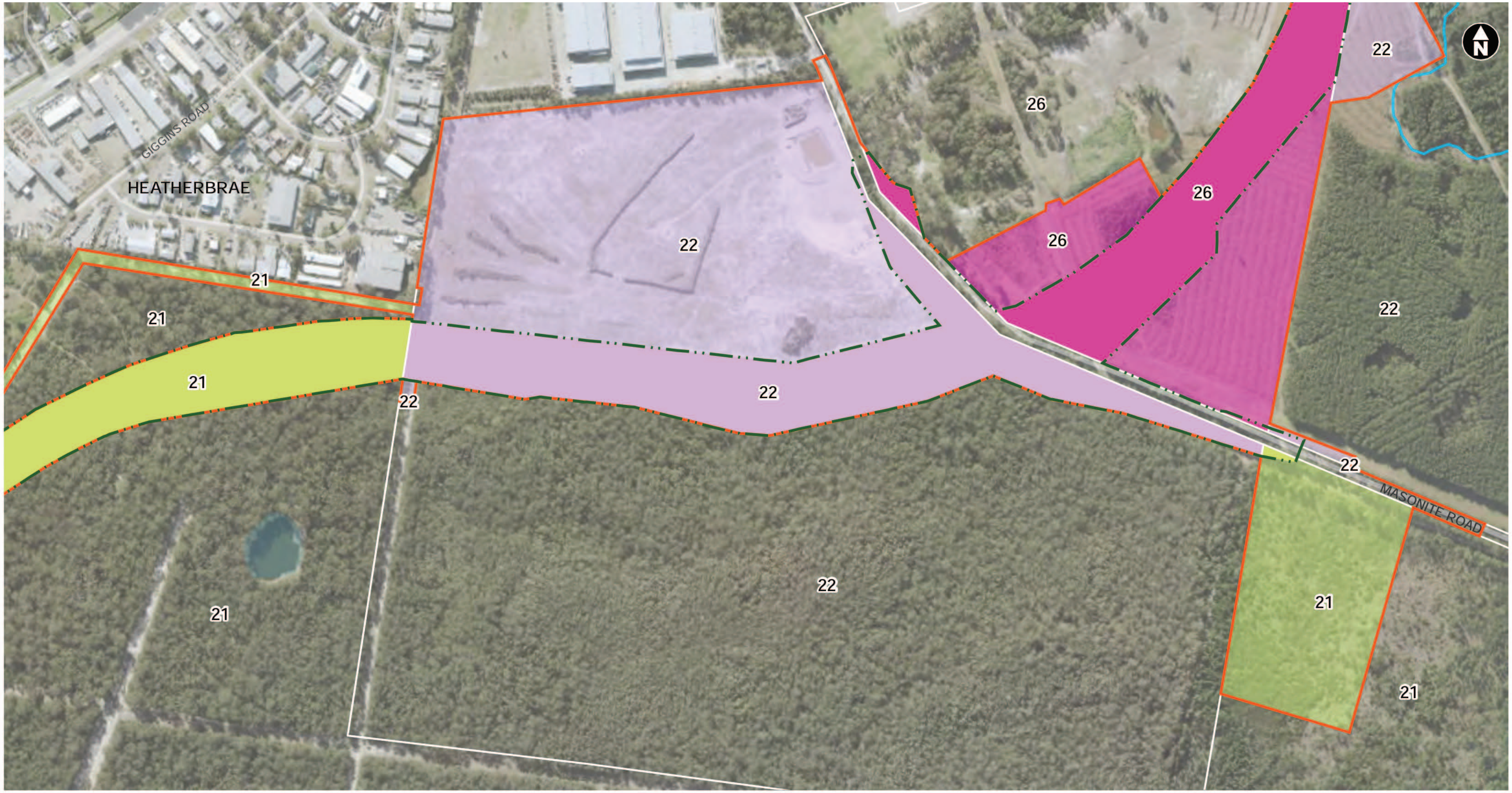
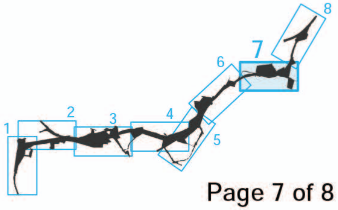


Construction footprint
Operational footprint
Properties impacted by acquisition or leasing have a unique property ID number and may include more than one lot
Waterways

0 150 300 m

Note: Sections of the properties that are impacted by acquisition are shown in unique full colour and sections of the properties impacted by lease arrangements are shown in the same colour at 30% transparency.



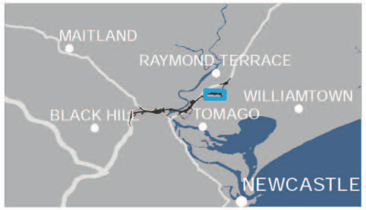
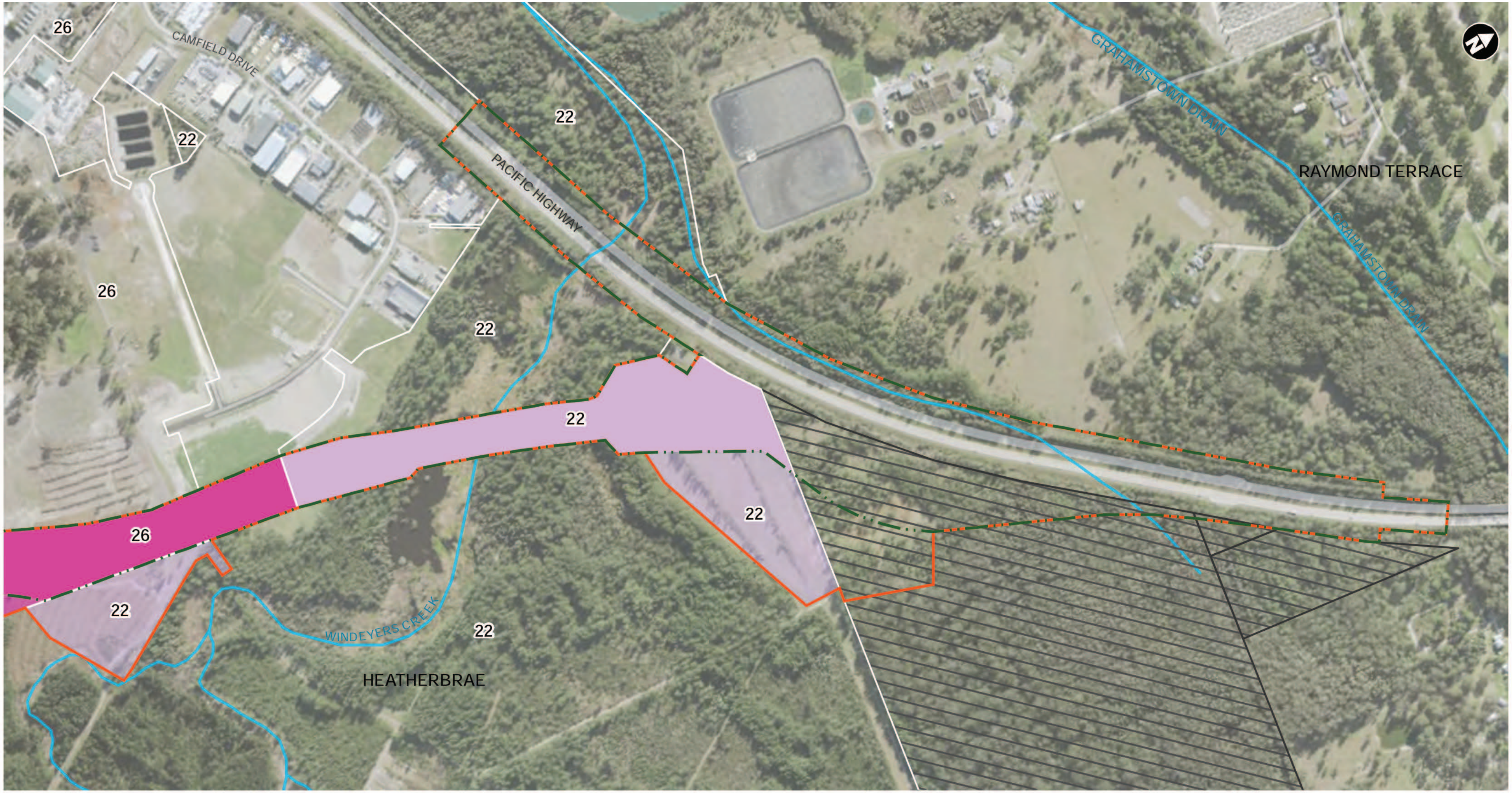


Figure 14-6 Properties impacted by acquisition or temporary lease (map 7 of 8)



Construction footprint

Operational footprint

Properties impacted by acquisition or leasing have a unique property ID number and may include more than one lot

Project land owned by Transport

Waterways

0 150 300 m

Note: Sections of the properties that are impacted by acquisition are shown in unique full colour and sections of the properties impacted by lease arrangements are shown in the same colour at 30% transparency.

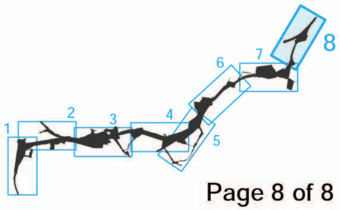


Figure 14-6 Properties impacted by acquisition or temporary lease (map 8 of 8)

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Changes to property access

During construction, access to properties near to construction works would be maintained although temporary changes may be required for some properties at Black Hill, Tarro, Tomago, Heatherbrae and Raymond Terrace. Once complete, the project would be classified as a motorway owned by Transport with no direct access from surrounding properties in accordance with the provisions of the *Roads Act 1993*.

Properties that are likely to experience access changes during construction and operation are outlined in **Table 14-4**. During construction, suitable access arrangements for affected properties would be implemented in consultation with affected property owners and tenants. Where existing property access would be permanently affected by the project, access would be provided either from existing roads or new access roads provided as part of the project.

Table 14-4 Properties with access changes during construction and operation

Location	Lot/DP	Ownership	Project phase
Black Hill	122/DP1235373	City of Newcastle	Construction and operation
	10/DP1186448	City of Newcastle	Construction
	1617/DP1153099, 102/DP846451	Hunter Water Corporation	Construction and operation
	50/DP879741, 14/DP1186448	Transport for NSW (TransGrid infrastructure)	Construction and operation
Tarro	2/DP873320	Private owner	Construction and operation
	4/DP735235	Private owner	Construction
	103/DP1084709	Private owner	Construction
	52/DP551256	City of Newcastle	Construction
	10/DP735235, 2/DP735456, 104/DP1084709	Aurizon Operations Limited	Construction and operation
	100/DP1044020	Private owner	Construction
	1/DP128309	Hunter Water Corporation	Construction and operation
Hexham	1/DP1165954	Private owner	Construction
Tomago	2/DP1043561, 3/DP1043561, 4/DP1043561	AGL Macquarie	Construction and operation
	51/DP739336, 202/DP1173564	Transport for NSW (TransGrid infrastructure)	Construction and operation
	1/DP748716	Hunter Water Corporation (HRBG)	Construction and operation
	102/DP1038663	Private owner	Construction
	43/DP558481	Private owner	Construction
	2/DP1173564	Tomago Aluminium	Construction
	1203/DP1229590	AGL Energy	Construction
Heatherbrae	Lot 430/DP833938	Private owner	Construction
	B/DP163470	Private owner	Construction

Location	Lot/DP	Ownership	Project phase
Tomago / Heatherbrae / Raymond Terrace	1/DP748716, 2/DP748716, 18/DP1082495, 2/DP450444	Hunter Water Corporation	Construction and operation
	211/DP1103169	Hunter Water Corporation	
Raymond Terrace	905/DP1256183, 906/DP1256183	Weathertex	Construction and operation
	34/DP1041438	Hunter Water Corporation	Construction and operation

Property infrastructure and dwellings

Permanent adjustments would be required to some private properties for the project, including demolition or relocation of infrastructure such as fencing, dams, sheds and other directly affected structures prior to construction, due to partial property acquisition. Any adjustments to properties required for the project would be carried out in consultation with the property owner.

The project would directly impact three dwellings, including two dwellings on rural land and one dwelling associated with a commercial property at Heatherbrae. Residents of these dwellings would be required to relocate prior to the commencement of construction.

One dwelling is located within the site of the proposed power station, which is due to be operational prior to construction of the project. If the proposed power station proceeds within the timeframe expected, it is assumed that this dwelling would be removed as part of the proposed power station development and would require the residents of this dwelling to relocate. Should this occur, only two dwellings would be directly impacted by the project.

An additional dwelling is located within the construction footprint at Tarro, next to ancillary facility AS5. While this dwelling would not be directly impacted by the project, the residents of this property may be required to temporarily relocate during construction.

Flooding impacts

The project has potential to change flooding impacts for surrounding properties. During construction, raised construction access tracks around the viaduct, viaduct piers, wharf structures and permanent road embankments have potential to cause increased flood levels and potential flood hazard and duration of inundation. This would affect 19 lots and five habitable buildings. Construction of the project is not expected to result in substantial changes to flow velocities across the floodplain, with any changes mainly localised around the construction footprint. The change in flood hazard during the construction phase is also expected to be localised.

During operation, a total of 10 lots and one habitable building would experience afflux exceeding the adopted criteria during operation. The majority of existing flood-affected residential, commercial and industrial properties would experience at most, a negligible change in flood depth, flood hazards or duration of inundation. The project would also result in localised increases in flow velocities, flood hazards and duration of inundation, although potential impacts of these changes are generally expected to be negligible.

During operation, the project is expected to have negligible to minor flooding impacts on agricultural and grazing activities, emergency services (including evacuation routes) and future development potential of affected land, existing roads and rail infrastructure.

Construction and operational impacts on flooding from the project are described in **Chapter 10** (hydrology and flooding).

Local amenity impacts

Potential impacts may occur for properties near the project due to temporary and permanent changes in local amenity related to construction traffic noise, visual impacts and changes to air quality. These impacts are described in **Chapter 8** (noise and vibration), **Chapter 15** (urban design, landscape and visual amenity) and **Chapter 18** (air quality), respectively.

Residual land

As discussed above, partial acquisition of land has the potential to result in severance or fragmentation of some rural properties, particularly larger land holdings. Transport would continue to consult with property owners through the detailed design about these land parcels and possible options.

Acquisitions for the project would be carried out by Transport in accordance with the provisions of the NSW *Land Acquisition (Just Terms Compensation) Act 1991* and the Land Acquisition Reform 2016 process (**https://www.propertyacquisition.nsw.gov.au/**). The Act provides the basis for an appropriate valuation process and the fair assessment of compensation.

Where properties are only partly affected by the project, Transport would generally carry out a partial acquisition of the directly affected portion. Transport would consider the acquisition of any residual parcels created by the location and design of the project. Total acquisition offers may be triggered in instances where:

- Residual land is not developable
- Transport is unable to provide access to the residual land
- The project directly impacts and requires removal of the main residence on the property
- Transport receives a request from the property owner.

14.4.2 Existing land use

Potential impacts on existing land use from construction and operation of the project would mainly relate to:

- Direct impacts on land use, including:
  - Temporary impacts from the placement of ancillary construction facilities
  - Permanent impacts from the siting of the project.
- Changes in amenity for some land uses along the existing Pacific Highway or near to the project, associated with:
  - Noise and dust from construction activities and traffic
  - Changes in operational road traffic noise.
- Changes to property access, including:
  - Temporary changes near to construction works
  - Permanent changes due to the siting of the project.

The main land uses impacted by the construction footprint (which would directly impact about 466 hectares) and the operational footprint (which would directly impact about 300 hectares) are described in **Table 14-5**.

Table 14-5 Impacts to key land uses during construction and operation

Key land use	Area impacted	Impacts to land use
Primary production	About 219 hectares, of which about 121 hectares would be permanently impacted and changed to transport infrastructure	• Predominately impacts to grazing land, including at Beresfield, Black Hill and Tarro • The project would impact on land identified for plantation forest at Heatherbrae, although most of the affected land is identified for future industrial uses • Potential for the spread of weeds to occur between properties, potentially impacting on rural land uses • New construction access tracks may also encourage pest animals such as foxes and cats • Changes to flooding from the construction and operation of the project have the potential to impact on agricultural and grazing activities, due to increased flood extents and durations of inundation affecting productivity of land and impacts to stock flood refuge access on the floodplain. Overall, any additional impacts are considered minor compared to the existing case flood effects • The project would not impact on any land use for horticulture or cropping.
Intensive uses	Residential: About 6 hectares, of which about 3 hectares would be permanently impacted	• The affected land mainly comprises residential uses on farming land and vacant land next to residential uses at Beresfield • The project would not impact on the availability of land for residential uses in the study area or wider LGAs. • Once operational, the project would provide improved access and connectivity for existing and future residential uses in Black Hill, Beresfield and Raymond Terrace, including through improved safety outcomes and reduced travel times for motorists.
	Manufacturing / industrial: About 7 hectares is permanently impacted but it is currently not used for manufacturing/ industrial uses	• During construction, impacts would be mainly confined to vacant manufacturing and industrial land between the Hunter River and the Pacific Highway at Tomago. Opportunities to use suitable existing sites as construction ancillary facilities in the surrounding industrial areas in Black Hill, Beresfield, Hexham, Tomago and Raymond Terrace would be investigated to reduce the construction footprint • Not expected to impact on the availability of land for manufacturing and industrial uses within the study area or wider LGAs • Once operational, the project would support improved access to the M1 Pacific Motorway and Pacific Highway for manufacturing and industrial uses at Beresfield and Tomago, including through improved safety outcomes and reduced travel times for motorists and freight vehicles.
	Services: About 14 hectares, of which about 9 hectares would be permanently impacted	• This includes commercial land uses at Heatherbrae, land within the Hunter Region Botanic Gardens, and land within one property at the Tomago industrial estate • This represents a very small proportion (about 0.3 per cent) of this land use type in the City of Newcastle and Port Stephens Council LGAs.
	Infrastructure: About 98 hectares, of which about 79 hectares would be permanently impacted	• Comprising land within utility corridors for power, water and gas pipelines • Utilities would need to be relocated, adjusted or protected where they may be affected during construction particularly in areas where ground disturbance is required. This work would be carried out in consultation with the relevant service provider to minimise any service disruptions. • Once operational, it is anticipated that there would be no impacts to land used for infrastructure.

Key land use	Area impacted	Impacts to land use
	Other: About 9 hectares, of which about 1 hectare would be permanently impacted	• During construction, intensive animal production (consisting of a horse stud at Heatherbrae) would be impacted. Impact would require modifications to the training track and adjustments to the fencing and railings • The project would not impact on any land used for mining related uses.
Conservation and natural environments	About 91 hectares, of which about 62 hectares would be permanently impacted	• Most of the land affected by the construction footprint comprises managed resource protection (about 58.5 hectares), with this mainly being Hunter Water Corporation land at Tomago and Heatherbrae • The project would require clearing within these areas for the road corridor and establishment of ancillary construction sites • Areas not required for the ongoing operation of the project, would be rehabilitated and reinstated as agreed with the property owner • Impact to 0.6 hectares of a BioBank site.
Water	About 22 hectares, of which about 10 hectares would be permanently impacted	• About half the water land use area comprises land within the Hunter River, with other areas of affected land comprising marsh / wetland areas next to the Hunter River at Tomago, water pipeline easements at Black Hill and creeks at Tarro • Access would be maintained to the Hunter River for recreational and commercial uses, although temporary disruptions would occur during construction due to access restrictions near to construction works • No impacts to recreational and commercial users of the Hunter River are anticipated once the project is operational • The project would impact on the Hunter Valley Flood Mitigation Scheme due to access roads that would be constructed immediately next to the existing flood levees on the western Hunter River floodplain. While these roads may modify the structure and maintenance of the levees, they are not expected to impact on operation, function or structural integrity of the Scheme, including floodgates • The Hunter Valley Flood Mitigation Scheme would not be impacted during operation of the project.

Use of, and access to, land within the construction footprint would be disrupted during the construction period. Areas subject to temporary lease would be reinstated after construction to pre-construction use or as agreed with the property owner.

About 216 hectares of existing land uses would permanently change to transport infrastructure. This would increase the footprint of transport infrastructure within the study area from about 237 hectares to about 453 hectares. Most of the affected land uses, however, represent a very small proportion of these land uses within the wider City of Newcastle and Port Stephens Council LGAs (about one per cent or less) and are not expected to impact on the overall availability of these uses. The exceptions to this are primary production uses (about 6.4 per cent for construction and 2.6 per cent for operation) and infrastructure (about two percent for construction and operation). Further detail about the proportions of land use affected is in the Land Use and Property Working Paper (**Appendix N**).

14.4.3 Land use zoning

About 173 hectares of the project's construction footprint (37 per cent) would directly impact land zoned SP2 (Infrastructure), including land within the gazetted road corridor and existing road corridors. The remaining area of land affected by the construction of the project is zoned for a range of commercial, environmental, industry, residential, rural and recreation uses.

About 157 hectares of the operational footprint (52 per cent) would directly impact land zoned SP2 (Infrastructure). This includes land within the gazetted road corridor and existing road corridors. The remaining area of land affected by the operation of the project is zoned for a range of commercial, environmental, industry, residential, rural and recreation uses

The impacts on land zoning in the study area are further discussed in Land Use and Property Working Paper (**Appendix N**).

14.4.4 Mining

Neither the construction footprint nor the operational footprint would directly impact the area covered by the mining lease (ML1618) with the boundary for the mining lease located west of the M1 Pacific Motorway and southwest of Beresfield. This mining operation is currently in care and maintenance mode and impacts from the project are not expected.

Parts of an exploration licence (EL5497) and an assessment lease (ALA71) located on the western side of the M1 Pacific Motorway at Black Hill extend into the construction and operational footprints (refer to **Figure 14-5**). Consultation with Donaldson Coal was carried out in 2016 to advise of potential mining impacts. Works in this area are generally located within or near to the existing M1 Pacific Motorway and potential impacts on any future mining uses are expected to be minimal. Access to the exploration licence and assessment lease areas would not be permitted from the M1 Pacific Motorway. However access to these areas would be available via Lenaghans Drive and John Renshaw Drive should future exploration activities be investigated.

Potential risks associated with the Black Hill Mine Subsidence District are described in **Chapter 22** (safety and risk).

14.4.5 Utilities

The project would affect some utilities and services, including electricity transmission lines, telecommunications infrastructure, water and sewer mains, and gas pipelines.

As described in **Section 5.3.15**, utilities would need to be relocated, adjusted or protected where they may be affected by project construction, particularly in areas where ground disturbance is required. This work would be carried out in consultation with the relevant service provider to minimise any service disruptions.

Depending on the utility service being relocated, work may be required to occur outside the construction footprint to meet requirements of the utility service provider. Changes to utilities that are located outside the construction footprint would be subject to separate environmental assessment.

Potential utility relocation, adjustments or protections are summarised in **Table 14-6**. Further work would be carried out prior to construction to confirm the exact impact on utilities and any permanent relocations that would be required.

Once operational the project is not expected to impact further on infrastructure and utilities in the study area.

Table 14-6 Summary of utility impacts

Location	Asset owner	Asset type	Summary of impact and protection strategy
• Black Hill interchange • Across the floodplain west of the Hunter River • Tomago interchange	Transgrid	Major overhead high voltage transmission lines	A minimum overhead clearance of 12m is required. The project would achieve this at Black Hill and Tomago, although is unable to achieve the minimum vertical clearance across the floodplain, west of the Hunter River. The overhead lines would be lifted in this location via the installation of a mid-span suspension structure to achieve the minimum clearance over the main alignment. A minimum horizontal clearance of 20m is required for transmission tower structures. This is achieved at the Tomago interchange. Minor embankments would encroach on the clearance at Black Hill. Transport will continue to consult with TransGrid regarding this issue.
Pacific Highway between Tomago Road and Heatherbrae	Ausgrid	Overhead and underground high and low voltage lines	High voltage overhead and underground low voltage lines near the Tomago interchange would be impacted by the project. These lines would be relocated adjacent to the realigned Pacific Highway and main alignment.
Black Hill between Weakleys Drive and Lenaghans Drive	Ausgrid	Overhead high voltage line	The high voltage overhead lines located parallel to the M1 Pacific Motorway between Weakleys Drive and Lenaghans Drive would be impacted by the project. These lines would be relocated adjacent to the project.
Black Hill, south of Weakleys Drive	Ausgrid	Overhead transmission and high voltage lines	The concrete pole supporting the overhead transmission and high voltage lines from John Renshaw Drive, east and west of the M1 Pacific Motorway, may be impacted by widening required for the project. This pole may require relocation or protection in consultation with Ausgrid.
Beresfield / Tarro between John Renshaw Drive and Anderson Drive	Ausgrid	Overhead transmission lines	The overhead transmission lines located parallel to the New England Highway between John Renshaw Drive and Woodlands Close would be impacted by the widening and realignment of the New England Highway. These lines would be relocated adjacent to the project main alignment in consultation with Ausgrid. The overhead lines that cross the New England Highway east of John Renshaw Drive and connect to Christie Road may also require minor adjustments.
Woodlands Close, Tarro	Ausgrid	Overhead high voltage transmission lines	The overhead lines located parallel to Woodlands Close would be impacted by Bridge B05. These lines would be relocated adjacent to Woodlands Close.
Heatherbrae, near Jura Street	Ausgrid	Underground and overhead high voltage lines	High voltage overhead and underground lines that intersect the project near Jura Street, Tomago. Minor adjustments to the overhead and underground lines would be required in consultation with Ausgrid.
Masonite Road, Heatherbrae	Ausgrid	Overhead high voltage transmission lines	The overhead lines located adjacent to Masonite Road would be impacted by the realignment of Masonite Road. These lines would be relocated adjacent to the realigned Masonite Road in consultation with Ausgrid. Additional minor adjustments may be required where the lines cross the main alignment north-east of Masonite Road.

Location	Asset owner	Asset type	Summary of impact and protection strategy
Heatherbrae, near Camfield Drive	Ausgrid	Overhead transmission lines and potential All-Dielectric Self-Supporting (ADSS) Fibre Optic	The overhead transmission lines and potential ADSS Fibre Optic cross the project alignment near Camfield Drive and would require minor adjustments to ensure that adequate clearances are maintained.
Pacific Highway, north of Masonite Road, Raymond Terrace	Ausgrid	Overhead high voltage and low voltage lines	The overhead electrical lines located at the Pacific Highway would be impacted by the project. A section of these lines would be relocated adjacent to the project in consultation with Ausgrid.
Tarro interchange	Hunter Water Corporation	Proposed Chichester Trunk Gravity Main (CTGM)	A substantial length of the gravity main would be beneath the project at Tarro. The CTGM would need to be either protected or relocated by the project in consultation with Hunter Water Corporation.
• Black Hill • Tomago • Heatherbrae • Raymond Terrace	Hunter Water Corporation	Water mains and sewer mains	A number of water and sewer mains would be impacted by the project. These assets will be further considered during detailed design and protected or relocated depending on their accurate location and depth.
Multiple locations within project footprint	Telstra, Nextgen, and Optus	Optical fibre and copper network	Numerous major and minor aerial and underground cables are located along and through the project and would be impacted by the project at various locations. These cables are typically located within existing road corridors. Locations where telecommunications utilities would be impacted and require either protection and/or relocation include: • The main alignment, Lenaghans Drive, Weakleys Drive and John Renshaw Drive at Black Hill • The New England Highway at Beresfield and Tarro • Woodlands Close at Tarro • Tomago Road and Old Punt Road at Tomago • The Pacific Highway at Tomago, Heatherbrae and Raymond Terrace • Masonite Road at Heatherbrae. Further survey to accurately locate these cables will be carried out during detailed design to determine the need for protection and/or relocation.
Tomago	AGL	High pressure gas main and proposed plant site	The Tomago to Hexham gas pipeline would be in the vicinity of the project and may require protection and relocation. In addition, a gas-fired power station is proposed at Tomago between the Pacific Highway and Old Punt Road, near ancillary facility AS12. The proposed power station would be in the vicinity of the main alignment, and an easement for the gas pipeline would be impacted by the project.
Pacific Highway between Tomago and Heatherbrae	Jemena	Gas main	Gas mains are in the vicinity of the project and would be relocated to avoid potential impacts.

Location	Asset owner	Asset type	Summary of impact and protection strategy
Old Punt Road, Tomago	AGL	Gas main	A gas main is located in the vicinity of the project at Old Punt Road and may require protection or relocation to avoid impacts.

14.4.6 Water users

No water access licences are located within the construction footprint or would be impacted by the project.

Construction and operation of the project has potential to impact on surface water and groundwater features within the study area, including waterways, wetlands and aquifers that have a high conservation or community value and that support ecosystems/human uses of water. During construction, potential impacts on groundwater would be associated with temporary groundwater dewatering and introduction or mobilisation of contaminants.

The project has potential to change stormwater discharges (i.e. increased runoff due to vegetation clearance and paving of the new motorway, and changes to drainage paths), which may lead to changes to the flow regimes of the existing receiving environment. This may result in impacts to local receiving waterway processes and health immediately downstream of project discharge locations from storm events, including increased erosion and water turbidity, reduced bank stability and minor increases to the duration and depth of inundation for overbank events. Impacts to surface water quality and hydrology are further described in **Chapter 10** (hydrology and flooding) and **Chapter 11** (surface water and groundwater quality).

The project would be located on land within the Tomago Sandbeds Catchment Area. Potential impacts on the water quality of the Tomago Sandbeds Catchment Area during construction and operation of the project are expected to be appropriately managed with the implementation of management measures including the lining of temporary sediment basins, permanent water quality basins and the swales leading to these basins located within the Catchment Area (refer to **Chapter 11** (surface water and groundwater quality)).

14.4.7 Future land use

Land within and surrounding the study area comprises several areas identified for future growth and development as part of the Hunter Regional Plan (DPE 2016) and as important trading hubs by the Greater Newcastle Metropolitan Plan (DPE 2018).

The M1 Pacific Motorway is a key north-south corridor linking Sydney to the Central Coast, Newcastle and Hunter region while the New England Highway and the Pacific Highway between the M1 Pacific Motorway at Black Hill and Raymond Terrace also form part of the National Land Transport Network.

The project would support future land use and development within the study area. In particular, improved access and connectivity provided by the project, such as improved safety outcomes and reduced travel times for motorists and freight vehicles, would support:

- Future employment and population growth at Raymond Terrace
- Growth and development of employment precincts at Tomago and Thornton, Beresfield and Black Hill
- Urban development within urban release areas such as West Wallsend, Cameron Park and Edgeworth south of the study area.

Improved connectivity between strategic centres and growth areas is a key objective for future planning, supporting efficiencies in freight movements and future growth, and making it easier for people to get to work, recreation facilities and services. The project would be an important part of the transport network allowing more efficient and safer access for residents, workers, businesses and freight in these locations, as well as the wider region.

Several industrial developments are proposed or planned within the study area at Black Hill, Beresfield and Heatherbrae, consistent with these strategies. In general, the project's operation would support these developments by improving access and connectivity to the motorway network.

14.4.8 Evaluation of potential land use risk conflicts

Most land use conflict risks between the project and adjoining land uses during construction and operation would be effectively managed (ratings of negligible or minor) following the implementation of management measures and environmental safeguards.

The potential impacts that are likely to have the highest risk ranking would be the impacts to land uses for other intensive uses, such as intensive animal production (for example, the horse stud at Heatherbrae), although this risk was considered to only have a minor consequence following the implementation of the appropriate management measures and environmental safeguards.

The next highest risks were generally considered to have negligible consequences following the implementation of the appropriate management measures and environmental safeguards, including:

- The permanent loss of primary production land
- Direct impact on residential dwellings
- Impacts on land used for commercial and public services, infrastructure and conservation and natural environments
- Clearing of land used for conservation and natural environment uses.

The environmental focus of the route selection for the project was to align the construction footprint with existing development and infrastructure and thereby avoid biodiversity impacts where possible. This has resulted in a construction footprint that has minimal impact to vegetation connectivity at a landscape scale due to the fact that the route follows along the edge of existing vegetation, particularly north of Tomago Road (refer to **Section 9.4.1**).

Where impacts were unable to be avoided or minimised, a number of management measures have been identified to mitigate potential impacts, outlined in **Section 14.5.**).

Further details on the outcomes of the land use conflict risk assessment are presented in the Land Use and Property Working Paper (**Appendix N**).

14.5 Environmental management measures

The environmental management measures that will be implemented to minimise the land use and property impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 14-7**.

Table 14-7 Environmental management measures (land use and property)

Impact	Reference	Environmental management measure	Responsibility	Timing
Property acquisition	LU01	All partial and full acquisitions and associated property adjustments will be carried out in accordance with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991* and the Land acquisition reform 2016 in consultation with landowners. This will include the provision of monetary compensation determined in accordance with the provisions of the Act.	Transport	Prior to construction
	LU02	Property adjustments will be completed in consultation with property owners/business managers.	Transport / Contractor	Prior to construction/ construction
Rehabilitation of affected land	LU03	Land subject to temporary use will be rehabilitated as soon as practicable to an appropriate condition, taking into consideration the location, land use characteristics, area and adjacent land uses. This will be carried out in consultation with the land owner.	Transport / Contractor	Construction
Other relevant management measures				
Community consultation	SE01	A Community Communication Strategy (CCS) will be prepared for the project to facilitate communication with the community and stakeholders including relevant Government agencies, Councils, adjoining affected landowners and businesses, residents, motorists and other relevant stakeholders that may be affected by the project. The strategy will: • Identify people or organisations to be consulted during the delivery of the project • Set out procedures and mechanisms for the regular distribution of information about the project • Outline mechanisms to keep relevant stakeholders updated on site construction activities, schedules and milestones • Outline avenues for the community to provide feedback (including a 24-hour, toll free project information and complaints line) or to register complaints and through which Transport will respond to community feedback • Outline a process to resolve complaints and issues raised.	Transport/ Contractor	Prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Property access	TT02	Existing accesses to properties and businesses will be maintained during construction. Where this is not feasible or reasonable, temporary alternative access arrangements will be provided following consultation with the affected property and business owners.	Transport / Contractor	Detailed design/ prior to construction/ construction
Invasion and spread of weeds	B11	Weed species will be managed in accordance with 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011) (Guide 6: Weed management).	Contractor	Construction
Invasion and spread of pest animal, pathogens and disease	B12	Pest species and pathogens will be managed in accordance Guide 2: Exclusion zones of the 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011), the Commonwealth *Biosecurity Act 2015,* NSW *Biosecurity Act 2015* and where relevant, the Australian Ballast Water Management Requirements.	Contractor	Construction

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M1 Pacific Motorway extension to Raymond Terrace

Environmental impact statement – Chapter 15: Urban design, landscape and visual amenity

Transport for NSW | July 2021

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15. Urban design, landscape and visual amenity

This chapter describes the potential landscape character and visual amenity impacts that may be generated by the construction and operation of the project and describes the environmental management measures that have been developed to manage these impacts. It also summarises the urban design and landscape strategy which has been developed to integrate and respond to findings from the Urban Design, Landscape Character and Visual Amenity Working Paper (**Appendix O**).

The desired performance outcomes for the project relating to urban design and visual amenity, as outlined in the SEARs, are to:

- Complement the visual amenity, character and quality of the surrounding environment
- Contribute to the accessibility and connectivity of communities
- Minimise the adverse impacts of the project on the visual amenity of the built and natural environment (including public open space) and capitalise on opportunities to improve visual amenity.

Table 15-1 outlines the SEARs that relate to urban design and visual amenity and identifies where they are addressed in this EIS. The full assessment of urban design and visual amenity impacts is provided in the Urban Design, Landscape Character and Visual Amenity Working Paper (**Appendix O**).

Table 15-1 SEARs (urban design and visual amenity)

Secretary's requirement	Where addressed
10. Urban design	
1. The proponent must	
(a) identify the urban design and landscaping aspects of the project and its components, including interchanges, bridge and viaduct structures, embankments, noise barriers (including walls and mounds), ancillary buildings, and road infrastructure facilities and services	The urban design and landscaping aspects of the project and its components are identified in **Table 15-4**.
(b) assess the impact of the project on the urban, rural and natural fabric, including residual land treatment, and demonstration of how the proposed hard and soft urban design elements of the project would be consistent with the existing and desired future character of the area traversed or affected by the project	The impact of the project on landscape character is provided in **Section 15.5**. Residual land treatment is discussed in **Section 5.3.19**, **Section 14.4.1** and **Table 15-4** **Section 15.3.3** describes the urban design approach, objectives and principles to maximise integration of the project with the character of the area. Consistency of hard project elements including bridges, retaining walls, noise barriers and roadside furniture with the existing and desired future character of the area is described in **Table 15-4** and **Section 15.3.4** Consistency of soft project elements such as earthwork formations, drainage and stormwater and landscape design is described in **Table 15-4** and **Section 15.3.4**.
(c) explore the use of Crime Prevention Through Environmental Design (CPTED) principles during the design development process, including natural surveillance, lighting, walkways, signage and landscaping	CPTED is discussed in **Section 15.3.4**.
(d) identify urban design strategies to enhance healthy, cohesive and inclusive communities directly impacted by the project	The urban design strategy plans are detailed in **Section 15.3.3**. Urban design treatments for project elements are described in **Table 15-4**.

Secretary's requirement	Where addressed
(e) describe urban design and landscape mitigation measures, having regard to the urban design and landscape objectives for the project.	The urban design and landscape concept is shown in **Section 15.3.4** and further described in the Urban Design, Landscape Character and Visual Amenity Working Paper (**Appendix O**). Urban design and landscape management measures are provided in **Section 15.6**.
11. Visual amenity	
1. The Proponent must assess the visual impact of the project and any ancillary infrastructure (including noise barriers) on:	
(a) views and vistas;	The visual impact of the project on views and vistas is assessed in **Section 15.5**
(b) streetscapes, key sites and buildings;	The visual impact of the project on streetscapes, key sites and buildings is assessed in **Section 15.5**
(c) heritage items including Aboriginal places and environmental heritage; and	The visual impact of the project on heritage items (including Aboriginal places and environmental heritage) is assessed in **Section 15.5** Visual impacts to Aboriginal places are also discussed in **Chapter 12** (Aboriginal cultural heritage) and environmental heritage in **Chapter 17** (non-Aboriginal heritage).
(d) the local community (including view loss and overshadowing).	The visual impact of the project on the local community (including view loss and overshadowing) is assessed in **Section 15.5**
2. The Proponent must provide artist impressions and perspective drawings of the project from a variety of locations along and adjacent to the route to illustrate how the project has responded to the visual impact through urban design and landscaping.	**Section 15.3.3** provides the strategy plans for the project. Indicative urban design concept are shown in **Figure 15-2** to **Figure 15-5**, and further described in the Urban Design, Landscape Character and Visual Amenity Working Paper (**Appendix O**). Indicative photomontages with the project and embedded design mitigation in place have been provided in **Table 15-9**.

15.1 Policy and planning setting

The urban design, landscape character and visual impact assessment was prepared to assess the potential impacts of the project in accordance with the following relevant legislation, policy and guidelines:

- Legislation:
  - Port Stephens Local Environmental Plan 2013
  - Newcastle Local Environmental Plan 2012
  - Maitland Local Environmental Plan 2011.
- Plans and policies:
  - Hunter Regional Plan 2036 (DPE 2016)
  - Hunter Regional Plan Vision (DPE 2016).

- Guidelines:
  - Beyond the Pavement – urban design policy, procedures and design principles (Transport for NSW 2020a)
  - Australian Standard AS4282-1997 Control of the obtrusive effects of outdoor lighting (AS4282), (Australian Standard 1997)
  - AS/NZS1158:2005 Lighting for roads and public spaces
  - Bridge Aesthetics: Design Guidelines to improve appearance of bridges in NSW (Transport for NSW 2019a)
  - NSW Sustainable Design Guidelines Version 3.0 (Sustainable Design Guidelines) (Transport for NSW 2013)
  - Crime prevention and the assessment of development applications (DUAP 2001)
  - Crime Prevention through Environmental Design (Queensland Government 2007)
  - Urban Green Cover in NSW. Technical Guidelines (Urban Tree Cover), (OEH 2015)
  - Healthy Urban Development Checklist (NSW Health 2009)
  - Pacific Highway Urban Design Framework 2013 (Pacific Highway Urban Design Framework), (Roads and Maritime Services 2013b).

Further detail on the above legislation, policies and guidelines, and how they apply to the project, is provided in **Section 3.1** and in the Urban Design, Landscape Character and Visual Amenity Working Paper (**Appendix O**).

15.2 Assessment methodology

The landscape character and visual impact assessment was completed in accordance with Roads and Maritime Services Practice Note – Environmental Impact Assessment Practice Note: Landscape Character and Visual Assessment EIA-N04 (Transport for NSW 2020d).

The assessment methodology included:

- A review of relevant guidelines, planning and policies
- A desktop review of existing conditions to allow for the contextual analysis of the existing environment
- Site inspections in 2015, 2016 and 2020, to ground-truth and confirm the study area existing conditions, landscape character and views
- Identification of landscape character zones
- Development of the project urban design strategy, including urban design objectives and principles, building on the overall project objectives and the contextual analysis. The urban design strategy was used to develop the urban design concept to fit into the surrounding area, support local connections and contribute to communities and their natural, built and community setting
- Assessment of landscape character impacts during construction and operation, including shadow analysis
- Assessment of visual impacts during construction and operation
- Development of a mitigation strategy and management measures.

Further detail on the assessment methodology is provided in the following sections. The urban design strategy is discussed in **Section 15.3**.

15.2.1 Study area

For the purpose of this assessment, the study area is based on views, topography and in consideration of where the project would be visible. The study area is shown in **Figure 15-1**.

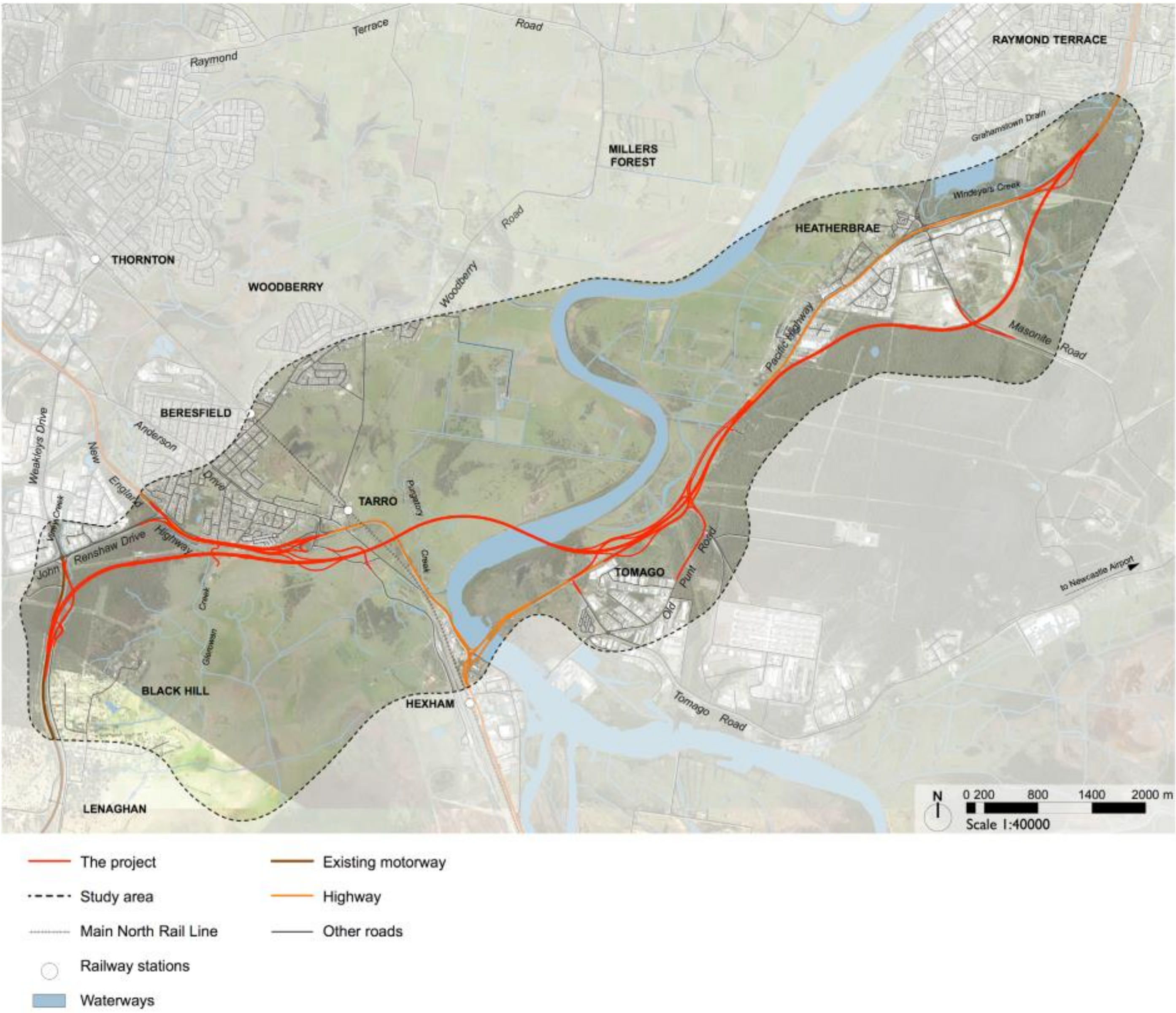


Figure 15-1 Urban design and visual amenity study area

15.2.2 Landscape character assessment

Landscape character refers to the combined quality of the built, natural and cultural aspects of an area which shape its unique sense of place. Landscape character zones (LCZ) were identified within the study area based on the existing environment and are defined as areas of distinct character, generally grouping together similar characteristics in terms of natural, built and community elements such as land use, vegetation cover, topography, heritage or scenic values.

Landscape character attributes that were considered as part of the urban design, landscape character and visual impact assessment include:

- Landform and views (refer to Section 16.3 and Section 15.4.2)
- Traffic and transport including public transport, walking and cycling networks (refer to **Section 7.3**)
- Biodiversity including vegetation and fauna habitat (refer to **Section 9.3**)
- Flooding and hydrology (refer to **Section 10.3**)
- Surface water and groundwater (refer to **Section 11.3**)
- Aboriginal and non-Aboriginal heritage (refer to **Section 12.3** and **Section 17.3**)

- Existing land use (refer to **Section 14.3**)
- Utility services (refer to **Section 5.3.15**).

Within each LCZ the landscape character impact is derived from the sensitivity of the zone and the magnitude of the project in that zone where:

- 'Sensitivity' refers to how easily affected the existing character of the setting is by the proposed change. This can also be understood as the setting's inherent capacity to absorb change. For example, a pristine natural environment would be more sensitive to change than an industrial area. Sensitivity is influenced by both professional judgement and objective measures. For example, an area's listing on a State level heritage register would mean a higher level of sensitivity
- 'Magnitude' refers to the physical size and scale of the project. For example, a large intersection would have a greater magnitude than a localised road widening, and therefore have a greater impact on the landscape character.

The combination of sensitivity and magnitude provides the rating of the landscape character impact. Landscape character impact is calculated using the landscape character and visual impact rating matrix provided in EIA-N04 (**Table 15-2**).

Table 15-2 Landscape character and visual impact rating matrix

Sensitivity \ Magnitude	High	Moderate	Low	Negligible
High	High	High-Moderate	Moderate	Negligible
Moderate	High-Moderate	Moderate	Moderate-low	Negligible
Low	Moderate	Moderate-low	Low	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

15.2.3 Visual impact assessment

The visual catchment is the extent or area where the project would be visible considering factors such as landform, direction of travel or direction of the view, built structures and vegetation. Vegetation, while often obscuring potential views, is not considered a permanent obstruction as it can be relatively easily removed.

The visual catchment for the project is illustrated in a Visual Envelope Map (VEM). Within the VEM a number of viewpoints were selected for assessment to represent a range of views including views and vistas from residential properties, public buildings, key sites and spaces, heritage items, businesses and the existing road corridor/ streetscapes (refer to **Figure 15-7**).

Visual impact is the measure of change that new interventions would have on existing views and impacts to the local community (including view loss and overshadowing). The visual impact of the project was derived from an analysis of the viewpoints and the magnitude of change. The severity of these impacts is a combination of the sensitivity and magnitude rating in accordance with the impact rating matrix (refer to **Table 15-2**).

Overshadowing impact assessment

The assessment of visual impact also addresses potential overshadowing impacts of the project during operation. Two main factors inform the degree of overshadowing impacts:

- The three-dimensional form of the project, that is the height of project elements relative to adjoining areas which would inform the extent of overshadowing
- The presence of sensitive users that may be affected by overshadowing.

The detailed shadow analysis was carried out using a three-dimensional model of the existing terrain. It was created from contours at one metre intervals with adjacent building footprints added. The assessment focussed on a 100 metre wide corridor extending either side of the operational footprint. Project elements including proposed landform and bridge structures were then modelled to determine the extent of overshadowing at 9am, noon and 3pm on the two equinoxes (20 March and 20 September) and the two solstices (20 June and 20 December).

15.2.4 Mitigation strategy

The mitigation strategy comprises principles or treatments recommended to manage the identified landscape character and visual impacts of the project. They include:

- Measures embedded in the project design that have already mitigated potential landscape character and visual impacts. They include a strategy and design principles that continue to provide guidance during future design and construction stages in order to minimise landscape character and visual impacts
- Environmental management measures for further investigation during future project stages in order to manage landscape character and visual impact.

15.3 Urban design and landscape strategy

15.3.1 Urban design vision

The urban design vision adopted for the project is:

> 'Provide a flowing green corridor that integrates sensitively with the natural environment and community setting of the area. The project will capitalise on its setting with expansive views over the Hunter River floodplain with simple and well-designed project elements. The project will provide a clear and legible junction integrating the Pacific Motorway and the New England Highway that improves local, regional and interstate connectivity while contributing to the sense of places of communities along the corridor'

15.3.2 Urban design objectives and principles

Building on the project urban design vision, five urban design objectives and a sub-set of design principles were adopted for the project. These objectives and how they have been built into the urban design are detailed in **Table 15-3**.

The urban design approach for the project considers:

- The travel experience along the project as created by the various project elements and their interaction with the surrounding natural, built and community context
- The existing character and values of the surrounding natural, built and community context, specifically:
  - The project's landscape setting, including the Hunter River, the contrast between the low-lying floodplain and elevated areas with their mix of urban areas and bushland remnants and the resulting differences in spatial character and available views
  - The road network context which facilitates an array of local and regional transport movements.
  - Local communities. The project seeks to value communities along the project and enhance healthy, cohesive and inclusive communities.
  - Providing buffers to sensitive receivers.

Table 15-3 Urban design objectives and principles

Objectives	Principles	Urban design application
Objective 1: Provide a flowing road alignment that is responsive and integrated with the landscape	Maintain and integrate the road corridor with existing landscape types and characters, considering different woodland, open floodplain and rural landscapes	• The project's alignment was designed to follow existing road and utility corridors as much as possible, in order to reduce the visual impacts of the project • The landscape design for the project maximises revegetation with local Plant Community Types (PCTs) to integrate the project with the existing landscape character • Vegetation has been used to mitigate project elements and provide visual buffers to reinforce the character of the area and avoid the appearance of project infrastructure incongruous with a regional setting • Bridges were designed to span across creeks, wetlands and floodplains, minimising impacts on these waterways and existing native vegetation communities
Objective 2: Provide a landscaped Motorway that integrates with the adjoining natural setting	• Integrate the road into existing vegetation patterns to maintain the sense of place and help maintain ecological and biodiversity values • Use vegetation strategically to guide motorists' views to contribute to and maintain the scenic quality of the route • Use planting to visually separate adjoining roadways and to maximise the character of the Motorway through the coastal hinterland landscape setting • Design cuttings and embankments to maximise opportunities for vegetation to be established	The landscape design for the project maximises revegetation with local PCTs to maximise biodiversity outcomes

Objectives	Principles	Urban design application
Objective 3: Provide an enjoyable, interesting motorway	• Use tree cover and other landscape treatments to provide an interesting sequence of open views and sections of motorway enclosed by vegetation, drawing on existing views, vistas and spatial patterns • Take advantage of the opportunities provided by the viaduct and other elevated road infrastructure to provide views of the surrounding landscape • Retain and where possible strengthen views to local landmarks including heritage items • Design the motorway, interchanges and local road connections to be self-explanatory, legible and easy to navigate • Identify opportunities for art and/ or interpretive elements to contribute to place-making, and strengthen local and cultural identities • Capitalise on the opportunities offered by the Hunter River bridge and viaduct that provides a positive legacy and a new landmark for both local communities and motorists travelling the length of the M1 Pacific Motorway	• Vegetation is used to guide views from the project, maximising opportunities for views of the landscape while screening detracting elements to enhance the experience of the project setting overall • The design for retaining walls maximises opportunities for landscaping to assist in the integration of the walls into the landscape setting, including through the design of batter slopes that maximise opportunities for successful vegetation establishment
Objective 4: Value the communities and towns along the road	• Provide an alignment that avoids community severance by skirting the edges of existing townships or settlements • Design the project to provide connectivity between the motorway and key populated areas and for ease of access to current and future residential, community, industrial and employment areas • Maintain the accessibility and connectivity of surrounding communities for all users including motorists, public transport users, cyclists and pedestrians and ensure connections are safe, convenient, logical and integrate the principles of Crime Prevention Through Environmental Design (CPTED) • Support the area's tourism industry by maintaining cultural and landscape values • Provide visual buffers to sensitive receivers to enhance the sense of privacy through landscaped areas • Design interchanges as attractive decision-making points that highlight the towns and other destinations along and beyond the route. Consider the potential of major project elements to integrate art, interpretation and other place-making features to celebrate local communities and provide contextual interest	• The project has been designed to maintain all existing access and connectivity, some with minor modifications including property access such as to the Glenrowan Homestead, the Aurizon access road and the Hunter Region Botanic Gardens access (refer to **Chapter 14** (land use and property) and to the Land Use and Property Working Paper (**Appendix N**)) • The project enhances opportunities for active transport by providing a more direct and continuous cycle route along the main alignment road shoulders between Black Hill and Raymond Terrace (refer to **Chapter 7** (traffic and transport) and the Traffic and Transport Working Paper (**Appendix G**).

Objectives	Principles	Urban design application
Objective 5: Provide a simplified and unobtrusive road design	• Endeavour to avoid placing road furniture in areas that may affect key views and vistas • Take measures to reduce lighting impacts to adjoining land use and the natural environment • Design bridges as simple and elegant structures of contemporary form • Maximise consistency of design and detailing for similar types of bridges	• The bridge design approach supports legibility and way-finding through the use of colour integrated into bridges • Consistency of substructure and materials was maximised for bridges of similar types • The bridges integrate contemporary bridge design approaches, are robust and avoid unnecessary visual clutter.

15.3.3 Urban design strategy

The urban design approach for the project considers the travel experience and the existing and desired future character and values of the surrounding area. To further illustrate this approach, four main inter-related strategy plans have been identified:

- Integration with existing features and vistas in the study area
- Spatial character and views
  - Long-distance views from the project would contribute to the motorists' experience and provide a connection to the study area
  - The existing spatial and landscape character would be enhanced and views over the Hunter River floodplain would be reinforced.
- Cycle connections
  - Connection points between the project and the surrounding road network would supplement the existing network and support active transport use in the study area, contributing to the accessibility and connectivity of communities.
- Place-making
  - Consistent approach to the design of bridges and potential place-making opportunities, such as the bridge (B09) and special "highlight" landscape treatments at the Hunter Region Botanic Gardens would provide an overall sense of place.

The consideration of the above strategy plans have informed the development of the urban design and landscape concept outlined in **Section 15.3.4**.

15.3.4 Urban design and landscape concept

The urban design and landscape concept for the project has been developed based on the urban design strategy outlined above. The concept is described in the four sub-sections that follow:

- Structural elements
- Landscape design
- CPTED
- Assessment of noise barriers.

The urban design and landscape concepts plans are included in the Urban Design, Landscape Character and Visual Amenity Working Paper (**Appendix O**). The urban design concept for bridges and typical sections indicating potential landscape treatments are shown in **Figure 15-2** to **Figure 15-5**.

Further consideration and review would be carried out during the detailed design to refine the urban design concept and ensure its the continued integration.

Structural elements

Table 15-4 describes and illustrates the relationship between the various project structural elements and the study area's built, natural and community context.

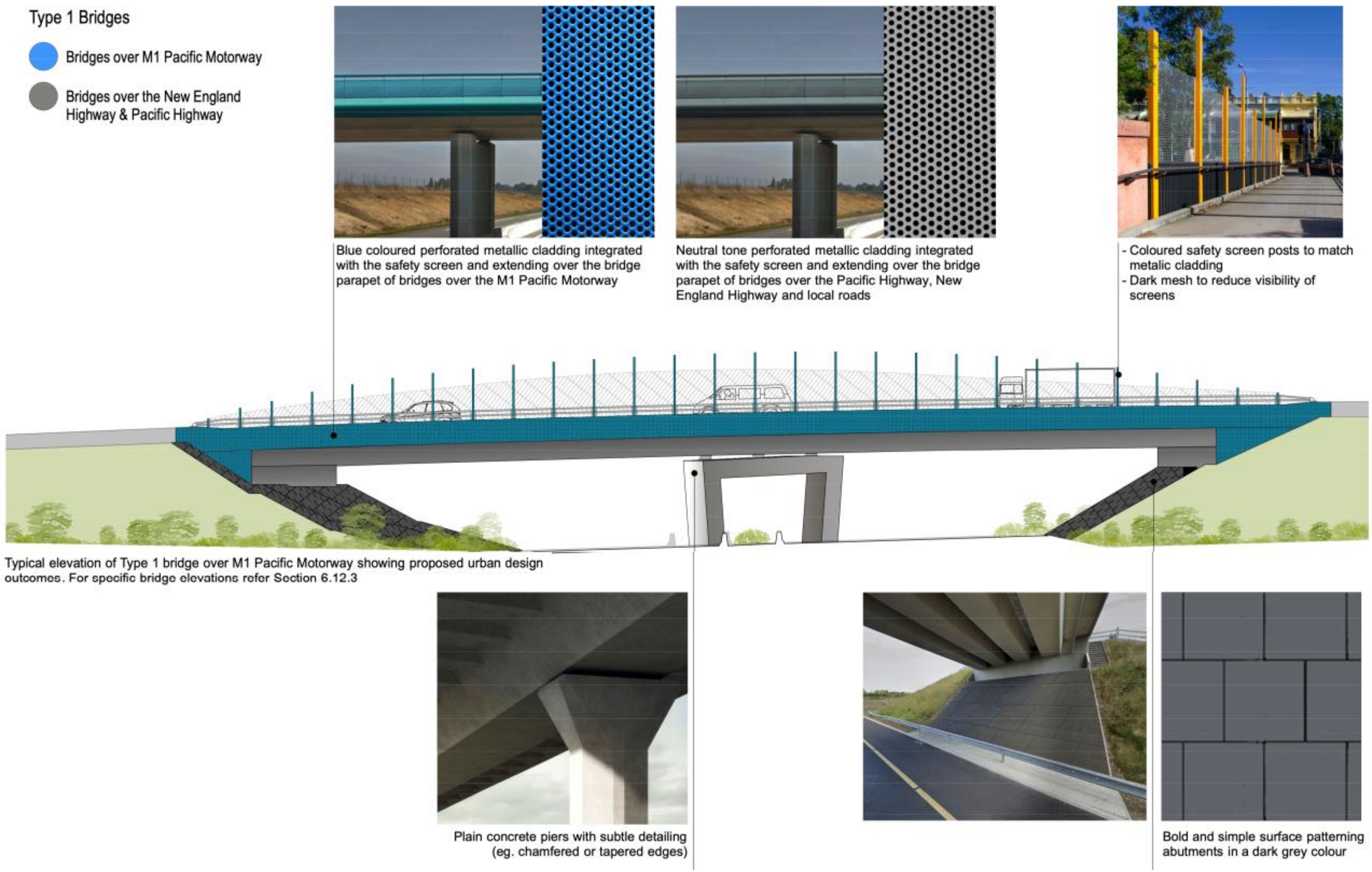


Figure 15-2 Urban design concept for Type 1 bridges

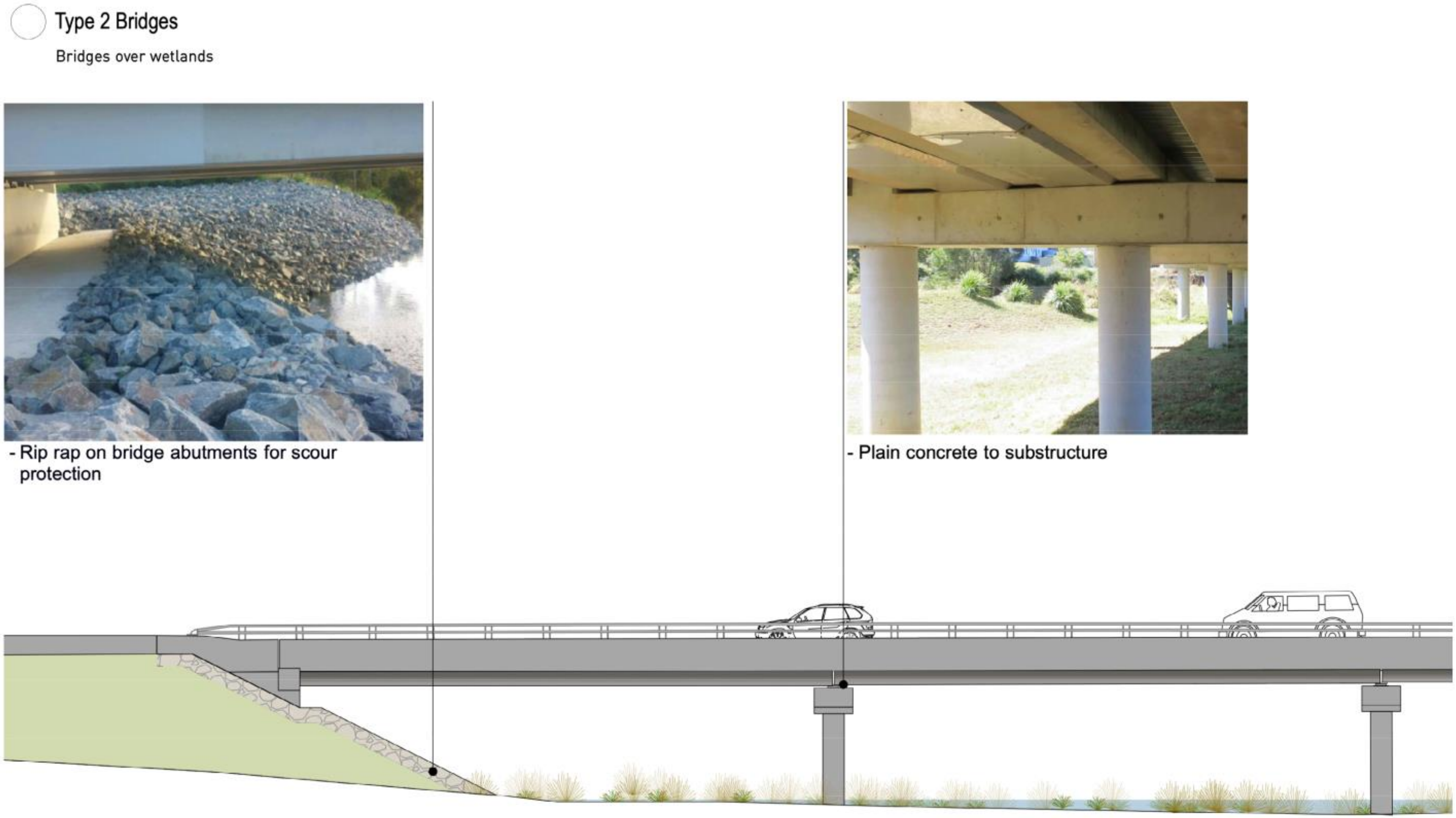


Figure 15-3 Urban design concept for Type 2 bridges

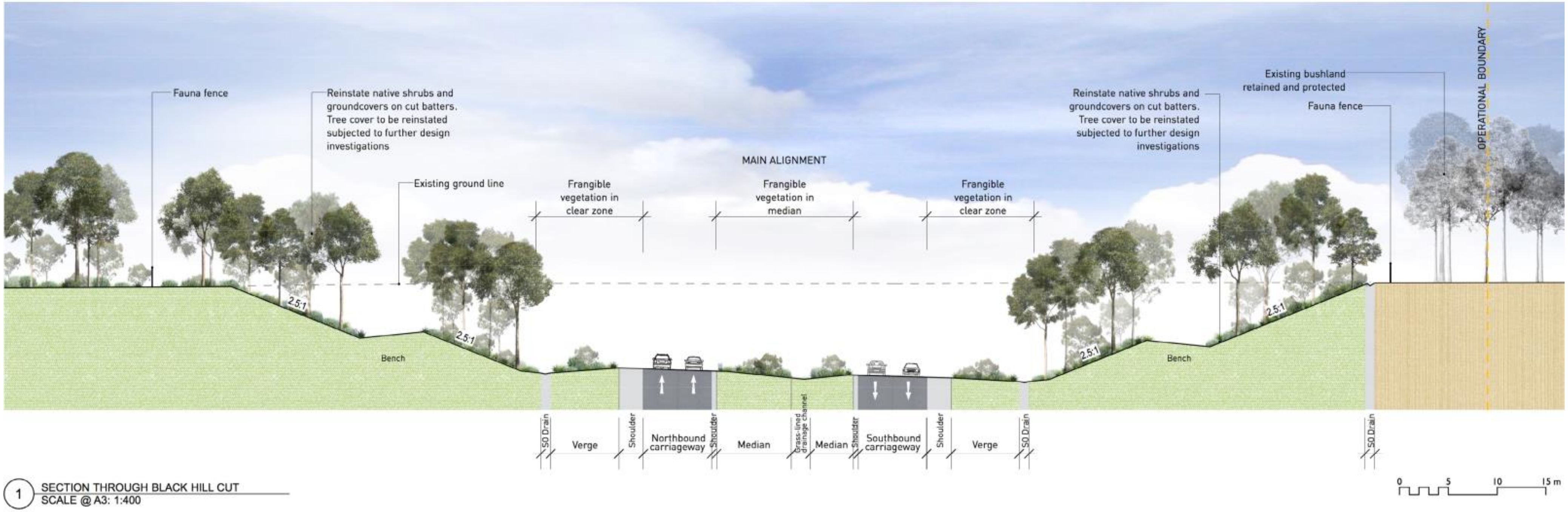


Figure 15-4 Cross section (indicative only) at Black Hill cut, about 700m east of the existing M1 Pacific Motorway at Black Hill

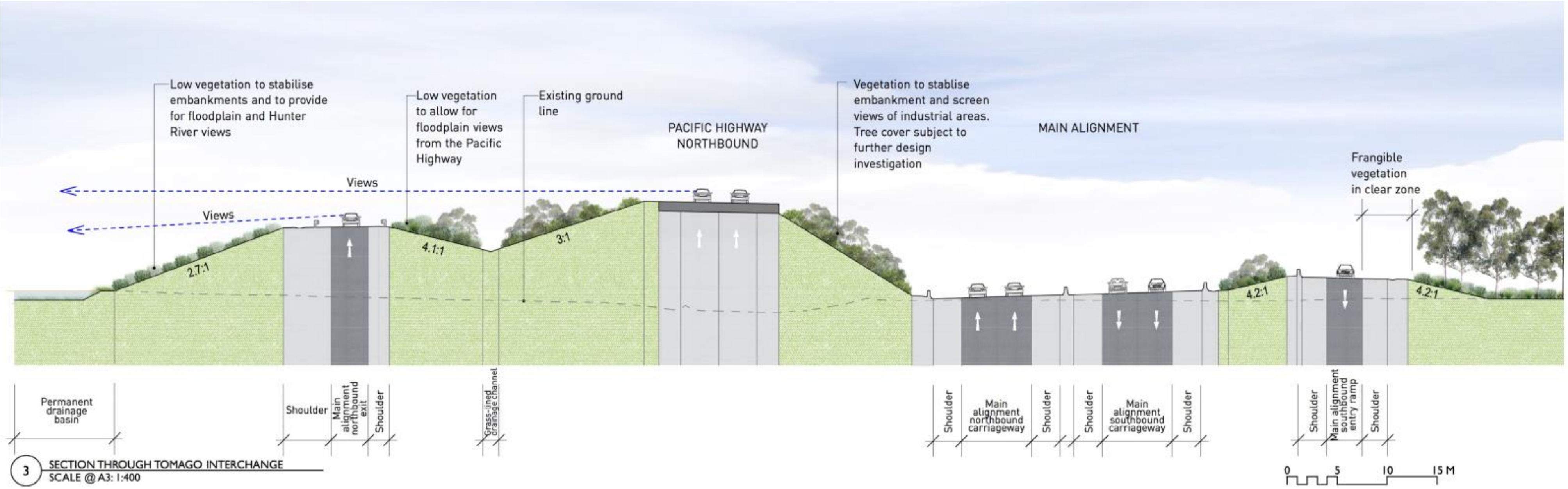


Figure 15-5 Cross section (indicative only) at Tomago Interchange, about 400m north of Tomago Road at Tomago

Table 15-4 Proposed urban design treatments for project elements

Project element	Description	Proposed urban design treatment
Interchanges	Four new interchanges to provide free-flowing connections for motorists travelling on the main alignment	• Interchanges would be of a type typical for motorway environments • Urban design surrounding the interchanges would be consistent with that of the main alignment and in accordance with respective standards and guidelines. • Major components of interchanges such as bridges and retaining walls are outlined further below
Bridges and viaduct structures (Refer to **Section 5.3.5**)	Twelve bridges to be designed as either: • Type 1 (over roads) – Considered design approach that can signal landmarks for orientation and wayfinding for the motorist. • Type 2 (over floodplains and wetlands) – Simple and refined structural design would be key to the creation of a new landmark that responds to the cultural and community context as well as the functional requirements.	**Type 1 bridges** • Perforated metallic cladding along bridge parapets that is integrated with the bridge safety screen. The design of the safety screen would reinforce the horizontal form of the bridges and help reduce visual bulk. The colour of safety screens and cladding serves to differentiate the respective road corridors and respond to the waterways and floodplains of the study area • The remaining visible elements of the superstructure and substructure would remain standard concrete colouring and exhibit subtle design detailing. Examples might include chamfered corners or tapered piers and headstocks with a smooth plain concrete finish • Safety screen posts would match the parapet cladding colour. Safety screen mesh would be of a type and colour that would maximise transparency • The spill-through bridge abutments would be a simple concrete paved finish in a dark grey colour to provide a restrained finish that visually recedes relative to the adjoining landscape. **Type 2 bridges** • Design bridges to be efficient and functional structures that exhibit simplicity of form and character. Standard details for the parapets and bridge rail barriers would maximise views for motorists to surrounding areas • Standard bridge detailing would be appropriate for the superstructure and substructure in order to maximise ease of construction and maintenance • The spill-through bridge abutment would be a simple rip-rap finish to meet scour protection requirements.
Retaining walls (Refer to **Section 5.3.6**)	Three retaining walls designed to maximise visually open arrangements under bridges	• Treated to ensure surfaces restrict glare, where appropriate • Where possible, well set back from traffic lanes to allow the use of vegetation to soften the wall façade and maintain a green outlook that corresponds to the project's setting.

Project element	Description	Proposed urban design treatment
Noise barriers (Refer to **Section 5.3.14**)	Three noise barriers in locations where there are either existing noise barriers present or on alignments that closely follow existing road corridors to minimise changes to the existing environment and the associated landscape character and visual impacts	• Use finishes and materials that are sympathetic to the immediate setting as well as the local environment, reduce the perceived scale of noise walls and contribute to the amenity and visual quality of the area • Integrate noise walls with project design, including road furniture and landscape elements, to ensure a considered composition of all elements • Where it is safe and feasible provide space for screening vegetation on both sides of noise barriers, in order to maintain the predominantly green landscape outlook, and to soften the perceived scale of walls
Earthworks, including cuttings and embankments (Refer to **Section 5.3.6** and **Section 5.4.5**)	A number of cuttings and embankments would be required along the main alignment due to the undulating topography	• All slopes would be revegetated to integrate the project with the surrounding landscape. **Cuttings** • Vegetation that incorporates trees is preferred outcome to maximise integration with surrounding bushland • Rounding of the top edges of the batters would be applied to transition from batter slopes to natural ground • Cut batters left in natural stone where stable and revegetation is not reasonable and feasible • Seek to avoid the use of shotcrete in cuttings. Shotcrete would only be used in locations where unstable geology unsuitable for vegetation is uncovered. **Embankments** • Project alignment has been developed to generally follow the edge of the floodplain where embankments would integrate with rising topography • Vegetation of embankments to soften their appearance and to reflect and integrate with the surrounding landscape • Installation of trees at the bottom of embankments, where feasible • Flattening out the toes of steep embankments would be flattened out to achieve better integration with the surrounding landform.

Project element	Description	Proposed urban design treatment
Drainage and stormwater (Refer to **Section 5.4.8** to **Section 5.4.11**)	Water quality controls such as 39 permanent water quality basins, vegetated swales and spill containment bunds at drainage outlets	**Water quality** • Use of vegetated swales on the approach to water quality basins would be maximised to assists in visually integrating swales with the landscape setting • Construction basins would be converted to operational wherever possible, to avoid extensive impacts from basin construction. **Creek adjustments** • Adjusted creeks would be rehabilitated with vegetation following construction of the project
Roadside furniture (Refer to **Section 5.3.11**)	A range of roadside furniture will be implemented to support safety in operation	• Roadside furniture would be of a type typical for motorway environments and would be placed in accordance with respective standards and guidelines
Pedestrians, cyclists and public transport (Refer to **Section 5.3.16** and **Section 5.3.17**)	The project would include a shared path and consistent widened shoulders for on road cyclist use	• Urban design would be consistent with that of the main alignment.
Property access and residual land (Refer to **Section 5.3.20** and **Section 14.4.1**)	A new access road into the Hunter Region Botanic Gardens would be required, as well as realignment of two existing access roads Following construction, land not required for the ongoing operation of the project would be reinstated to its original use or as agreed with affected property owners or disposed of	• Urban design treatments for the new and realigned access roads would be progressed during detail design • Land subject to temporary use will be rehabilitated as soon as practicable to an appropriate land use, taking into consideration the location, land use characteristics, area and adjacent land uses in consultation with the relevant council and/or the land owner.

Landscape design

The landscape design for the project provides specific direction for landscape work associated with the project, including to:

- Provide vegetative cover
- Stabilise the embankments and other disturbed areas
- Complement adjoining cultural and natural landscapes, helping to integrate the project with the local area and mitigating the landscape character and visual impacts associated with the project
- Restore native plant communities to maximise integration with existing PCTs.

Landscape design principles

The landscape design is based on the following principles:

- Retain existing vegetation where possible
- Vegetate all areas affected by the project and construction work to their existing condition, including appropriate weed management (refer to **Section 9.5**)
- Re-establish native PCTs where they would be disturbed in order to restore ecological and habitat values and help biodiversity protection and recovery, where feasible
- Provide distinct and/or larger plant stock in key locations such as urban interfaces and visitor destination to create visual landmarks or highlights
- Provide trees in verges and medians where it is safe and feasible to do so
- Use vegetation to visually separate travel lanes and road corridors, where it is safe to do so, in order to:
  - Reduce the visual and landscape character impacts of multiple parallel travel lanes
  - Maintain a green outlook consistent with the regional setting and floodplain location.
- Use vegetation to screen the project from nearby sensitive receivers, where appropriate and feasible
- Place vegetation with regard to the presence of existing utility services assets and in accordance with the requirements of the respective asset owner
- Use predominantly large-scale revegetation techniques such as seeding applications and/or bushland restoration
- Maximise the use of locally sourced plant material for all native vegetation including locally collected seed and plants grown from locally collected seed.

Crime prevention through environmental design

The project, through its urban design principles and objectives, has made a commitment to the provision of safe connections for all users through the integration of CPTED principles. These principles have been applied using design and place management principles as follows:

- Surveillance: People feel safe in public areas when they can easily see and interact with others. Would-be offenders are often deterred from committing crime in areas with high levels of surveillance. The project achieves deterrence by:
  - Clear sightlines between public and private places, ensuring passive surveillance by motorists
  - Vegetation that does not provide potential offenders with a place to hide or entrap victims by maximising sightlines and passive surveillance.
- Access control: Physical and symbolic barriers minimise opportunities for crime and increase the effort required to commit crime by channelling or restricting the movement of people. The project achieves effective access control through the use of fencing to create physical barriers that restrict access and are reinforced by signage provided as required in accordance with the relevant Transport guidelines and design standards.

- Territorial reinforcement: Community ownership recognises that people often feel comfortable in places which feel owned and cared for. The project achieves territorial enforcement and community ownership through:
  - The application of the urban design objectives and principles, to ensure the project constitutes an interesting an enjoyable motorway that integrates with surrounding communities
  - Project elements designs that allow for safe and cost-effective maintenance to ensure that the project maintains a well-cared for appearance, consistent with this principle.
- Space management: Ensures that space is appropriately utilised and well cared for and is linked to the principle of territorial reinforcement. Space management strategies include:
  - Site cleanliness
  - Rapid repair of vandalism and graffiti
  - Replacement of burned out lighting
  - Removal or refurbishment of decayed physical elements.

Note that there would be no need for the project to provide public space for good surveillance at night as the project would not provide any public places where people would be expected to gather.

Assessment of noise barriers

The project includes new and relocated noise barriers with a height of about 3.8 metres for noise barrier NB02 and about four metres for noise barrier NB03 (noise barrier locations are shown on **Figure 8.5**).

All noise barriers were assessed for changes to visual impact spatial character. While NB02 and NB03 were further assessed for visual and overshadowing impacts that may result from an increase in noise barrier height, NB01 would be relocated at its existing height and was not assessed for an alternative height.

15.4 Existing environment

15.4.1 Landscape character

Seven LCZ were identified within the study area as described in **Table 15-5** and shown on **Figure 15-6.** As discussed in **Section 15.2.2**, landscape sensitivity is a record of the inherent and intrinsic sensitivity of the landscape and the degree to which it can accommodate change. The sensitivity of each LCZ is also provided in **Table 15-5**.

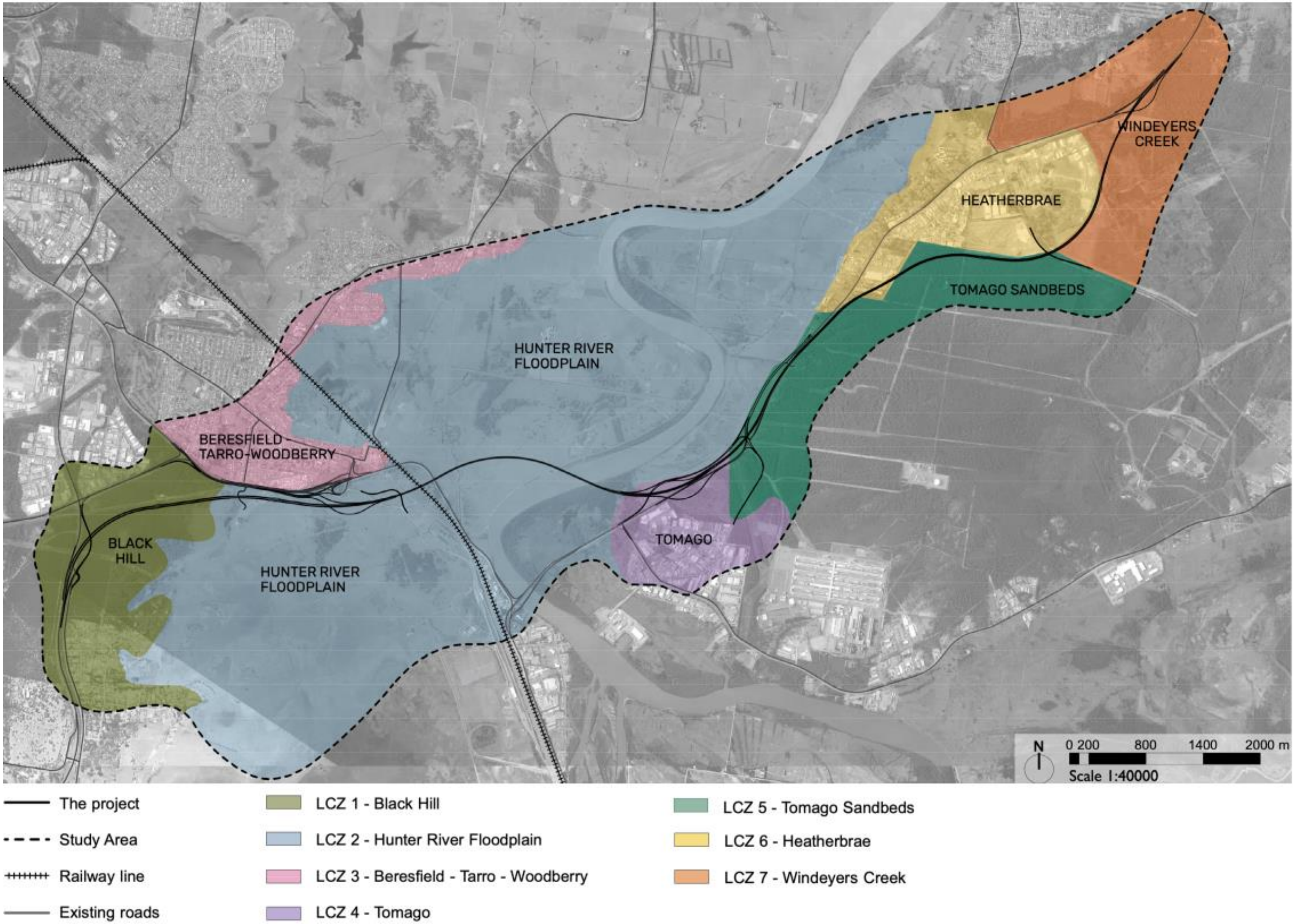


Figure 15-6 Landscape character zones within the study area

Table 15-5 Landscape character zones within the study area

LCZ	Imagery	Description	Sensitivity
LCZ1: Black Hill		The Black Hill landscape is characterised by dense native woodlands incised by clearings for the existing M1 Pacific Motorway, John Renshaw Drive and utility easements. The area is situated on elevated land adjacent the Hunter River floodplain and Hexham Swamp and includes rural residential properties in Black Hill. The topography is gently undulating.	**Moderate** Due to the undulating topography and extensive tree cover, changes within this LCZ would not be widely visible beyond the project's operational footprint. However, bushland in the LCZ is important as a visual backdrop to the open floodplain. Accommodating change of the order brought about by the project would not be possible without altering the spatial qualities and landform of the LCZ.
LCZ2: Hunter River Floodplain		The Hunter River Floodplain landscape is characterised by the low-lying and flat topography of the floodplain and its predominant grazing land use. There are also large areas of wetlands and natural swamps including Hexham Swamp. Intermittent stands and clumps of swamp and floodplain forests as well as stands of mangroves along the Hunter River provide a contrast with the low-growing vegetation cover associated with grazing and swampy and wetland areas.	**High** The predominantly greenfield setting and the open landscape character with expansive views in all directions result in a low capacity to absorb change of the order associated with the project.

LCZ	Imagery	Description	Sensitivity
LCZ3: Beresfield – Tarro – Woodberry		The Beresfield – Tarro – Woodberry landscape comprises the urban areas of Beresfield, Tarro and Woodberry. These areas are characterised by predominantly low-density residential areas located on gently undulating land on higher ground overlooking the floodplain. Each suburb has a small centre and incorporated public open space and recreation areas. A light industrial area/employment area is located in Beresfield north of and next to John Renshaw Drive.	**Moderate** The primarily residential urban areas of Beresfield, Tarro and Woodberry would be highly sensitive to changes that alter the character, function and built form of the setting such as would be associated a new motorway. This sensitivity would be somewhat reduced by the proximity of the existing New England Highway in the adjoining LCZ 2.
LCZ4: Tomago		The Tomago landscape is distinct from other urban areas surrounding the project, functioning primarily as an employment area with a diversity of industrial uses, the largest of which is aluminium smelting at Tomago Aluminium. Pockets of native open forests and woodland remain including along the road system and the edges of major power easements.	**Low** The LCZ is an existing urban area that would be compatible with the change of the nature involved with the project. Sensitive character elements include large stands of remnant bushland and long-distance views over the Hunter River floodplain from the edge of the LCZ.

LCZ	Imagery	Description	Sensitivity
LCZ5: Tomago Sandbeds		The Tomago Sandbeds landscape is characterised by dense native woodland cover into large blocks by power easements and associated access and management tracks. The western edge encompasses elevated land along the edge of and overlooking the Hunter River Floodplain including the existing Pacific Highway alignment.	**Moderate** The majority of the LCZ constitutes a greenfield site densely vegetated with remnant bushland. Due to extensive tree cover, changes within the bushland portion of the LCZ would not be widely visible beyond the project. However, bushland in the LCZ is important as a visual backdrop to both the open Hunter River floodplain and the urban areas of Heatherbrae. Accommodating change, of the order of the project, would not be possible without altering the spatial qualities of the LCZ.
LCZ6: Heatherbrae		The Heatherbrae Village landscape is characterised by the small urban centre of Heatherbrae, situated above the edge of the Hunter River floodplain and laid out along the existing Pacific Highway. The centre functions as a local residential, service and employment centre.	**Moderate** The LCZ is an existing urban area that comprises a wide range of uses including large industrial areas that would constitute the predominant land use interfacing with the project. Industrial areas would generally be compatible with the change of the kind associated with the project. Higher levels of sensitivity are associated with residential and community uses, as well as with remnant and heritage listed vegetation.

LCZ	Imagery	Description	Sensitivity
LCZ 7: Windeyers Creek		The Windeyers Creek landscape separates the urban area of Heatherbrae from the urban area of Raymond Terrace. The landscape character constitutes a highly modified landscape along Windeyers Creek and the Grahamstown Drain and incorporates associated wetlands and tributaries. It is characterised by a mix of native vegetation, wetlands, pastures and pine plantations. It also has important water management functions that include the Raymond Terrace water treatment works.	**Moderate** The majority of the LCZ comprises of dense vegetation including native bushland remnants and pine plantations. Changes in heavily vegetated areas would not be widely visible beyond the project but would be more difficult to absorb in open areas. The cemeteries and wastewater treatment works would be sensitive to change while the existing Pacific Highway and M1 Pacific Motorway would be able to absorb further road upgrades.

15.4.2 Existing views

Nineteen key viewpoints within the VEM were selected to represent the surrounding area and environment. The location and sensitivity of each viewpoint is provided in **Table 15-6** and **Figure 15-7**. Photographs of each of the viewpoints are provided in **Table 15-9**.

Table 15-6 Existing viewpoints within the VEM

Viewpoint	Description	Potential viewers	Sensitivity
1	Existing M1 Pacific Motorway near Lenaghans Drive at Black Hill, looking north-east.	Motorists travelling north on the M1 Pacific Motorway.	**Moderate** Existing road and utility infrastructure and the grassed median comprise a large portion of the existing view composition. However, a notable portion of the view consists of remnant bushland that frames and characterises this section of the existing M1 Pacific Motorway.
2	Existing M1 Pacific Motorway, about 150m south of the Weakleys Drive and John Renshaw Drive intersection, looking south-east towards the new Black Hill interchange.	Motorists travelling north along the existing M1 Pacific Motorway, south along Weakleys Drive, south onto the M1 Pacific Motorway and east or west along John Renshaw Drive	**Low** Existing road infrastructure comprises a large portion of the existing view composition. However, a portion of the view comprises remnant bushland that frames the M1 Pacific Motorway and John Renshaw Drive.
3	Eastern end of Walter Parade at Lenaghan looking north-east across the floodplain.	Residents in Black Hill overlooking the Hunter River floodplain.	**High** Residents have an open rural outlook over pastures and wetlands in the Hunter River floodplain.
4	Quarter Sessions Road, corner of the New England Highway, Tarro, looking south-west.	Residents of nearby properties, visitors to Palm Valley Village and motorists travelling south on Quarter Sessions Road.	**High** This viewpoint provides for open views from the edge of the Tarro urban area across the Hunter River floodplain, towards the wooded hills surrounding Hexham Swamp. The openness of the view would be sensitive to change. The New England Highway is in the foreground of the view but constitutes a relatively small portion of the composition of this view.
5	Tarro residential areas, looking in a south-easterly direction.	Residents and visitors at the Palm Valley Village and Caravan Park, motorists along the New England Highway and of views from nearby residences in Eastern Avenue including the historic residence at 29 Eastern Avenue.	**High** Sensitive elements in this view include vegetation such as mature trees that provide visual separation between the rear of residences in Eastern Avenue and the existing New England Highway exit ramp. Residential viewers would be highly sensitive to change in the outlook from their homes and private outdoor areas.

Viewpoint	Description	Potential viewers	Sensitivity
6	Eastern end of Anderson Drive, Tarro looking south.	Residents of Anderson Drive. Staff and visitors to the Pumping Station and Tarro Substation.	**Moderate** This viewpoint provides for open views across the Hunter River floodplain and towards the hills surrounding Hexham Swamp. The open view of grazing lands, wetlands and stands of trees would be highly sensitive to change. The foreground of the viewpoint is comprised of the New England Highway.
7	Rail station at Tarro, looking in a south-easterly direction from the southbound station platform.	Rail customers	**High** The viewpoint is comprised of the grazing landscape of the Hunter River floodplain. Detracting elements reducing sensitivity include existing low and high voltage power lines as well as degraded rural structures. However, the landscape is open to long-distance views and would not easily absorb change. It would be seen by rail customers for possibly extended periods of time while they wait for the train.
8	Open space in Redbill Drive, Woodberry, opposite the intersection with Eagle Close, looking south-east.	Residents of Woodberry	**High** This viewpoint is comprised of open space, grazing lands and wetlands in the Hunter River floodplain. It illustrates expansive views over the open landscape that would be sensitive to change
9	New England Highway in Tarro, looking north.	Motorists travelling along the New England Highway westbound and train passengers traveling on the Main North Rail Line.	**Moderate** A large portion of this viewpoint is comprised of the New England Highway road corridor and would have a low level of sensitivity towards change. This is balanced by highly sensitive elements in the view which include existing roadside tree cover and views across the open floodplain in the east
10	Pacific Highway Hexham Bridge over the Hunter River at Hexham, looking north-west.	Motorists travelling along the Pacific Highway towards Taree and view from the parallel, heritage listed Hexham Bridge where motorists travel towards Hexham.	**High** The elevated viewing position from the Hexham Bridge provides for open and panoramic views over the floodplain towards the hills and mountains beyond. The major visual element in the view is the Hunter River itself which would be highly sensitive to change. Despite the prominence of high voltage transmission lines, this viewpoint represents a memorable event along the route.
11	Tomago Road at the existing Pacific Highway intersection in Tomago, looking north-east.	Motorists travelling along Tomago Road, north along the Pacific Highway, industrial workers in Tomago and residents and visitors at the Tomago Village Van Park.	**Moderate** Located at an important intersection, predominately comprised of existing road infrastructure with a low level of sensitivity to change. Mature tree cover on the northern side of the Pacific Highway provides a strong visual frame to the road corridor and would be sensitive to change.

Viewpoint	Description	Potential viewers	Sensitivity
12	South side of the Hunter River, about 500m east of the Hunter River bridge (B05), near the confluence of a small drainage canal with the Hunter River in Tomago. View is looking west.	Water-based viewers, including tourists on river charter services and people engaged in commercial and recreational boating, as well as farmers on the adjacent land.	**High** The view is characterised by the natural setting of the Hunter River and its riverside forests. Views are expansive with the open sky above the wider river a second important, visually highly sensitive component of the view. High voltage transmission line stanchions are visual detractors but overall, the natural environment dominates the composition.
13	Bus stop and U-turn bay along the northbound Pacific Highway, opposite the Hunter Region Botanic Gardens in Heatherbrae, looking south-west.	Motorists travelling south along the realigned Pacific Highway and the main alignment, and the section of the Pacific Highway between Heatherbrae and Tomago generally that follows the edge of the floodplain.	**Moderate** This viewpoint provides for open views from the Pacific Highway across the Hunter River floodplain, towards the hills and mountains in the west. The open vistas, clumps of tree cover and the overall rural landscape character would be sensitive to change, despite the detracting presence of high voltage transmission lines. The Pacific Highway comprises the left portion of the view and would be much less sensitive to change.
14	Hunter Region Botanic Gardens entrance, looking west.	Visitors and staff at the Hunter Region Botanic Gardens.	**High** The Hunter Region Botanic Gardens is a tourism and local recreation destination. The entrance road currently looks out over the Hunter River floodplain with its combination of grazing lands and tree cover. This outlook would be highly sensitive to change. The existing Pacific Highway constitutes only a minor portion of the view.
15	Northern edge of the Pacific Highway near 2179 Pacific Highway, Heatherbrae, looking south-west.	Motorists on the Pacific Highway, adjoining residents and business in southern Heatherbrae and people waiting for the bus.	**Moderate** The view is at the southern entrance to Heatherbrae, an important centre for employment and services including schools and residential living. While the view is along the existing Pacific Highway road corridor which would have a low sensitivity to change, more sensitive elements in the view include the large stand of bushland on the southern side of the road corridor, the long vista along the road corridor and the avenue of mature trees on the northern side of the road corridor.
16	Masonite Road in Heatherbrae, looking south-east.	Motorists travelling along Masonite Road.	**Moderate** The view along Masonite Road is comprised of the two lane road formation, adjoining grass and gravel verges, cleared land in future employment areas framed by bushland within the project's operational footprint. A mix of tree cover is also present along the eastern side of the road.

Viewpoint	Description	Potential viewers	Sensitivity
17	South-eastern end of Camfield Drive, Heatherbrae (near Ivory Close) looking south-east.	Workers and visitors to the Camfield Drive industrial estate and the future Kinross industrial estate.	**Low** The view is located within the developing industrial estate. The vast majority of the view is composed of the subdivision under development and represents a visually poor outlook across future industrial lots and the project operational footprint which is already mostly cleared. Pine plantations are located beyond the project's operational footprint and provide a visual backdrop that would have higher level of sensitivity to change.
18	Pacific Highway north of the existing Windeyers Creek bridge north of Heatherbrae, looking north-east.	Motorists travelling north along the Pacific Highway.	**Moderate** The view is taken along the existing northbound Pacific Highway travel lanes. The Pacific Highway constitutes the major compositional element and would have a low level of sensitivity to change. Mature vegetation provides a consistent green and dense edge along both sides of the road corridor and would be sensitive to change.
19	Pacific Highway in Raymond Terrace, about 300m north of the proposed Raymond Terrace interchange, looking south-west.	Motorists travelling south along the existing Pacific Highway.	**Moderate** The view is located on the existing southbound Pacific Highway travel lanes. The Pacific Highway constitutes the major compositional element and would have a low level of sensitivity to change. Mature vegetation provides a consistent and dense green edge along both sides of the road corridor and would be highly sensitive to change.

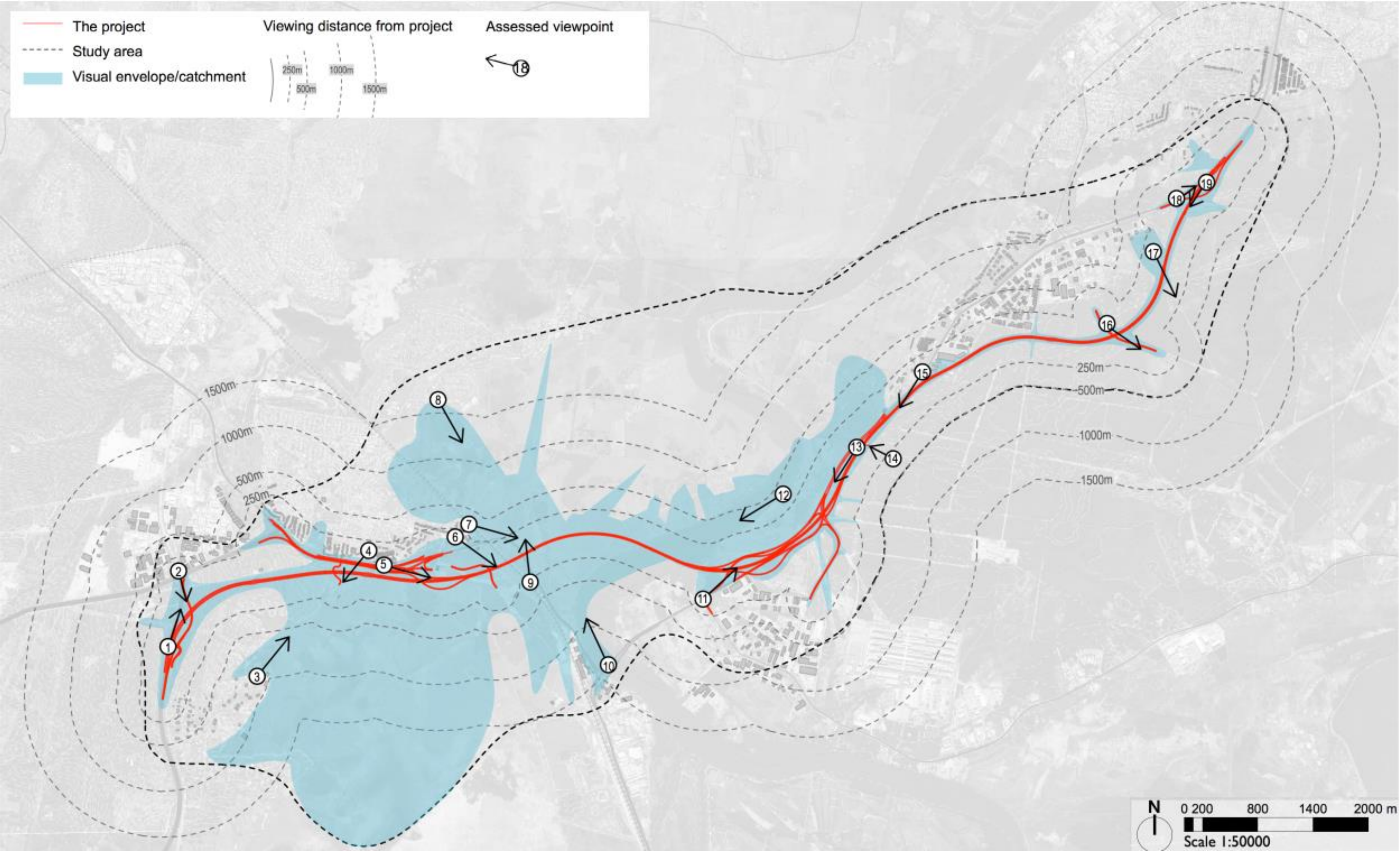


Figure 15-7 Visual envelope and viewpoint locations

15.5 Assessment of potential impacts

15.5.1 Construction

Landscape character

Construction-related landscape character impacts would vary across the construction footprint depending on the construction activities being carried out at the time.

The key construction activities that have the potential to result in landscape character impacts include:

- Establishment of the construction footprint including vegetation removal, fencing and hoarding
- Ancillary facilities establishment and operation including vegetation removal, fencing and hoarding
- Construction activities including the operation of plant and equipment
- Construction-related traffic movements including workforce movements
- Traffic management including temporary traffic changes and management measures
- Temporary lighting for night work and traffic management.

Construction activities would take place in all LCZs and result in temporary landscape character impacts within the respective LCZs.

LCZs that have a high sensitivity to change would experience greater landscape character impacts during construction. The landscape character impacts of the project during construction are expected to be:

- High for the Hunter River Floodplain (LCZ 2)
- High-moderate for Tomago Sandbeds (LCZ 5)
- Moderate for the Black Hill (LCZ 1), Beresfield-Tarro-Woodberry (LCZ 3), Heatherbrae (LCZ 6) and Windeyers Creek (LCZ 7)
- Moderate-low for the Tomago LCZ (LCZ 4).

Overall, impacts during construction are temporary in nature and would be managed, where possible, through appropriate siting of infrastructure, materials and finishes of sheds and hoardings, and management of traffic in the study area.

In order to prevent adverse impacts on the health and wellbeing of sensitive receivers in close proximity, all night work and lighting would be managed in accordance with statutory requirements and guidelines to ensure that there would be no unacceptable lighting impacts. Lighting procedures and management measures would be documented in the CEMP and carried out accordingly. This may include consideration of lighting levels, projection angles, direction, and length of frequency of exposure.

Visual impacts

Temporary visual impacts would result from general construction activities, the movement and operation of plant and machinery as well as the erection of temporary structures including fencing, hoarding, working platforms and ancillary facilities. Sources of visual impacts during construction typically include a combination of vegetation removal, the visibility of temporary structures, barriers, hoardings, signage and ancillary facilities including stockpiles, machinery and plant, buildings, lighting, construction work activities and increased vehicle movements.

During construction, partially constructed operational project elements would also result in changes to viewpoints. Therefore, project construction would result in at least the same amount of change to existing views as operation of the project, without the benefit of progressive vegetation and visual impact mitigation that would reduce the visual impacts of the project during operation. As a consequence, construction visual impacts would generally be of equal or greater magnitude than operational visual impacts but for a limited length of time.

The visual amenity impacts of the project during construction are expected to be:

- Five viewpoints (VP4, 5, 7, 12, 14) would have a high visual impact
- Ten viewpoints (VP1, 3, 6, 9, 11, 13, 15, 16, 18, 19) would have a high to moderate visual impact
- Three viewpoints (VP2, 8, 10) would have a moderate visual impact
- One viewpoint (VP 17) would have a moderate to low visual impact.

The type and intensity of construction facilities and activities would vary throughout the duration of construction. As the nature and intensity of construction activities changes, temporary visual impacts would also vary. The above visual impact ratings would therefore constitute a worst case and may at times be lower than those identified. Further information on the visual amenity assessment for construction impacts is provided in the Urban Design, Landscape Character and Visual Amenity Working Paper (**Appendix O**).

Impacts during construction would be temporary in nature and would be mitigated where possible through appropriate siting of infrastructure, materials and finishes of structures and hoardings, the management of light spill and progressive rehabilitation of vegetation. Management measures are detailed **Section 15.6**.

15.5.2 Operation

Landscape character

Landscape character impacts would vary along its length as result of the different levels of landscape character sensitivity and magnitude of the project elements.

Beneficial landscape character impacts would be associated with:

- Enhanced access and connectivity within and between LCZs through improved flood immunity
- Reduced congestion and a reduction in freight movements in existing road corridors and urban centres
- A more direct and continuous cycle route option between Black Hill and Raymond Terrace along the project road shoulders
- Enhanced town centre amenity in Heatherbrae as a result of reduced traffic, in particular freight traffic
- Opportunities for new views over the open Hunter River floodplain landscape, enhancing the experience for motorists and cyclists with improved orientation and wayfinding.

Residual adverse landscape character impacts would be associated with:

- Built form changes including new motorway infrastructure duplicating existing road corridors in some areas and extending through greenfield sites in others
- Impacts on heritage items including removal of non-Aboriginal heritage and Aboriginal heritage items
- Clearing of remnant native vegetation resulting in changes to the spatial character, and increased fragmentation of bushland at Black Hill
- Changes to the spatial character altering the outlook and views including as a result of noise barriers in new locations.

Potential landscape character impacts are discussed in **Table 15-7** in relation to the landscape character zones identified in **Figure 15-6**.

Table 15-7 Summary of landscape character impacts during operation

LCZ	Sensitivity	Magnitude	Impact
LCZ1: Black Hill	Moderate	**Moderate** The project would increase the amount of the road-related infrastructure in this LCZ. It would require clearing of remnant bushland vegetation and result in changes to the natural landform to accommodate the project's geometric requirements, including the large Black Hill cut (C01). The changes would affect the spatial character of this LCZ. Beneficial outcomes from the project would be a reduction in traffic volumes on John Renshaw Drive and the New England Highway, reducing congestion and improving connectivity. The provision of a more direct cycle route along the project also delivers further connectivity improvements.	Moderate
LCZ2: Hunter River Floodplain	High	**Moderate** The project would increase the amount of the road-related infrastructure. Changes to the spatial qualities of the LCZ and its vegetation cover would be minor, with disturbed vegetation reinstated following project construction. The open spatial experience travelling along the New England Highway would be replaced with a similar experience along the main alignment. The project would impact on the heritage values and significance of the Glenrowan Homestead through removal of the weatherboard cottage and bisection of the curtilage, affecting the integrity, vistas and landscape setting of the complex. Beneficial outcomes from the project would be a reduction in traffic volumes on the New England Highway, reducing congestion and improving connectivity. The provision of a more direct cycle route along the project delivers further connectivity improvements.	High to moderate
LCZ3: Beresfield – Tarro – Woodberry	Moderate	**Low** The main project infrastructure introduced into LCZ would be new noise barriers along the New England Highway. New noise barriers would result in the loss of the open interface to the Hunter River floodplain in LCZ 2, changing the spatial character at the edge of LCZ 3. This would affect a relatively small portion of this LCZ and would provide other amenity benefits such as a reduction in noise impacts on residential dwellings in close proximity to the New England Highway. Due to the alignment of the project within existing major road corridors located outside the Beresfield-Tarro-Woodberry LCZ, the existing character of sensitive residential areas would not be altered.	Moderate to low
LCZ4: Tomago	Low	**Low** The project infrastructure would be consistent in character with existing industrial and road corridor uses in LCZ 4. The most notable changes would be associated with the new Tomago interchange including the realignment of the Pacific Highway north of the Tomago Road intersection, with separation of the northbound and southbound travel lanes. This would affect the spatial qualities in the northern portion of the LCZ and increase the amount of the road-related infrastructure in the zone. The spatial experience along the Pacific Highway would be replaced with a similar experience along the project. The project would remove one rural residential dwelling which would otherwise be removed as part of the proposed Newcastle Power Station. There would be no impacts on public domain and key activity areas. Improved traffic flow would benefit the functionality of industrial and employment areas. The provision of a more direct cycle route along the project delivers additional connectivity improvements.	Low

LCZ	Sensitivity	Magnitude	Impact
LCZ5: Tomago Sandbeds	Moderate	**High** The project would result in an increase in the amount of the road related infrastructure including a new cleared road corridor through remnant bushland areas. It would alter the bushland backdrop to Heatherbrae, replacing it with road infrastructure. It would require clearing of a large tract of remnant bushland and result in changes to the natural landform to accommodate the project's geometric requirements, resulting in a deep cutting. The changes would affect the spatial character of this zone. Beneficial outcomes from the project would be a reduction in traffic volumes on the Pacific Highway, reducing congestion and improving connectivity. The provision of a more direct cycle route along the project delivers active transport connectivity improvements. The shared path along Masonite Road provides the opportunity for future expansion of the cycle network by Port Stephens Council, should this be desired. The signalised intersection at the Hunter Region Botanic Gardens access road would improve pedestrian and cyclist access to the Hunter Region Botanic Gardens, including from the bus stop on the western side of the Pacific Highway.	High to moderate
LCZ6: Heatherbrae	Moderate	**Low** The project would result in a relatively minor increase in road related infrastructure in the Heatherbrae LCZ. It would alter the bushland backdrop to Heatherbrae through clearing in the adjoining Tomago Sandbeds and Windeyers Creek LCZs, although this change would be somewhat offset over time by landscaping provided as part of the project. Beneficial outcomes from the project would be a reduction in traffic volumes on the Pacific Highway, reducing congestion and enhancing town centre amenity for residential and community uses. The provision for cycling along the project's shoulders delivers active transport connectivity improvements. The shared path along Masonite Road provides the opportunity for future expansion of the cycle network by Port Stephens Council, should this be desired.	Moderate to low
LCZ 7: Windeyers Creek	Moderate	**Moderate** The project would result in a large increase in the amount of the road-related infrastructure including a new motorway through greenfield areas. However, much of the project's operational footprint is already cleared, with the exception of minor portions north-east of Heatherbrae. The spatial qualities within the Windeyers Creek LCZ overall would not be altered by the project and the project would be compatible with the character of the existing M1 Pacific Motorway as well as with the industrial area in the adjoining Heatherbrae LCZ. Beneficial outcomes from the project would be a reduction in traffic volumes on the Pacific Highway, reducing congestion and improving connectivity. The provision for cycling along the main alignment delivers active transport connectivity improvements. The shared path along Masonite Road provides the opportunity for future expansion of the cycle network by Port Stephens Council, should this be desired.	Moderate

Visual impact

Based on the sensitivity of the views to change and the magnitude of change to the view as a result of the project, the project's visual impacts would vary in intensity. Higher impacts would result where elements that are sensitive to change would be altered by the project, such as removal of remnant bushland for an interchange at Black Hill the loss of open views of the landscape such as at Tarro and the Hunter Region Botanic Gardens.

The visual impact of the project from the 19 viewpoints (identified in **Figure 15-7** and **Table 15-6**) are presented in **Table 15-8**. In summary:

- Two viewpoint would have a high visual impact
- Ten viewpoints would have a high to moderate visual impact
- Four viewpoints would have a moderate visual impact
- One viewpoint would have a low visual impact
- Two viewpoints would have a negligible visual impact.

Indicative photomontages with the project and embedded design mitigation in place have been provided in **Table 15-9**.

The introduction of elevated bridge and viaduct structures, noise barriers in new locations, removal and severance of remnant bushland, the introduction of embankments to negotiate interchanges and the creation of parallel road corridors adjoining each other with little visual separation result in moderate to high visual impacts. In addition, due to the open landscape setting of the Hunter River floodplain, project elements would potentially be seen from areas at a considerable distance from the project.

Where the project aligns with existing urban areas and road corridors, such as the Heatherbrae industrial area and Masonite Road, views would have a higher ability to accommodate change, reducing the overall level of impact within the moderate to low range. All but the largest project elements have substantially reduced visibility at viewing distances greater than about 1.5 kilometres. When seen from this distance, the project would have a low to negligible visual impact.

Light spill from the roadway and permanent operational lighting would add to changes to the visual environment at night however lighting would be designed in accordance with relevant Australian standards and illumination and light spill would be mostly confined within the operational footprint. Therefore, light impacts are considered to be low in the context of the project as a whole.

Table 15-8 Summary of visual amenity impacts during operation

Viewpoint	Sensitivity	Magnitude	Impact
1	Moderate	**High** The view would undergo a notable change with an increase in road infrastructure and associated bushland removal. Compensatory native vegetation between the project's southbound main alignment and the southbound entry ramp would mitigate changes to the view as vegetation matures over time.	High to moderate
2	Low	**High** The southbound entry would introduce a prominent new landform into this view, requiring the removal of bushland. Bushland would also need to be removed for drainage infrastructure including the adjustment to the drainage channel connected to Viney Creek, resulting in changes to a notable portion of this view. Vegetation installed as part of the project landscape design would somewhat reduce the visual effect of change over time.	Moderate

Viewpoint	Sensitivity	Magnitude	Impact
3	High	**Low** New road infrastructure would be visible from this viewpoint. However, the project would be at least about 1.3km from this viewpoint. Given this distance, only a minor portion of the view would change and the changes would be difficult to discern in detail.	Moderate
4	High	**Moderate** The upgrade of the New England Highway would result in the highway constituting a larger visual element in the eastern foreground of this view. The main alignment would also alter the midground of the view. The main alignment would be on embankments, which would close off much of the existing view across the floodplain and towards the distant hills.	High to moderate
5	High	**High** The major change to this view would result from noise barrier NB03 that would replace mature screening vegetation, notably altering the outlook for the residents. Project elements including the westbound New England Highway supported on a fill embankment on the approach to bridge B03 would be visible above the noise barrier and would notably alter the central part of the view.	High
6	Moderate	**Moderate** The project would alter the central portion of this view, replacing the low-lying open floodplain with a view of the main alignment on fill embankments. The effect of the project would be major new visual elements in the mid distance of the view and the loss of long-distance views across the floodplain. There would be no change to the foreground of the view. Traffic on the main alignment would be highly visible silhouetted against the sky, increasing the visibility of the project in the view. Vegetation provided as part of the project at the base of the embankments would somewhat compensate for the removal of existing stands of trees. Over time this would reduce the visual effect of the project through integration with the existing landscape setting.	Moderate
7	High	**Moderate** The viaduct over the Hunter River floodplain would introduce a large new structure, elevated above the ground, affecting the open views across the floodplain. In addition, trucks travelling along the viaduct would further increase visibility of the project in the view. The magnitude of these changes would be somewhat mitigated by the viewing distance of at least 700m. Mangrove forests currently terminating the view would be replaced with the viaduct and its substructure. The open sky would also be affected, with parts of the viaduct and traffic travelling along it visually exposed against the sky.	High to Moderate
8	High	**Negligible** The viaduct over the Hunter River floodplain would introduce a large new structure, elevated above the ground, interrupting views along the floodplain. In some areas, the viaduct would intrude into the open skyline above existing tree cover. Trucks and other vehicles travelling along the viaduct would increase the overall size of the project in the view, however, at a minimum distance of about 1.95km from the viewpoint, only a small portion of the view would be altered.	Negligible

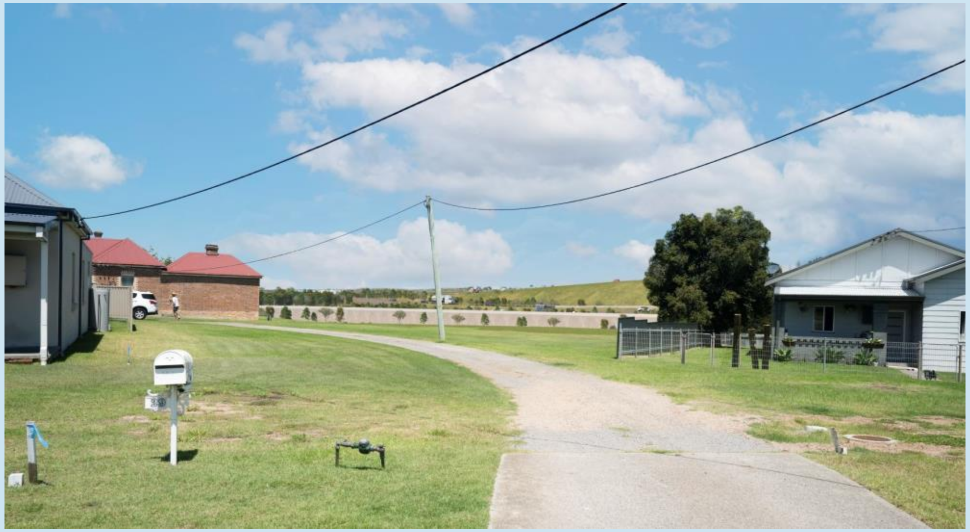
Viewpoint	Sensitivity	Magnitude	Impact
9	Moderate	**High** The viaduct above the open floodplain landscape and associated piers would introduce a new focal point into this view and alter the open outlook across the floodplain. The change to the view would be further amplified by the visual effect of traffic travelling along the viaduct including large trucks. Sensitive vegetation would be retained in the foreground, while some tree removal may be required close to the viaduct to enable construction.	High to moderate
10	High	**Negligible** The viaduct over the Hunter River floodplain would introduce a large new structure into this view. However, it would generally not protrude above the horizon line. As a result of the viewing distance (about 1.5km), the viaduct would comprise a relatively small portion of the view, being seen by viewers primarily in moving cars, and looking sideways. Tree cover and grazing lands in the floodplain, as well as the view of the hills in the background would not be affected.	Negligible
11	Moderate	**High** Clearing within the operational footprint and the construction of the new northbound Pacific Highway alignment and associated fill embankments would alter the bushland frame of the view, resulting in a high level of change.	High to moderate
12	High	**Moderate** The view is characterised by the natural setting of the Hunter River and its riverside forests. Views are expansive with the open sky above the wider river a second important, visually highly sensitive component of the view. High voltage transmission line stanchions are visual detractors but overall, the natural environment dominates the composition.	High to moderate
13	Moderate	**High** This viewpoint provides for open views from the Pacific Highway across the Hunter River floodplain, towards the hills and mountains in the west. The open vistas, clumps of tree cover and the overall rural landscape character would be sensitive to change, despite the detracting presence of high voltage transmission lines. The Pacific Highway comprises the left portion of the view and would be much less sensitive to change.	High to moderate
14	High	**High** The project would almost completely alter this view as a result of the fill embankments required to bridge the main alignment over the access road. The embankments, bridge abutments and bridge superstructure would become the main compositional items in the foreground. In the background of the view, vegetation would be removed and replaced with the realigned Pacific Highway including its intersection with the modified Hunter Region Botanic Gardens access road.	High
15	Moderate	**High** The main alignment would result in the removal of bushland on the southern side of the road corridor. Bushland would be replaced with a second road corridor within the view, resulting in change to a large portion of the view. Due to space constraints, there would be limited opportunity for vegetation to visually separate the road corridors which might contribute to reducing the visual effect over time.	High to moderate

Viewpoint	Sensitivity	Magnitude	Impact
16	Moderate	**High** The project would relocate the road corridor further to the right in the view and increase the amount of road-related infrastructure, primarily as a result of the widened footprint of Masonite Road and a fill embankment. Part of the existing road infrastructure would be able to be removed and vegetation provided to integrate with the adjoining landscape. Another change to the view would be the removal of bushland vegetation to facilitate project construction along Masonite Road. Vegetation provided as part of the project landscape work along the main alignment would partially reduce this effect over time, as vegetation matures.	High to moderate
17	Low	**Low** The project would introduce a new motorway in the middle ground of the view. Given the minor embankments, the project itself would not be obvious and alter only a minor portion of the view. The visibility of the project and changes to the outlook would primarily result from traffic along the project' main alignment. Vehicles would take up a small portion of the view and would be partially obscured by vegetation provided as part of the project landscape design between the view and the main alignment. Project vegetation would make a positive contribution to the view over time, especially as trees mature. The backdrop of plantations would not be affected by the project. The view would be subject to notable change as a result of the continuing development of the industrial area as part of the Kinross Industrial Estate/Weathertex. This will involve construction of industrial buildings that will likely block a large part of the view and would likely exceed and conceal the changes to the view brought about by the project.	Low
18	Moderate	**Moderate** The major new element in the view would be the southbound exit ramp onto the existing Pacific Highway. The fill embankments required for the exit ramp as well as removal of vegetation along the eastern side of the existing road corridor would further alter this portion of the view. Removal of the existing southbound travel lanes and replacement with vegetation provided as part of the project landscape design would over time reduce the amount of road infrastructure in the view and provide a visual buffer between the northbound Pacific Highway travel lanes and the southbound exit ramp of the interchange.	Moderate
19	Moderate	**High** The project would involve the removal of mature vegetation on both sides of the view, altering this view to a large extent. Bridge 12 would be located over the main alignment. Together with its associated fill embankments, it would change the centre of the view. Vegetation provided as part of the project landscape design would over time reduce the amount of road infrastructure in the view. It would also create a visual buffer and a green frame to the view, somewhat compensating for removal of mature vegetation.	High to moderate

Table 15-9 Operational visual impacts at each viewpoint

VP	Existing viewpoint	Viewpoint during project operation (artist impression)
1		
2		

VP	Existing viewpoint	Viewpoint during project operation (artist impression)
3		
4		

VP	Existing viewpoint	Viewpoint during project operation (artist impression)
5		
6		

VP	Existing viewpoint	Viewpoint during project operation (artist impression)
7		
8		

VP	Existing viewpoint	Viewpoint during project operation (artist impression)
9		
10		

VP	Existing viewpoint	Viewpoint during project operation (artist impression)
11		
12		

VP	Existing viewpoint	Viewpoint during project operation (artist impression)
13		
14		

VP	Existing viewpoint	Viewpoint during project operation (artist impression)
15		
16		

VP	Existing viewpoint	Viewpoint during project operation (artist impression)
17		
18		

VP	Existing viewpoint	Viewpoint during project operation (artist impression)
19		

Overshadowing

The analysis of potential shadowing impacts focused on large three-dimensional project elements (such as interchanges and bridges) with the potential to cause shadowing that are located in areas with sensitive receivers such as Tarro urban area and the Hunter Region Botanic Gardens.

The analysis of shadow impacts in these areas indicates that there would be no overshadowing impacts on sensitive receivers as a result of project elements. Overshadowing impacts of the project are further discussed in the Urban Design, Landscape Character and Visual Amenity Working Paper (**Appendix O**).

15.6 Environmental management measures

The environmental management measures that will be implemented to minimise the landscape character and visual impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 15-10**.

Table 15-10 Environmental management measures (urban design, landscape and visual amenity)

Impact	Reference	Management measure	Responsibility	Timing
Landscape character and visual impacts including during construction	UD01	An Urban Design and Landscape Plan (UDLP) will be prepared to support the project. The plan will present an integrated urban design for the project, providing practical detail on the application of design principles and objectives identified in the EIS. The plan will include: • Location and identification of existing vegetation and proposed landscaped areas, including species to be used • Built elements including retaining walls, bridges and noise barriers • Walking and cyclist elements including footpath locations, paving types and pedestrian crossings • Fixtures such as lighting, fencing and signs • Details on the staging of landscape work including related environmental controls such as erosion and sedimentation controls and drainage • Procedures for monitoring and maintaining landscaped or rehabilitated areas • The project will consider CPTED principles during detailed design to minimise safety and security risks to all users and communities in the study area. The project will carry out CPTED reviews at each milestone by a qualified professional. Additional recommendations as a result of reviews will be implemented where reasonable and feasible • Water sensitive urban design solutions. The plan will be prepared in accordance with Transport urban design policy guidelines including: • Beyond the Pavement – Urban design approach and procedures for road and maritime infrastructure planning, design and construction (Transport for NSW 2020a) • Landscape design guideline: Design guideline to improve the quality safety and cost effectiveness of green infrastructure in road corridors (Roads and Maritime Services 2018a) • Bridge Aesthetics: Design Guidelines to improve appearance of bridges in NSW (Transport for NSW 2019a) • Noise wall design guideline: Design guideline to improve the appearance of noise walls in NSW (Transport for NSW 2016a) • Shotcrete Design Guideline: Design guidelines to avoid, minimise and improve the appearance of shotcrete in NSW (Transport for NSW 2016b) • Water sensitive urban design guideline, Applying water sensitive urban design principles to NSW transport projects (Transport for NSW 2017b)	Contractor	Prior to construction

Impact	Reference	Management measure	Responsibility	Timing
	UD02	Disturbed areas outside the operational footprint and within the construction footprint will be revegetated following completion of construction activities.	Contractor	Construction
	UD03	Cut batters and fill embankments for the project will be designed to allow revegetation to assist with the integration of the project into the surrounding landscape where possible depending on site conditions.	Contractor	Construction
	UD04	Project construction elements such as fencing and hoardings will be designed to minimise impacts to landscape character and visual amenity where practicable	Transport/ Contractor	Prior to construction/ construction
	UD05	Temporary and permanent lighting will be installed and operated in accordance with AS/NZS1158 Lighting for Roads and Public Spaces.	Transport/ Contractor	Prior to construction/ construction
Aboriginal cultural heritage	UD06	The project detailed design will incorporate relevant Aboriginal cultural heritage elements of Beyond The Pavement (Transport for NSW 2020a) and Designing With Country (GANSW 2020), where practical.	Transport/ Contractor	Prior to construction/ construction

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Environmental impact statement – Chapter 16: Soils and contamination

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16. Soils and contamination

This chapter describes the potential soils and contamination impacts that may be generated by the construction and operation of the project and presents the approach to the management of these impacts.

The desired performance outcomes for the project relating to soils and contamination, as outlined in the SEARs, are to:

- Protect the environmental values of land, including soils, subsoils and landforms
- Minimise risks arising from the disturbance and excavation of land and disposal of soil, including disturbance to acid sulfate soils (ASS) and site contamination.

Table 16-1 outlines the SEARs that relate to soils and contamination and identifies where they are addressed in this EIS. The full assessment of soils and contamination impacts is provided in the Soils and Contamination Working Paper (**Appendix P**).

Table 16-1 SEARs (soils and contamination)

Secretary's requirement	Where addressed
6. Soils	
1. The Proponent must verify the risk of acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Risk Map) within, and in the area likely to be impacted by, the project.	The risk of acid sulfate soils within the construction footprint is discussed in **Section 16.3.2**.
2. The Proponent must assess the impact of the project on acid sulfate soils (including impacts of acidic runoff offsite) in accordance with the current guidelines.	Construction and operational impacts on acid sulfate soils are described in **Section 16.4.1** and **Section 16.4.2**.
3. The Proponent must assess whether the land is likely to be contaminated and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and future land uses. Where assessment and/or remediation is required, the Proponent must describe how the assessment and/or remediation would be undertaken in accordance with current guidelines.	Areas of potential contamination risk are identified in **Section 16.3.6**. The contamination assessment and remediation requirements are discussed in **Section 16.4.1** and **Section 16.4.2**. Further remediation requirements are included as part of the management measures in **Section 16.5**.
4. The Proponent must assess whether salinity is likely to be an issue and if so, determine the presence, extent and severity of soil salinity within the project area.	Existing soil salinity is described in **Section 16.3.4**. Construction and operational impacts relating to soil salinity are discussed in **Section 16.4.1** and **Section 16.4.2**.
5. The Proponent must assess the impacts of the project on soil salinity and how it may affect groundwater resources and hydrology.	Construction and operational impacts relating to soil salinity are discussed in **Section 16.4.1** and **Section 16.4.2**. **Chapter 11** (surface water and groundwater quality) assesses the water quality impacts associated with saline groundwater.
6. The Proponent must assess the impacts on soil and land resources (including erosion risk or hazard). Particular attention must be given to soil erosion and sediment transport consistent with the practices and principles in the current guidelines.	Construction and operational impacts relating to soil erosion and sediment transport are discussed in **Section 16.4.1** and **Section 16.4.2**.

16.1 Policy and planning setting

The soils and contamination assessment has been prepared to assess the potential impacts of the project in accordance with the following relevant legislation, policy and guidelines:

- Legislation:
  - National Environmental Protection Measure (Assessment of Site Contamination) 1999 (as amended 2013) (National Environment Protection Council 2013)
  - *Contaminated Land Management Act 1997*
- Plans and policies:
  - State Environmental Planning Policy No 55 – Remediation of Land
- Guidelines:
  - The Acid Sulfate Soils Manual (ASSMAC 1998)
  - Acid Sulfate Soils Assessment Guidelines (Department of Planning 2008)
  - Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land (Department of Urban Affairs and Planning & Environment Protection Authority 1998)
  - Guidelines for Consultants Reporting on Contaminated Land (NSW Environment Protection Authority 2020)
  - Guidelines on the Duty to Report Contamination under the *Contaminated Land Management Act 1997* (NSW Environment Protection Authority 2015)
  - Waste Classification Guidelines (NSW Environment Protection Authority 2014a)
  - Guidelines for the NSW Site Auditor Scheme, 3rd Edition (NSW Environment Protection Authority 2017).

Where investigations have been required, they have been carried out in accordance with the relevant state and national guidelines, and other appropriate/endorsed guidelines including the following:

- Urban and regional salinity guidance given in the Local Government Salinity Initiative booklets which includes Site Investigations for Urban Salinity (Department of Land and Water Conservation 2002)
- Landslide risk management guidelines presented in Australian Geomechanics Society (2007)
- Soil and Landscape Issues in Environmental Impact Assessment (Gray and Department of Land and Water Conservation 2000)
- Guidelines for the Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008 (DECC 2009b)
- Contaminated Sites: Sampling Design Guidelines (NSW Environment Protection Authority 1995)
- PFAS – National Environmental Management Plan (HEPA 2020)
- Managing asbestos in or on soil (WorkCover NSW 2014).

The Blue Book – Landcom's Managing Urban Stormwater: Soils and Construction series (Landcom 2004) would inform the rehabilitation of disturbed areas and management of soil erosion and sedimentation.

In addition to the above guidelines under section 105 of the *Contaminated Land Management Act 1997*, the following specialist guidance documents were used as part of the assessment of the former mineral sands processing site:

- ARPANSA 2008, Management of Naturally Occurring Radioactive Material (NORM) Radiation Protection Series Publication No. 15, (ARPANSA 2008) Australian Radiation Protection and Nuclear Safety Agency
- ARPANSA 2014, Fundamentals for Protection Against Ionising Radiation, Radiation Protection Series F-1 (ARPANSA 2014), Australian Radiation Protection and Nuclear Safety Agency
- ARPANSA 2015, Radiation Protection of the Environment, Guide G-1 (ARPANSA 2015), Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)

- ARPANSA 2017, Guide for Radiation Protection in Existing Exposure Situations, Radiation Protection Series G-2 (ARPANSA 2017, Australian Radiation Protection and Nuclear Safety Agency (ARPANSA))
- enHealth 2012a, Environmental Health Risk Assessment, Guidelines for assessing human health risks from environmental hazards, Commonwealth of Australia, Canberra, (enHealth 2012a)
- enHealth 2012b, Australian Exposure Factors Guide, Commonwealth of Australia, Canberra (enHealth 2012b)
- International Atomic Energy Agency 2007, Radiation Protection and NORM residue Management in the Zircon and Zirconia Industries, Safety Reports Series No. 51. (International Atomic Energy Agency 2007).

Further detail on the above legislation, policies and guidelines, and how they apply to the project, is provided in the Soils and Contamination Working Paper (**Appendix P**).

16.2 Assessment methodology

Information on soils, including acid sulfate soils, soil contamination, soil salinity and soil and land resources presented in this chapter was sourced from publicly available information and geotechnical and site investigations carried out for the project in 2015, 2017 and 2020.

The methodology for the soils and contamination assessment included:

- Reviewing the relevant legislation, policy and guidelines (as outlined in **Section 16.1**)
- Defining the study area, which comprises a 500 metre buffer from the construction footprint as shown in **Figure 16-1**
- Carrying out a desktop assessment, including a review of existing project documentation and publicly available information
- Carrying out site inspections and investigations to establish existing conditions including:
- Identifying areas of potential contamination risk (AOPCRs) applicable to the project
- Establishing and confirming current soil conditions including soft soils, acid sulfate soils and salinity.
- Assessing the potential soils and contamination impacts of the project
- Developing management measures to mitigate potential soils and contamination impacts
- Assessing cumulative soils and contamination impacts that may arise from the interaction between construction and operation activities of the project and those of other approved or proposed projects in the area, as presented in **Chapter 23** (cumulative impacts).

Aspects of the methodology are described in more detail in the following sections. Further detail on the assessment methodology is provided in the Soils and Contamination Working Paper (**Appendix P**).

16.2.1 Desktop assessment

A desktop review was carried out to characterise the existing environment with respect to soils and contamination and identify areas of potential contamination risk. Relevant databases and literature reviewed included:

- Publicly-available information (as of June 2020), including:
  - Port Stephens Council website
  - Geographical and soil mapping
  - Published public data, including topographical, ASS and salinity risk maps
  - Bureau of Meteorology (BoM) data
  - NSW EPA Contaminated Sites Record of Notices (under section 58 of the *Contaminated Land Management Act 1997*)
  - The list of contaminated sites notified to the NSW EPA (under section 60 of the *Contaminated Land Management Act 1997*)
  - NSW EPA current PFAS investigation sites
  - Environmental Protection Licenses (EPLs) and non-compliances related to EPL requirements under the *Protection of the Environment Operations Act 1997*
  - Australian Soil Resource Information System (ASRIS) database
  - The WaterNSW groundwater database.
- Historical aerial photography and land use information including:
  - Available historical aerial photographs for the years 1954, 1966, 1976, 1984, 1993, 2001, 2007 and/or 2010, 2014, 2015, and 2019, 2020 (as available for various portions of the study area)
  - Available historical maps for the years 1913, 1941, 1981 and 2015
  - Universal Business Directory (UBD) records from 1950, 1961, 1982 and 1991.
- Previous soil, geotechnical and contamination investigation reports.

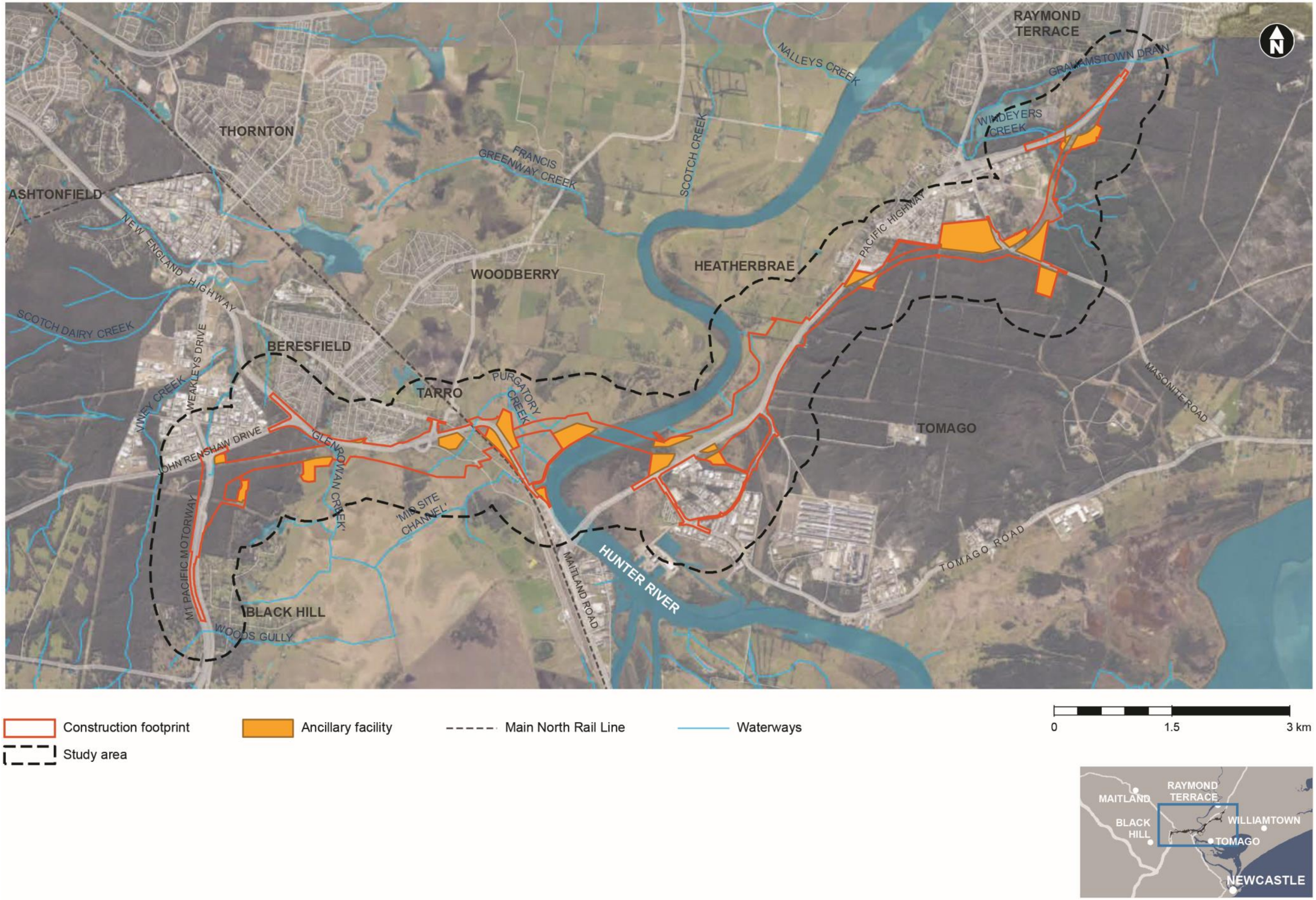


Figure 16-1 Soils and contamination study area

16.2.2 Site inspections

Site inspections were carried out within the construction footprint focusing on potentially contaminated areas (as identified during desktop assessment), including:

- Stockpiles of crushed sand and glass within industrial land
- A likely former septic system within industrial land
- Buildings potentially constructed with asbestos cement material
- Buildings containing lead paint
- Abandoned vehicles
- Waste tyres
- Illegally dumped demolition and construction debris.

The findings of these site inspections are presented in the Preliminary Site Investigation Contamination and Acid Sulphate Soil Assessment (Douglas Partners 2015) report, and were used to inform this assessment.

Site inspections were also carried out between 2019 and 2020 at the former mineral sands processing facility at Tomago that is located within the construction footprint (discussed further in **Section 16.3.6**). The information collected (including observations made) during the site inspections have been used to inform this assessment as described in **Table 16-7**.

16.2.3 Identification of areas of potential contamination risk

AOPCRs within the study area were identified based on a review of historical and current potentially contaminating activities applicable to the project and an initial assessment of:

- Known and potential sources of contamination and contaminants of concern, including the mechanism(s) of contamination
- Potentially-affected media (soil, sediment, groundwater, surface water)
- Proximity and/or sensitivity of human and ecological receivers
- Potential and complete exposure pathways
- The impact of construction or operation of the project on the behaviour, exposure or migration of identified or suspected contamination.

Identified AOPCRs were then assigned a contamination risk rating of ‘High’, ‘Medium’ or ‘Low’ based on:

- The weight of evidence gathered throughout the desktop assessment process
- The results of previous contamination assessments and data
- Professional judgement based on experience with similar sites and projects.

All risk rankings have been based on unmitigated project risks and have not considered the implementation of design or engineering controls. Where there is direct evidence or the combined weight evidence indicates a likely exposure scenario of workers to known contamination, the risk ranking potential is considered ‘High’.

The AOPCRs were used to carry out an assessment of potential impacts based on construction and operational information contained in **Chapter 5**. The assessment considered how the AOPCR risk ratings may change due to a change in land use as a result of construction and operation of the project.

16.3 Existing environment

16.3.1 Topography, geology and soil landscapes

Topography

The topography of the study area varies from flat floodplain associated with the Hunter River, stabilised sand dunes associated with Tomago Sandbeds and rolling hills to the north and south. Elevation across the project is variable, however can be separated into three key areas:

- Western portion (between Tarro and Black Hill): Comprising gently sloping ground between four metres Australian height datum (AHD) and 30 metres AHD (with a ridgeline oriented north to south)
- Central portion (between Tomago and Tarro): Comprising low lying, gently undulating flood plains at below three metres AHD
- Eastern portion (between Raymond Terrace and Heatherbrae): Comprising mildly undulating terrain between two metres AHD and 10 metres AHD.

Geology

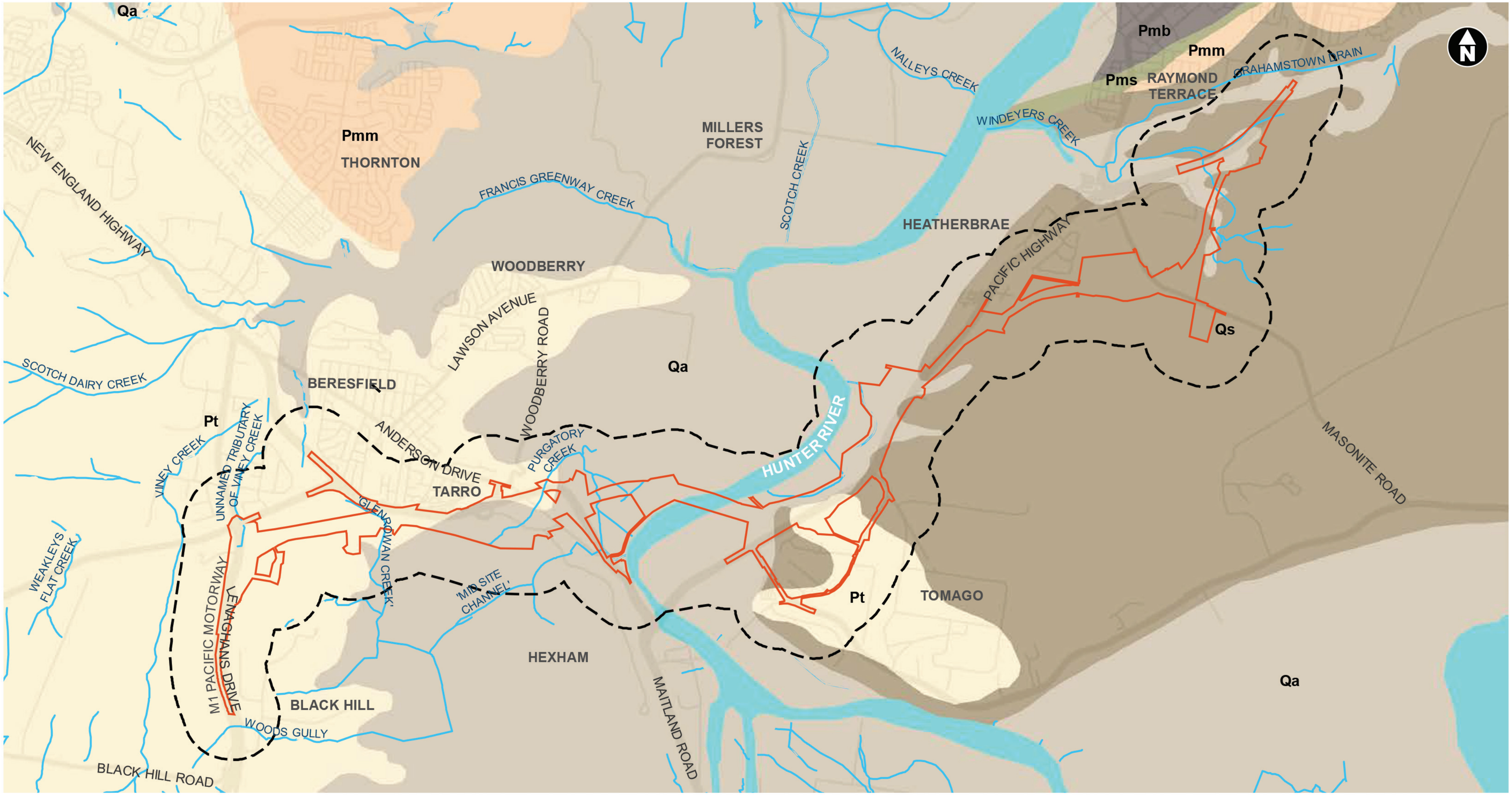
Based on a review of the Newcastle Coalfield Regional 1:100,000 scale Geology Map (Hawley, Glen and Baker 1995), the geology applicable to the project is characterised as follows (refer to **Figure 16-2**):

- Tomago Coal Measures of late Permian age (Pt):
  - Located at the south western end of the construction footprint at Black Hill, Beresfield and Tarro and to the east of the project in Tomago
  - Consist of shale, siltstone, fine sandstone, coal and minor tuffaceous claystone.
- Quaternary aged sediments (Qa and Qs):
  - The central and low lying areas of the construction footprint near the Hunter River and floodplain include quaternary alluvium
  - The northern part of the construction footprint is dominated by a Pleistocene aged dune system (quaternary coastal sands) which forms part of the Tomago Sandbeds
  - The sediments predominately comprise fine to medium grained sand: the Tomago Sandbeds are locally incised by Holocene aged alluvium, particularly around Windeyers Creek near the northern parts of the construction footprint.
- Mulbring Siltstone and the Muree Sandstone of the Maitland Group of middle to late Permian age (Permian Maitland Group; Pmm):
  - Exposed near the northern end of the project
  - Consist of siltstone, sandstone, conglomerate and minor clay.

Geotechnical investigations carried out for the project in 2015 identified a deep paleo-channel which may run parallel to the western side of the Hunter River, passing though the construction footprint. This paleo-channel is expected to have formed where the Hunter River has incised a channel into the underlying Permian aged rocks (Roy, Hudson and Boyd 1995). The channel has been filled with initially Pleistocene-aged estuary deposits and channel sands which have since been overlain by Holocene-aged swamp and flood deposits. The Holocene deposits are generally clay-dominated soils which are normally or slightly over-consolidated.

The 1:100,000 scale regional geology map for Newcastle (Newcastle Coalfield Regional Geology, Sheet 9321, NSW Department of Mineral Resources) also shows two geological structures which pass through or close to the construction footprint:

- The Williams River Fault, which crosses the Hunter River in the vicinity of the project's proposed crossing
- The Thornton Syncline, which crosses the south-western part of the construction footprint.



0 1 2 km

Construction footprint

Study area

Waterways

Water bodies

Geology

Pmb – Permian Maitland Group - Branxton Formation - Undifferentiated

Pmm – Permian Maitland Group - Mulbring Siltstone

Pms – Permian Maitland Group - Branxton Formation - Muree Sandstone Member

Pt - Permian Tomago Coal

Qa - Quaternary Alluvium

Qs - Quaternary Coastal Sand

Data source: DIRE 2016

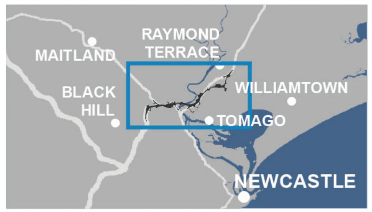


Figure 16-2 Geology

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Soil landscapes

Based on a review of the 1:100,000 Newcastle soil landscape map (Matthei L.E. 1995), the project would transverse eight soil landscapes, as summarised in **Table 16-2** and shown on **Figure 16-3**.

Table 16-2 Summary of soil landscapes within the construction footprint

Soil landscape	Location	Characteristics
Residual soil of the Beresfield soil landscape	In the western portion of the construction footprint near the existing M1 Pacific Motorway and near the former mineral sands processing facility in Tomago	• Comprises undulating low hills and rises on Permian sediments with slopes between three per cent to 15 per cent and an elevation of 20m to 50m • Dominant soils comprise brown black loam (topsoils) and yellow brown sandy loam (topsoil), brown plastic mottled clays (subsoil), red brown plastic clays (subsoil) or silty clays (subsoil) • Limitations include high foundation hazard, water erosion hazard, seasonal water logging and high run-on on localised low slopes, highly acidic soils of low fertility. Red-brown clays and silty clays are sodic / highly sodic and susceptible to dispersion.
Residual soil of the Hamilton soil landscape	East of the construction footprint in Tomago	• The Hamilton soil landscape group comprises level to gently undulating well-drained plain on Quaternary aged deposits with slopes less than two per cent and elevations up to 12m • Dominant soils comprise brown black loamy sand and pale coarse sand (topsoils) and brown to orange sandy pan (subsoil) • Limitations include wind erosion hazard, groundwater pollution hazard, strong acidity, non-cohesive soils.
Millers Forest estuarine landscape	On lower-lying land in Hexham and Tomago	• The Millers Forest landscape group comprises extensive alluvial plain on recent sediments with an elevation of 6m to less than 3m and slopes less than one per cent • Dominant soils comprise brown black silty clay loam (topsoils) and brown silty clay (subsoil) • Limitations include flood hazard, permanently high water tables, seasonal waterlogging and foundation hazard, low wet bearing strength soils. Brown silty clay subsoils are also limited by sodicity / dispersion, salinity (localised, at depth) and potential ASS at depths below 1.5m AHD.
Fullerton Cove estuarine landscape	Surrounding the Hunter River north of the Hexham Bridge	• The Fullerton Cove landscape group comprises tidal flats and creeks in tidal inlets and estuaries with slopes less than three per cent and elevation less than 3m • Dominant soils comprise black organic rich peat or saturated saline organic mud • Limitations include flooding, wave erosion hazard and foundation hazard, saturated, saline, potential ASS.
Hexham Swamp landscape	Between the Hunter River bank and Tomago Road	• The Hexham Swamp landscape group comprises broad, swampy, estuarine backplains on the Hunter delta with slopes less than one per cent and elevation less than 2m • Dominant soils comprise black silty clay loam (topsoil) and plastic clays (subsoil) • Limitations include flood hazard, permanently high water tables, seasonal waterlogging, foundation hazard, groundwater pollution hazard, localised tidal inundation, highly plastic potential ASS of low fertility. Both topsoils and subsoils are sodic and very highly saline in localised areas.

Soil landscape	Location	Characteristics
Tea Gardens Landscape Variant Aeolian landscape	Between the former mineral sands processing facility and Heatherbrae (except for Windeyers Creek)	• The Tea Gardens landscape group comprises Pleistocene beach ridges on the Tomago coastal plain with slopes less than five per cent, elevations between 5m to 8m • Dominant soils comprise sandy peat, brown/black to brown /grey loamy sand (topsoil), saturated brown/black coarse sandy clay loam (topsoil), bleached sands (shallow subsoil), massive organic pan (loamy sand to sand), coarse smelly saturated sand • Limitations include permanently high water tables, seasonal waterlogging, groundwater pollution hazard, strongly to extremely acid soils of low fertility and low available water-holding capacity.
Blind Harrys Swamp soil landscape	Near the creeks and swamps near the Hunter Region Botanic Gardens	• The Blind Harrys Swamp landscape group comprises waterlogged swales and deflation areas on sands of the Tomago coastal plain with elevation less than 10m and slopes less than two per cent • Dominant soils comprise black organic fibrous peat and saturated brown mottled sand • Limitations include permanently high water tables, foundation hazard, permanently waterlogged, ground water pollution hazard and strongly acid soils. Sands are also limited by salinity and localised potential ASS.
Bobs Farm Beach soil landscape	Along Windeyers Creek	• The Bobs Farm variant landscape group comprises low remnant lake shore beach deposits with up to 1m relief, 15m width and 200m in length • Dominant soils comprise dark brown loose loamy sands (topsoil) and yellow brown loose coarse beach sand (subsoil) • Limitations include flood hazard, high run-on, wind erosion hazard, non-cohesive soils, groundwater pollution hazard, foundation hazard and permanently high water table.

Soft soils

A number of areas within the construction footprint were identified through the geotechnical investigations as having soft soils. These soils have a tendency to have fluid-like behaviour and can be difficult to dewater and consolidate. Soft soils generally need to be preconditioned for improvement of the mechanical strength prior to the construction of overlying structures, such as buildings and roads. Soft soil areas within the construction footprint are identified in the Geotechnical Concept Design Report (Douglas Partners 2020) and are shown on **Figure 16-3**. Locations within the construction footprint include:

- The main viaduct approach embankment
- Tarro interchange embankments
- Tomago interchange embankments
- The approach to the bridge on Masonite Road
- Raymond Terrace interchange embankments.

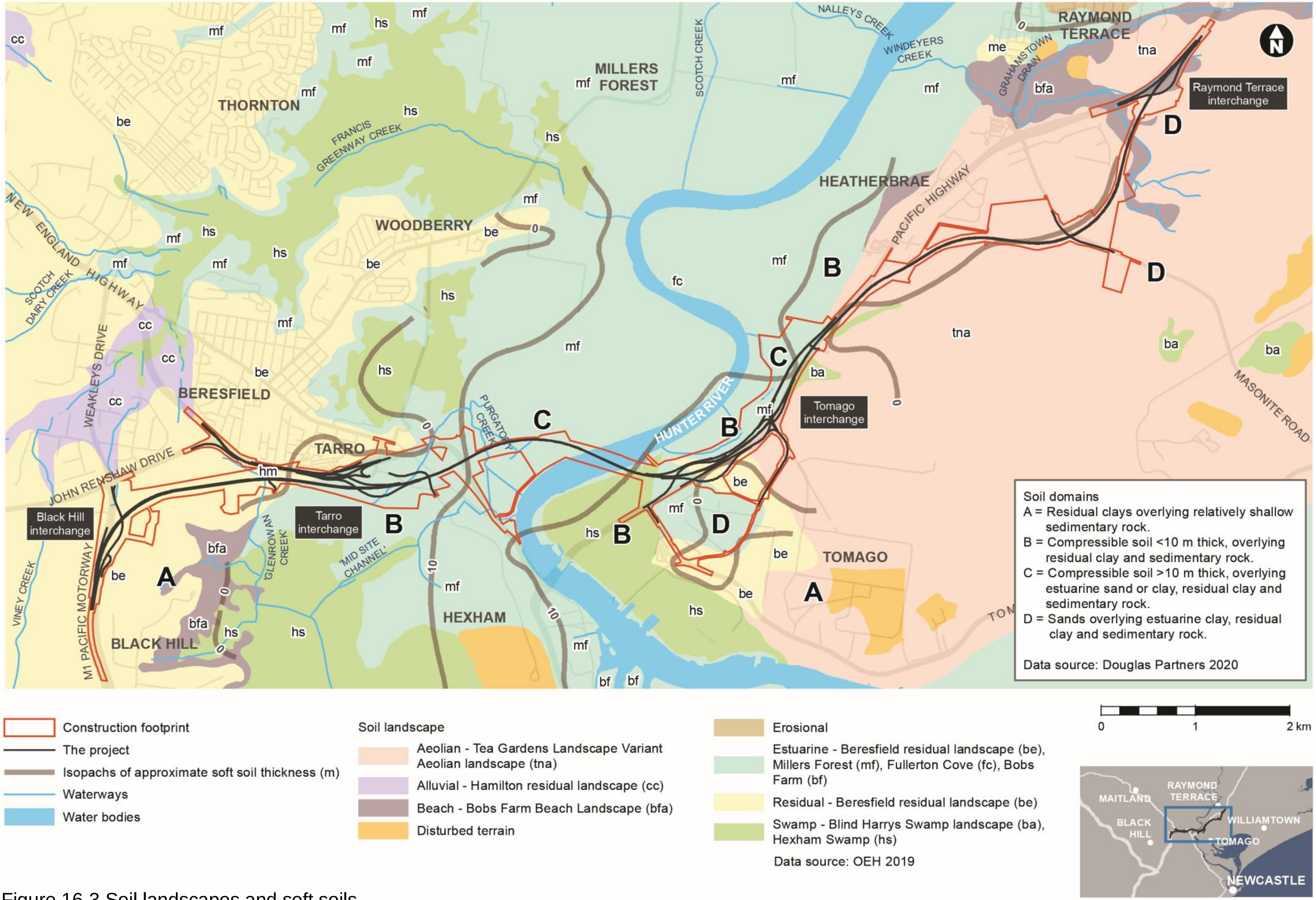


Figure 16-3 Soil landscapes and soft soils

Sodic soil

Sodicity can be a major cause of land degradation in water catchments. It is caused by high concentrations of sodium which is generally attached to clay particles of the soil. As a result, clay particles in the soil lose their tendency to stick together when wet. This leads to unstable soils that may erode or become impermeable to water and plant roots. Signs of sodic soil are poor water infiltration, surface crusting, waterlogging, collapsing areas which appear to result from underground tunnelling and piping, and cloudy water in dams and creeks that never settles out. Dewatering in sodic soils may also contribute to an increase in soil salinity in areas where water is applied to land as part of the dewatering process.

Waterlogging is common in sodic soil, since swelling and dispersion closes off pores, reducing the internal drainage of the soil. Visual indications of waterlogging of surface soils have been observed across low lying areas in Tomago and Heatherbrae, suggesting that sodic soil may be an issue in these areas where construction activities may be carried out.

Soil landscape data indicates that the following soil landscapes (as shown in **Figure 16-3**) have sodic characteristics:

- Beresfield soil landscape: In the western portion of the project near the existing M1 Pacific Motorway and near the former mineral sands processing facility in Tomago
- Millers Forest estuarine landscape: To the east of the project in Tomago
- Hexham Swamp: Between the Hunter River bank and Tomago Road.

16.3.2 Acid sulfate soils and acid rock

Acid sulfate soils

Soils along the construction footprint have been assessed by reviewing the results of laboratory tests and in situ testing from boreholes and test pits, from both current and previous investigations, and comparing the site-specific results to previous experience in similar soils. Analytical results from geotechnical testing carried out in 2015 and 2017 were also compared with the ASS risk map predictions.

Regional mapping from the Atlas of Australian Acid Sulfate Soils (CSIRO 2020) indicate that there is a high probability of ASS being present within the Hunter River sediments and associated low lying floodplains and swamp areas within the construction footprint. The maps indicate that there is a low probability of potential ASS in northern parts of the construction footprint over the Tomago Sandbeds. The remaining portions of the construction footprint are mapped as having no known occurrence of ASS.

The potential locations of ASS within the construction footprint are shown on **Figure 16-4** and summarised as follows:

- Class 1 (Any work presents an environmental risk as Class 1 ASS are likely to be found on and below the ground surface): Within the Hunter River
- Class 2 (Work below the ground surface): On the southern side of the construction footprint between Black Hill and Hexham and between Tarro and Tomago, Raymond Terrace, and along Windeyers Creek and Grahamstown Drain
- Class 3 (Work more than one metre below the natural ground surface): In central Tomago, in central Black Hill and in Beresfield (adjoining the northern and western construction footprint extent)
- Class 4 (Work more than two metres below the natural ground surface): On the western side of the construction footprint in Heatherbrae, in Tarro at the western end of the Tarro interchange, in Tomago on the eastern side of the construction footprint, along Tomago Road, Old Punt Road, the existing Pacific Highway, Heatherbrae and Raymond Terrace
- Class 5 (Work within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below five metres AHD and by which the water table is likely to be lowered below one metre AHD on adjacent Class 1, 2, 3 or 4 land): At Black Hill and Beresfield.

In addition to ASS risk maps, previous investigations and reports have noted the following:

- There is a high probability of ASS being present within the low-lying floodplain and swamp areas within the construction footprint (Douglas Partners 2015 and Douglas Partners 2017)
- The majority of ASS conditions are associated with Class 1, 2, 3 and 4 soils, from existing ground surfaces to depths up to approximately three metres below ground surface, noting that the distribution and thickness of the units vary considerably along the construction footprint (Douglas Partners 2017).

Actual measured change in pH from field samples demonstrated a strong agreement between desktop mapping and actual field and laboratory results. On this basis, the results of field screening and laboratory results verify that the data is reliable, accurate, and represent likely or expected ASS conditions across the site at the locations tested.

The locations of construction activities (such as bridge work and excavation) with the potential to encounter ASS are discussed in **Section 16.4.1**.

Acid rock

Acid rock is defined as rock that contains sulfide or sulfate minerals (commonly pyrite) which has the potential to oxidise when exposed and produce sulfuric acid. Acid rock is potentially an issue where the sulfide bearing rock that has previously been protected from weathering, or is below the water table, becomes exposed, such as in deep cuttings. A review of the Acid Sulfate Rock Risk Map (Roads and Maritime Services 2017d) carried out in June 2020 indicated a low potential for acid rock in the construction footprint.

Acid sulfate testing was carried out on 10 rock samples collected along the project with all results reporting pH levels above five. The results indicate that rocks at all locations tested generally have a low potential for generation of acid upon oxidation (Douglas Partners 2017).

Based on a review of the desktop data and the analytical results contained in the Douglas Partners (2017) Geotechnical Investigation Factual Report, it is considered unlikely that construction activities would interact with acid sulfate rock.

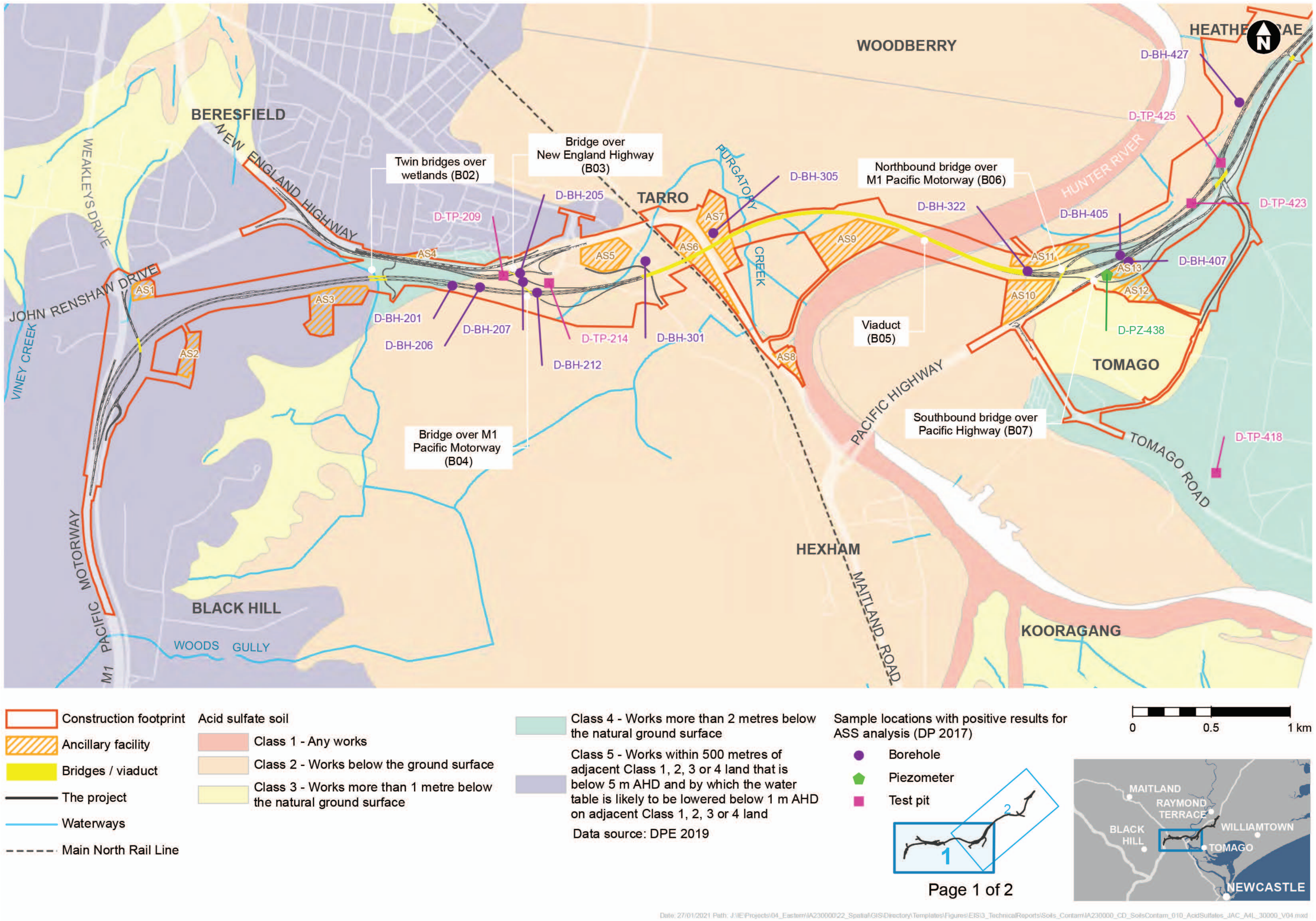


Figure 16-4 Acid sulfate soil risk areas (map 1 of 2)

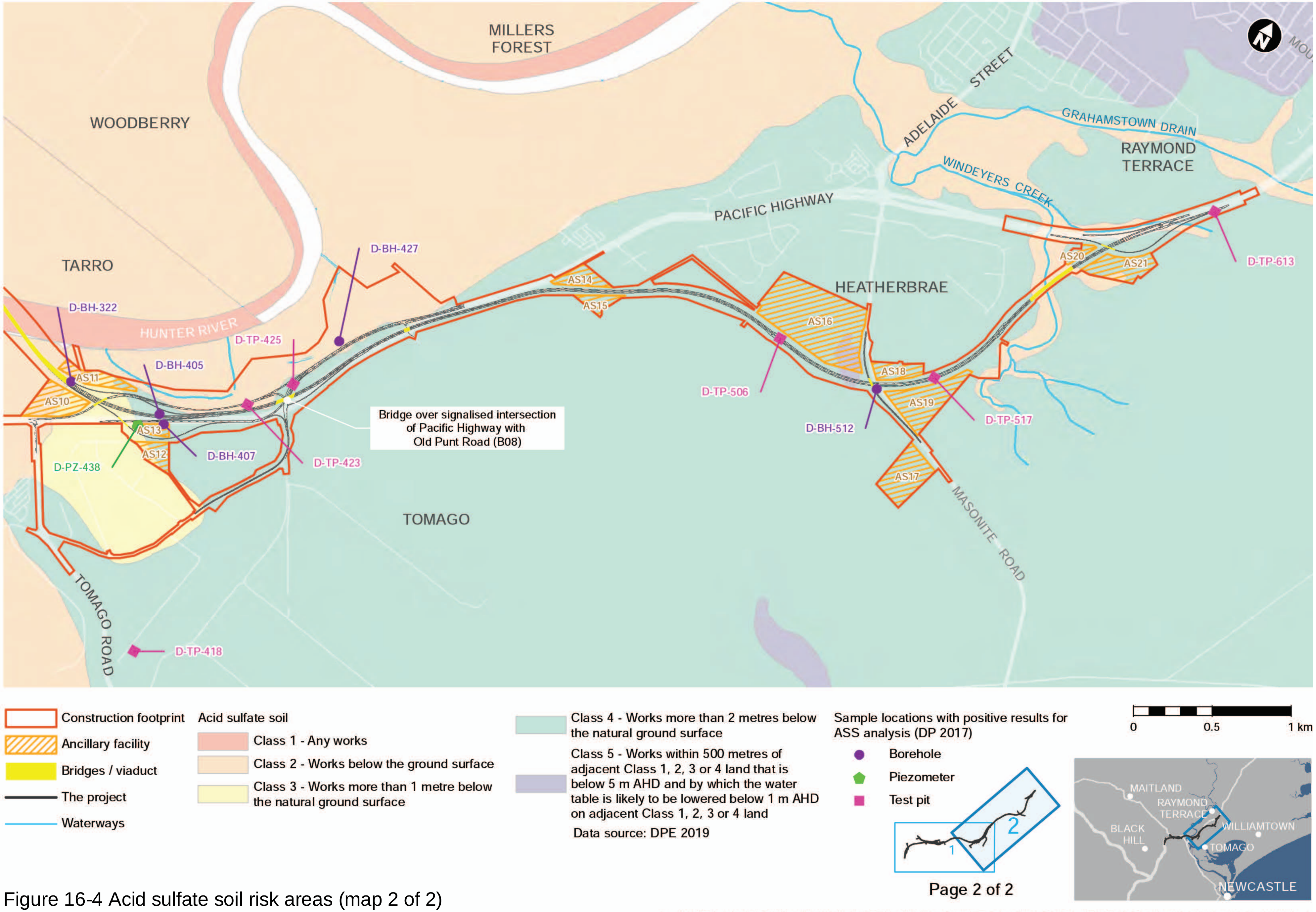


Figure 16-4 Acid sulfate soil risk areas (map 2 of 2)

16.3.3 Contamination

Historic land use

Based on historical aerial photography, the construction footprint was largely vegetated or used for agricultural and rural/residential purposes until between the mid-1950s and the 1960s. At this time, industrial development in the area increased, including next to the Hunter River. The area surrounding the construction footprint was predominantly vegetated or used for agricultural/rural residential land uses until the mid-1960s. After this, increased development of Tarro, Heatherbrae, Tomago and Raymond Terrace was evident until the present. Tarro has remained predominantly residential, while other areas were a mixture of residential and industrial/commercial development. Industrial/commercial development in the areas of the construction footprint within Beresfield and Black Hill began in the early 2000s. Existing land uses within and around the construction footprint are identified in **Chapter 14** (land use and property)

The findings of the historical aerial photography review of the study area are summarised in **Table 16-3**. Sites located within the construction footprint are shaded grey.

Table 16-3 Summary of potential contamination issues in the study area as identified from the historical aerial photography review

Site	Location	Potential contamination
Agricultural land use	Black Hill, Tarro, Hexham, Tomago and Heatherbrae	• Diffuse pesticide and herbicide use (pesticides/herbicides) • Isolated waste disposal (hydrocarbons, metals, biological hazards, nitrates, pesticides/herbicides, asbestos) • Chemical/fuel use and storage (hydrocarbons, pesticides, herbicides, phenols) • Degradation and demolition of structures containing hazardous building materials (asbestos).
Former mineral sands processing facility	Tomago	• Processing of radioactive sands (heavy metals, solvents) • Chemical/fuel use and storage (hydrocarbons, solvents, heavy metals) • Filling or stockpiling (metals, asbestos).
Former dairy processing and wastewater treatment works	Hexham	• Chemical/fuel use and storage (hydrocarbons) • Wastewater treatment and discharge (nitrates, metals, nutrients, biological hazards) • Dairy processing (chlorinated hydrocarbons, nutrients).
Former and current coal loading facilities and railway	Hexham	• Fuel storage and use (hydrocarbons) • Particulate deposition (asbestos) from brake pads and leaks from rolling stock (hydrocarbons) • Polycyclic aromatic hydrocarbons (PAH) from coal fines and coal wash • Pesticide and herbicide use (pesticides, herbicides) • Potential for stockpiling or filling (metals) • Demolition of former buildings containing hazardous building materials (asbestos).
Wastewater treatment works	Raymond Terrace	• Chemical/fuel use and storage (hydrocarbons) • Wastewater treatment and discharge (nitrates, metals, nutrients, biological hazards).
Commercial/ industrial use	Hexham, Tomago, Heatherbrae	• Potential for localised filling or waste disposal (metals, nutrients, asbestos) • Fuel/chemical storage and use (hydrocarbons, metals, solvents, paints) • Degradation and demolition of structures containing hazardous building materials (asbestos).

A summary of the potential contamination issues relevant to the study area is presented in **Table 16-4**. This is based on the review of available historical maps and business directories. Sites located within the construction footprint are shaded grey.

Table 16-4 Summary of potential contamination issues within the study area as identified from historical maps and business directories

Site use	Location	Location relevant to construction footprint	Potential contamination	Source
Agricultural land use	Black Hill, Beresfield, Tarro, Hexham, Tomago, Heatherbrae	Within the construction footprint	• Diffuse pesticide and herbicide use (pesticides/herbicides) • Isolated waste disposal (hydrocarbons, metals, biological hazards, nitrates, pesticides/herbicides, asbestos) • Chemical/fuel use and storage (hydrocarbons, pesticides, herbicides, phenols) • Degradation and demolition of structures containing hazardous building materials (asbestos).	Historical maps 2015, 1981, 1941 and 1913
Crematorium and cemetery (former and current)	Tarro	About 200m north of the construction footprint	• Human burial and embalming (nitrates, lead, formaldehyde, biological hazards).	1941 and 2015 historical maps
Former Sanitary depot	Tarro	Outside of the construction footprint within the Hunter Water Corporation easement	• Waste disposal (hydrocarbons, nitrates, metals, biological hazards).	1941 historical map
Petrol stations / motor garages	New England Highway, Tarro and Beresfield	Various locations outside of the construction footprint	• Chemical/fuel use and storage (hydrocarbons, lead, volatile organic compounds).	UBD, 1961, 1970, 1982
Timber mills	Tarro	About 100m south of the project, outside the construction footprint	• Timber treatment (copper, chromium, arsenic, phenols).	1913 historical map
Former and current coal loading facilities and railway	Hexham	About 150m south of ancillary facility AS8, outside the construction footprint	• Coal storage and handling (hydrocarbons).	1941 historical map
Former dairy processing (butter factory)	Hexham	About 200m south of AS8, outside the construction footprint	• Dairy processing (chlorinated hydrocarbons, nutrients).	1941 historical map
Former mineral sands processing facility	Tomago	Within the construction footprint	• Processing and stockpiling of mineral sands • Concentrated NORM, heavy metals and localised hydrocarbons.	Historical maps 2015, 1981
Steel fabricators	Tomago	Within the construction footprint	• Pickling solutions of acids • Heavy metals.	UBD 1991
Chemical manufacturer	Tomago	Within the construction footprint	• Chemical storage.	UBD 1991

Site use	Location	Location relevant to construction footprint	Potential contamination	Source
Electrical switchboard manufacturer and or distributer	Tomago	About 400m south of AS12, outside the construction footprint	• Metals (copper, lead, mercury and tin) • Polychlorinated biphenyls (PCBs) • Solvents (trichloroethene) • Asbestos.	UBD 1982
Scrap metal merchants	Tomago	Within the construction footprint	• Heavy metals • Hydrocarbons.	UBD 1982
Paint and anti-corrosive protective coating manufacturer	Tomago	About 500m south of AS12, outside the construction footprint	• Solvents (chlorinated hydrocarbons) • Paints (heavy metals, hydrocarbons).	UBD 1991
Motor garage and service station	Heatherbrae	About 280m north-west of the construction footprint	• Chemical/fuel use and storage (hydrocarbons, lead, volatile organic compounds).	UBD 1991

Per- and polyfluoroalkyl substances (PFAS) are extremely persistent both in the environment and the human body, with potential for significant accumulation with prolonged exposure. Current NSW EPA investigations are focused on sites where it is likely that large quantities of PFAS have previously been used. A search of NSW EPA current PFAS investigation sites indicates there are no areas within the construction footprint. Two areas are within the broader study area, however, and are located at:

- Our Lady of Lourdes Primary School, Anderson Drive, Tarro: about 280 metres north of the construction footprint
- Heatherbrae Total Fire Solutions, Griffiths Road, Heatherbrae: about 170 metres north of the construction footprint.

Surface water and groundwater investigations and assessment, as provided in **Chapter 11** (surface water and groundwater quality)**,** indicate that groundwater drawdown would not reach these two areas. However, for the reason of PFAS persistence and potential to impact on surface water and groundwater that could flow into the construction footprint, the two areas have been included as AOPCRs for the project.

Results of register searches

Six NSW EPA registered sites were identified within the study area. This includes three NSW EPA registered sites within the construction footprint that were either regulated (subject to a current notice) or had been notified. Identified sites within the study area are presented in **Table 16-5**. Sites located within the construction footprint are shaded grey.

Table 16-5 Regulated/notified sites within the study area

Suburb in database	Regulated/ Notified	Site address	Site activity	Contamination status	Location relative to construction footprint
Beresfield	Notified to EPA	2 Kinta Drive, corner John Renshaw Drive	Beresfield service station	Regulation under CLM Act not required	About 300m to the north of the construction footprint
Millers Forest	Regulated	Chichester Trunk Gravity Main	Water pipeline	Contamination regulated under POEO Act	Within construction footprint

Suburb in database	Regulated/ Notified	Site address	Site activity	Contamination status	Location relative to construction footprint
Tomago	Notified to EPA	1877 Pacific Highway	Mineral sands processing	Regulation under CLM Act not required	Within the construction footprint, AS10
Tarro	Notice issued	Green Acres Farm, Woodland Close	Waste burial (asbestos)	Regulated under CLM Act	Within the construction footprint.
Heatherbrae	Notified to EPA	Motto Farm Service Station 2137 Pacific Highway	Service station	Regulation under CLM Act not required	Within construction footprint
Raymond Terrace	Notified to EPA	Raymond Terrace Wastewater Treatment Works, 22 Elizabeth Avenue	Other industry	Regulation under CLM Act not required	About 200m north-west of AS20, outside the construction footprint

Table 16-6 presents the 15 POEO public record sites identified within the study area, including four sites within the construction footprint that are shaded grey.

Table 16-6 POEO public record search within the study area

Suburb	Regulated/ Notified	Site address	Site activity	Location relative to construction footprint
Newcastle	Licensed	Waterways (Hunter River)	Application of herbicides	Next to the Hunter River, within the construction footprint
Black Hill	Licenced	1132 John Renshaw Drive	Coal mining and coal works	About 100m west of the construction footprint
Beresfield	Licenced	2 Balbu Close	Recovery of general waste and waste storage	About 480m north-west of the construction footprint
Black Hill	Delicenced, regulated by EPA	Lenaghans Drive	Boral, Bitumen mixing	About 200m north-west of the construction footprint
Beresfield	Delicenced, regulated by EPA	72 Enterprise Drive	Concrete works	About 320m north-west of the construction footprint
Hexham	Licenced	Maitland Road	Railway systems activities	About 200m west of the construction footprint
Hexham	Licenced	Maitland Road	Dairy processing	About 200m south of AS8, outside the construction footprint
Tomago	Licenced	12 Old Punt Road	General chemicals storage	About 400m south of AS12, within the construction footprint
Tomago	Delicenced, regulated by EPA	25-27 Kennington Drive	Bitumen pre-mix or hot-mix production	About 260m south-west of AS12, within the construction footprint
Newcastle	Licenced	-	Other activities	About 40m south-west of the construction footprint
Maitland	Licenced	-	Other activities	About 85m west of the construction footprint

Suburb	Regulated/ Notified	Site address	Site activity	Location relative to construction footprint
Heatherbrae	Licenced	42 Heather Street	Waste storage – hazardous, restricted solid, liquid, clinical and related waste and asbestos waste	About 40m west of AS16, outside the construction footprint
Heatherbrae	Delicenced, regulated by EPA	14 Motto Lane	Concrete works	About 140m south-east of AS16, outside the construction footprint
Raymond Terrace	Delicenced, regulated by EPA	Masonite Road	Hazardous, Industrial or Group A Waste Generation or Storage	Next to AS16, within the construction footprint
Raymond Terrace	Licenced	Off Elizabeth Terrace	Sewage treatment processing by small plants	About 200m north-west of AS20, outside the construction footprint

Previous contamination investigations

A number of previous contamination investigations have been carried out within and around the construction footprint. The findings of these investigations that have informed the soils and contamination assessment of the project are summarised in **Table 16-7**.

Table 16-7 Findings of previous contamination investigations

Previous investigation	Findings applicable to the project
Preliminary Contamination Assessment, Proposed Train Support Facility (TSF), Woodlands Close, Hexham (Douglas Partners 2012)	• Subsurface investigations identified fill material (typically coal reject intermixed with silts and clays) to depths of about 0.2 to greater than about 5.5m below ground level (bgl). The fill material was underlain by natural clayey silts, silty clays and sandy clay/clayey sands • The depth of groundwater ranged from about 0.54 to 2.45m bgl and was expected to flow to the west, north and east of the TSF • Observations during the investigation indicated the absence of gross contamination within soil, groundwater and surface water • Bonded Asbestos Containing Material (ACM) was observed in the immediate vicinity of former buildings within the TSF and believed to be present in localized dumped piles. It was not thought to be widespread.
Former RZM Site: Preliminary Site Investigation (Sinclair Knight Merz 2013)	• The preliminary site investigation (PSI) identified potential contamination risks associated with the previous, historical operations on site specifically associated with mineral sands storage and processing and recommended that a Detailed Site Investigation (DSI) be carried out • Potential contaminants of concern included elevated levels of NORM, elevated concentrations of some metals, and localised hotspots of hydrocarbon contamination in soils and possibly groundwater and surface water.
Preliminary Site Investigation Contamination and Acid Sulphate Soil Assessment (Douglas Partners 2015)	• ASS was identified along majority of the construction footprint, particularly in the central and eastern portions. Hydrocarbons, pesticides, metals and PCBs were also reported in soil samples • The PSI recommended that further investigation of these areas of potential concern be carried out and remediation / validation / management (if required) be completed as early works for the project
Asbestos Clearances – RMS Land Off Lenaghans Drive, Black Hill (Hazmat Services 2016)	• An unspecified amount of illegally dumped waste material including asbestos was removed and validation was completed by a licensed contractor. The validation report stated that asbestos removal had been completed and the site is fit for re-use.

Previous investigation	Findings applicable to the project
Former RZM Site: Detailed Site Investigation (DSI) (Jacobs 2016)	• There is contamination in soils, sediment, groundwater and surface water on the site in excess of the applied criteria • The DSI concluded that it is considered that the site would trigger formal notification to the NSW EPA under Section 60 of the *Contaminated Land Management Act 1997*, based on off-site identification of contamination in the road verge, the off-site open drain, and in foreshore sediment • Additional monitoring of groundwater and surface water was recommended to establish trends and support predictions that would be required for future site management • Additional studies were recommended to calculate estimates for the depths and volumes of contaminated soil and to support remedial design options.
Geotechnical Investigation Factual Report (Douglas Partners 2017)	• Analytical results for limited soil and groundwater contamination sampling in conjunction with geotechnical field testing in 2016 indicated seven shallow soil sample locations with slightly elevated concentrations for nickel, in excess of the applied ecological investigation limits for Open Space (Parkland) criteria as detailed in NEPC (2013) • It is considered these results present a low contamination risk.
Former RZM Site – Consolidated Human Health and Ecological Risk Management Report (Jacobs 2020)	• The results of previous field assessments, laboratory analysis and specialist ecological modelling for radionuclides at the former mineral sands processing facility indicate a very low risk to ecosystems from impacted soil, groundwater and surface water and sediments on the site • There is an increased risk to human health from exposure to elevated radionuclides measured in soil on the site • Exposure risks to humans and ecosystems are appropriately managed by the NSW EPA approved Interim Soil Management Plan that was completed in March 2019.

16.3.4 Soil salinity

Areas of salinity potential are where soil, geology, topography and groundwater conditions predispose a site to salinity. These areas are most commonly drainage systems or low lying/flat grounds where there is a high potential for the ground to become waterlogged.

A review of the National Land and Water Resources Audit Dryland Salinity Data Source identified that the majority of the construction footprint lies in an area rated as high hazard or risk of dryland salinity, as shown on **Figure 16-5**. This means that the inherent characteristics of the landscape predispose it to salinisation (i.e. there is a high probability that dryland salinity may occur following certain management practices or activities). High salinity risk areas are located within the construction footprint at Black Hill, Tarro, Hexham, Tomago, Heatherbrae and Raymond Terrace.

A desktop review of salinity risk carried out as part of the Preliminary Site Investigation Contamination and Acid Sulphate Soil Assessment (Douglas Partners 2015) identified several areas with dryland salinity characteristics that correlate with the salinity risk mapping, including:

- Around Purgatory Creek
- Between Hexham Bridge and Tomago Road
- Within creek alignments south of the Hunter River
- Along Windeyers Creek.

Salinity in the context of surface water and groundwater is discussed in **Chapter 11** (surface water and groundwater quality).

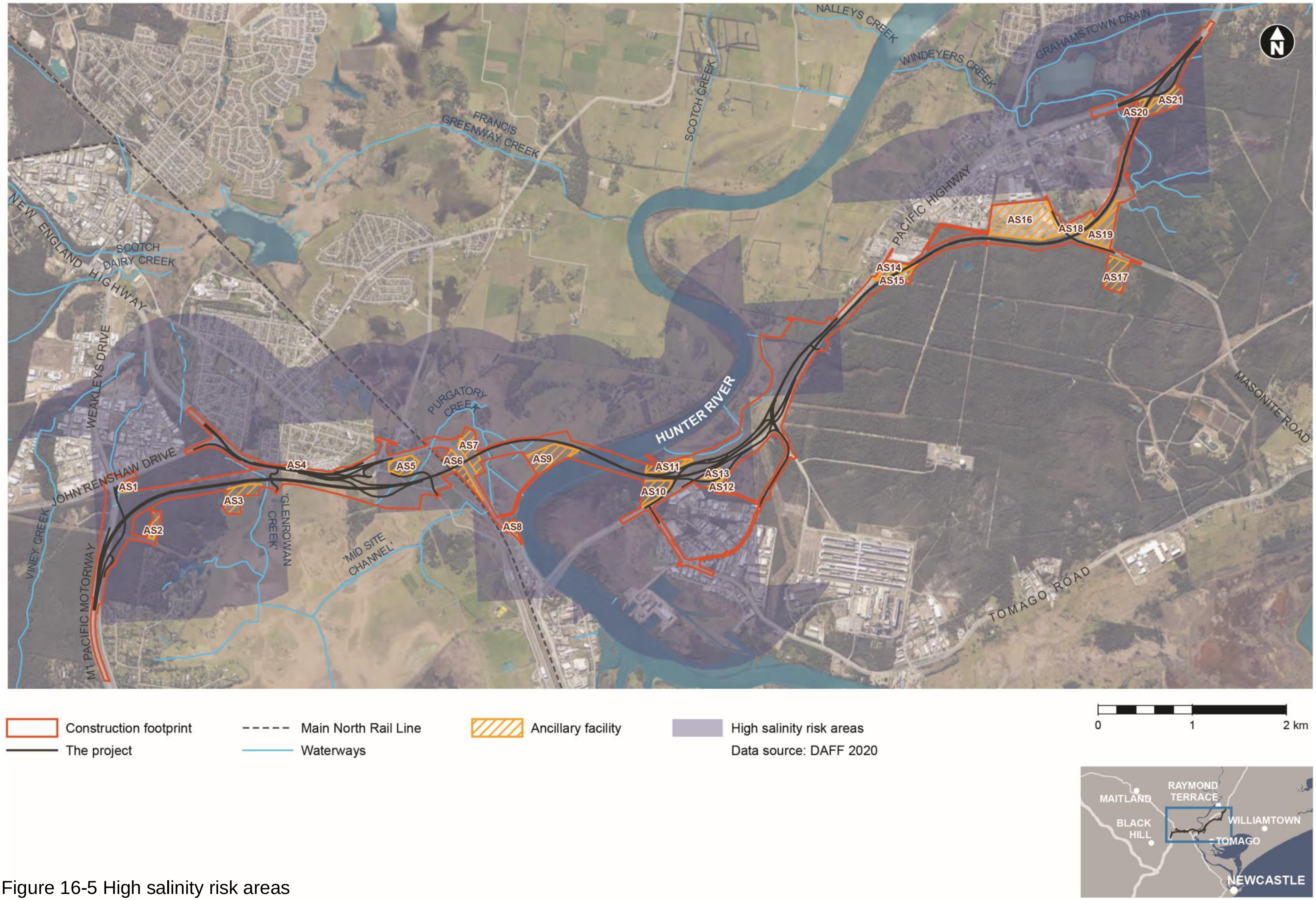


Figure 16-5 High salinity risk areas

16.3.5 Sensitive receiving environments

Sensitive receiving environments are defined as those with either high conservation or community value or those that support ecosystems or human uses of water that are particularly sensitive to pollution or degradation of water quality. The sensitive receiving environments within the study area relevant to soils and contamination risks are summarised in **Table 16-8**.

Table 16-8 Sensitive receiving environments in the study area

Sensitive receiving environment	Description
Terrestrial ecological communities	Several plant community types were identified within the construction footprint, including threatened ecological communities listed under the *Threatened Species Conservation Act 1995*, *Biodiversity Conservation Act 2016* and under the *Environment Protection and Biodiversity Conservation Act 1999.* These plant communities represent habitat for threatened flora and fauna species, some of which are State and/or Commonwealth-listed. Terrestrial ecology is discussed further in **Chapter 9** (biodiversity).
Wetlands	• Freshwater wetland habitats are present on the Hunter River floodplain at Tarro, Hexham and Tomago, with saline wetlands including areas of Coastal Saltmarsh near the Hunter River • Wetlands designated as groundwater dependent ecosystems (GDEs) have been mapped within the construction footprint, associated with the Hunter River floodplain at Beresfield and Tarro and the western extent of the Tomago Sandbeds at Heatherbrae and Tomago • Coastal Wetlands as designated by the State Environmental Planning Policy (Coastal Management) 2018 are located along the banks of the Hunter River and south of the New England Highway in Tarro • The Hunter Estuary Wetland Ramsar site is located about 5.1km downstream of the project, while portions of the Hunter Wetlands National Park (which overlaps in areas with the Ramsar Site) are located about 1.9km downstream of the project.
Waterways	The key waterways within the study area include: • Viney Creek • Purgatory Creek • Hunter River • Windeyers Creek • Grahamstown Drain. There are also other minor waterways within the construction footprint. The waterways are receiving environments that drain directly into the Hunter River or nearby wetland systems.
Groundwater	The construction footprint overlaps with three groundwater systems divided by the Hunter River as designated by the Department of Planning, Industry and Environment (Water), including: • Hunter Alluvium system, comprising coastal alluvial floodplain along the Hunter River. Groundwater levels are typically shallow in these locations (between about 2.4 to 0.2m below ground level (bgl)) • Tomago Sandbeds coastal sands to the east of the Hunter River (between about 2.7 to 1.6m bgl) • The Tomago Coal Measures, comprising porous rock to the north of the floodplain (between about 16.8 to 6.3m bgl, and to 0.3m bgl where it is confined beneath the Hunter Alluvium system). Three active extraction bores are located within the construction footprint, with many other operating bores in the study area associated within the Tomago Sandbeds Catchment Area. The project runs along the western boundary of the Tomago Sandbeds Catchment Area, which is protected as a drinking water supply under the *Hunter Water Act 1991*.

16.3.6 Areas of potential contamination risk

Identified AOPCRs are shown on **Figure 16-5**. The contamination risk rating for each AOPCR is detailed in **Table 16-9** and summarised below:

- Five high risk AOPCRs: Associated with asbestos waste at Tarro and Tomago, the former mineral sands processing facility at Tomago, potentially impacted Hunter River Sediments and at locations where construction work may interact with ASS (including within sediments)
- Six medium risk AOPCRs: Associated with buried waste at Tomago, industrial and commercial operations at Tomago and Heatherbrae (including potential PFAS contamination), the Raymond Terrace Wastewater Treatment Works, the Weathertex site in Heatherbrae, along the Hunter River bank where herbicide has historically been applied, and illegally dumped waste at various locations within the construction footprint
- Several low risk AOPCRs including industrial premises, service stations, and areas of potential fill and discarded waste within and next to the construction footprint.

Low risk AOPCRs have not been considered further in this assessment.

As discussed in **Section 16.2.3**, the basis for the determination of inferred contamination risk rankings is based on the weight of evidence gathered throughout the desktop assessment process, the results of previous contamination assessments and data, and professional judgement based on experience with numerous similar sites and projects. Further detail is provided in the Soils and Contamination Working Paper (**Appendix P**). All risk rankings have been based on unmitigated project risks and have not considered the implementation of design or engineering controls.

Table 16-9 Areas of potential contamination risk

AOPCR No.	Site	Location	Construction element at / near this location	Potential contaminants of concern	Potential pathway	Potential receivers	Inferred risk rating
1	Service station	Beresfield, next to the construction footprint	• General excavation activities • Culvert and drainage installation • Installation of water quality controls • Ancillary facility (AS1) is located about 240m south west of the site • Bridge piling about 600m south west for entry ramp to M1 Pacific Motorway (B01)	• Petroleum hydrocarbons • Monocyclic aromatic hydrocarbons • Heavy metals • Polycyclic aromatic hydrocarbons • Oil and greases • Solvents • Methyl tertiary-butyl ether and other oxygenates	• Contact with impacted soil • Migration of hydrocarbon into trenches during excavation work	Construction workers	Low
2	Former sanitary depot	Tarro, next to construction footprint	• General excavation activities • Installation of water quality controls next to the site • Culvert and drainage installation • Ancillary facilities (AS3 and AS4 located about 250m to the south and 300m to the east respectively). • Bridge over wetlands about 200m south east (B02)	• Hydrocarbons • Nitrates • Metals • Biological hazards	Contact with impacted soil or groundwater	Construction workers	Low
3	Waste burial (asbestos)	Tarro, within construction footprint	• General excavation activities • Culvert and drainage installation • Soft soil treatment • Viaduct construction including piling and pile caps • Ancillary facility (AS5) next to site	Asbestos	Inhalation of asbestos fibres	Construction workers	High

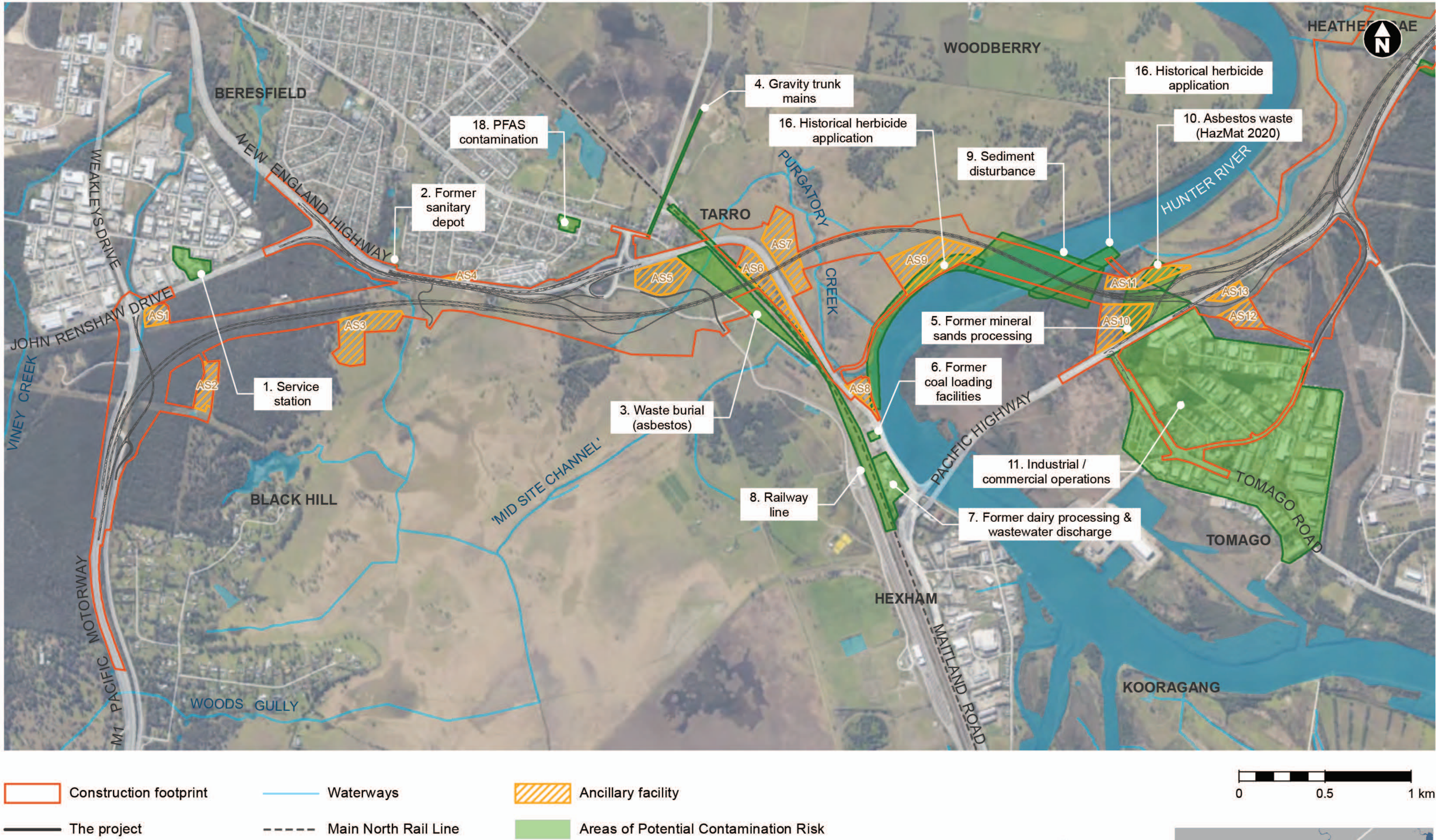
AOPCR No.	Site	Location	Construction element at / near this location	Potential contaminants of concern	Potential pathway	Potential receivers	Inferred risk rating
4	Gravity trunk mains	Tarro, adjacent to construction footprint	• General excavation activities • Culvert and drainage installation • Soft soil treatment	• Asbestos • Metals (lead paint)	Contact with impacted soil	Construction workers	High
5	Former mineral sands processing facility	Tomago, within construction footprint	• Topsoil removal • General excavation activities • Culvert and drainage installation • Ancillary facility (AS10) for construction support • Piling and pile caps for viaduct (B05) and bridge (B06)	• Naturally occurring radioactive materials • Heavy metals • Hydrocarbons • ASS • Asbestos	• Contact with impacted soil • Mobilisation of contaminants to sensitive ecological receivers	• Construction workers • Wetland ecological receivers	High
6	Former coal loading facilities	Hexham, outside the construction footprint (about 150m south of ancillary facility AS8)	• Ancillary facility (AS8) supporting construction	• Petroleum hydrocarbons • Heavy metals • Carbamates • Organochlorine pesticides • Organophosphate pesticides • PCBs • Herbicides • Asbestos	• Contact with impacted soil • Mobilisation of contaminants to sensitive ecological receivers	• Construction workers • Ecological receivers	Low
7	Former dairy processing and wastewater discharge	Hexham, about 250m south of Maitland Road, outside the construction footprint	• Ancillary facility (AS6) supporting construction.	• Nutrients • Metals • Phenols • Pathogens	• Contact with impacted soil or groundwater • Contact with impacted sediments or surface water	Construction workers	Low

AOPCR No.	Site	Location	Construction element at / near this location	Potential contaminants of concern	Potential pathway	Potential receivers	Inferred risk rating
8	Railway	Hexham and Tarro, within construction footprint	• Ancillary facility (AS6) supporting construction next to site • Piling and pile caps for viaduct on approach to the Hunter River	• Monocyclic aromatic hydrocarbons • Petroleum hydrocarbons • Heavy metals • Carbamates • Organochlorine pesticides • Organophosphate pesticides • PCBs • Herbicides • Asbestos	Contact with impacted soil	Construction workers	Low
9	Hunter River sediments	Within construction footprint	• Piling and pile caps for viaduct (B05) and bridge (B06) • Access tracks and ancillary facilities (AS7 and AS9) • Excavation for water quality controls	• ASS • Heavy metals • Petroleum hydrocarbons • Monocyclic aromatic hydrocarbons • Polycyclic aromatic hydrocarbons • Pesticides and herbicides • Nutrients • Pathogens	• Contact with existing impacted soil, Hunter River sediments or groundwater • Mobilisation of contaminants to sensitive ecological receivers	• Construction workers • wetland ecological receivers	High
10	Asbestos waste (HazMat 2020)	Tomago, within construction footprint	• Ancillary facility (AS11) for construction support • Bridge (B07) and ancillary facility (AS11) • Culvert and drainage installation • General excavation activities • Installation of water quality control	• Metals • Nutrients • Hydrocarbons • Asbestos	Contact with impacted soil	Construction workers	High

AOPCR No.	Site	Location	Construction element at / near this location	Potential contaminants of concern	Potential pathway	Potential receivers	Inferred risk rating
11	Industrial/ commercial operations	Tomago, within construction footprint	• General excavation activities • Culvert and drainage installation • Tomago Road and Pacific Highway intersection upgrade	• Petroleum hydrocarbons • Monocyclic aromatic hydrocarbons • Heavy metals • Polycyclic aromatic hydrocarbons • Oil and greases • Solvents • Methyl tertiary-butyl ether and other oxygenates	• Contact with impacted soil • Migration of hydrocarbon into trenches during excavation works	Construction workers	Medium
12	Service station	Heatherbrae, next to construction footprint	• General excavation activities • Culvert and drainage installation • Installation of water quality controls about 60m south west	• Petroleum hydrocarbons • Monocyclic aromatic hydrocarbons • Heavy metals • Polycyclic aromatic hydrocarbons • Oil and greases • Solvents • Methyl tertiary-butyl ether and other oxygenates	• Contact with impacted soil • Migration of hydrocarbon into trenches during excavation works	Construction workers	Low
13	Industrial/ commercial operations	Heatherbrae, within construction footprint	• Culvert and drainage installation • Cutting excavation • Ancillary for construction support (AS14 next to site, AS15 south, and AS16 and AS18 within site) • Piling associated with construction of Masonite Road bridge (B10) • Installation of water quality controls	• Solvents • Polyaromatic hydrocarbons • Organochlorine Pesticides • Aldrin and dieldrin • Metals • Boron • Ammonia • Cresols	• Contact with impacted soil or groundwater • Migration of hydrocarbon into trenches during excavation works • Migration of sediments to nearby ecological receivers	• Construction workers • Ecological receivers at Windeyers Creek and surrounding water bodies	Low

AOPCR No.	Site	Location	Construction element at / near this location	Potential contaminants of concern	Potential pathway	Potential receivers	Inferred risk rating
14	Wastewater treatment works	Raymond Terrace, directly north of the construction footprint	• Topsoil removal • Culvert and drainage installation • Piling for Raymond Terrace Interchange about 250m south east • Piling for bridge over Windeyers Creek about 370m south • Ancillary facilities (AS20 and AS21) about 200m and 350m south east • Installation of water quality controls about 250m east	• Nutrients • Metals • Phenols • Pathogens	• Contact with impacted soil, sediments or groundwater • Mobilisation to nearby sensitive receivers	• Construction workers • Ecological receivers at Windeyers Creek and surrounding water bodies	Medium
15	Hazardous, industrial or Group A waste generation or storage	Raymond Terrace	• Weathertex site, Masonite Road, next to ancillary facility (AS16), within the construction footprint	• Solvents • Polyaromatic hydrocarbons • Organochlorine pesticides • Aldrin and dieldrin • Metals • Boron • Ammonia • Cresols	• Contact with impacted soil or groundwater • Migration of hydrocarbon into trenches during excavation works	• Construction workers • Ecological receivers at surrounding water bodies	Medium
16	Historical herbicide application	Next to the Hunter River, Tomago and Tarro	• Within the construction footprint	• Organochlorine pesticides • Aldrin and dieldrin • Herbicides	• Runoff to sensitive ecological receivers	Ecological receivers	Medium
17	Historical rifle range	Within the construction footprint at Motto Farm	• South of Raymond Terrace	• Lead from bullets and shot • Copper casings	• Contact with impacted soil • Migration of metals in surface water during excavation works	• Construction workers • Ecological receivers at surrounding water bodies	Low

AOPCR No.	Site	Location	Construction element at / near this location	Potential contaminants of concern	Potential pathway	Potential receivers	Inferred risk rating
18	PFAS contamination	Next to construction footprint at Tarro and Heatherbrae	• Culvert and drainage installation • Cutting excavation • Ancillary facilities for construction support (AS4 next to site, AS15 south of site) • Installation of water quality controls	• Per-and polyfluoroalkyl substances	• Contact with impacted soil, surface water sediments or groundwater • Mobilisation to nearby sensitive receivers	• Construction workers • Ecological receivers at surrounding water bodies	Medium
Not an Area of Potential Contam-ination Concern; included as a high risk item	ASS	Within the construction footprint at the Hunter River and floodplain, the western side of project in Heatherbrae and Raymond Terrace and Windeyers Creek	General construction in Class 1, 2, 3 and 4 ASS risk areas, particularly piling for construction of bridges (B02, B03, B04, B05, B06, B07 and B08)	• Sulfuric acid • Heavy metals	Runoff to sensitive ecological receivers	Ecological receivers	High
Various	Stockpiling and/or illegal dumping	General, within construction footprint	General construction	• Asbestos • Metals • Hydrocarbons	Contact with impacted soil or materials	Construction workers	Medium



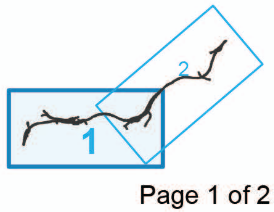


Figure 16-6 Areas of Potential Contamination Risk (map 1 of 2)

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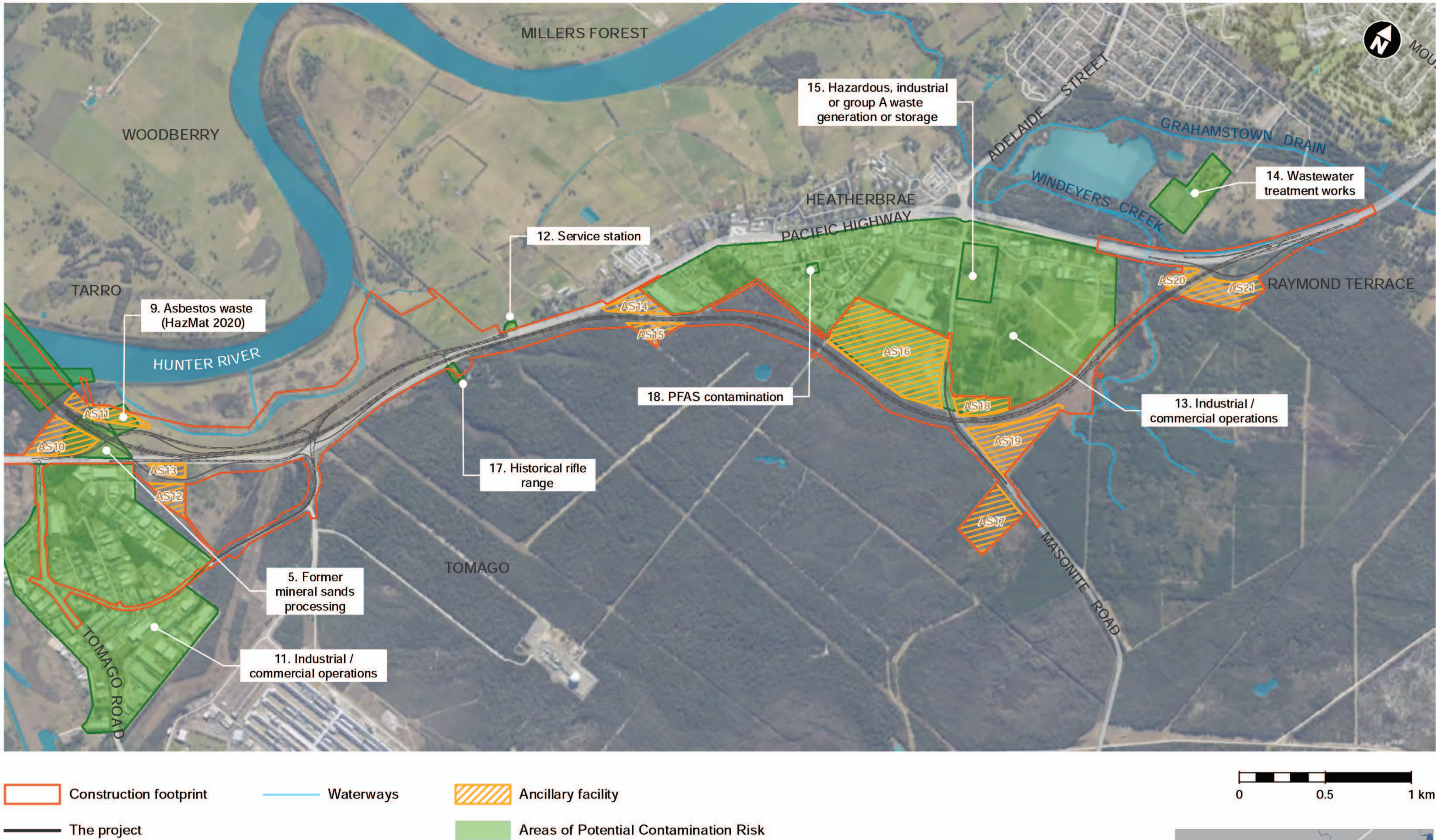

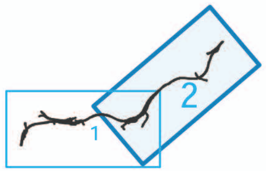

Figure 16-6 Areas of Potential Contamination Risk (map 2 of 2)

16.4 Assessment of potential impacts

16.4.1 Construction impacts

Activities during the construction phase have the potential to modify the topography and landscape, facilitate increased erosion and sedimentation, as well as interact with identified ASS, areas of existing salinity, and identified sources of contamination.

Topography and geology

Bulk earthwork associated with construction of the project would change the topography and current landscape. Following construction, the built structures would be higher than pre-development and the secondary impact would mainly relate to hydrology and visual amenity as discussed in **Chapter 10** (hydrology and flooding) and **Chapter 15** (urban design, landscape and visual amenity) respectively, noting that hydrology has an impact on soil erosion, particularly across the floodplain.

Soil erosion

Activities which involve disturbing soils on existing slopes (such as areas from Beresfield to Tarro, Tomago and Heatherbrae) or highly sodic soils have the highest potential to cause erosion during construction. Given the terrain of the construction footprint includes rolling hills to alluvial floodplains, and that soil disturbance would take place across the length of the construction footprint, there is the potential for soil erosion during construction.

A number of construction activities have the potential to impact soils as presented in **Table 16-10**.

Table 16-10 Potential soil erosion impacts resulting from construction activities

Construction activity	Potential soil erosion impacts
Vegetation removal	Disturbance of soils while exposing them to mobilisation processes, increasing the risk of erosion and sedimentation at steeper locations in Beresfield and Tomago, and also gentle slopes from Tomago to Heatherbrae.
Cut earthwork	Earthworks have the potential to destabilise a landform making it more susceptible to erosion.
Fill earthwork	Loose fill could be eroded and movement of soils could occur.
Stockpiling	Excavated material would require stockpiling before being reused on the project. If stockpiles are not adequately stabilised or placed away from concentrated flow paths, material could erode during high rainfall, flood or windy conditions.
Construction of bridges	Bridge construction requires piles to support bridge foundations. Piling requires excavation which would disturb soil. The disturbance of soil by machinery would increase the potential for soil erosion and bridge foundations can change stream currents with the potential for increased erosion.
Relocation of utilities	Utility relocation would involve soil disturbance from activities such as trenching and underboring. The disturbance of soil by machinery would increase the potential for soil erosion.
Site restoration and landscaping	Exposed topsoil has the potential to mobilise prior to establishing adequate stabilisation or controls.

Due to the relatively low elevations present within the construction footprint, the high extent of existing vegetation cover and extent of excavation required, waterborne soil erosion is a comparatively low risk for the project. Soil erosion hazards are temporary during project construction, and with appropriate remediation (as described in **Table 16-11**) these should not persist post construction.

Acid sulfate soil and acid rock

Many low-lying areas within the construction footprint are underlain by actual and potential ASS. Excavation, drainage or groundwater drawdown can allow potential ASS layers to dry out and oxidise, generating sulfuric acid. It is therefore important to maintain the groundwater level above the potential ASS layer, where possible, so that it does not dry out, oxidise and generate sulfuric acid.

A decline in water and soil quality as a result of ASS poses a risk to:

- Aquatic, wetland or terrestrial ecosystems
- Release of heavy metals from contaminated soils
- Human and animal health
- Corrosion and structural damage to steel and concrete structures
- Agricultural productivity
- Social amenity of waterways.

Activities that have the potential to expose ASS (causing in situ oxidisation) during construction of the project include:

- Excavation into or below ASS layers, including at depths of:
  - Below ground level in the central low-lying areas either side of the Hunter River and next to Windeyers Creek
  - About two metres near the New England Highway at Beresfield
  - About five metres in Black Hill
  - Ground surface and at about one to two metres at Tomago
  - About two metres at Masonite Road in Heatherbrae.
- Bridge piling: Where the bridge piling method requires extraction of piling waste. This applies to bridges B02, B03, B04, B05 and B06 in Tarro and Tomago in areas of high ASS risk and at B07 in Heatherbrae (refer to **Figure 5-1** for bridge locations)
- Dredging: Dredging sediments for construction barges, temporary wharves or other in-River work that may disturb and mobilise sediments within the Hunter River
- General ground disturbance, including but not limited to:
  - Vegetation removal
  - Utility installation, upgrades, removal or protection
  - Drainage work
  - Waterway adjustments.
- Bored concrete piles associated with the construction of the bridges.

Treatment of ASS, potential ASS and various leachates (generated through treatment) would also present a risk as there would be a need to move chemicals and treated materials around the construction footprint. It may be possible to reuse treated ASS if the geotechnical constraints allow.

Since substantial and prolonged drawdowns are not expected as part of construction, water quality impacts as a result of oxidation of ASS and generation and release of acidic runoff are expected to be minor and manageable.

Measures to reduce the risks associated with ASS are presented in **Table 16-11**. ASS disturbance, if managed in accordance with the proposed measures, is not likely to result in a significant impact to the environment.

Construction impacts associated with the dewatering that would be required at Tarro and other areas for soft soil consolidation would also pose a risk due to oxidation of potential ASS material and the possible generation of acidic water. Acidic water would be tested then treated before being released into the environment. If chemical contamination is present, waste classification and offsite disposal by a licensed contractor may be required.

As described in **Section 16.3.2**, acid rock is considered to have a low potential of being present within the construction footprint. As such, there is a low likelihood for the oxidation of pyrite in rock (if any) to occur due to the project.

Soil contamination

Construction will require areas of existing contamination to be disturbed. The highest risk construction activities include vegetation removal (grubbing), topsoil stripping, excavations, earthwork or demolition work in identified AOPCR sites. The greatest risk is where the construction activities coincide with contaminated soils, asbestos, potentially contaminated demolition waste and NORM at the former mineral sands processing facility. These high-risk construction activities would present the following potential impacts during project construction:

- Human health risks (to construction workers): Construction workers are most at risk from contaminated land impacts due to the potentially complete exposure pathways including dermal contact (contaminated soil and water) and inhalation/ingestion (impacted dusts/soils)
- Risks to the receiving environment (waters and soils): Construction work may create exposure pathways through (for example) disturbance, removal of vegetation and topsoil and dewatering.

The identified contaminated material from the former mineral sands processing facility would be remediated, in accordance with a Remediation Action Plan that would be approved by a NSW EPA accredited site auditor, representing beneficial protection of the environment both in the short and long term.

Any contaminated materials or water exposed, generated, stockpiled, treated or transported during construction poses a risk and will need to be managed appropriately to limit the potential spread to other uncontaminated material or water. Measures to reduce the risks associated with soil contamination are presented in **Table 16-11**.

With appropriate management the disturbance of contaminated soil is not likely to result in a significant impact to the environment.

Soil salinity

The majority of the construction footprint lies in an area identified as having characteristics that predispose it to a high risk of salinity. The construction activities that have the potential to generate salinity impacts on soil, surface water and/or groundwater include:

- Excavation activities, vegetation clearance and movement of groundwater would have the potential to expose or mobilise identified environmental salinity (i.e. saline groundwater, saline soils) and create saline runoff or additional areas with saline characteristics
- Use of saline water or soils during construction either for dust suppression or as part of a stabilisation process would have the potential to introduce salt to low salinity areas
- Dewatering of groundwater would have the potential to expose groundwater to saline soils

- Preloading of fill onto soft soils would increase groundwater levels, with the potential to mobilise salts, However, as this fill would be limited to localised areas and the associated increases in groundwater levels would be consistent with seasonal groundwater level variations, it would not influence salinity substantially.

An increase in salinity because of such construction activities would result in the following potential impacts to surface water and/or groundwater and soil:

- Reduced water quality in freshwater receiving environments, potentially impacting habitats and limiting the ability to use such resources for drinking water or irrigation
- Increased vulnerability of soils to erosion, and other degradation issues
- Reduced moisture content changes in soils and decreased permeability of soils.

The risk of saline soils altering the salinity of the waterways because of construction of the project is considered low as water quality controls and management measures would be implemented to control runoff to surface waterways. Measures to reduce the risk of the project to soil salinity are presented in **Section 16.5**.

Disturbance of saline soils, if managed correctly, is not likely to result in a significant impact to the environment.

Water contamination

During construction, there is potential to contaminate surface water and groundwater, especially where work takes place in and around surface water bodies including Hunter River, Purgatory Creek and Windeyers Creek. The severity of impacts to receiving environments would be dependent upon the sensitivity of the receiving environment.

The following potential water contamination impacts during construction have been identified:

- Disturbance of sediments due to the construction of bridges over the Hunter River, including through mobilisation of piling barge and support vessels. Based on the likely construction methods and consideration of typical controls that are associated with the construction methods, the potential contamination impacts would be effectively managed
- Disturbance and mobilisation of sediments resulting in liberation of sulfuric acid from ASS. Acid drainage can have a high impact on receiving water bodies causing fish kills and mobilisation of contaminants due to changes in water chemistry
- Mobilisation of contaminants in groundwater impacting groundwater users. Such impacts are unlikely due to low groundwater flows in the areas of potential and known contamination
- Groundwater interaction with PFAS contamination associated with the Our Lady of Lourdes Primary School at Tarro and the Total Fire Solutions site at Heatherbrae. Additional consultation with relevant agencies and assessment works for groundwater within the construction footprint specific to PFAS contamination near these locations will be carried out to inform what construction management is required (if any).

Potential impacts of the project on surface water and groundwater quality are assessed in detail in **Chapter 11** (surface water and groundwater quality).

16.4.2 Operational impacts

Topography and geology

The built structures of the operational project would be higher than pre-development and the secondary impact would mainly relate to hydrology and visual amenity as discussed in **Chapter 10** (hydrology and flooding) and **Chapter 15** (urban design, landscape and visual amenity) respectively. There are not predicted to be any operational impacts of the project on the geological environment.

Soil erosion

During operation of the project, roads and bridges would be sealed, cleared areas would be landscaped and scour protection installed where required. Some unsealed access tracks incorporating appropriate drainage design measures would be present and infrequently used for maintenance purposes. The Black Hill cut would be stepped back with low slopes, to allow vegetation and supporting topsoils to be applied to slopes which will aid in decreasing water velocities. Topsoil exposure during operation would be minimal or none, and therefore there would be low risk of soil erosion and subsequent transport of sediment into nearby receiving waterways.

Acid sulfate soil and acid rock

During operation of the project, roads and bridges would be sealed, cleared areas would be landscaped and scour protection installed where required. Some unsealed access tracks incorporating appropriate drainage design measures would be present and infrequently used for maintenance purposes. Ongoing exposure of ASS or acid rock would not be expected or required as part of project operation.

Some water quality basins may intercept ASS and potential ASS. Fluctuating water levels however, would limit exposure times which would in turn limit acid generation. Over time, the acid generation potential would be exhausted and acid input will cease.

As construction activities are completed, the potential for generation of acidic runoff would be negligible, though acid levels in water quality basins should be checked till acidity stabilises.

Soil contamination

Impacts to known areas of contamination are not expected during operation of the project as suitable rehabilitation activities would be implemented to address areas disturbed during construction.

Spills of contaminating materials such as oils, fuels or chemicals from road users or Transport maintenance activities could potentially contaminate soil near project roads and adjacent areas outside the project. Transport would implement spill containment controls and spill response procedures during operation of the project.

The contaminated former mineral sands processing facility site would be remediated, in accordance with a Remediation Action Plan that would be approved by a NSW EPA accredited site auditor, and appropriately utilised and managed as an infrastructure site. Ongoing management and appropriate use of the site represents a minimisation of contamination risk and beneficial protection of the environment over the long term.

Salinity

During operation the risk of saline soils is considered low and would be minimised as disturbed areas would be stabilised, rehabilitated and revegetated in accordance with the urban design for the project (refer to **Chapter 15** (urban design, landscape and visual amenity)).

Shallow, saline groundwater may impact on concrete and steel structures. Road and bridge damage caused by shallow, saline groundwater is a potential operational risk, potentially resulting in earlier, greater and more frequent maintenance requirements and lower asset operational life. However, the risk of this occurring during operation is considered low as the design of structures likely to come into contact with saline conditions (such as bridges and bridge elements) has considered saline conditions in exposure standards.

Water contamination

Impacts to surface water and groundwater from the project during operation are addressed in **Chapter 11** (surface water and groundwater quality). Specific operational impacts relating to soils and contamination impacts are described below.

Water quality risks during operation would be associated with runoff of pollutants from new road surfaces and increased vehicular traffic, accidental spills, increased impervious areas and permanent structures within waterways. These risks would be managed by operational water quality measures (as detailed in **Chapter 11** (surface water and groundwater quality)). Transport would implement spill containment controls and spill response procedures during operation of the project.

There would be numerous permanent water quality basins that would intersect with the groundwater table during operation of the project, resulting in the potential to expose local groundwater to contaminants in the basin water (typically hydrocarbons from operational road surfaces). Any contaminants would most likely be introduced through spills and runoff.

Basins have been designed to contain potential spills up to 20,000 litres and to prevent accidental discharge or migration to groundwater. An underflow baffle arrangement is present in basins to capture accidental spills, such as petroleum hydrocarbons in dry weather as well as during small to moderate storm events. From a groundwater quality perspective, hydrocarbon spills would float on the surface of the basins and minimise the potential for groundwater contamination. Most non-spill related contaminants likely to enter the basin would be associated with suspended sediment or road particulate in runoff water. These particulates would settle out in the water quality basin and impacts of these contaminants on groundwater would be negligible.

As described in **Chapter 11** (surface water and groundwater quality), no impacts to water quality within the Tomago Sandbeds Catchment Area are anticipated as a result of project operation. The project has been designed to minimise and avoid impacts to the drinking water catchment through the direction of runoff to lined grassed swales and impervious permanent water quality basins with a sufficient capacity to capture the likely volume from a spill involving a vehicle transporting fuel or similar (30,000 litres). Once captured a spill could be either treated and discharged or appropriately disposed as required. As such, potential risk of poor water quality mobilising to downstream waterways from spills would be negligible and would be sufficiently managed through proposed design and management measures.

16.5 Environmental management measures

The environmental management measures that will be implemented to minimise the soils and contamination impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 16-11**. These measures should be read in conjunction with those in **Chapter 11** (surface water and groundwater quality).

Table 16-11 Environmental management measures (soils and contamination)

Impact	Reference	Management measure	Responsibility	Timing
Soil and groundwater contamination	SC01	A Contaminated Land Management Plan (CLMP) and procedures prepared in accordance with TfNSW's Guideline for the Management of Contamination (Roads and Maritime Services 2013c) will be developed and will include: • Control measures to manage identified areas of potential contamination risk (AOPCRs), where the risk has been assessed as being medium or high and is confirmed within the construction footprint • Procedures for managing unexpected contamination (including buried waste, illegal dumping and asbestos) • Requirements for the disposal of contaminated waste in accordance with the *Protection of the Environment Operations Act 1997* and the Protection of the Environment Operations (Waste) Regulation 2014.	Contractor	Prior to construction/ construction
Salinity	SC02	A Salinity Management Plan will be prepared and implemented as part of the CSWMP and in accordance with the NSW Department of Primary Industries (2014) Salinity Training Handbook. The plan will include (but not be limited to): • Identification and management of saline groundwater discharge sites • Identification of areas sensitive to salinity and subject to saline soil import limitations (such as the Tomago Sandbeds Catchment Area) • Testing and reuse conditions of saline soils • Requirements for reuse of saline water.	Contractor	Prior to construction/ construction
Acid sulfate soils	SC03	An Acid Sulfate Soils Management Plan (ASSMP) will be prepared and implemented as part of the CSWMP and in accordance with TfNSW's Guidelines for the Management of Acid Sulfate Materials (RTA 2005c) and the Acid Sulfate Soil Manual (ASSMAC 1998). The ASSMP will outline how potential ASS within sediments of the waterways and soils that will be disturbed within the construction footprint will be handled, tested, treated and reused during construction.	Contractor	Prior to construction/ construction
Former mineral sands processing facility	SC04	A Remediation Action Plan prepared and implemented in accordance with TfNSW Guideline for the Management of Contamination (Roads and Maritime Services 2013c), in consultation with NSW EPA and approved by a NSW EPA accredited site auditor for the former mineral sands processing facility.	Contractor	Prior to construction/ construction

Impact	Reference	Management measure	Responsibility	Timing
Other relevant management measures				
Avoid, minimise and sustainably manage waste	WM01	A Waste Management Plan (WMP) will be prepared and implemented to manage and minimise the generation of waste and encourage reuse of materials. It will include, but not be limited to: • Identification of the waste types and volumes that are likely to be generated by the project • Adherence to the waste minimisation hierarchy principles of avoid/ reduce/ reuse/ recycle/ dispose • Waste management procedures to lawfully manage the handling and disposal of waste • Identification of reporting requirements and procedures for tracking of waste types and quantities • A resource management strategy detailing the process to identify reuse options for surplus materials • Site-specific waste management plans for concrete and asphalt batching plants • Spoil management procedures outlining reuse and disposal • Identification of areas for management of materials.	Contractor	Detailed design/ prior to construction/ construction
Management of spoil	WM02	Spoil management procedures will be outlined in the WMP. Spoil will be beneficially reused as part of the project before alternative spoil disposal options are considered. Any excess spoil will be managed using the following order of priorities: • Review alignment and profile refinements during detailed design • Assess opportunities to reuse excess spoil in works within the construction footprint or in adjacent land • Beneficial reuse within the construction footprint for rehabilitation of ancillary facilities • Transfer to other nearby Transport projects for immediate use, use on future projects, or routine maintenance • Transfer to a Transport approved site for reuse on other projects • Disposal at an approved materials recycling or licensed waste disposal facility.	Contractor	Construction

Impact	Reference	Management measure	Responsibility	Timing
General	WQ01	A Construction Soils and Water Management Plan (CSWMP) would be developed as a sub plan of the CEMP and will outline measures to manage soil and water quality impacts associated with the construction work, including contaminated land. The CSWMP would include but not be limited to: • Measures to minimise/manage erosion and sediment transport both within the construction footprint and offsite including requirements for the preparation of erosion and sediment control plans (ESCP) for all progressive stages of construction and the implementation of erosion and sediment control measures • Erosion and sediment control measures, which will be implemented and maintained in accordance with Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (DECC 2008) • Measures to manage stockpiles including locations, separation of waste types, sediment controls and stabilisation in accordance with the Stockpile Site Management Guideline (Roads and Maritime Services 2015e). • Procedures for dewatering (including waterways, wetlands and excavations and temporary sediment basins) including relevant discharge criteria. • Concrete waste management procedures • Measures to manage accidental spills including the requirement to maintain materials such as spill kits, an emergency spill response procedure and regular visual water quality checks when working near waterways • Measures to manage tannin leachate and potential saline soils • Controls for sensitive receiving environments which may include but not be limited to identification of 'no go' zones for construction plant and equipment (where applicable).	Contractor	Prior to construction/ construction/ operation
	WQ02	A soil conservation specialist will be engaged for the duration of construction of the project to provide advice on the planning and implementation of erosion and sediment control including review of the CSWMP and ESCP.	Transport / Contractor	Prior to construction/ construction/ operation
Discharge of saline groundwater to surface waterways	WQ05	Basins TB04, TB06, TPB10 (PB12), TPB18 (PB24), PB14 and PB15 shall be further investigated to confirm requirement for lining to avoid discharge of saline groundwater to surface waterways during construction and operation.	Transport	Detailed design

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Environmental impact statement – Chapter 17: Non-Aboriginal heritage

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17. Non-Aboriginal heritage

This chapter describes the potential non-Aboriginal heritage impacts that may be generated by the construction and operation of the project and presents the approach to the management of these impacts.

The desired performance outcomes for the project relating to non-Aboriginal heritage, as outlined in the SEARs, are to:

- Ensure the design, construction and operation of the project facilitates, to the greatest extent possible, the long term protection, conservation and management of the heritage significance of items of environmental heritage and Aboriginal objects and places
- Ensure the design, construction and operation of the project avoids or minimises impacts, to the greatest extent possible, on the heritage significance of environmental heritage and Aboriginal objects and places.

Table 17-1 outlines the SEARs that relate to non-Aboriginal heritage and identifies where they are addressed in this EIS. The full assessment of non-Aboriginal heritage impacts is provided in the Non-Aboriginal Heritage Working Paper (**Appendix Q**).

Table 17-1 SEARs (non-Aboriginal heritage)

Secretary's requirement	Where addressed
13. Heritage	
1. The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of:	
(c) environmental heritage, as defined under the *Heritage Act 1977*; and	Direct and indirect impacts on environmental heritage are identified and assessed in **Section 17.4.2**. There are no Aboriginal places of heritage significance within the Aboriginal heritage study area (refer to **Section 12.4.3**). Cumulative impacts are assessed in **Chapter 23** (cumulative impacts).
(d) items listed on the National and World Heritage lists.	There are no heritage items within the construction footprint that are listed on the National or World Heritage lists (refer to **Section 17.3.2** and **Section 12.4.3**).
2. Where impacts to State or locally significant heritage items are identified, the assessment must:	
(a) include a significance assessment and statement of heritage impact for all heritage items (including any unlisted places that are assessed as having heritage value);	Significance assessments and statements of heritage impacts are summarised in **Section 17.3.4** and **Section 17.4.2,** respectively. The full assessments are detailed in the Non-Aboriginal Heritage Working Paper (**Appendix Q**).
(b) provide a discussion of alternative locations and design options that have been considered to reduce heritage impacts	Discussion on considered alternative location and design options is provided in **Section 17.4.1**.

Secretary's requirement	Where addressed
(c) in areas identified as having potential archaeological significance, undertake a comprehensive archaeological assessment in line with Heritage Council guidelines which includes a methodology and research design to assess the impact of the works on the potential archaeological resource and to guide physical archaeological test excavations and include the results of these excavations;	Following discovery of historical artefact deposits during test excavation for Aboriginal heritage, one item (Glenrowan Homestead) was assessed as having potential archaeological significance (refer to **Section 17.3**). A detailed archaeological assessment was carried out for Hexham Shipyards and Tarro Historic Site however neither required test excavation as works are not impacting on the location of archaeology. A summary of the significance assessment for these sites is provided in **Section 17.3.4**. Further information on the detailed archaeological assessment, the test excavation results, archaeological assessment, methodology and research design for the salvage excavation at Glenrowan Homestead (Item 3) is provided in the Non-Aboriginal Heritage Working Paper (**Appendix Q**).
(d) consider impacts to the item of significance caused by, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, increased traffic, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment (as relevant);	Statements of heritage impact which consider direct and indirect impacts are summarised in **Section 17.4.2**. The full assessments are detailed in the Non-Aboriginal Heritage Working Paper (**Appendix Q**).
(e) outline measures to avoid and minimise those impacts in accordance with the current guidelines; and	Proposed environmental management measures are provided in **Section 17.5**.
(f) be undertaken by a suitably qualified heritage consultant(s) (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria).	Details of the qualified heritage consultants who carried out this assessment are provided in the Non-Aboriginal Heritage Working Paper (**Appendix Q**).
3. Noise and vibration – Structural	
1. The Proponent must assess construction and operation noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	Statements of heritage impact which consider noise and vibration impacts from the project during construction and operation are provided in **Section 17.4.2**. Surface and subsurface artefacts (Aboriginal heritage) are not subject to potential noise or vibration impacts (refer to **Section 12.5.1** and **Section 12.5.2**). Further discussion on vibration impacts on heritage structures are provided in **Chapter 8** (noise and vibration).
11. Visual amenity	
1. The Proponent must assess the visual impact of the project and any ancillary infrastructure (including noise barriers) on: (c) heritage items including Aboriginal places and environmental heritage	Statements of heritage impact which consider impacts, such as visual impacts of the project, are provided in **Section 17.4.2**. Visual impacts on Aboriginal places is discussed in **Section 12.5.1**.

17.1 Policy and planning setting

The non-Aboriginal heritage assessment was prepared to assess the potential impacts of the project in accordance with the following relevant legislation, policy and guidelines:

- *Environmental Planning and Assessment Act 1979* (EP&A Act)
- *Heritage Act 1977* (Heritage Act)
  - NSW State Heritage Register (SHR)
  - Part 6 Division 9 of the Heritage Act – Archaeological relics
  - Section 170 Heritage and Conservation registers.
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
  - Commonwealth Heritage List (CHL)
  - National Heritage List (NHL)
  - Register of the National Estate (RNE).
- Australia ICOMOS Charter for Places of Cultural Significance (The Burra Charter) (Australia ICOMOS 2013)
- Assessing Significance for Historical Archaeological Sites and 'Relics' (NSW Heritage Branch 2009)
- NSW Heritage Manual (NSW Heritage Office 1996)
  - Assessing Heritage Significance (NSW Heritage Office 2001)
  - Investigating Heritage Significance (draft guideline) (NSW Heritage Office 2004)
  - Statements of Heritage Impact (OEH 1996).
- Roads and Maritime Services Cultural Heritage guidelines (Roads and Maritime Services 2015g).

Skeletal remains were not found during the only excavation for the project at Glenrowan and therefore the Skeletal Remains: Guidelines for Management of Human Skeletal Remains under the *Heritage Act 1977 (*NSW Heritage Office 1998) were not relevant to preparing the assessment. However, the skeletal remains guidelines is referred to for consideration during the preparation of the Non-Aboriginal Heritage Management Plan (refer to **Section 17.5**).

The Criteria for the Assessment of Excavation Directors (Heritage Council of NSW 2011) would be applied during future test excavations at the Glenrowan Homestead and Tarro Historic Site (refer to **Section 17.5**).

Further detail on the above legislation, policies and guidelines, and how they apply to the project, is provided in the Non-Aboriginal Heritage Working Paper (**Appendix Q**).

17.2 Assessment methodology

17.2.1 Assessment approach

The overall approach to the non-Aboriginal heritage assessment comprised identifying heritage items[1] within and next to the construction footprint and assessing their significance in accordance with the Heritage Office (2001) guidelines and the Australia ICOMOS Charter for Places of Cultural Significance 2013 (The Burra Charter) (Australia ICOMOS 2013).

The methodology for the assessment of non-Aboriginal heritage included:

- Reviewing the relevant heritage legislation (as outlined in **Section 17.1**)
- Searching all available historical heritage registers for heritage places within or next to the construction footprint, including searches of the following heritage registers:
  - NSW State Heritage Inventory (SHI)
  - NSW SHR
  - Section 170 Heritage and Conservation Registers
  - National Trust of Australia Register (NTAR)
  - RNE
  - CHL
  - NHL
  - World Heritage List (WHL)
  - Newcastle Local Environmental Plan 2012 (NLEP)
  - Maitland Local Environmental Plan 2011 (MLEP)
  - Port Stephens Local Environmental Plan 2011 (PSLEP).
- Collating any known heritage curtilage (boundary) information as part of the heritage searches
- Carrying out a literature review, including previous archaeological reports, historical heritage studies, local heritage studies, and conservation management plans; as well as regional and local history documents and maps, where available
- Developing a predictive model for occurrence of historical site types in the landscape, including the use of aerial imagery, and applying this to the construction footprint to identify priority areas for field survey
- Carrying out field survey of the identified priority areas to inspect known historical heritage items, identify any previously unidentified historical heritage items, assess potential for historical archaeology, and identify heritage curtilages where necessary
- Developing a list of historical heritage items and features located within or next to the construction footprint
- Preparing a Statement of Heritage Impact (SOHI), including assessments of significance, for all historical heritage items potentially impacted by the project
- Developing management measures to mitigate impacts on non-Aboriginal heritage.
- Assessing cumulative non-Aboriginal heritage impacts that may arise from the interaction between project construction and operation activities and the activities of other approved or proposed projects in the area.

17.2.2 Study area

The study area for the project comprises the construction footprint with a one kilometre buffer, used to identify the types and nature of heritage items in the broader region and to inform an understanding of the potential for previously unidentified heritage items within the construction footprint. The impact assessment focusses on those heritage items within or next to the construction footprint.

[1] The term 'heritage item' is used throughout this chapter to indicate any non-Aboriginal historical heritage place including buildings, structures, and archaeological remains. Each heritage item is individually numbered but may include either a single component or multiple components making up a broader complex with direct historical and cultural associations.

17.2.3 Site investigations

Prior to carrying out the field survey, priority areas for survey were identified using background information. This included aerial images, the predictive statement for historical site types, previous studies and field surveys, and historical heritage register listings.

Field surveys were carried out at identified priority areas by suitably-qualified archaeologists between December 2015 and June 2020, and typically involved:

- Inspection of listed historical heritage items within or next to the construction footprint
- Inspection of areas identified as having the potential for heritage items.

The findings of field surveys are provided in **Section 17.3**.

17.2.4 Assessment of significance and impact assessment

Assessments of significance

Where non-Aboriginal heritage items were identified within or next to the construction footprint, assessments were carried out to determine their relative importance ('assessments of significance'). Places which are likely to be significant are those which 'help an understanding of the past or enrich the present, and which would be of value to future generations' (Australia ICOMOS 2013). In Australia, the significance of a place is generally assessed according to aesthetic, historic, scientific and/or social value.

Assessments of significance were carried out in accordance with the Assessing Heritage Significance manual (NSW Heritage Office 2001). The NSW Heritage Council has adopted specific criteria for heritage assessment, which have been gazetted pursuant to the Heritage Act. The seven criteria upon which assessments of significance are based are outlined below:

- Criterion (a) an item is important in the course, or pattern, of NSW cultural or natural history
- Criterion (b) an item has strong or special association with the life or works of a person, or group or persons, of importance in NSW cultural or natural history
- Criterion (c) an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW
- Criterion (d) an item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons
- Criterion (e) an item has potential to yield information that would contribute to an understanding of NSW cultural or natural history
- Criterion (f) an item possesses uncommon, rare or endangered aspects of NSW cultural or natural history
- Criterion (g) an item is important in demonstrating the principal characteristics of a class of NSW cultural or natural places or cultural or natural environments.

Assessments of significance were prepared for all heritage items located within or next to the construction footprint. The results are provided in **Section 17.3**.

Level of impact

The level of impact on the heritage significance of each heritage item in the construction footprint has been assessed based on the definitions and framework for assessing severity of impacts from the EPBC Act

Significant impact guidelines 1.2 (Department of Sustainability Environment Water Population and Communities 2013). The following characteristics were used to assess the level of impact:

- The scale of the project and its impacts
- The intensity of the project and its impacts
- The duration and frequency of the project and its impacts.

The levels of impact used in this assessment are defined in **Table 17-2**. For impacts to meet a certain level they generally need to have two or more of the characteristics noted above and in **Table 17-2**. The level of impact assigned to each heritage item is based on the level assessed following implementation of management measures.

Table 17-2 Definitions of levels of impact

Level of impact	Characteristics assessed		
	Scale	**Intensity**	**Duration/Frequency**
Major	Medium – large	Moderate – high	Permanent/irreversible
Moderate	Small – medium	Moderate	Medium – long term
Minor	Small/localised	Low	Short term/reversible
Negligible	Little or no physical impact; or little or no impact on heritage significance from physical impacts; or potential physical impacts are now able to be prevented through implementation of management measures (for example, vibration).		

Statements of heritage impact

A SOHI is used to identify what impact the project would have on a heritage item identified in the assessment. A SOHI, together with supporting information, addresses:

- Why the item is of heritage significance
- What impact the proposed works would have on that significance
- What measures are proposed to mitigate negative impacts
- Why more sympathetic solutions are not viable (NSW Heritage Office 2002).

A SOHI for each heritage item with the potential to be impacted by the project has been prepared in accordance with the NSW Heritage Office (2002) Statements of Heritage Impact guidelines. A summary of each SOHI is provided in **Section 17.4.2**. Further details are provided in the Non-Aboriginal Heritage Working Paper (**Appendix Q**).

17.3 Existing environment

17.3.1 Historical context

During the early days of convict settlement at Sydney, the favoured means of transport was by boat up and down the coast and inland via the waterways. In 1797, coal was discovered at the mouth of the Hunter River by Lieutenant Shortland and in 1801, Lieutenant-Colonel Paterson took the survey boat ‘Lady Nelson’ to investigate and report on this coal outcrop as well as other natural resources. A second survey was carried out by Charles Grimes and Francis Barrallier six months later. Shortly after their return to Sydney, Governor King established the first European settlement at Newcastle, located to the south of the construction footprint.

In 1812, 1818 and 1821 Governor Macquarie took parties up the Hunter River. He named a location on the riverbank where they camped in 1818 as 'Raymond Terrace', located to the north of the construction footprint. They proceeded up the Hunter and Paterson Rivers, visiting some of the farms Governor Macquarie had permitted settlers to occupy. In the 1820s, grants for land east and west of the Hunter River were made available. The alluvial flats along the Hunter River began to be settled and by 1825 there were almost 300 settlers living in the region. The increase in population resulted in the construction of a carriage road between Wallis Plains and Newcastle, as well as the introduction of a regular boat service along the Hunter River, which dissects the construction footprint.

The Pacific Highway, a section of which is located within the construction footprint, was the first large construction project carried out by the Main Roads Board. The establishment of industries, such as the steelworks, in Newcastle, located to the east of the construction footprint, resulted in Newcastle becoming the second largest city in NSW, prior to 1925. As a result of this growth, it was necessary to form a road connection with Sydney and the rest of NSW, particularly as motor cars became more popular. Work on the road commenced in 1925. The North Coast Road between Hexham and Tweed Heads was proclaimed in 1928 and named the Pacific Highway in 1931.

Today, the surrounding area is largely rural in nature with the main population concentrated in the town of Raymond Terrace. Smaller towns, such as Tarro, are located throughout the remaining rural and semi-rural areas. Some parts of the surrounding suburbs have continued their industrial past with Heatherbrae and Tomago containing both rural and industrial characteristics.

Further information on the history of the individual towns in the vicinity of the construction footprint is outlined in the Non-Aboriginal Heritage Working Paper (**Appendix Q**).

17.3.2 Heritage context

Desktop assessment

A review of previous heritage assessments and the heritage register searches indicated the following (refer to **Figure 17-1**):

- Three listed heritage items are located within the construction footprint; Hexham Shipbuilding Yards, Hannell Family Vault and Tarro Historic Site (original township of what was formerly known as Upper Hexham)
- Three listed heritage items are located next to the construction footprint (Residence, Tarro Substation and Pumping Station).

Two LEP-listed heritage items, the Newcastle Crematorium (I34) and Our Lady of Lourdes Church (I547), are not situated within or next to the construction footprint but have been identified as being eligible for consideration of at-property architectural noise treatment in the Noise and Vibration Working Paper (**Appendix H**) and hence have been included in this assessment.

One heritage item, Hunter Estuary Wetland was identified on the Register of National Estate (RNE), however this register was closed in 2007 and is no longer a statutory list.

A further 13 heritage items are situated within the study area (within one kilometre of the construction footprint). None of these items are considered further in this assessment due to their distance from the construction footprint, or the distance of key historical heritage elements of the item from the construction footprint.

Based on the desktop assessment, there is also the potential for previously unidentified historical heritage items to be situated within the construction footprint, particularly in the more rural sections, including:

- Houses, homesteads and other buildings associated with the settlement of the region
- Past rural uses related to pastoral industry and farming, including stockyards, fences, sheds and outbuildings, and creek fords.

Searches did not identify any heritage items listed on the SHR, SHI, NTAR, CHL, NHL, MLEP, PSLEP or WHL within or next to the construction footprint.

Review of aerial imagery

Aerial imagery from 2015 was reviewed to identify areas of heritage potential prior to the field survey. Several properties were identified where the nature of features or buildings indicated that they may have some heritage potential. Of these properties, six areas were identified for field survey, as identified in **Table 17-3**.

Table 17-3 Areas with potential for heritage items within the construction footprint

Description of area of potential	Location
Glenrowan Homestead	51 New England Highway, Black Hill
An industrial site at the former mineral sands processing site	1877 Pacific Highway, Tomago
Building remains and footings	15 Pacific Highway, Tomago
A racetrack (possible Motto Farm)	2171 Pacific Highway, Tomago
Possible building footings located next to the Hunter River and possible man-made canals	Lot 131 DP 1092779
A creek crossing	1 Anderson Drive, Tarro

17.3.3 Field survey results

Field surveys were carried out for listed historical heritage items and for priority areas within and next to the construction footprint which were identified as having the potential for heritage items.

Following the field survey and subsequent assessment, eight listed heritage items, one former listing (Item 5) and one potential heritage item (Item 3) were considered to occur within or next to the construction footprint, or would be subject to project-related work, including:

- Item 1: Hannell Family Vault (NLEP I179)
- Item 2: Hexham Shipbuilding Yards (NLEP I180)
- Item 3: Glenrowan Homestead
- Item 4: Residence, 29 Eastern Avenue, Tarro (NLEP I548)
- Item 5: Hunter Estuary Wetland
- Item 6: Tarro Historic Site (original township of what was formerly known as Upper Hexham) (NLEP A18)
- Item 7: Tarro Substation (NLEP I546)
- Item 8: Pumping Station (listed on NLEP I550, Hunter Water Corporation Section 170 register)
- Item 9: Newcastle Crematorium (NLEP I34)
- Item 10: Our Lady of Lourdes Church (NLEP I547).

The location of these items is shown on **Figure 17-1** (with the exception of Item 5, refer to discussion below). A description of these heritage items and photographs from field surveys are provided in **Table 17-4**.

As described in **Section 17.3.2**, Item 5, Hunter Estuary Wetland, listed on the non-statutory RNE, was removed from further assessment as former listings have been superseded by stronger ongoing heritage protection provisions under national environment law. There is no current listing affecting this item within the construction footprint of the project.

Field surveys did not involve survey of the Newcastle Crematorium (Item 9) or Our Lady of Lourdes Church (Item 10) as the historical heritage elements of this listing are located over 250 metres and 500 metres from the construction footprint, respectively. These two items have been included in this assessment due to eligibility for at-property treatment for noise mitigation (discussed further in **Chapter 8** (noise and vibration)).

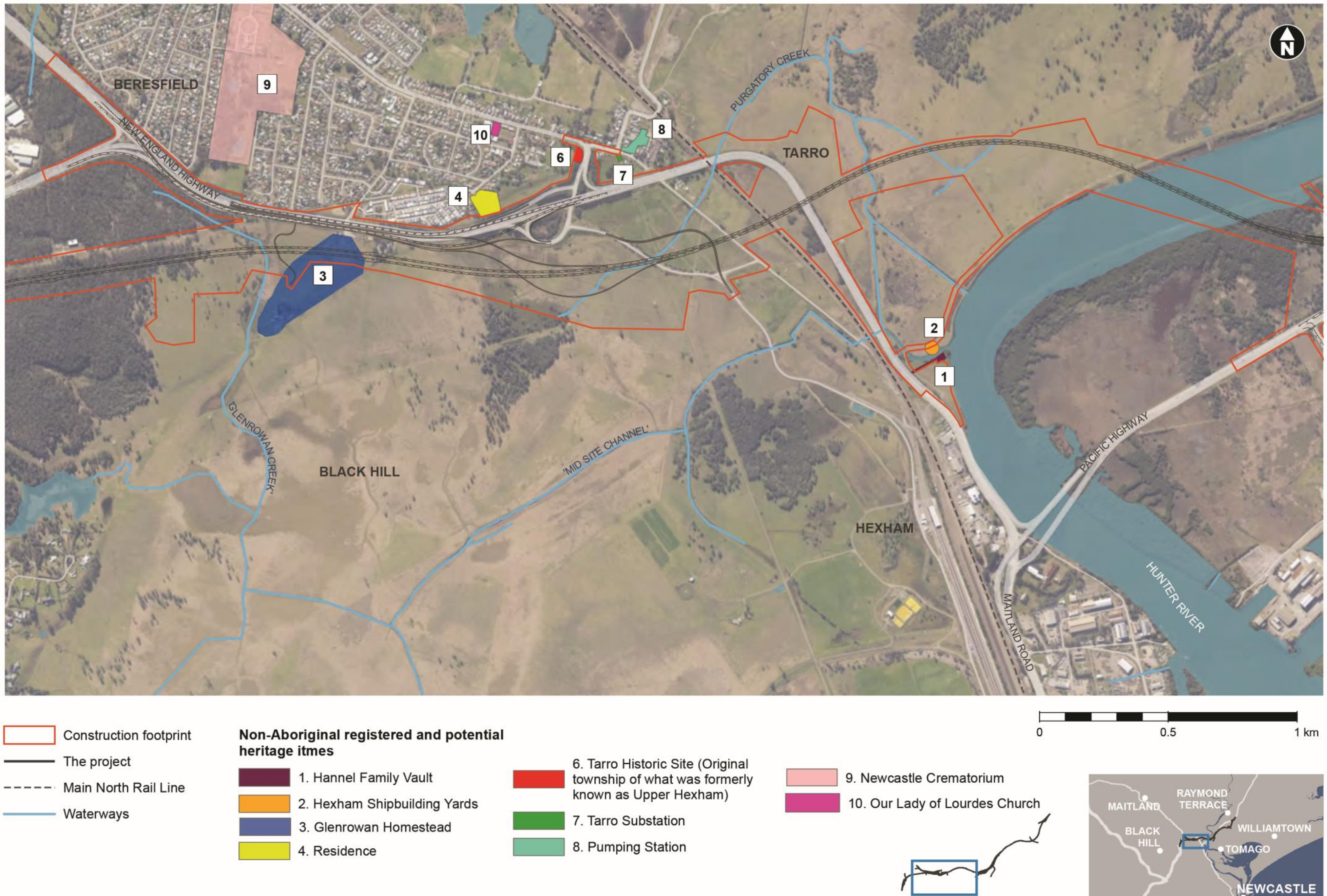

Figure 17-1 Listed and potential heritage items within or next to the construction footprint, or subject to project-related work

Table 17-4 Description and photographs of listed and potential heritage items identified during field surveys

Item name and register no.	Description and results of survey	Photographs from field surveys	
Listed heritage items			
Hannell Family Vault (Item 1) NLEP I179	This heritage item is located within the construction footprint. This heritage item comprises a stone vault structure, located about 20m from the banks of the Hunter River, and standing about three metres above the flat Hexham Plain. The vault is surrounded by overgrown vegetation including shrubs, weeds and grass. Due to its proximity to the Hunter River, over the years it has been flooded several times and, during major floods, has been completely covered by water. The heritage curtilage of the vault includes the entire lot which overlaps with about 10m of the construction footprint at the western end of the lot. This section of the construction footprint comprises mostly an existing gravel vehicle track, with a small band of grass on either side. The physical building comprising the vault is located about 120m east and 20m north of the construction footprint.	 Photo 17-1 Hannell Family Vault, facing southeast.	 Photo 17-2 Front door of the vault
Hexham Shipbuilding Yards (Item 2) NLEP I180	This heritage item is located within the construction footprint. The Hexham Shipbuilding Yards comprises a mangrove swamp containing straight cuts commensurate with 19th century boat building. The listing also includes a location description 'public open space', although the curtilage is located on privately owned land. The construction footprint passes through the heritage curtilage of the Hexham Shipbuilding Yards. The construction footprint at this location comprises an existing informal gravel vehicle track, built up by around one metre above the Hunter River floodplain. The area to either side of the existing vehicle track is grassed. Several shallow depressions in the ground were noted next to the construction footprint on the north side of the vehicle track. Several pieces of timber were located at the end of one of the depressions.	 Photo 17-3 The Hexham Shipbuilding Yards, facing east	 Photo 17-4 Depressions in foreground and construction footprint in background, facing south

Item name and register no.	Description and results of survey	Photographs from field surveys	
Residence, 29 Eastern Avenue, Tarro (Item 4) NLEP I548	This heritage item is located next to the construction footprint. The site comprises a single storey facebrick work building with dichromatic brick work emphasising building edges around window openings and doorways, and corners of building. The main roof is hipped with corrugated metal sheets. It has a secondary bull nose corrugated metal roof over L-shaped verandah. The residence also has a number of brick squat chimneys to main building. The residence is situated on top of a rise which slopes steeply down to level ground next to the construction footprint. The building of significance is located about 60m from the construction footprint. No other heritage elements are in proximity to the construction footprint.	 Photo 17-5 Residence located on top of a rise, facing north.	 Photo 17-6 Level ground at base of rise and rubbish pile, facing east.
Tarro Historic Site (Item 6) NLEP A18	This heritage item is located within the construction footprint. This heritage item is listed as the actual site of the church of St Stephen and burial ground, and it represents the settlement of the area Upper Hexham, now called the suburb of Tarro. This heritage item is located within road reserve on the corner of Anderson Drive and the Tarro interchange. At least three quarters of the heritage curtilage contain thick vegetation in the form of small shrubs and trees. The northern portion has short grass allowing visibility of several features. There is an undated stone plaque located on a concrete slab (**Photo 17-7**) in the centre of the grassed area marking the site as St Stephen's Church of England. To the east of the undated stone plaque is a second stone plaque on a concrete slab (**Photo 17-8**) which commemorates the	 Photo 17-7 Undated stone plaque marking the site as St Stephen's Church of England, facing south	 Photo 17-8 Second stone plaque marking the opening of the Tarro Interchange, facing south

Item name and register no.	Description and results of survey	Photographs from field surveys	
	opening of the Tarro Interchange in 1996. Northeast of the second stone plaque, and next to the road, there is a concrete slab containing a raised stone feature (**Photo 17-9**). A view from Tarro Historic Site, facing north, is shown in **Photo 17-10**. No other historical heritage features were observed during the site inspection.	 Photo 17-9 Concrete and stone feature, facing south.	 Photo 17-10 The Tarro Historic Site next to road, facing north
Tarro Substation (Item 7) NLEP I546	This heritage item is located next to the construction footprint. The Tarro Substation is a stretcher bond brick single storey building on concrete footings, with decorative render and stone features. It has a stop hipped Marseille tiled roof with timber ventilation and exposed eaves, a sheeted double door in a rusticated stone opening, and a multi-pane timber window within a rusticated stone framed opening. The building has moulded rendered concrete detailing. The building was built at the same time as the Tarro Pumping Station (Item 8). The physical structure of the building is located next to the construction footprint.	 Photo 17-11 Tarro substation, facing southwest.	 Photo 17-12 Tarro substation, facing southwest

Item name and register no.	Description and results of survey	Photographs from field surveys	
Pumping Station (Item 8) NLEP I550	This heritage item is located next to the construction footprint. The survey confirmed that the description from the NLEP is accurate, as follows. The main building of the Tarro Pumping Station is a large, purpose-built water pumping station in the Federation style. The building is brick built in Flemish bond with black tuck pointing, which is now faded. The building has painted render and concrete details with a parapeted and hipped Marseille tiled roof. There are two timber louver vent stacks and extended eaves supported on steel brackets, as well as ornate dormer with cast detail. The building has a Colorbond downpipe and guttering. The entrance door is a panelled timber door with glazed overlight. There are mostly replacement timber windows, some glazed and some broken, as well as some original windows. Internally virtually all equipment has been removed and the space is largely used for storage.	 Photo 17-13 Pumping Station, facing northeast.	 Photo 17-14 Pumping Station, facing northeast
Potential heritage items identified during field surveys			
Glenrowan Homestead (Item 3)	This potential heritage item is located within the construction footprint. Glenrowan Homestead is located on a large somewhat flat rise overlooking floodplain and swamp landforms. The Glenrowan Homestead is a farm complex comprising two clusters of buildings/structures, one located about 300m (Site 1) and one about 100m (Site 2) south of the New England Highway, Tarro. The houses at both of the sites were occupied at the time of the survey. The house at Site 1 has been modified over time and additional buildings have been constructed near the house at Site 2, reflecting the residential use of the houses. An artefact scatter and area of archaeological potential are located about 130m south of the New England Highway (Site 3). Site 1 at Glenrowan Homestead contains a single storey farmhouse, sheds, remnant gardens and a driveway. Site 2 at Glenrowan Homestead contains a weatherboard house.	 Photo 17-15 South-eastern section of brick house (Site 1), facing north	 Photo 17-18 Weatherboard and cement sheeting shed (Site 1), facing west

Item name and register no.	Description and results of survey	Photographs from field surveys	
	Site 3 contains subsurface historical archaeological artefacts. Previous archaeological excavations carried out at Site 3 uncovered 73 historical artefacts across the site, which are catalogued in full in the Non-Aboriginal Heritage Working Paper (Appendix Q). Findings across Site 3 comprised of mostly domestic artefacts likely deposited in the late 19th century, including materials made of ceramic, shell, bone, metal, glass, metal and cement. Given its close proximity, it was determined most likely that these artefacts are part of a rubbish dump associated with the Glenrowan Homestead. Alternatively, they may have been dumped by residents of the nearby township of Tarro in a dump of a more communal nature.	 Photo 17-16 Weatherboard house (Site 2), facing east  Photo 17-17 Start of the test excavation at Site 3 facing south-east, looking downhill	 Photo 17-19 Rubbish pile (Site 2), facing north  Photo 17-20 Complete boot polish bottle found during excavations at Site 3

17.3.4 Assessments of significance

As outlined in **Section 17.2**, assessments of significance were carried out for the historic heritage items identified within or next to the construction footprint. Significance assessments are summarised in **Table 17-5**.

Table 17-5 Summary of significance of heritage items within or next to the construction footprint

Item name and register no.	Level of significance	Summary of heritage significance
Registered heritage items		
Hannell Family Vault NLEP I179 (Item 1)	Local	Associated with the locally prominent Hannell Family, and in particular, John Hannell, who was a well-known publican who also founded several sporting associations in the broader region. The vault is an unusual monument in an uncommon location.
Hexham Shipbuilding Yards NLEP I180 (Item 2)	Local	The Hexham Shipbuilding Yards are locally significant as they are associated with the development of this area and the rise of shipbuilding along the Hunter River in the 19th century. The archaeological remains could contribute to a greater understanding of this industry.
Residence, 29 Eastern Avenue, Tarro NLEP I548 (Item 4)	Local	The house demonstrates the development of social class and economic growth of the region. The interiors are of significance.
Tarro Historic Site NLEP A18 (Item 6)	Local	The Tarro Historic site is the site of the original township of Tarro, and the original site of St Stephens Church and burial ground from 1840. The site has local historical significance as a place of first settlement of the area and is associated with Edward Sparkes, the original grantee. The site has a strong association with Bishop Broughton (the first Bishop of Australia). The site has local associative significance with the development of a settlement on high land to the west of the Hunter River and may contain relics of the period.
Tarro Substation NLEP I546 (Item 7)	Local	The Tarro Substation is a small decoratively built masonry valve house across the street from the former Tarro Pumping Station. The building is still in service and complements the Pumping Station, with both designed in a style which demonstrates the high degree of civic pride which the Hunter District Water Board took in its early infrastructure. The building is representative of form and style of architecture used for this particular function and a rare example of this architectural style in this region.
Pumping Station NLEP I550 (Item 8)	Local	The Tarro Pumping Station is an exceptionally finely detailed early 20th century water pumping station, which superseded the pumping station at the Walka Water Works near Maitland. The Pumping Station is constructed in the Federation Free Style and is the most finely constructed building remaining within the Hunter Water Corporation network. It includes a matching boundary fence and valve house. As a purpose-built industrial building it is a rare example of public architecture, built at a time when the ornamentation of infrastructure was part of the civic pride in its development. Now decommissioned, the building lacks most internal elements or machinery.

Item name and register no.	Level of significance	Summary of heritage significance
Newcastle Crematorium, Beresfield NLEP I34 (Item 9)	Local	The Newcastle Crematorium has a high level of historical and aesthetic significance for Newcastle and the wider Hunter Region. Its construction was associated with the introduction of the modern practice of cremation to the region, as this form of funerary rite became more widely accepted across the State in the 1930s. As part of a small group of NSW crematoria of that decade, the Newcastle Crematorium thus helps to demonstrate the changing understandings of and responses to death associated with the practice. The Newcastle Crematorium represents a high level of architectural and landscaping achievement within Newcastle and the wider Hunter region, as a fine example of the Art Deco style, set in a formally landscaped garden. Along with the other crematoria designed by Robertson, and the C. Bruce Dellitt's Anzac Memorial (Sydney), it forms part of a small group of commemorative buildings in NSW that employ the Art Deco style to create a dignified and solemn atmosphere. Along with other architectural landmarks in Newcastle, the Crematorium is a marker of the status of Newcastle as NSW's second city as the city matured in the first half of the twentieth century.
Our Lady of Lourdes Church, Tarro NLEP I547 (Item 10)	Local	Important local landmark representative of an important step in the development of church facilities in the suburb of Tarro. The interiors are of significance.
Potential heritage items identified during field surveys		
Glenrowan Homestead (Item 3)	Local	A farm house is usually intimately connected with farming and a typical settlement pattern is one of a farm house and associated sheds, stables and yards being located as a single complex within the landscape. The Glenrowan Homestead, comprising these features, is significant at a local level for demonstrating early to mid-20th century dairying/grazing activities in the region and the particular way of life for residents during this period of time, who engaged in early farming. The artefact scatter identified at Site 3 of the Glenrowan Homestead item potentially extends further along the edge of the slope to the north-east and south-west. The artefacts recovered have the potential to yield information about domestic life on a late 19th century to mid-20th century dairy farm and within a rural settlement. The artefacts also have the potential to indicate the importance of the homestead in the region through the types of artefacts present at the site.

17.4 Impact assessment

17.4.1 Alternatives and design options considered

As described in **Chapter 4**, route options were evaluated within a value management process between November 2005 and February 2006. Following selection of a preferred route and consideration of the community and stakeholder feedback, the preferred route design for the project was progressed into a concept design which was placed on public display in July and August 2008. After responding to submissions, a corridor was reserved and gazetted, and the concept design became the 2010 Preferred Route.

Alternate alignment options to the 2010 Preferred Route were identified to address the issues raised in the project review and to better meet the project objectives. This included providing improved accessibility, addressing design constraints in crossing the Hunter River and floodplain and minimising environmental impact. Accordingly, the area between Black Hill and Heatherbrae was reviewed. Alignment 1 and Alignment 2 were progressed for further investigation. A number of interchange arrangements were also investigated at Black Hill, Tarro, Tomago, Heatherbrae and Raymond Terrace. All of these options met the project objectives.

The preferred alignment selected from the options was Alignment 2. Alignment 0 (the 2010 Preferred Route) was closer to the LEP-listed Oak Factory (NLEP I178) and Hexham Bridge (NLEP I187) than Alignment 2. Alignment 0 would also have destroyed Site 1 at the Glenrowan Homestead (Item 3 of this assessment) and had a greater likelihood of causing heritage impacts. Alignment 1 was closer to the Hexham Shipbuilding Yards (NLEP I180) and the Hannell Family Vault (NLEP I179) with the potential to cause greater heritage impacts than Alignment 2. Alignment 2 was selected as the preferred option as it would avoid the high value biodiversity areas located either side of the Hunter River compared to Alignment 0 and Alignment 1, while best balancing the functional, social and economic and natural environment and culture considerations.

The concept design was revised in 2016 following community and stakeholder feedback. Further non-Aboriginal heritage assessment was carried out on these design refinements but there was no substantive difference to impacts on heritage from these changes.

Ultimately, the project alignment has reduced the potential for heritage impacts as compared to earlier options and alignments considered.

In locations where impacts to heritage items were unable to be avoided, a number of management measures have been provided to avoid further impacts as a result of the project, provided in **Section 17.5**.

17.4.2 Assessment of potential impacts

A summary of the potential project impacts that relate to each heritage item and the potential direct and indirect impacts on heritage items is provided in **Table 17-6**. The complete SOHIs for above heritage items are provided in the Non-Aboriginal Heritage Working Paper (**Appendix Q**).

Table 17-6 Summary of potential impacts on heritage items

Heritage item and significance	Project activities	Impacts	Summary of heritage impact
Major impact			
Glenrowan Homestead (Item 3) Local significance	Construction of the motorway requiring demolition of Site 2 and destruction of Site 3	**Direct impact** • Demolition of weatherboard house and non-heritage buildings at Site 2 due to construction of motorway. • Destruction at Site 3 (artefact scatter) due to ground disturbance associated with construction of motorway. Although Site 3 is about twelve metres south of the main alignment, it is within the construction footprint and would be subject to impacts related to construction in the area. • The main house at Site 1 has been identified as being eligible for consideration of at-property architectural noise treatment such as double glazing of external windows and/or provision of ventilation systems (or similar). No indirect impacts to this heritage item are anticipated.	**Major impact** The proposed work within heritage curtilage of the Glenrowan Homestead would impact on two of the three sites within the heritage complex's curtilage; Site 2 would be demolished and Site 3 would be destroyed. The project would not have a direct impact on the main house, buildings and gateway at Site 1. The overall impact would be of medium-large scale and moderate-high intensity, with the changes being permanent and irreversible. The project would result in the disturbance of archaeological deposits at Site 3. Archaeological salvage excavation, as outlined in the Non-Aboriginal Heritage Working Paper (**Appendix Q**) would occur at Site 3 prior to work proceeding. The visual amenity of Glenrowan Homestead would be altered, as it is currently within a rural setting. Upon completion of the project the surrounding area to the north of the homestead would be a motorway. However, the impact would be limited given that there is already a highway in this location. Further, rural vistas to the south of the homestead would remain. The project would remove the existing access arrangements at the site and increase traffic near the heritage item, however these outcomes would not impact on the significance of the heritage item. The main house at Glenrowan Homestead has also been identified as being eligible for consideration of at-property noise treatment such as double glazing of external windows and/or provision of ventilation systems (or similar). Site 1 is beyond the safe working distances for cosmetic damage from vibration, however the safe working distances assumes that the heritage buildings are structurally sound. As this may not be the case for the buildings at Site 1, management measures for potential vibration impacts have been included for this item.

Heritage item and significance	Project activities	Impacts	Summary of heritage impact
Minor impact			
Hexham Shipbuilding Yards NLEP I180 (Item 2) Local significance	Upgrade of existing vehicle track involving building up and widening existing track	**Direct impact** • The construction of an upgraded access track would directly impact the heritage curtilage of the item. There is low potential for archaeological remains to be disturbed or destroyed by the works as the area with the highest potential for archaeological remains specifically related to the shipyards is outside the construction footprint. No indirect impacts to this heritage item are anticipated.	**Minor impact** The project is unlikely to have a direct impact on the Hexham Shipbuilding Yards as the area most likely to contain the shipyard remains is outside the construction footprint, and the proposed access track would be built up over the existing ground surface and existing access track rather than heavily disturbing sub-surface remains. There would be increased traffic on the access track both during construction and operation of the project, however as discussed this would not impact on the likely areas of archaeological remains.
Negligible impact			
Hannell Family Vault NLEP I179 (Item 1) Local significance	• Upgrade of existing vehicle track involving excavation of the ground surface • Adjacent ancillary facility (AS8)	**Direct impact** • Direct impact to the heritage curtilage of the heritage item from upgrade of an access track located about 120m southwest of the vault; however, the vault itself would not be directly physically impacted and there would be no change to the curtilage. **Possible direct impact** • Possible unplanned impacts by accidental damage from machinery from the ancillary construction area (AS8) located about 20m south of the physical structure of the vault. **Possible indirect impact** • Possible indirect impacts from vibration during construction activities.	**Negligible impact** No adverse impacts on the physical vault structure of the Hannell Family Vault have been identified. However, as a proposed ancillary facility (AS8) is located 20m south of the physical structure of the vault, there may be indirect impacts to the vault due to vibration if vibration-generating machinery is operating within the ancillary facility and within the safe working distances for heritage items. The vault may also be incidentally impacted by accidental damage from machinery or vehicles operating in the vicinity.

Heritage item and significance	Project activities	Impacts	Summary of heritage impact
Residence, 29 Eastern Avenue, Tarro NLEP I548 (Item 4) Local significance	Construction of motorway adjacent to LEP heritage curtilage	**Direct impact** • The heritage item has been identified as being eligible for consideration of at-property architectural noise treatment such as double glazing of external windows and/or provision of ventilation systems (or similar). **Possible indirect impact** • Possible indirect impacts from vibration during construction activities.	**Negligible impact** No construction impacts to the heritage item are expected as construction would be limited to the construction footprint, next to the heritage item curtilage. The physical heritage building is located about 40m from the construction footprint and about 65m from the project. The physical building is beyond the safe working distances for cosmetic damage from vibration, however the safe working distances assumes that the heritage buildings are structurally sound. As this may not be the case for the building, management measures for potential vibration impacts have been included for this item. The installation of a noise barrier (NB.03) and associated vegetation removal would change the character of the landscape setting for the heritage listed residence by altering the spatial character and outlook. However, the distance between the proposed noise barrier and the residence is sufficient that there would be little or no impact on the heritage significance of the heritage item. The residence has been identified as being eligible for consideration of at-property noise treatment such as double glazing of external windows and/or provision of ventilation systems (or similar).
Tarro Historic Site NLEP A18 (Item 6) Local significance	Potential work on the existing road pavement, kerbs/gutters and subsurface drainage on Anderson Drive, Tarro	**Possible direct impact** • The proposed works would be confined to existing road pavement, kerb/gutter and subsurface drainage outside the heritage item curtilage • Possible unplanned impacts by accidental damage from machinery given the proximity of works to the site • If construction works are to take place within the curtilage of this heritage item the project would directly impact the site through destruction of potential archaeological deposits relating to the former church and burial ground. No indirect impacts to this heritage item are anticipated.	**Negligible impact** Works in the location would be confined to the existing road pavement, kerbs/gutters and subsurface drainage on Anderson Drive and would not overlap with the heritage curtilage. As such, the heritage item would be avoided. If work was to take place within the curtilage of this heritage item, the project would have a direct impact on potential subsurface archaeological deposits at the Tarro Historic Site. In this event, the level of impact on the heritage item would be major during construction and operation.

Heritage item and significance	Project activities	Impacts	Summary of heritage impact
Tarro Substation NLEP I546 (Item 7) Local significance	Potential work on the existing road pavement, kerbs/gutters and subsurface drainage on Anderson Drive, Tarro	**Possible direct impact** • The proposed works would be confined to existing road pavement, kerb/gutter and subsurface drainage, about three metres from the building. • Possible unplanned impacts by accidental damage from machinery given the proximity of works to the site. **Possible indirect impact** • Possible indirect impacts from vibration as the distance is less than the safe working distances (less than 25m) for cosmetic damage from vibration as presented in the Table 2 of the Construction Noise and Vibration Guideline (Roads and Maritime Services 2016b).	**Negligible impact** No adverse impacts on the Tarro Substation are expected from the project. However, as the project would be located next to the Tarro Substation there may be unplanned impacts to the Tarro Substation building façade due to vibration or accidental damage from machinery or vehicles. Depending on the location of vibration inducing works carried out within Anderson Drive there is potential to comply with the safe working distances for heritage items. The effect of the project would be major new visual elements in the mid distance of the view from the heritage item, and the loss of long-distance views across the floodplain. There would be no change to the foreground of the view. While the distant views would change, this would not impact on the heritage significance of the heritage item.
Pumping Station NLEP I550 (Item 8) Local significance	Potential work on the existing road pavement, kerbs/gutters and subsurface drainage on Anderson Drive, Tarro	**Possible direct impact** • The proposed works would be confined to existing road pavement, kerb/gutter and subsurface drainage, about four metres from the brick fence of the heritage item. • Possible unplanned impacts by accidental damage from machinery given the proximity of works to the site. **Possible indirect impact** • Possible indirect impacts from vibration as the distance is less than the safe working distances (less than 25m) for cosmetic damage from vibration as presented in the Table 2 of the Construction Noise and Vibration Guideline (Roads and Maritime Services 2016b).	**Negligible impact** No adverse impacts on the Pumping Station are expected as a result of the project construction and operation. However, as the project would be located next to the Pumping Station and its associated brick fence, there may be indirect impacts to the heritage item due to vibration or unplanned direct impacts by accidental damage from machinery or construction vehicles. Depending on the location of vibration inducing works carried out within Anderson Drive there is potential to comply with the safe working distances for heritage items. The effect of the project would be major new visual elements in the mid distance of the view from the heritage item, and the loss of long-distance views across the floodplain. There would be no change to the foreground of the view. While the distant views would change, this would not impact on the heritage significance of the heritage item.

Heritage item and significance	Project activities	Impacts	Summary of heritage impact
Newcastle Crematorium NLEPI34 (Item 9) Local significance	At-property architectural noise treatment	**Direct impact** • The heritage item has been identified as being eligible for consideration of at-property architectural noise treatment such as double glazing of external windows and/or provision of ventilation systems (or similar). No indirect impacts to this heritage item are anticipated.	**Negligible impact** No adverse impacts on the Newcastle Crematorium are expected as a result of project construction as the main crematorium building is more than 500m from the construction footprint. The only proposed works at or near this heritage item would be at-property architectural noise treatment such as double glazing of external windows and/or provision of ventilation systems (or similar) in response to operational impacts.
Our Lady of Lourdes Church, Tarro NLEPI547 (Item 10) Local significance	At-property architectural noise treatment	**Direct impact** • The heritage item has been identified as being eligible for consideration of at-property architectural noise treatment such as double glazing of external windows and/or provision of ventilation systems (or similar). No indirect impacts to this heritage item are anticipated.	**Negligible impact** No adverse impacts on the church are expected as the heritage item is more than 250m from the construction footprint. The only proposed works at or near this heritage item would be at-property architectural noise treatment such as double glazing of external windows and/or provision of ventilation systems (or similar) in response to operational impacts.

Following the implementation of management measures (**Section 17.5**), the project would have the following impacts:

- **Major impact:** Item 3: Glenrowan Homestead
- **Minor impact:** Item 2: Hexham Shipbuilding Yards.

The project was assessed as having a **negligible** impact on the remaining items, these are:

- Item 1: Hannell Family Vault
- Item 4: Residence, 29 Eastern Avenue, Tarro
- Item 6: Tarro Historic Site (original township of what was formerly known as Upper Hexham)
- Item 7: Tarro Substation
- Item 8: Pumping Station
- Item 9: Newcastle Crematorium
- Item 10: Our Lady of Lourdes Church.

17.5 Environmental management measures

The environmental management measures that will be implemented to minimise the non-Aboriginal heritage impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 17-7**.

Table 17-7 Environmental management measures (non-Aboriginal heritage)

Impact	Reference	Management measure	Responsibility	Timing
Non-Aboriginal heritage impacts	NA01	A Non-Aboriginal Heritage Management Plan (NAHMP) would be prepared prior to construction in consultation with Heritage NSW. As a minimum, the NAHMP would include the following: • A list, plan and maps with GIS layers showing the location of identified heritage items both within, and near, the construction footprint • Procedures to be implemented during construction to avoid or minimise impacts on items of heritage significance including protective fencing • The Unexpected Heritage Items Procedure (Transport for NSW 2019b) which will be followed in the event that unexpected heritage finds are uncovered during construction • A procedure for the unexpected discovery of human skeletal remains as per the Skeletal remains: guidelines for the management of human skeletal remains (NSW Heritage Office 1998).	Transport/ Contractor	Prior to construction
Hannell Family Vault	NA02	• A dilapidation survey will be carried out. • Barrier fencing will be erected between the construction project activities and vault structure.	Contractor	Prior to construction/ construction
Glenrowan Homestead	NA03	• Archival photographic recording of Site 2 will be carried out prior to demolition. • Archaeological salvage excavation at Site 3 under the supervision of an Excavation Director, who meets the NSW Heritage Council criteria will be carried out prior to works proceeding. • A dilapidation survey will be carried out. • Architectural noise treatment at the main house at Site 1 would be sympathetic to the heritage values of the item.	Contractor	Prior to construction
Residence, 29 Eastern Avenue, Tarro	NA04	• A dilapidation survey will be carried out. • Architectural noise treatment at the heritage residence would be sympathetic to the heritage values of the item.	Contractor	Prior to construction

Impact	Reference	Management measure	Responsibility	Timing
Tarro Historic Site	NA05	If construction works are to take place within the site curtilage further archaeological investigation under the supervision of an Excavation Director, who meets the NSW Heritage Council criteria, would be carried out as follows: • Non-invasive survey using ground penetrating radar or other appropriate geophysical inspection technique will be carried out across the curtilage of the heritage item to assist in identifying the presence of burials or other archaeological features. • Following the non-invasive survey, archaeological test excavation of the heritage item within the construction footprint will be carried out to confirm presence and nature of archaeological relics in accordance with a research design and methodology to be developed.	Contractor	Detailed design/ prior to construction/ construction
Tarro Substation and Pumping Station	NA06	• A dilapidation survey will be carried out.	Contractor	Detailed design/ prior to construction/ construction
Newcastle Crematorium and Our Lady of Lourdes Church	NA07	Architectural noise treatment at the heritage buildings would be sympathetic to the heritage values of the item.	Contractor	Detailed design/ prior to construction/ construction
Other relevant management measures				
Impacts on known Aboriginal sites	AH01	An Aboriginal Cultural Heritage Management Plan (ACHMP) will be prepared in accordance with the Procedure for Aboriginal cultural heritage consultation and investigation (Roads and Maritime Services 2011b) and Standard Management Procedure – Unexpected Heritage Items (Roads and Maritime Services 2015f). The ACHMP will be prepared in consultation with all relevant Aboriginal groups. The ACHMP will include: • Details of investigations completed or planned to be carried out and any associated approvals required • Mapping of areas of Aboriginal heritage value and identification of protection measures to be applied during construction • Procedures to be implemented if previously unidentified Aboriginal objects, including skeletal remains, are discovered during construction • An induction program for construction personnel on the management of Aboriginal heritage values • Opportunities for on-going Aboriginal community engagement in the project.	Transport / Contractor	Prior to construction

Impact	Reference	Management measure	Responsibility	Timing
	AH02	Archaeological salvage excavation, surface collection and exclusion fencing as detailed in Table 9-1 of the Aboriginal Cultural Heritage Assessment Report must be carried out in accordance with the methodology specified in the Chapter 9 of the Aboriginal Cultural Heritage Assessment Report (**Appendix L**).	Contractor / Transport	Prior to construction/ construction
Vibration impacts to residential and commercial structures	NV03	Where vibration generating activities will be carried out within minimum working distances for cosmetic damage, vibration monitoring will be carried out. Where monitoring indicates cosmetic damage criteria are exceeded, alternative low vibration work practices will be investigated and implemented.	Contractor	Construction
Vibration impacts to heritage structures	NV05	Heritage items within 100m of vibration intensive work are to be considered on a case by case basis and further investigation would be carried out during detailed design to confirm the structural integrity (i.e. structurally sound or unsound) of all potentially affected structures. Where items are considered sensitive to vibration, appropriate vibration criteria would be determined after detailed inspections have been completed.	Contractor	Prior to construction/ construction
Operational road traffic noise impacts	NV07	Operational noise and vibration mitigation measures would be identified in an Operational Noise and Vibration Review (ONVR). Requirements for mitigation measures, including quieter noise pavements, noise barriers, and at-property treatments, would be reviewed as part of the ONVR and as the detailed design progresses. Detailed information on floorplans and facade construction for school classrooms, places of worship and childcare centres determined to exceed the applicable Noise Criteria Guideline (NCG) (Roads and Maritime Services 2015c) internal noise criteria will be obtained during design development. The implementation of treatments would be carried out in accordance with the Noise Mitigation Guideline (NMG) (Roads and Maritime Services 2015d).	Transport / Contractor	Detailed design/ construction/ prior to operation
Landscape character and visual impacts including during construction	UD01	An Urban Design and Landscape Plan (UDLP) will be prepared to support the project. The plan will present an integrated urban design for the project, providing practical detail on the application of design principles and objectives identified in the EIS. The plan will include: • Location and identification of existing vegetation and proposed landscaped areas, including species to be used • Built elements including retaining walls, bridges and noise barriers • Walking and cyclist elements including footpath locations, paving types and pedestrian crossings • Fixtures such as lighting, fencing and signs • Details on the staging of landscape work including related environmental controls such as erosion and sedimentation controls and drainage	Contractor	Prior to construction

Impact	Reference	Management measure	Responsibility	Timing
		• Procedures for monitoring and maintaining landscaped or rehabilitated areas • The project will consider CPTED principles during detailed design to minimise safety and security risks to all users and communities in the study area. The project will carry out CPTED reviews at each milestone by a qualified professional. Additional recommendations as a result of reviews will be implemented where reasonable and feasible • Water sensitive urban design solutions. The plan will be prepared in accordance with Transport urban design policy guidelines including: • Beyond the Pavement – Urban design approach and procedures for road and maritime infrastructure planning, design and construction (Transport for NSW 2020a) • Landscape design guideline: Design guideline to improve the quality safety and cost effectiveness of green infrastructure in road corridors (Roads and Maritime Services 2018a) • Bridge Aesthetics: Design Guidelines to improve appearance of bridges in NSW (Transport for NSW 2019a) • Noise wall design guideline: Design guideline to improve the appearance of noise walls in NSW (Transport for NSW 2016a) • Shotcrete Design Guideline: Design guidelines to avoid, minimise and improve the appearance of shotcrete in NSW (Transport for NSW 2016b) • Water sensitive urban design guideline, Applying water sensitive urban design principles to NSW transport projects (Transport for NSW 2017b).		

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18. Air quality

This chapter describes the potential air quality impacts that may be generated by the construction and operation of the project and presents the approach to the management of these impacts.

The desired performance outcome for the project relating to air quality, as outlined in the SEARs, is to:

- Minimise air quality impacts (including nuisance dust and odour) to reduce risks to human health and the environment to the greatest extent practicable through the design, construction and operation of the project.

Table 18-1 outlines the SEARs that relate to air quality and identifies where they are addressed in this EIS. The full assessment of air quality impacts is provided in the Air Quality Working Paper (**Appendix R**).

Table 18-1 SEARs (air quality)

Secretary's requirement	Where addressed
14. Air quality	
1. The Proponent must undertake an air quality impact assessment (AQIA) for construction and operation of the project in accordance with the current guidelines.	The air quality impact assessment for the project is provided in the Air Quality Working Paper (**Appendix R**). A summary of the working paper is provided in this chapter, with details of current guidelines provided in **Section 18.1**.
2. The Proponent must ensure the AQIA also includes the following:	
(a) demonstrated ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations (Clean Air) Regulation 2010*;	The regulatory framework as relevant to the *Protection of the Environment Operations Act 1997* and the Protection of the Environment Operations (Clean Air) Regulation 2010 is discussed in **Section 18.1**. The compliance of the project with the regulatory framework is discussed in **Section 18.4**.
(b) an assessment of the impacts of the construction and operation of the project on sensitive receivers and the local community, including risks to human health;	The location of existing sensitive receivers is provided in **Section 18.3.1**. The risks of air quality issues to human health are provided in **Section 18.4.1**, while the assessment of these air quality issues during construction and operation is provided in **Section 18.4**.
(c) details of the proposed mitigation measures to minimise the generation and emission of dust (particulate matter and TSP) and air pollutants (including odours) during the construction of the project, particularly in relation to the operation of ancillary facilities (such as concrete and asphalt batching, treatment of acid sulfate soils and stockpiling of mulch), the use of mobile plant and machinery, stockpiles and the processing and movement of spoil, and construction vehicle movement along the alignment; and	Specific environmental management measures to minimise impacts from dust and air pollutants (including odours) during construction, including the operation of ancillary facilities and other construction activities are outlined in **Section 18.5**.
(d) a cumulative assessment of the local and regional air quality.	Potential cumulative impacts are assessed in **Chapter 23** (cumulative impacts).

18.1 Policy and planning setting

The air quality assessment was prepared to assess the potential impacts of the project in accordance with the *Protection of the Environment Operations Act 1997* (POEO Act), as construction of the project would constitute the Scheduled Activity of "Road construction" as defined in Schedule 1 of the POEO Act. As such, project construction activities would need to comply with the requirements of Chapter 5, Part 5.4 – Air Pollution of the POEO Act. In general, these requirements seek to ensure that emissions from a project do not result in unacceptable air quality, including at surrounding sensitive receivers.

The Protection of the Environment Operations (Clean Air) Regulation 2010 contains provisions for the regulation of emissions to air from motor vehicles, fuels and industry and specifies criteria for the assessment of the obligations imposed by Part 5.4 – Air Pollution of the POEO Act. The requirements of this Regulation have been incorporated into the air quality assessment for the project.

The air quality assessment was prepared to assess the potential impacts of the project in accordance with the following relevant legislation, policy and guidelines:

- Legislation:
  - POEO Act
  - Protection of the Environment Operations (Clean Air) Regulation 2010
  - National Environment Protection (Ambient Air Quality) Measure (National Environment Protection Council (NEPC) 2016)
  - National Environment Protection Measure for Air Toxics (NEPC 2011)
- Guidelines:
  - Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (the Approved Methods) (NSW Environment Protection Authority 2016)
  - Approved Methods for Sampling and Analysis of Air Pollutants in NSW (DEC 2005)
  - Air Emissions Inventory for the Greater Metropolitan Region in New South Wales (NSW Environmental Protection Authority 2019a)
  - Guidance on the assessment of dust from demolition and construction (UK IAQM 2014)
  - Assessment and Management of Odour from Stationary Sources in NSW (DEC 2006).

Although the Approved Methods do not relate specifically to road projects, the impact assessment criteria have been considered to provide an indication of the significance of the project's effect on air quality. Ambient air quality data was collected from stations being operated by DPIE in accordance with The Approved Methods for Sampling and Analysis of Air Pollutants in NSW.

In the absence of a NSW guideline for the assessment of dust from construction activities, the UK IAQM was used. The UK IAQM provides an approach for assessing the potential for dust-related impacts during construction, taking into consideration the sensitivity of the local environment and the expected magnitude of different construction activities.

Further detail on legislation, policies and guidelines, and how they apply to the project, is provided in the Air Quality Working Paper (**Appendix R**).

18.2 Assessment methodology

18.2.1 Air quality data review

In order to determine existing air quality parameters, data from nearby air quality monitoring stations was examined. The closest air quality monitoring station to the area of interest is the DPIE station located at Beresfield, about 1.5 kilometres north of the project. Additional air quality parameters were measured at the next nearest DPIE station, in Newcastle, located about 14 kilometres south of the project.

18.2.2 Meteorological modelling

In order to determine the direction and rate at which emissions from a source would disperse, meteorological data collected over five recent years (2015 to 2019 inclusive) from the DPIE Beresfield monitoring station, located about 1.5 kilometres north of the project, were analysed in order to identify a representative year for the assessment. Hourly records of wind speed and wind direction were also examined. The process for identifying a representative meteorological year involved comparing statistics and wind patterns.

18.2.3 Construction assessment methodology

Dust impacts

Potential impacts to human health and ecology (e.g. impacts to plant health) as well as annoyance, represent the primary air quality-related risks from dust generation during construction. A study area of 350 metres from the construction footprint, extending to 500 metres from site egress points has been adopted for human receivers, and a study area of 50 metres from the construction footprint, extending to 500 metres from site egress points has been adopted for ecological receivers.

The UK IAQM was used to identify the potential for dust impacts during the project, arising from the following four primary activities:

- Demolition
- Earthworks
- Construction
- Trackout, or the transport-related handling of construction materials.

In accordance with the UK IAQM the following four-step assessment procedure (refer to **Figure 18-1**) was carried out:

- Step 1, a screening review to establish the study area and identify nearby human and ecological receivers which have the potential to be impacted by the project
- Step 2, an evaluation of the potential magnitude (Step 2A) and sensitivity of the surrounding environment to dust impacts (Step 2B). Step 2A and 2B were combined in Step 2C to estimate the risk of dust impacts if no mitigation measures are applied. Step 2 was completed for different work areas across the project so that changes in risk profiles could be identified and assessed across the entire project
- Step 3, the development of mitigation for each work location, commensurate to the level of risk determined in Step 2

- Step 4, an evaluation of any residual dust-related risks following the application of the control measures developed during Step 3 to verify that a suitable level of mitigation has been developed to reduce the impacts to the extent practicable.

This process is described further in **Section 18.4.2** and further details are provided in the Air Quality Working Paper (**Appendix R**).

Odour

The indicative odour impacts of an asphalt plant have been quantified by dispersion modelling. This involved estimating odour emissions from a typical asphalt plant and running the NSW EPA approved dispersion model, AUSPLUME, to predict odour levels at various distances from an asphalt plant. Based on simulated meteorological conditions, a 99th percentile odour level was predicted as a function of distance from a plant producing 100 tonnes per hour of asphalt. Based on this odour level and relevant criteria, a recommended separation distance between asphalt batching plants and residential receivers was identified. Further details are provided in the Air Quality Working Paper (**Appendix R**).

Odour from the handling of potentially contaminated materials was also investigated. The Areas of Potential Contamination Risk (AOPCRs) identified as part of the soils and contamination assessment for the project (refer to **Chapter 16** (soils and contamination)) were reviewed to determine AOPCRs that may result in odour impacts during construction.

Odour from the generation and stockpiling of mulch was also considered. The volume of mulch that would be generated for the project (refer to **Chapter 19** (waste)), was qualitatively assessed to determine if stockpiles would have potential to cause offensive odours due to the accumulation of odorous decomposition products.

Other impacts

Other air quality risks have the potential to result in impacts to sensitive receivers throughout local communities during construction. Potential impacts of exhaust emissions from construction plant and equipment are incorporated into the activities defined by the IAQM. Where available, data from projects that may result in cumulative impacts have been incorporated into the air quality assessment as described in **Chapter 23** (cumulative impacts). Where unavailable, a high-level qualitative cumulative assessment has been carried out.

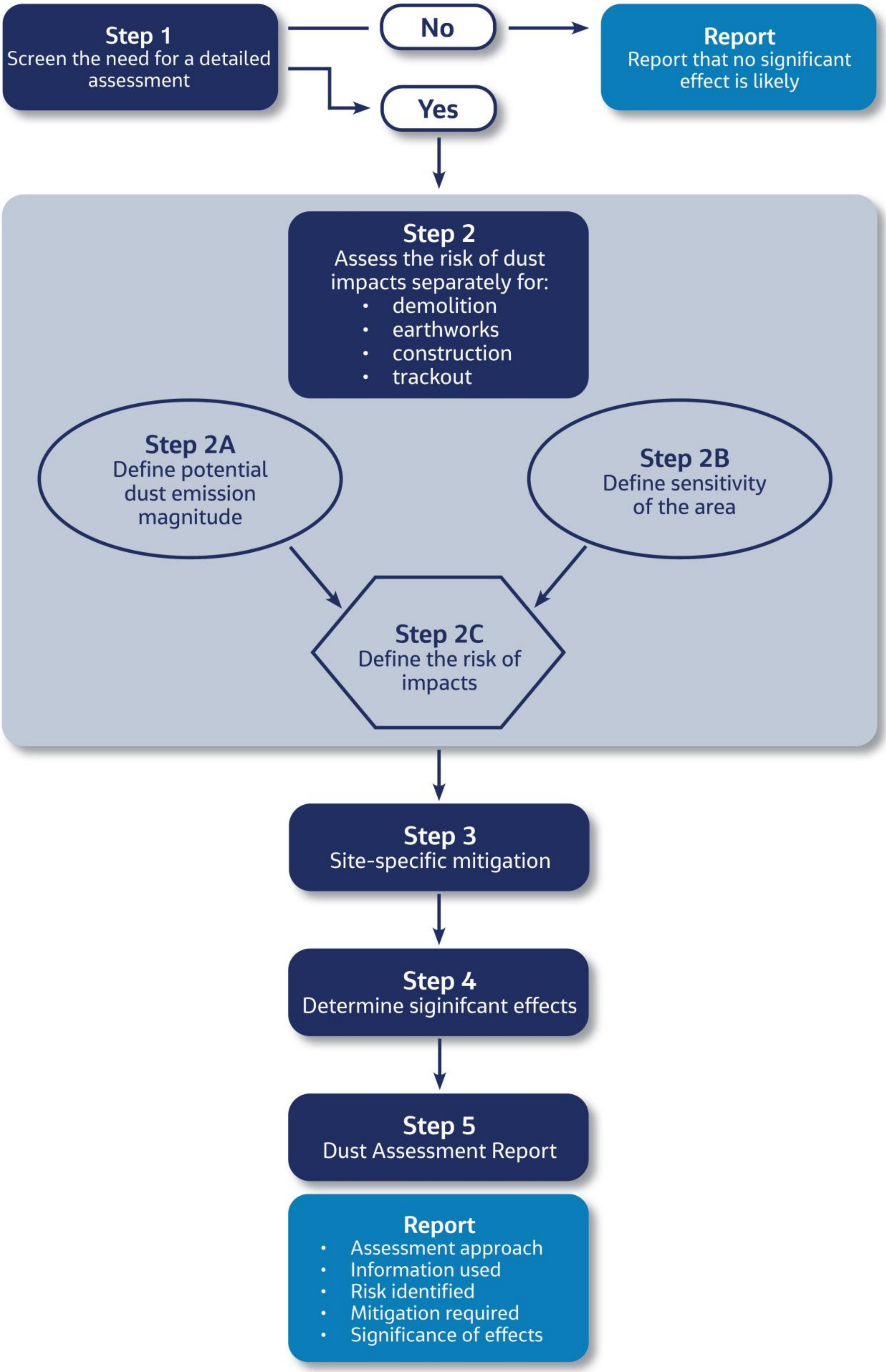

Figure 18-1 Construction air quality assessment procedure (UK IAQM 2014)

18.2.4 Operational assessment methodology

Overview

Air dispersion modelling was carried out in accordance with the ‘Approved Methods for the Modelling and Assessment of Air Pollutants in NSW’ (NSW Environmental Protection Authority 2016) (hereafter referred to as the Approved Methods), which uses meteorological data, reporting requirements and air quality assessment criteria to assess dispersion model predictions.

Emissions from vehicles on the local road network at selected sensitive receivers (R1 to R9) have been estimated using information on traffic volumes, traffic mix and link locations, combined with emission factors from the NSW EPA. GRAL (a computer-based dispersion model) has been used to predict key air pollutant concentrations, including emissions of carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter and hydrocarbons (HC) under a range of operational scenarios, taking into account the local meteorological conditions. Further details on modelling of emissions, including traffic volumes and calculated hourly emissions is described in the Air Quality Working Paper (**Appendix R**).

While emissions of $PM_{2.5}$ have not been explicitly modelled, the potential for $PM_{2.5}$ impacts has been assessed by assuming that 100 per cent of the PM_{10} is $PM_{2.5}$. This is a conservative approach as not all the PM_{10} would be $PM_{2.5}$ and emissions of PM_{10} are anticipated to be higher than $PM_{2.5}$.

Model predictions for air toxics (including benzene, formaldehyde, toluene, xylenes and benzo(a)pyrene) as a marker for polycyclic aromatic hydrocarbons (PAHs) were derived from HC modelling results.

Study area

The study area for the operational air quality assessment has been identified based on surrounding local communities which would be sensitive to air quality impacts. Local communities adjacent to the project include Black Hill, Beresfield, Tarro, Hexham, Tomago, Heatherbrae and Raymond Terrace. The sensitive receivers that were selected, represent a range of potentially sensitive locations within surrounding local communities and are further described in **Section 18.3.1**.

During operation, changes in air quality at both ecological locations and identified sensitive receivers were assessed. As it was determined that impacts at the identified sensitive receivers would represent potential worst case outcomes, they have been further considered as representative receptors in this assessment.

Criteria

The Approved Methods contain criteria for assessing whether potential changes in operational air quality conditions predicted as a result of a project would lead to an unacceptable level of impacts (refer to **Table 18-2**). Although these criteria were developed for stationary sources of air pollutants, rather than moving sources such as vehicles, they are considered to provide an indication of the significance of the project’s effect on air quality during operation, given that the criteria set out in the Approved Methods are a summary of criteria from other relevant guidelines and policies.

Table 18-2 Operational air quality impact assessment criteria contained within the Approved Methods

Pollutant	Averaging time	Criterion
Criteria pollutants		
Carbon monoxide (CO)	1-hour	30,000µg/m^3
	8-hours	10,000µg/m^3
Nitrogen dioxide (NO_2)	1-hour	246µg/m^3
	Annual	62µg/m^3
Particulate matter (as PM_{10})	24-hour	50µg/m^3
	Annual	25µg/m^3
Particulate matter (as $PM_{2.5}$)	24-hour	25µg/m^3
	Annual	8µg/m^3
Particulate matter (as TSP)	Annual	90µg/m^3
Air toxics		
Benzene	1-hour	29µg/m^3
Formaldehyde	1-hour	20µg/m^3
Toluene	1-hour	360µg/m^3
Xylenes	1-hour	190µg/m^3
PAHs as benzo(a)pyrene	1-hour	0.4µg/m^3

Assessment scenarios

To determine whether the project would result in an “unacceptable” outcome, pollutant concentrations of PM_{10}, $PM_{2.5}$, CO, NO_2 and benzene were predicted from road operations by dispersion modelling for the following assessment scenarios:

- 2017 base: Representing approximately existing traffic conditions
- 2028 Do Nothing (2028DN): Traffic conditions in the planned opening year, without the project
- 2028 With Project (2028WP): Traffic conditions in the planned opening year, with the project
- 2038 Do Nothing (2020DN): Traffic conditions 10 years after the planned opening year, without the project
- 2038 With Project (2028DN): Traffic conditions 10 years after the planned opening year, with the project.

Further details relating to the assessment scenarios, including the full details of the emission calculations and road links for each scenario, are provided in the Air Quality Working Paper (**Appendix R**).

18.3 Existing environment

18.3.1 Sensitive receivers

Nine sensitive receivers within the study area were selected for this assessment to represent a range of residential, occupational and other potentially sensitive locations within surrounding local communities (refer to **Table 18-3** and **Figure 18-2**). Due to their proximity to the project, these selected sensitive receivers have been used as the basis for summarising worst case potential impacts during the operational phase of the project on local communities.

In addition, there are various vegetation communities (i.e. ecological receivers), primarily around Hexham Swamp, north of the Hunter River and south and east of Heatherbrae. These habitat areas have been considered as ecological receivers for the purposes of this assessment due to their proximity to the project (within study area) and that they may be directly and indirectly impacted by dust soiling.

Table 18-3 Selected sensitive receivers

Selected sensitive receiver ID	Local community	Location of selected sensitive receiver
R1	Black Hill	Along Lenaghans Drive
R2	Beresfield	North of the New England Highway around the John Renshaw Drive Interchange
R3	Tarro	North of the New England Highway
R4		
R5	Hexham	Around the intersection of Maitland Road and the Pacific Highway
R6		Old Maitland Road
R7	Tomago	Tomago Road
R8	Heatherbrae	South east of the Pacific Highway
R9	Raymond Terrace	East of the Pacific Highway

Based on Step 1 of the UK IAQM (refer to **Section 18.4.2**), a construction study area was developed as described in **Section 18.2.3**.

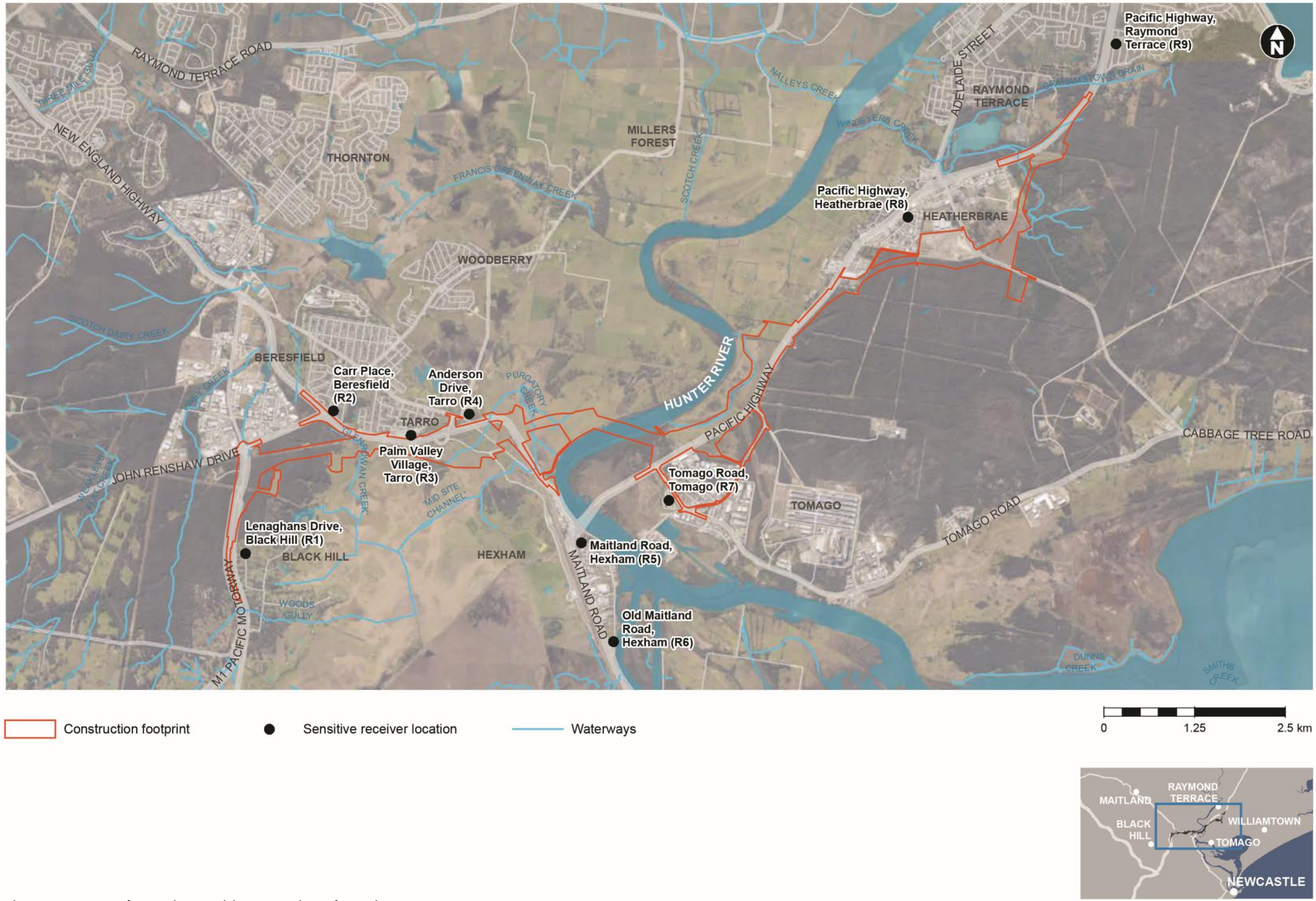

Figure 18-2 Selected sensitive receiver locations

18.3.2 Existing air quality conditions

Carbon monoxide

Table 18-4 provides a summary of measured CO concentrations at Newcastle monitoring station from 2015 to 2019. As shown, measured CO concentrations have consistently been below the criteria contained within the Approved Methods.

Table 18-4 Summary of measured background CO concentrations

Statistic	Criterion	2015	2016	2017	2018	2019
Maximum 1-hour average in µg/m^3	30,000	2,000	2,400	1,600	1,400	2,200
Maximum 8-hour average in µg/m^3	10,000	1,700	1,600	1,300	1,200	1,700

Nitrogen dioxide

Table 18-5 provides a summary of measured NO_2 concentrations from the Beresfield monitoring station from 2015 to 2019. As shown, measured NO_2 concentrations have consistently been below the criteria contained within the Approved Methods.

Table 18-5 Summary of measured background NO_2 concentrations

Statistic	Criterion	2015	2016	2017	2018	2019
Maximum 1-hour average in µg/m^3	246	92	77	75	75	105
Annual average in µg/m^3	62	17	15	16	17	15

While the air quality assessment was based on the modelling of NO_x emissions, NO_2 is the pollutant of interest for comparison with the air quality criteria. It is therefore important to distinguish between total NO_x and NO_2 and it is useful to assess the likely fraction of NO_x that is converted to NO_2 at locations where maximum impacts may be expected to occur. Based on the available data, it has been assumed that 20 per cent of the NO_x is NO_2 when assessing the maximum 1-hour average predictions.

PM_{10}

Table 18-6 provides a summary of measured PM_{10} concentrations from the Beresfield monitoring station in comparison to the daily impact assessment criteria contained within the Approved Methods.

From 2015 to 2019 there were multiple instances when the 24-hour average PM_{10} concentrations exceeded the criterion (refer to red shaded cells in **Table 18-6**). During this period, particle levels increased across NSW due to dust from the widespread, intense drought and smoke from bushfires and hazard reduction burning (OEH 2019a), with a period of unprecedented bushfires in late 2019.

Table 18-6 Summary of measured PM_{10} concentrations

Statistic	Criterion	2015	2016	2017	2018	2019
Maximum 24-hour average in µg/m³	50	65	48	49	149	137
Number of days above 50µg/m³	N/A	2	0	0	8	30
Annual average in µg/m³	25	19	19	20	22	26

$PM_{2.5}$

Table 18-7 provides a summary of measured $PM_{2.5}$ concentrations from the Beresfield monitoring station, in comparison to the daily impact assessment criteria contained within the Approved Methods.

From 2015 to 2019 there were multiple instances when the 24-hour average $PM_{2.5}$ concentrations exceeded the criterion (refer to red shaded cells in **Table 18-7**), with a higher frequency of exceedances occurring in 2019 as a result of the bushfires.

Table 18-7 Summary of measured $PM_{2.5}$ concentrations

Statistic	Criterion	2015	2016	2017	2018	2019
Maximum 24-hour average in µg/m³	25	26	28	19	25	101
Number of days above 25µg/m³	NA	1	1	0	0	23
Annual average in µg/m³	8	7.4	7.4	7.6	8.7	12.2

Assumed background levels

Assumed background levels at the selected sensitive receivers were determined by reviewing local air quality monitoring data as described above. The assumed background levels for the receivers adjacent to the project, and how each background level was determined, is summarised in **Table 18-8**.

Table 18-8 Assumed project background levels

Pollutant	Averaging time	Assumed background level	Background level determination
CO	1-hour	2400µg/m³	Maximum 1-hour concentration from Newcastle (2015 to 2019)
	8-hour	1700µg/m³	Maximum 8-hour concentration from Newcastle (2015 to 2019)
NO_2	1-hour	105µg/m³	Maximum 1-hour concentration from Beresfield (2015 to 2019)
	Annual	17µg/m³	Highest annual concentration from Beresfield (2015 to 2019)
PM_{10}	24-hour	48µg/m³	Maximum 24-hour average in 2016 (2017 to 2019 were excluded due to drought, dust storms and bushfires)
	Annual	22µg/m³	Highest annual concentration from Beresfield (2015 to 2018)
$PM_{2.5}$	24-hour	28µg/m³	Maximum 24-hour average in 2016 (2017 to 2019 were excluded due to drought, dust storms and bushfires)
	Annual	8.7µg/m³	Highest annual concentration from Beresfield (2015 to 2018)

18.3.3 Meteorological conditions

Meteorological conditions are important for determining the direction and rate at which emissions from a source would disperse. The key meteorological requirements of air dispersion models are, typically, hourly records of wind speed, wind direction, temperature and atmospheric stability.

Wind at a location can be summarised in data plots known as wind roses. Wind roses show the strength, direction and frequency of winds at a nominated location. The wind roses in **Figure 18-3** have been constructed in the following way:

- Each branch of the rose represents wind coming from that direction, with north to the top of the diagram. Eight directions are used
- The branches are divided into segments of different thickness and colour, which represent wind speed ranges from that direction. The length of each segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction.

Meteorological data showed that the most common winds in the area of the project would be from the west-northwest, as shown in the wind roses in **Figure 18-3**. This pattern of winds is common for the Lower Hunter Valley and reflects the influence of the northwest to southeast alignment of the Hunter Valley. It is also clear from **Figure 18-3** that wind patterns were similar in all five years of data presented. This suggests that wind patterns do not vary significantly from year to year, and potentially the data from any of the years presented could be used as a representative year for modelling purposes.

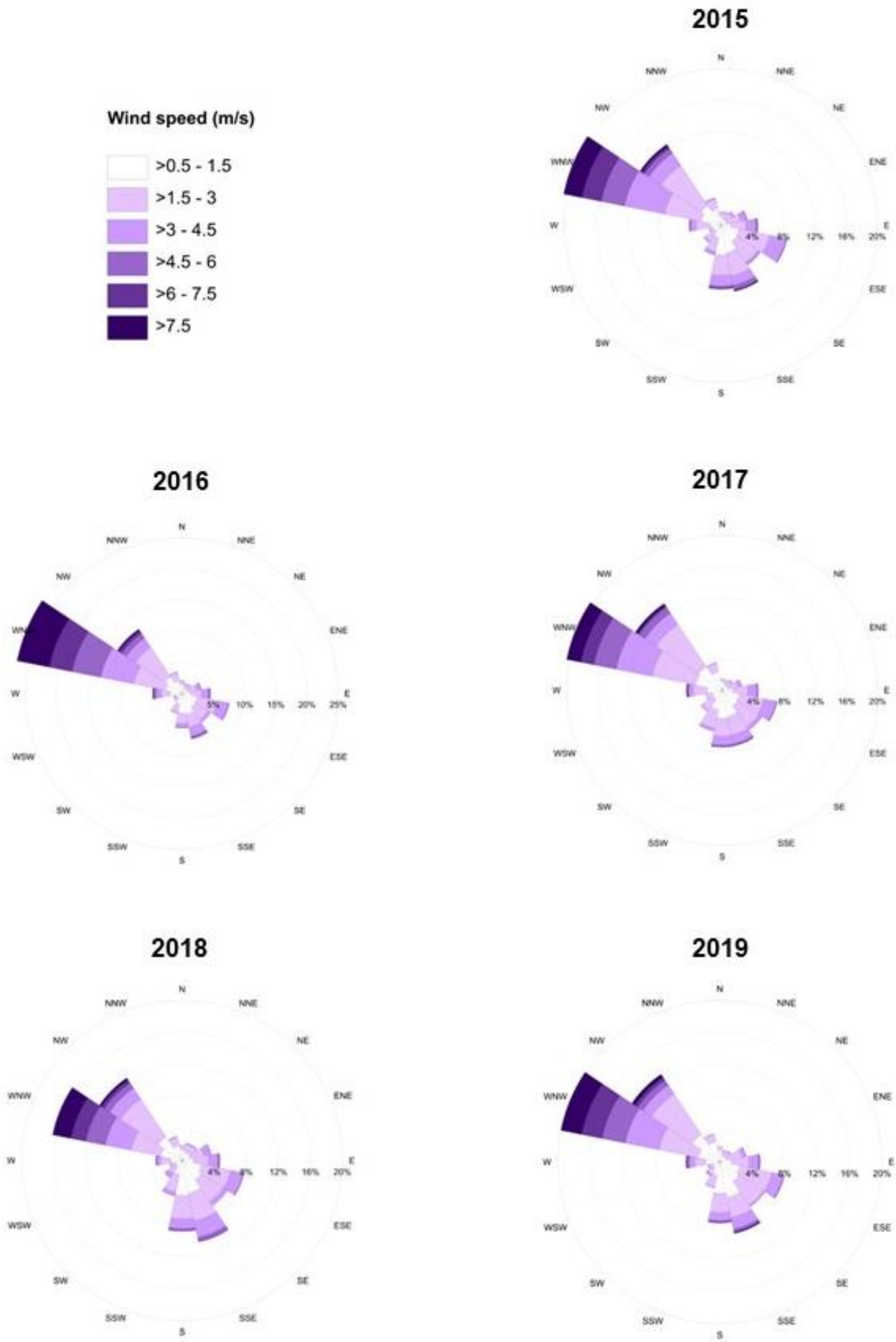

Figure 18-3 Annual wind roses for data collected at the DPIE Beresfield Station

18.4 Assessment of potential impacts

18.4.1 Air quality impacts

The project design as described in **Chapter 5** was developed using a multi-disciplinary process that identified and assessed routes against a range of engineering, environmental, social, land-use and economic criteria. This process (refer to **Chapter 4**) ultimately determined that the project alignment represented the best balance after a multi-criteria analysis of all known constraints and opportunities. The design of the project would result in free-flowing traffic conditions and reduced travel time, reducing motor vehicle emissions and the potential air quality impacts associated with these emissions compared to other alternatives considered.

Construction of the project could lead to emissions to air from a variety of activities including land clearing, earthworks, material handling, and material transport. Emissions may also arise from wind erosion of exposed areas. Construction-related emissions would mainly comprise of particulate matter in the form of:

- Total suspended particulates typically where particles are less than 30 microns in equivalent aerodynamic diameter (TSP)
- Particulate matter with equivalent aerodynamic diameter of 10 microns or less (PM_{10})
- Particulate matter with equivalent aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$).

Relatively minor emissions (i.e. smaller quantities) may also be generated from construction machinery exhausts such as CO, oxides of nitrogen (NO_x), PM_{10}, $PM_{2.5}$ and some HC. Odour and other volatile organic compounds also have the potential to be generated from asphalt batching, and the handling of potentially contaminated soils. Due to the relatively minor emissions anticipated (compared with operational traffic emissions), exhaust emissions from plant and equipment are not identified as a key issue. In addition, the UK IAQM notes that these emissions are unlikely to have a significant impact on local air quality.

Operation of the project could lead to emissions to air from vehicles using both the existing and modified road network. There are a variety of air pollutants associated with road vehicles with the most significant pollutants, in terms of potential impacts to health, being:

- CO
- NO_x, representing the total of nitrogen oxide (NO) and NO_2
- Particulate matter as PM_{10} and $PM_{2.5}$
- HC.

These pollutants may be generated from the combustion of fuel and emitted via the exhaust system. Particulate matter emissions may also be also generated from brake and tyre wear, as well as re-suspended road dust.

CO is widespread in an urban environment and comes from the burning of fuels that contain carbon, such as petrol, diesel or gas in motor vehicles. CO is absorbed into the bloodstream much more readily than oxygen so that small amounts of it inhaled can affect bodily function.

The main source of NO_x in the urban atmosphere is from the combustion of fossil fuels (petrol, diesel, coal, gas). NO_x emitted from combustion activities include NO and NO_2. While NO is generally not harmful to humans at the concentrations normally found in urban environments, NO_2 is known to affect the throat and the lungs.

Particulate matter in the atmosphere can have an adverse effect on health and amenity. The health effects of particles are largely related to the extent to which they can penetrate the respiratory tract. Common sources of particulate matter less than 10 microns (PM_{10}) include sea salt, pollen and combustion activities such as motor vehicles and industrial processes. High levels of PM_{10} particles in the air can irritate the eyes and throat, while finer particles can impair lung function.

HCs such as benzene have an adverse effect on human health, but the effects are thought to occur at concentrations higher than the levels of exposure found at roadsides from traffic emissions.

18.4.2 Construction impacts

Dust impacts

Dust is the key air quality issue during construction. Dust emissions from construction works have the potential to cause nuisance impacts if not properly managed. Air quality impacts to the study area during construction would largely result from vegetation clearing, topsoil stripping, lime stabilisation of soils and lime neutralisation of acid sulphate soils, demolition of redundant assets, stockpiling of soil operation, of batch plants, and general material handling.

As described in **Section 18.3**, the UK IAQM was used to assess the potential for dust impacts within the study area during construction of the project using a four-step assessment procedure. The findings of each step are presented in the following sections.

Step 1 (screening review)

Step 1 involved a screening review to confirm the presence of human and ecological receptors near the project that may be impacted by the proposed work. The IAQM considers human receivers as any location where people spend some period of time and where property may be impacted by dust, and ecological receivers as any ecological areas that might be sensitive to dust impacts. This definition is considered to include threatened ecological communities, as well as ecologically sensitive commercial developments. Based on the UK IAQM methodology, a study area of 350 metres from the construction footprint, extending to about 500 metres of site egress points has been adopted for human receivers, and a study area of 50 metres from the construction footprint extending to about 500 metres of site egress points has been adopted for ecological receivers (IAQM 2014).

As there are human and ecological receivers located within the construction footprint setback distances identified above, it was determined that the next stages of the assessment would be required.

Step 2 (risk assessment)

Step 2 involved a risk evaluation of dust impacts during construction. This step is further divided into three steps which are described in the following sections.

Step 2A (potential for dust emissions)

Step 2A involved estimating the magnitude of potential dust emissions associated with the project's construction activities. The magnitude of potential emissions was evaluated by considering the scale and nature of the anticipated activities and assigned a classification of large, medium or small. The dust emission magnitude classifications for the project and their corresponding IAQM classification are shown in **Table 18-9**.

Table 18-9 Dust emission magnitude classifications determined for the project

Activity	Potential dust emission magnitude classification	Corresponding classification (IAQM 2014)
Demolition	Medium	Total building volume 20,000 to 50,000m^3, potentially dusty construction material, demolition activities 10 to 20m above ground.
Earthworks	Large	Total site area greater than 10,000m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), more than 10 heavy earth moving materials active at any one time, formation of bunds greater than eight metres in height, total materials moved exceeding 100,000t.
Construction	Large	Total building volume greater than 100,000m^3, on-site concrete batching, sandblasting
Trackout	Large	More than 50 heavy vehicle movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road lengths greater than 100m.

Step 2B (sensitivity of surrounding local environment)

Step 2B involved the evaluation of the sensitivity of the receiving environment described in Step 1. The sensitivity of the surrounding receiver areas to the effects of dust soiling and human health and ecosystem impacts were classified based on:

- The specific sensitivities of receptors in the area
- The proximity and number of nearby receivers
- Local background air quality conditions characterised based on PM_{10} concentrations
- Site-specific factors such as whether natural shelters are present, to reduce the risk of wind-blown dust.

The dust soiling, human health and ecological sensitivity classifications during the four assessed activities (demolition, earthworks, construction and trackout) for the project were all determined to be 'high' (refer to **Table 18-10**). Further detail regarding the methodology used to determine these sensitivities is provided in the Air Quality Working Paper (**Appendix R**).

Table 18-10 Surrounding receiver sensitivity classifications determined for the project

Potential impact	Surrounding receiver sensitivity rating	Corresponding classification (IAQM 2014)
Dust soiling	High	Surrounding land where: • Users can reasonably expect enjoyment of a high level of amenity • The appearance, aesthetics or value of a property would be diminished by soiling • The people or property would reasonably be expected to be present continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land.
Human health impacts	High	Locations where members of the public are exposed over a time period relevant to the air quality criteria for PM_{10}. Indicative examples include residential properties. Hospitals, schools and residential care homes should also be considered as having equal sensitivity to residential areas for the purpose of this assessment.

Potential impact	Surrounding receiver sensitivity rating	Corresponding classification (IAQM 2014)
Ecological effects	High	Locations with an international or national designation and the designated features may be affected by dust soiling. Locations where there is a community of particularly dust sensitive species

Step 2C (Evaluation of the risk of dust impacts)

The potential dust emission magnitude ratings determined in Step 2A and the surrounding area sensitivity classifications determined in Step 2B were combined in Step 2C to identify the risk of unmitigated impacts. **Table 18-11** lists unmitigated construction dust risk values associated with construction activities. As shown in **Table 18-11**, the highest unmitigated risk rating determined for the project was 'high risk', the highest risk rating classification under the UK IAQM. Dust soiling, impact to human health and ecological effects are considered high risk during earthworks, construction and trackout activities. Further detail on high risk rating classifications is described in the Air Quality Working Paper (**Appendix R**).

Table 18-11 Unmitigated construction dust risk values for the project

Activity	Potential impact		
	Dust soiling	Human health impacts	Ecological effects
Demolition	Medium risk	Medium risk	Medium risk
Earthworks	High risk	High risk	High risk
Construction	High risk	High risk	High risk
Trackout	High risk	High risk	High risk

Step 3 (mitigation and management)

As shown in **Table 18-11**, a 'high' potential risk was the highest unmitigated level determined for the construction of the project. This outcome represents the worst case, unmitigated outcome across the whole project. Based on this result, measures commensurate to this level of risk have been recommended with guidance from the IAQM method. These measures include the preparation and implementation of an Air Quality Management Plan (AQMP) and are presented in **Section 18.5**.

Step 4 (residual risks)

Based on the application of the measures detailed in **Section 18.5**, residual risks from key activities during construction are considered to be reduced to the extent where impacts could be effectively managed. Adverse residual dust impacts as a result of the project construction activities are therefore not anticipated.

Odour impacts

Odour from asphalt batching plants, the handling of potentially contaminated materials and mulch stockpiles has the potential to impact on sensitive receivers throughout local communities during construction.

Asphalt batching plants

Odour is one of the key air quality issues for asphalt batching plants, with the most significant emissions arising from the dryer, storage tanks and loadout areas. Potential locations for asphalt batching plants in Black Hill, Tarro, Tomago and Heatherbrae have been considered based on the construction report prepared for the project. The number of asphalt plants would be dependent on the construction needs for the project. Each necessary plant would occupy an area of approximately one hectare.

Based on the typical odour levels from an asphalt batching plant, the 99th percentile odour levels as a function of distance from a plant producing 100 tonnes per hour of asphalt were modelled based on simulated meteorological conditions as described in the Air Quality Working Paper (**Appendix R**). These results reflect an assumed production and anticipated operating arrangements of a typical plant and are therefore indicative of the expected odour levels. Based on these 99th percentile odour levels, it was determined that if a temporary project-specific asphalt batching plant is required it should be located a minimum of 300 metres from the closest residence. This is reflected in the environmental management measures described in **Section 18.5**. It is noted that odour impacts from asphalt laying have not been assessed due to the temporary nature of the work.

Contaminated materials

The following contaminated materials have been identified as potentially resulting in odour impacts during construction:

- ASS
- Buried waste and asbestos waste at Tarro and Tomago
- Illegally dumped waste at various locations
- Hunter River sediments.

When exposed during construction actives, ASS has the potential to oxidise and generate odours by releasing hydrogen sulphide gas. As identified in **Chapter 16** (soils and contamination), a number of AOPCRs contain or potentially contain ASS. Given that ASS will be handled, tested, treated and reused during construction in accordance with the ASSMP to minimise environmental impacts, including odour impacts, ASS are not considered likely to result in significant odour impacts.

Buried waste, asbestos waste and illegally dumped waste may result in odour impacts through exposure of unknown contaminants. As identified in **Chapter 16** (soils and contamination), buried waste, asbestos waste and illegally dumped waste would be managed through unexpected contamination procedures. As a result, disturbance of these wastes during construction is not considered likely to result in significant odour impacts.

Further consideration of contamination impacts, such as from disturbance of Hunter River sediments, would confirm specific remediation, treatment and management requirements for areas of potential contamination risk, and odour from contamination, prior to construction. With the implementation of the environmental management measures described in **Section 18.5**, adverse odour impacts are not anticipated.

Mulch

Mulch would be generated by clearing of vegetation. Construction of the project is estimated to generate about 75,000 cubic metres of mulch, about half of which would be stockpiled within ancillary facilities for landscape planting and site rehabilitation.

While odour from the generation and stockpiling of mulch would generally be of a fresh cut wood or soil nature, mulch stockpiles have potential to cause offensive odours due to the accumulation of odorous decomposition products. Mulch would be turned regularly to prevent accumulation of odorous decomposition products and minimise odour impacts.

18.4.3 Operational impacts

The potential operational impacts of the project have been quantified using dispersion modelling for the scenarios described in **Section 18.2.4**. Traffic network changes assumed for these scenarios are described in the Traffic and Transport Working Paper (**Appendix G**).

Results from the traffic modelling have been assessed by examining the spatial differences between with and without project scenarios, and also in terms of the potential for the project to cause exceedances of NSW EPA air quality impact assessment criteria at sensitive receivers. Where the project would result in a decrease in the concentrations of key air quality indicators, due to the redirection of traffic that would result from the project, this has been identified within this section.

Operation of the project would lead to a redistribution of vehicle emissions across the road network, generally from existing main roads to the proposed new roads. The highest concentrations of key air quality indicators are expected to occur close to main roads under all 'with project' and 'without project' scenarios (refer to **Section 18.2.4**). Increases in the concentrations of key air quality indicators, due to the project, are generally expected in areas where there are no existing main roads such as east of Tarro, north of the Hunter River. In these locations there are generally few sensitive receivers. Decreases are expected to occur along the existing main connection from the M1 Pacific Motorway to Heatherbrae, and most significantly from Tarro to the Hexham Bridge.

Carbon monoxide

The predicted CO concentrations within the study area for each project scenario are shown in **Figure 18-4** to **Figure 18-7**. These results represent the contribution of emissions from those roads that are expected to undergo the most change as a result of the project. In summary:

- The highest 1-hour and 8-hour average CO concentrations are predicted to occur close to existing main roads and where applicable, the project, as this is where traffic would be concentrated
- The highest maximum 1-hour average CO concentrations are predicted to be in the order of 2000 to 5000µg/m^3 under all scenarios (refer to **Figure 18-4**)
- Increases in the maximum 1-hour average CO concentrations are expected in areas where there are no existing main roads such as east of Tarro, north of the Hunter River where there are few sensitive receivers (refer to **Figure 18-5**). Some decreases in maximum 1-hour average CO concentrations are expected along the New England Highway, east of Quarter Sessions Road where there are sensitive receivers
- The highest maximum 8-hour average CO concentrations are predicted to be in the order of 1000 to 2000µg/m^3 under all scenarios (refer to **Figure 18-6**)
- Increases in maximum 8-hour average CO concentrations are expected in areas where there are no existing main roads (refer to **Figure 18-7**). Some decreases in maximum 8-hour average CO concentrations are expected along the M1 Pacific Motorway, south of John Renshaw Drive, along the New England Highway, east of Quarter Sessions Road, and in the vicinity of the existing Hexham Bridge.

The predicted changes in CO concentrations due to the project (both increases and decreases) represent less than five per cent of the NSW EPA air quality assessment criteria. These changes are also within the range of historically measured fluctuations in CO concentrations for the region (refer to **Table 18-4**).

Table 18-12 provides a summary of the model results at the selected sensitive receivers. These results show that, at the selected sensitive receivers and local communities located near main roads along the proposed route, the project would lead to very little change to maximum CO concentrations. The changes in CO concentrations are predicted to be less than one per cent of the NSW EPA criteria. Accordingly, the project would not cause exceedances of the NSW EPA air quality impact assessment criteria.

Table 18-12 Predicted CO concentrations at selected sensitive receivers

Location	Criterion	Concentration due to modelled sources					Background level	Cumulative with project concentrations[1]	
		2017	2028DN	2028WP	2038DN	2038WP		2028	2038
Maximum 1-hour average CO (µg/m3)									
R1	30000	266	465	464	432	459	2400	2399	2427
R2		402	344	451	292	355		2507	2463
R3		585	479	651	348	588		2572	2641
R4		811	725	851	520	665		2526	2545
R5		1087	778	791	690	735		2413	2445
R6		817	716	663	495	542		2347	2448
R7		157	162	212	129	176		2450	2447
R8		167	224	228	198	221		2404	2423
R9		163	299	397	253	333		2498	2480
Maximum 8-hour average CO (µg/m3)									
R1	10000	135	244	221	197	215	1700	1676	1717
R2		214	193	238	155	208		1745	1753
R3		287	221	330	163	328		1809	1865
R4		449	345	431	264	383		1786	1819
R5		575	449	444	374	408		1696	1735
R6		383	345	366	272	297		1721	1725
R7		93	88	107	70	94		1719	1724
R8		96	120	127	101	122		1706	1721
R9		93	160	216	145	192		1756	1747

[1] This is the background level plus the difference between the 'with project' and 'without project' scenarios

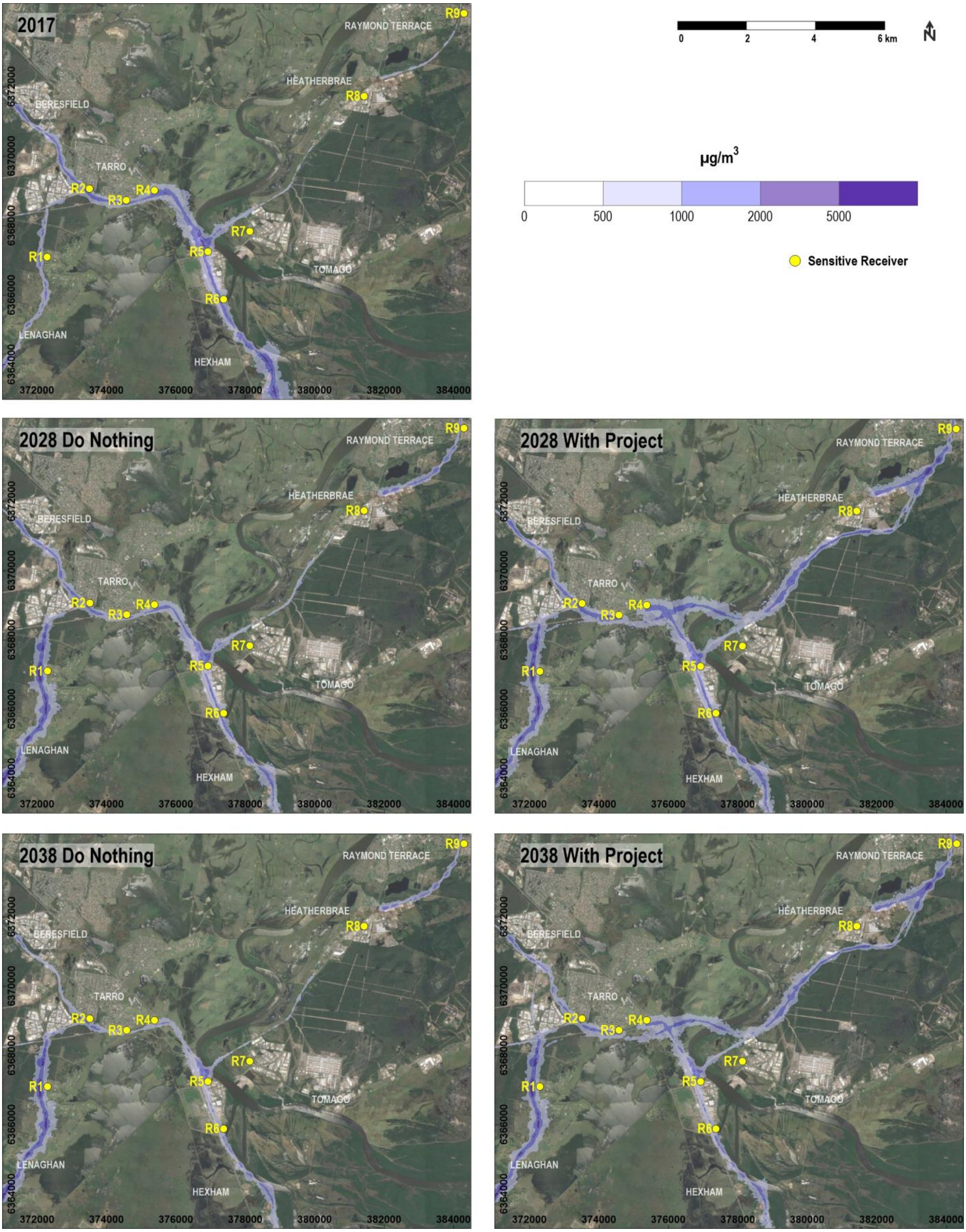

Figure 18-4 Predicted maximum 1-hour average CO

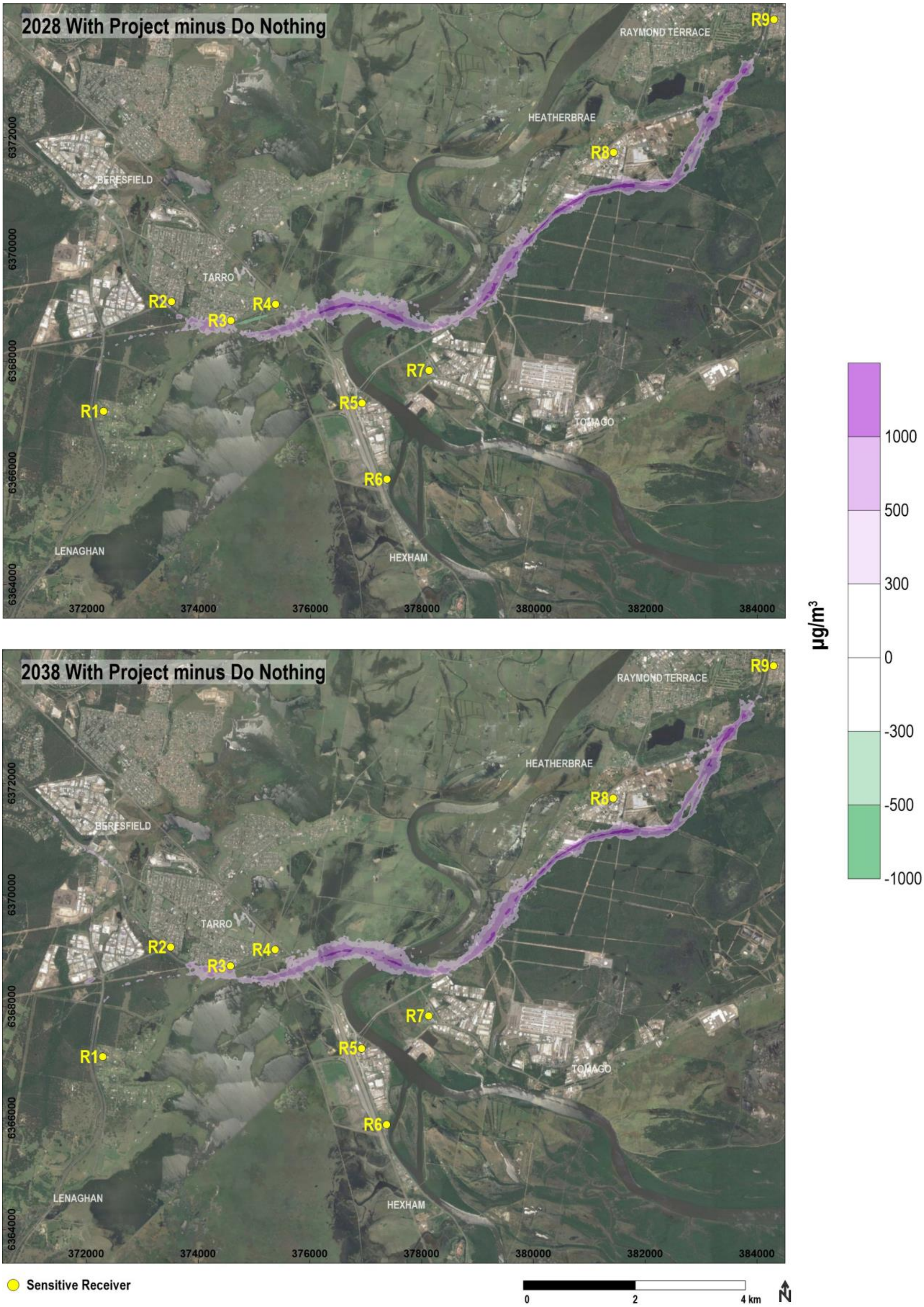

Figure 18-5 Predicted change in maximum 1-hour average CO

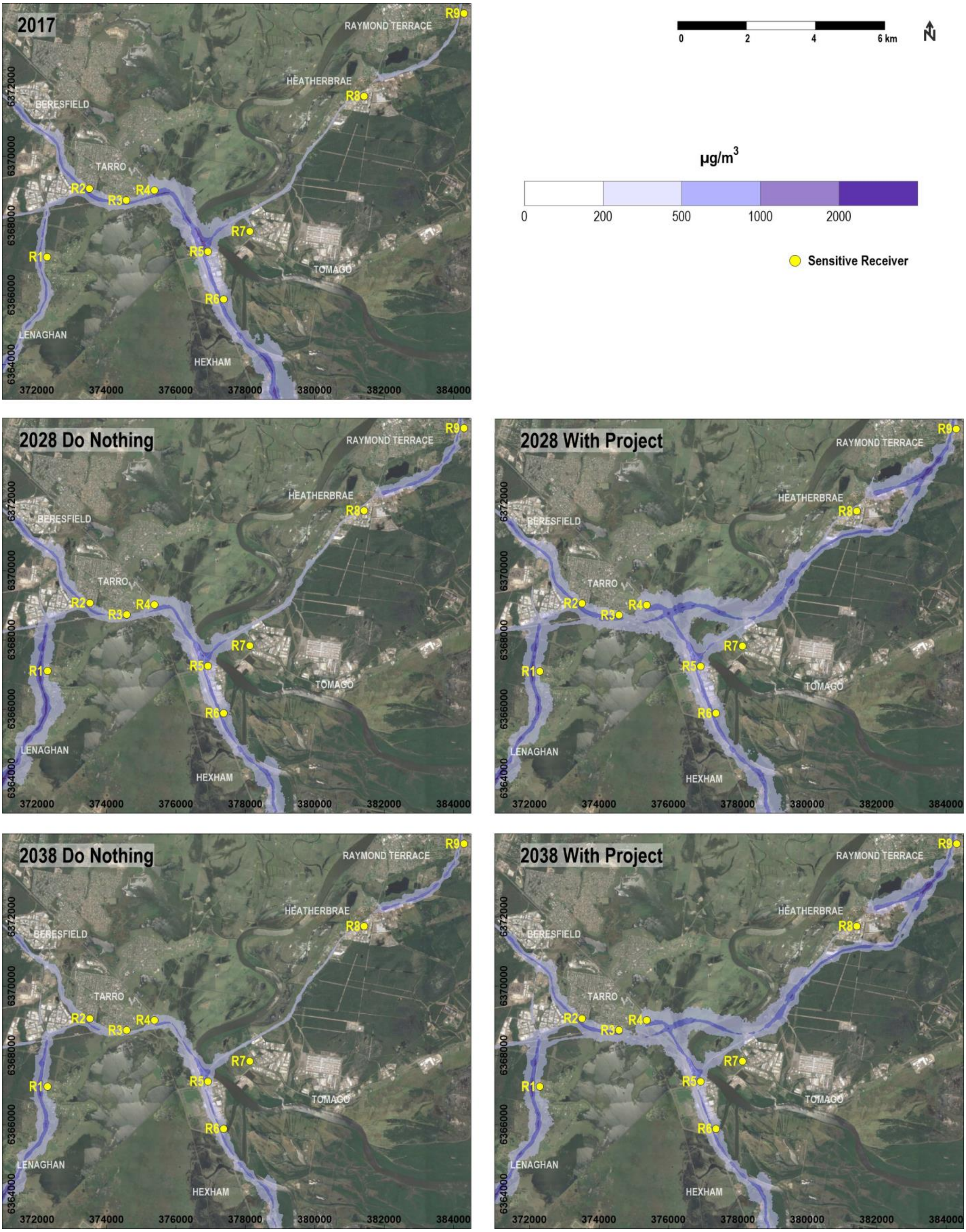

Figure 18-6 Predicted maximum 8-hour average CO

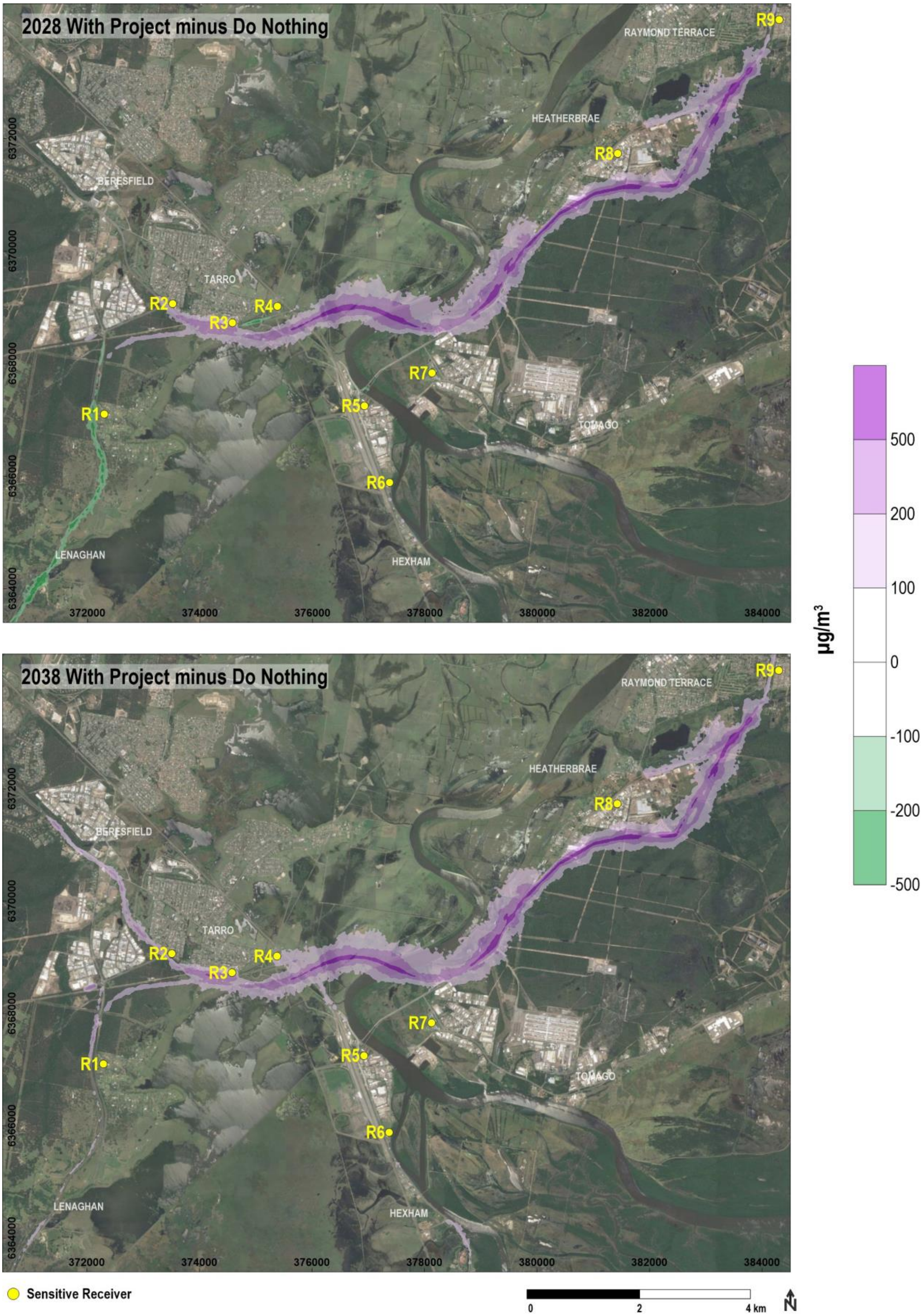

Figure 18-7 Predicted change in maximum 8-hour average CO

Nitrogen dioxide

The predicted NO_2 concentrations within the study area for each project scenario are shown in **Figure 18-8** to **Figure 18-11**. These results represent the contribution of emissions from those roads that are expected to undergo the most change as a result of the project. In summary:

- The highest 1-hour and annual average NO_2 concentrations are predicted to occur close to existing main roads and where applicable, the project, as this is where traffic would be concentrated
- The highest maximum 1-hour average NO_2 concentrations are predicted to be in the order of 100 to 200µg/m^3 for all scenarios (refer to **Figure 18-8**)
- Increases in the maximum 1-hour average NO_2 concentrations are generally expected in areas where there are no existing main roads such as east of Tarro, north of the Hunter River where there are few sensitive receivers (refer to **Figure 18-9**). Decreases in maximum 1-hour average NO_2 concentrations are expected along the New England Highway, east of Quarter Sessions Road, and on the Pacific Highway around the Hexham Bridge where sensitive receivers are located
- The highest annual average NO_2 concentrations are predicted to be in the order of 20 to 50µg/m^3 under all scenarios (refer to **Figure 18-10**). The greatest changes in annual average NO_2 concentrations are predicted at the New England Highway at Tarro
- Increases in annual average NO_2 concentrations are generally expected in areas where there are no existing main roads such as east of Tarro, north of the Hunter River where there are few sensitive receivers (refer to **Figure 18-11**). Decreases in annual average NO_2 concentrations are expected along the existing connection from the M1 Pacific Motorway to Heatherbrae (specifically, from M1 Pacific Motorway, New England Highway, Hexham Bridge and Pacific Highway), with the highest decreases from Tarro to the Hexham Bridge where sensitive receivers are located.

The predicted maximum changes in NO_2 concentrations due to the project (both increases and decreases in 1-hour averages) are generally within the range of historically measured fluctuations in maximum NO_2 concentrations for the region (refer to **Table 18-5**).

Table 18-13 provides a summary of the model results at the selected sensitive receivers. These results show that, at the selected sensitive receivers and local communities located near main roads along the proposed route, the project would lead to very little change to maximum and annual NO_2 concentrations, relative to background levels. Accordingly, the project would not cause exceedances of the NSW EPA air quality impact assessment criteria.

Table 18-13 Predicted NO_2 concentrations at selected sensitive receivers

Location	Criterion	Concentration due to modelled sources					Background level	Cumulative with project concentrations[1]	
		2017	2028DN	2028WP	2038DN	2038WP		2028	2038
Maximum 1-hour average NO_2 (µg/m³)									
R1	246	25	30	33	30	38	105	108	113
R2		36	32	37	39	36		111	102
R3		50	36	43	36	39		112	108
R4		84	78	47	53	54		74	107
R5		112	74	84	70	61		115	96
R6		75	52	50	42	47		103	109
R7		20	18	17	18	18		104	105
R8		21	25	24	24	19		104	100
R9		14	18	27	19	21		114	107
Annual average NO_2 (µg/m³)									
R1	62	3	4	4	4	4	17	17	17
R2		8	5	6	6	5		17	17
R3		9	6	5	6	5		16	16
R4		12	7	6	7	6		16	16
R5		18	12	12	12	11		17	16
R6		13	8	9	8	8		18	17
R7		3	3	2	2	2		17	17
R8		3	3	2	3	2		16	16
R9		2	2	3	2	3		18	17

[1] This is the background level plus the difference between the 'with project' and 'without project' scenarios

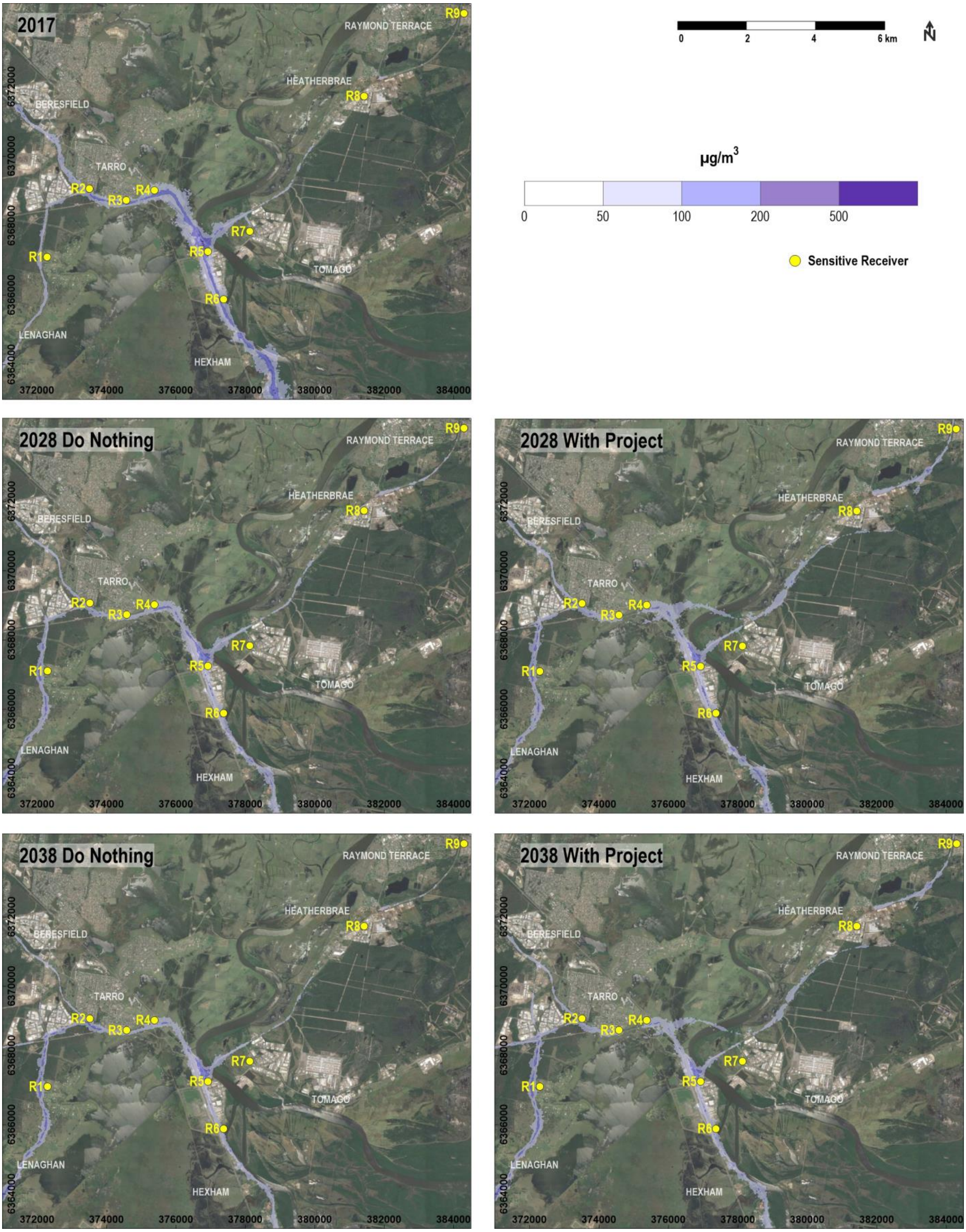

Figure 18-8 Predicted maximum 1-hour average NO_2

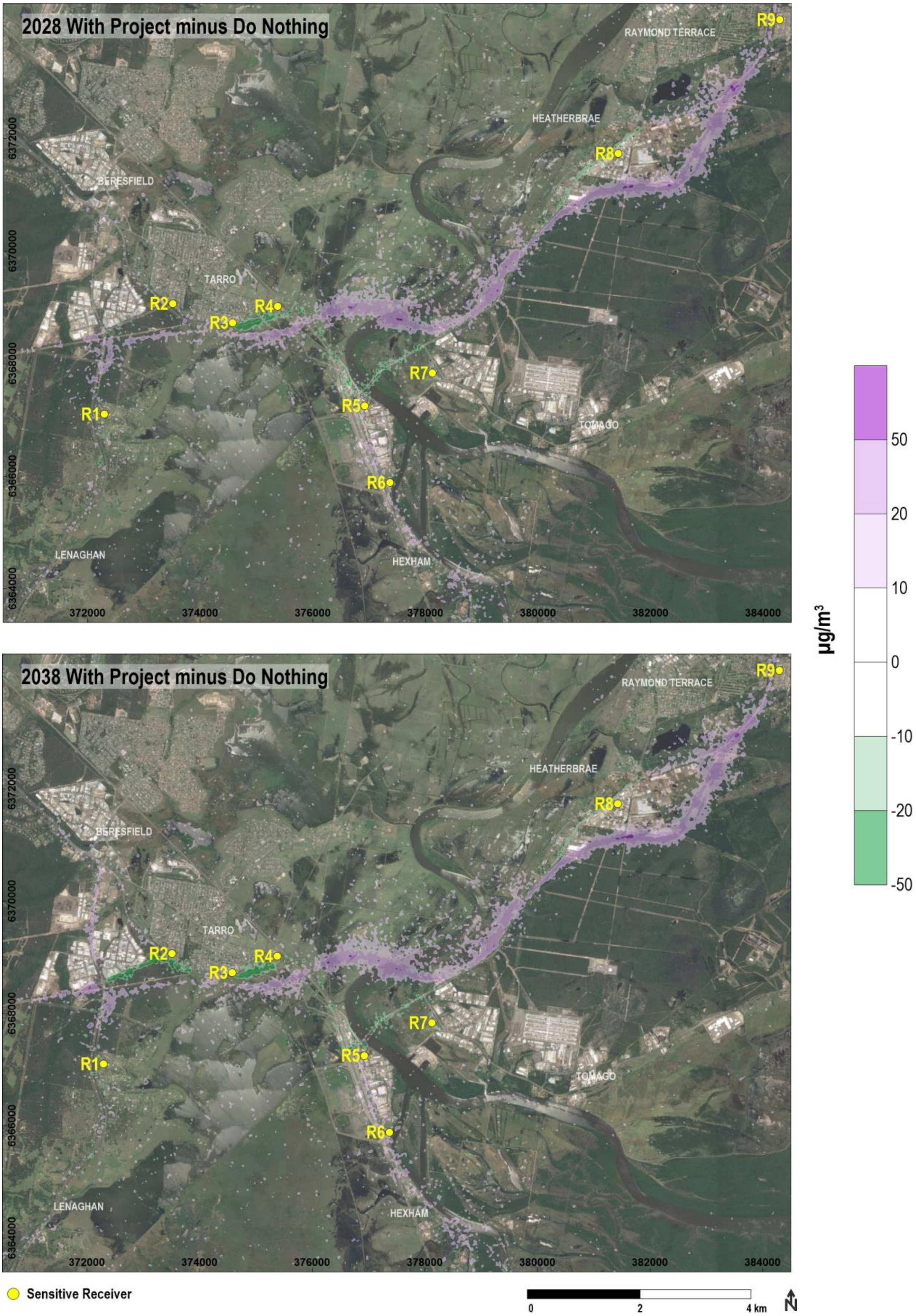

Figure 18-9 Predicted change in maximum 1-hour average NO_2

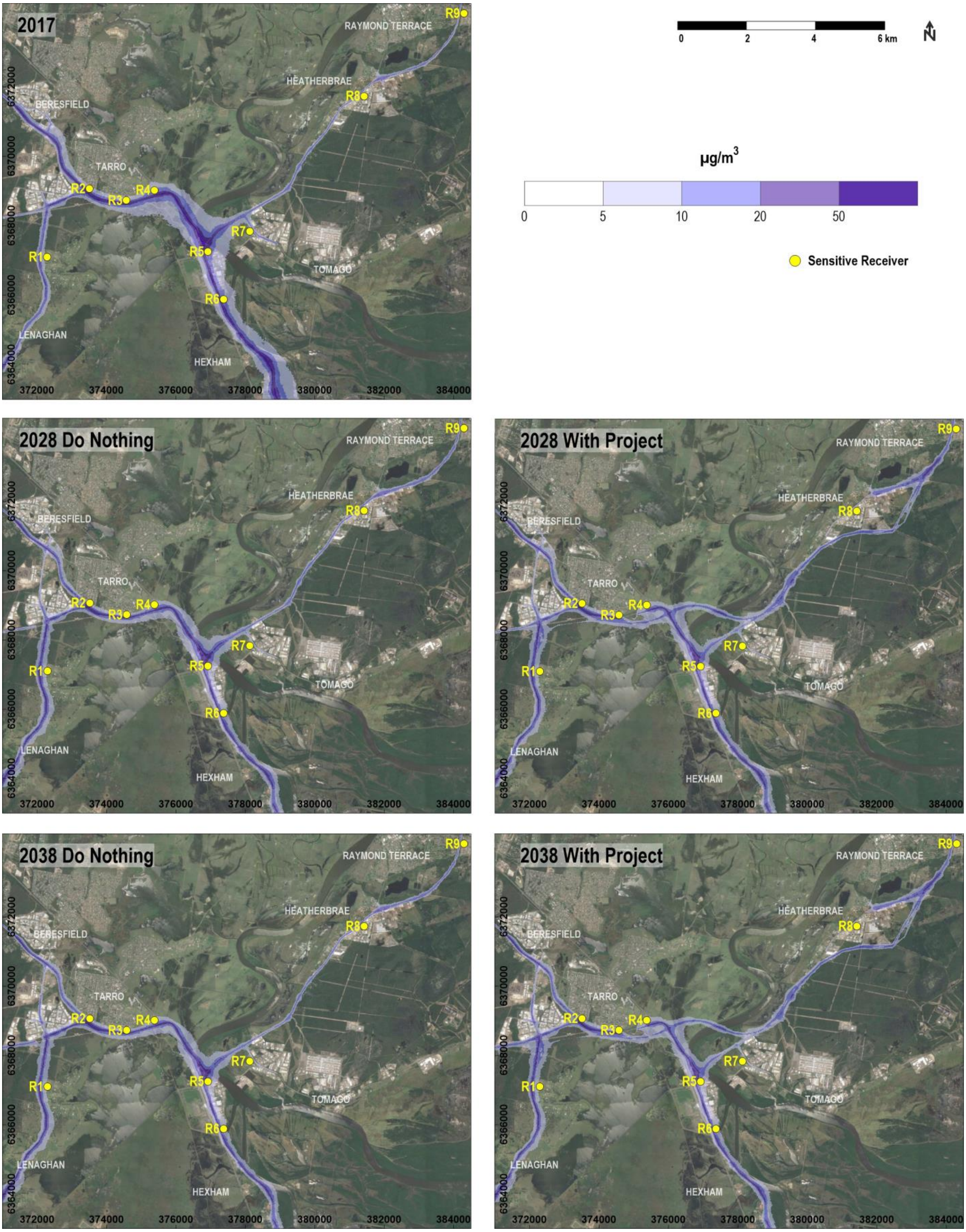

Figure 18-10 Predicted annual average NO_2

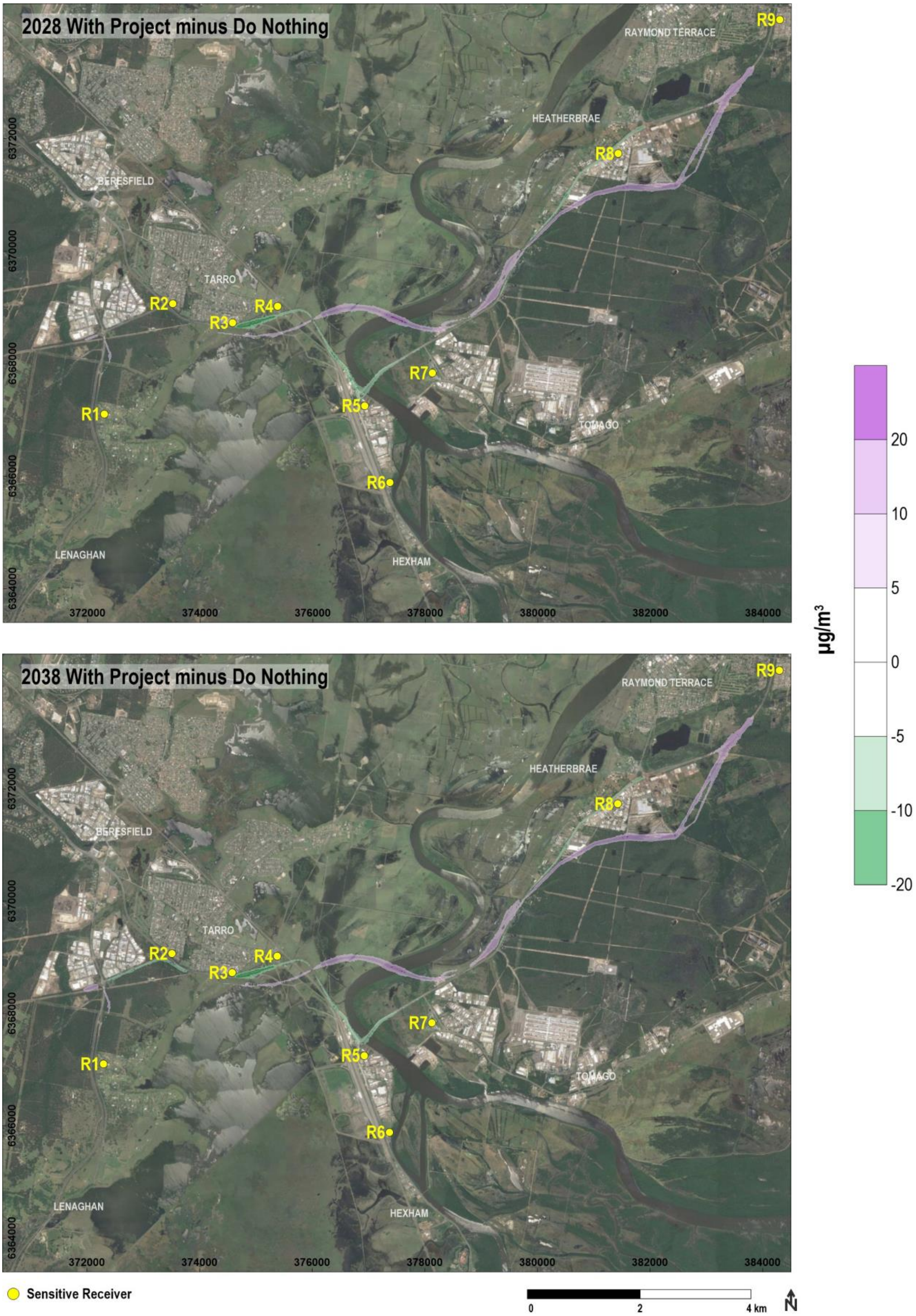

Figure 18-11 Predicted change in annual average NO_2

PM_{10}

The predicted PM_{10} concentrations within the study area for each project scenario are shown in **Figure 18-12** to **Figure 18-15**. These results represent the contribution of emissions from those roads that are expected to undergo the most change as a result of the project. In summary:

- The highest 24-hour and annual average PM_{10} concentrations are predicted to occur close to existing main roads and where applicable, the project, under all scenarios, as this is where traffic would be concentrated
- The highest maximum 24-hour average PM_{10} concentrations are predicted to be in the order of 20µg/m^3 under all scenarios (refer to **Figure 18-12**). The greatest changes in concentration are predicted on the main roads around the existing Hexham Bridge, including Maitland Road and the Pacific Highway
- Increases in the maximum 24-hour average PM_{10} concentrations are generally expected in areas where there are no existing main roads such as east of Tarro, north of the Hunter River where there are few sensitive receivers (refer to **Figure 18-13**). Decreases in maximum 24-hour average PM_{10} concentrations are expected along the existing connection from the M1 Pacific Motorway to Heatherbrae (that is, from M1 Pacific Motorway, New England Highway, Hexham Bridge and Pacific Highway), with the largest decrease from Tarro to the Hexham Bridge
- The highest annual average PM_{10} concentrations are predicted to be in the order of 5 to 10µg/m^3 (refer to **Figure 18-14**). The greatest changes in concentrations are predicted on the main roads around the existing Hexham Bridge
- Increases in annual average PM_{10} concentrations as a result of the project are generally expected in areas where there are no existing main roads such as east of Tarro, north of the Hunter River where there are few sensitive receivers (refer to **Figure 18-15**). Decreases in annual average PM_{10} concentrations are expected along the existing main connection from the M1 Pacific Motorway to Heatherbrae, with the largest decrease from Tarro to the Hexham Bridge.

The predicted maximum changes in PM_{10} concentrations due to the project (both increases and decreases in maximum 24-hour and annual averages) are within the range of historically measured fluctuations in maximum PM_{10} concentrations for the region (refer to **Table 18-6**).

Table 18-14 provides a summary of the model results at the selected sensitive receivers. These results show that, at the selected sensitive receivers and local communities located near main roads along the proposed route, the project would lead to very little change to maximum 24-hour and annual average PM_{10} concentrations, relative to background levels. Accordingly, the project would not cause exceedances of the NSW EPA air quality impact assessment criteria.

Table 18-14 Predicted PM_{10} concentrations at selected sensitive receivers

Location	Criterion	Concentration due to modelled sources					Background level	Cumulative with project concentrations[1]	
		2017	2028DN	2028WP	2038DN	2038WP		2028	2038
Maximum 24-hour average PM_{10} (µg/m^3)									
R1	50	2	3	3	3	3	48	48	48
R2		3	4	5	4	4		48	48
R3		4	4	4	4	5		48	49
R4		8	9	7	8	8		47	48
R5		9	11	11	10	11		48	48
R6		6	7	8	7	8		48	49
R7		2	2	2	3	3		48	48
R8		2	4	3	4	3		47	47
R9		1	2	3	2	3		49	49
Annual average PM_{10} (µg/m^3)									
R1	25	0.2	0.6	0.5	0.6	0.5	22	22	22
R2		0.7	1.0	0.9	1.0	0.9		22	22
R3		0.8	0.9	0.8	1.0	1.0		22	22
R4		1.3	1.3	1.1	1.5	1.3		22	22
R5		2.0	2.4	2.2	2.7	2.6		22	22
R6		1.4	1.6	2.0	2.0	2.0		22	22
R7		0.4	0.5	0.4	0.5	0.5		22	22
R8		0.3	0.6	0.4	0.6	0.4		22	22
R9		0.1	0.3	0.4	0.3	0.4		22	22

[1] This is the background level plus the difference between the ‘with project’ and ‘without project’ scenarios

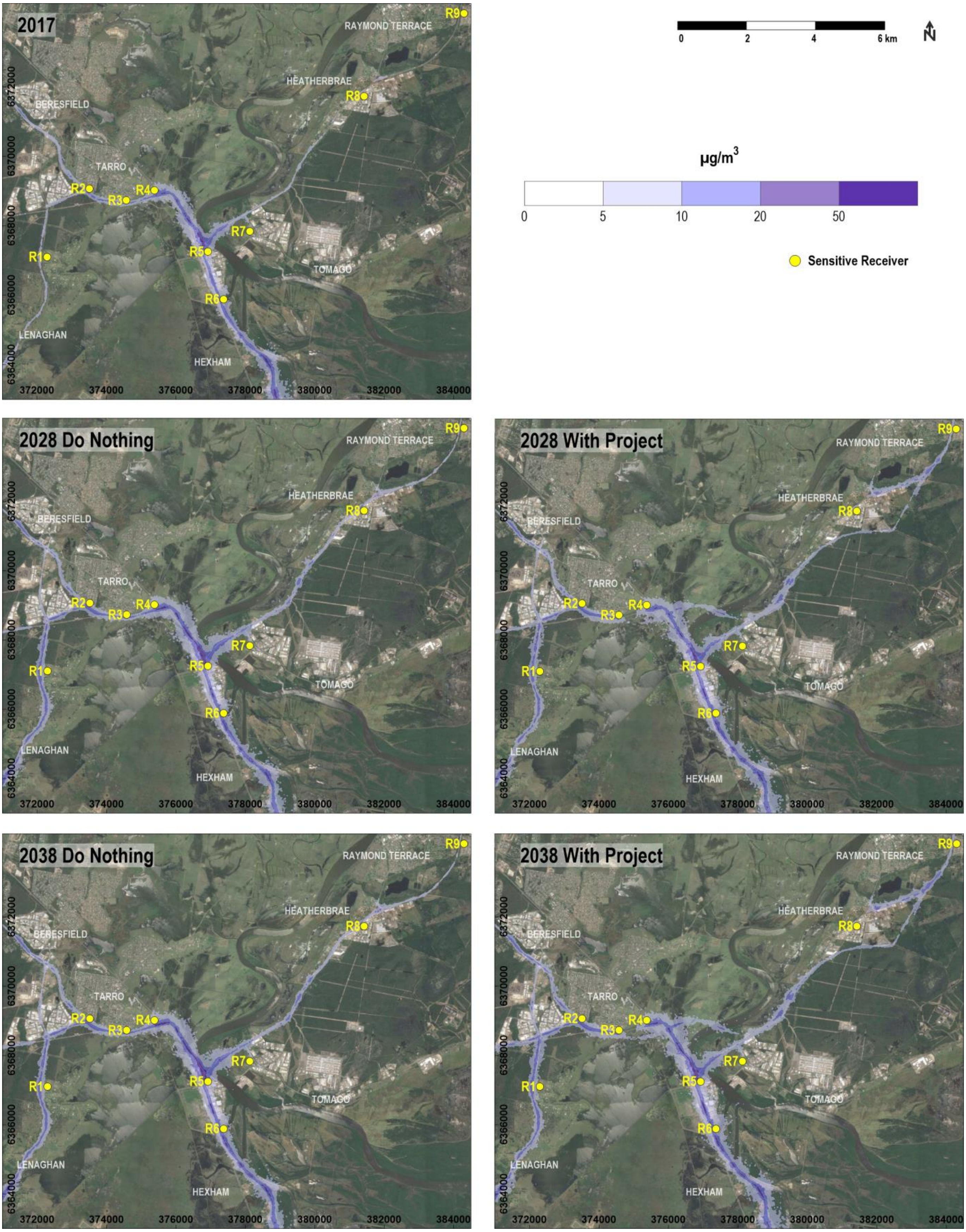

Figure 18-12 Predicted maximum 24-hour average PM_{10}

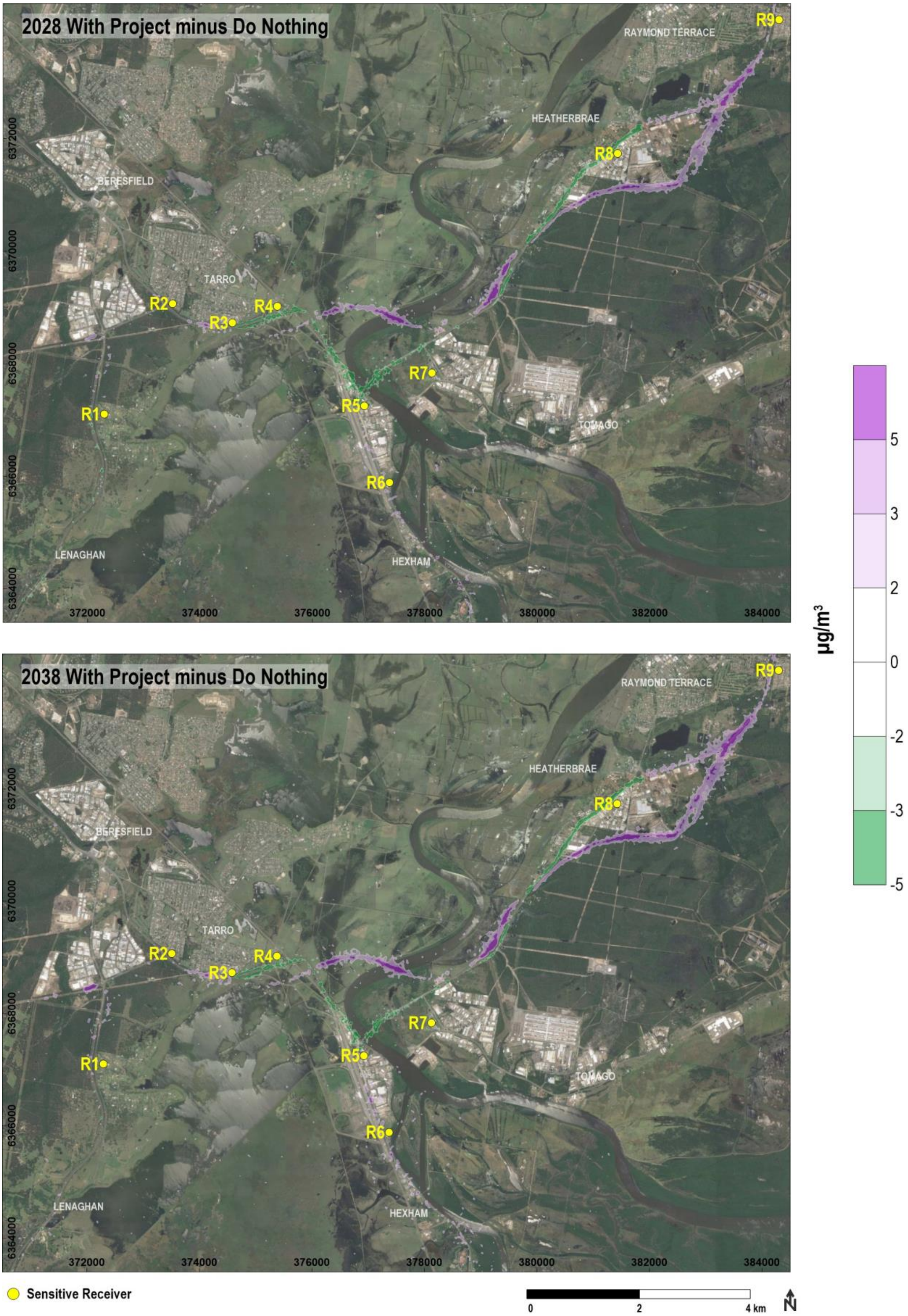

Figure 18-13 Predicted change in maximum 24-hour average PM_{10}

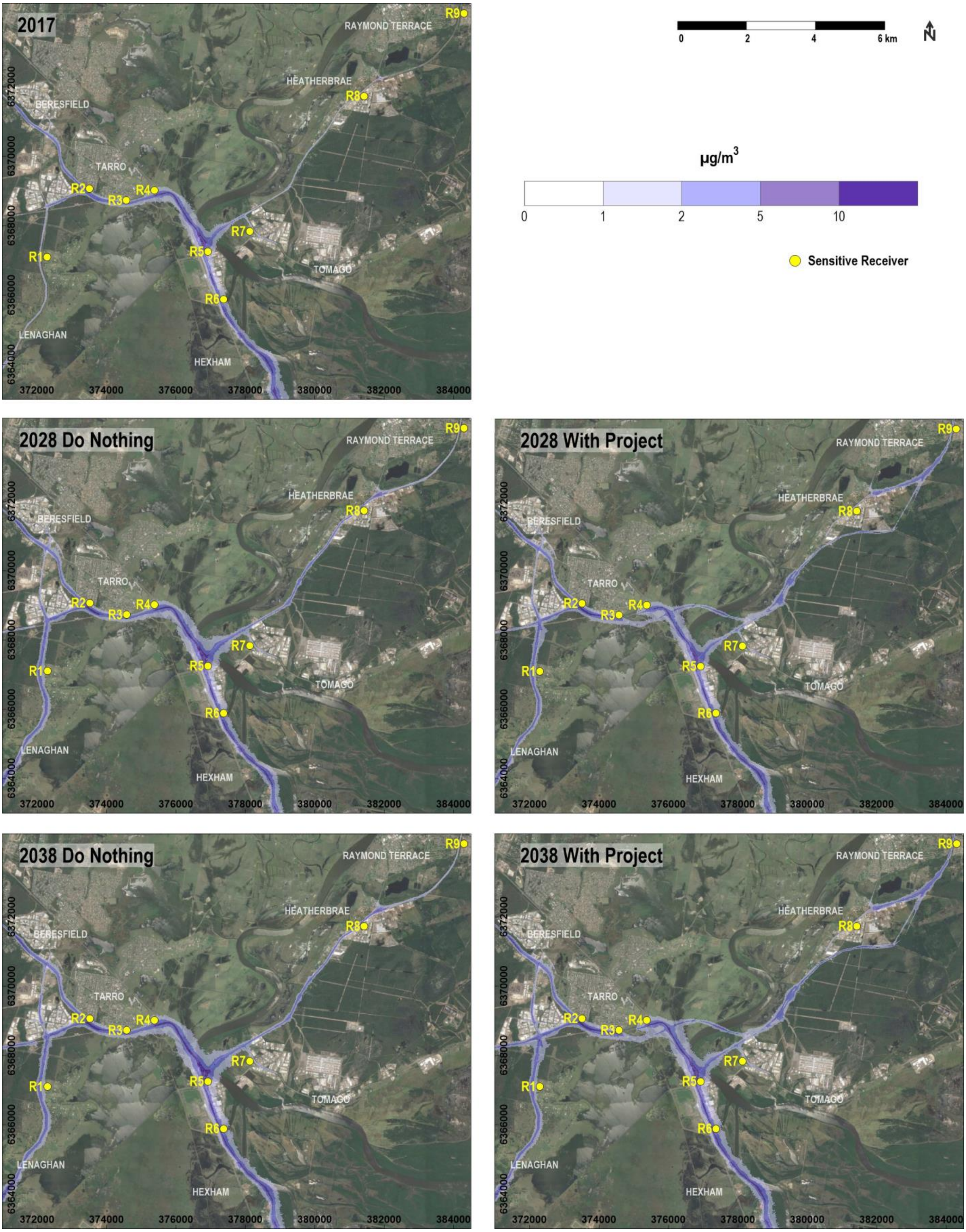

Figure 18-14 Predicted annual average PM_{10}

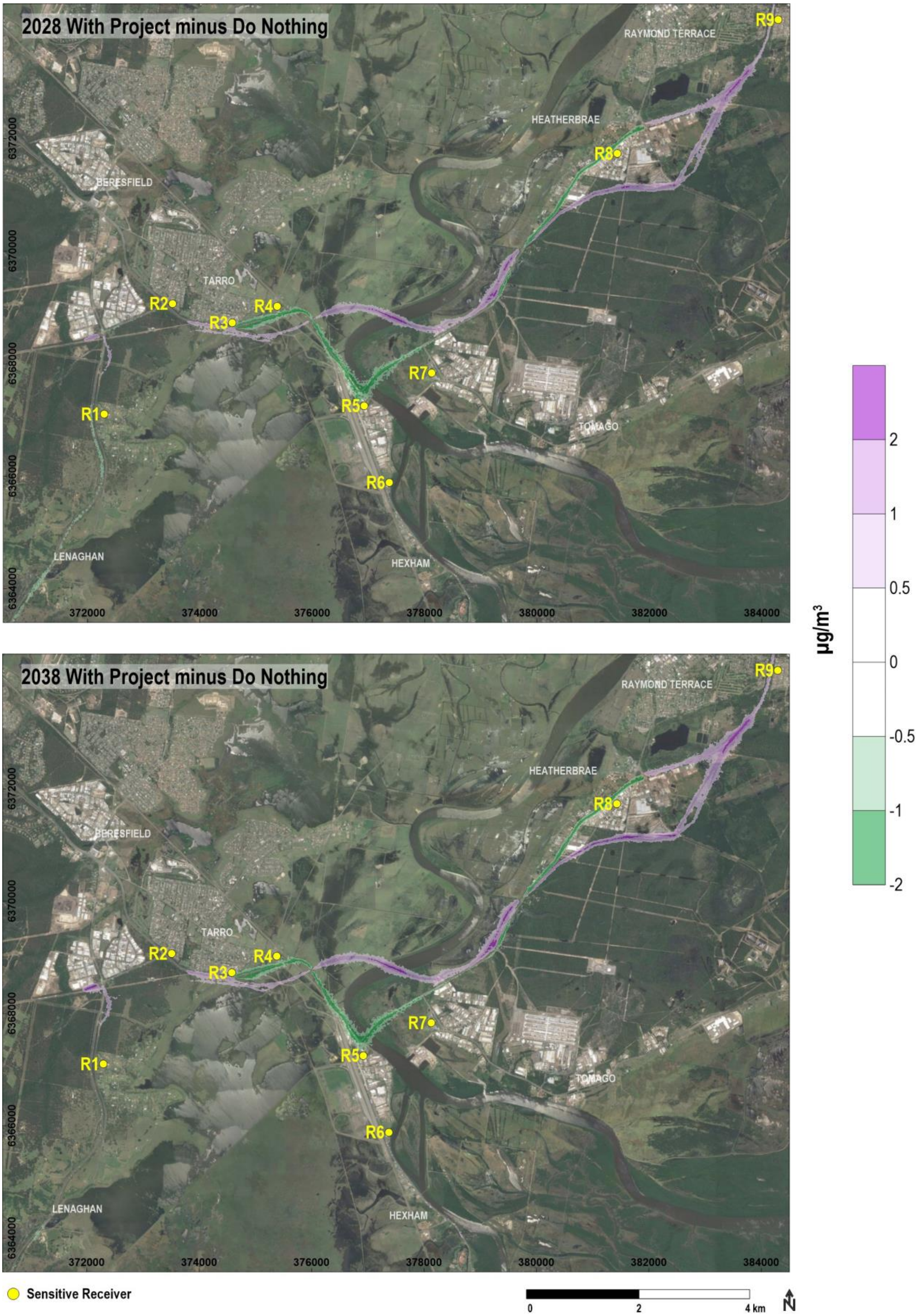

Figure 18-15 Predicted change in annual average PM_{10}

$PM_{2.5}$

As described in **Section 18.2.4**, the potential for $PM_{2.5}$ impacts has been assessed by assuming that 100 per cent of the PM_{10} is $PM_{2.5}$. **Figure 18-13** and **Figure 18-15** show model predictions of PM_{10} concentrations. On the assumption that all PM_{10} is $PM_{2.5}$, the contribution of emissions discussed for $PM_{2.5}$ would be the same as the contribution of emissions for PM_{10} discussed above.

A comparison of existing background levels to the predicted cumulative with-project concentrations shows that the predicted changes in $PM_{2.5}$ concentrations due to the project represent less than five per cent of the criteria contained within the Approved Methods. The predicted changes in $PM_{2.5}$ concentrations are within the range of historically measured fluctuations in $PM_{2.5}$ concentrations for the region.

Table 18-15 provides a summary of the model results for selected sensitive receivers. These results show that, at the selected sensitive receivers located near main roads along the main alignment, the project would lead to very little change to maximum 24-hour and annual average $PM_{2.5}$ concentrations, relative to background levels, as this is where traffic is already concentrated. Background particle levels (as $PM_{2.5}$) have historically exceeded the criteria contained within the Approved Methods, particularly in recent years due to the widespread, intense drought and smoke from bushfires and hazard reduction burning. The project would not cause additional exceedances of the criteria.

The change in annual average $PM_{2.5}$ concentration is a key metric for assessing the risk to human health. An increment change in annual average $PM_{2.5}$ of 1.7µg/m^3 has recently been determined as the criterion to manage the risk of all-cause mortality below one in 10,000 (ERM 2020). None of the selected sensitive receivers identified in **Table 18-15** are expected to experience increases in $PM_{2.5}$ concentrations above 1.7µg/m^3 due to the project, relative to either the 2017 baseline or the future without project scenarios.

Table 18-15 Predicted $PM_{2.5}$ concentrations at selected sensitive receivers

Location	Criterion	Concentration due to modelled sources					Background level	Cumulative with project concentrations[1]	
		2017	2028DN	2028WP	2038DN	2038WP		2028	2038
Maximum 24-hour average $PM_{2.5}$ (µg/m^3)									
R1	25	2.0	3.5	3.1	3.2	3.2	28	28	28
R2		3.5	4.4	4.7	3.6	4.0		28	28
R3		3.8	4.2	3.8	4.2	5.0		28	29
R4		8.2	8.6	7.4	8.0	8.2		27	28
R5		9.0	10.7	10.6	10.5	11.0		28	28
R6		5.7	7.5	8.0	6.7	7.9		28	29
R7		2.2	2.5	2.5	2.5	2.9		28	28
R8		2.4	3.5	2.8	3.6	2.7		27	27
R9		1.2	1.7	2.9	2.0	2.9		29	29

Location	Criterion	Concentration due to modelled sources					Background level	Cumulative with project concentrations[1]	
		2017	2028DN	2028WP	2038DN	2038WP		2028	2038
Annual average $PM_{2.5}$ (µg/m³)									
R1	8	0.2	0.6	0.5	0.6	0.5	8.7	8.6	8.7
R2		0.7	1.0	0.9	1.0	0.9		8.6	8.6
R3		0.8	0.9	0.8	1.0	1.0		8.6	8.7
R4		1.3	1.3	1.1	1.5	1.3		8.5	8.5
R5		2.0	2.4	2.2	2.7	2.6		8.5	8.6
R6		1.4	1.6	2.0	2.0	2.0		9.1	8.7
R7		0.4	0.5	0.4	0.5	0.5		8.6	8.7
R8		0.3	0.6	0.4	0.6	0.4		8.4	8.5
R9		0.1	0.3	0.4	0.3	0.4		8.8	8.9

[1] This is the background level plus the difference between the 'with project' and 'without project' scenarios

Air toxics

Table 18-16 presents the predicted air toxics concentrations for each emissions scenario at selected sensitive receivers. These results show that, at the selected sensitive receivers along the main alignment, air toxic concentrations would not exceed criteria contained within the Approved Methods (refer to **Table 18-2**). Lower concentrations are predicted at locations further from main roads. It is therefore concluded that the project would not lead to any adverse air quality impacts with regards to air toxics.

Table 18-16 Predicted air toxics concentrations at selected sensitive receivers

Selected sensitive receiver ID	Criterion	Concentration due to modelled sources under each scenario				
		2017 base (Existing conditions)	2028 Do Nothing	2028 With Project	2038 Do Nothing	2038 With Project
Maximum 1-hour average benzene (µg/m³)						
R1	29	2	3	3	2	3
R2	29	4	4	3	3	3
R3	29	4	3	3	3	3
R4	29	7	6	6	5	5
R5	29	8	5	6	5	6
R6	29	7	5	6	4	5
R7	29	3	2	3	2	2
R8	29	2	3	2	2	2
R9	29	2	2	2	2	2

Selected sensitive receiver ID	Criterion	Concentration due to modelled sources under each scenario				
		2017 base (Existing conditions)	2028 Do Nothing	2028 With Project	2038 Do Nothing	2038 With Project
Maximum 1-hour average formaldehyde (µg/m^3)						
R1	20	0.6	0.9	0.9	0.6	0.8
R2	20	1.0	1.0	0.7	0.8	0.9
R3	20	1.0	0.8	0.8	0.8	0.9
R4	20	2.0	1.5	1.7	1.3	1.5
R5	20	2.1	1.4	1.7	1.4	1.6
R6	20	1.8	1.2	1.6	1.2	1.4
R7	20	0.7	0.7	0.7	0.6	0.5
R8	20	0.7	0.9	0.6	0.6	0.5
R9	20	0.6	0.4	0.6	0.5	0.6
Maximum 1-hour average toluene (µg/m^3)						
R1	360	2.0	3.2	3.3	2.0	2.9
R2	360	3.6	3.6	2.5	2.8	3.0
R3	360	3.3	2.8	2.8	2.9	3.1
R4	360	6.9	5.2	5.8	4.6	5.2
R5	360	7.2	5.0	6.1	4.8	5.8
R6	360	6.2	4.4	5.7	4.1	4.9
R7	360	2.5	2.3	2.6	2.1	1.7
R8	360	2.3	3.0	2.1	2.2	1.6
R9	360	2.0	1.5	2.1	1.7	2.2
Maximum 1-hour average xylene (µg/m^3)						
R1	190	1.5	2.4	2.4	1.5	2.1
R2	190	2.6	2.7	1.8	2.0	2.2
R3	190	2.4	2.1	2.1	2.2	2.3
R4	190	5.0	3.8	4.2	3.4	3.8
R5	190	5.2	3.7	4.5	3.5	4.2
R6	190	4.5	3.2	4.2	3.0	3.6
R7	190	1.8	1.7	1.9	1.5	1.2
R8	190	1.7	2.2	1.5	1.6	1.2
R9	190	1.5	1.1	1.5	1.3	1.6

Selected sensitive receiver ID	Criterion	Concentration due to modelled sources under each scenario				
		2017 base (Existing conditions)	2028 Do Nothing	2028 With Project	2038 Do Nothing	2038 With Project
Maximum 1-hour average PAHs as benzo(a)pyrene µg/m^3						
R1	0.4	0.05	0.08	0.08	0.05	0.07
R2	0.4	0.09	0.09	0.06	0.07	0.07
R3	0.4	0.08	0.07	0.07	0.07	0.08
R4	0.4	0.17	0.13	0.14	0.11	0.12
R5	0.4	0.17	0.12	0.15	0.12	0.14
R6	0.4	0.15	0.11	0.14	0.10	0.12
R7	0.4	0.06	0.05	0.06	0.05	0.04
R8	0.4	0.06	0.07	0.05	0.05	0.04
R9	0.4	0.05	0.04	0.05	0.04	0.05

18.5 Environmental management measures

The environmental management measures that will be implemented to minimise the air quality impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 18-17**.

Table 18-17 Environmental management measures (air quality)

Impact	Reference	Management measure	Responsibility	Timing
Adverse air quality during construction	AQ01	Preparation and implementation of an Air Quality Management Plan (AQMP) to minimise risks to air quality. The AQMP will identify: • Potential sources of air pollution (including odours and dust) during construction • Air quality management objectives consistent with relevant published guidelines • Identification of all dust and odour sensitive receivers • Measures to manage dust • Requirements to separate temporary project specific asphalt batching plants, if feasible, from the nearest residences by at least 300m • Community notification and complaint handling procedures.	Contractor	Detailed design/ prior to construction

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19. Waste

This chapter describes the potential waste impacts that may be generated by the construction and operation of the project and presents the approach to the management of these impacts.

The desired performance outcome for the project relating to waste, as outlined in the SEARs, is to:

- Ensure that all wastes generated during the construction and operation of the project are effectively stored, handled, treated, reused, recycled and/or disposed of lawfully and in a manner that protects environmental values.

Table 19-1 outlines the SEARs that relate to waste and identifies where they are addressed in this EIS. The full assessment of waste impacts is provided in the Waste Working Paper (**Appendix S**).

Table 19-1 SEARs (waste)

Secretary's requirement	Where addressed
15. Waste	
1. The Proponent must assess predicted waste generated from the project during construction and operation including:	
(a) classification of the waste in accordance with the current guidelines;	**Section 19.1** outlines the relevant waste legislation, policy and guidelines. **Table 19-3** provides preliminary classifications of expected wastes.
(b) estimates / details of the quantity of each classification of waste to be generated during the construction of the project, including bulk earthworks and spoil balance;	**Section 19.4.2** provides estimates of the quantity of waste to be generated during construction.
(c) handling of waste including measures to facilitate segregation and prevent cross contamination;	**Section 19.5** outlines proposed environmental management measures to facilitate segregation and prevent cross contamination.
(d) management of waste including estimated location and volume of stockpiles;	**Section 19.4.2** provides estimates of the volume and location of stockpiles.
(e) waste minimisation (particularly of unsuitable material) and reuse;	**Section 19.5** provides an overview of waste minimisation measures.
(f) lawful disposal or recycling locations for each type of waste; and	**Table 19-2** identifies waste and recycling facilities near the project.
(g) contingencies for the above, including managing unexpected waste volumes.	**Section 19.5** describes the proposed contingencies and other environmental management measures for the project, including managing unexpected waste volumes.
2. The Proponent must assess potential environmental impacts from the excavation, handling, storage on site, and transport and disposal of the waste particularly with relation to sediment/leachate control, noise and dust, and traffic and transport.	**Section 19.4.1** and **Section 19.4.3** assesses the waste that is predicted to be generated during construction and operation of the project. **Section 11.4** assesses the water quality impacts of the project from sediment and leachate. **Section 8.4** and **Section 8.5** assess the noise impacts of the project. **Section 18.4** assesses the dust impacts of the project. **Section 7.4** and **Section 7.5** assess the traffic and transport impacts of the project.

19.1 Policy and planning setting

The waste assessment was prepared in accordance with the following relevant legislation, policy and guidelines:

- Legislation:
  - *Protection of the Environment Operations Act 1997*
  - Protection of the Environment Operations (Waste) Regulation 2014
  - *Waste Avoidance and Resource Recovery Act 2001*
  - *Environmentally Hazardous Chemicals Act 1985*
- Plans and policy
  - National Waste Policy 2018 (Australian Government 2018b)
  - National Waste Policy Action Plan 2019 (Australian Government 2019)
  - NSW Circular Economy Policy (NSW Environment Protection Authority 2019b)
  - NSW Government Resource Efficiency Policy (OEH 2019b)
- Guidelines:
  - Waste Classification Guidelines (NSW Environment Protection Authority 2014a)
  - Technical Guide: Management of Road Construction and Maintenance Wastes (Roads and Maritime Services 2016f)
  - NSW Acid Sulfate Soils Manual (NSW Environment Protection Authority 2014b)
  - NSW Sustainable Design Guidelines Version 3.0 (Transport for NSW 2013)
  - Environmental Sustainability Strategy 2019-2023 (Roads and Maritime Services 2019)
  - Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004).

Further detail on the above legislation, policies and guidelines, and how they apply to the project, is provided in the Waste Working Paper (**Appendix S**).

19.2 Assessment methodology

The methodology for this assessment included:

- Reviewing the likely sources of construction materials for the project
- Quantifying expected waste volumes generated during construction and operation of the project
- Reviewing expected waste classifications and streams
- Reviewing data sources and relevant reports
- Assessing the opportunities for avoidance, reduction, reuse, and recycling of waste during construction
- Assessing potential environmental impacts associated with waste management on the project
- Identifying environmental management measures to minimise potential waste impacts associated with the project.

19.3 Existing environment

The project is predominantly located in greenfield areas, generally next to existing road infrastructure in the lower portion of the Hunter River catchment on a low-lying, gently undulating topographic environment which includes floodplain areas.

Existing land uses in and around the project include residential, rural residential, transport, agricultural, commercial and industrial (refer to **Chapter 14** (land use and property) for further information). As described in **Chapter 16** (soils and contamination), site investigations carried out have identified that there is potential for Acid Sulfate Soil (ASS), contaminated soils and asbestos to be present within the construction footprint.

ASS risk maps from the Atlas of Australian Acid Sulfate Soils (CSIRO 2020) indicate that there is a high probability of ASS being present within the Hunter River sediments and associated low lying floodplains and swamp areas within the construction footprint. The maps indicate that there is a low probability of potential ASS in northern parts of the construction footprint over the Tomago Sandbeds. The western portion of the construction footprint is mapped as having no known occurrence of ASS.

Historical and current potentially contaminating activities within the construction footprint include agricultural and rural land use, a former mineral sand processing site, areas of fill material and industrial land uses. Five high, six medium and several low areas of potential contamination risk have been identified within and next to the construction footprint. These areas of potential contamination include the Hunter River and banks where sediment would be disturbed, Tarro, Tomago and the construction footprint at the western side of the project in Heatherbrae, Raymond Terrace and Windeyers Creek (refer to **Chapter 16** (soils and contamination)).

Further discussion of existing ASS, contaminated soils and asbestos risks and associated locations are provided in **Chapter 16** (soils and contamination).

Multiple waste and recycling facilities are located near the project for recycling and disposal of construction waste. The closest facilities to the project are listed in **Table 19-2**.

Table 19-2 Nearest waste management facilities

Facility	Address	Processing capabilities
Mount Vincent Road Waste Management Centre	109 Mount Vincent Road, East Maitland NSW 2323	• General solid waste including recyclables • Asbestos waste
Summerhill Waste Management Centre	141 Minmi Road, Wallsend NSW 2287	• General solid waste including recyclables • Some special waste including asbestos waste
SUEZ Hunter	122 Woodstock Street, Mayfield North NSW 2304 Australia (not open to public)	• General solid waste • Special waste • Hazardous waste • Liquid waste
SUEZ Raymond Terrace	330 Newline Road, Raymond Terrace NSW 2324 Australia (not open to public)	• General solid waste • Special waste • Hazardous waste • Liquid waste

19.4 Assessment of potential impacts

19.4.1 Resource use

The main construction materials and resources to be used for the project, based on the concept design, would include, but not be limited to:

- Earthworks material: About 1,080,000 cubic metres of imported fill would be required, primarily north of the Hunter River
- Pavement: About 355,000 cubic metres of pavement materials would be imported across the entire project including about 140,000 cubic metres of concrete, about 60,000 cubic metres of asphalt, and 155,000 cubic metres of select material
- Bridge construction:
  - Concrete: About 70,000 cubic metres of concrete would be imported for bridge structures, not including pre-cast elements
  - Steel: About 13,500 tonnes of reinforcing steel and 12,000 tonnes of steel piles would be required for bridge structures, not including pre-cast elements
  - Pre-cast elements: Around 1,030 pre-cast girders and 185 pre-cast box segments consisting of reinforced concrete would be imported for bridge structures.
- Water: About 380 megalitres of water would be required to support construction.

The project would also require fuel and electricity. The quantity of fuel and electricity to be used would be estimated before construction by the contractor.

19.4.2 Construction waste

Waste generation

Use of materials during construction of the project would generate waste, which would contribute to increased greenhouse gas emissions and incur landfill levy costs.

Waste resulting from project activities would primarily arise from site establishment, excavating, clearing, stripping, demolition of existing structures, earthwork, and construction of roads, retaining walls, bridges and drains. Pre-cast elements would minimise waste impacts by avoiding over-ordering of materials.

Table 19-3 outlines potential waste streams that would arise from construction activities, including volumes and likely classification in accordance with the Waste Classification Guidelines (NSW Environment Protection Authority 2014a). The construction waste streams are then detailed in the sections that follow.

Table 19-3 Indicative construction waste streams and volumes

Activity	Potential waste streams produced	Expected classification	Potential waste quantity
Early work (including site establishment activities, site office establishment, utilities, and other facilities) Note that other activities may also be carried out as early work including demolition work	Surplus construction material including fencing, geofabric, concrete, steel, timber and sand bags	• General solid waste (non-putrescible)	Minimal

Activity	Potential waste streams produced	Expected classification	Potential waste quantity
Earthwork and drainage work (including topsoil stripping, cut and fill preparation, and vegetation clearance) Note these activities would not necessarily be carried out concurrently	Excavated contaminated materials	• Hazardous waste • Restricted solid waste • Special waste	• Hazardous, restricted and special waste quantities are estimated to be minimal
	Excavated non-contaminated materials	• General solid waste (non-putrescible) • Virgin excavated natural material (VENM) • Excavated natural material (ENM) • Potential ASS	• There would be no waste from the earthwork activities if the excavated fill from south of the river is suitable for reuse. The project is estimated to generate about 80,000m^3 of topsoil, which would be reused • Quantities of general solid waste (non-putrescible) are estimated to be minimal • The project is estimated to excavate 90,000m^3 of potential ASS, with about 50,000m^3 estimated to be actual ASS after testing. The majority of ASS is expected to be treated and re-used on site.
	Mulch (green waste, cleared vegetation)	• General solid waste (putrescible)	• The project is estimated to generate approximately 75,000m^3 of mulch, with about half expected to be re-used on site for landscape planting and rehabilitation of the site. • Mulch may be used during construction or applied in thicker layers to reduce the quantity of excess mulch.
	Contaminated water (e.g. generated by a spill)	• Liquid waste	• Minimal
Demolition of existing redundant infrastructure and buildings and site clearance	Demolition materials including concrete, bricks, road base, tiles, timber, metals, plasterboard, carpets, electrical and plumbing fittings and furnishing. May also include tyres, asbestos and lead paint, abandoned vehicles and illegally dumped demolition and construction debris	• General solid waste (non-putrescible) • Special waste • Restricted solid waste • Hazardous waste	• Three dwellings would be demolished during construction • A hazardous building materials audit would be carried out before the demolition of any structure and/or building

Activity	Potential waste streams produced	Expected classification	Potential waste quantity
Construction of pavements and bridges, retaining structures, including finishing work (e.g. line marking, installation of roadside furniture, landscaping)	General construction waste including timber formwork, scrap metal, steel, concrete, plasterboards, and packaging material	• General solid waste (non-putrescible)	• Waste amounts are likely to be minimal due to appropriate ordering of construction materials
	Surplus construction material including fencing, sediment, gravel/crushed rock, asphalt, concrete, steel, aggregate, formwork, landscaping material and sand bags	• General solid waste (non-putrescible)	• Minimal. Surplus construction material would be reused onsite or reused at an alternate Transport project where possible
Temporary work including the construction of work platforms, hardstand areas, and sediment basins	General construction waste including timber formwork, scrap metal, steel, concrete, plasterboards, and packaging material	• General solid waste (non-putrescible)	• Minimal
	Sediment and sludge within sediment basins	• General solid waste (non-putrescible)	• Minimal. Any sediment/sludge is expected to be treated and reused onsite
Activities at site offices	General waste from site office including putrescibles, paper, cardboard, e-waste plastics, metal, glass, site litter, cigarette butts, printer cartridges, e-waste, and sewage waste	• General solid waste (non-putrescible)	• Volumes of waste produced would be dependent on the number of workers onsite at any one time
Operation of plant and equipment	Waste from operation and maintenance of construction vehicles and machinery including adhesives, lubricants, waste fuels, batteries, hoses and tyres, wastewater associated with washdown water	• Hazardous waste • Special waste • Liquid waste	• Minimal
	Clean up waste in the event of an accidental spill of fuel or chemicals	• Hazardous waste • Liquid waste	• Minimal • Any waste from spills would be dependent on the size and nature of the spill.

For the purposes of providing a conservative assessment, it has been assumed that waste such as VENM and ENM (including potential ASS), mulch, topsoil, soil and demolition waste (including asbestos) would be temporarily stockpiled until the waste could be reused on the project, reused on other projects, or disposed of at a licensed facility. Stockpiles would be located at all ancillary facilities except for AS9 and stockpiling would also occur at other locations within the construction footprint as required.

Estimated stockpile volumes are included in **Table 19-4**. The volume of material would be spread over smaller stockpiles throughout the construction footprint.

Table 19-4 Estimated stockpile volumes

Material	Volume to be stockpiled (m^3)
Potential ASS	90,000
Excavated topsoil	80,000
Excavated fill	860,000 Not all excavated general fill would require stockpiling. If stockpiling is required the total volume in stockpile would be significantly less than the total quantity, because production of general fill from cuttings and placement in embankments would take place over time.
Mulch	75,000
Demolition materials	Three dwellings would be demolished during construction. A hazardous building materials audit would be carried out before the demolition of any structure and/or building.

Excavated earthworks fill

Potential impacts from excavated fill material when it is stockpiled on site include:

- Risk of contaminated or sediment-laden surface water run-off from stockpiles impacting the surrounding environment
- Dust generation if stockpile is not properly dampened or at an inappropriate height
- If excess excavated fill cannot be reused on site or beneficially reused offsite, then it would require disposal at a licensed waste facility
- Impacts associated with dust generation and noise impacts if substantial amounts of excess spoil require transportation.

The project has been developed with a strategy of maintaining an earthwork balance to the south of the Hunter River. To minimise waste, the excavated fill taken from south of the Hunter River may be used to offset the amount of imported fill needed north of the river where appropriate. This would reduce the amount of imported fill required. The cut/fill balance of the project may also change following detailed design.

Excavated fill material sourced from cutting locations, particularly at Black Hill, is anticipated to be suitable for general fill. Imported fill would be sourced from quarries, local borrow pits and/or other sources, with potential fill sources including local mine backfill, former brick pits, interbedded sedimentary and volcanic rocks at Eagleton, coal ash, sand quarries, and other projects. If there is imported fill that is available that would otherwise be disposed of, this would be prioritised for use within the project in accordance with the waste hierarchy. Excavated fill that is not classified as being suitable for general fill requirements would be treated and reclassified, prior to reuse or disposal as described below.

Topsoil

Potential impacts from stockpiling topsoil on site include:

- Dust generation if stockpile is not properly dampened or at an inappropriate height
- If excess topsoil cannot be reused on site or beneficially reused offsite then it would require disposal in landfill
- Impacts associated with dust generation and noise impacts if substantial amounts of excess topsoil require transportation.

All topsoil would be stripped and temporarily stockpiled and respread across the project where needed. About 70,000 cubic metres is required for topsoil spreading for the project in line with Transport Specification R178, as well as for open drainage channels. As a result, there would be a surplus of about 10,000 cubic metres of topsoil from the project's construction. This surplus could be used to apply a thicker uniform layer of topsoil across the project. As a result, it is anticipated that topsoil would neither need to be imported or exported.

As the topsoil would be stripped in the initial earthwork activities and not placed until after completion of pavement work, topsoil would be stockpiled. Topsoil would be stockpiled south of the Hunter River at AS1, AS2 and AS3 and north of the Hunter River at AS10 and AS21.

Mulch waste

The total amount of mulch produced by the project is estimated to be about 75,000 cubic metres. If stockpiling mulch is not feasible due to construction timelines, the project could engage in community giveaways and with other projects in the area to reuse the mulch.

Mulch produced on site would be used in landscaping and soil and erosion control measures for the project where possible. Tannin rich leachate could occur as a result of raw mulch being stored on site. Mulch stockpiles would require appropriate management to prevent tannins from impacting the water quality of surrounding water resources.

Demolition waste

Demolition waste may arise from the following activities:

- Demolition of buildings including at Black Hill/Hexham (rural properties) and Heatherbrae (residential and commercial buildings)
- Existing drainage infrastructure may need to be removed or upgraded at Purgatory Creek for construction of access tracks
- Relocation of existing utilities at Black Hill, Tomago interchange, Heatherbrae, and Raymond Terrace interchange
- Demolition of sections of existing road infrastructure, including sections of Lenaghans Drive, Aurizon Access road, Masonite Road and the Pacific Highway
- The potential removal of sections of the existing noise wall at Black Hill.

If improperly managed, demolition waste and leachates may enter receiving environments resulting in soil, water quality and air quality impacts. Demolition of structures may expose site personnel to asbestos or other hazardous materials. If handled incorrectly, asbestos or other hazardous materials may impact human health. Human health impacts may be amplified if waste is incorrectly classified, stockpiled, or managed. Management of demolition waste, leachates, asbestos and other hazardous materials will be carried out in line with the environmental management measures outlined in **Table 19-6**.

Wastewater

Wastewater may be classified as liquid waste and/or hazardous waste according to the Waste Classification Guidelines (NSW Environment Protection Authority 2014a) and may be generated by:

- Groundwater intrusion in excavations
- Tannin affected water being removed from site
- Turbid water captured in excavations and sediment basins
- Sewage from site compounds
- Contaminated groundwater inflows from cuttings and excavations (trenches, footings, piling)
- Water runoff from construction activities, including acidic runoff, vehicle washdown and concrete batching
- Spills leading to contamination of surface water or encountering already contaminated groundwater.

The impacts of contaminated water on the environment is discussed in **Chapter 11** (surface water and groundwater quality).

Site office waste

Site office waste would be generated from office activities and may include general solid waste (putrescible and non-putrescible). Site office waste would be separated onsite into non-recyclable general solid waste (putrescible) and recyclable general solid waste (non-putrescible) to prevent recyclables from being sent to landfill. The contractor would be responsible for the control of waste generation and management during construction including either transporting waste to an offsite facility or engaging a waste contractor to do so.

Regional waste facilities

The waste hierarchy would guide waste management for waste generated as a result of construction of the project, with any waste that cannot be avoided or reused being either recycled or sent to landfill. Sending project waste to landfill would have the following impacts:

- Increase project costs due to landfill levies
- Increase greenhouse gas emissions
- Increase processing times at regional waste facilities due to greater waste volumes.

The use of the waste hierarchy to manage waste would reduce the likelihood of unexpected waste occurring during construction. As a result, the project would limit landfill waste where practicable.

Contamination and ASS

Construction activities including excavation and general ground disturbance in high-risk areas have the potential to expose and mobilise ASS, contaminated materials, and asbestos. Appropriate management, storage and disposal is the key waste-related impact associated with exposing ASS, contaminated materials, and asbestos. Waste must be classified and, if appropriate or required by the Waste Classification Guidelines, treated and reclassified, prior to reuse or disposal. Should this not occur appropriately, cross-contamination of waste may occur, and environmental pollution and human health impacts may arise.

Further information on environmental and health impacts associated with exposing ASS, contaminated materials and asbestos are discussed in **Chapter 16** (soils and contamination), **Chapter 18** (air quality) and **Chapter 22** (safety and risk).

Other impacts

During construction, waste generation may also have the following impacts:

- Odour: Waste generation may result in odour due to waste decomposition. Odours can affect human populations near to the construction site or waste processing facilities
- Air quality impacts and emissions from waste generation: These are expected to be minimal. Dust impacts from construction are assessed in **Chapter 18** (air quality), while emissions from construction are assessed in **Chapter 21** (climate change risk)
- Traffic impacts from transportation of waste offsite: Waste generated by the project that cannot be reused onsite would need to be taken offsite for processing. Traffic impacts from construction vehicle movements have been assessed in **Chapter 7** (traffic and transport)
- Noise impacts from transportation and disposal of waste: Noise impacts relating to waste are expected to be minimal compared to general noise impacts from project construction. Noise impacts are assessed in **Chapter 8** (noise and vibration).

19.4.3 Operational waste

Resource use

Ongoing resource use during operation would be minimal. Resources that may be used during operation would include; water for landscaping, electricity for road and traffic lights, asphalt and concrete for road surface maintenance, and fuel for maintenance vehicles. Resource supply impacts during operation are unlikely.

Waste generation

Operational waste is anticipated to be minimal and would arise from minor repair and maintenance work. Waste resulting from major repair, maintenance, or upgrade work would be assessed separately, outside of this approval. **Table 19-5** describes the expected waste arising from operation of the project. All operational waste volumes are expected to be minimal.

Table 19-5 Indicative operational waste streams and volumes

Activity	Waste	Possible classification
Minor maintenance and repair work	Excess maintenance material including timber, concrete, steel, sediment, asphalt, sand Vegetation, mulch from landscape maintenance	• General solid waste (non-putrescible) • General solid waste (putrescible)
Waste from vehicles and machinery	Fuels, lubricants, chemicals, tyres, batteries, metals	• Liquid waste • Hazardous waste • Special waste
Litter from vehicles	General litter such as food scraps, cigarette butts, food wrappers etc.	• General solid waste (non-putrescible) • General solid waste (putrescible)
Clean up waste resulting from a spill or accident	Fuels, lubricants, chemicals and soaked rags and bunds	• Liquid waste • Hazardous waste • Special waste
Sediment from basins, culverts and drains	Sediment	• General solid waste (non-putrescible)

Operational waste impacts are expected to be minimal due to the guidance of appropriate waste management framework and low volumes of waste. However, mismanagement of operational waste could potentially result in the following :

- Increased volumes of waste to landfill due to incorrect separation, management, and classification of waste
- Environmental impacts from incorrect sorting, classification, or disposal of waste.

Environmental impacts may also arise from spills of liquid and hazardous waste such as fuels and lubricants during operation of the project.

19.5 Environmental management measures

The environmental management measures that will be implemented to minimise the waste impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 19-6**. Details on the treatment of ASS during construction of the project is outlined in **Section 16.5**.

Table 19-6 Environmental management measures (waste)

Impact	Reference	Management measure	Responsibility	Timing
Avoid, minimise and sustainably manage waste	WM01	A Waste Management Plan (WMP) will be prepared and implemented to manage and minimise the generation of waste and encourage reuse of materials. It will include, but not be limited to: • Identification of the waste types and volumes that are likely to be generated by the project • Adherence to the waste minimisation hierarchy principles of avoid/ reduce/ reuse/ recycle/ dispose • Waste management procedures to lawfully manage the handling and disposal of waste • Identification of reporting requirements and procedures for tracking of waste types and quantities • A resource management strategy detailing the process to identify reuse options for surplus materials • Site-specific waste management plans for concrete and asphalt batching plants • Spoil management procedures outlining reuse and disposal Identification of areas for management of materials.	Contractor	Detailed design/ prior to construction/ construction
Management of spoil	WM02	Spoil management procedures will be outlined in the WMP. Spoil will be beneficially reused as part of the project before alternative spoil disposal options are considered. Any excess spoil will be managed using the following order of priorities: • Review alignment and profile refinements during detailed design • Assess opportunities to reuse excess spoil in works within the construction footprint or in adjacent land • Beneficial reuse within the construction footprint for rehabilitation of ancillary facilities • Transfer to other nearby Transport projects for immediate use, use on future projects, or routine maintenance • Transfer to a Transport approved site for reuse on other projects • Disposal at an approved materials recycling or licensed waste disposal facility.	Contractor	Construction

Impact	Reference	Management measure	Responsibility	Timing
Other relevant management measures				
Soil and groundwater contamination	SC01	A Contaminated Land Management Plan (CLMP) and procedures prepared in accordance with TfNSW's Guideline for the Management of Contamination (Roads and Maritime Services 2013c) will be developed and will include: • Control measures to manage identified areas of potential contamination medium and high risk (AOPCRs), where the risk is confirmed within the construction footprint • Procedures for managing unexpected contamination (including buried waste, illegal dumping and asbestos) • Requirements for the disposal of contaminated waste in accordance with the *Protection of the Environment Operations Act 1997* and the Protection of the Environment Operations (Waste) Regulation 2014.	Contractor	Prior to construction/ construction
General	WQ01	A Construction Soils and Water Management Plan (CSWMP) would be developed as a sub plan of the CEMP and will outline measures to manage soil and water quality impacts associated with the construction work, including contaminated land. The CSWMP would include but not be limited to: • Measures to minimise/manage erosion and sediment transport both within the construction footprint and offsite including requirements for the preparation of erosion and sediment control plans (ESCP) for all progressive stages of construction and the implementation of erosion and sediment control measures • Erosion and sediment control measures, which will be implemented and maintained in accordance with Managing Urban Stormwater – Soils and Construction, Volume 1 and Volume 2D (DECC 2008) • Measures to manage stockpiles including locations, separation of waste types, sediment controls and stabilisation in accordance with the Stockpile Site Management Guideline (Roads and Maritime Services 2015e) • Procedures for dewatering (including waterways, wetlands and excavations and temporary sediment basins) including relevant discharge criteria • Concrete waste management procedures • Measures to manage accidental spills including the requirement to maintain materials such as spill kits, an emergency spill response procedure and regular visual water quality checks when working near waterways • Measures to manage tannin leachate and potential saline soils • Controls for sensitive receiving environments which may include but not be limited to identification of 'no go' zones for construction plant and equipment (where applicable).	Contractor	Prior to construction/ construction/ operation

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20. Sustainability

This chapter describes the potential sustainability impacts that may be generated by the construction and operation of the project and presents the approach to the management of these impacts.

The desired performance outcomes for the project relating to sustainability, as outlined in the SEARs, are to:

- Reduce the NSW Government's operating costs and ensure the effective and efficient use of resources
- Maximise the conservation of natural resources.

Table 20-1 outlines the SEARs that relate to sustainability and identifies where they are addressed in this EIS. The full assessment of sustainability impacts is provided in the Sustainability Working Paper (**Appendix T**).

Table 20-1 SEARs (sustainability)

Secretary's requirement	Where addressed
16. Sustainability	
1. The Proponent must assess the project against the current guidelines including targets and strategies to improve Government efficiency in use of water, energy and transport.	**Section 20.1** lists the relevant guidelines, strategies and policies **Section 20.3** assesses the project against relevant guidance relating to use of water, energy and transport (such as emissions reduction) **Section 20.4** describes management measures which focus on improving the resource use efficiency by the government on this project.

20.1 Policy and planning setting

The sustainability assessment was prepared to assess the potential impacts of the project in accordance with the following relevant legislation, policy and guidelines:

- Legislation:
  - *Environmental Planning and Assessment Act 1979* (EP&A Act)
  - *Transport Administration Act 1988*
  - *Protection of the Environment Operations Act 1997*
  - *Waste Avoidance and Resource Recovery Act 2001*
- Plans and policies:
  - Transport Environment and Sustainability Policy Framework and Statement (Transport for NSW 2020e)
  - NSW Government Resource Efficiency Policy (GREP) (OEH 2019b)
  - Environmental Sustainability Strategy 2019-23 (Roads and Maritime Services 2019)
  - NSW Transport Future Strategy 2056 (Transport for NSW 2018a)
  - Beyond the Pavement (Transport for NSW 2020a)
  - NSW Government Procurement Policy Framework
  - The Social Procurement and Workforce Development Guide (Transport for NSW 2020f)
  - NSW Procurement Aboriginal Participation in Construction Policy (NSW Procurement 2018)
  - United Nations Sustainable Development Goals (United Nations 2015).

Specifically, the Environmental Sustainability Strategy 2019-2023 (Roads and Maritime Services 2019) has been used as the guiding framework to undertake the assessment as this was current at the time of the development of the concept design.

The Strategy identifies 10 focus areas to embed sustainability into the delivery of infrastructure and services and defines objectives and targets for sustainability in the context of Transport projects. The Strategy also defines the sustainability delivery model and targets in the context of Transport projects. It also establishes focus areas, targets and initiatives for Transport (formerly Roads and Maritime Services) projects and operation activities.

Further detail on the above legislation, policies and guidelines, and how they apply to the project, is provided in the Sustainability Working Paper (**Appendix T**).

20.2 Assessment methodology

The sustainability assessment for the project has considered the application of sustainability principles and the opportunities to satisfy the objective of Section 1.3(b) of the EP&A Act. The assessment also assesses whether the project achieves Transport's sustainability targets and is aligned with best practice for infrastructure projects.

The sustainability targets and initiatives for this project have been developed in response to government and Transport guidance documents (outlined in **Section 20.1**) and would be integrated into the detailed design, construction and operation of the project.

The assessment broadly involved:

- Defining the sustainability context for the project within the broader context of NSW's objective of improving transport efficiency and the relevant Transport policies and guidelines
- Reviewing the sustainability focus areas, associated objectives and identifying how these focus areas apply to the project
- Identifying requirements for managing sustainability during detailed design, construction and operation.

The environmental management measures detailed in **Section 20.4** respond to the sustainability focus areas identified in the Environmental Sustainability Strategy 2019-2023 (Roads and Maritime Services 2019).

20.3 Assessment of the project

Sustainability, or sustainable development, can be defined in different ways depending on the application and context in which it is being applied. Sustainable development is often defined as 'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased' (World Commission on Environment and Development 1987).

As described in **Section 20.1**, the project was assessed against the Environmental Sustainability Strategy 2019-23 (Roads and Maritime Services 2019) (the strategy), which was a key guidance document for the project. **Table 20-2** details the project response to the objectives of the sustainability focus areas and objectives in the strategy that relate to the project.

Table 20-2 Sustainability focus areas that relate to the project

Sustainability focus area	Objective	Relevant key initiatives in strategy	Project response
Energy and carbon management	Minimise energy use and reduce carbon emissions without compromising the delivery of services to our customers.	• Ensuring the road network effectively integrates with rail, air and maritime transport networks to efficiently move freight and increase access for B-Double and B-Triple trucks on the road network where there is a positive impact on fuel consumption.	The provision of a motorway standard road that alleviates congestion and allows for free-flowing traffic conditions is in line with Transport's objective to minimise energy use and reduce carbon emissions without compromising services for road users. The project would result in improvements to network-wide speeds, travel times and intersection level of service and provide a lower gradient and comparatively high-speed route for through traffic. The operation of the project would result in fewer emissions produced per kilometre travelled when compared with the existing road network in the same year.
		• Setting project specific energy efficiency and carbon emission improvement targets for State significant infrastructure projects covering both direct and indirect emission sources • Developing a strategy by 2020 to transition all Roads and Maritime street lights and road signs to LED light sources • Using solar panels to power roadside signage, alert and messaging systems when cost effective and fit for purpose • Promoting the use of innovation and technology to investigate and manage road network impacts such as hazardous road conditions, severe weather impacts, bushfires, travel incidents and congestion.	Initiatives in regard to energy efficiency and sourcing of low carbon materials for construction will be identified by construction contractors and will form part of the evaluation process by Transport in selection of the preferred contractor. The operation of the project would result in fewer emissions produced per kilometre travelled when compared with the existing road network in the same year. In operation the estimated annual CO_2e emission contribution is 23kt. The assessment in **Chapter 21** (climate change risk) has estimated that construction of the project would generate 243kt of carbon dioxide equivalent (CO_2e). Consideration would be given throughout the detailed design, construction and operation of the project include project-specific targets for greenhouse gases, exploration of low-carbon energy sources and energy efficient technology.
Climate change resilience	Design and construct transport infrastructure to be resilient or adaptable to climate change impacts.	• Reviewing climate change impacts and risks during the planning phase of potentially affected projects with a level of detail commensurate to the size of the project and the potential risk • Designing infrastructure for the predicted future climate or designing for cost-effective adaptation in the future	The key climate change resilience targets in the strategy relate to assessing climate change risks for projects and addressing any risks identified as high or above during project planning. A climate change risk assessment was undertaken for the project (refer to **Chapter 21** (climate change risk)) When considering the residual risk post adoption of management measures, some risks were identified are high. These risks related to increased extent and depth of flooding of the project and inadequate drainage as a result of an increase

Sustainability focus area	Objective	Relevant key initiatives in strategy	Project response
		• Minimising the carbon impacts associated with vegetation clearance by reducing project footprints where possible.	in the frequency and intensity of severe rainfall events coupled with sea level rise. In line with the strategy, these risks are addressed below. Broadly, the project achieves a minimum design standard flood immunity parameter of 5% AEP events. Furthermore, the vast majority of the project achieves flood immunity up to the 1% AEP event with only a few short sections not meeting this immunity. Adjusting the design to accommodate flooding as a result of potential climate change is not considered desirable as raising the road level would exacerbate the assessed flooding impacts from the project. Raising the proposed road levels would also result in an increased project footprint, increased resources required for construction and operation, and increased property and environmental impacts. Additionally, the existing road network connecting to the project generally has a lower flood immunity. In a climate change flood scenario, the vast majority of the existing road network would be flooded and inaccessible in the construction footprint.
		• Ensuring our specifications for delivery, maintenance and operation of infrastructure consider suitable climate and weather-related constraints which include current best practice climate change predictions.	Initiatives in regard to resilient materials for construction will be identified by construction contractors as part of the Sustainability Management Plan.
		• Maintaining our capacity to respond to significant events on our roads or waterways through emergency management plans to ensure our agency responds appropriately when required.	Transport has and will continue to liaise with key emergency management stakeholders to ensure features are included in the project design to enable continued management during significant events.
Air quality	Minimise the air quality impacts of road projects and support initiatives that aim to reduce transport related air emissions.	• Monitoring air emissions across our projects and operations • Actively monitoring and minimising non-road diesel emissions from our activities • To optimise the design and management of the road network to smooth traffic flows and manage congestion with the aim of	The air quality targets in the strategy relate to identifying and applying best practice air quality controls and initiatives during construction and operation of projects. The specific initiatives that are relevant to the project that will help achieve these targets are discussed below. Energy efficient work practices and other measures to minimise non-road related diesel use for plant and equipment during construction would be specified by potential construction contractors during the tendering phase. Transport will consider these measures in evaluating and appointing a preferred contractor.

Sustainability focus area	Objective	Relevant key initiatives in strategy	Project response
		reducing travel times for vehicles using the network • Implementing Transport for NSW's NSW Freight and Ports Strategy Plan 2018-2023 to improve freight movement productivity and reduce truck travel times.	Additionally, air quality management measures will apply to the construction phase (refer to **Chapter 18** (air quality)). In operation the project contributes to achieving Transport's identified initiatives by providing for more reliable traffic flows and reduced congestion and travel times for vehicles including freight movements. This network efficiency results in reduced vehicle emissions per vehicle kilometre travelled.
Resource use and waste management	Minimise the use of non-renewable resources and minimise the quantity of waste disposed to landfill.	• Monitoring and reporting on significant waste streams • Ensuring that infrastructure design and construction planning considers how to minimise the generation of excess spoil • Identifying where there is potential to recover and reuse materials on site • Substituting non-renewable materials with recycled or reused materials where they are fit for purpose, cost effective and affordable • Managing waste to minimise transport related risks and impacts by using local disposal facilities where feasible and appropriate • Working with our supply chain to assess the feasibility of reusing key wastes, such as glass, in road construction to reduce our consumption of virgin materials.	The strategy recognises a key way to achieve the resource use and waste management objective is through the implementation of the waste management hierarchy. The waste management hierarchy will apply to the project in both the construction and operational phases. The strategy incorporates targets for 100% beneficial reuse of VENM, clean concrete and clean recycled asphalt. As the project has a large deficit of material all available reuse options will be implemented during construction. A Waste Management Plan incorporating many of the strategy's key initiatives in relation to resource use and waste management will be implemented during construction (refer to **Chapter 19** (waste)).
		• Monitoring and reporting on potable and non-potable water use in areas where water scarcity occurs • Maximising the use of non-potable water in preference to potable water where feasible.	A water reuse strategy for both construction and operational phases of the project would be prepared to reduce reliance on potable water. This strategy would outline alternative water supply options to potable water, with the aim of reusing water collected on-site in temporary construction sediment basins where feasible.

Sustainability focus area	Objective	Relevant key initiatives in strategy	Project response
Pollution control	Minimise noise, water and land pollution from road and maritime construction, operation and maintenance activities.	• Implementing land and contamination management practices on Roads and Maritime landholdings that avoid creating or exacerbating long term legacy issues • Managing pre-existing contamination to mitigate land and water pollution and to meet legal requirements.	Based on the desktop assessment and site inspections, five high risk areas of contamination and six medium risk areas are located within the construction footprint. A number of low risk areas were also identified outside of the construction footprint. The project would implement management measures to mitigate potential impacts of the project on land and soil contamination, including the implementation of a Contaminated Land Management Plan and the development of a Remediation Action Plan for contamination identified at the former mineral sands processing facility (refer to **Chapter 16** (soils and contamination)). During operation, the main risk from the operational use of the motorway is from large scale chemical or hydrocarbons spills from freight transport. These would be minimised through good design and subsequently managed by a combination of authorities (Transport, Police and other emergency services) as individual scenarios require.
		• Actively playing a role in reducing the potential impact of pollution caused by users of the road network and waterways through: – Monitoring pollution from vehicles that use roads and from vessels using waterways – Managing impacts from accidents – Managing spills into our waterways.	The project design includes construction and operational water quality strategies to manage water quality impacts from the project, including the use of construction temporary sediment basins and permanent operational water quality basins, other physical controls and the implementation of management measures during construction and operation. Basins and grassed swales in the Tomago Sandbeds Catchment Area will be lined to avoid impact to the underlying groundwater resources. Spill containment is built into basins throughout the project to minimise the impact of accidental spills on receiving waterways.
		• Using the Roads and Maritime Noise Criteria Guideline across our activities • Managing our noise impacts, where practical and reasonable, using the following prioritised approach: – Eliminating noise sources – Using materials, construction methods and equipment specifications that reduce noise generation – Using engineering noise control methods such as enclosures, acoustic	The project design and noise assessment has considered the requirements of the Noise Criteria Guideline (Roads and Maritime Services 2015c). The inclusion of potential noise management measures in the project design, such as quieter pavements, noise barriers and/or at-property noise mitigation treatment, aid in reducing noise levels at affected receivers during operation of the project. The project would seek to mitigate and manage noise pollution impacts during construction through the preparation and adherence to a Construction Noise and Vibration Management Plan (refer to **Chapter 8** (noise and vibration)). The management plan would include consideration of different plant and equipment, scheduling of noise intensive equipment during less sensitive periods (i.e. standard hours), noise and vibration monitoring and building surveys.

Sustainability focus area	Objective	Relevant key initiatives in strategy	Project response
		sheds and noise walls to reduce construction and operational noise at or close to the source – Implementing noise management measures where impacts are above our guideline levels.	
		• Sharing learnings from significant environmental incidents within Roads and Maritime and with relevant contractors and industry partners.	Learnings from projects previously undertaken by Transport help inform tender documentation and project specifications that will be relevant to this project.
Biodiversity	Improve outcomes for biodiversity by avoiding, mitigating or offsetting the potential impacts of road and maritime projects on plants, animals and their environments.	• Avoiding impacts on biodiversity through route selection, planning and design processes • Minimising impacts by applying best practice approaches to unavoidable habitat loss (e.g. following pre-clearing processes, establishing exclusion zones and careful management of weeds and pathogens) • Mitigating impacts on biodiversity by providing fauna connectivity where appropriate, and supplementing habitat where needed (e.g. targeting vegetation rehabilitation, installing nest boxes and reusing woody debris and bush rocks). • All projects identified as State significant infrastructure or requiring a review of environmental factors must review the need for biodiversity offsets in accordance with Roads and Maritime Biodiversity Offset Policy. • Avoiding the spread of weeds, pests and diseases outside of our sites through appropriate management of mulch and	The project has sought to achieve the objective through consideration of biodiversity values during the extensive options development and project design stages, as follows: • Consolidating the project with other development corridors to reduce the area of vegetation disturbance and fragmentation • Aligning the construction footprint between the Black Hill and Tarro interchange to align with the Hunter Water Corporation trunk main and the New England Highway to avoid many direct impacts to Hexham Swamp • Design of a viaduct crossing of the Hunter River and adjacent floodplain, in contrast to a built formation option, to avoid a lengthy direct impact to floodplain wetlands and associated biodiversity • Moving the proposed viaduct (B05) crossing the Hunter River further upstream of the existing Hexham Bridge to reduce impacts to coastal wetlands and threatened ecological communities • Moving the main alignment north between Black Hill and the Hunter River – to be closer to the New England Highway • Challenging the scope and functionality of project elements to avoid impacts on remnant vegetation, threatened species and fauna connectivity • Positioning ancillary facilities, where possible, within previously cleared and disturbed land • Offsetting unavoidable impacts in accordance with NSW Biodiversity Offset Policy for Major Projects. Biodiversity management measures have been developed and proposed for the project which together work to achieve the biodiversity objectives. Refer to

Sustainability focus area	Objective	Relevant key initiatives in strategy	Project response
		vegetation wastes generated, reused or removed from our sites.	**Chapter 9** (biodiversity) for details on the project's impacts to biodiversity within the construction footprint and the management measures proposed.
Heritage – Aboriginal and non-Aboriginal	Manage and conserve cultural heritage according to its heritage significance and contribute to the awareness of the past.	• Avoiding or minimising impacts on heritage assets where feasible through route selection or by innovative designs • Preserving and developing our heritage knowledge and sharing this knowledge with the community and interested stakeholders.	The project has achieved the key heritage target in the strategy by identifying and assessing heritage assets early in the project planning stage to allow appropriate consideration of potential impacts and solutions. **Non-Aboriginal heritage** The non-Aboriginal heritage assessment identified a major impact to the Glenrowan Homestead and a minor impact to the Hexham Shipbuilding Yards. Management measures, including barrier fencing, archival recording, dilapidation surveys and vibration monitoring, have been proposed for the project to avoid, minimise to the greatest extent possible and manage the impacts to non-Aboriginal heritage items. Further information is provided in **Chapter 17** (non-Aboriginal heritage). **Aboriginal heritage** Consultation with Aboriginal stakeholders has been carried out throughout the project development in accordance with Transport requirements and has involved meetings with affected Aboriginal stakeholder groups and site surveys and test excavations attended by registered aboriginal parties. The Aboriginal cultural heritage assessment identified impacts to a number of Aboriginal cultural heritage items (refer to **Chapter 12** (Aboriginal cultural heritage)). Where complete avoidance of archaeological sites was not possible, management measures for impacted areas have been developed.
Liveable communities	Provide high quality urban design outcomes that contribute to the sustainability and liveability of communities in NSW.	Applying the Beyond the Pavement policy to all Roads and Maritime Services infrastructure projects that have an appreciable impact on the built and natural environment and achieve the following outcomes: • Road and Maritime Services transport infrastructure fits sensitively with the built, natural, community and cultural environments in which it is situated in both urban and rural locations • infrastructure planning and design contributes to the accessibility and	The four identified objectives of Transport's Beyond the Pavement policy are discussed below. **Projects should fit sensitively into the built, natural, and cultural environment in both urban and rural locations** Throughout the project development process there has been extensive consideration of how the project is integrated into the landscape and communities through which it passes. The project has been aligned with existing roads and infrastructure as far as possible to fit within the built environment and minimise impacts to the natural environment. A key outcome of the route selection process was an alignment that minimises impacts on the natural environment including wetland communities on the floodplain and habitat for koalas. The potential for impacts on cultural heritage has been considered through extensive consultation

Sustainability focus area	Objective	Relevant key initiatives in strategy	Project response
		connectivity of communities and a general permeability of movement through areas by all modes of movement, including walking and cycling and public transport.	and collaboration with local Aboriginal groups throughout the route alignment and environmental assessment process. **Projects should contribute to the accessibility and connectivity of communities and a general permeability of movement through areas by all modes of movement** The project provides for improved accessibility and connectivity within its regional setting. The four interchanges provide access for the local community to the motorway which provides for improved travel times and conditions when moving between local areas and connecting to the wider road network for regional and interstate travel. With regard to provision for all modes of movement, the project incorporates wide shoulders which provides for cyclist use. While there is generally no pedestrian specific features on the main motorway alignment, the project does incorporate some design features to accommodate pedestrian movements at certain locations. The bridge at Masonite Road (B10) and associated alignment changes incorporates a pedestrian pathway and the signalised access to the Hunter Region Botanic Gardens allows for improved pedestrian safety at this location. **The design and management of projects should contribute to the overall design quality of the public domain for the community, including transport users** The project has sought to deliver high quality urban design outcomes and has been developed in recognition of the existing natural, built and community values. The urban design for the project has been developed based on the urban design principles identified in Beyond the Pavement (Transport for NSW, 2020a). **Projects should help revitalise areas and contribute to the local and broader economy** A key project objective is to improve road network efficiency for freight and commuters on the National Land Transport Network (NLTN) at the key strategic junction of the M1 Pacific Motorway, the New England Highway and Pacific Highway. The existing NLTN linking the M1 Pacific Motorway at Black Hill with the Pacific Highway at Raymond Terrace is in one of the most highly trafficked areas of the road network in the region and is more heavily congested than adjacent high standard sections of the M1 Pacific Motorway and Pacific Highway. The project would provide for a free flowing dual carriageway route along this section of the NLTN providing benefits for the local, regional and national economy.

Sustainability focus area	Objective	Relevant key initiatives in strategy	Project response
			The project would also provide for future demand generated from substantial local land releases at Black Hill, Tomago and Heatherbrae.
Sustainable Procurement	Procure goods, services, materials and works for infrastructure development and maintenance projects that over their lifecycle deliver value for money and contribute to the environmental, social and economic wellbeing of the community.	• Ensure assessment criteria, and associated weightings, for tenders include relevant environmental and social responsibility outcomes • Including sustainability performance criteria in our contracts to increase awareness in our supply chain • Implementing the Aboriginal Participation in Construction Policy • Where possible, procuring from small and medium-sized enterprises Aboriginal businesses and Australian disability enterprises by including such requirements in procurement strategies and policies.	The sustainable procurement objective would be achieved for the project through inclusion of non-price selection criteria in the construction tender process to embed environmentally and socially responsible outcomes. The project would also procure locally produced goods and services where feasible and cost effective. Transport is preparing an Aboriginal Participation Strategy for the construction phase of the project.
Corporate Sustainability	Communicate Roads and Maritime's sustainability objectives to employees, contractors and other key stakeholders, and foster a culture which encourages innovative thinking to address sustainability challenges.	• Ensuring offices purchased or leased are rated against the NABERS system prior to tenure and meet the NSW Government Resource Efficiency Policy requirements • Publishing exclusively electronic media versions of external and internal publications rather than printed copies where possible.	Sustainability has been considered at all stages of the project to date and will continue to be considered and assessed throughout the detailed design, construction and operation phases. Transport's sustainability objectives and requirements will form part of the tender documentation for the construction phase of the project and form part of the selection criteria in the evaluation of a preferred contractor.

20.4 Environmental management measures

The environmental management measures that will be implemented for sustainability, along with the responsibility and timing for those measures, are presented in **Table 20-3**.

Table 20-3 Environmental management measures (sustainability)

Impact	Reference	Environmental management measure	Responsibility	Timing
Project sustainability outcomes	SU1	A Sustainability Management Plan (or similar framework) for the project will be developed and implemented during detailed design and construction, detailing measures to meet the project's sustainability objectives and targets. The Sustainability Management Plan will: • Demonstrate leadership and commitments to sustainability • Adopt relevant sustainability performance targets in accordance with the Transport Sustainability Strategy • Identify sustainable procurement requirements • Document the process for the identification, assessment and implementation of sustainability initiatives and opportunities • Document the process to be used to monitor and review of sustainability performance against achieving the project's sustainability targets • Outline the documentation and reporting requirements for sustainability on the project.	Transport/ Contractor	Prior to construction/ construction
Other relevant management measures				
Flood risk	CC01	Hydrological and hydraulic assessments would be carried out for any design changes during detailed design and would consider the climate change related flood risks to the project and flood impacts from the project.	Contractor	Detailed design
Adverse air quality during construction	AQ01	Preparation and implementation of an Air Quality Management Plan (AQMP) to minimise risks to air quality. The AQMP will identify: • Potential sources of air pollution (including odours and dust) during construction • Air quality management objectives consistent with relevant published guidelines • Identification of all dust and odour sensitive receivers • Measures to manage dust • Requirements to separate temporary project specific asphalt batching plants, if feasible, from the nearest residences by at least 300m • Community notification and complaint handling procedures.	Contractor	Detailed design. Prior to construction

Impact	Reference	Environmental management measure	Responsibility	Timing
Avoid, minimise and sustainably manage waste	WM01	A Waste Management Plan (WMP) will be prepared and implemented to manage and minimise the generation of waste and encourage reuse of materials. It will include, but not be limited to: • Identification of the waste types and volumes that are likely to be generated by the project • Adherence to the waste minimisation hierarchy principles of avoid/ reduce/ reuse/ recycle/ dispose • Waste management procedures to lawfully manage the handling and disposal of waste • Identification of reporting requirements and procedures for tracking of waste types and quantities • A resource management strategy detailing the process to identify reuse options for surplus materials • Site-specific waste management plans for concrete and asphalt batching plants • Spoil management procedures outlining reuse and disposal • Identification of areas for management of materials.	Contractor	Detailed design/ prior to construction/ construction
Soil and groundwater contamination	SC01	A Contaminated Land Management Plan (CLMP) and procedures prepared in accordance with TfNSW's Guideline for the Management of Contamination (Roads and Maritime Services 2013c) will be developed and will include: • Control measures to manage identified areas of potential contamination risk (AOPCRs), where the risk has been assessed as being medium or high and is confirmed within the construction footprint • Procedures for managing unexpected contamination (including buried waste, illegal dumping and asbestos) • Requirements for the disposal of contaminated waste in accordance with the *Protection of the Environment Operations Act 1997* and the Protection of the Environment Operations (Waste) Regulation 2014.	Contractor	Prior to construction/ construction

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21. Climate change risk

This chapter describes the potential climate change risk impacts that may be generated by the construction and operation of the project and presents the approach to the management of these impacts.

The desired performance outcome for the project relating to climate change risk, as outlined in the SEARs, is to:

- Ensure the project is designed, constructed and operated to be resilient to the future impacts of climate change.

Table 21-1 outlines the SEARs that relate to climate change risk and identifies where they are addressed in this EIS. The full assessment of climate change risk impacts is provided in the Climate Change Risk Working Paper (**Appendix U**).

Table 21-1 SEARs (climate change risk)

Secretary's requirement	Where addressed
9. Climate Change Risk	
1. The Proponent must assess the risk and vulnerability of the project to climate change in accordance with the current guidelines.	**Section 21.1** outlines the relevant legislation, policy and guidelines that were used to assess potential impacts **Section 21.4** assesses the risk and vulnerability of the project to climate change
2. The Proponent must quantify specific climate change risks with reference to the NSW Government's climate projections at 10 km resolution (or lesser resolution if 10 km projections are not available) and incorporate specific adaptation actions in the design.[1]	**Section 21.4** assesses the specific climate change risks associated with the project and **Section 21.5** outlines specific measures which will be used in future stages of the project.

[1] The proponent has also received permission from The Department of Planning and Environment (as was) to use the Climate Futures Tool from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM) (attenuated for the project region), to assess climate impacts (letter dated 26/3/2018, Ref IRF18/1522)

21.1 Policy and planning setting

The climate change risk assessment was prepared to assess the potential impacts of the project in accordance with the following relevant legislation, policy and guidelines:

- Legislation:
  - *National Greenhouse and Energy Reporting Act 2007*
- Plans and policies:
  - Paris Agreement
  - The Greenhouse Gas Protocol (World Business Council for Sustainable Development and World Resources Institute)
  - NSW Net Zero Plan Stage 1: 2020 – 2030 (DPIE 2020f)
  - NSW Climate Change Policy Framework (OEH 2016b)
  - National Climate Resilience and Adaptation Strategy (DoE 2015)
  - NSW Future Transport Strategy 2056 (Transport for NSW 2018a)
  - Environmental Sustainability Strategy 2019 – 2023 (Roads and Maritime Services 2019)

- Guidelines:
  - Climate Change Impacts and Risk Management – A Guide for Business and Government (DoEH 2006)
  - Technical Guide for Climate Change Adaptation for the State Road Network (Roads and Maritime Services in draft).

Further detail on the above legislation, policies and guidelines, and how they apply to the project, is provided in the Climate Change Risk Working Paper (**Appendix U**).

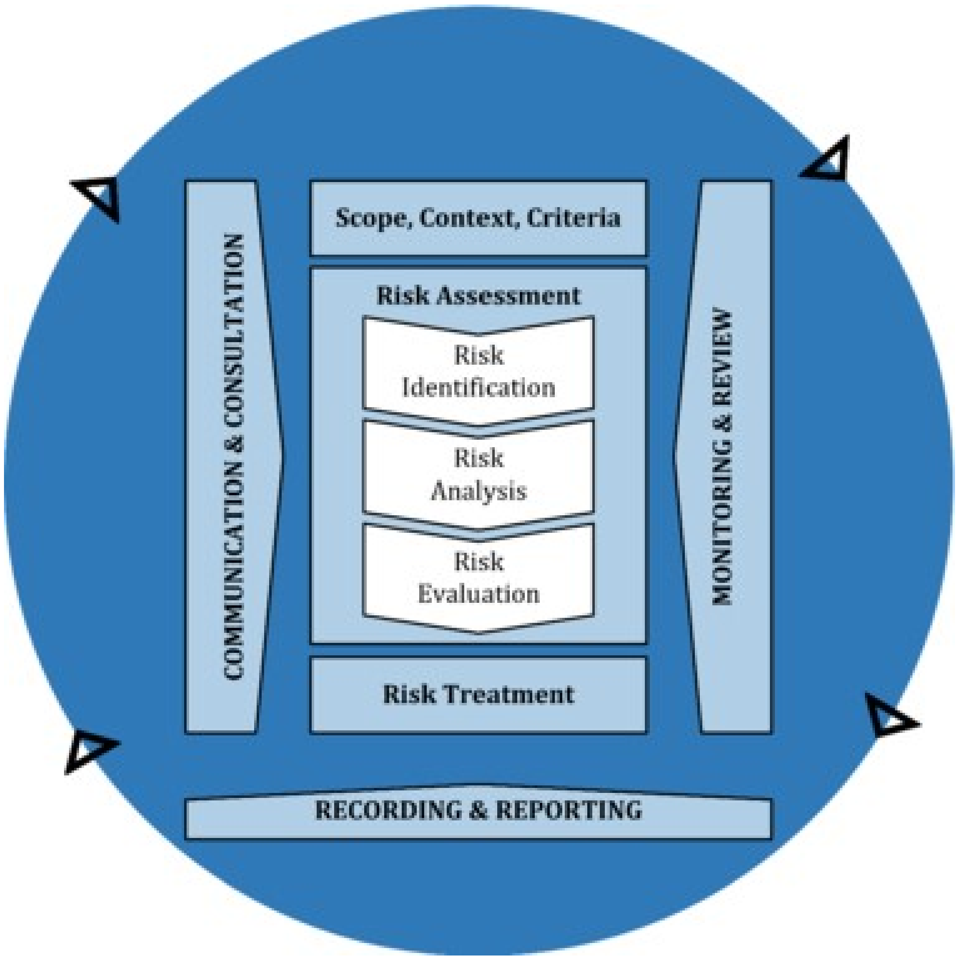
21.2 Assessment methodology

21.2.1 Climate change risk assessment

The methodology for conducting the climate change risk assessment was based on the Australian Standard AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk based approach. The standard follows the International Standard ISO 31000:2018, Risk management – Principles and guidelines (adopted in Australian and New Zealand as AS/NZS ISO 31000:2018), which provides a set of internationally endorsed principles and guidance on how organisations can integrate decisions about risks and responses into their existing management and decision-making processes.

The risk assessment forms part of a risk management process that would be carried out throughout the different project stages. This would involve communication and consultation between the design team, Transport and relevant stakeholders, as well as regular monitoring and review of the risk assessment plan as shown in **Figure 21-1**.

It is noted that while the SEARs for the project (refer to **Table 21-1**) require modelling with reference to the NSW Government's climate projections at a resolution of 10 kilometres, Transport has received permission from the NSW Department of Planning, Industry and Environment (formerly Department of Planning and Environment) to instead use the Commonwealth Scientific and Industrial Research Organisation's Climate Futures Tool to assess climate impacts.



Source: Reproduced from AS/NZS ISO 31000

Figure 21-1 Risk management process

Risks to the operation and maintenance of the project that might be influenced by climate change were identified using the hazard-receptor pathway model and are listed in **Section 21.4**. This model is outlined below:

- Hazard: climate or climate-influenced attributes with potential to influence the project's operation and maintenance
- Receptor: the component of the project's operation and/or maintenance impacted by the hazard; this may also include users of the project and affected elements of the surrounding environment
- Risk Rating: utilising the likelihood and consequence rating system, including an assessment of the way hazards influence the project receptors and a risk rating awarded.

Within the risk assessment process, the risk resulting from the projected change in climate is assessed, whether this is a newly identified or elevated existing risk. For example, some risks are already present (flooding) but the frequency and intensification of these are projected to change. Other risks (such as migration of pests and weeds) may not be expected to happen in the absence of a changing climate.

21.2.2 Greenhouse gas assessment

The greenhouse gas (GHG) assessment was carried out by first determining the GHG assessment boundary, then determining the quantity of GHG emissions generated by each emission source.

The following six GHGs are covered under international climate change agreements and were considered in this assessment:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HCFs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6).

It is common practice to aggregate the emissions of these gases into the equivalent emission of carbon dioxide. This provides a simple, single figure for the comparison of emissions against targets. The aggregation is based on the potential of each gas to contribute to global warming relative to carbon dioxide and is known as the global warming potential. The resulting number is expressed as carbon dioxide equivalents (CO_2e).

Under the Greenhouse Gas Protocol, the direct and indirect GHG emission sources of a development can be classified into three 'Scopes' for GHG accounting and reporting purposes. The GHG scopes are presented in **Figure 21-2** and are described as follows:

- Scope 1: Direct emissions from sources that are owned or operated by a reporting organisation
- Scope 2: Indirect emissions associated with the import of energy from another source
- Scope 3: Other indirect emissions (other than scope 2 energy imports) which are a direct result of the operations of the organisation but from sources not owned or operated by them.

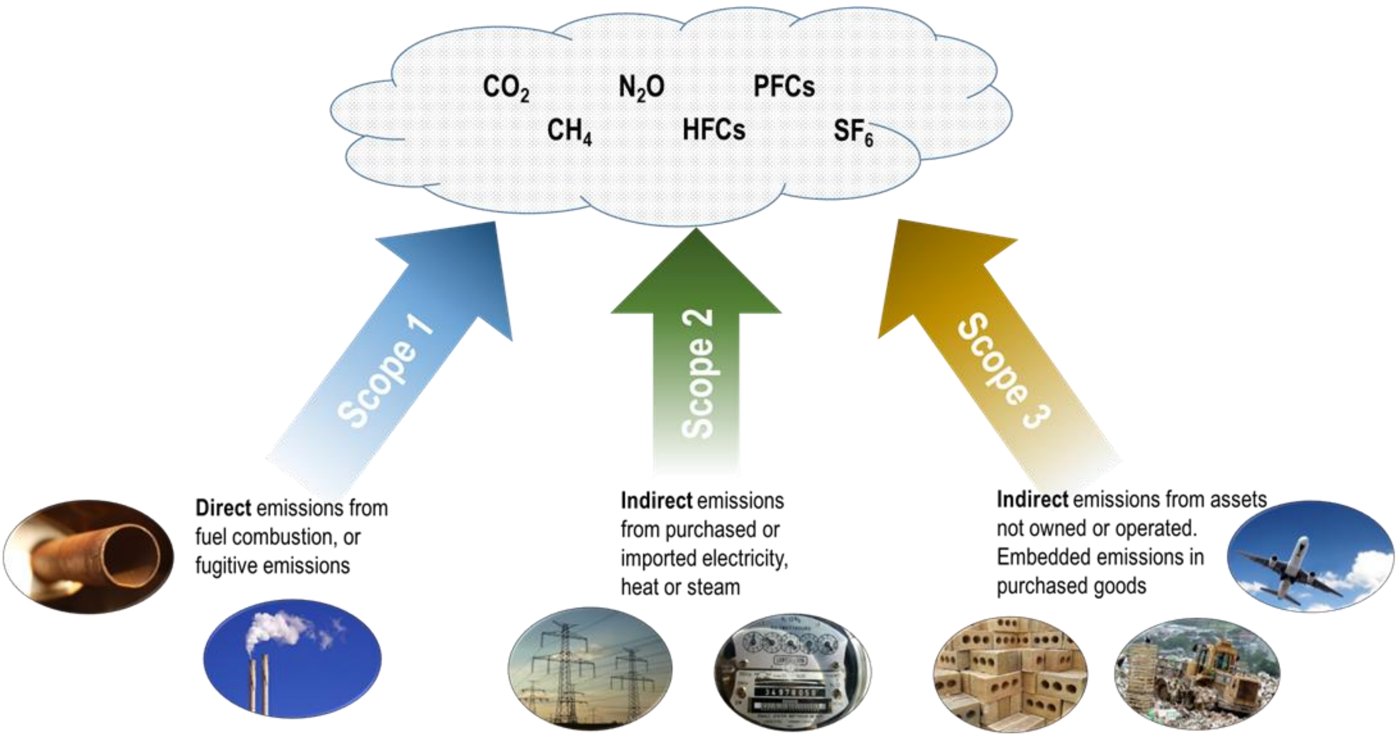


Figure 21-2 Sources of GHGs – Adapted from World Business Council for Sustainable Development – Greenhouse Gas Protocol

The results of this assessment are presented in terms of the above-listed ‘scopes’ to help define and understand the direct and indirect sources of the GHG emissions generated by the project. All three ‘scopes’ have been assessed for this project. The initial action for a GHG inventory is to determine the potential sources of GHG emissions. This is done in order to assess their likely significance and set a provisional boundary for the assessment. Following this, data are collected to represent the activities being carried out for the project and converted to GHG emissions typically using emissions factors (a published figure for the particular activity representing the aggregated GHG emissions per unit of the activity).

GHG assessment boundary

The assessment boundary defines the scope of GHG emissions and the activities to be included in the assessment. **Table 21-2** summarises the emission sources and activities considered within the project’s assessment boundary for construction and operation, according to scope. Note that some emission sources are accounted for in more than one scope. This is typically the case where there are direct emissions (e.g. combustion of fuel in a vehicle operated as part of the project) as well as indirect emissions (extraction and processing of the fuel before it is used).

Table 21-2 GHG emission sources

Emission source	Included	Scope 1	Scope 2	Scope 3
Construction				
Fuel use – diesel consumption in plant and equipment during construction	✓	●		●
Construction materials	✓			●
Fuel use – transport of construction materials	x (Materials are likely to be sourced from less than 50km away*)			
Fuel use – transport of construction waste, spoil or dredged material	x (Materials are likely to be taken less than 50km away from site*)			
Vegetation removal	✓	●		
Operation				
Road use by vehicles (differential between ‘without project’ and ‘project’ scenarios)	✓			●
Electricity consumption – lighting	✓		●	●
Maintenance activities – fuel	✓	●		●
Maintenance activities – materials	✓			●

* The assessment methodology does not consider emissions associated with the transportation of material/waste less than 50 kilometres to be material

Quantity of GHG emissions generated

The GHG emissions that may result from the construction of the project were estimated using the Transport Authorities Greenhouse Group's (TAGG) Carbon Gauge GHG assessment tool (Carbon Gauge). The tool was also used to:

- Determine the fuel combustion, material requirements and vegetation clearance associated with the construction of the project
- Determine the embodied emissions, a Scope 3 emissions source associated with the extraction of raw materials, processing, manufacturing and transportation of materials for construction
- Calculate the projected electrical energy during operation
- Calculate the maintenance fuel and materials required during operation (with emissions factors updated from other sources as required).

Emissions associated with the change in traffic resulting from the road alignment have been calculated in the Tool for Roadside Air Quality (TRAQ). TRAQ was used to determine emissions associated with current and future operational road use, both with and without the project. The tool calculates air quality and GHG emissions based on a number of factors, including:

- The type of roads in the scope of the project
- Road length and grade
- Daily traffic count on the road
- Peak and average speeds on the road
- Traffic composition
- The year of the assessment.

Figure 21-3 shows the roads in the project scope and how they relate to the assessment scenarios described in **Section 21.4**.

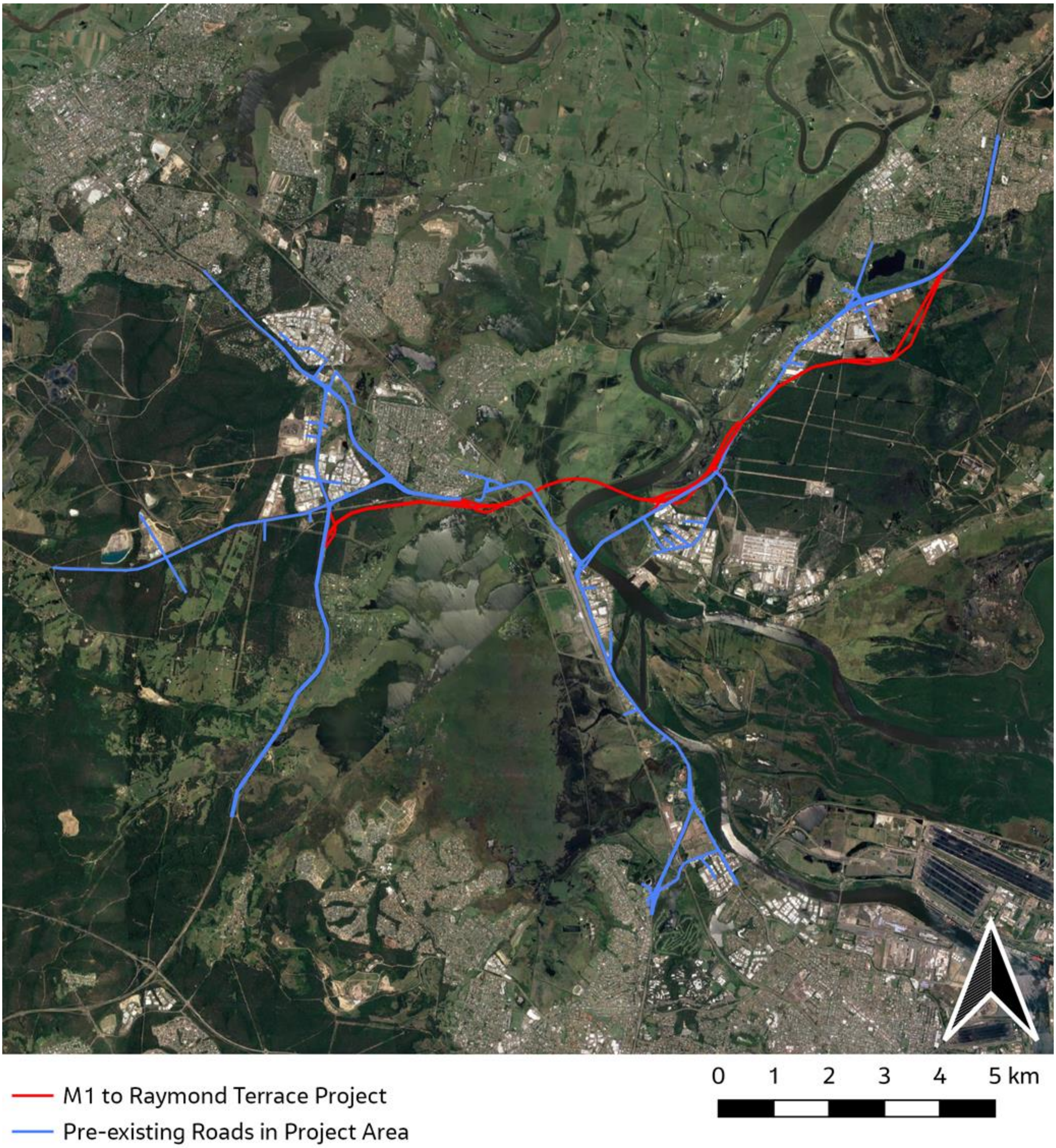


Figure 21-3 Extent and division of roads within the project scope

21.3 Existing environment

GHGs are gases that when released into the atmosphere effectively trap heat, influencing global temperatures. The release of GHGs into the atmosphere is caused by both natural processes (such as bushfires) and human activities (such as burning fossil fuels and land clearing).

Since the industrial revolution, the concentration of GHGs in the atmosphere, has been rapidly increasing. This has led to an increase in the earth's average surface temperature and has contributed to the phenomenon of climate change.

The term 'climate' refers to the typical weather conditions for a specific geographical area, usually averaged over at least 30 years. Climate variability represents the normal day to day, seasonal, and year to year variability of the different climate components (e.g. temperature, rainfall). This climate variability may also generate extreme conditions, such as flooding, heatwaves and hail, which require management.

Among some of the key findings presented by the world's leading climate scientists in the Intergovernmental Panel on Climate Change Fifth Assessment Report (AR5) (IPCC 2014) was the finding that surface temperature is projected to rise over the 21st century under all assessed emission scenarios, meaning that it is very likely that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions. In urban areas, climate change is projected to increase risks for people, economies, and ecosystems, making building adaptive capacity crucial for effective selection and implementation of adaptation options.

Historical climate in the vicinity of the project

The historical climate for the project area is based on meteorological observations from Bureau of Meteorology (BoM) station 061078 located at the Royal Australian Air Force Base (RAAF) Williamtown (operating from 1942 until present). This BoM station was selected to be representative of the Lower Hunter region which comprises the City of Newcastle, Lake Macquarie, Cessnock, Maitland and Port Stephens local council areas. RAAF Williamtown is located about 10 kilometres east of the project but is the nearest BoM station with a substantial level of historical climate data available. Rainfall observations are available for the years 1960-2025 and temperature observations are available for the years 1951-2020. There are some data gaps in the rainfall record between 2010 and 2015.

Rainfall

The project would be located in the Lower Hunter region. Annual rainfall for this region over the full period of record is 1,120 millimetres, with a high level of year-to-year variability.

Average monthly rainfall in the region ranges between 61 millimetres in September and 130 millimetres in June. Average monthly rainfall during late winter and early spring is considerably lower than the average for autumn, where rainfall almost doubles. The pattern in extreme monthly rainfall indicates that the potential for very wet months is highest during January to June.

Maximum recorded daily rainfall totals are typically greater during summer-autumn than at other times of year.

Temperature

There are consistent trends for increased maximum temperatures since about 2000. This trend is most obvious for maximum and minimum recorded temperatures. Average temperatures over the 1976 – 2015 climate change projection reference period are 0.1 degrees Celsius to 0.2 degrees Celsius warmer than over the entire period of record.

Monthly average and average maximum temperatures for the climate change projection reference period are typically higher than those for the full period of record. Average monthly minimum temperatures are generally the same.

Days in which maximum temperatures exceed 35 degrees Celsius are reasonably common in the Lower Hunter, while days during which minimum temperatures are 2 degrees Celsius or less are less common.

Over the period of record there has been an annual average of 23.8 heatwave days and 2.2 severe heatwave days. The average incidence of heatwave days and severe heatwave days during the climate change projection reference period was 24.8 days per annum and 1.9 days per annum respectively.

Wind

Wind speeds in the Lower Hunter typically increase through the day. During summer months, the wind speed increases by about 10 kilometres per hour from 9am to 3pm, while in the winter months this is lower, ranging from an increase of two to four kilometres per hour from 9am to 3pm. Maximum recorded wind gusts in the Lower Hunter range between 98 kilometres per hour in February and 137 kilometres per hour in August and December.

21.4 Assessment of potential impacts

21.4.1 Climate change projections

Carbon dioxide (CO_2) is a vital gas for photosynthesis and global climate regulation. CO_2 and other greenhouse gases trap long wave radiation, as such, changes in their concentrations in the atmosphere influence the Earth's radiation balance and contribute to the warming of both the atmosphere and the Earth's surface. This phenomenon is known as the greenhouse effect.

Climate change projections are derived using general circulation models (often referred to as global climate models or GCMs), which simulate the ocean, atmospheric and land surface processes which influence climate. The IPCC's Fifth Assessment Report (AR5) (IPCC 2014) provides a synthesis of climate change modelling carried out by leading international climate research organisations. The RCP8.5 representative concentration pathway (RCP) identified under AR5, is used throughout this report as it reflects the highest of the emissions scenarios considered in AR5.

The reliability of climate change projections varies between climate variables. In general, global projections are more certain than regional projections which were used for this assessment, and temperature projections are more certain than those for rainfall. Changes in average conditions are also more certain than changes in extremes.

Rainfall

The average rainfall is projected to decrease in 2030 and the climate is projected to become drier in 2050 and 2090. Maximum annual rainfall is projected to increase very slightly from the 1976 to 2015 baseline to 2090, while minimum annual rainfall is projected to decline by 2090.

Seasonal patterns in rainfall are not projected to change much to 2030, 2050 or 2090, although winter rainfall is projected to be slightly less.

Extreme daily rainfall values are generally projected to increase in summer by 2090. Design of the project has considered very low frequency rainfall events, with average recurrence intervals (ARI) in excess of 500 years. Atmospheric warming may increase the frequency of the current 1000-year ARI event, as well as increase the rainfall total during the projected 500-year daily rainfall event with the 2050 or 2090 climate.

Temperature

Average and extreme maximum and minimum temperatures are projected to increase 3.8 degrees Celsius and 3.9 degrees Celsius, respectively, under the RCP8.5 scenario. The highest projected temperature for 2030 onwards exceeds the highest recorded temperature for the RAAF Williamtown BOM meteorological station.

The historical trend for reduced incidence of extreme cold conditions is projected to continue (albeit with more recent slight increase in the number of these days). The number of days with freezing minimum temperatures is projected to reduce, with temperatures being less severe.

Climate change is projected to increase average and extreme temperatures for the Lower Hunter throughout the year. Temperatures through the cooler months of winter are projected to increase to a lesser extent than those during other times of year. The range in average temperatures for winter is projected to increase from 11.9 degrees Celsius to 23.4 degrees Celsius during the climate change reference period to 15.8 degrees Celsius to 27.2 degrees Celsius in 2090.

Periods throughout the year with maximum temperatures above 40 degrees Celsius are projected to change from between November to February and extend to between September to April.

Days in which maximum temperatures reach high temperature benchmarks (35/40/45 degrees Celsius) in the Lower Hunter are projected to increase in frequency. The frequency of days with temperatures exceeding 35 degrees Celsius is projected to more than triple relative to the climate change projection reference period by 2090. Days with temperatures exceeding 40 degrees Celsius are projected to experience a fivefold increase in frequency. Historically, temperatures exceeding 45 degrees Celsius have only been experienced in the last few years. Such days are projected to be experienced almost once every 2 years by 2090.

Days with extreme minimum temperatures are projected to decline in frequency over the course of this century under the RCP8.5 scenario. Freezing days occur at a rate of approximately 0.5 days per year over the reference period and are projected to decline to zero by 2090. Days of frost are also projected to decline from 3.6 days per year to zero days per year by 2090.

The frequency of days with excess heat is projected to increase more than fourfold between the climate change reference period and 2090, with the frequency of such days increasing from 24.75 occurrences per year to 117 occurrences per year. Severe heatwave days are projected to increase in frequency by a similar order.

Wind

Climate change is anticipated to have only marginal impact on average and extreme wind events. Average wind speed is projected to decline by up to five per cent in all seasons, except winter in 2050 and summer in 2090 under the RCP8.5 scenario, when small increases in wind speed are projected.

The severity of the 1 in 20-year wind gust is projected to decline slightly in summer and autumn throughout the projection period and in winter in 2030 and spring in 2090, under the RCP8.5 scenario.

21.4.2 Construction impacts

Climate change

While construction of the project would generate GHGs as described in the section below, the resulting climate change impacts are not anticipated to occur during construction due to the short-term nature of construction. As a result, the risks associated with climate change are considered to be operational, and have been assessed in **Section 21.4.3**.

GHG emissions estimations

The estimated Scope 1, 2 and 3 emissions for the construction of the project are summarised below and in **Table 21-3**. Construction emissions associated with the project would result from the following:

- Construction fuel combustion
- Construction material embedded emissions
- Vegetation clearing.

Electricity generation resulting from fuel combustion for the project was assumed to be from diesel generators.

Construction fuel combustion

Construction fuel combustion is estimated to produce 31,669 tonnes of CO_2e throughout the duration of construction. Diesel used for site offices and site vehicles, construction works, demolition and earthworks and vegetation removal would produce scope 1 emissions of 30,124 tonnes of CO_2e and would produce scope 3 emissions of 1,545 tonnes of CO_2e.

Construction material embedded emissions

Emissions factors for activities associated with the production of construction materials were derived from the Infrastructure Sustainability Council of Australia (ISCA) Materials Calculator. These represent the emissions 'embedded' in the production of 1 metric tonne of each material and are largely derived from the Australian Life Cycle Inventory (AusLCI) project. The emission factors for construction materials are as follows:

- Aggregate (0.006t CO_2e/t)
- Asphalt and bitumen (0.390t CO_2e/t)
- Cement and concrete (0.200t CO_2e/t)
- Steel (2.324t CO_2e/t).

In total, 1,288,076 tonnes of material would be used during construction and 151,210 tonnes of CO_2e would be produced as scope 3 emissions.

Vegetation clearance

Clearing of vegetation is estimated to produce 60,384 tonnes of CO_2e. About 171 hectares of vegetation would be cleared and all emissions would be scope 1 emissions.

In summary, construction fuel combustion is estimated to produce 31,669 tonnes of CO_2e throughout the construction phase. Further, 151,210 tonnes of CO_2e are estimated to be embedded in the materials used for the construction of the project and clearing of vegetation is estimated to produce 60,384 tonnes of CO_2e.

Table 21-3 Construction GHG emissions

Emission source	Scope 1 Emissions (t CO_2e)	Scope 2 Emissions (t CO_2e)	Scope 3 Emissions (t CO_2e)	Total Emissions (t CO_2e)
Fuel combustion				
Site offices and site vehicles	634	-	33	667
Construction works	15,607	-	801	16,407
Demolition and earthworks	12,618	-	647	13,265
Vegetation removal	1,266	-	65	1,330

Emission source	Scope 1 Emissions ($t\ CO_2e$)	Scope 2 Emissions ($t\ CO_2e$)	Scope 3 Emissions ($t\ CO_2e$)	Total Emissions ($t\ CO_2e$)
Total fuel combustion	**30,124**	**-**	**1,545**	**31,669**
Construction materials				
Aggregate	-	-	5,128	5,128
Asphalt and bitumen	-	-	973	973
Cement and concrete	-	-	80,651	80,651
Steel	-	-	64,458	64,458
Total construction materials	**-**	**-**	**151,210**	**151,210**
Vegetation clearance				
Class A (Rainforest and Vine Thicket)	0	-	-	0
Class B (Eucalypt Tall Open Forest)	4,754	-	-	4,754
Class C (Open Forest)	47,551	-	-	47,551
Class I (Grasslands)	8,079	-	-	8,079
Total vegetation clearance	**60,384**	**-**	**-**	**60,384**
Total construction emissions				**243,263**

21.4.3 Operational impacts

Climate change

Climate change is anticipated to have direct and indirect impacts on the proposal. The types of impacts are relatively well understood however their severity and extent are uncertain. The combined direct and indirect impacts of climate change may contribute to one or more of the following:

- Accelerated infrastructure deterioration and increased maintenance requirements
- Safety incidents
- Increased frequency and/or duration of road closure/cancellations
- Infrastructure loss (total or partial loss because of a severe weather event).

Risk analysis and evaluation was carried out through desktop assessment and liaison with other technical specialists. Prior to the implementation of environmental management, four risks were identified as ‘high’, four risks were identified as ‘medium’ and eight risks were identified as ‘low’. Medium and high risks are presented in **Table 21-4**.

Following the implementation of design controls or proposed risk treatments, three risks were identified as ‘high’, two risks were identified as ‘medium’ and eleven risks were identified as ‘low’. The full results of the risk assessment are presented in Appendix C of the Climate Change Risk Working Paper (**Appendix U**).

Table 21-4 Climate change risks with a residual risk of ‘medium’ or higher

ID	Cause, trigger or issue	Risk, hazard or opportunity	Potential consequences	Inherent (original) risk rating	Proposed risk treatment	Residual risk
9	Increase in the frequency and intensity of severe rainfall events coupled with Sea Level Rise.	Increased flooding (extent and depth) covers and damages areas previously modelled/designed to be immune from flooding (to the 5% AEP design standard).	Flooding damage to road and road infrastructure which could temporarily close the road which will severely delay traffic. Impact will require clean up and repair depending on level of damage. Impact could extend to neighbouring properties due to inability of flood waters to dissipate.	High	Much of the current alignment achieves immunity to the 1% AEP event and as such provides a level of immunity above the design parameter 5% AEP event. With 5% AEP immunity, the road is expected to flood at times, and is therefore designed to provide a level of resilience to this. Additional flood modelling will be carried out if any design changes are made during detailed design. Additional flood modelling would consider climate change related flood risks to the project and the flood impacts from the project.	High
10		Increased flooding (extent and depth) overwhelms areas previously modelled/designed to be immune from flooding (to the 5% AEP design standard).	Flooding/standing water causes accidents for motor vehicles and cyclists resulting in safety incidents for road users	High	Much of the current alignment achieves immunity to the 1% AEP event and as such provides a level of immunity above the design parameter 5% AEP event. Access to the motorway would be limited during a flood event as local roads would be inundated (the motorway would be one of the more flood proof areas). Number of road users would therefore be greatly reduced and limited to those already travelling north or south along the M1 Pacific Motorway. Variable messaging signs would inform road users of hazards. Additional flood modelling will be carried out if any design changes are made during detailed design. Additional flood modelling would consider climate change related flood risks to the project and the flood impacts from the project	High

ID	Cause, trigger or issue	Risk, hazard or opportunity	Potential consequences	Inherent (original) risk rating	Proposed risk treatment	Residual risk
11	Increase in the frequency and intensity of severe rainfall events.	Drainage channels and culverts are too small as 5% AEP storms (the design standard) are more severe as a result of climate change. Exits of culverts suffer increased scour.	Culverts and drainage channels are overwhelmed causing increased flooding on the up-flow side of the culverts, and increased scour at the outflows. This results in increased road closures, and increased maintenance/rectification costs. Diverted water may lead to increased flooding at existing properties.	High	Additional drainage and flood assessment will be carried out if any design changes are made during detailed design. This is presented as management measure FH02 (**Chapter 10** (hydrology and flooding))	High
13	More severe fire weather and elevated fire weather conditions.	Increased local bushfires cause decreased visibility due to smoke.	Road users suffer reduced visibility due to smoke resulting in accidents.	Medium	The project includes Variable Message Signs to warn road users of potential hazards.	Medium
14		Increased local bushfires cause damage to structures such as retaining walls and bridges.	Bushfires in proximity to the project may cause direct damage to structures, utilities and fauna connectivity measures, resulting in road closures while repairs / damage assessment is carried out.	High	Concept design has considered potential impacts to structures, utilities and fauna connectivity structures in bushfire prone areas. Access to fire trails will be maintained.	Medium

GHG emissions

Activities that would generate GHG emissions during operation include:

- Grid electricity consumption (e.g. for powering street lights and traffic signals)
- Pavement maintenance
- Use of the road by vehicles.

Annual use of electricity would result in scope 2 and scope 3 GHG emissions. The predicted total GHG emissions associated with the use of electricity during operation of the project is estimated to be 217t CO_2e per annum.

Ongoing annual maintenance of the project would result in the use of pavement materials including full depth asphalt, deep strength asphalt and plain concrete. The use of materials to carry out annual maintenance activities was estimated to generate about 279t CO_2e of scope 1 emissions and 82t CO_2e of scope 3 emissions. The total GHG emissions associated with annual road maintenance would be 361t CO_2e.

Fuel combustion by future road users would likely generate the greatest amount of GHG during project operation. A comparison was made of GHG emissions that would be produced by the project against a ‘no project’ scenario where vehicles use the existing road network. The results are presented in **Table 21-5**.

As shown in **Table 21-5**, the net 2028 emission contribution of traffic is 13,905t CO_2e per annum and the 2038 emission contribution is 23,726t CO_2e per annum. Given the contribution traffic makes to the overall annual predicted emissions for the project, it should be noted that due to potential future changes in technology in regard to road vehicles in Australia, emissions projected from traffic may significantly decrease in the future. The modelling method used assumes improved fuel efficiency in new models of cars when predicting future emissions, however it does not yet account for the growing adoption of lower emission electric vehicles. It is likely that the increased production and adoption of electric vehicles would mean that by 2028 and 2038 there would be a much greater number of electric vehicles using the project roads, hence resulting in lower traffic emissions than estimated.

Table 21-5 CO_2e contribution of traffic to the project emissions

Emissions source	Scope 3 emissions as a result of traffic (t CO_2e/yr)					
	With project 2028	Without project 2028	Project contribution 2028	With project 2038	Without project 2038	Project contribution 2038
Project roads	35,036	0	35,036	40,014	0	40,014
Pre-existing roads	177,707	198,838	-21,131	201,709	217,997	-16,288
Total	212,743	198,838	13,905	241,724	217,997	23,726

Table 21-6 presents the annual vehicle kilometres travelled (VKT) for scenarios with and without the project. The VKT are higher for scenarios that include the project (‘With project’) compared to scenarios without the project (‘Without project’), indicating that more vehicles can use the roads in the ‘With project’ scenarios, leading to higher emissions for these scenarios. Emissions per kilometre are lower for ‘With project’ scenarios, indicating that the ‘With Project’ scenario is about 2.4 per cent more carbon efficient than the ‘Without project’ scenario. As a result, operation of the project would result in 2.4 per cent fewer emissions produced per kilometre travelled when compared with the existing road network in the same year.

Table 21-6 Comparison of vehicle kilometres travelled between model scenarios

Scenario	Scope 3 emissions ($t\ CO_2e$/year)	Vehicle kilometres travelled (VKT)	$t\ CO_2e$/VKT
'Without project' 2028	198,838	921,662,910	0.000216
'With project' 2028	212,743	1,009,609,085	0.000211
'Without project' 2038	217,997	1,033,154,080	0.000211
'With project' 2038	241,724	1,174,701,268	0.000206

Overall, the project is estimated to result in the generation of 23 kilotonnes of carbon dioxide equivalent annually during the operation of the project over the design life of the project (100 years).

21.5 Environmental management measures

The environmental management measures that will be implemented to minimise the climate change risk and GHG impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 21-7**.

Table 21-7 Environmental management measures (climate change risk)

Impact	Reference	Management measure	Responsibility	Timing
Flood Risk	CC01	Hydrological and hydraulic assessments would be carried out for any design changes during detailed design and would consider the climate change related flood risks to the project and flood impacts from the project.	Contractor	Detailed design
Other relevant management measures				
Project sustainability outcomes	SU1	A Sustainability Management Plan (or similar framework) for the project will be developed and implemented during detailed design and construction, detailing measures to meet the project's sustainability objectives and targets. The Sustainability Management Plan will: • Demonstrate leadership and commitments to sustainability • Adopt relevant sustainability performance targets in accordance with the Transport's Sustainability Strategy • Identify sustainable procurement requirements • Document the process for the identification, assessment and implementation of sustainability initiatives and opportunities • Document the process to be used to monitor and review of sustainability performance against achieving the project's sustainability targets • Outline the documentation and reporting requirements for sustainability on the project.	Transport/ Contractor	Prior to construction/ construction

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M1 Pacific Motorway extension to Raymond Terrace

Environmental impact statement – Chapter 22: Safety and risk

Transport for NSW | July 2021

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22. Safety and risk

This chapter presents an assessment of project safety and risks during construction and operation, and identifies management measures to minimise and reduce these risks. The safety and risk assessment for this project will inform the detailed design, construction and operation of the project to avoid, to the greatest extent possible, risk to public safety and the environment.

The desired performance outcomes for the project relating to safety and risk, as outlined in the SEARs, are to:

- Avoid, to the greatest extent possible, risk to public safety.

Table 22-1 outlines the SEARs that relate to safety and risk and identifies where they are addressed in this EIS.

Table 22-1 SEARs (safety and risk)

Secretary's requirement	**Where addressed**
17. Safety and risk	
1. The Proponent must assess the likely risks of the project to public safety, paying particular attention to pedestrian safety, subsidence risks, bushfire risks and the storage, handling and use of dangerous goods and contaminated material.	The likely risks of the project are identified and assessed in **Section 22.4**.
2. The Proponent must assess the biosecurity risk of the project to minimise the inadvertent spread of disease and pathogens affecting agricultural activities, native vegetation and threatened fauna.	The biosecurity risk of the project is assessed in **Section 22.4**. Further information on potential for spread of pests, disease or weeds, and the 'general biosecurity duty' is provided in **Chapter 9** (biodiversity).

22.1 Policy and planning setting

The safety and risk assessment has been prepared in accordance with local, state and national and legislation, policy and guidance that is endorsed or accepted by Australian health and environmental authorities. This includes, but is not limited to:

- Legislation:
  - *Work Health and Safety Act 2011*
  - *Rural Fires Act 1997*
  - *Dangerous Goods (Road and Rail Transport) Act 2008*
  - Dangerous Goods (Road and Rail Transport) Regulation 2014
- Plans and policies:
  - Australian Dangerous Goods Code (National Transport Commission 2020).
  - Newcastle Bush Fire Management Committee Bush Fire Risk Management Plan (BFRMP) (Newcastle Bush Fire Management Committee 2018)
  - State Environmental Planning Policy No. 33 (SEPP 33) – Hazardous and Offensive Development (NSW)

- Guidelines:
  - Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards: 2012 (enHealth 2012a)
  - Applying State Environmental Planning Policy 33 (SEPP 33): Hazardous and Offensive Development Application Guidelines (DPE 2011)
  - Health Impact Assessment Guidelines (enHealth 2017)
  - Health Impact Assessment: A Practical Guide (NSW Health 2007)
  - Planning for Bush Fire Protection (NSW Rural Fire Service 2006).

22.2 Assessment methodology

The project has the potential to impact the safety of the public, construction workforce, road users and communities surrounding the project. An assessment was carried out in accordance with the policies and guidance presented in **Section 22.1** and using the methodology described in this section.

22.2.1 Public safety risks

Public safety risks include risks present in the construction workplace and environmental hazards that may present risks to road users and surrounding communities. An assessment of public safety in the context of exposure to environmental hazards was conducted in accordance with the methodology for assessing health impacts as defined by NSW Health (2007) and included:

- A review of the potential noise and vibration and air quality impacts that may arise from construction and operation of the project as described in **Chapter 8** (noise and vibration) and **Chapter 18** (air quality)
- Identification of hazards which may lead to or contribute to human health and public safety risks, through desktop analysis, based on typical hazards encountered during construction and operation of a motorway.

22.2.2 Road, pedestrian and cyclist safety

The assessment of road, pedestrian and cyclist safety included a review of the traffic and transport safety hazards that may arise from the construction and operation of the project as described in **Chapter 7** (traffic and transport) to identify potential risks associated with the identified traffic and transport safety hazards.

22.2.3 Bushfire risk

The assessment of bushfire risk for the project was conducted in accordance with Planning for Bush Fire Protection (NSW Rural Fire Service 2006) and involved a desktop review of spatial datasets and available literature, including:

- NSW Bushfire Prone Land Map Tool (NSW Rural Fire Service 2016)
  - City of Newcastle Bush Fire Prone Land Map (City of Newcastle 2018b)
  - Port Stephens Council Bush Fire Prone Land Map (Port Stephens Council 2009)
  - Maitland City Council online mapping (Maitland City Council 2018).
- Climate data in the vicinity of the project (Australian Bureau of Meteorology 2020b)
- Newcastle Bushfire Risk Management Plan 2018-2023 (Newcastle Bush Fire Management Committee 2018).

The NSW Bushfire Prone Land Map Tool (NSW Rural Fire Service 2016) (accessed December 2020) was reviewed to identify where the construction footprint intersects bushfire prone land. Existing land uses, based on spatial data and aerial photography, were also assessed to determine the potential bushfire risk on properties.

22.2.4 Flood evacuation risks

The assessment of flood evacuation risks included a review of the impacts to flood evacuation routes that may arise from the construction and operation of the project as described in **Chapter 10** (hydrology and flooding) to identify risks associated with identified flood evacuation routes.

22.2.5 Storage, handling and use of dangerous goods and hazardous material

The Australian Dangerous Goods Code (National Transport Commission 2020) lists all dangerous goods and notes their classification. Each of the dangerous goods are assigned a specific United Nations number and are divided into classes, based on their predominant hazard. The assessment of dangerous goods and hazardous material risk for the project included:

- A desktop review to identify potentially dangerous and hazardous material required during construction and operation of the project
- Identification of the risks to road users and the public arising from the storage, handling and use and transportation of dangerous goods and hazardous materials to and within the construction footprint.

It is noted that while SEPP 33 is not applicable to the project, given that the project is classified as State Significant Infrastructure (refer to **Chapter 2**), the principles of SEPP 33 and Applying State Environmental Planning Policy 33 (SEPP 33): Hazardous and Offensive Development Application Guidelines (Department of Planning and Environment 2011) have been considered to identify potential hazards associated with the project.

22.2.6 Contamination hazards

The assessment of risks from contamination hazards included a review of the contamination hazards that may arise from the construction and operation of the project as described in **Chapter 16** (soils and contamination).

22.2.7 Subsidence risk

The assessment of subsidence risk included:

- A search of the NSW Planning Portal (administered by the NSW Government) to identify mine subsidence districts in the vicinity of the project
- A review of data from the NSW Department of Planning, Industry and Environment (DPIE) MinView database for mining, extractive industries and exploration activities
- A comparison of the identified subsidence districts with the construction and operational footprints of the project to identify whether construction or operational activities would occur within a subsidence district, resulting in subsidence risks.

22.2.8 Biosecurity risk

The assessment of biosecurity risk included:

- A review of the impacts of the spread of disease and pathogens to native vegetation and threatened fauna identified within **Chapter 9** (biodiversity)
- A review of the Australian Interstate Quarantine map (administered by Plant Health Australia) on 17 December 2020 to identify any biosecurity zones in the vicinity of the project
- A review of the existing agricultural activities within the construction footprint identified within **Chapter 14** (land use and property) to identify agricultural activities that may be impacted by spread of disease and pathogens.

22.3 Existing environment

22.3.1 Public safety risks

The existing public safety risks of the construction footprint and surrounding areas are those typically associated with the operation of the existing road network. Existing public safety hazards include:

- Hazards to the maintenance workforce as a result of road maintenance activities
- Health risks to road users and nearby communities, including:
  - Existing road noise impacts as described in **Section 8.3.2**
  - Air quality impacts as described in **Section 18.3.3**
  - Noise impacts associated with any existing construction activities.

22.3.2 Road, pedestrian and cyclist safety

Existing road safety performance is detailed in **Section 3.2.6** and **Section 7.3.4**.

A summary of the crash history for the five-year period between October 2014 to September 2019 on key roads within the traffic and transport study area (identified in **Figure 7-2**) is provided in **Table 3-3**. In summary, a total of 289 crashes were recorded, of which six crashes were fatal. The New England Highway and Pacific Highway recorded the highest number of crashes, commensurate with the high traffic volumes on these roads. Old Punt Road and Tomago Road recorded the lowest number of crashes over the five-year period.

Of all the crashes recorded, two involved pedestrians, both being fatalities. Of these two crashes one was located outside of the construction footprint on Weakleys Drive with the other located within the construction footprint on the Pacific Highway south of Old Punt Road. Three crashes recorded involved cyclists. Of these crashes, none involved fatalities and all were located within the construction footprint.

As described in **Section 5.3.16** existing pedestrian infrastructure is limited along the existing M1 Pacific Motorway due to the relatively low demand. Footpaths are located on some local roads within the vicinity of the project. Signalised pedestrian crossings are located at existing intersections along the Pacific Highway and Tomago Road.

As there are no existing cycle paths located within the vicinity of the project, cyclists use the shoulders of the existing road network. Dedicated off road cycleways are currently proposed by the City of Newcastle as described in **Section 5.3.16**.

22.3.3 Bushfire risks

Bushfire season for the lower Hunter region is typically from October to March, with most fires a result of illegal burning off, lightning strikes and car dumping (Newcastle Bush Fire Management Committee 2018).

Based on a review of the City of Newcastle Council Bush Fire Prone Land Map (City of Newcastle 2018b) and Port Stephens Council Bush Fire Prone Land Map (Port Stephens Council 2009) and Maitland City Council's online mapping tool (Maitland City Council 2018), the project would be located within and near bushfire prone land. As shown on **Figure 22-1** the project includes vegetation classified as:

- Vegetation Category 1, considered to be the highest risk for bushfire. Within the vicinity of the project, Category 1 vegetation is mostly located in Black Hill and through Tomago, Heatherbrae and Raymond Terrace
- Vegetation Category 2, considered to be a lower bush fire risk than Category 1 and 3. Within the vicinity of the project, Category 2 vegetation is mostly located to the west and north of the Hunter River
- Vegetation Category 3, considered to be a medium bush fire risk. Within the vicinity of the project, Category 3 vegetation is located mostly along the floodplain west of the Hunter River
- Buffer zones, which are also considered to be bushfire prone land.

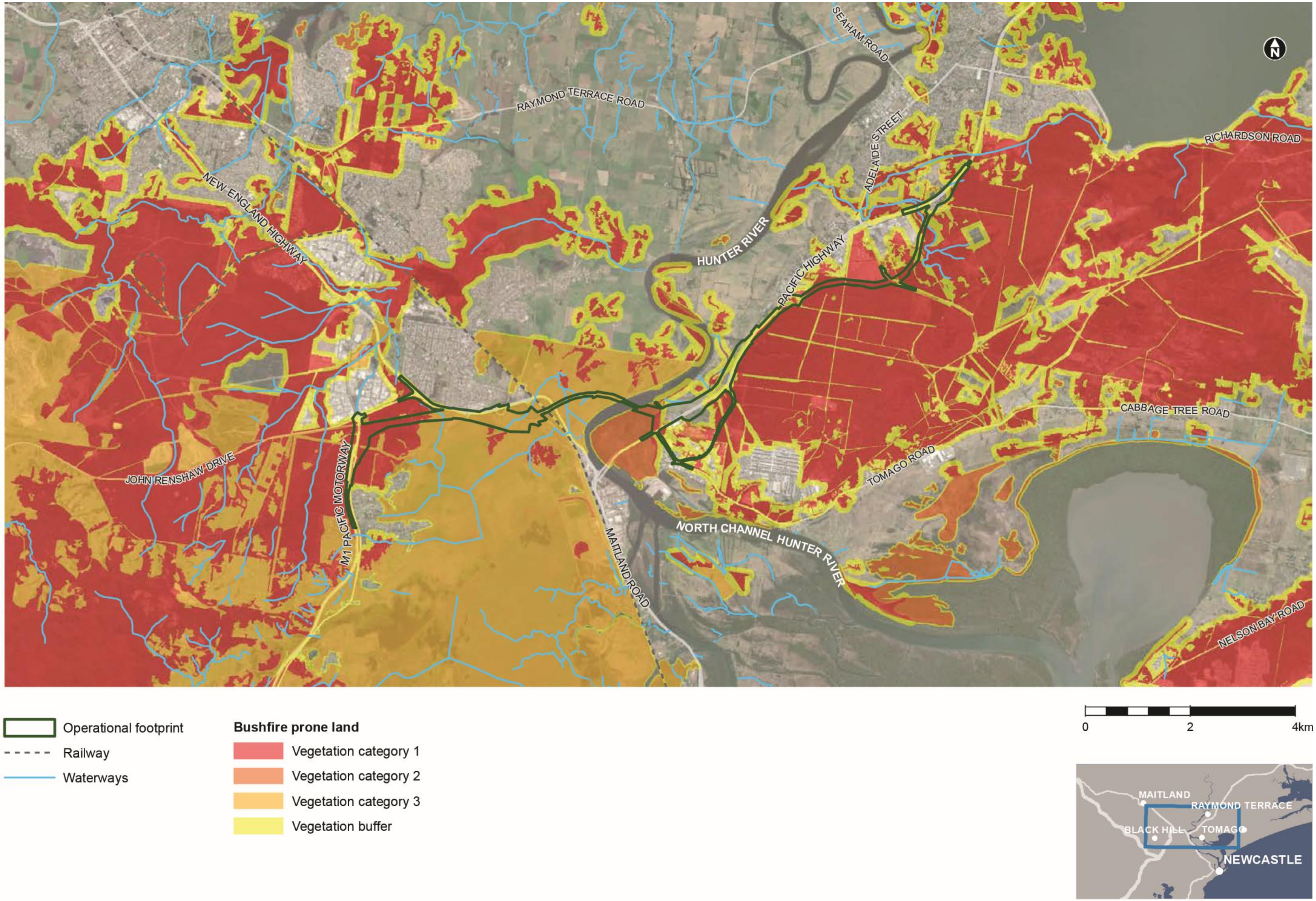

Figure 22-1 Bushfire prone land

22.3.4 Flood evacuation risks

The existing major roads near the project that form the main evacuation and emergency access routes from areas that are flood prone are listed in **Table 22-2**. The conditions in which these roads would flood are also listed in **Table 22-2**. Existing flooding conditions and the main emergency and access routes that are flood prone are further discussed in **Section 10.3.5**.

Table 22-2 Flooding on existing major roads

Road	Comment
West of Hunter River	
M1 Pacific Motorway and John Renshaw Drive – Black Hill to Tarro	• Flood free except for in the PMF at Lenaghan, at crossing of an unnamed creek which drains to the north-western end of Hexham Swamp
New England Highway – Thornton to Beresfield	• Flood free up to and including 1% AEP flood event • Flooded during the PMF at Viney Creek
New England Highway – Tarro	• Flooded in 2% AEP flood event, immediately west of Anderson Drive overpass
Pacific Highway – Hexham	• Existing twin bridges crossing the Hunter River (Hexham Bridge) are flood free in all events except for the PMF
New England Highway, Pacific Highway, Maitland Road – Hexham	• New England Highway heading north into Tarro flooded to 0.3m depth in 10% AEP flood event • Pacific Highway flooded in 10% AEP flood event affecting access to the south toward Hexham and Sandgate • Unlikely to be trafficable in 5% AEP flood event
East of Hunter River	
Pacific Highway – Tomago	• Flooded to 0.1m depth in 20% AEP flood event, between Hexham Bridge and Tomago Road. Tomago Road also flooded at intersection. Unlikely to be trafficable in 10% AEP flood event due to depths over 0.4m • Minor flooding in 10% AEP flood event, just south of Hunter Region Botanic Gardens
Old Punt Road – alternative access from Tomago to Heatherbrae	• Flooded in 20% AEP flood event
Tomago Road and Masonite Road – alternative access from Tomago to Heatherbrae	• Flooded to 1m depths in 20% AEP flood event, access cut-off
Pacific Highway – Heatherbrae and Raymond Terrace	• Remains flood free up to the 5% AEP flood event • The Pacific Highway experiences depths of flooding over 0.5m during the 2% AEP flood event near Windeyers Creek, access cut-off over 1km length • Access cut-off at Grahamstown Drain in the PMF
Adelaide Street – Alternative access to north of Raymond Terrace	• Access cut-off in 2% AEP flood event at Windeyers Creek and 450m section to the north.

22.3.5 Storage, handling and use of dangerous goods and hazardous material

Dangerous goods and hazardous materials are currently stored within the vicinity of the project for use in construction activities of other projects, farming practices or industrial uses. Road users are required to transport dangerous goods and hazardous materials within the surrounding road network in accordance with the *Dangerous Goods (Road and Rail Transport) Act 2008* and the Dangerous Goods (Road and Rail Transport) Regulation 2014.

Businesses within the vicinity of the project include automotive, construction and industrial manufacturing businesses, which may store or transport higher quantities of dangerous goods such as diesel fuels and oils, greases and lubricants, paints and epoxies, cement and concrete, hydrated lime and curing compounds. Businesses are required to store, handle and use these dangerous goods and hazardous substances in accordance with the *NSW Work Health and Safety Act 2011* and relevant Australian Standards. Further information on businesses surrounding the project is provided in **Chapter 13** (socio-economic).

22.3.6 Contamination hazards

- Within and adjacent to the construction footprint there are several areas of potential contamination risk (AOPCR) that were identified as medium to high risk including: High risk AOPCRs:
  - Asbestos waste at Tarro and Tomago
  - The former mineral sands processing facility at Tomago
  - Potentially impacted Hunter River sediments
  - Locations where construction works may interact with acid sulphate soils
- Medium risk AOPCRs:
  - Buried waste at Tomago
  - Industrial and commercial operations at Tomago and Heatherbrae (including potential PFAS contamination)
  - Raymond Terrace Wastewater Treatment Works
  - The Weathertex site in Heatherbrae
  - Along the Hunter River bank where herbicide has historically been applied
  - Illegally dumped waste at various locations within the construction footprint.

AOPCR that are not land use specific may also be present across the construction footprint. AOPCR are further described in detail in **Section 16.3.6**.

22.3.7 Subsidence risk

A search of the NSW Planning Portal on 6 July 2020 showed that the Black Hill Mine Subsidence District (administered by Subsidence Advisory NSW) is located immediately to the west of the project at Black Hill (refer to **Figure 14-5**).

Subsidence Advisory NSW records indicate that an un-remediated exploration shaft may be present near the intersection of the M1 Pacific Motorway and John Renshaw Drive at Black Hill north of the project.

22.3.8 Biosecurity risk

Within the vicinity of the project there are several primary production land uses such as grazing, forestry, horticulture and cropping. The majority of agricultural land in the vicinity of the project is used for grazing including areas at Black Hill, Tarro, Woodberry, Tomago, Heatherbrae, and Raymond Terrace. The land surrounding the project does not include any land mapped by DPIE as Biophysical Strategic Agricultural Land, that is, land with high quality soil and water resources capable of sustaining high levels of productivity.

Commercial fisheries are also present within the vicinity of the project, including prawn trawling and oyster aquaculture (refer to **Chapter 13** (socio-economic)).

Within NSW there are several pathogens that have the potential to impact agricultural activities and biodiversity. The project is located within the citrus red mite (*Panonychus citri*) biosecurity zone, which is located across the Central Coast region of NSW. Three pathogens that have the potential to impact biodiversity are also listed as a key threatening process under either the EPBC Act and/or TSC Act, and include:

- Dieback caused by *Phytophthora* (Root Rot; EPBC Act and TSC Act)
- Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis (EPBC Act and TSC Act)
- Introduction and establishment of exotic Rust Fungi of the order *Pucciniales* on plants of the family *Myrtaceae* (TSC Act).

22.4 Assessment of potential impacts

22.4.1 Construction impacts

Public safety risks

Construction workplace hazards

Construction workplace hazards would be limited to the construction footprint. Generally, the risk is limited to the construction workforce within the construction footprint. Given the nature of a motorway construction site, potential construction workplace hazards to the construction workforce may include the following:

- Slips and trips from walking around the construction footprint
- Falls from height
- Fire or explosion
- Personnel struck by dropping or swinging loads or other objects
- Manual handling injuries
- Accidents involving vehicles, equipment and people
- Accidents involving vehicle to vehicle collisions
- Asbestos containing material
- Mobile plant interaction
- Electrocution or fire hazards
- Working near or over water.

These risks would be managed in accordance with the NSW *Work Health and Safety Act 2011* and the Work Health and Safety Regulation 2017.

Secure perimeter fencing would be installed to prevent unauthorised access to the construction footprint. As a result, the general public is not anticipated to have access to the construction footprint and safety risks to the general public would be limited to the environmental hazards and other safety risks described in the following subsections.

Environmental hazards

Health risks associated with the construction of the project may be present due to exposure to the following environmental hazards:

- Construction noise impacts
- Construction air quality impacts, including dust.

In summary, the highest impacts at residential receivers are generally in catchments where receivers are located close to the construction footprint. The highest construction noise impacts would occur during 'peak impact' activities, which would only occur for a relatively short period of time. However, high impacts may also occur at residential receivers during other construction activities, including during daytime, evening and night time periods. Other receivers that may also be impacted by noise from construction include educational facilities, places of worship, childcare centres, outdoor recreation areas and commercial and industrial receivers. Environmental management measures as described in **Section 8.6** will be implemented to minimise potential construction noise impacts. Construction noise impacts are further described in **Section 8.4**.

No adverse residual construction air quality impacts are anticipated given that dust impacts would be temporary and would be minimised with the implementation of environmental management measures. The environmental management measures that will be implemented to minimise potential construction air quality impacts are described in **Section 18.5**. Construction air quality impacts are further described in **Section 18.4**.

Road, pedestrian and cyclist safety

Construction of the project could result in an increased risk of vehicular, cyclist and pedestrian accidents. This increased risk is due to an increased number of vehicles, including heavy vehicles, in the local road network, along with changed traffic conditions (e.g. reduced speed limits, temporary signage and temporary traffic lane closures) near the project. To manage safety risks, temporary changes to roads would be audited in relation to road safety. A Traffic Management Plan and traffic control plans will be implemented during construction to ensure the safe movement of traffic, cyclists and pedestrians during construction, including the development of a response plan for any construction traffic incidents as described in **Section 7.7**.

Construction of the project would not impact any separated walking and cycling paths as described in **Section 5.4**. Given the lack of pedestrian infrastructure, pedestrian volumes are anticipated to be very low as described in **Section 7.4**. Where practical, minimum two-metre shoulders have been adopted for cycling access during construction. However, shoulders would be reduced for areas with limited clearance widths, which may pose an increased safety risk to cyclists.

Where construction activities impact pedestrian movements and cyclist access, pedestrian and cyclist traffic management would be implemented as part of the Traffic Management Plan and associated traffic con trol plans described in **Section 7.7**.

Bushfire risks

As the project would be located within and near bushfire prone land, the project has the potential to increase bushfire risk from accidental ignition. Potential bushfire risks could result from activities and materials used at ancillary facilities with increased fuel loads, the use of mobile equipment, fuels and chemicals, and work on days that are classified as high fire risk. Construction ancillary facilities and construction infrastructure are temporary in nature and, where required, would be cleared of vegetation.

During construction, there would be impacts on roads in and next to the construction footprint including reduced speed limits and modified arrangements. This may delay response times and/or access for emergency services including fire crews, in the event of a bushfire. Construction personnel would be made aware of the potential for bushfires before working on the project. Measures to reduce bushfire risk during construction will be developed as described in **Table 22-3**.

Flood evacuation risks

During construction, there would be no change in total length of road impacted for the majority of named roads within the study area. There would be minor increases (up to 0.11 kilometres) in length of inundated roads at locations that are currently inundated during floods. Some roads would experience a decrease in length affected by flood hazard, an improvement when compared to the existing flooding conditions as described in **Section 10.5.3**. A new 46 metre section of the Pacific Highway at Tomago Road intersection would become cut-off in the 20% AEP event.

While traffic conditions as a result of project construction work could reduce capacity of existing evacuation routes, the minor change in the length of roads affected by flood hazard combined with minor changes in duration of inundation, would result in a negligible impact of flooding on emergency access and evacuation routes in up to the 5% AEP during construction (refer to **Section 10.5.3**).

Construction flood evacuation risks would be managed in accordance with the environmental management measures described in **Section 10.7**. Potential flood evacuation impacts during construction of the project are further described in **Section 10.5**.

Storage, handling and use of dangerous goods and hazardous material

Based on typical construction methods and maintenance requirements for similar projects, the dangerous goods and hazardous substances required for the project may include:

- Diesel fuels
- Oils, greases and lubricants
- Explosives
- Gases (oxy-Acetylene)
- Bitumen
- Paints and epoxies
- Herbicides
- Cement and concrete.

During construction, dangerous goods and hazardous substances are likely to be transported to and from and used within the construction footprint. Storage, handling and use of dangerous goods and hazardous substances may adversely impact human safety, either directly through contact, or indirectly through damage to the local environment, including the sensitive receiving environments described in **Section 10.3.2** and **Section 11.3.3**. This may impact construction workers and residents surrounding the construction footprint and haulage routes. The types of dangerous goods and hazardous substances that would be stored and used within each temporary ancillary facility would be dependent on the purpose of each temporary ancillary facility, as described in **Section 5.4.3**.

The storage, handling and use of dangerous goods and hazardous substances would be carried out in accordance with the *NSW Work Health and Safety Act 2011*, relevant Australian Standards and the environmental management measures described in **Table 22-3**. As such, the potential for impacts to construction workers and the environment is considered to be low.

Contamination hazards

Contaminants within AOPCR have potential to be exposed or disturbed by construction activities, such as excavation and ground disturbing works, dewatering activities, and dredging and bridge construction activities. This disturbance may result in risks of contaminant exposure to construction workers, road users and surrounding communities. Should asbestos be disturbed during construction, it can pose a health risk if inhaled into the lungs, potentially causing asbestosis, lung cancer and mesothelioma to workers or nearby residents (WorkCover NSW 2014).

Potential contamination hazards would be managed in accordance with the environmental management measures described in **Section 16.5**.

Subsidence risk

The construction footprint of the project would be located outside of the Black Hill Mine Subsidence District. As a result, no mine induced subsidence impacts are anticipated during operation of the project.

An un-remediated exploration shaft may be present within the John Renshaw Drive road corridor next to a site identified for use as an ancillary facility (AS1) during construction. The project would be located south of this location and is not likely to interact with this shaft, if present. No subsurface investigations to date have indicated the presence of a shaft in the project area. Additionally, the potential shaft is mapped in the vicinity of existing sub surface works carried out by Hunter Water Corporation for major utility mains, yet there is no known knowledge of a shaft in the construction footprint. Any potential residual risks surrounding this shaft would be managed by the contractor prior to and during construction.

Biosecurity risk

Biosecurity risks, including the introduction or spread of pathogens and diseases, may result in impacts to native vegetation, threatened fauna, agricultural activities and commercial fisheries during construction.

While the pathogens described in **Section 22.3** were not observed in the construction footprint during the biodiversity field surveys described in **Section 9.2**, pathogens may be transported by machinery or from fill sources during construction. About 1,080,000 cubic metres of imported fill would be required for the project. Where possible, fill material would be sourced from onsite. Imported fill will be sourced from quarries, local borrow pits and/or other sources, potentially including local mine backfill, former brick pits, interbedded sedimentary and volcanic rocks at Eagleton, coal ash, sand mines, and other projects. Fill and engineering materials from these sources are less likely to contain pathogens and diseases.

Environmental management measures, including the management of pest species and pathogens in accordance Guide 2: Exclusion zones of the RTA (2011) and the *Biosecurity Act 2015*, are described in **Section 9.5**. Given that none of the diseases and pathogens identified as having the potential to impact on biodiversity are waterborne, no biosecurity impacts to commercial fisheries or aquaculture are anticipated.

The citrus red mite feeds on the leaves, bark and fruit of citrus trees, and could result in biosecurity impacts to citrus plants and commercial orchards. As the project is not located in the vicinity of any citrus orchards, biosecurity impacts as a result of the citrus red mite are not anticipated. To prevent the potential spread of citrus red mite, no materials would be imported from citrus orchards or from sites adjacent to citrus orchards.

Construction of the project has the potential to introduce pathogens and disease, such as Phytophthora, amphibian chytrid fungus and exotic Rust Fungi, into the construction footprint and adjacent areas. While pathogens were not observed in the construction footprint the potential for pathogens to occur should be treated as a risk during construction as pathogens can be transported by machinery or vehicles. While forested areas are likely at greater risk from plant disease than the freshwater wetland areas of the construction footprint, all areas should be treated equally in terms of the potential risk and managing the spread of pathogens and disease. Refer to **Chapter 9** (biodiversity) for the measures outlined to manage this risk.

Instream works that are required for the construction of the project have the potential to result in unplanned introduction and establishment of marine pest species to the Hunter River estuary and other aquatic environments within the construction footprint (refer to **Section 9.4.2**). Project activities within the Hunter River including the movement and use of the instream floating barge platforms and other vessels required for dredging presents the highest risk to aquatic biosecurity due to the potential for biofouling on external surfaces of vessels and within internal niche areas and systems, and through exchange of the vessel's ballast water. Other instream activities including piling, installation and use of temporary crossing structures and in situ concrete pouring and installation of precast concrete structures present a minor risk to aquatic biosecurity should equipment and/or materials be contaminated.

Potential biosecurity risks would be managed in accordance with the environmental management measures described in **Section 9.5**.

22.4.2 Operational impacts

Public safety risks

Operational workplace hazards

The potential workplace hazards to public safety that could occur during the operation of the project are related to road maintenance activities and include:

- Exposure to hazards associated with road safety: such as traffic accidents while performing maintenance activities near live traffic
- Exposure to hazards associated with utilities: such as exposure of workers, pedestrians and nearby residents to electrocution risks, fire risks and vehicle accidents.

Transport is experienced in road maintenance and has developed effective safety guidelines and procedures for all maintenance activities. With the effective implementation of these guidelines and procedures, the safety risk of operational workplace hazards would be low.

Fencing would be installed where required (refer to **Figure 5-1**) to prevent unauthorised access to the main alignment and other operational areas. Where water quality basins pose a risk to the general public, they will be fenced and/or have their access obstructed with traffic barriers. In addition, safety barriers and screens would be used as described in **Table 5-7**. As a result, the general public is not anticipated to have access to the main alignment except from the road corridor while driving or during a vehicle breakdown. Safety risks to the general public would be limited to the environmental hazards and other safety risks described in the following subsections.

Environmental hazards

Health risks associated with the operation of the project may be present due to exposure to the following environmental hazards:

- Road noise impacts
- Operational air quality impacts.

The predicted change in road traffic noise exposure as a result of the project is typically less than 2 dB(A) at about 83 per cent of the sensitive receivers within the study area for the assessment of operational traffic noise. This level of change in road traffic noise exposure is described by the NSW Road Noise Policy to be barely perceptible and is not anticipated to constitute an environmental hazard. Environmental management measures, as described in **Section 8.6** would be implemented to minimise potential operational noise impacts. Operational road noise impacts are further described in **Section 8.5**.

Operation of the project would lead to a redistribution of vehicle emissions across the road network, generally from existing main roads to the proposed new roads. The project is not expected to cause exceedances of the NSW EPA air quality impact assessment criteria for CO, NO_2, PM_{10}, $PM_{2.5}$ or key air toxics such as benzene and formaldehyde. Environmental management measures, as described in **Section 18.5** would be implemented to minimise potential operational air quality impacts. Operational air quality impacts are further described in **Section 18.4**.

Road, pedestrian and cyclist safety

The project would improve operational road safety for all users, including pedestrians and cyclists as described in **Section 7.5.8**. The project would achieve this by providing a motorway standard of design, including a dual carriageway with a median, an improved road alignment, wider lanes and shoulders and grade separated interchanges and reducing traffic volumes on the existing road network. As a result, the project would have a positive impact on road safety by addressing the following issues:

- Rear end, multi-vehicle crashes are the most common type of crash occurring within the traffic and transport study area. Many of these crashes occur on the New England Highway and Pacific Highway and are caused by traffic congestion. The project would reduce congestion on the New England Highway and Pacific Highway and is anticipated to result in a substantial reduction in rear-end type crashes
- Lane changes are the second most frequent type of crash in the traffic and transport study area with 66 per cent of these crashes occurring on the New England Highway. The project would reduce the number of vehicles travelling on the New England Highway which would reduce the risk of lane change crashes
- Access to and from the project is to be provided via grade-separated interchanges. This would reduce potential points of conflict between vehicles. Providing grade-separated interchanges would also result in free-flow conditions along the project, minimising the risk of congestion-related incidents
- Off road and off bend crashes are a common cause of fatal and serious injury crashes in the traffic and transport study area. The project provides improved road alignment, wider lanes and shoulders with barriers, and would minimise the risk and impact of any off-road crashes.

The project is also anticipated to improve pedestrian and cyclist safety.

The traffic and transport study area is predominantly comprised of industrial land uses which leads to very low volumes of pedestrians. The project would result in fewer traffic movements on the existing road network as traffic reroutes to the M1 Pacific Motorway.

The project would provide a shared path about 900 metres long along the southbound lane of Masonite Road in order to provide safer pedestrian access and to accommodate future development in the surrounding area. No shared path would be provided along the main alignment.

The proposed signalised intersection at the HRBG would provide a signalised pedestrian crossing which would provide access to the bus stop located on the eastern side of the Pacific Highway. It would also offer improved pedestrian access to the HRBG.

As a result, the project would provide safer access for pedestrians.

Cyclists would be able to use the 2.5 metre to three metre wide shoulders provided on the motorway and two metre to 2.5 metre wide sealed shoulders provided on ramps. This would improve cycle connectivity through the traffic and transport study area. Changes to the existing cycle network include:

- A signalised crossing at the M1 Pacific Motorway/John Renshaw Drive intersection with connectivity to the project to provide a safe crossing location for cyclists
- Relocating the existing cyclist crossing on the New England Highway, just east of John Renshaw Drive further west before the northbound entry ramp at the Tarro interchange
- Provision of a westbound cyclist crossing on the New England Highway across John Renshaw Drive

- Replacing the existing gore crossings at the Tarro interchange with new ramps which would create a link between the main alignment in both directions and the future Richmond Vale Rail Trail from Tarro to Shortland
- Provision for northbound cyclists on the Pacific Highway crossing to access Old Punt Road and for crossing from Old Punt to access the northbound Pacific Highway Carriageway
- Provision for northbound cyclists on Pacific Highway to access the main alignment at Tomago interchange and to connect to the traffic signals at Tomago Road
- Provision for northbound cyclists on Pacific Highway to access the HRBG
- Provision for a shared path over the realigned Masonite Road.

Overall, the project would provide additional cycling routes and enhanced safety for cyclists.

Bushfire risks

The operational infrastructure of the project is largely not vulnerable to bushfire due to its incombustible nature (road surface materials, retaining walls, road barriers). Bushfires may occur as a result of car accidents or littering (e.g. cigarette butts). However, landscape treatments would be appropriately designed along the road corridor to reduce potential fuel load, including use of low combustibility vegetation and regular maintenance (through slashing).

The clearing of vegetation for the project would create a fire break and result in a reduced risk of bushfires to the residential areas located adjacent to the main alignment. This would reduce the risk of bushfire, allowing for better containment. Water contained within the permanent operational water quality basins described in **Chapter 11** (surface water and groundwater quality) would be available to be used for emergency firefighting.

Access for emergency services would be improved by the operation of the project. In the instance that sections of the project are closed for safety reasons during a bushfire, the existing M1 Pacific Motorway would provide an alternate route for emergency and evacuation traffic.

Flood evacuation risks

The project would be the main emergency access and flood evacuation route for the surrounding area. The project would provide an improved road alignment and provide a new access route between Black Hill and Raymond Terrace, with flood immunity up to a 5% AEP event.

When operational, there would be no change in total length of road impacted for the majority of named roads within the study area. Minor increases (up to 0.09 kilometres) in length of inundated roads would occur at locations that are currently inundated during floods. Some roads would experience a decrease in total length of flooding, an improvement when compared to the existing flooding conditions. On minor roads, there is negligible change in operational flooding.

While a new 46 metre section of the Pacific Highway at Tomago Road intersection would become cut-off in the 20% AEP event, flooding would generally have a negligible impact on emergency access and evacuation routes in up to the probable maximum flood during project operation. The project would therefore provide some improvements of the trafficability of the Pacific Highway and New England Highway during operation.

Environmental management measures, as described in **Section 10.7** would be implemented to minimise potential operational flood evacuation risks. Potential flood evacuation impacts during operation of the project are further described in **Section 10.6.3**.

Storage, handling and use of dangerous goods and hazardous material

It is not anticipated that substantial volumes of dangerous goods or hazardous substances would be used for maintenance activities during operation of the project. However, dangerous goods and potentially hazardous materials would be transported along the M1 Pacific Motorway as part of the operational use of the project. The nature of the project means that there is an inherent risk of vehicle accidents and associated spillage associated with project operation.

Contaminants either directly associated with a spill or hazardous material clean-up may enter the receiving environment from both paved and unpaved surfaces. However, the potential for such a spill and consequential impacts is considered to be low due to the following factors:

- The high standard road design of the project would reduce the potential for road crashes in comparison to the existing situation
- The existing legislative controls on the transport of dangerous goods and hazardous materials
- In the unlikely event of a traffic crash involving a vehicle carrying dangerous goods or hazardous materials, any spills would typically be managed by the emergency services and the permanent water quality controls described in **Chapter 11** (surface water and groundwater quality).

The project has been designed to minimise and avoid impacts to the Tomago Sandbeds Catchment Area through directing runoff to permanent water quality basins, and the lining of all permanent water quality basins and swales within the Tomago Sandbeds Catchment Area, reducing the risk of spills entering a drinking water catchment. Water quality controls and impacts to the Tomago Sandbeds Catchment Area are further described in **Section 11.4**.

Environmental management measures, as described in **Table 22-3** would be implemented to minimise risks associated with the handling and use of dangerous goods and hazardous materials during operation.

Contamination hazards

Impacts to known areas of contamination would not be expected during operation of the project as suitable rehabilitation and revegetation activities would have been implemented to address areas disturbed during construction. Ongoing exposure of ASS would not be expected or required during project operation. While spills of contaminating materials from the project could potentially contaminate soil near roads associated with the project and adjacent areas, they are not anticipated to enter a drinking water catchment as described above. Environmental management measures, as described in **Section 16.5** would be implemented to minimise operational contamination hazards. Operational contamination impacts are further described in described in **Section 16.4**.

Subsidence risk

The operational footprint of the project is located outside of the Black Hill Mine Subsidence District. As a result, no mine induced subsidence impacts are anticipated during operation of the project.

It is anticipated that any potential risks surrounding the un-remediated exploration shaft would be resolved during construction. As a result, no residual risks surrounding this shaft are anticipated during operation of the project.

Biosecurity risk

Minimal native vegetation, threatened species and agricultural land would be disturbed during operation of the project as described in **Section 9.4** and **Section 14.4**. As a result, pathogens, diseases, and the citrus red mite, are considered unlikely to be transported by machinery during maintenance or by vehicle movements during operation.

22.5 Environmental management measures

The environmental management measures that will be implemented to minimise the safety and risk impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 22-3**.

Table 22-3 Environmental management measures (safety and risk)

Impact	Reference	Management measure	Responsibility	Timing
Bushfire	HS01	A Bushfire Management Plan prepared in accordance with the Planning for Bush Fire Protection 2006 (Rural Fire Service 2006). Measures to be implemented to manage bushfire risk include: • Community notifications in the event of a bushfire • Ensuring plant and equipment are fitted with appropriate spark arrestors, where practicable • Ensuring site workers are informed of the site rules including designated smoking areas and putting rubbish in designated bins • Obtaining hot work permits and implementing total fire bans as required • Implementing adequate storage and handling requirements for potentially flammable substances in accordance with the relevant guidelines.	Contractor	Prior to construction
Subsidence risk	HS02	Potential residual risks surrounding the un-remediated exploration shaft near the John Renshaw Drive road corridor would be managed by the contractor.	Contractor	Prior to construction/ construction
Other relevant management measures				
Management of traffic during construction	TT01	A Traffic Management Plan (TMP) will be prepared and implemented in accordance with the Traffic Control at Work Sites Manual (Roads and Maritime Services 2018b) and QA Specification G10 Control of Traffic. The TMP will include: • Confirmation of haulage routes, including minimisation of haulage movements during peak periods on routes where feasible. • Access management plan to ensure access to properties can be maintained where it is safe and feasible during construction • Site specific traffic control measures (including signage) to manage and regulate traffic movement • Measures to manage temporary changes to the road network including use of barriers, lane occupancies or temporary road closures • Measures to maintain pedestrian and cyclist access (including communication, signage and alternative routes)	Contractor	Prior to construction/ construction

Impact	Reference	Management measure	Responsibility	Timing
		• Requirements and methods to consult and inform the local community of impacts on the local road network (including for out of hours work) • Access to ancillary and construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads • A response plan for any construction traffic incident • Consideration of other developments that may be under construction to minimise traffic conflict and congestion.		
Emergency vehicle access	TT05	Where possible, access for emergency vehicles will be maintained at all times during construction. Any site-specific requirements will be determined in consultation with the relevant emergency services agency.	Contractor	Construction
Flooding impacts during construction	FH01	A Flood Management Plan (FMP) will be prepared for the project and will detail the processes for flood preparedness, materials management, weather monitoring, site management and flood incident management. The FMP will also address procedures and responsibilities for flood response (preparation of site upon receipt of flood warning, evacuation of site personnel) during and recovery following a flood event. The FMP will also include: • Consideration of temporary traffic arrangements to minimise impact on flood evacuation route traffic capacity. • Appropriate measures to manage potential flood impact associated with temporary ancillary facilities subject to flooding within 20% AEP flood level • Where feasible, the size of the ancillary facilities and the height and extent of temporary access tracks will be reduced to minimise flood impacts • Ancillary facilities will also be designed to provide for conveyance of flood flows in order to minimise flooding impacts to adjacent properties and environment.	Transport / Contractor	Prior to construction

Impact	Reference	Management measure	Responsibility	Timing
General	WQ01	A Construction Soils and Water Management Plan (CSWMP) would be developed as a sub plan of the CEMP and will outline measures to manage soil and water quality impacts associated with the construction work, including contaminated land. The CSWMP would include but not be limited to: • Measures to minimise/manage erosion and sediment transport both within the construction footprint and offsite including requirements for the preparation of erosion and sediment control plans (ESCP) for all progressive stages of construction and the implementation of erosion and sediment control measures • Erosion and sediment control measures, which will be implemented and maintained in accordance with Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (DECC 2008) • Measures to manage stockpiles including locations, separation of waste types, sediment controls and stabilisation in accordance with the Stockpile Site Management Guideline (Roads and Maritime Services 2015e). • Procedures for dewatering (including waterways, wetlands and excavations and temporary sediment basins) including relevant discharge criteria. • Concrete waste management procedures • Measures to manage accidental spills including the requirement to maintain materials such as spill kits, an emergency spill response procedure and regular visual water quality checks when working near waterways • Measures to manage tannin leachate and potential saline soils • Controls for sensitive receiving environments which may include but not be limited to identification of 'no go' zones for construction plant and equipment (where applicable).	Contractor	Prior to construction/ construction/ operation
Invasion and spread of weeds	B11	Weed species will be managed in accordance with 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011) (Guide 6: Weed management).	Contractor	Construction
Invasion and spread of pest animal, pathogens and disease	B12	Pest species and pathogens will be managed in accordance Guide 2: Exclusion zones of the 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011), the Commonwealth *Biosecurity Act 2015,* NSW *Biosecurity Act 2015* and where relevant, the Australian Ballast Water Management Requirements.	Contractor	Construction