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M1 Pacific Motorway extension to Raymond Terrace

Soils and Contamination Working Paper

Transport for NSW | July 2021

Executive summary

Background

Transport for New South Wales (Transport) proposes to construct the M1 Pacific Motorway extension to Raymond Terrace (the project). Approval is sought under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and Part 9, Division 1 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Performance outcomes

This assessment has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) (SSI 7319) relating to soils and contamination. In addition, the desired performance outcomes for the project in relation 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 and site contamination.

Soils and contamination impacts

An extensive desktop review of publicly available information, historical land use information, aerial imagery, government registers and historical reports has been conducted. The desktop review and site inspections have informed the findings of this working paper.

Based on the desktop assessment and site inspections, a series of Areas of Potential Contamination Risk (AOPCR) were identified and ranked from low to high risk, including:

- Five high risk AOPCR were identified within the project construction footprint. These are associated with asbestos waste at Tarro and Tomago, at the former mineral sands processing facility at Tomago, potentially impacted Hunter River Sediments and at locations where construction works may interact with acid sulfate soils (including within sediments)
- Six medium AOPCR were identified including buried waste at Tomago and Heatherbrae, industrial and commercial operations at Tomago and Heatherbrae (including potential PFAS contamination), including at Raymond Terrace Wastewater Treatment Works, at 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
- A number of low risk AOPCR (including service stations, areas of potential fill and discarded waste) were also identified within the study area outside of the construction footprint.

During construction, key soils and contamination impacts may occur as a result of:

- Exposure of acid sulfate soils (ASS): Large portions of the construction footprint, especially in the low-lying floodplain areas next to the Hunter River and Windeyers Creek, have been identified as potential or actual ASS (up to and including Class 1). Activities in these areas that have the potential to expose ASS include earthworks, construction of new roads, construction of bridges, relocation of utilities and dewatering activities. Dredging within the Hunter River also has the potential to expose or disturb ASS
- Disturbance of existing contamination: Existing contamination present within soils or groundwater in the construction footprint has the potential to be exposed or disturbed by construction activities, such as:
  - Excavation and ground disturbing earthworks and utility relocations within the former mineral sands processing facility at Tomago, and where isolated historical waste burial and dumping has occurred in Tarro and Tomago
  - Dewatering activities at the former mineral sands processing facility at Tomago

  - Dredging and bridge construction activities within Hunter River sediments.

  These activities have the potential to mobilise contamination and contaminated groundwater during ground disturbing activities and impact nearby waterways such as Purgatory Creek, the Hunter River, Windeyers Creek, and drainage lines
- Soil erosion and loss of topsoil: Removal of vegetation and disturbance of the ground surface has the potential to mobilise sediments. These would include cut and fill earthworks, construction of new roads, stockpiling, construction of bridges, relocation of utilities and landscaping. Soil disturbance is expected across the construction footprint so soil erosion has the potential to occur requiring management measures
- Activities that involve disturbing soils on existing slopes or highly sodic soils have the highest potential to erode soils during construction. The construction footprint includes sodic soils within the low-lying floodplain areas either side of the Hunter River
- Spills of contaminating materials: There would be potential for construction activities to result in contamination of soil and/or water due to leaks and spills of potentially contaminating materials.

Soils and contamination impacts during operation of the project are expected to be minimal. The main risk from the operational use of the motorway is from large scale chemical or hydrocarbon spills from freight transport. These will be managed by a combination of authorities (Transport, Police and other emergency services) as individual scenarios require.

Management measures

Specific soils and contamination management measures would be detailed within the Construction Environmental Management Plan, and a series of issue specific sub plans including:

- Construction Soil and Water Management Plan, which will include:
  - Salinity Management Plan
  - Acid Sulfate Soils Management Plan
  - Progressive erosion and sediment control plans.
- Contaminated Land Management Plan incorporating testing and treatments for location-specific contamination as well as an unexpected finds protocol.

A Remediation Action Plan for contamination from the former mineral sands processing facility would be developed and approved prior to construction. The site would be remediated to an acceptable standard and subject to a Site Audit Statement and Site Audit Report from an NSW Environment Protection Authority Accredited Contaminated Land Auditor to support the project.

Conclusion

Based on the results within this assessment and following implementation of the management measures, the project is unlikely to have a significant impact on soils and has a low risk of increasing contamination.

The project has minimised the risks arising from the disturbance and excavation of land and disposal of soil, including disturbance to acid sulfate soils and site contamination. As a result, the project has also sought to protect the environmental values of land, including soils, subsoils and landforms. As such, the project has met the both the SEARs and the desired performance outcomes for the project in relation to soils and contamination.

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1. Introduction

1.1 Background

Transport for New South Wales (Transport) proposes to construct the M1 Pacific Motorway extension to Raymond Terrace (the project). Approval is sought under Part 5, Division 5.2 of the E*nvironmental Planning and Assessment Act 1979* (EP&A Act) and Part 9, Division 1 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The project would connect the existing M1 Pacific Motorway at Black Hill and the Pacific Highway at Raymond Terrace within the City of Newcastle and Port Stephens Council local government areas (LGAs). The project would provide regional benefits and substantial productivity benefits on a national scale. The project location is shown in **Figure 1-1** within its regional context.

1.2 Project description

The project would include the following key features:

- A 15 kilometre motorway comprised of a four lane divided road (two lanes in each direction)
- Motorway access from the existing road network via four new interchanges at:
  - Black Hill: connection to the M1 Pacific Motorway
  - Tarro: connection and upgrade (six lanes) to the New England Highway between John Renshaw Drive and the existing Tarro interchange at Anderson Drive
  - Tomago: connection to the Pacific Highway and Old Punt Road
  - Raymond Terrace: connection to the Pacific Highway.
- A 2.6 kilometre viaduct over the Hunter River floodplain including new bridge crossings over the Hunter River, the Main North Rail Line, and the New England Highway
- Bridge structures over local waterways at Tarro and Raymond Terrace, and an overpass for Masonite Road in Heatherbrae
- Connections and modifications to the adjoining local road network
- Traffic management facilities and features
- Roadside furniture including safety barriers, signage, fauna fencing and crossings and street lighting
- Adjustment of waterways, including at Purgatory Creek at Tarro and a tributary of Viney Creek
- Environmental management measures including surface water quality control measures
- Adjustment, protection and/or relocation of existing utilities
- Walking and cycling considerations, allowing for existing and proposed cycleway route access
- Permanent and temporary property adjustments and property access refinements
- Construction activities, including establishment and use of temporary ancillary facilities, temporary access tracks, haul roads, batching plants, temporary wharves, soil treatment and environmental controls.

A detailed project description is provided in Chapter 5 of the environmental impact statement (EIS). The locality of the project is shown in **Figure 1-1**, while an overview of the project is shown in **Figure 1-2**.

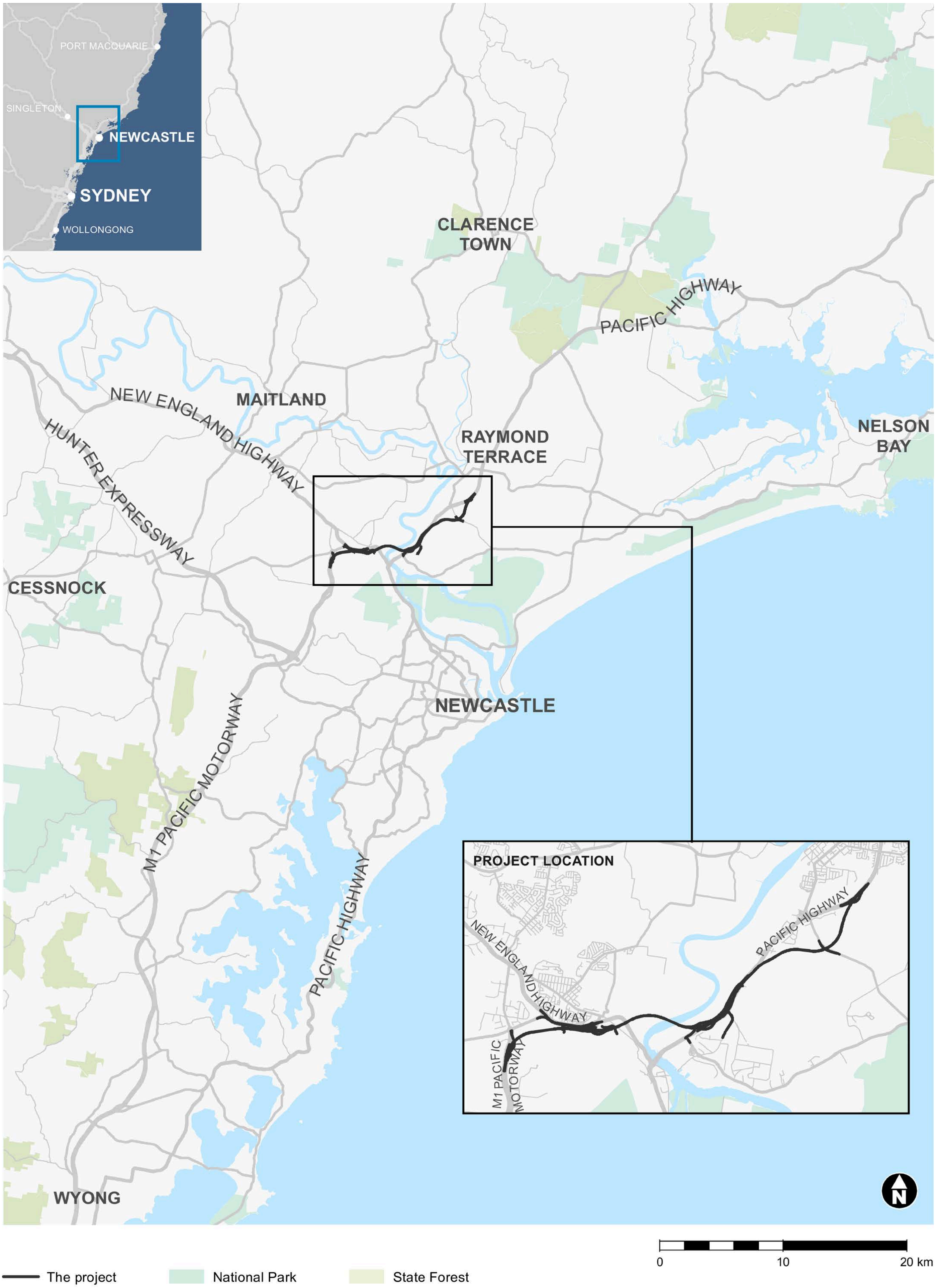

Figure 1-1 Regional context of the project

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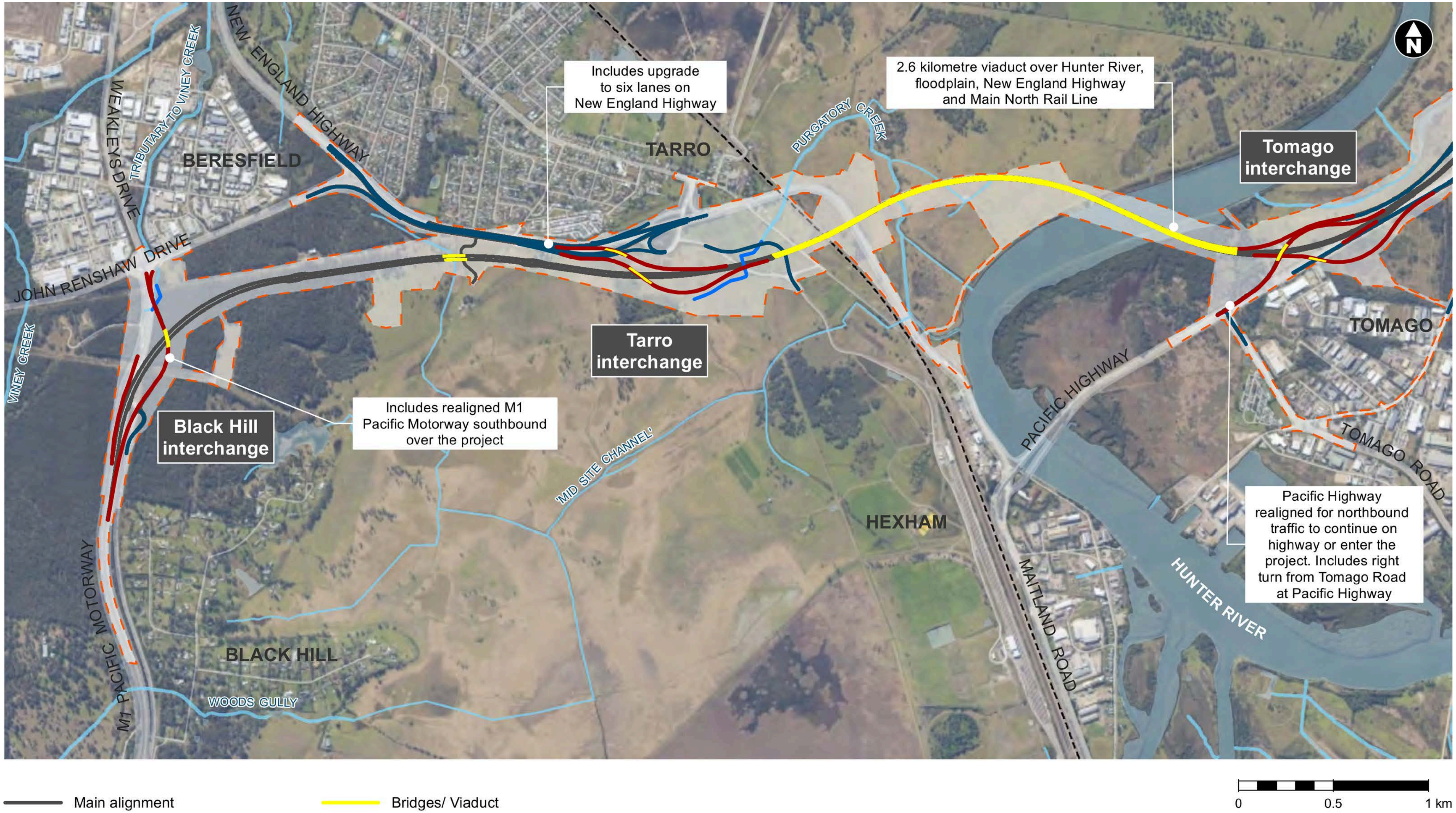

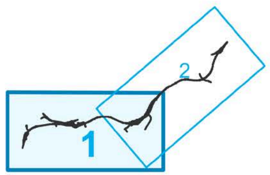

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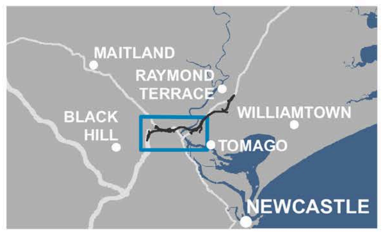

Figure 1-2 Project key features (map 1 of 2)

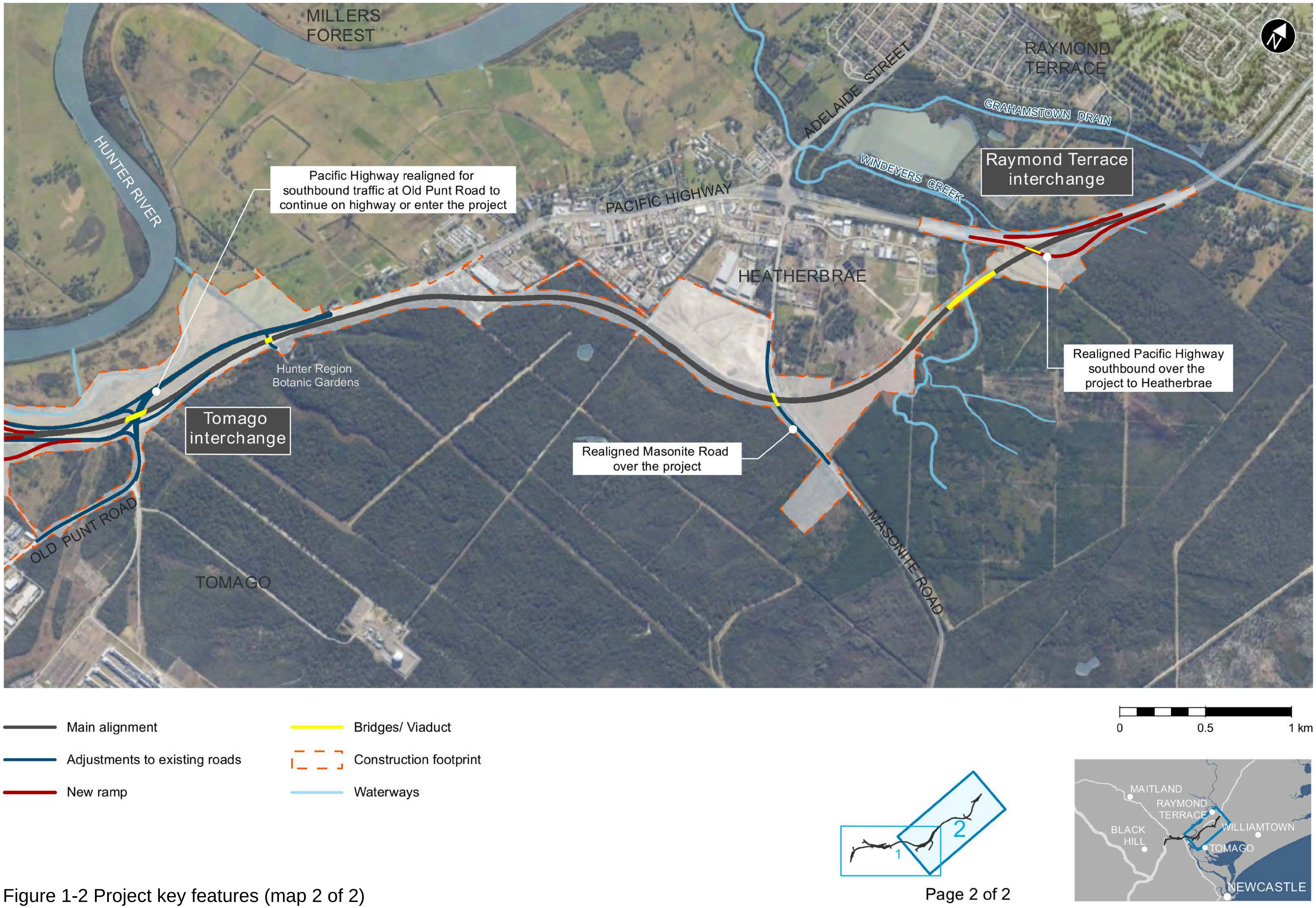

Figure 1-2 Project key features (map 2 of 2)

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1.3 Performance outcomes

The desired performance outcomes for the project relating to soils and contamination are to:

- Protect the environmental values of land, including soils, subsoils and landforms (see **Chapter 7** and **Chapter 9**)
- Minimise risks arising from the disturbance and excavation of land and disposal of soil, including disturbance to acid sulfate soils and site contamination (see **Chapter 7** and **Chapter 9**).

1.4 Secretary's environmental assessment requirements

This assessment forms part of the EIS for the project. The EIS has been prepared under Division 5.2 of the EP&A Act. This assessment has been prepared to address the SEARs (SSI 7319) relating to soils and contamination and will assist the NSW Minister for Planning and Public Spaces in making a determination on whether the project can proceed. It provides an assessment of potential impacts of the project on soils and contamination and outlines proposed management measures.

In 2019 revised SEARs were issued for the project, which included soils and contamination as a key issue. **Table 1-1** outlines the SEARs relevant to this assessment along with a reference to where these are addressed.

Table 1-1 SEARs relevant to soils and contamination

Secretary's requirement	Where addressed in this report
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 presence of acid sulfate soils (ASS) within the study area is discussed and verified by assessing desktop mapping against field testing in **Section 4.5.** Areas likely to be impacted by the project are displayed on **Figure 4-6**.
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 associated with ASS and acidic runoff are detailed in **Section 7.1.1** and **Section 7.2.1** respectively.
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.	Contamination risk associated with previous land use is described in **Section 5.4** and **Section 7.1.3**, including identification of contaminated land, ecological and human health risks associated with the former mineral sands processing facility and the requirement for and objectives of its remediation, in accordance with current guidelines (**Section 5.4.5** and **Section 5.4.7**). Remediation is described in **Section 7.1.3** and **Section 7.2.3** and **Chapter 9**.
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 discussed in **Section 4.7.** Construction and operational impacts relating to soil salinity are discussed in **Section 7.1.2** and **Section 7.2.2**.

Secretary’s requirement	Where addressed in this report
5. The Proponent must assess the impacts of the project on soil salinity and how it may affect groundwater resources and hydrology.	Soil salinity is discussed in **Section 4.7**. Construction impacts on salinity and associated impacts on groundwater resources and hydrology are detailed in **Section 7.1.2**. Salinity operational impacts are detailed in **Section 7.2.2**. The Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS) 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.	Potential for soil erosion and landscape impacts during construction and operation are detailed in **Section 7.1.4** and **Section 7.2.4**. An assessment of sediment transport is documented in **Section 7.1.4** and **Section 7.1.5**.

1.5 Report structure

The report is structured as follows:

- Chapter 1 – Introduces the project with a summary of the project background, project description, performance outcomes and SEARs
- Chapter 2 – Provides an overview of the policy and planning setting and how the project aligns with these plans and policies
- Chapter 3 – Provides a summary of the methodology used to inform this assessment
- Chapter 4 – Details the existing environment including geology, presence of ASS, salinity and receiving environment
- Chapter 5 – Provides an overview of existing contamination within and near the project
- Chapter 6 – Details areas of potential contamination risk
- Chapter 7 – Details potential impacts during construction and operation
- Chapter 8 – Provides an assessment of the potential cumulative impacts from the construction and operation of the project with respect to other projects which are proposed nearby
- Chapter 9 – Details the proposed management measures for the project
- Chapter 10 – Outlines the conclusions of this assessment
- References
- Terms and acronyms
- Appendix A – Historical summary
- Appendix B – Potential contamination sources.

2. Policy and planning setting

In preparing this assessment, the following regulations and guidelines were considered (where relevant):

- National Environmental Protection Measure (Assessment of Site Contamination) 1999 (as amended 2013) (National Environment Protection Council, 2013)
- The Acid Sulfate Soils Manual (NSW Acid Sulfate Soils Advisory Committee, 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, 2014)
- 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 available at that time, and have included the following:

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

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 facility (1877 Pacific Highway, Tomago):

- Management of Naturally Occurring Radioactive Material (NORM) Radiation Protection Series Publication No. 15, (Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), 2008)
- Fundamentals for Protection Against Ionising Radiation, Radiation Protection Series F-1 (ARPANSA, 2014)
- Radiation Protection of the Environment, Guide G-1 (ARPANSA, 2015)
- Guide for Radiation Protection in Existing Exposure Situations, Radiation Protection Series G-2 (ARPANSA, 2017)
- Environmental Health Risk Assessment, Guidelines for assessing human health risks from environmental hazards, Commonwealth of Australia, Canberra, (enHealth, 2012a)
- Australian Exposure Factors Guide, Commonwealth of Australia, Canberra (enHealth, 2012b)
- Radiation Protection and NORM residue Management in the Zircon and Zirconia Industries, Safety Reports Series No. 51. (International Atomic Energy Agency, 2007).

3. Assessment methodology

Information on soils, including acid sulfate soils, soil contamination, soil salinity and soil and land resources presented in this assessment 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 **Chapter 2**)
- Defining the study area (refer to **Section 3.1**)
- Carrying out a desktop assessment, including a review of existing project documentation and publicly available information(refer to **Section 3.2**)
- Carrying out site inspections and investigations to establish existing conditions including (refer to **Section 3.3** and **Section 3.4**):
  - 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 (refer to **Section 3.5**)
- Developing management measures to mitigate potential soils and contamination impacts (refer to **Section 3.7**)
- 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 (refer to **Section 3.6**).

Aspects of the methodology are described in more detail in the following sections.

3.1 Study area

The construction footprint is the total area required to construct the project, including ancillary facilities, and forms the area of impact for the project. The study area is a 500 metre buffer from the construction footprint(refer to **Figure 3-1**). Chapter 5 of the EIS provides a detailed description of the project including general construction and ancillary facility activities.

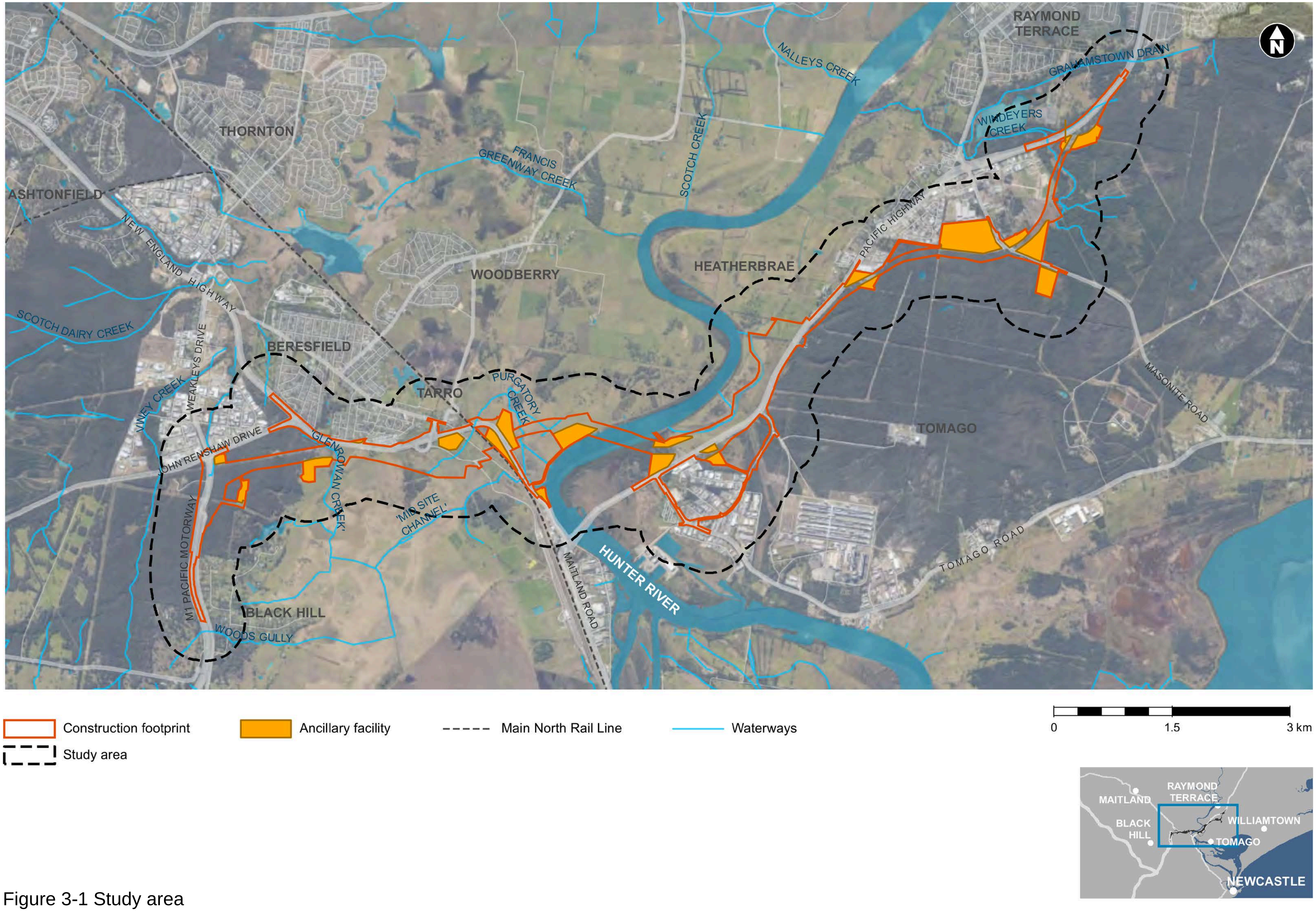

Figure 3-1 Study area

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3.2 Desktop assessment

Several sources were investigated to determine the history of land use within the study area. These are summarised in the following sections. The desktop assessment included:

- Review of publicly available information (refer to **Section 3.2.1**)
- Review of historical land use information (refer to **Section 3.2.2**)
- Review of previous contamination investigation reports (refer to **Section 3.2.3** and **Section 3.2.4**).

The findings of the desktop assessment are detailed in **Chapter 4**.

3.2.1 Review of publicly available information

A review of existing information was carried out using publicly available information, including:

- Port Stephens Council website
- Geographical and soil mapping
- Published public data, including topographical, ASS and salinity risk maps
- Bureau of Meteorology (BoM) data, including:
  - Climate and rainfall data.
- NSW Environment Protection Agency (EPA) data, including:
  - Record of Notices (under section 58 of the *Contaminated Land Management Act 1997*)
  - List of contaminated sites notified to the NSW EPA (under section 60 of the *Contaminated Land Management Act 1997*)
  - POEO Public Register (under section 308 of the *Protection of the Environment Operations Act 1997*).
- Australian Soil Resource Information System (ASRIS) database
- The WaterNSW groundwater database.

Findings from the review of publicly available data are detailed in **Chapter 4** and **Chapter 5**.

3.2.2 Historical land use information

Historical aerial photographs from the Department of Lands and Property Information (LPI) were reviewed for the years 1954, 1966, 1976, 1984, 1993, 2001, 2007 and/or 2010, 2014, 2015, and 2019, 2020 (as available for the study area). The aerial photography review focused on the construction footprint, specific AOPCR and general land use that could be potentially impacted by the project construction (discussed further in **Section 7.1**).

Historical maps (for 1913, 1941, 1981 and 2015) from LPI and Geoscience Australia and Universal Business Directory (UBD) business directories (for 1991, 1982, 1970, 1961 and 1950) were also reviewed in order to identify historical land use information and potential sources of contamination within the study area, to support the aerial photography review.

The current and historical aerial imagery (sourced from Aerial Imagery from NSW Department of Customer Service, 2020) were used to assess land use and changes in general conditions within the study area. Additional land use history records were from the following Datasets:

- Universal Publishers (UBD Business Directories) Dry Cleaners and Motor Garages/Service Stations

- NSW Department of Customer Service - Spatial Services Tanks (Areas/Point)
- NSW EPA Former Gasworks Data Source
- Waste Management Facilities Data Source from Geoscience Australia.

The reports also identified:

- Businesses with potentially contaminating activities. Where street addresses are unknown, the assessment has considered potentially contaminating activities as part of the general assessment
- Waste facilities listed on the National Waste Management Site Database. One waste site was reported within the 500 metres of the study area
- Records of liquid fuel facilities within a one kilometre radius of the project. A total of three sites were identified within one kilometre of the study area.

Historical land use information is detailed in **Chapter 5**, with historical information from the reviewed datasets search summarised in **Appendix A**.

3.2.3 Previous contaminated site investigations

Information from the following reports was reviewed in preparation of this report:

- Preliminary Site Investigation Contamination and Acid Sulphate Soil Assessment, Proposed M1 Extension to Raymond Terrace (Douglas Partners, 2015)
- Preliminary Contamination Assessment, Proposed Train Support Facility, Woodlands Close, Hexham (Douglas Partners, 2012)
- Asbestos Clearances – RMS Land off Lenaghans Drive, Black Hill (HazMat Services, 2016)
- Former RZM Site: Preliminary Site Investigation (PSI) (Sinclair Knight Merz, 2013a)
- Former RZM Site: Detailed Site Investigation (DSI), (Jacobs, 2016)
- Former RZM Site - Consolidated Human Health and Ecological Risk Management Report (Jacobs, 2020)
- Other contamination assessment reports associated with the former mineral sands processing facility (full list of reports contained within the references presented in **Chapter 11**). Not all these reports have been explicitly summarised in the body of this report, including those provided by HazMat Services 2011, Jacobs 2014 to 2019, Queensland Government 2014a, Rutile Zircon Mines Pty Ltd 2002, SGS 2015 and Sinclair Knight Merz 2013, however they have been listed in **Chapter 11** to demonstrate that extensive assessment has been carried out at the former mineral sands processing facility.

Previous contaminated site investigations are summarised in **Section 5.4**.

3.2.4 Previous soil and geotechnical investigations

Information from the following reports was reviewed in preparation of this report:

- Geotechnical Investigation Factual Report, M1 Pacific Motorway extension to Raymond Terrace, Black Hill to Raymond Terrace (Douglas Partners, 2017)
- Geotechnical Concept Investigation Interpretive Report M1 Extension to Raymond Terrace [M12RT] Variation Pacific Motorway, Hexham-Raymond Terrace– Embankments on Soft Soils (Douglas Partners, 2020).

A summary of relevant information relating to soils, potential contamination and acid sulfate conditions from the previous geotechnical investigations are summarised in **Section 4.4**, **Section 4.5** and **Section 5.4.6,** with further summary discussion included in **Chapter 6**.

3.3 Site inspections

A series of inspections across targeted areas of the construction footprint were carried out in 2015, 2019 and 2020.

In 2015 inspections were carried out to support the Preliminary Site Investigation Contamination and Acid Sulphate Soil Assessment (Douglas Partners, 2015). Inspection locations were informed by the desktop study within the construction footprint. As part of these inspections, observations were carried out to identify potentially contaminated areas which included:

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

Several specific inspections were carried out by Jacobs and other specialists throughout 2019 and 2020 during contamination investigations at the former mineral sands processing facility at Tomago, and during milestone field works at the mineral sands processing facility during demolition of buildings and removal of demolition waste off the site. Quarterly inspections are also carried out by Transport project managers at the former mineral sands processing facility as part of the requirements under the Interim Site Management Plan (ISMP) (Jacobs 2021) for the ongoing management of access restrictions. Additionally, periodic inspections carried out as part of the ongoing assessment process identified minor amounts of illegally dumped asbestos waste at a property in Tomago in 2020.

The information collected (including observations made) during the site inspections have been used to inform this assessment.

3.4 Identification of areas of potential contamination risk

In order to assess these potential impacts and inform management options, Areas of Potential Contamination Risk (AOPCR) have been identified within and next to the construction footprint. For completeness, a study area was overlain across the construction footprint, to ensure that off-site potentially contaminating activities were considered, and the possibility of contamination that could impact or migrate from outside of the construction footprint.

AOPCR are areas that are considered to have potential risks (unmitigated) to construction and operation of the project associated with soil, sediment, surface water and groundwater. These risks may be present as a result of historical and/or current activities carried out on land within the construction footprint, or where the weight of evidence and professional judgement applied from existing data for soils and broader contamination issues indicates a potential risk to humans and/or the environment. Additionally, AOPCR are areas with geological conditions and soil types within the construction footprint that may be characterised as having potential to be acid forming, have erosion potential, and/or be saline.

Using the desktop assessment and information collected during site inspections, AOPCR were identified. The process of identifying the AOPCR included an initial assessment of:

- Known and potential sources of contamination and contaminants of concern including the mechanism(s) of contamination
- Identification or inference of potentially affected media (soil, sediment, groundwater, surface water)
- Human and ecological receivers
- Potential and complete exposure pathways
- The effects of construction works that may expose or disturb identified or suspected contamination.

Several potentially contaminating land uses (i.e. service stations) have been identified outside the construction footprint but within the study area (refer to **Section 3.1**). While these potential contamination sources would be unlikely to result in substantial contamination within the construction footprint, they were considered when assessing possible interactions with potential contamination sources as a result of construction activities due to their proximity to the project.

How specific AOPCR have been identified and ranked in terms of risk, including locations and potential contaminants of concern is detailed in **Chapter 6.**

3.5 Assessment of potential impacts

An assessment of potential impacts from the identified APOCRs was carried out using the construction and operational information contained in Chapter 5 of the EIS. Following the identification of potential impacts, Jacobs completed a weight of evidence and professional judgement exercise to consider existing exposure risks to AOPCRs, and then how these risks may change due to a change in land use due to construction and operation of the project.

The AOPRCs and associated potential impacts from the project are provided in **Chapter 7**.

3.6 Consideration of potential cumulative impacts

A review of projects in varying stages of delivery and planning located in and around the project was carried out. The assessment of potential cumulative impacts for soils and contamination was based on the most current and publicly available information for these projects. The assessment included consideration of project timing, environmental assessment findings, potential impacts and in many instances is a high-level qualitative assessment.

The findings of the cumulative impact assessment are detailed in **Chapter 8**.

3.7 Identification of management measures

Based on the findings of the assessment management measures were developed and have been provided in **Chapter 9**. Standard Transport safeguards have been considered in addition to the project specific measures.

4. Existing environment

This chapter includes a description of the existing environment based on a desktop review of publicly available information, historical reports and geotechnical site investigations. A detailed contamination review for the historical and existing environment is provided in **Chapter 5**.

4.1 Location and zoning

Figure 3-1 shows that the project is predominantly located in greenfield areas, generally next to existing road infrastructure. Existing land uses in and around the project include residential, rural residential, transport, agricultural, commercial and industrial. Parts of the project are located adjacent to the Tarro residential area.

The project is located within a range of land use zones within the City of Newcastle and Port Stephens Council LGAs. Land use zones for the project under the respective local environmental plans are shown on **Figure 4-1**.

4.2 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. The elevation across the study area is variable, however can be separated into three key areas (refer to **Figure 4-2**):

- Western portion (between Tarro and Black Hill): Comprising gently sloping ground between reduced level (RL) four metres Australian height datum (AHD) and RL 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 RL three metres AHD
- Eastern portion (between Raymond Terrace and Heatherbrae): Comprising mildly undulating terrain between RL two metres AHD and 10 metres AHD.

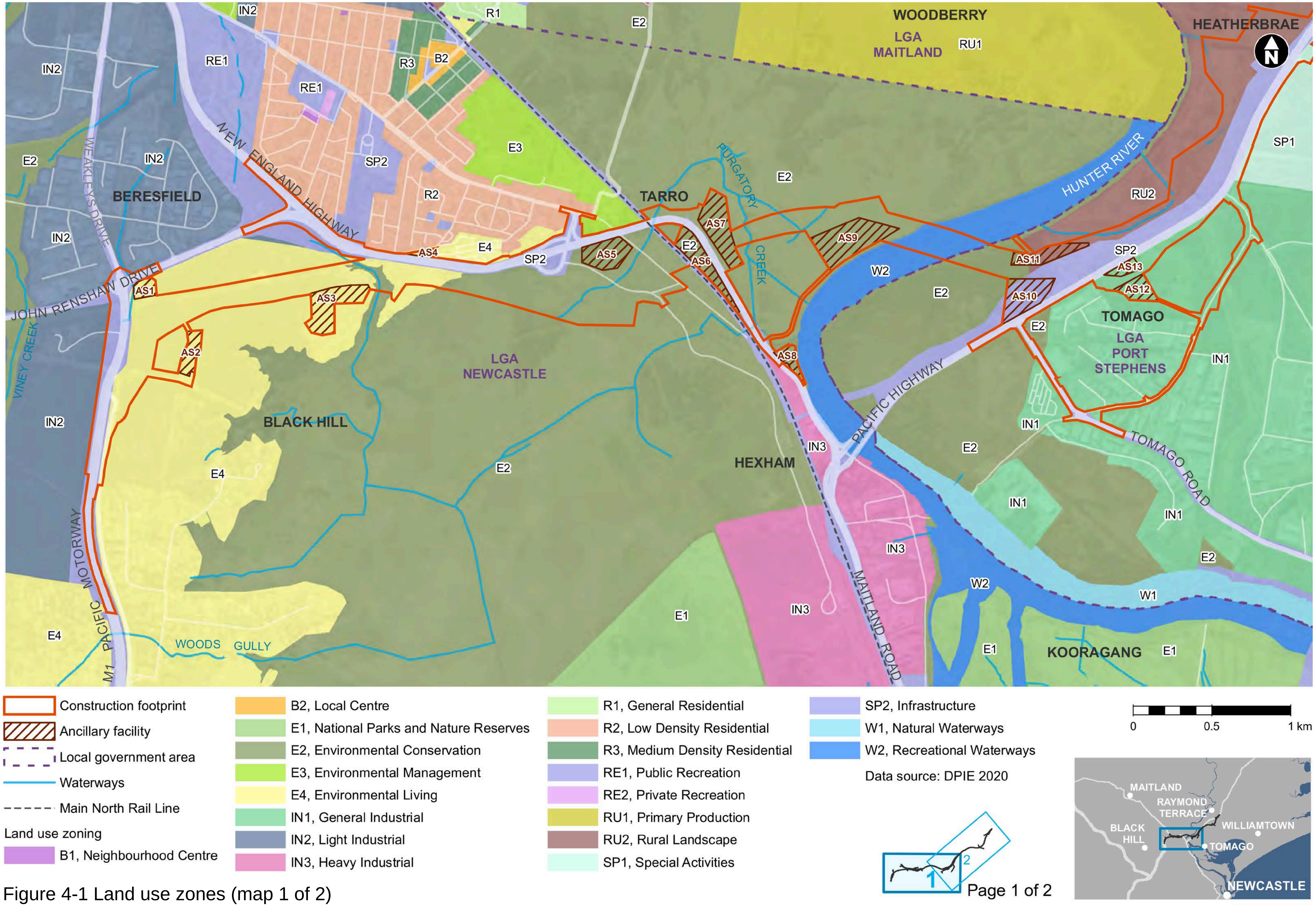

Figure 4-1 Land use zones (map 1 of 2)

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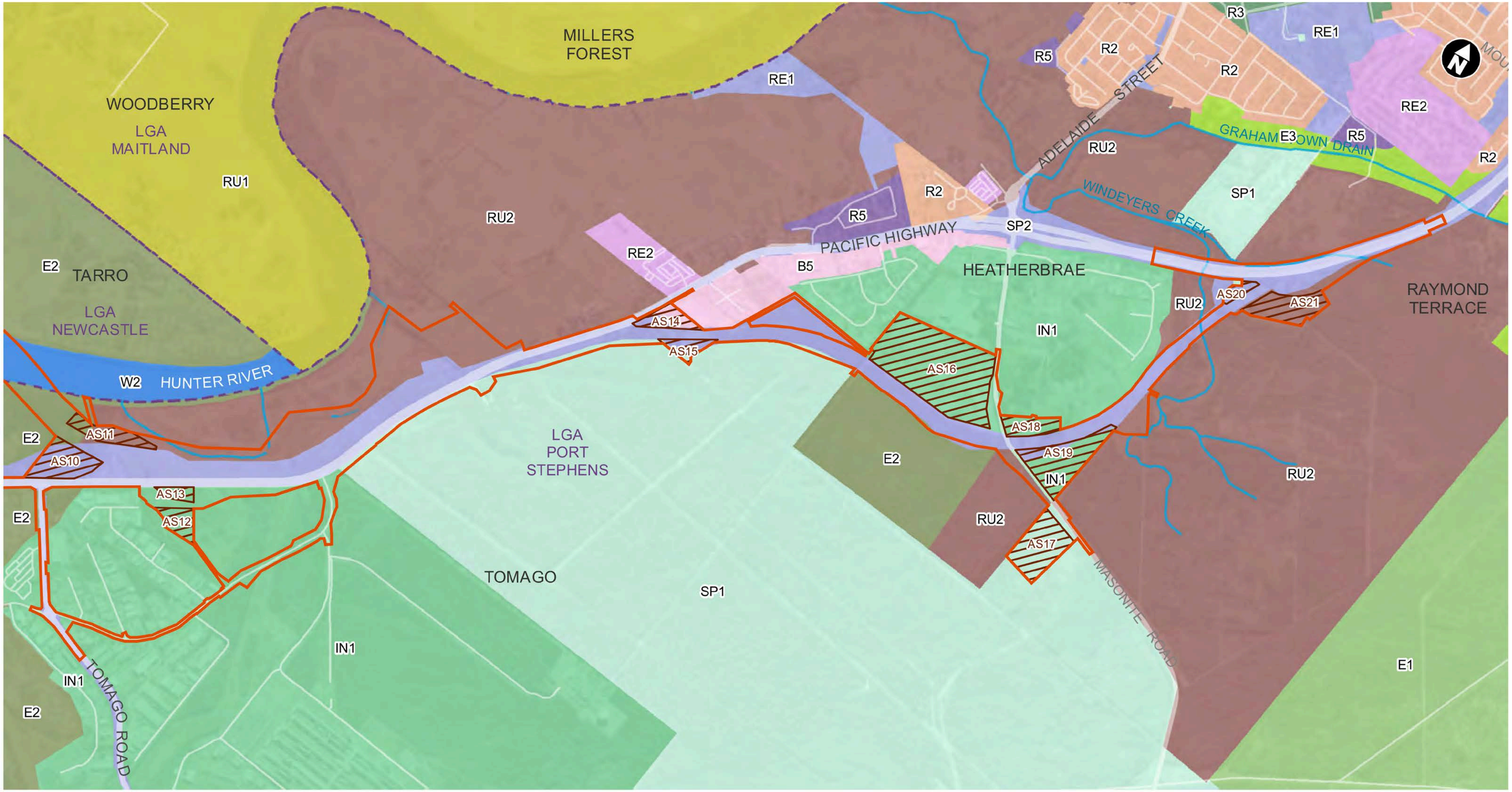

Construction footprint
Ancillary facility
Local government area
Waterways

Land use zoning

B5, Business Development
E1, National Parks and Nature Reserves
E2, Environmental Conservation
E3, Environmental Management
IN1, General Industrial
R2, Low Density Residential
R3, Medium Density Residential
R5, Large Lot Residential
RE1, Public Recreation
RE2, Private Recreation
RU1, Primary Production
RU2, Rural Landscape
SP1, Special Activities
SP2, Infrastructure
W2, Recreational Waterways

Data source: DPIE 2020

0 0.5 1 km

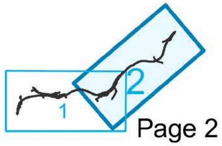

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Figure 4-1 Land use zones (map 2 of 2)

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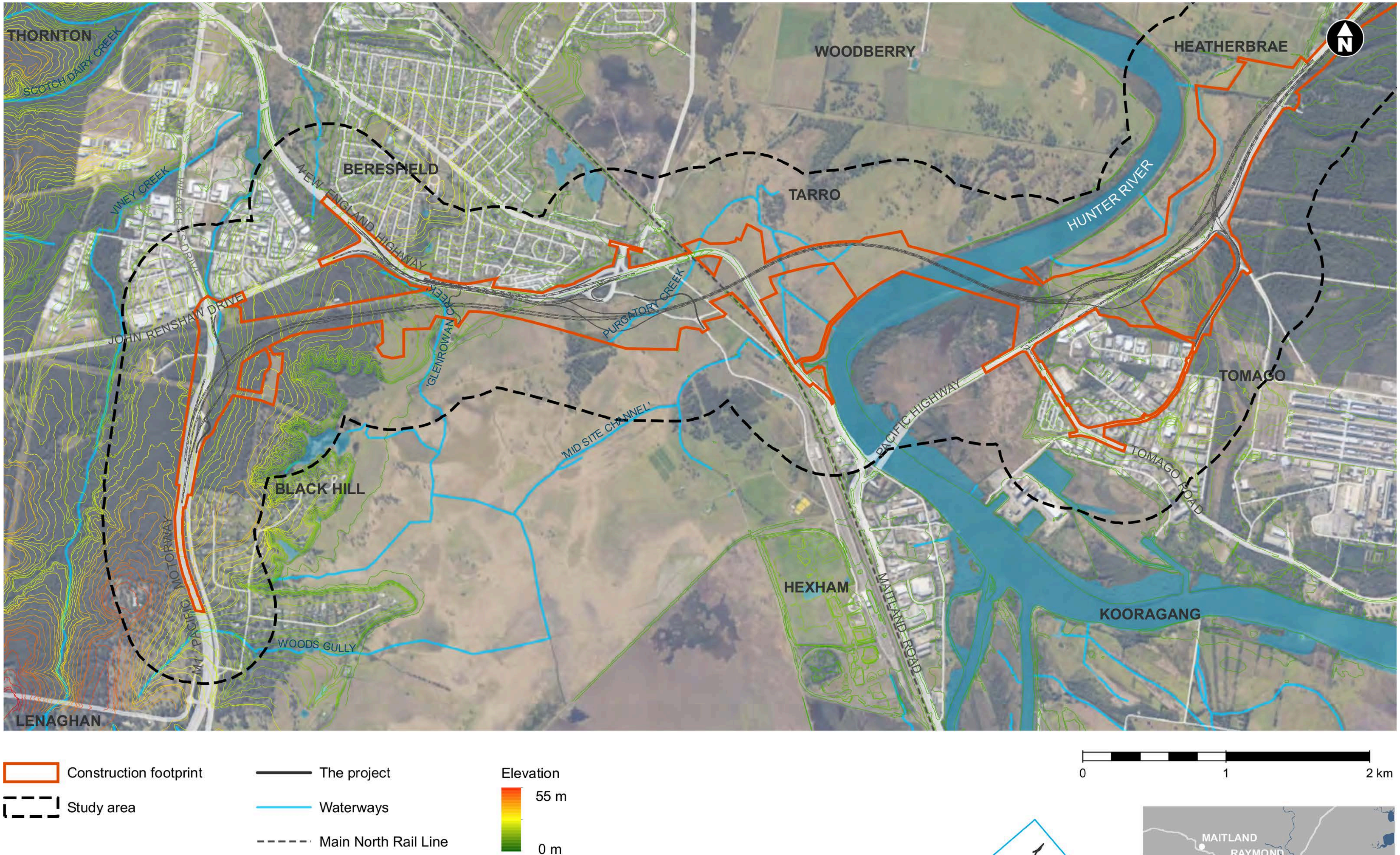

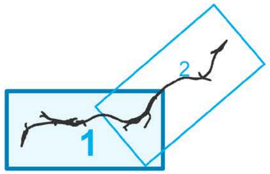

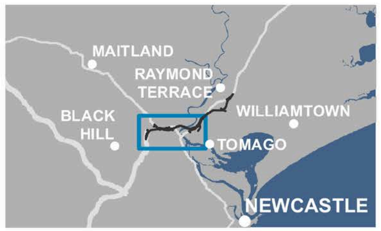

Figure 4-2 Topography (map 1 of 2)

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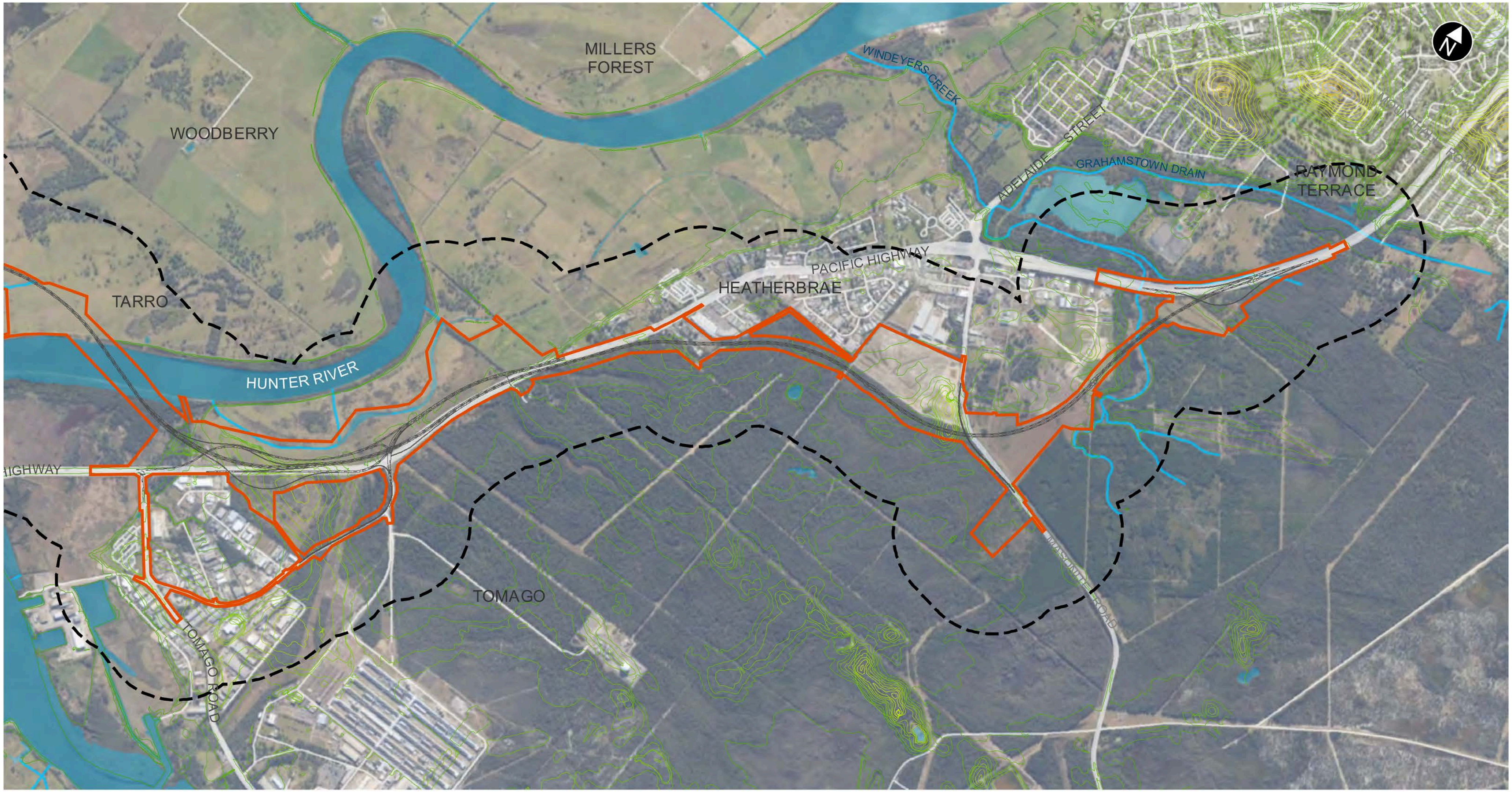

Construction footprint

Study area

The project

Waterways

Elevation

55 m

0 m

Data source: LPI 2015

0 1 2 km

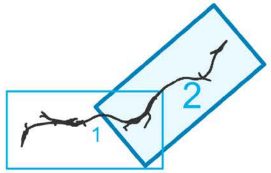

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Figure 4-2 Topography (map 2 of 2)

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4.3 Geology

The regional geology within the study area has been sourced from the 1:100,000 scale regional geology map for Newcastle (Newcastle Coalfield Regional Geology, Sheet 9321, NSW Department of Mineral Resources) and is characterised by (refer to **Figure 4-3**):

- The south western end of the project near at Black Hill, Beresfield and Tarro is underlain by the Tomago Coal Measures of late Permian age (Pt). The Permian Tomago Coal Measures is located to the east of the project in Tomago. The lithology of the Tomago Coal Measures consists of shale, siltstone, fine sandstone, coal and minor tuffaceous claystone
- Quaternary aged sediments (Qa and Qs) are located elsewhere along the project. The central and low lying areas of the project near the Hunter River and floodplain include quaternary alluvium. The northern part of the project 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 project
- The geology map suggests that the Mulbring Siltstone and the Muree Sandstone of the Maitland Group of middle to late Permian age (Permian Maitland Group; Pmm) are exposed near the northern end of the project. The lithologies of these units consist of siltstone, sandstone, conglomerate and minor clay.

The geotechnical investigation carried out for the project in 2015 (Douglas Partners, 2015) indicates that a deep paleo-channel may run approximately parallel to the western side of the Hunter River, passing through 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 & 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 regional geology map for Newcastle also indicates that geological structures pass through or close to the project (refer to **Figure 4-4**):

- The Williams River Fault which consists of an emergent thrust fault (position approximate) and crosses the Hunter River in the vicinity of the proposed crossing. The fault strikes approximately north east and parts of the Hunter River and Williams River, north of the project, follows the approximate alignment of the thrust fault. Two 'normal' faults (position approximate) are shown traversing in a north-south orientation to the south of the project
- The Thornton Syncline (position approximate) is shown to cross the south-western part of the project. A second syncline is also shown north of the project and the axis of the syncline is oriented north-south.

The region is an area of low to moderate seismicity and lies within an intra-plate tectonic region. An earthquake occurred in December 1989 ('the Newcastle Earthquake') which registered about 5.6 on the Richter Scale, and was assessed to have a return period of about 500 years (Douglas Partners, 2017).

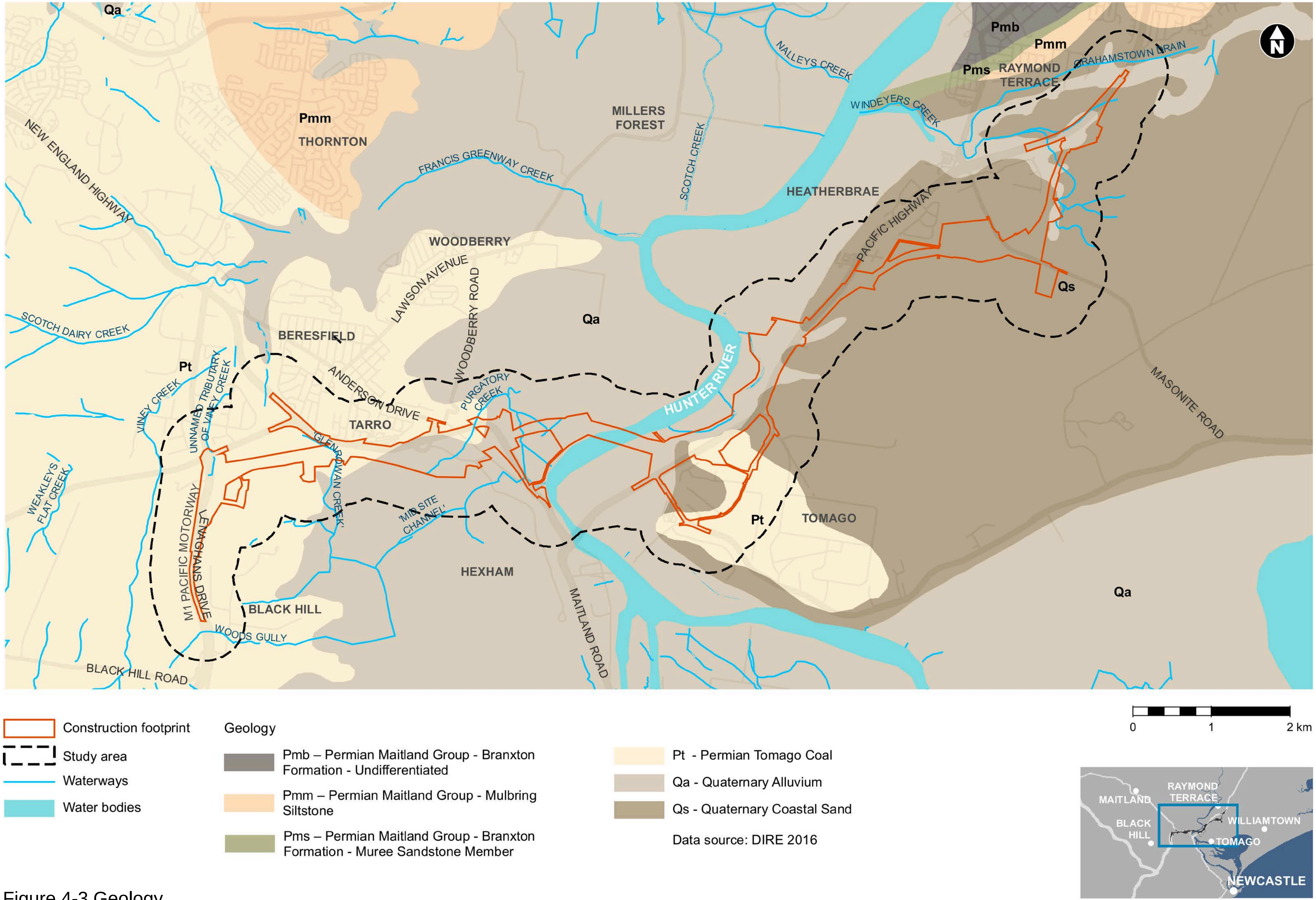

Figure 4-3 Geology

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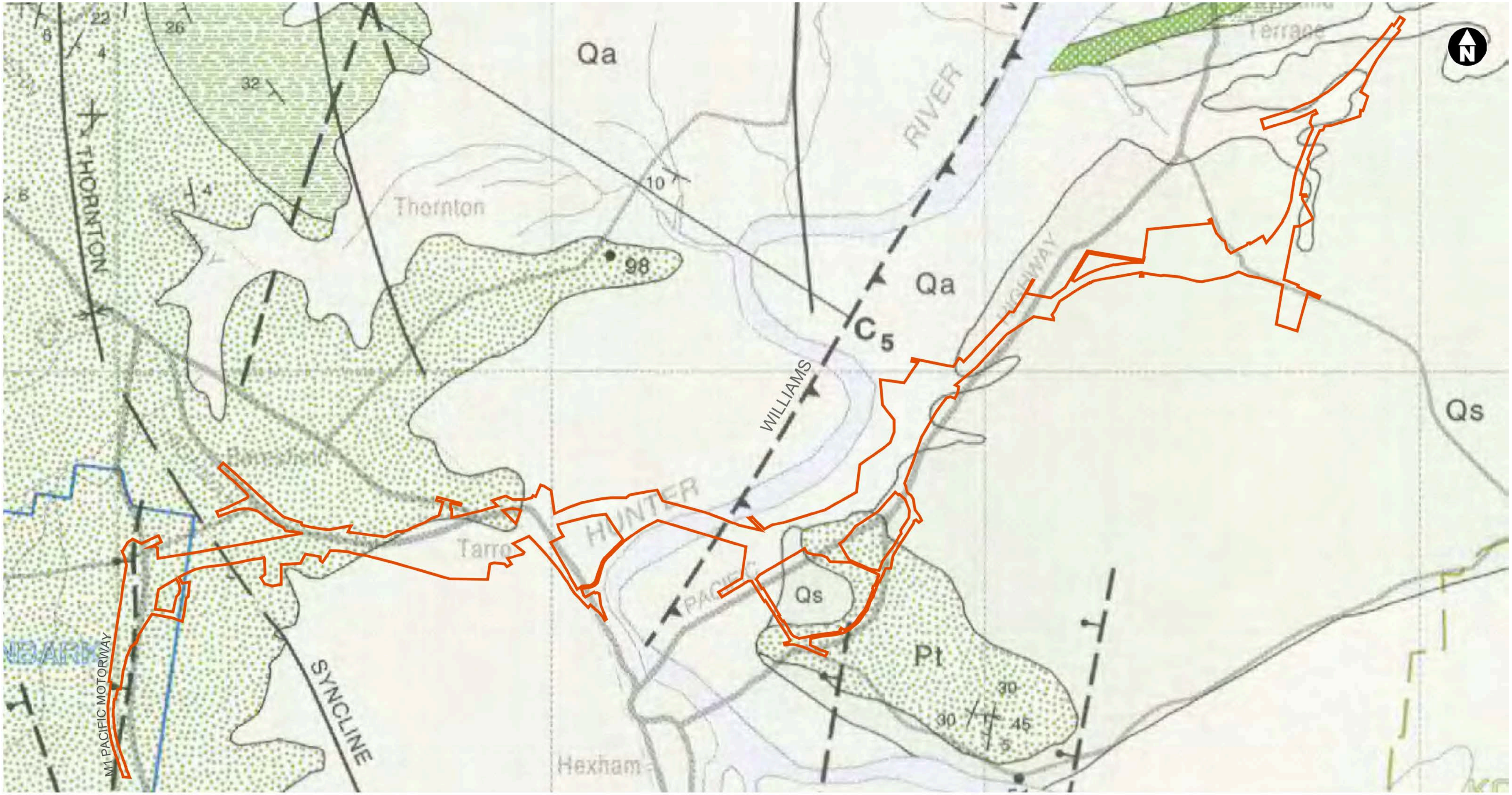

Construction footprint

Fault locations

Data source: Douglas Partners, 2017, based on the Newcastle Coalfield Regional Geology, Sheet 9321, NSW Department of Mineral Resources

0 1 2 km

Figure 4-4 Approximate fault locations

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4.4 Soil landscapes

The 1:100,000 Newcastle soil landscape map was reviewed as part of the Preliminary Contamination Assessment (Douglas Partners, 2015). This review indicated that the project traverses the following soil landscapes (refer to **Figure 4-5**):

- Residual soil of the Beresfield soil landscape in the western portion of the project near the existing Pacific Motorway, as well as near the former mineral sands processing facility in Tomago
  - *The Beresfield soil landscape group comprises undulating low hills and rises on Permian sediments with slopes between three per cent to 15 per cent and an elevation of 20 metres to 50 metres. 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 landscape to the east of the project 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 12 metres. 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, Hexham and Tomago
  - *The Millers Forest landscape group comprises extensive alluvial plain on recent sediments with an elevation of six metres to less than three metres 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 acid sulphate soils at depths below 1.5 metres 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 three metres. Dominant soils comprise black organic rich peat or saturated saline organic mud. Limitations include flooding, wave erosion hazard and foundation hazard, saturated, saline, potential acid sulphate soils.*
- 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 two metres. 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 acid sulphate soils of low fertility. Both topsoils and subsoils are sodic and very highly saline in localised areas.*
- 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 five metres to eight metres. 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 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 10 metres 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 acid sulphate soils.*
- Bobs Farm Beach Landscape along Windeyers Creek
  - *The Bobs Farm variant landscape group comprises low remnant lake shore beach deposits with up to one metre relief, 15 metre width and 200 metre 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.*

4.4.1 Soft soils

A number of areas have been identified through the geotechnical investigations as having ‘soft soils’ within the construction footprint and require improvement of the existing foundation material in order to meet settlement criteria applicable for the project (Douglas Partners 2020). Soft soils have a tendency towards fluidisation 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.

The location and character of soft soils, as reported by Douglas Partners (2020) are shown in **Figure 4-5**. The areas within the construction footprint where soft soils are located include:

- The main viaduct approach embankment (Area B and Area C)
- Tarro interchange embankments (Area B)
- Tomago interchange embankments (Area B)
- Approach to bridge on Masonite Road (Area D)
- Raymond Terrace interchange embankments (Area D).

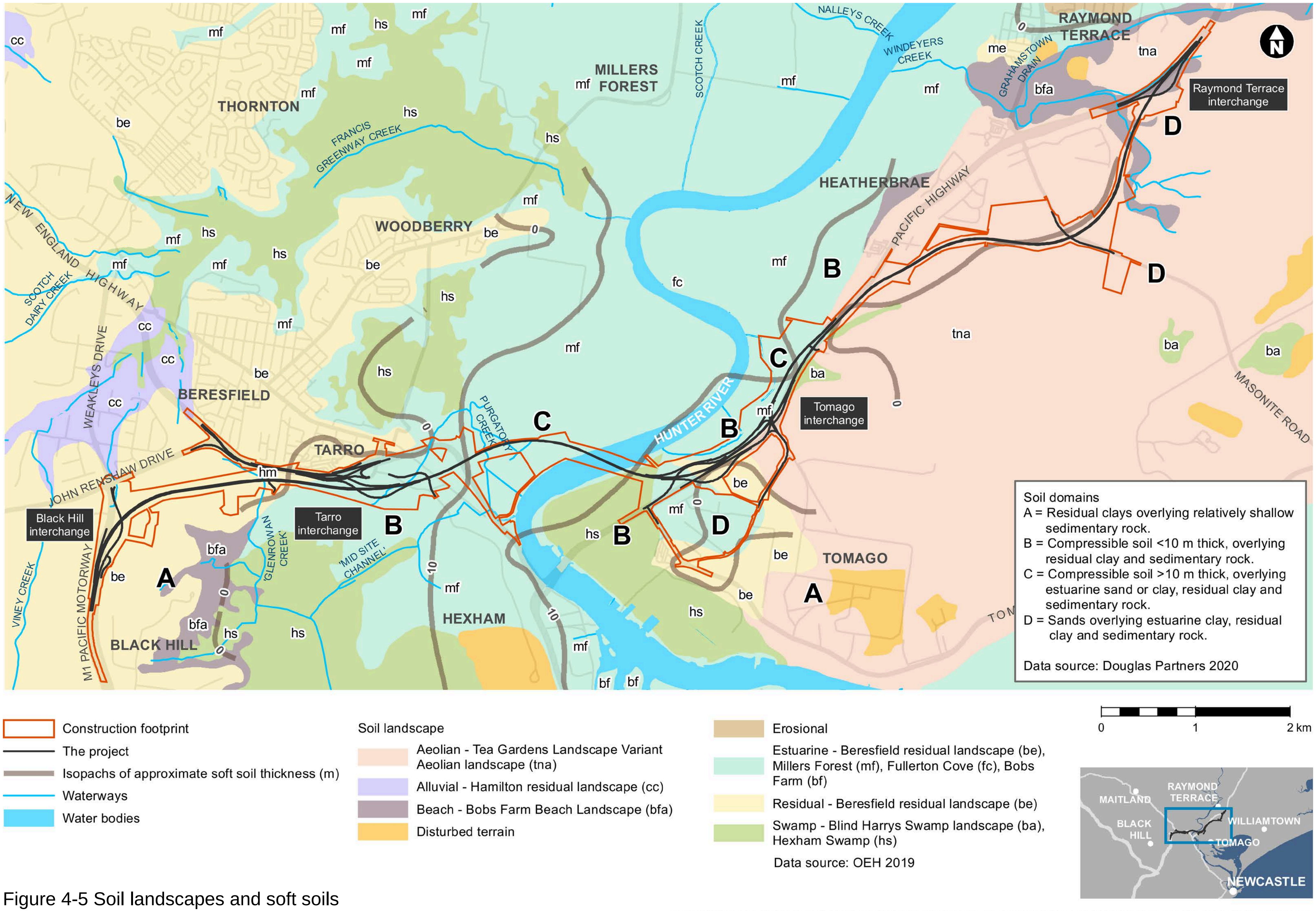

Figure 4-5 Soil landscapes and soft soils

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4.4.2 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, due to the dispersive nature of sodic soils.

Soil landscape data indicates that the following soil landscapes (as shown in **Figure 4-5**) 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.

The properties of the soils in the construction footprint have been assessed by reviewing the results of laboratory tests and in-situ testing (CPTs, SPTs and shear vanes), from both current and previous investigations and comparing the site-specific results to previous experience in similar soils (Douglas Partners, 2020). The weight of evidence from observing ground conditions at low lying locations within the project area suggest the presence of sodic soils and that some treatment measures (such as addition of gypsum) may be required if reuse of excavated soils in these areas is desired. Exchangeable Sodium Percentage (ESP) is required to indicate the presence of sodic soils at these areas.

4.5 Acid sulfate soils

The ASS assessment included a desktop assessment, review of existing mapping, field investigations and laboratory testing to inform and verify the risk of ASS within and in the area likely to be impacted by the project.

4.5.1 Desktop assessment

The desktop assessment involved reviewing existing mapping carried out for the construction footprint. The ASS risk map for the construction footprint (Atlas of Australian Acid Sulfate Soils Data Source: CSIRO), Review of Sharing and Enabling Environmental Data (SEED Database) and Acid Sulfate Soil Risk layer (OEH) were reviewed.

The regional acid sulfate soil (ASS) maps and ASS risk maps from the Atlas of Australian Acid Sulfate Soils (Data Source CSIRO, June 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 acid sulfate soils.

As shown on **Figure 4-6**, the different mapped classes of ASS have potential to be disturbed within the construction footprint:

- Class 1 (Any works present an environmental risk) – Within the Hunter River
- Class 2 (Works below the ground surface) – On the southern side of the project between Black Hill and Hexham, between Tarro and Tomago, and at Raymond Terrace along Windeyers Creek and Grahamstown Drain
- Class 3 (Works more than one metre below the natural ground surface) – In central Tomago, in central Black Hill and in Beresfield (adjoining the northern and western project extent)
- Class 4 (Works more than two metres below the natural ground surface) – On the western side of the project in Heatherbrae, in Tarro at the western end of the Tarro interchange, in Tomago on the eastern side of the project, along Tomago Road, Old Punt Road, the existing Pacific Highway, Heatherbrae and Raymond Terrace
- Class 5 (works 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.

4.5.2 Field investigations and laboratory testing

Field investigations and ASS sampling for the project were carried out in accordance with the Guidelines for the Management of Acid Sulfate Materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze (RTA, 2005), and included combined acidity and sulfate testing and chromium reducible sulfur testing.

Geotechnical investigations carried out in 2015 and 2016/17 for the project indicated that 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 Preliminary Site Investigation Contamination and Acid Sulfate Soil Assessment (Douglas Partners, 2015) also indicated that in the Tomago Sandbeds (northern parts of the project) there would be a low probability of potential ASS while the remaining portions of the project (southern parts of the project) were mapped as having no known occurrence of ASS.

The properties of the soils along the construction footprint have been assessed by reviewing the results of ASS risk maps and application of laboratory tests, 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. The analytical results from geotechnical testing carried out in 2015 and 2017 were compared with the ASS risk map predictions, resulting in broad agreement with test results and ASS map locations.

As part of the Douglas Partners (2017) Geotechnical Investigation Factual Report, a total of 153 soil samples were screened for ASS at targeted locations within areas considered to hold a higher potential ASS risk. A total of 98 of the soil samples returned testing or screening results indicating potential or actual acid sulfate conditions collected across 22 locations. These field results support the risk mapping shown on **Figure 4-6**.

A statistical summary of screening and laboratory tests, by soil unit, is provided in **Table 4-1** below.

Table 4-1 Summary of acid sulfate tests

Unit	Screening tests				Laboratory chromium suite			
	Total number	Average change in pH	Exceedances		Total number	Average net acidity %S	Exceedances	
			No.	%			No.	%
Topsoil	18	1.83	15	83.3	4	0.08	3	75.0
Surface clays	15	1.05	6	40.0	3	0.07	2	66.7
Fine grained sand	14	1.57	10	71.4	4	0.12	4	100.0
Stiff clays	11	1.28	4	36.4	0	-	-	-
Alluvial soils	61	2.06	47	77.0	20	0.04	12	60.0
Dense gravel	2	0.50	0	0.0	0	-	-	-
Weathered bedrock	22	0.53	10	45.5	0	-	-	-
Bedrock	9	1.53	5	55.6	1	0.06	1	100.0
Overall	**153**	**1.56**	**98**	**64.1**	**32**	**0.06**	**22**	**68.8**

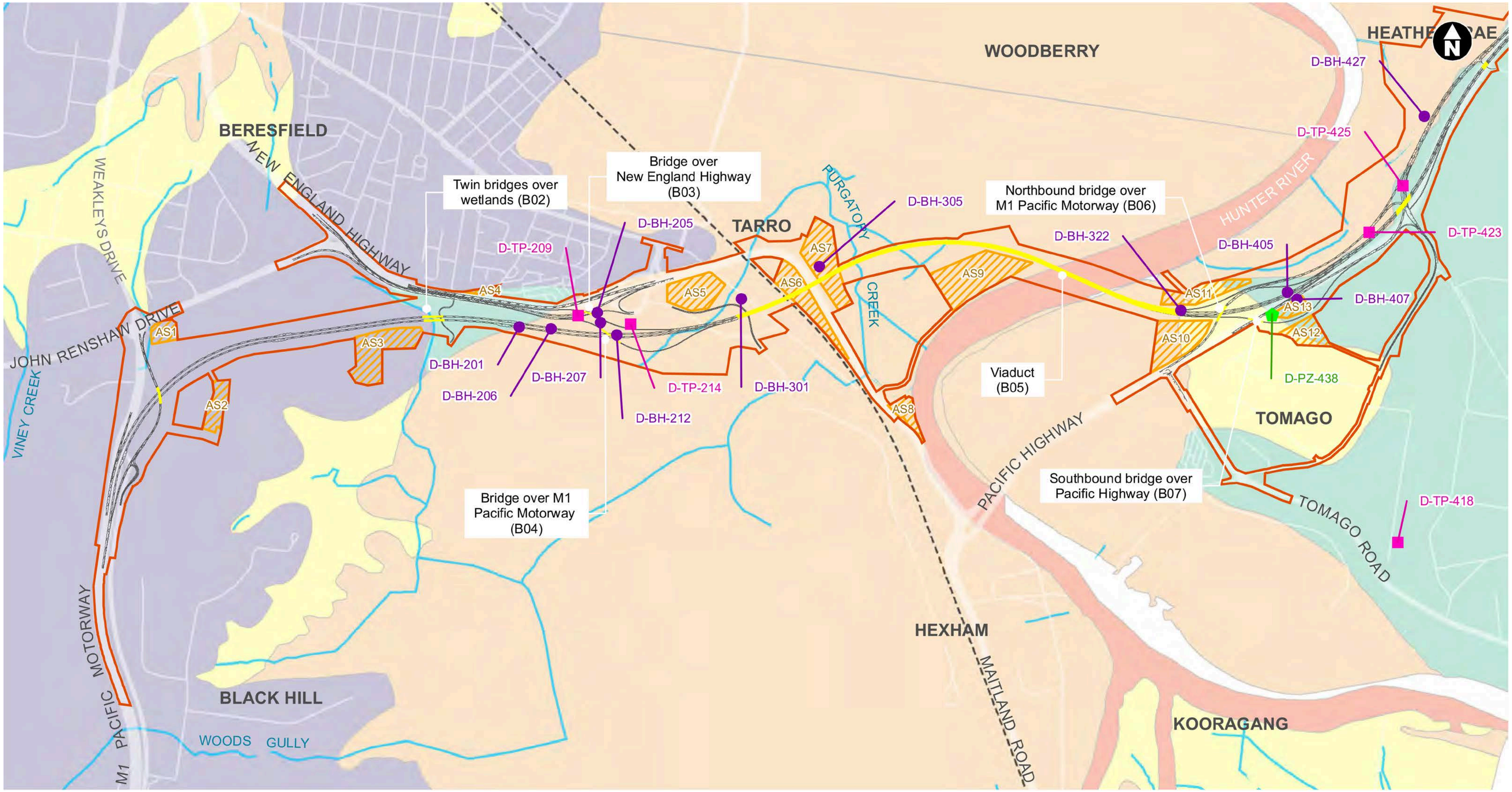
The distribution and thicknesses of the various units vary considerably along the construction footprint, however it can be inferred from the analytical results that the majority of ASS conditions are associated with Class 1, 2, 3 and 4 soils, from existing ground surfaces to depths up to approximately three metres below ground surface.

The majority of samples tested (64.1 per cent) recorded changes in pH greater that 1 in screening tests, while 68.8 per cent of laboratory tests exceeded the relevant criteria for net acidity. This indicates that potential acid sulfate soils are common along most of the construction footprint. The main exceptions, where acid sulfate soils are unlikely, are the Black Hill section of the project (i.e. western extent) and soils above RL 12 metres AHD.

The results of laboratory testing and field screening for ASS were compared to the predicted areas displayed on ASS risk maps. 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.

No sampling and analytical data was collected from potential acid sulfate sediments within the Hunter River as part of the 2017 geotechnical assessment program, however, the **Figure 4-6** indicates that Class 1 (High Risk of ASS) are likely to be associated within the Hunter River Sediments.

An assessment of construction impacts in the context of ASS including potential for project features (such as bridge works and excavation) to encounter ASS is documented in **Section 7.1.1**. The project features in the context of acid sulfate soil risk areas are also shown on **Figure 4-6**.



Construction footprint

Ancillary facility

Bridges / viaduct

The project

Waterways

Main North Rail Line

Acid sulfate soil

Class 1 - Any works

Class 2 - Works below the ground surface

Class 3 - Works more than 1 metre below the natural ground surface

Class 4 - Works more than 2 metres below the natural ground surface

Class 5 - Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below 5 m AHD and by which the water table is likely to be lowered below 1 m AHD on adjacent Class 1, 2, 3 or 4 land

Data source: DPE 2019

Sample locations with positive results for ASS analysis (DP 2017)

Borehole

Piezometer

Test pit

0 0.5 1 km

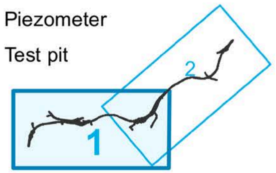


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Figure 4-6 Acid sulfate soil risk areas (map 1 of 2)

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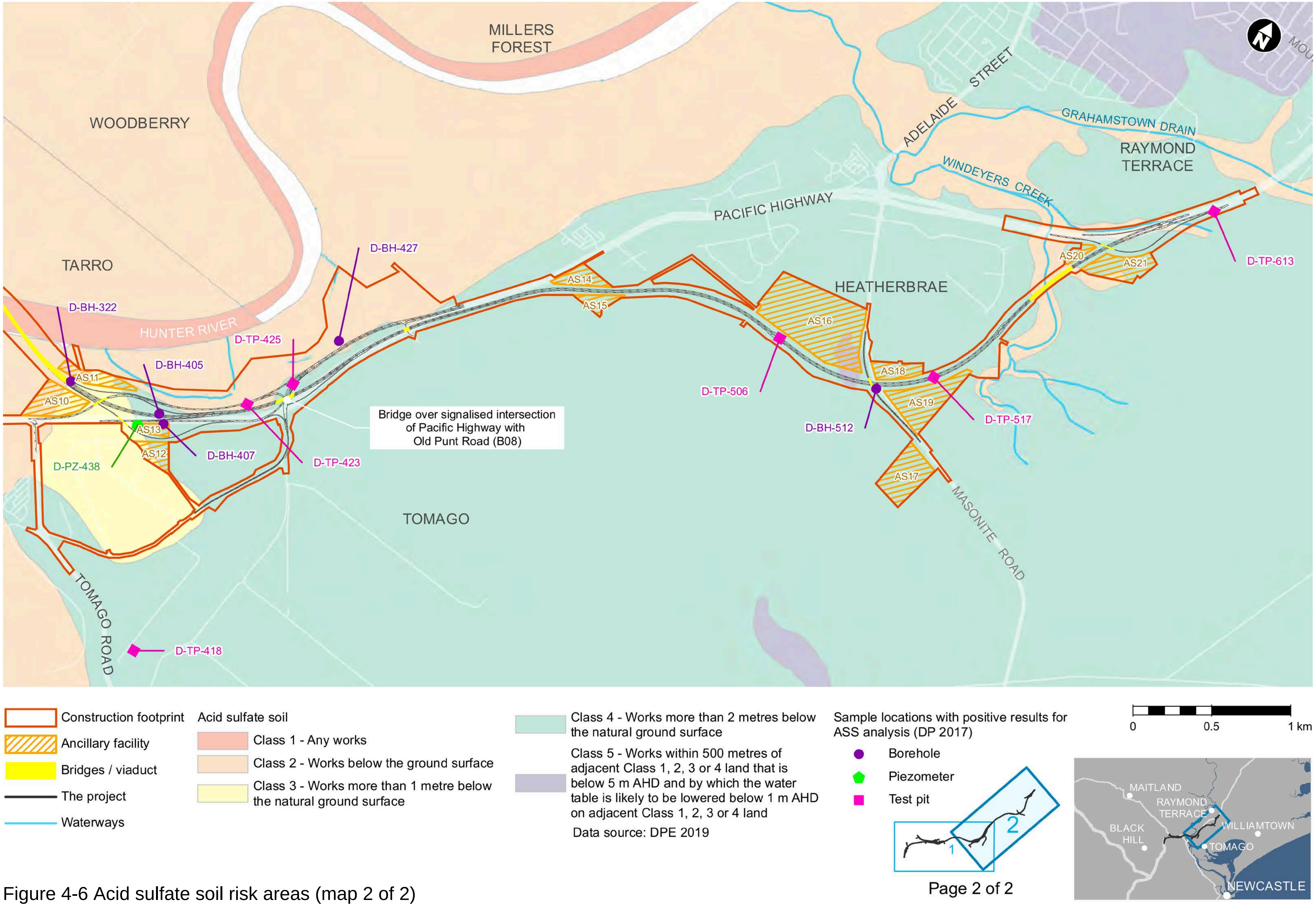

Figure 4-6 Acid sulfate soil risk areas (map 2 of 2)

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4.6 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.

The assessment of acid sulfate rock involved:

- Review of the preliminary Acid Sulfate Rock Risk Map (Roads and Maritime, 2017)
- Review of Managing the Risks Associated with Acid Sulfate Rock in NSW Road Projects, (Bridgement, 2017) in Australian Geomechanics
- Laboratory testing of select rock samples collected along the project (Douglas Partners, 2015). Testing was carried out in accordance with the Guidelines for the Management of Acid Sulfate Materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze (RTA 2005).

The review of the Acid Sulfate Rock Risk Map (June 2020) indicated a low potential for acid rock in the construction footprint.

There are known occurrences of acid rock drainage associated with deep excavations during the construction of the Grahamstown Dam to the north east of the project.

Acid mine drainage testing was determined by the AMIRA International - Acid Rock Drainage Test method for the Douglas Partners Geotechnical Investigation Factual Report (Douglas Partners, 2015 and 2017). Acid sulfate testing of rock core was carried out on 10 samples, 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, which supports what is indicated on the Acid Sulfate Rock Risk Map (Roads and Maritime, 2017). **Table 4-2** below summarises laboratory analytical testing results from the Factual Report.

Table 4-2 Summary of acid rock drainage testing results

Parameter	pH	EC	Acid Generation			Chromium Suite		
			Total sulfur (%)	pHFOX	NAPP (kg H_2SO_4/t)	pHKCL	SCr %S	Net acidity %S
Number	10	10	10	10	10	10	10	10
Minimum	5.1	130	<0.01	5.5	-20	4.4	<0.005	<0.005
Maximum	8.1	1300	0.05	7.8	0.6	6.8	0.018	0.14
Average	6.86	847	0.0235	6.77	-10.37	5.78	0.0062	0.046

According to bore logs, no presence of sulphide minerals (pyrite) in rock outcrops or drill samples were observed during the field work program. The Net Acid Generation Values (kg H_2SO_4/tonne) reported values for all samples of less than five, and in accordance with the Victorian EPA Criteria for Acid Sulfate Rock (EPA Victoria, 1999), these samples indicate a low likelihood of being classified as Acid Sulfate Rock at the locations tested.

The proposed construction methodology is unlikely to require significant deep excavations north of the Hunter River.

Based on the construction approach and location, 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.

4.7 Soil salinity

Soil salinity is a complex issue relating to salt and water cycles both above and below the ground. Surface water and groundwater can dissolve and mobilise salts and cause their accumulation in other areas. Development can cause changes to these water flows and result in salt accumulating in different areas.

Dryland salinity occurs where salt in the landscape is mobilised and redistributed closer to the soil surface and/or into waterways by rising groundwater. As salts accumulate in saline discharge areas they can reach levels that affect plants in a number of ways. This leads to poor plant health, a loss of productive species and dominance of salt-tolerant species. Dryland salinity is also closely linked to other soil degradation issues, including soil erosion. Salinity is often associated with prolonged wetness and lack of surface cover and therefore increases the vulnerability of soils to erosion.

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. The source data used to derive the maps of "Australia, Forecast Areas Containing Land of High Hazard or Risk of Dryland Salinity from 2000 to 2050" have been modelled using the National Assessment data. Results indicate that high salinity risk areas are located within the construction footprint at Black Hill, Tarro, Hexham (north), Tomago, Heatherbrae and Raymond Terrace (refer to **Figure 4-7**).

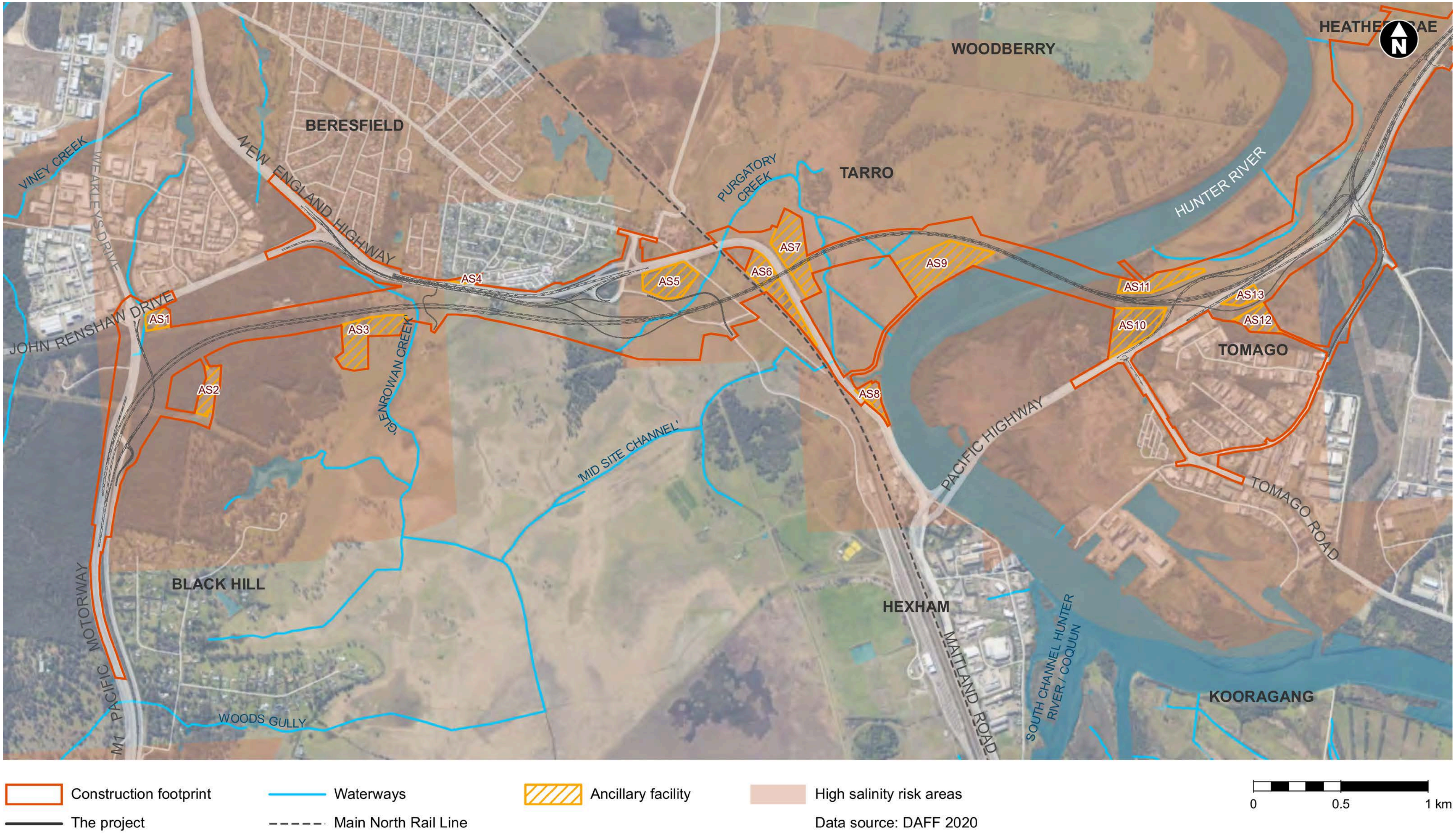
DIPNR 1999 dryland salinity occurrences and indicators plan, indicates areas considered to have dryland salinity characteristics (i.e. observations of saline indicator species to salt outbreaks). The plan shows that the study area contains several areas with salinity characteristics, including in the vicinity of Purgatory Creek, between Hexham Bridge and Tomago Road, within creek alignments south of the Hunter River and along Windeyers Creek. The data review indicates potential presence of localised saline/sodic soils along the alignment and identified salinity occurrences generally within the creeks and low-lying areas within the central portion of the study area.

The presence of saline soils is not considered to be a contamination issue, rather potential saline and/or sodic soils could affect proposed infrastructure (i.e. concrete, steel, pavements etc.) in terms of durability. The proposed alignment could exacerbate existing conditions depending on alterations / impacts to hydrogeology.

Soil aggressiveness testing was carried out on selected soil samples from investigations carried out by Douglas Partners during 2020 (Douglas Partners 2020). Soil aggressiveness testing included chloride testing, which can be compared to durability criteria for concrete and steel under Australian Standards. Chloride results indicated mildly aggressive to non-aggressive conditions at the locations tested.

Based on the preliminary assessment, concrete elements above ground have an exposure classification of B1, steel elements (aside from the Tomago area) have a corrosivity category of C3, whereas steel in the Tomago area has a corrosivity category of C4/C5. For substructure elements such as piles, the laboratory tests carried out as part of the geotechnical investigation (to date) indicated that the site conditions are typically non-aggressive for steel and mild for concrete. Results near the location of bridge B07 indicate a severe exposure classification for concrete and moderate for steel (based on the pH of the soil and the soil being sandy in nature).

Existing water quality in the context of salinity information is presented in the Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS), which also provides an assessment of likely impacts associated with saline groundwater. Substantial groundwater salinity variation occurs along the project with median salinity values ranging from 72 µS/cm in the Tomago Sandbeds up to over 18,000 µS/cm in the Hunter Alluvium.



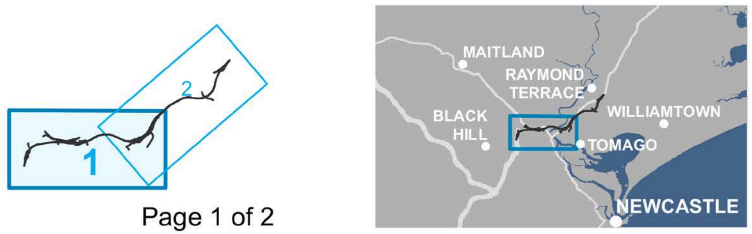


Figure 4-7 High salinity risk areas (map 1 of 2)

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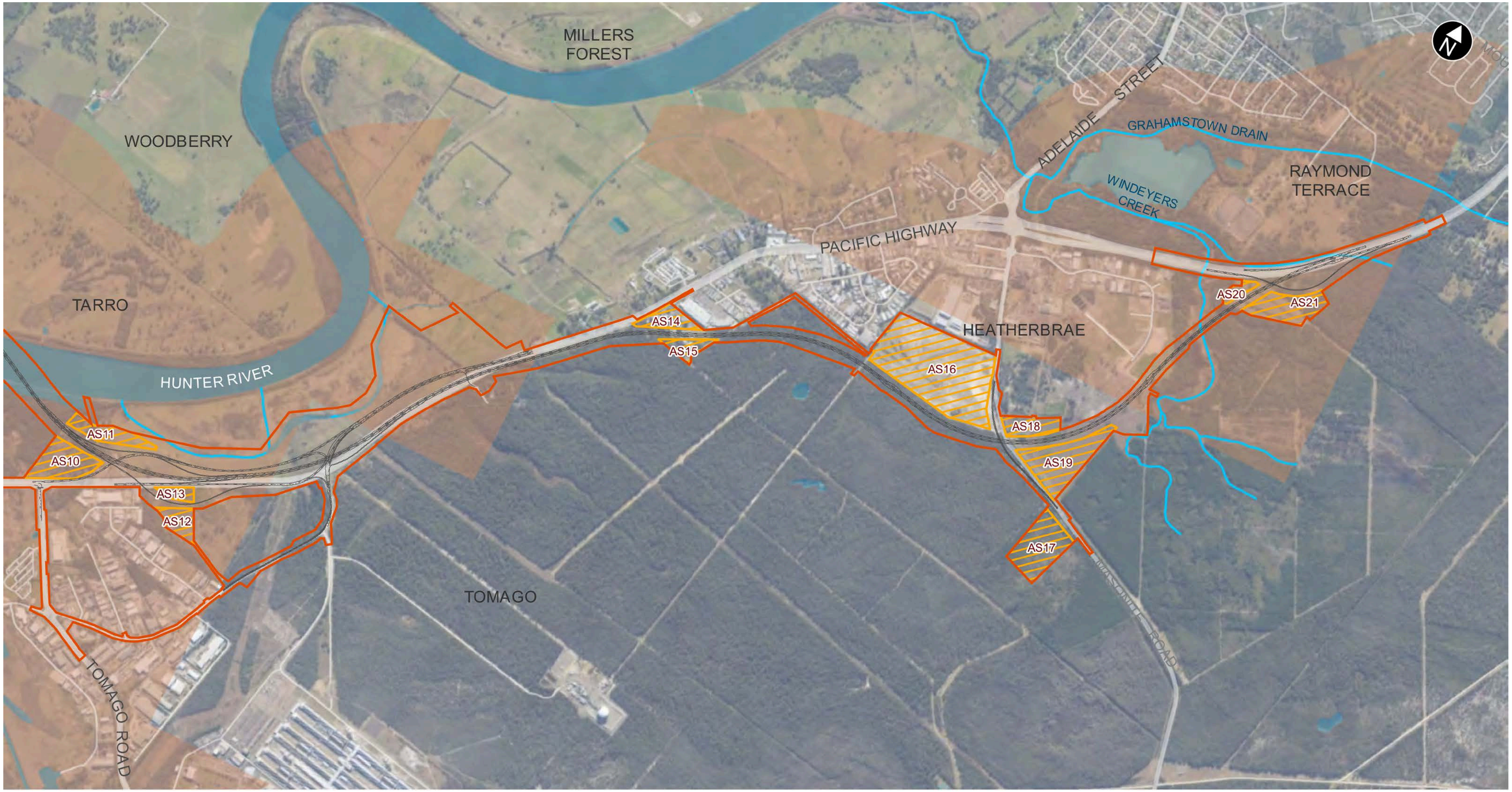

Construction footprint
The project
Waterways
Ancillary facility
High salinity risk areas
Data source: DAFF 2020

0 0.5 1 km

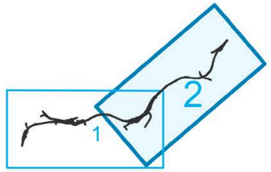

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Figure 4-7 High salinity risk areas (map 2 of 2)

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4.8 Sensitive receiving environments

Receiving environments with a high conservation or community value or that support ecosystems/human uses of water that are particularly sensitive to pollution or degradation of water quality within the study area are summarised as:

- 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 (applied to this project under transitional provisions), the 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 which are State and/or Commonwealth listed
- 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. Freshwater and brackish wetlands and waterways also provide aquatic habitats for a range of fish and aquatic species
  - Wetlands designated as groundwater dependent ecosystems (GDEs) have been mapped within the project, 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 five kilometres downstream of the project, while portions of the Hunter Wetlands National Park (which overlaps in areas with the Ramsar Site) is located about 1.5 kilometres downstream of the project.
- Waterways: The key waterways in and near the construction footprint (refer to **Figure 1-2**) include
  - Viney Creek
  - Purgatory Creek
  - The 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 project 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 -0.2 metres below ground level (bgl))
  - Tomago Sandbeds coastal sands to the east of the Hunter River (between about 2.7 to 1.6 metres bgl)
  - The Tomago Coal Measures, comprising porous rock to the north of the floodplain (between about 16.8 to 6.3 metres bgl, and to -0.3 metres bgl where it is confined beneath the Hunter Alluvium system).
- Active extraction bores are located close to the project, with many operating bores 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*.

5. Information review

This chapter details the findings of the desktop review including:

- Historical aerial photography review
- Records from the NSW EPA Contaminated Land database
- Record of Notices within the NSW EPA database
- Review of waste management and liquid fuel facilities within the construction footprint
- Review of the Per- and polyfluoroalkyl substances (PFAS) Investigation and Management Programs database
- A review of current EPA Licensed Activities (Licensed Activities under the *Protection of the Environment Operations Act 1997*)
- Historical Business Directories and NSW EPA search register results.

This chapter also provides a summary of relevant historical contaminated land and soil investigation reports.

5.1 Historical aerial photography

The historical aerial photography review indicated that the construction footprint was largely vegetated or used for agricultural and rural/residential purposes until between the mid-1950s and 1960s. At this time there was an increase in industrial development, including next to the Hunter River. In the mid-2000s, industrial development increased in Tomago and between 2014 and 2015 vegetation clearing, stockpiling and excavation was evident at the Masonite processing site in Raymond Terrace. Portions of the construction footprint remained as bushland throughout the review period, including south of Heatherbrae.

The area surrounding the project was predominantly vegetated or used for agricultural/rural residential land uses until the mid-1960s when increased development of Tarro, Heatherbrae, Tomago and Raymond Terrace was evident until the present. Tarro remained predominantly residential, while other areas were a mixture of residential and industrial/commercial development. Industrial/commercial development in the Beresfield and Black Hill area of the project began in the early 2000s.

The findings of the historical aerial photography review are summarised in **Table 5-1** for the study area. A summary of the historical information from the LotSearch search results (sourced in June 2020) is provided in **Appendix A**. Findings within the construction footprint are shaded grey.

Table 5-1 Summary of potential contamination issues 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)

Site	Location	Potential contamination
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)

5.2 Historical maps and business directories

A review of available historical maps and UBD business directories from the reports identified in a was carried out to supplement and support the aerial photograph review in identifying historic land uses that may have resulted in contamination. Maps for the years 2015, 1981, 1941 and 1913 were reviewed and a search of business directory records from 1991, 1982, 1970, 1961 and 1950 conducted. A summary of the review findings relevant to the project are presented in **Table 5-2**, with sites within the construction footprint shaded grey.

Table 5-2 Summary of potential contamination issues – 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

Site use	Location	Location relevant to construction footprint	Potential contamination	Source
Crematorium and cemetery (former and current)	Tarro	About 200m north of the project, outside the construction footprint	• Human burial and embalming (nitrates, lead, formaldehyde, biological hazards)	1941 and 2015 historical maps
Former rifle range	Motto Farm	Within the construction footprint	• Historical target practice and lead bullets and copper casings	Historical map c. 1913
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 ancillary facility AS8, outside the construction footprint	• Dairy processing (chlorinated hydrocarbons, nutrients)	1941 historical map
Former mineral sands processing	Tomago	Within the construction footprint	• Processing and stockpiling of mineral sands • Concentrated Naturally Occurring Radioactive Materials (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
Electrical switchboard manufacturer and or distributer	Tomago	About 400m south of ancillary facility 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 ancillary facility AS12, outside the construction footprint	• Solvents (chlorinated hydrocarbons) • Paints (heavy metals, hydrocarbons)	UBD 1991

Site use	Location	Location relevant to construction footprint	Potential contamination	Source
Motor garage and service station	Heatherbrae	About 280m north west of the project, outside the construction footprint	• Chemical/fuel use and storage (hydrocarbons, lead, volatile organic compounds)	UBD 1991

5.3 NSW EPA registers

5.3.1 Regulated/notified sites

A search was conducted on 17 June 2020 of the NSW EPA Contaminated Sites Record of Notices (under section 58 of the *Contaminated Land Management Act 1997* and the list of contaminated sites notified to the NSW EPA (under section 60 of the *Contaminated Land Management Act 1997*). This search indicated that there were six NSW EPA registered sites in the study area, with three NSW EPA registered sites within the construction footprint that were either regulated (subject to a current notice) or had been notified (refer to **Table 5-3**). Sites within the construction footprint are shaded grey.

Table 5-3 Regulated/notified sites

Suburb in database	Regulated/ Notified	Site address	Site activity	Contamination status	Location relative to project
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
Tomago	Notified to EPA	1877 Pacific Highway	Mineral sands processing	Regulation under CLM Act not required	Within the construction footprint, ancillary facility 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 ancillary facility AS20, outside the construction footprint

5.3.2 Per- and polyfluoroalkyl substances

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 been used. A search of NSW EPA current PFAS investigation sites indicates two areas that are within the broader catchment area:

- Our Lady of Lourdes Primary School, Anderson Drive, Tarro, located about 280 metres north of the construction footprint - Fire and Rescue NSW (FRNSW) are currently carrying out a preliminary site investigation into their past use of PFAS containing foams during firefighting training at the School. Preliminary results have identified the presence of PFAS in surface soils at the eastern end of the School, near the Tarro Fire Station
- Heatherbrae Total Fire Solutions, Griffiths Road, Heatherbrae, located about 170 metres north of the construction footprint - Total Fire Solutions is investigating the presence of PFAS contamination stemming from the historical use of fire-fighting foams at their Heatherbrae site. Investigations have found PFAS in groundwater.

No data specific to these sites is available in the public domain to enable an opinion on the risk that may be associated with PFAS from these locations and their ability (if any) to impact on project construction.

Hydraulic gradients beneath these sites are anticipated to be in a general north-easterly direction and therefore would be expected to direct any potential contamination away from the project. As such, contaminated groundwater is unlikely to reach the project from the Tarro and Heatherbrae PFAS sites and the project activities are not anticipated to influence or capture potential contaminant migration. Further, the Surface Water and Groundwater Quality Paper (Appendix K of the EIS) notes that groundwater drawdown would not reach these areas and therefore PFAS contamination should not migrate as a result of this project.

Despite this, PFAS are known to be persistent and highly resistant to physical, chemical and biological degradation. Their high solubility means that PFAS readily leach from soil to groundwater, where they can move long distances. When the groundwater reaches the surface, the PFAS can enter creeks, rivers and lakes. For this reason, the sources of PFAS that are currently being investigated by the EPA at Tarro and Heatherbrae have been included as AOPCR (refer to **Chapter 6**), as there is some potential for PFAS to have be present in surface water that may flow into the construction project.

PFAS contamination is also present at the Williamtown RAAF base. However, this site is located greater than five kilometres from the construction footprint and is situated in a separate groundwater and surface water catchment. NSW Government (2017) management areas associated with this contamination do not encroach upon the study area.

5.3.3 EPL licences

A search for current Environmental Protection Licenses (EPLs) and non-compliances related to EPL requirements under the *Protection of the Environment Operations Act 1997* was completed on 17 June 2020. Results of the search are listed in **Table 5-4**, with four sites identified within the construction footprint (grey shading). Several surrendered licences were also identified in the NSW EPA website searches.

Table 5-4 POEO public record search within 500 metres of the project

Suburb	Regulated/ Notified	Site address	Site activity	Location relative to project
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 project, outside the construction footprint
Beresfield	Licenced	2 Balbu Close	Recovery of general waste and waste storage	About 480m north-west of the project, outside 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 project, outside 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 ancillary facility AS8, outside the construction footprint
Tomago	Licenced	12 Old Punt Road	• General • Chemicals storage	About 400m south of ancillary facility 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 ancillary facility AS12, within the construction footprint
Newcastle	Licenced	-	Other activities	About 40m south west of the project, outside the construction footprint
Maitland	Licenced	-	Other activities	About 85m west of the project, outside the construction footprint
Heatherbrae	Licenced	42 Heather Street	Waste storage - hazardous, restricted solid, liquid, clinical and related waste and asbestos waste	About 40m west of ancillary facility AS16, outside the construction footprint
Heatherbrae	Delicenced, regulated by EPA	14 Motto Lane	Concrete works	About 140m south east of ancillary facility AS16, outside the construction footprint
Raymond Terrace	Delicenced, regulated by EPA	Masonite Road	Hazardous, Industrial or Group A Waste Generation or Storage	Next to ancillary facility AS16, within the construction footprint
Raymond Terrace	Licenced	Off Elizabeth Terrace	Sewage treatment processing by small plants	About 200m north west of ancillary facility AS20, outside the construction footprint

5.4 Previous contamination investigations

A summary of relevant previous investigations is provided in the following sections.

5.4.1 Preliminary Contamination Assessment, Proposed Train Support Facility, Woodlands Close, Hexham (Douglas Partners, 2012)

In 2012, a Preliminary Contamination Assessment (PCA) for the proposed Train Support Facility (TSF) located at Woodlands Close, Hexham (Douglas Partners, 2012). The TSF and associated rail line crosses the construction footprint to the south, about 800 metres east of the Tarro interchange.

The objective of the PCA was to assess past and present contaminating activities, report on site conditions and provide a preliminary assessment of site contamination. The PCA included a desktop review, site inspection, sampling of soil, groundwater and surface water, laboratory analysis, interpretation and reporting.

Subsurface investigations identified fill material (typically coal reject intermixed with silts and clays) to depths of about 0.2 metres to greater than about 5.5 metres 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 metres to 2.45 metres 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.

The results from the investigation indicated that there was an absence of gross soil contamination associated with the TSF development. Exceedances of guideline levels in soil were associated with non-volatile medium to heavy chained hydrocarbons. It was concluded, based on historical information, site observations and analytical results, that widespread soil contamination within the TSF was low.

Bonded Asbestos Containing Material (ACM) was observed in the immediate vicinity of former buildings within the TSF. It was also believed ACM may be present within a localised dumped pile of fill containing building rubble and was thought not to be widespread.

The analytical results from groundwater and surface water samples indicated widespread elevated levels of nutrients and faecal coliforms. The results indicated that the Hexham Wetland (located to the west of the railway line and about two kilometres from the construction footprint) was in a degraded state as a result of a long history of industrialisation within the area. The elevated concentrations of faecal coliforms and nutrients were also thought to be possibly attributed to the infiltration of irrigated treated effluent or cattle grazing.

5.4.2 Former RZM Site: Preliminary Site Investigation (Sinclair Knight Merz, 2013a)

Several site-specific, progressive contamination and waste classification investigations were carried out at the former Rutile, Zircon and Monazite (RZM) processing facility, beginning in 2012 and described further in **Section 5.4.5** and **Section 5.4.7**). The former mineral sands processing facility in located within the construction footprint next to the Pacific Highway at Tomago (refer to **Figure 1-2** and **Figure 6-1**).

Based on the site history and the likelihood of other forms of potential contamination possibly associated with the site, the PSI identified potential contamination risks associated with the previous, historical operations on site specifically associated with mineral sands storage and processing. The PSI recommended (among other recommendations) that a DSI be carried out to help identify and understand the potential occurrence, extent and significance of potential contaminants of concern. Based on the results of the PSI report, potential contaminants of concern included elevated levels of naturally occurring radioactive material (NORM), elevated concentrations of some metals, and localised hotspots of hydrocarbon contamination in soils and possibly groundwater and surface water.

Based on the likelihood of potentially significant contamination being associated with the historical operations at the site, a NSW EPA Accredited Contaminated Land Auditor was engaged by Transport to assist with the independent assessment of contamination assessment works and planning considerations under the CLM Act.

5.4.3 Preliminary Site Investigation Contamination and Acid Sulphate Soil Assessment (Douglas Partners, 2015)

In 2015, Douglas Partners completed a Preliminary Site Investigation (PSI) for the project. The assessment provided a review of desktop information to identify potential areas of environmental concern and inform the project options assessment. The PSI consisted of a review of published data including geological and soil mapping, groundwater bores, aerial photographs, and NSW EPA records. A review of previous environmental, geotechnical and groundwater investigations within the study area was also completed, as well as a review of previous investigations completed for Transport for other nearby road upgrade projects.

Previous geotechnical investigations included those completed for Pacific Highway upgrade works between F3 and Raymond Terrace (by Coffey in 2007 and GHD in 2005 and 2006) identified fill between about 0.5 and three metres in depth in some locations. ASS was also identified along majority of the project, particularly in the central and eastern portions. Hydrocarbons, pesticides, metals and PCBs were also reported in soil samples. Groundwater was identified at shallow depths between about 0.06 and 1.4 metres in the central portion of the project surrounding the Hunter River, and about 2.6 to 11.4 metres in the western portion of the project.

Several areas of environmental concern were identified including the potential for ASS, saline soils as well as potential or actual contamination associated with agricultural or industrial facilities across some areas. Douglas Partners considered that the potential impacts arising from these areas of concern were likely to be localised. Potential contamination sources that were identified (as detailed in the PSI) and potential contaminants associated with these sources are summarised in **Appendix B**.

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.

5.4.4 Asbestos Clearances – RMS Land Off Lenaghans Drive, Black Hill (Hazmat Services, 2016)

In 2016, after removal of asbestos containing materials from bushland next to the M1 Pacific Motorway in Black Hill, Hazmat Services carried out air monitoring, visual clearance inspections and soil validation sampling. The area had been used for illegal dumping of waste material, including asbestos. This area is located off Lenaghans Drive within the western extent of the construction footprint.

The quantity of material removed was not documented in the clearance report. The removal work and validation were completed by a licensed contractor. The validation report stated that asbestos removal works were complete and the site was fit for re-use, the validation report was signed by a licensed asbestos assessor.

5.4.5 Former RZM Site: Detailed Site Investigation (DSI) (Jacobs, 2016)

Radiation assessment works was carried out on accessible site areas, and at suitable off-site locations, to measure radiation levels, establish Worker Dose Constraint Levels for the site and to inform decisions relating to potential future contamination management options. Once background radiation levels were understood and the dose constraint levels established for the site, a Sampling, Analysis and Quality Plan (SAQP) was created to guide the DSI scope and Data Quality Objectives for the study.

The SAQP scope defined vegetation clearing works across the site to allow greater site access and established the locations for comprehensive radiation surveys across all newly accessible ground surfaces and at depth in selected locations, test-pit and drilling investigations, sample capture and analysis of soil, sediment, surface water and groundwater.

In-situ radiation monitoring using Radiation Solutions RS-220 gamma surveyor instruments was carried out to map elevated radiation levels at surface and at depth within test-pits and boreholes. X-ray fluorescence (XRF) spectrometry screening of soils at surface and at depth was also carried out for metals, to allow dynamic interpretation of the potential extent of metals in soil during the test pitting events. **Figure 5-1** and **Figure 5-2** illustrates the former mineral sands processing facility features, indicative sampling and testing locations for soil, sediment, radiation screening, surface water and groundwater.

Based on the DSI site works and SAQP objectives, the results of the DSI are summarised as follows:

- Localised hydrocarbons in soil exceeded management limits in surface soils at the former transformer location, next to former Building 4 (see **Figure 5-1**)
- ASS exceeded the action level criteria at most locations sampled across the site
- Some metals detected within the sediments of the Hunter River and drainage line exceeded the applied criteria
- Dissolved concentrations of cadmium, dissolved copper, dissolved nickel, dissolved zinc were detected in surface water and groundwater exceeding investigation levels at locations within and next to the drainage line and at several well locations Widespread distribution of naturally occurring radioactive materials (NORM - areas of elevated dose rates relative to surrounds) were identified across the site at surface and at depth.

Based on the combined results of the DSI and associated previous assessment works, the following conclusions were made:

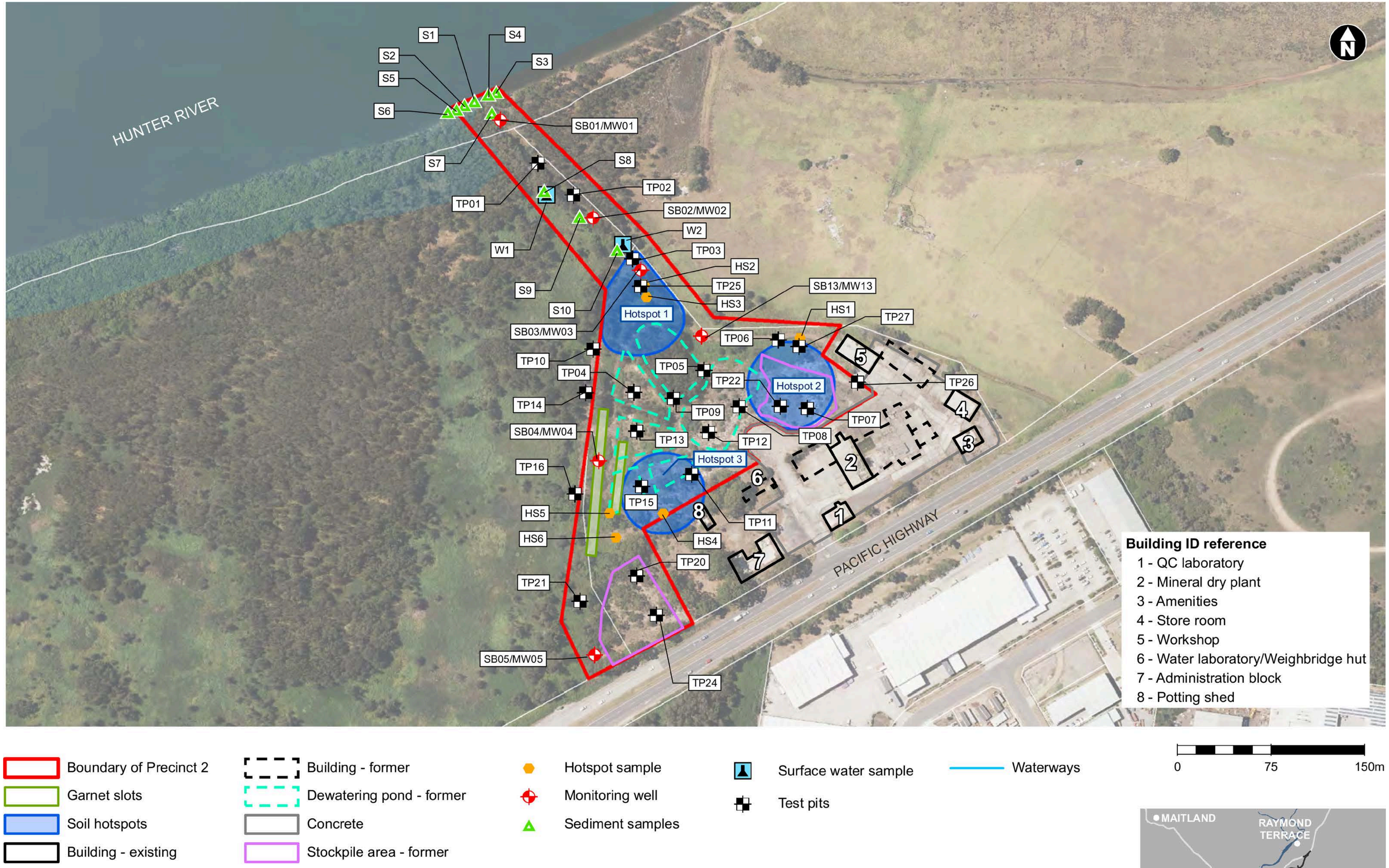
- There is contamination in soils, sediment, groundwater and surface water on the site in excess of the applied criteria
- A change of site usage conditions as a highway upgrade construction site may provide an exposure pathway to residual contamination
- Construction activities may alter ground conditions, contaminant behaviour and migration from the currently understood status
- Elevated radiation dose rates in soils at surface need management to be protective of humans.

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.

Based on the above conclusions, the following recommendations were made in the DSI and have been implemented on site:

- An Interim Site Management Plan (ISMP) was recommended to control access to the site and to establish other controls as necessary. The ISMP includes management measures and controls to manage potential human health exposure risks associated contamination within the road verge and within the open drain
- 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.

In-situ waste classification studies in accordance with NSW EPA Waste Classification Guidelines Part 3: Waste Containing Radioactive Material (2008) was recommended to allow decisions relating to site future highway construction works and remedial design decisions.



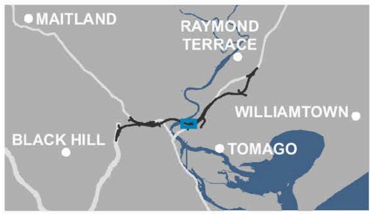


Figure 5-1 Former mineral sands processing facility

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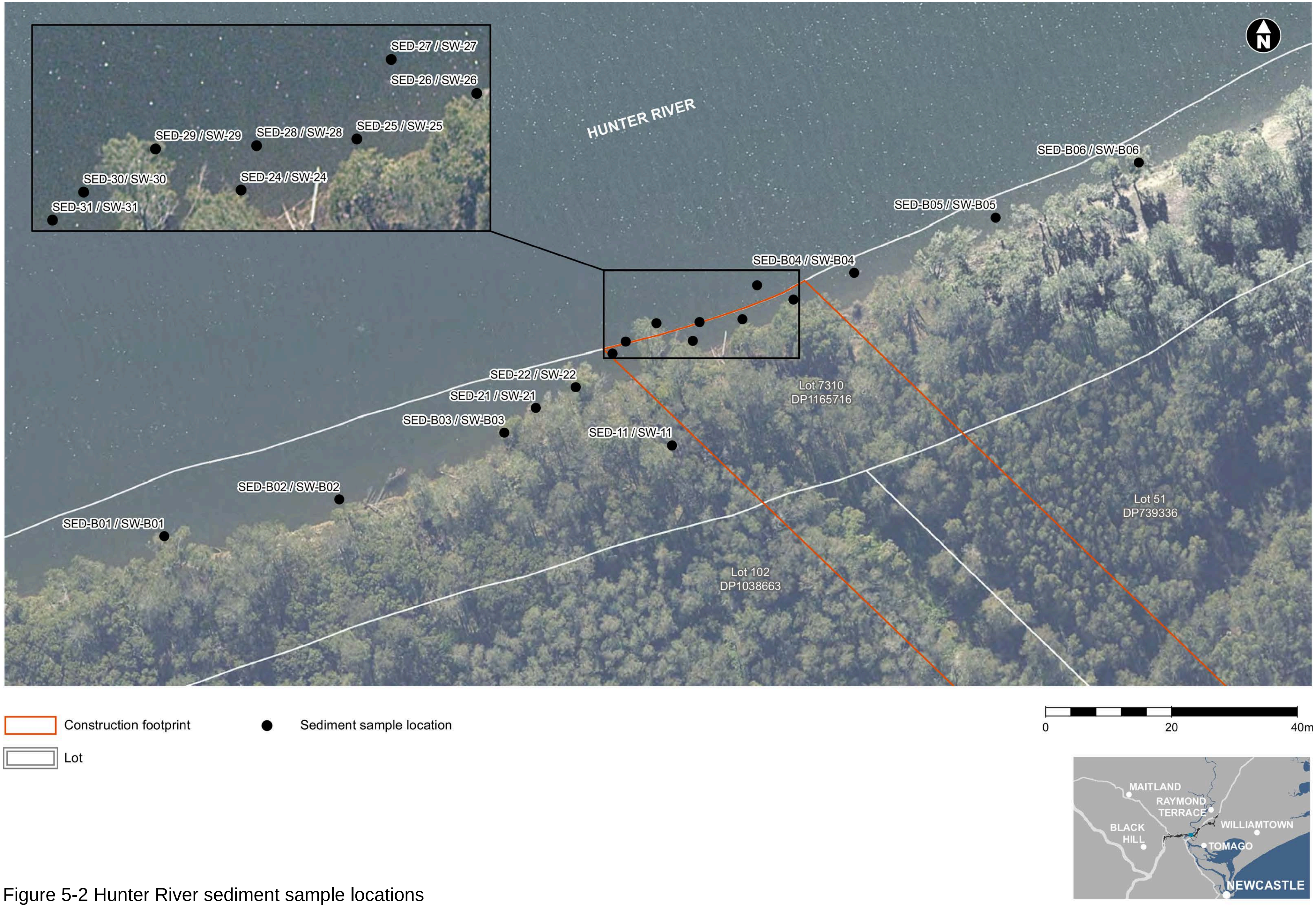

Figure 5-2 Hunter River sediment sample locations

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5.4.6 Geotechnical Investigation Factual Report (Douglas Partners, 2017)

Based on the findings and recommendations of the PSI (Douglas Partners, 2015), contamination samples were collected by Douglas Partners from ‘Medium Risk’ areas during geotechnical field work carried out across the construction footprint. Specifically, where geotechnical test locations overlapped possible contamination locations.

The PSI carried out limited soil and groundwater contamination sampling in conjunction with geotechnical field testing in 2016. Selected soil samples were analysed for the following suite of analytes:

- Metals - arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), iron (Fe), nickel (Ni) and zinc (Zn)
- Total recoverable hydrocarbons (TRH)
- Benzene, toluene, ethylbenzene and xylene (BTEX)
- Herbicides/pesticides
- Phenols
- Asbestos.

A total of 60 soil samples were analysed. Analytical results for the above potential contaminants of concern 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). **Figure 4-6** shows locations where samples were collected as part of the geotechnical assessment works, and some contamination samples were analysed. Given the minor exceedances for applied ecological criteria in soils at the locations tested under a land use of a highway upgrade, it is considered these results present a low contamination risk, as confirmed in additional contamination studies carried out for metals in soil, sediment, surface water and groundwater at the former mineral sands processing facility and surrounding areas (as detailed in **Chapter 6**).

5.4.7 Former RZM Site - Consolidated Human Health and Ecological Risk Management Report (Jacobs, 2020)

Based on the conclusions and recommendations associated with the DSI for the former mineral sands processing facility (Jacobs, 2016), the NSW EPA accredited Contaminated Land Auditor's Interim Opinion of the DSI (AECOM, 2017) agreed that the Duty to Report Notification obligations under Section 90 of the *Contaminated Land Management Act 1997* had been triggered. Transport formally notified the former mineral sands processing facility to NSW EPA in February 2018.

As a consequence of the potential environmental risks associated with the site, the Auditor agreed with a recommendation in the DSI that an ISMP be created, to manage potential exposure pathways to humans and the environment to identified contamination risks.

An ISMP was completed in March 2019, with Auditor endorsement received shortly thereafter.

Transport have completed a series of site works to secure the former mineral sands processing facility from unauthorised access and initiate the next phase of contamination assessment works under a SAQP. The objective of the SAQP was to address the remaining data gaps for the site and provide information sufficient to support ongoing site management decisions and remediation works (if necessary).

The EPA also requested additional information to allow their assessment and respond to the notification of the site under Section 60 of the *Contaminated Land Management Act 1997*.

Under the NSW EPA approved SAQP, a field sampling campaign was carried out in 2019, including additional groundwater, surface water, sediment and soil sampling across the site. Samples were analysed for priority contaminants of concern, including radionuclides and metals at previously identified hot spot locations on the former mineral sands processing facility.

Specialist radiological analysis, interpretation and reporting was carried out by the Australia Nuclear Science and Technology Organisation to compare the 2019 data against the previously measured radiological data collected (DSI Jacobs, 2016) and to provide data required to support Human Health and Ecological Risk Assessment (HHRA/ ERA) exposure modelling.

Exposure modelling was designed to ensure that decisions on environmental risks and subsequent management were giving appropriate weight to the actual environmental exposure, effects and risks from ionising radiation with emphasis on protecting human health and ecosystems.

Additional risk assessment and interpretation was also carried out in relation to previously identified elevated metals within sediments and water across the site and within the Hunter River to allow a greater understanding of exposure risks.

The results of the sampling, analysis and modelling and reporting events resulted in the following general conclusions:

- The results of all 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
- Current exposure risks to humans and ecosystems are appropriately managed by the NSW EPA approved ISMP.

6. Areas of potential contamination risk

As described in **Chapter 5**, the construction footprint includes areas of historical and current potentially contaminating activities, which may require further investigation prior to construction and management during the construction of the project. Historical and current potentially contaminating activities within the construction footprint include agricultural and rural land use, a former mineral sands processing facility, areas of fill material and industrial land use.

Several AOPCR have been identified within and next to the construction footprint (refer to **Figure 6-1**). **Table 6-1** provides details on their associated contaminants of potential concern, risks to environmental receivers and limitation on construction and site users, within the context of the potential for contamination and proposed construction activities. This assessment identified the following:

- Five high risk AOPCR exist within the construction footprint. These are 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 risks were applied to areas of identified including 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 AOPCR (industrial premises, service stations, and areas of potential fill and discarded waste) were also identified within and next to the construction footprint.

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. All risk rankings have been based on unmitigated project risks and have not considered the implementation of design or engineering controls.

The results of the contamination risk assessment are required to support and inform current decisions that focus on potential exposure risks to human health and the environment caused by residual levels of contaminants across the project, and the potential for construction and operations works to exacerbate or change contaminant behaviour. Residual, historical contamination may have been inferred at a given location, based on the past land use or an assumption that contaminating activities may be associated with an activity, such as agricultural land usage and the application of herbicides.

Under the existing agricultural land use, it would be considered common practice to apply herbicides to control weeds. Under a change of land use such as a highway upgrade, the construction activity of excavating herbicide impacted soil could pose an exposure risk to construction workers during excavation or mobilise potential contamination sources during construction activities. The Douglas Partners (2017) Geotechnical Investigation Factual Report includes data for soil samples that were collected and analysed for herbicides/pesticides in shallow soils at locations across the construction footprint, with all analytical results reported below the applied criteria. Accordingly, the inferred risk ranking for a hypothetical exposure scenario to a construction worker would be considered 'Low'.

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'. Several locations in and or next to the construction footprint are also considered to represent a low contamination risk. No further consideration of contamination risk has been provided for these locations. Additionally, generic AOPCR across the construction footprint (refer to figure reference 11 and 13 in **Table 6-1**) have been mapped as larger areas on **Figure 6-1** due to the generic/widespread nature of the AOPCR or being unable to identify the exact site address.

Table 6-1 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
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

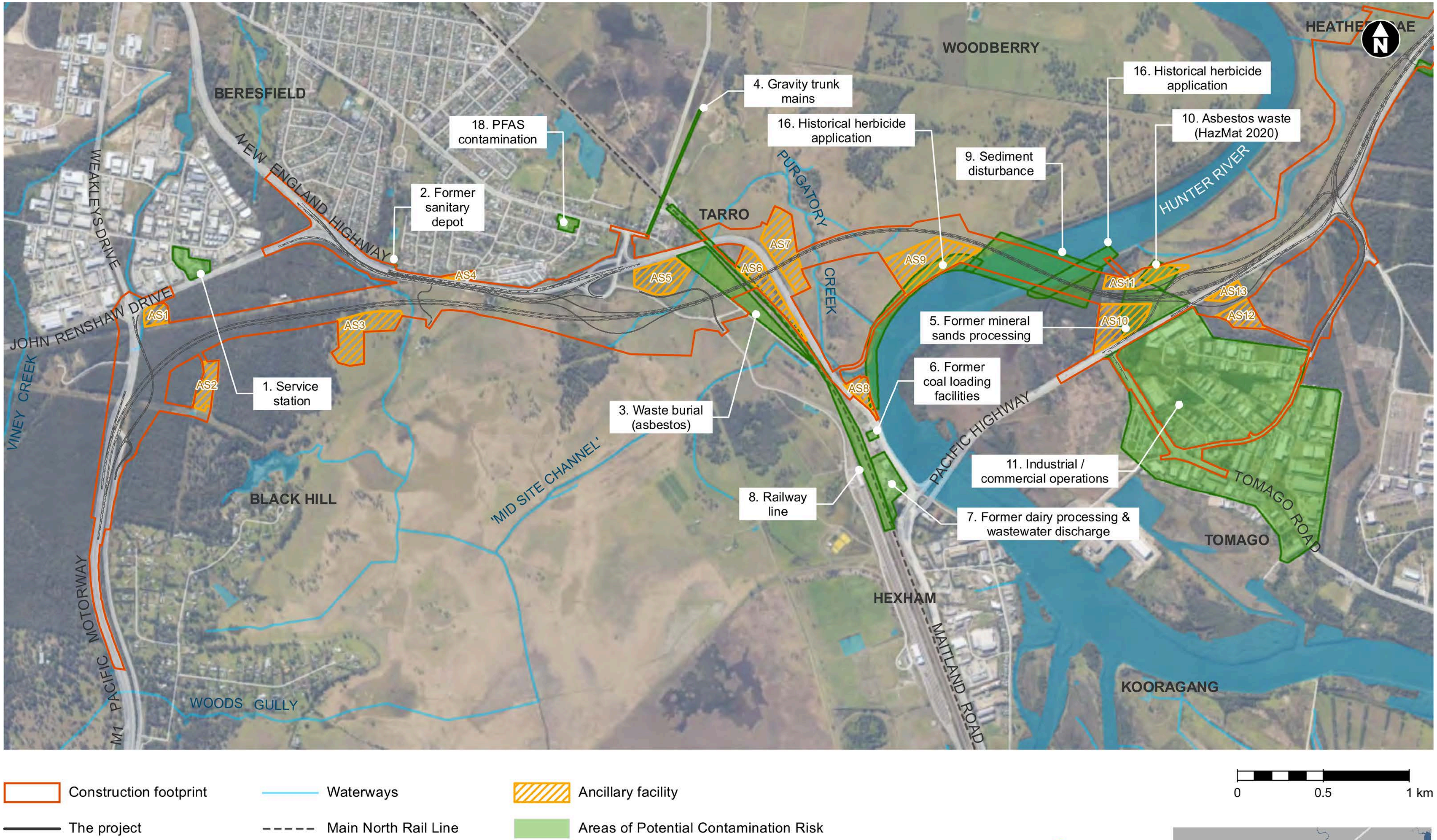
AOPCR No.	Site	Location	Construction element at/near this location	Potential contaminants of concern	Potential pathway	Potential receivers	Inferred risk rating
5	Former mineral sands processing	Tomago, within construction footprint	• Topsoil removal • General excavation activities • Culvert and drainage 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, about 150m south of ancillary facility AS8, outside the construction footprint	• 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) to 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 surroundings 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 including 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 Contamination 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. Refer to **Figure 4-6** for ASS locations	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



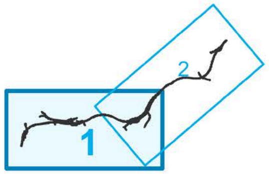


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Figure 6-1 Areas of Potential Contamination Risk (map 1 of 2)

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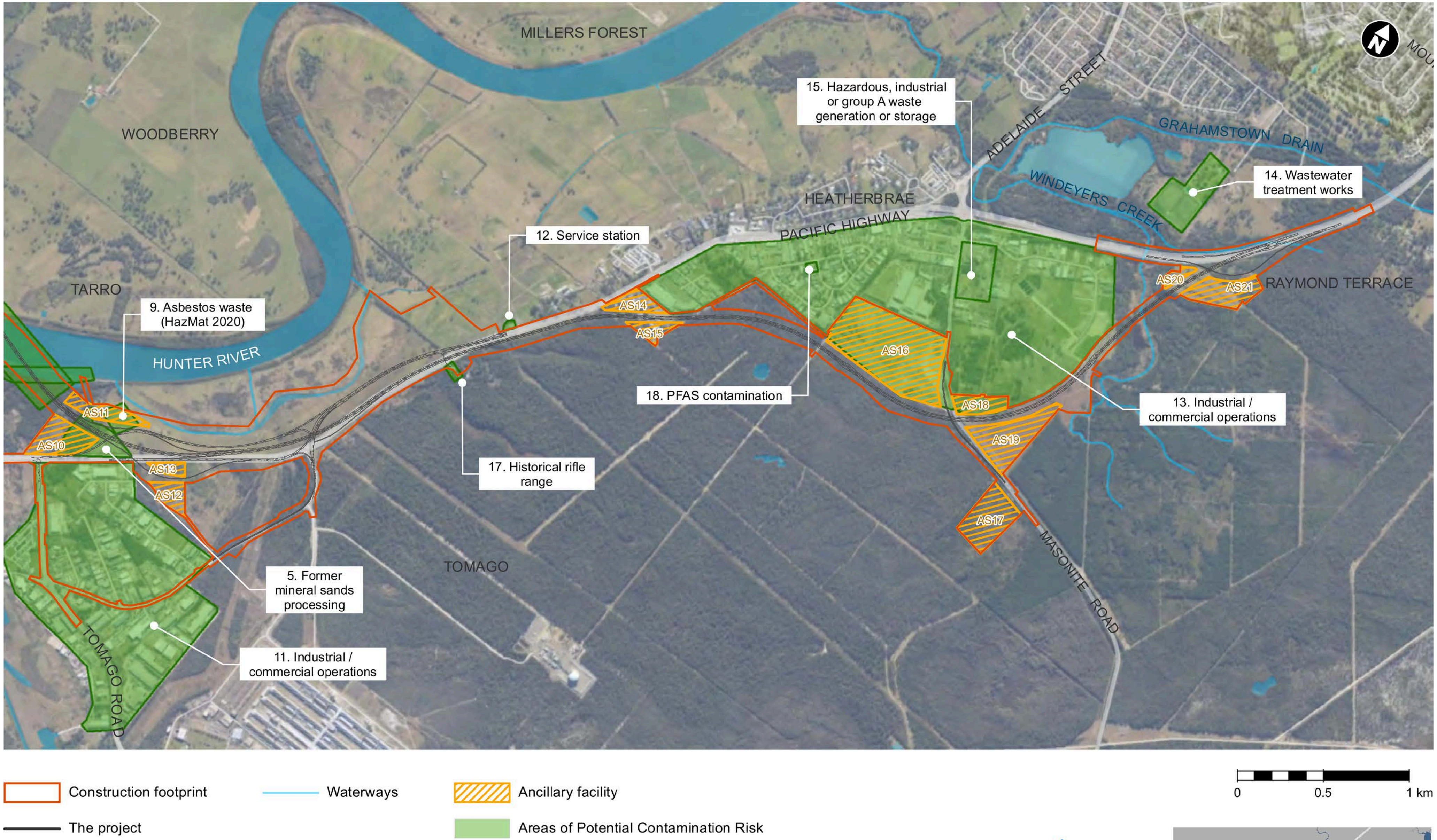

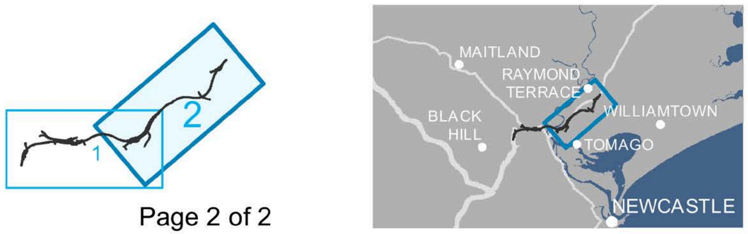

Figure 6-1 Areas of Potential Contamination Risk (map 2 of 2)

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7. Assessment of potential impacts

7.1 Construction impacts

Activities during the construction phase have the potential to interact with identified ASS, areas of existing salinity, and identified sources of contamination.

7.1.1 Acid sulfate soil and acid rock

A range of environmental impacts are associated with disturbance and oxidation of ASS. A decline in water and soil quality as a result of acid sulfate soils poses a risk to:

- Aquatic, wetland or terrestrial ecosystem impacts
- 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.

The low-lying areas within the construction footprint are underlain by actual and potential ASS. These soils can be oxidised through a drop in groundwater levels due to drawdown, and exposure of ASS during excavation and stockpiling. Furthermore, treatment of actual and potential ASS poses risks to the environment as the treatment process involves the use of chemicals and can generate leachate and other contaminants. These scenarios and associated impacts are discussed further in the sections below.

De-watering and oxidation of potential acid sulfate soils

A drop in groundwater levels can allow potential ASS layers to dry out and oxidise. Sulfuric acid can be produced after a rainfall event, impacting aquatic ecosystems, terrestrial ecology and water quality of sensitive receiving environments.

The project has been designed to minimise long term impacts on surface water and groundwater hydrology, including drawdown, flow rates and volumes. Based on the reviews and modelling carried out as part of the Hydrology and Flooding Working Paper (Appendix J of the EIS), the project is not anticipated to have any detrimental effect on the local groundwater hydrology regime, including groundwater dependent ecosystems and other groundwater users.

The groundwater drawdown assessment carried out in the Hydrology and Flooding Working Paper (Appendix J of the EIS) indicates that shadowing and drawdown impacts during construction would be temporary in duration and limited in lateral extent. Because substantial and prolonged drawdowns are not expected as part of construction, water quality impacts as a result of oxidation of ASS are expected to be minor and manageable (refer to the Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS)). No water quantity or quality impacts are expected to the nearby Tomago Sandbeds Catchment drinking water supply.

The construction works would require temporary dewatering of groundwater to manage ingress to construction excavations. Localised extraction of groundwater inflow or seepage to cuttings and water exuded from wick drains during the construction of embankments in soft soils would be required. In addition, changes to the hydraulic properties of soft soils during construction can result in both increases and decrease in groundwater water levels.

Key activities with potential to alter groundwater flow include temporary construction dewatering, water quality basins below the water table, and soft soil consolidation areas. Temporary construction dewatering would be required where excavations occur below The water table. Substantial excavation is required to construct the temporary and permanent water quality basins, bridge piers and the Purgatory Creek adjustment.

Details relating to the areas where dewatering may be carried out and the associated volumes are contained in the Hydrology and Flooding Working Paper (Appendix J of the EIS). A dewatering management sub plan would be prepared as part of the Construction Soil and Water Management Plan which would manage dewatering methodology, monitoring, training and any approvals required before any dewatering activity commences.

Excavations and oxidation/exposure of acid sulfate soils

ASS can be oxidised in situ (in place). This is most likely to occur in areas of open excavations and especially where potential ASS are stockpiled and moved, as aeration and disturbance accelerates oxidation.

Construction activities that have the potential to expose ASS include:

- Excavation carried out in areas that contain ASS and potential ASS, including:
  - Below ground level in the central low-lying areas either side of the Hunter River and next to Windeyers Creek
  - Excavations about two metres near the New England Highway at Beresfield
  - Excavations about five metres in Black Hill
  - Below ground surface and at about one to two metres at Tomago
  - Excavations about two metres at Masonite Road in Heatherbrae.
- Bridge piles – Bridge piling can expose ASS if 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
- Dredging – Dredging sediments for construction barges, temporary wharves or other in-river works that may disturb and mobilise sediments within the Hunter River can expose ASS
- General civil works including (but not limited to):
  - Vegetation removal
  - Utility installation, upgrades, connections, removal or protection
  - Drainage work
  - Waterway adjustments.
- Bored concrete piles – Associated with the construction of the bridges in soils and sediments.

The project is expected to generate about 90,000 cubic metres of potential ASS, of which about 50,000 cubic metres testing as actual ASS to be treated.

Treatment of ASS and ASS water / leachate

Treatment of ASS, potential ASS and various leachates presents a risk as it involves the use of chemicals (typically lime products or similar). The use of the chemicals generally poses a short term and localised risk to soils water and biodiversity if not managed appropriately.

The location of treatment areas for ASS, potential ASS and leachate would be variable across the project and may include small mobile containment facilities or more substantial longer term facilities. Their locations would be based on minimising risk associated with receivers, transport, stockpiling, and flooding.

Treatment areas would be confirmed, however possible sites include:

- Ancillary facility AS3 for treatment of soil generated from piling associated with bridges over the wetlands (B02), bridges at the Tarro interchange (B03 and B04) and the main viaduct (B05)
- The area south of the Hunter River for the construction of piles and drainage infrastructure on the floodplain:
  - This area is flood prone with an inundation depth exceeding two metres for the 10% AEP event. However, trucking the material on public roads to ancillary facilities further south (for instance AS3) is likely impractical (given the properties of the material) and similarly for trucking or barging to the north of Hunter River. Therefore, it is considered that treating ASS south of the river proximate to where the material is excavated is most likely the preferred option
  - It is likely that treatment of ASS will need to be somewhat removed from the banks of the Hunter River, so trucking of some ASS material to the south (but still within the floodplain) will likely be required.
- Ancillary facility AS8 or ancillary facility AS9, or the former mineral sands processing facility for treatment of soil generated from:
  - Piling associated with the Tomago/Heatherbrae interchange
  - Piling associated with the main viaduct north of the Hunter River.

Based on the potential volumes and anticipated durations of construction, each of the treatment areas could be in the order of approximately 1,500 square metres and stockpile areas of 1,000 square metres.

All excavated materials currently mapped as ASS would be tested and treated before reuse or disposal. Treatment of ASS can comprise of neutralisation using lime or other neutralising agents to rapidly oxidise and change the pH of the ASS sediment, however this can often result in the generation of heat and create oxygen sulphide odours during the treatment process. While ASS treatment would be confirmed following finalisation of construction design, it would include implementation of an ASS Management Plan prepared in accordance with the Acid Sulfate Soil Manual (ASSMAC, 1998), establishing designated treatment areas, lime dosing prior to disturbance, transfer of soil to treatment area and leaving it until such time as soil testing confirms its acceptable for reuse or transferred off site. These measures and treatment measures would substantially reduce the risk to water quality. As such, ASS disturbance, if managed in accordance with the proposed measures, is not likely to result in a significant impact to the environment.

As detailed in **Section 4.6,** 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.

7.1.2 Soil salinity

Identified environmental salinity (saline groundwater and dryland salinity) and the potential risks associated with saline construction water (salt introduced as part of a dust suppression or stabilisation processes) pose the greatest construction impacts associated with salinity. The Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS) assesses the water quality impacts associated with saline groundwater. Impacts associated with dryland salinity are assessed further in this section.

As detailed in **Section 4.7**, the majority of the construction footprint lies in an area rated as high hazard or risk of dryland salinity (refer to **Figure 4-7**). Construction activities have the potential to disturb areas of dryland salinity, which can then have flow on effects onto groundwater and surface water, sensitive receiving environments, wetlands, terrestrial ecosystems and aquatic ecology.

The most significant risk of dryland salinity is the potential for saline runoff from saline soils to impact on freshwater reserves. Salinity in waterways varies across the construction footprint, with freshwater receiving environments more sensitive to saline inflows than brackish or saline receiving environments. The main area where this presents a risk is the area overlying the Tomago Sandbeds groundwater resource. To avoid this impact, potentially saline soils would not be permitted to be imported into this area as seepage and leachate from the soils presents a risk to the quality of the underlying groundwater (refer to **Chapter 9**).

The likely presence of localised saline soils within the construction footprint has been identified, based on risk and salinity characteristics mapping verified by salinity testing. Salinity is considered to occur generally within the creeks and low-lying areas within the central portion of the study area. However, due to the generally predicable rainfall across the construction footprint, the salt-affected soils are not considered to pose a significant risk because rainfall is sufficient to leach excess salts out of the soils, into groundwater, and ultimately to the brackish waters within the Hunter River.

In areas of the construction footprint that are mapped for elevated soil salinity, reuse of topsoils would have negligible impact on salinity of surrounding soils and as these areas already have saline groundwater, no groundwater impacts are expected from soil reuse. Testing and reuse of saline soils would be managed by the project Construction Soils and Water Management Plan.

Construction activities with the potential to impact salinity include:

- Use of higher salinity water for dust suppression in low salinity areas within the construction footprint has the potential to increase salt accumulation in the soil
- Reuse of saline soils in areas of low salinity, possibly introducing increased salinity at these locations
- Increases in groundwater levels. Artificial increases in groundwater levels from preloading has the potential to mobilise salts from unsaturated soils, resulting in elevated shallow groundwater salinity and eventually increased salt loading in local waterways. Increases in groundwater level are expected to be small, localised in lateral area and consistent with seasonal variations and so are not expected to influence salinity substantially. Further detail is provided in the Surface Water and Groundwater Working Paper (Appendix K of the EIS)
- Potential impacts resulting from soil salinity on groundwater resources and hydrology due to interactions with groundwater dewatering, exposure of saline soils to groundwater and saline surface water migration (assessed further in the Surface Water and Groundwater Working Paper (Appendix K of the EIS))
- Introduction of saline soil or associated water in previously low saline soil areas may produce higher maximum dry densities at lower moisture content, may reduce moisture content changes in soils, and decrease the permeability of soils
- Clearing vegetation, particularly in low/lying areas and areas with high soil sodicity, may encourage erosion/washout and increase the potential for waterlogging. Waterlogging has the potential to mobilise salts accumulated in unsaturated soils and can result in elevated shallow groundwater salinity. Potential to mobilise salts is higher in situations where the ground is not already saturated on a regular basis. This impact is assessed further in the Hydrology and Flooding Working Paper (Appendix J of the EIS). Management practices to mitigate this would be employed within the high-risk areas identified in **Figure 4-7**.

The Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS) indicates that the risk of saline soils altering the salinity of the waterways as a result of construction of the project is considered low as water quality controls and management measures will be implemented to ensure runoff to surface waterways is controlled. Further measures to reduce the risk of the project to soil salinity are presented in **Table 9-1**.

7.1.3 Soil contamination

Based on the information reviewed, the project disturbed areas would generally occur in greenfield areas with low levels of contamination due to land use, however 20 AOPCR (including generic AOPCRs) were identified within and next to the construction footprint (refer to **Table 6-1**). Of the 20 AOPCRs, 12 areas/items (rated medium and high risk) are specific to potential contamination or waste management issues within or adjacent to the construction footprint were raised, including:

- AOPCR 3 – Buried/incidental (asbestos) waste at Tarro
- AOPCR 5 – The former mineral sands processing facility at Tomago
- AOPCR 9 – Hunter River sediments within the bed sediments of the Hunter River
- AOPCR 10 – Asbestos waste at Tomago
- AOPCR 11 and 13 – General historical industrial/commercial operations across built up areas
- AOPCR 14 – The wastewater treatment works at Raymond Terrace
- AOPCR 15 – The Weathertex site at Raymond Terrace
- AOPCR 16 – Historical herbicide application areas at the Hunter River foreshore at Tomago and Tarro
- AOPCR 17 – The historical rifle range formerly located at Motto Farm
- AOPCR 18 – PFAS contamination at the Our Lady of Lourdes Primary Scholl (Tarro) and Total Fire Solutions (Heatherbrae)
- Various – Stockpiling and/or illegal dumping within the construction footprint.

While not considered a potential contamination issue, the widespread presence and associated risk of consequences with the potential mismanagement of ASS and runoff has been included within the risk ranking **Table 6-1** for completeness.

The soil contamination assessment works carried out concurrently with geotechnical assessments (Douglas Partners, 2015 and 2017) have provided a comprehensive understanding of the extent and distribution of the potential occurrence of contamination sources identified in **Table 6-1**.

The following sections provide an overview of the key contamination risks potentially associated with the project.

Construction activities

Any existing contamination present in soils and groundwater in the construction footprint have the potential to be exposed or disturbed by ground disturbing activities.

The highest risk construction activities that would interact with soil contamination include any of the following works in identified AOPCR sites, such as vegetation removal (grubbing), topsoil stripping, excavations, earthworks, demolition, dewatering, stockpiling or transport of material and waste where the construction activities coincide with impacted contaminated soils, water, potentially contaminated demolition waste and naturally occurring radioactive material (NORM) at the former mineral sands processing facility.

Any contaminated materials or water exposed, generated, stockpiled treated or transported during construction pose a risk and need to be managed appropriately to limit the further spread of their distribution or the impact to other uncontaminated material or water.

These high-risk construction activities present the following potential risks 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) The potential impacts of

this exposure include a range of physical health issues in the case where the exposure is not appropriately controlled
- Risks to the environment (to receiving environment) – Construction works may create exposure pathways through (for example) disturbance, removal of vegetation and topsoil and dewatering. The potential impacts of this exposure include a reduction in exiting environmental quality or impairment to biological processes where the exposure is not appropriately controlled.

Existing fill

Geotechnical investigations and site inspections have assessed the construction footprint for fill. While the project is generally within a greenfield setting and presents minimal risk of widespread uncontrolled filling on the site, isolated occurrences of pre-existing filling have been located.

Previous investigations identified general fill within the construction footprint, with hydrocarbons, pesticides, metals and radionuclides identified in soil samples associated with the former mineral sands processing facility (AOPCR 5 in **Figure 6-1**). The identified contaminated material from AOPCR 5 would be remediated, in accordance with a Remediation Action Plan that would be approved by a NSW EPA accredited site auditor (refer to **Chapter 9**).

Any soil/fill materials generated across the project that are surplus to construction needs would be classified in accordance with the NSW EPA (2014) Waste Classification Guidelines, reused where possible and/or disposed of appropriately.

Previous analytical results in fill (and soil) as reported in previous investigations (Douglas Partners, 2017) at selected locations across the construction footprint did not encounter any potential contaminants of concern in excess of the applied human health criteria. As such it generally presents a low risk.

Imported fill

The project requires about 680,500 cubic metres of imported material during construction. This imported soil has the potential to introduce new contaminant if not managed appropriately. The potential impact of imported contaminants includes degradation of existing soil, water and biodiversity.

The imported fill also introduces increased risk of erosion and sedimentation due to the large volumes of material transported, stockpiled and placed. Potential impacts of erosion of imported material include rain and wind erosion causing degradation of existing soils, water and biodiversity.

Other materials may be imported to the project to support the construction works. These materials may include beneficial reuse of surplus offsite materials.

Asbestos

Geotechnical investigations and site inspections have assessed the site for asbestos. While the project is generally within a greenfield setting and presents minimal risk of widespread asbestos contamination, isolated occurrences of asbestos have been identified within the construction footprint.

Asbestos is located within the construction footprint at AOPCR 3, AOPCR 10 and potentially where fill has been previously used at random areas within the construction footprint (see **Figure 6-1**). There is no mapped naturally occurring asbestos in the construction footprint.

Construction activities that have the risk of unearthing or disturbing asbestos within the construction footprint, which can include:

- Isolated fragments of fibre cement sheeting / fragments or fibrous material n surface soils potentially representing isolated disposal activities or surface water flow driven deposition

- Unknown infrastructure containing asbestos such as conduits, pipes, pits, informal underground structures, or similar.

Asbestos risks to the project include:

- Human health risks (to construction workers and the public) – inhalation of respirable fibres resulting in respiratory illness
- Waste management – the management of asbestos includes appropriate identification, isolation, testing, verification and of asbestos wastes. The potential impact of waste management includes the risk of further disturbance or distribution of asbestos wastes if not controlled appropriately.

Management measures for asbestos are presented in **Table 9-1**.

Demolition

One weatherboard residential structure within the construction footprint at Tarro would likely be demolished as part of construction works. Based on the suspected age of the dwelling (c1901), there is a possibility that there may be ACM associated with materials that the structures have been constructed with. About 75 metres south east of the house there is a mound of dumped rubbish comprising building rubble, for example bricks, cement sheeting, timber and iron. The pile measures about 50 metres long and 15 metres wide. The presence of cement sheeting material may indicate ACM waste.

Two residential structures of unknown building material located within the construction footprint at Tomago and Heatherbrae would also be demolished as part of construction works. Other non-residential structures such as farm sheds within the construction footprint may also be demolished.

Demolition of structures during construction may contribute to soil contamination or unlawful offsite disposal if materials are not managed appropriately. Structures containing hazardous building materials (where present) have the potential to contaminate surrounding environments during demolition via airborne dust and have the potential to impact on human health, soils and waterways. Hazardous building materials (where present) would be managed to reduce the potential for contamination and ensure appropriate handling and waste disposal. Hazardous building materials audits in accordance with the Australian Standard (AS2601-2001) carried out before the demolition of any structure or building would allow the project to appropriately manage any contamination arising from demolition.

7.1.4 Soil erosion due to construction

Activities which involve disturbing soils on existing slopes (as illustrated in **Figure 4-2** for areas from Beresfield to Tarro, Tomago and Heatherbrae and discussed in **Section 4.4**) have the highest potential to cause erosion during construction. Given the terrain of the construction footprint includes low elevation rolling hills to alluvial floodplains, and that soil disturbance is expected across the length of the construction footprint, soil erosion has a relatively low potential to occur.

Construction activities which may cause soils erosion include:

- Vegetation removal – Vegetation removal (during site establishment or construction) would disturb soils while exposing them to mobilisation or degradation processes, increasing the risk of erosion and sedimentation at steeper locations in Beresfield and Tomago, and also gentle slopes from Tomago to Heatherbrae
- Cut earthworks – Earthworks have the potential to destabilise a landform making it more susceptible to erosion
- Fill earthworks – Construction of fill areas has the potential to impact on soils and landform, as loose fill could be eroded. During rainfall events, sedimentation of downstream drainage lines through mass

movement of soils could occur. In windy conditions, wind erosion can occur, temporarily impacting on local air quality

- 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 substantial disturbance to riparian areas during construction. Temporary wharfs and sheet piling, staging and hard stand areas, materials management and other amenities are required and expose soils to potential erosion. Due to the location these works can present a higher risk during construction
- Adjustments of waterways and other instream works – Instream works include the temporary diversion of existing waterways and disturbance of aquatic soils and sediment. These are higher risk activities due to the higher potential for mobilisation of sediment within the dynamic setting and immediate presence of potentially sensitive receiving aquatic environment
- 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 – Site restoration during and after construction has the potential to mobilise sediment prior to establishing adequate stabilisation or controls. Mobilisation may be due to wind or rain and has the potential to negatively impact adjacent areas. The aeolian landscapes and resultant sandy soil types generally present on the eastern side of the Hunter River present an increased wind erosion due to unconsolidated character of the sandy soil. This higher potential for wind mobilisation has the potential to affect adjacent land uses and increase edge effects in adjacent native vegetation.

Due to the relatively low elevations present within the construction footprint, the high extent of existing vegetation cover and minimal excavation required, waterborne soil erosion is a comparatively low risk for the project. Soil erosion hazards are temporary during project construction, and with appropriate management as outlined in the Construction Soils and Water Management Plan, these erosion risks should not persist after construction.

7.1.5 Water contamination

Construction activities have the potential to contaminate surface water and groundwater. The potential for impacts to receiving environments would be dependent upon receiving environment sensitivity, as discussed in **Section 4.8**.

Surface water contamination

Construction would also be carried out in and around the Hunter River, Purgatory Creek and Windeyers Creek. Construction in these locations have the potential to contaminate surface water through the mobilisation and disturbance of sediments, and liberation of sulfuric acid in ASS. Acid drainage can have a high impact on receiving water bodies causing fish kills and mobilisation of some contaminants due to changes in water chemistry. Potential impacts of the project on surface water are assessed in detail in the Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS).

The drain leading to the Hunter River from AOPCR 5 contains known contamination in sediment and so needs to be managed in accordance with the RAP for that site.

Management measures are presented in **Table 9-1**.

Sediment in water bodies

The construction of bridges over the Hunter River and associated piling operations hold the potential to disturb sediments, which may lead to adverse environmental impacts. Sediment in water bodies and the impacts and environmental management measures are addressed in the Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS).

The viaduct and bridge (B05) construction methods are likely to include the mobilisation of a piling barge and support vessels, and the driving or screwing of piles to the appropriate depths within the bed sediments and concrete pouring of the piles. Piling and associated in-water activities hold the potential to disturb and mobilise bed sediments and impact on the receiving aquatic environment. Impacts may be associated with potentially contaminated sediments, an increase in water turbidity that may inhibit aquatic plant growth or impact on aquatic organisms, and dispersion of potential acid sulfate sediments that could allow oxidation and formation of acid.

To aid in bridge construction, temporary work, such as temporary rock platforms, temporary bridges and temporary wharves, would be installed in the Hunter River. Some piling activities may also be land based from the foreshore. Based on the likely construction methods, and consideration of typical controls that are associated with the construction methods, the potential contamination impacts associated with disturbance and mobilisation of suspended sediments could be effectively managed through a variety of management measures.

Smaller bridges over waterways or wetlands are less likely to impact the waterways they cross in the same way with standard bridge construction methods to be applied. There will remain a low risk of sediment mobilisation through these activities, but the risk will be reduced.

Bed sediments within the Hunter River collected at AOPCR5 (associated with the foreshore outlet from the former mineral sand processing site) has been tested and found to contain elevated concentrations of metals. Based on the historical heavy industrial land use along portions of the Hunter River, it is considered likely that some other localised areas of bed sediments may be impacted with industrial runoff and wastewater.

Groundwater

Key sources of data used in the assessment of existing groundwater quality in this assessment were obtained from the Bureau of Meteorology's (BOM) (2020) Australian Groundwater Explorer, Hunter Water Corporation and the project's groundwater monitoring bore network. A comprehensive groundwater assessment for the project, including groundwater modelling and assessment of groundwater flow and quantity, is presented in the Hydrology and Flooding Working Paper (Appendix J of the EIS).

Potential groundwater quality impacts arising from the project are expected to be localised to the area of predicted drawdown, mounding, spillage or existing contamination. As such, compounding or cumulative water quality impacts with other proposed projects or developments are not anticipated.

Groundwater within the construction footprint is present at shallow depths (refer to **Section 4.8**) and would be encountered during excavation activities, including sediment basin construction, utility works, drainage works, soft soil treatment and piling works. Project impacts on groundwater quality are assessed in detail in the Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS). The majority of the construction footprint overlies groundwater sources that have a primary use and value for ecological purposes. The exception is the area overlying the Tomago Sandbeds that is used for drinking water storage and extraction.

Groundwater associated with the former mineral sands processing facility area poses a risk of potential contamination impact if not appropriately managed, due to metals in processed mineral sands at the surface.

Previous geotechnical investigations included a comprehensive assessment of groundwater quality across the project footprint to gather data to support the construction design. As part of the geotechnical assessment program, some groundwater bores were also sampled and analysed for potential contaminants of concern. Findings from the groundwater monitoring bores which have been installed for the project are contained in the Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS), including comprehensive laboratory chemistry results. Generally, groundwater quality compliance with recommended ANZG (2018) thresholds for aquatic ecosystems is considered to be poor ((estuarine/marine) to very poor (lowland river).

Based on the historical data gathered across the construction footprint, there is potential for groundwater contamination to be present in the vicinity of the project within the areas discussed in the following sections.

Former mineral sands processing facility area at Tomago (within the construction footprint) (AOPCR 5)

A series of groundwater sampling, analysis and reporting projects have been carried out across the former mineral sand processing site over the past decade. Comprehensive data has been collected and interrogated in relation to a representative selection of contaminants of concern for the site, including dissolved heavy metals, polycyclic aromatic hydrocarbons (PAHs), phenols, polychlorinated biphenyls (PCBs), hydrocarbons and radionuclides.

The outcome of previous groundwater assessment programs consistently determined that dissolved heavy metals have impacted groundwater reserves at concentrations exceeding the applied human health and environmental protection criteria across the majority of groundwater monitoring locations across the site. Analytical results for all other potential contaminants of concern were either not detected or detected at concentrations that would not be considered to pose an ongoing risk to the environment.

Construction activities that interact with groundwater on the former mineral sand processing site would be appropriately managed so that metals impacted groundwater is not reused off site or is not allowed to impact on receiving waterways (refer to the Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS) which includes a dewatering and water reuse strategy).

General industrial areas in Hexham, Tomago and Heatherbrae (within and next to the construction footprint) (AOPCR 11, AOPCR 13 and AOPCR 15)

A wide variety of heavy industrial operations have historically and currently been carried out across these industrial/commercial zoned areas. Operations and activities that could use industrial chemicals and solvents, fuel storage and usage, pesticides and herbicides to control pests, metals in manufacturing or treatments, the production and storage of hazard wastes, acids, chemicals and a wide variety of other potentially contaminating substances may hold the potential to have impacted on the receiving groundwater reserves in these areas. Further site-specific groundwater quality data is required at locations in these areas where interaction with groundwater is anticipated.

Service station at Heatherbrae and Beresfield (next the construction footprint) (AOPCR 1 and AOPCR 12)

Groundwater contamination resulting from the operation of service stations is not uncommon for older, mis-managed assets. Hydrocarbon contamination can be associated with leaking fuel tanks, fuel bowsers and pipework, or with spills and other associated events. Further site-specific groundwater quality data is required at locations in these areas where interaction with groundwater is anticipated.

Wastewater treatment and disposal site at Raymond Terrace and PFAS contamination outside the construction footprint (AOPCR 14 and AOPCR 18)

Wastewater treatment and disposal sites can impact on groundwater due to leaks and spills of a variety of substances either used in the treatment process or resulting for waste products, including nutrients, metals, phenols and pathogens. Further site-specific groundwater quality data is required at locations in these areas where interaction with groundwater is anticipated to inform construction management.

Other potential contamination sources, that were identified in this assessment, were considered toto have a low potential to interact with the project, based on the distance of the potential source to the construction footprint (such as railway sites at Hexham and Tarro).

Potential groundwater interaction with PFAS contamination associated with the Our Lady of Lourdes Primary School at Tarro, and PFAS in groundwater at Heatherbrae Total Fire Solutions, Heatherbrae, is considered to be a medium risk, due to the mobility characteristics associated with PFAS and its persistence in the environment. 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).

7.2 Operational impacts

7.2.1 Acid sulfate soil and acid rock

During operation of the project, local 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 would not be expected or required as part of project operation.

Some detention 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.

Acid rock is not expected to be exposed during the operation of the project.

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

7.2.2 Soil salinity

Saline soils are known to occur within the construction footprint at Black Hill, Tarro, Tomago, Heatherbrae and Raymond Terrace. Saline soils present a risk to downstream waterways if they are exposed, erode or leach high concentrations of salt into runoff. Saline soils can alter the salinity of the waterways which can alter instream biodiversity and ecosystem function. However, the risk of this occurring as a result of operation of the project is considered low as the construction footprint of the project would be stabilised, rehabilitated and revegetated before operation in accordance with the project urban design (refer to the Urban Design, Landscape Character and Visual Amenity Working Paper (Appendix O of the EIS)). Revegetation of soil disturbance areas after construction would minimise salinity risks to surrounding environments and land uses during operation.

Shallow, saline groundwater may require infrastructure maintenance earlier than normal in the asset lifecycle, caused by impacts to concrete and steel structures. Road and bridge damage caused by shallow, saline groundwater is a potential operational risk, due to 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.

7.2.3 Soil contamination

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. Known areas of contamination in soils include the former mineral sand processing facility and identified illegal waste occurrences at Tarro.

The former mineral sands processing facility will be remediated to an agreed standard in accordance with an Independent Contaminated Land Auditor approval by a NSW EPA accredited site auditor. . The remediation objective will be to render the safe such that it does not pose an unacceptable risk to human health and the environment and will be subject to a Site Audit Report and a Site Audit Statement to that effect.

All contaminated waste that is encountered during construction activities will be appropriately classified and managed in accordance with NSW EPA guidance documents and requirements.

Spills of contaminating materials from the project's motorway could potentially contaminate soil near roads associated with the project and adjacent areas outside the project. Transport would implement spill containment controls and spill response procedures during operation of the project.

7.2.4 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.

Minor earthworks are required during landscaping and site restoration activities that could result in the erosion of disturbed soils that have not yet stabilised, with potential for sediment to be transported downstream by wind or runoff. Impacts associated with landscaping and site restoration would be temporary as stabilisation and revegetation would act to prevent future soil erosion.

Furthermore, the Black Hill cut would be stepped back, with low slopes, allowing the application of vegetation-supporting topsoil to the slopes which will aid in decreasing water velocities. While sediment-laden runoff and pollutants from erosion and sedimentation have the potential to temporarily reduce downstream water quality, they are unlikely to cause major or long term impacts to the overall condition of the surrounding waterways, as erosion and sedimentation will be managed with the implementation of erosion and sediment controls (as detailed in the Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS)). Further to this, additional environmental management measures would be implemented during operation of the project, roads and bridges, with these areas generally sealed, landscaped, and scour protection installed where required. Exposed topsoil during operation would be minimal or none, and therefore there would be little risk of soil erosion and subsequent transport of sediment into nearby receiving waterways.

7.2.5 Water contamination

Impacts to surface and groundwater from the project during operation are addressed in the Surface Water and Groundwater Working Paper (refer to Appendix K in the EIS). Specific operational impacts relating to soils and contamination impacts are detailed below.

Surface water

Water quality risks during operation would be associated with runoff of pollutants from new road surfaces, accidental spills, increased impervious areas and permanent structures within waterways. These risks are expected to be managed by operational water quality measures as discussed in the Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS). Transport will implement spill containment controls and spill response procedures during operation of the project.

Groundwater

Operational water quality basins that intersect with the groundwater table during operation of the project have the potential to expose local groundwater to any contaminants in the basin water. These contaminants are most likely introduced through spills and runoff. Spills on road networks are typically associated with hydrocarbons associated with fuels and oils.

Basins have been designed to account for potential spills and to prevent accidental offsite discharge. An underflow baffle arrangement is present in basins to capture accidental spills such as petroleum hydrocarbons as well as during small to moderate storm events. From a groundwater quality perspective, hydrocarbon spills would float on the surface of the basins where they are able to be actively removed during emergency clean-up operations or passively dispersed to atmosphere by volatilisation. This containment and removal would 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 is expected to be negligible and removed during network maintenance. Spill containment and management measures have been proposed so that adverse impacts are minimised as far as possible (refer to **Table 9-1**).

Tomago Sandbeds drinking water catchment

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 L). 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. Further information is provided in the Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS).

8. Cumulative impacts

Cumulative soils and contamination impacts may arise from the interaction of construction and operation activities of the project and other approved or proposed projects in the area. When considered in isolation, specific project impacts may be considered minor. These minor impacts may be more substantial, however, when the impact of multiple projects on the same receivers is considered.

The projects detailed in **Table 8-1** are in varying stages of delivery and planning. This chapter provides an assessment of cumulative soils and contamination impacts based on the most current and publicly available information for these projects. In many instances this is a high-level qualitative assessment.

The contribution of the project, to cumulative impacts on soils and contamination in the area, would be minor, considering the project has been located next to existing road infrastructure where possible, with construction managed through the implementation of a range of environmental management measures.

Table 8-1 Assessment of potential cumulative impacts for relevant identified projects

Project (approval status)	Relevance in consideration of cumulative impacts	Potential cumulative impacts
Kinross Industrial / Weathertex, Heatherbrae (Approved)	Located within the project's construction footprint at Heatherbrae	Excavation and ground disturbing activities for both the project and the Kinross Industrial development construction have the potential to result in a greater risk of contaminants entering Windeyers Creek, particularly if ASS are disturbed. If the Kinross development and the project are carried out concurrently, there is an increased risk of the generation of dust associated with excavations in the area.
Newcastle Power Station (In planning)	Located within the project's construction footprint at Tomago near Old Punt Road.	AGL propose to construct a 250 Mega Watt (MW) gas fired power station at Tomago, with gas pipelines and electricity transmission lines. Construction of the power station is due to commence in 2021 with the power station expected to be operational in 2022. The site for the proposed power station is located between the Pacific Highway and Old Punt Road, north of the Tomago industrial area (AGL, 2019). The power station would be located next to ancillary facilities AS12 and AS13. The project has considered the power station in development of the Tomago interchange.
Hexham Straight (In planning)	• Located about one kilometre south of the project at Hexham • Potential to be consecutive (back to back) construction and concurrent (simultaneous) operation.	The Hexham Straight project is located along the Pacific Highway (Maitland Road) at Hexham, between Sandgate and Hexham Bridge, south of the construction footprint. The proposed scope of the Hexham Straight project involves the addition of an extra lane in both directions of the Pacific Highway, removal of the existing bridges and construction of two new bridges at Ironbark Creek, adjustments to connecting roads and substantial utility relocations. Although Hexham Straight does not overlap with the project, there is potential for soils (including contaminated soil and ASS) to be hauled along roads also used for project construction. If the project and Hexham occur concurrently, there is increased risk of generation of dust associated with haulage.

Project (approval status)	Relevance in consideration of cumulative impacts	Potential cumulative impacts
Lower Hunter Freight Corridor (In planning)	• Investigation area includes Hexham.	The Lower Hunter Freight Corridor is a planned future rail infrastructure development which will enable a dedicated freight rail line between Fassifern and Hexham; bypassing Newcastle while improving regional and interstate links. The Lower Hunter Freight Corridor is currently under preliminary investigation. The investigation area includes Hexham in the south east of the project and the M1 Pacific Motorway and Lenaghans Drive in the south west of the project. As corridor options and environmental assessment are not available for the Lower Hunter Freight Corridor, the level of impact on soils and contamination generated by this project is currently unknown. Consequently, cumulative impacts associated with the construction or operation of the project is unknown.
Hunter Gas Pipeline (Approved)	• Intersects the project at Tomago	The Hunter Gas Pipeline is a critical infrastructure project, approved in 2009, which crosses the main alignment at Tomago, within the construction footprint. The development involves construction of an underground gas pipeline from the Wallumbilla Gas Supply Hub near Roma, Queensland to connect to the NSW gas transmission network in Newcastle. This project is planned to cross under the Pacific Highway at Tomago within the construction footprint. Potential impacts from waste disposal requirements associated with this project may impact on the ability of local waste receival facilities to accommodate waste from the project, depending on volumes and waste classifications.

9. Environmental management measures

The management measures provided in **Table 9-1** have been developed to specifically manage potential impacts which have been predicted as a result of the project. These management measures should be incorporated into relevant Environmental Management Plans (EMPs) during construction and operation.

The environmental management measures should be read in conjunction with those outlined in the Surface Water and Groundwater Quality Working Paper (Appendix K of the EIS). With the implementation of these recommended management measures, it is expected that the construction and operational impacts of the project are manageable and residual impacts would be minimal.

Table 9-1 Environmental management measures

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 (RMS 2013) will be developed and implemented for the project as part of the CEMP. The CLMP 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 2005) 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

Impact	Reference	Management measure	Responsibility	Timing
Contaminated land disturbance – Former mineral sands processing facility	SC04	A Remediation Action Plan prepared and implemented in accordance with TfNSW Guideline for the Management of Contamination (RMS 2013), 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

10. Conclusion

Based on the soils and contamination assessment, potential impacts associated with the ongoing operation of the project are low, with the highest potential for impacts during construction.

Five high risk AOPCR were identified within the project construction footprint including asbestos waste at Tarro and Tomago, the former mineral sands processing facility at Tomago, potentially impacted Hunter River Sediments and at locations where construction works may interact with ASS (including within sediments). Six medium AOPCR were identified including buried waste at Tomago and Heatherbrae, industrial and commercial operations at Tomago and Heatherbrae (including PFAS contamination), including at Raymond Terrace Wastewater Treatment Works, at the Weathertex site in Heatherbrae, along the banks of the Hunter River where herbicide has historically been applied and illegally dumped waste at various locations within the construction footprint.

The AOPCR are areas that are considered to have potential risks to construction and operation of the project associated with soil, sediment and groundwater. These risks may be present as a result of historical and/or current activities carried out on land within or next to the project construction footprint, or where the weight of evidence and professional judgement applied from existing data for soils and broader contamination issues indicated a potential exposure risk to humans and/or the environment.

The remediation of the former mineral sands processing facility would occur as part of the project under the requirements of the *Contamination Land Management Act 1997*.

In order to manage the potential soils and contamination impacts within the identified AOPCR, a number of avoidance, management and mitigation measures have been recommended for incorporation into the relevant Environmental Management Plans prior to construction and operation. These include measures for:

- ASS treatment and disturbance
- Erosion and sedimentation control
- Saline soil management
- Management of areas with known soil contamination (i.e. former mineral sands processing facility)
- Asbestos and construction waste management.

Where the proposed mitigation and management measures are implemented, and the proposed remediation of the former mineral sands processing facility is conducted, the overall risk of soils and contamination impacts both to and from the project is low.

Based on the results within this assessment and following the implementation of the management measures detailed above, the assessment carried out for the project relating to soils and contamination has satisfactorily addressed the SEARs, and the performance outcomes are capable of ensuring that the project would have a low impact on soils and contamination.

11. References

AECOM, 2017. Auditor's Interim Opinion of the Detailed Site Investigation Report, RZM Site, Tomago, NSW, 11 May 2017.

ASSMAC, 1998. Acid Sulfate Soil Manual, Acid Sulfate Soil Management Advisor Committee, August 1998

Management of Naturally Occurring Radioactive Material (NORM) Radiation Protection Series Publication No. 15, (Australian Radiation Protection and Nuclear Safety Agency (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).

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).

BMT WBM, 2017. Flood Assessment 251 Adelaide St, Raymond terrace. BMT WBM Pty Ltd. 28 March 2017.

BOM, 2020. Australian Government Bureau of Meteorology. Australian Groundwater Explorer http://www.bom.gov.au/water/groundwater/explorer/map.shtml. June 2020.

Coffey, 2011. Environmental Assessment – Newcastle Gas Storage Facility Project. Volume 3 Appendices 5-7. May 2011.

DPIE, 2014. Department of Primary Industries (2014) Salinity Training Handbook, Department of Planning, Industry and Environment, 2014.

DPIE, 2020. Department of Planning, Industry and Environment. Hunter catchment details: https://www.industry.nsw.gov.au/water/basins-catchments/snapshots/hunter. June 2020.

Douglas Partners, 2012. Preliminary Contamination Assessment, Proposed Train Support Facility, Woodlands Close, Hexham - Douglas Partners, 2012.

Douglas Partners, 2015. Preliminary Site Investigation – Contamination and Acid Sulfate Soil Assessment. Proposed M1 Extension to Raymond Terrace (M12RT) Black Hill to Raymond Terrace. May 2015.

Douglas Partners, 2017, Geotechnical Investigation Factual Report, M1 Pacific Motorway extension to Raymond Terrace, Black Hill to Raymond Terrace. October 2017

Douglas Partners, 2020, Geotechnical Concept Investigation Interpretive Report M1 Extension to Raymond Terrace [M12RT] Variation Pacific Motorway, Hexham-Raymond Terrace – Embankments on Soft Soils

HazMat Services, 2011. Hazmat Services Pty Ltd, Hazardous Materials Survey and Register – Former RZM site, 1877 Pacific Highway, Tomago, February 2011.

HazMat Services, 2016. RMS Land Off Lenaghans Drive, Black Hill – Hazmat Services, 2016.

HazMat Services, 2020. Hazmat Services Pty Ltd Asbestos Inspection and Risk Assessment report, Property No. 54, Lot 51 DP739336, Tomago NSW, 16 June 2020.

Hunter Water, 2020. Tomago Sandbed. https://www.hunterwater.com.au/our-water/water-supply/dams-and-catchments/tomago-sandbeds. June, 2020.

Jacobs, 2014. Jacobs Group Australia Pty Ltd (Jacobs – formerly SKM), Preliminary Biodiversity Investigation: Former RZM site, Tomago, NSW, May 2014.

Jacobs, 2015. Jacobs Group (Australia) Pty Ltd (Jacobs), Targeted Pre-demolition Survey for Amphibians and Microbats, January 2015.

Jacobs, 2016. Former RZM Site: Detailed Site Investigation, Jacobs, September 2016.

Jacobs, 2017. Waste Classification Assessment Report and Interpretation of Radioactivity in Soil Samples (Area 1 and Area 2 – south of Lot 101 Boundary), 2017.

Jacobs, 2018. NORM Impacted Soils Model – Estimated Volumes and Distributions, Jacobs 2017.

Jacobs, 2019. Sampling, Analysis and Quality Plan, (IA198300_Rev3, 27 May 2019.

Jacobs, 2019. Summary Analytical Results for Metals Samples – Former RZM DSI Recommendations Project, Jacobs 2019.

Jacobs, 2020. M1 Pacific Motorway extension to Raymond Terrace - Concept Design and Environmental Assessment Updated 80% Concept Design – Construction, Jacobs June 2020.

Jacobs, 2021. Lot 101, DP1038663 Former RZM Site - Interim Site Management Plan

Lotsearch, 2020. Lotsearch Environ Professional, 17 June 2020.

Landcom, 2004. Managing Urban Stormwater: Soils and Construction, Landcom 2004.

National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013), National Environmental Protection Council.

Newcastle Coalfield Regional Geology, Sheet 9321, NSW Department of Mineral Resources.

NSW Government, 2011. Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources, NSW Government 2011.

OEH, 2013. Office of Environment and Heritage (2013) Hunter Catchment Salinity Assessment Final Report. Prepared by OEH for the NSW Environment Protection Authority.

Queensland Government, 2014. Background and Demolition & DSI Planning Radiological Survey, Tomago, NSW, Queensland Government, Health Services Support Agency (HSSA), February 2014

Queensland Government, 2014a. Environmental Radioactivity Assessment: Vegetation Buffer between Pacific Highway and former RZM site, Tomago, NSW, Queensland Government, Health Services Support Agency (HSSA), April 2014.

Roads and Maritime, 2015. Stockpile Site Management Guideline, Roads and Maritime Service, 2015.

Roy, P.S. Hudson, J.P., & Boyd, R.L., in Sloan, S.W. & Allman, M.A., 1995, Engineering geology of the Newcastle-Gosford Region pp64 – 84.

Rutile Zircon Mines Pty Ltd, 2002. Tomago Separation Plant Site: Post Decommissioning Report, March 2002.

SGS, 2015. DECC Site Health Physics Support Demolition Works, 1877 Pacific Hwy, Tomago, SGS Australian Radiation Services, July 2015.

Sinclair Knight Merz, 2013. Building Materials Dust Characterisation Report: Former RZM site, Tomago, NSW, July 2013.

Sinclair Knight Merz 2013a. Preliminary Site Investigation (PSI): Former RZM site, Tomago, NSW, July 2013.

WaterNSW, 2020. State Overview – Groundwater Source Type. https://realtimedata.waternsw.com.au/. June 2020.

Woolley D, Mount T and Gill J (1995) Tomago Tomaree Stockton Groundwater Technical Review.

Terms and acronyms

Term/Acronym	Description
ACM	Asbestos Containing Material
AHD	Australian Height Datum
AMP	Asbestos Management Plan
AOPCR	Areas of Potential Contamination Risk
ASRIS	Australian Soil Resource Information System
ASS	Acid sulfate soil
ASSMP	Acid Sulfate Soils Management Plan
bgl	below ground level
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CLM	*Contaminated Land Management Act 1997*
CLMP	Contaminated Land Management Plan
DPIE	Department of Planning, Industry and Environment
DSI	Detailed Site Investigations
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW). Provides the legislative framework for land use planning and development assessment in NSW
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process
EMP	Environmental Management Plans
EPL	Environmental Protection License
HHRA and ERA	Human Health and Ecological Risk Assessment
ISMP	Interim Site Management Plan
LGA	Local Government Area
m	metre
mg/L	milligrams per litre
NORM	Naturally occurring radioactive material
NSW	New South Wales
OEH	Former Office of Environment and Heritage
PCA	Preliminary Contamination Assessment
PCBs	Polychlorinated biphenyl
POEO	*Protection of the Environment Operations Act 1997*

Term/Acronym	Description
PSI	Preliminary Site Investigation
RAP	Remediation Action Plan
RL	Relative level
RZM	Rutile, Zircon and Monazite
SAQP	Sampling, Analysis and Quality Plan
SEARs	Secretary Environmental Assessment Requirements
SSI	State Significant Infrastructure
TSF	Train Support Facility
μS/cm	Micro siemens per centimetre
XRF	X-ray fluorescence

Appendix A Historical summary

Date of aerial photography	Site	Surrounding areas
1954	Vegetation clearing for agricultural purposes is evident near Tarro and surrounding the Hunter River, with a small number of buildings on agricultural properties evident. The remainder of the construction footprint is vegetated, except for a number of roadways that intersect the project.	• Residential properties near Tarro are evident, north of the construction footprint. The Tarro Memorial Park is evident to the north of the project. • The Hunter Water pipeline alignment is evident running north-south to the west of the Hunter River. • Industrial style buildings are present next to the railway in Hexham, however further details are unclear from the photograph. • A large cluster of industrial style buildings is present north of AS16 in Heatherbrae and to the north west of the alignment near the corner of Masonite Road and the Pacific Highway. • The areas near Tarro and Heatherbrae are largely cleared and appear to be agricultural and rural residential use. • The remainder of the surrounding area is vegetated.
1966	Loading facilities are evident on the Hunter River in Hexham connecting to the railway. A small number of buildings are present near the former mineral sands processing facility. Some large industrial sheds are evident east of the Hunter River near the present day Tomago Road, potentially associated with poultry farming.	• The township of Tarro has been built up since the previous photograph. An area inferred to be the former sanitary depot is evident next to the construction footprint in this area. • Residential properties are clustered in the vicinity of Heatherbrae. • An inferred timber works is present at Heatherbrae north west of the alignment near the corner of Masonite Road and the Pacific Highway.
1976	The main loading facilities between the Hunter River and railway in Hexham are no longer present. Some small buildings remain. The former mineral sands processing facility appears to have several ponds and industrial style buildings, as well as a connection to the Hunter River. A loading facility and wharves are being built on the eastern side of the Hunter River in Hexham.	• Access roads and several buildings are present west of the southern extent of the construction footprint, potentially associated with the Black Hill Coal Mine site. • Additional development near Tomago has occurred including a racetrack, caravan park and industrial buildings. Gradual build-up of commercial/industrial as well as residential areas in Raymond Terrace and Heatherbrae are also evident. • Excavation of a sand quarry north of the project in Heatherbrae has commenced.
1984	No substantial change from the previous photograph.	• Increased activity is evident to the west of the southern extent of the construction footprint. A high voltage transmission line intersects the southern extent of the footprint in this vicinity. • The Raymond Terrace Wastewater Treatment Works has been built near the northern extent of the project. • Continued gradual development of commercial/industrial as well as residential areas in Raymond Terrace and Heatherbrae is evident. • The second bridge across the Hunter River at Hexham is in construction. • Excavation of the sand quarry near Heatherbrae has

Date of aerial photography	Site	Surrounding areas
		extended.
1993	Ponds and buildings at the former mineral sands processing facility are clearer, as well as an access route to the river. Ground disturbance, potentially filling, is evident at Green Acres Farm south of the New England Highway at Tarro. No other substantial changes from the previous photograph.	• A facility with several stockpiles is present to the north of the alignment in Beresford on John Renshaw Drive. • Several houses east of the Pacific Motorway at the southern extent of the alignment are present. • Continued gradual development of commercial/industrial as well as residential areas in Raymond Terrace and Heatherbrae is evident.
2001	No substantial changes from previous photograph.	• The service station in Beresford on John Renshaw Drive has been developed. • Four small rectangular dams (inferred for water treatment) have been constructed adjacent to the timber treatment works in Heatherbrae. • Additional tanks/buildings are present at the Raymond Terrace Wastewater Treatment Works.
2007/2010	The former mineral sands processing facility appears to be disused, with former ponds being covered with vegetation. The area near Tomago has been built up further with industrial style buildings. A horse track is present east of the Hunter River near Heatherbrae.	• Industrial subdivisions are present north of John Renshaw Drive in Beresford
2014/2015	Vegetation clearing and scarring is evident at AS16 (Weathertex site).	• Increased industrial buildings are present north of John Renshaw Drive in Beresford and along the Pacific Highway in Heatherbrae.
2019/Current	Stockpiling and excavation is evident at AS16 (Weathertex site)	• No substantial changes from previous photograph.

Appendix B Results from Douglas Partners 2015 Report

Source	Location	Potential for contamination	Inferred risk of contamination
Industrial / commercial site activities	Hexham, Tomago and Heatherbrae	Potential impact to soil and groundwater from filling, site activities, effluent irrigation, machinery and vehicle use/storage etc.	Medium
Rural Properties	Majority of alignment	Potential for hydrocarbon, heavy metal, pesticide impacts to soil and groundwater from machinery/equipment use/servicing, potential fuel/chemical storage / use etc.	Low to Medium
Possible Pesticide/Herbicide Use	Majority of alignment and potentially creeks / waterways including former / current cropping areas, along service easements, railways, roads etc.	Potential for heavy metal, hydrocarbon and pesticide impact to surface soils and sediments within waterways from use of pesticides for weed management.	Low
Indiscriminate dumping	Possible along service easements, tracks and roads	Likely to be localised and may contain a range of potential contaminants including hazardous building materials (i.e. asbestos, lead based paints, CCA treated timbers) and other contaminants depending on the source / material type	Medium to High (likely localised)
Effluent Disposal	Most rural and commercial properties along alignment (i.e. unsewered)	Potential soil and groundwater impacts including heavy metals, nutrients, microbiological, hydrocarbons etc.	Low (generally localised)
Industrial Wastewater disposal	Brancourts (Hexham), RZM (Tomago), Weathertex (Tomago)	Potential soil, groundwater and surface water impacts from treatment/irrigation/discharge of wastewater. Potential contaminants would depend on waste type however may include nutrients, microbiological, heavy metals, hydrocarbons, radioactive sediments (RZM), acidic/basic conditions etc.	Low to Medium
Former Buildings/ Infrastructure	Black Hill / Hexham (rural properties), Hexham (overhead conveyor and associated buildings, jetties, houses, commercial buildings)	Potential for impact to upper soils from demolition of buildings with hazardous materials (i.e. asbestos, lead, PCB etc.).	Medium (localised)

Source	Location	Potential for contamination	Inferred risk of contamination
Railway lines (former/current)	Hexham (Main Northern Railway) and current / former sidings	Potential soil and groundwater contamination from filling and pesticide application (as above) and also from hydrocarbons, heavy metals, PCBs, phenols, asbestos etc. from operations.	Medium (localised)
Asbestos impacted fill	1 Woodland Close	Asbestos impacted fill which may be capped and may contain other contaminants depending on source.	Medium
RZM Separation Plant	Pacific Hwy Tomago	Potential soil and groundwater impact from site activities including industrial wastewater, demolition of former buildings (as above), potential radiation impact (mineral sands processing), potential chemical contamination from other site activities.	Low
Shell Service Station	Heatherbrae	Hydrocarbon and heavy metal impact to soils and groundwater from fuel storage activities and associated infrastructure (USTs, fuel lines, bowsers).	Low to Medium (likely downgradient)
Hunter Water Pipeline	Beresfield (north of alignment), Hexham (crosses alignment)	Potential acid generation and mobilisation of contaminants from previous disturbance (i.e. drainage, excavations, dewatering, services, cropping etc.) or proposed disturbance (i.e. footings, service trenches, dewatering, bulk excavation etc.).	Medium
Saline/Sodic Soils	Along alignment, however, generally within creeks and low-lying areas	Not a contamination issue directly. Potential saline and/or sodic soils which could affect proposed infrastructure (i.e. concrete, steel, pavements etc.). Proposed alignment could exacerbate conditions depending on alterations / impacts to hydrogeology.	Low to Medium