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NSW GOVERNMENT

M1 Pacific Motorway extension to Raymond Terrace

Environmental impact statement – Chapter 16: Soils and contamination

Transport for NSW | July 2021

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Contents

List of figures

List of tables

16. Soils and contamination

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

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

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

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

Table 16-1 SEARs (soils and contamination)

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

16.1 Policy and planning setting

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

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

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

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

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

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

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

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

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

16.2 Assessment methodology

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

The methodology for the soils and contamination assessment included:

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

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

16.2.1 Desktop assessment

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

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

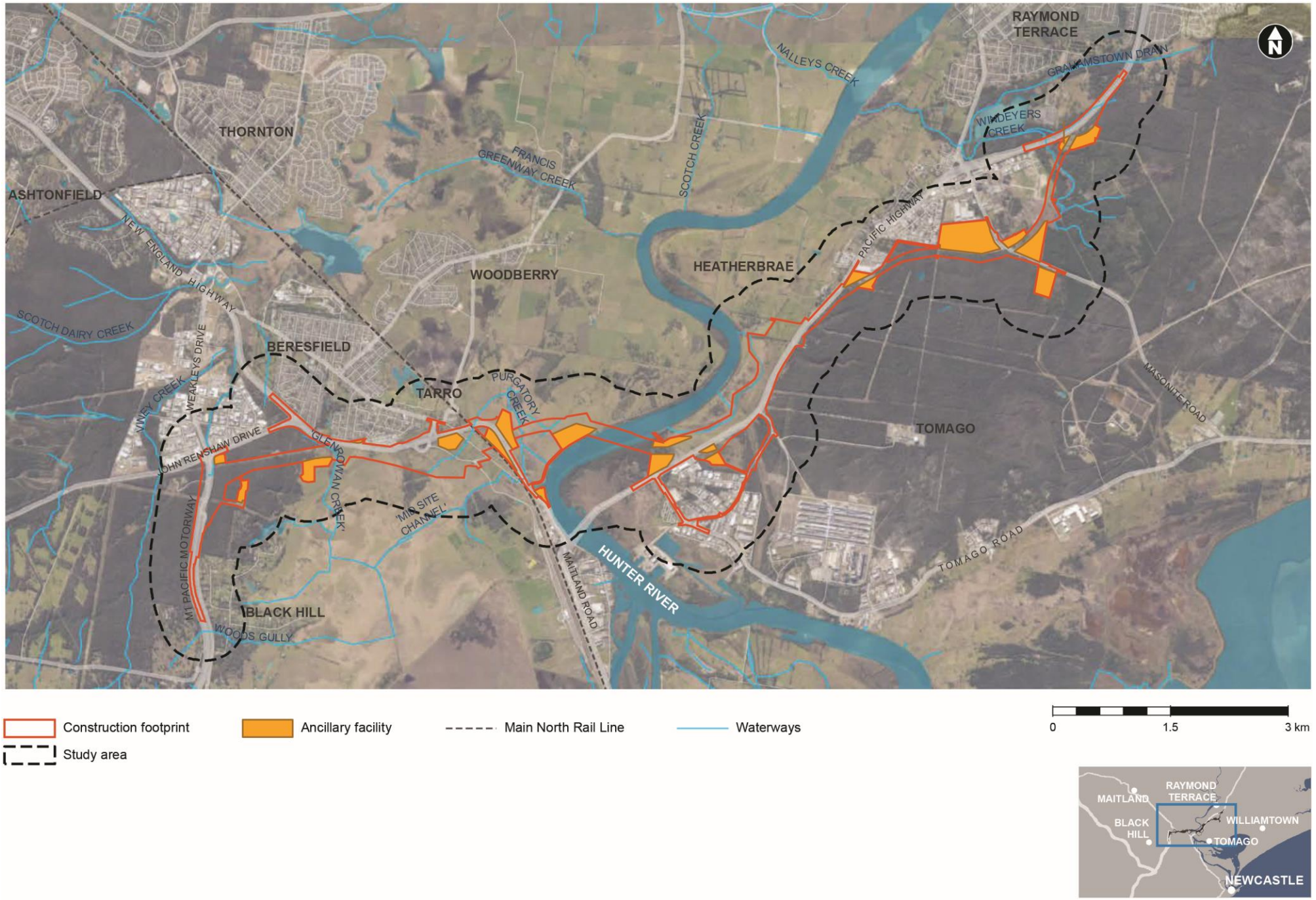

Figure 16-1 Soils and contamination study area

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16.2.2 Site inspections

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

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

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

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

16.2.3 Identification of areas of potential contamination risk

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

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

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

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

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

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

16.3 Existing environment

16.3.1 Topography, geology and soil landscapes

Topography

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

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

Geology

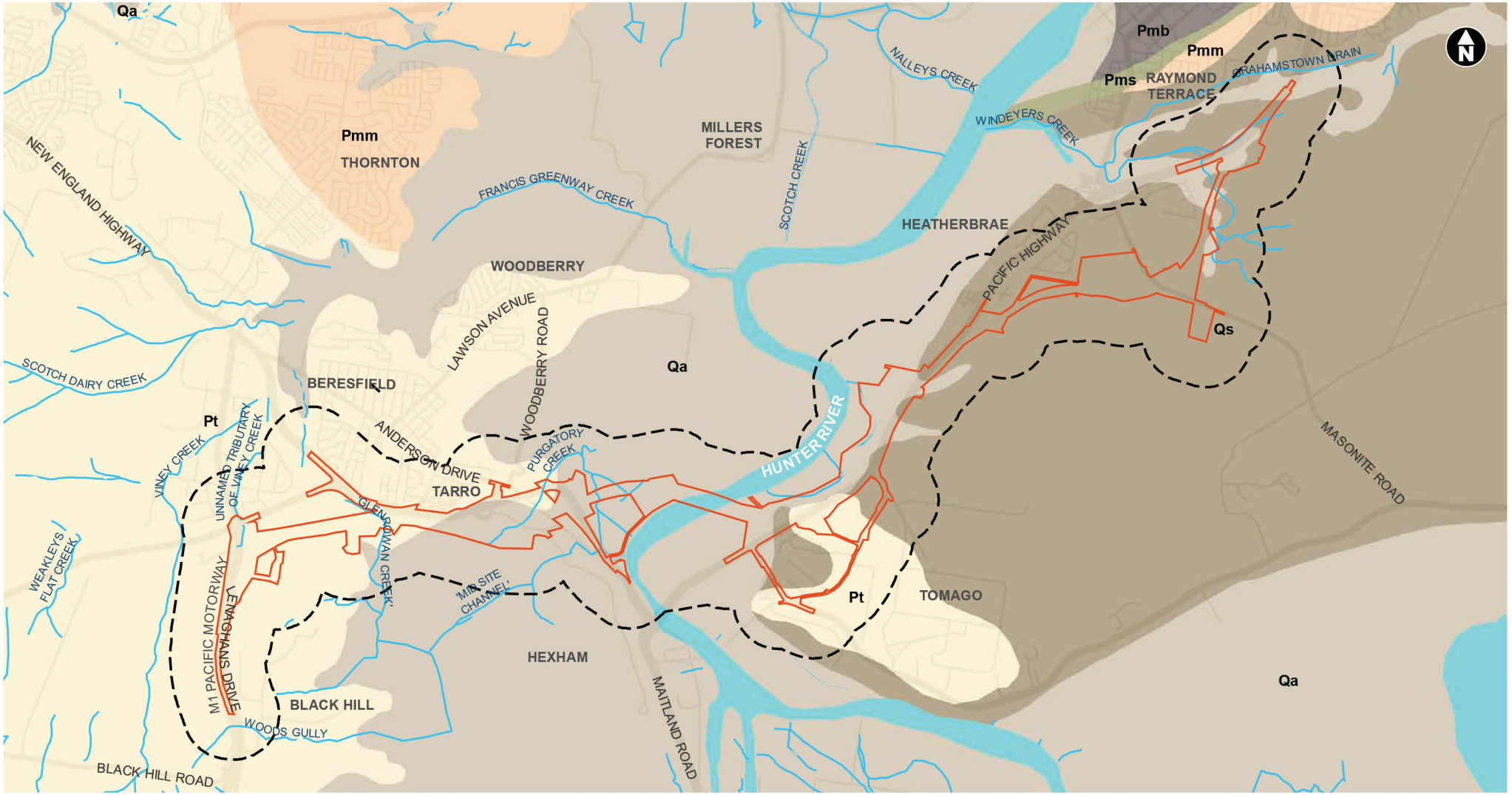
Based on a review of the Newcastle Coalfield Regional 1:100,000 scale Geology Map (Hawley, Glen and Baker 1995), the geology applicable to the project is characterised as follows (refer to **Figure 16-2**):

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

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

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

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



Construction footprint

Study area

Waterways

Water bodies

Geology

Pmb – Permian Maitland Group - Branxton Formation - Undifferentiated

Pmm – Permian Maitland Group - Mulbring Siltstone

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

Pt - Permian Tomago Coal

Qa - Quaternary Alluvium

Qs - Quaternary Coastal Sand

Data source: DIRE 2016

0 1 2 km

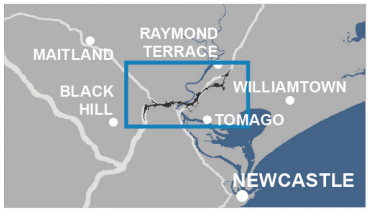


Figure 16-2 Geology

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Soil landscapes

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

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

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

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

Soft soils

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

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

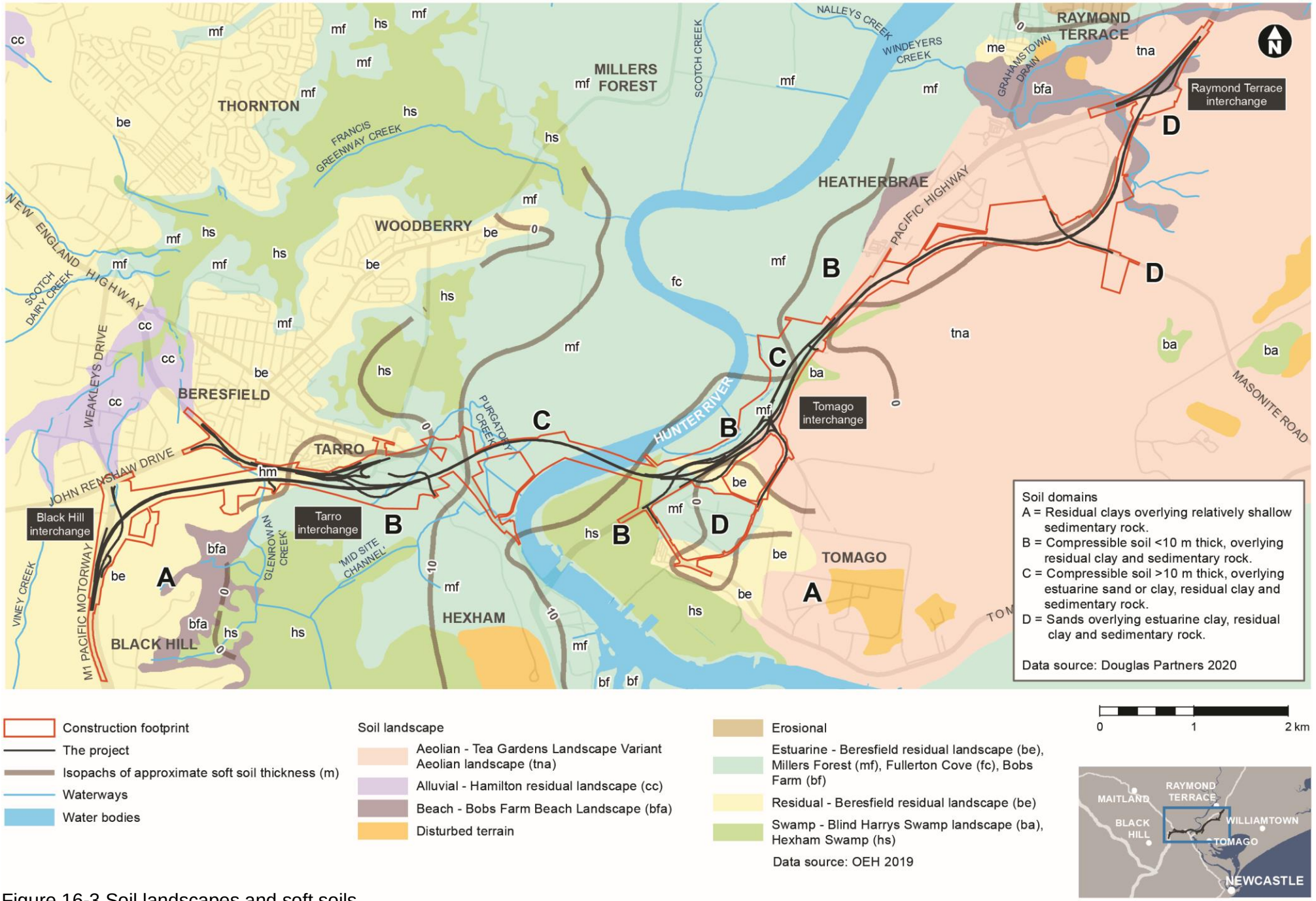


Figure 16-3 Soil landscapes and soft soils

Sodic soil

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

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

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

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

16.3.2 Acid sulfate soils and acid rock

Acid sulfate soils

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

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

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

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

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

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

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

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

Acid rock

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

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

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

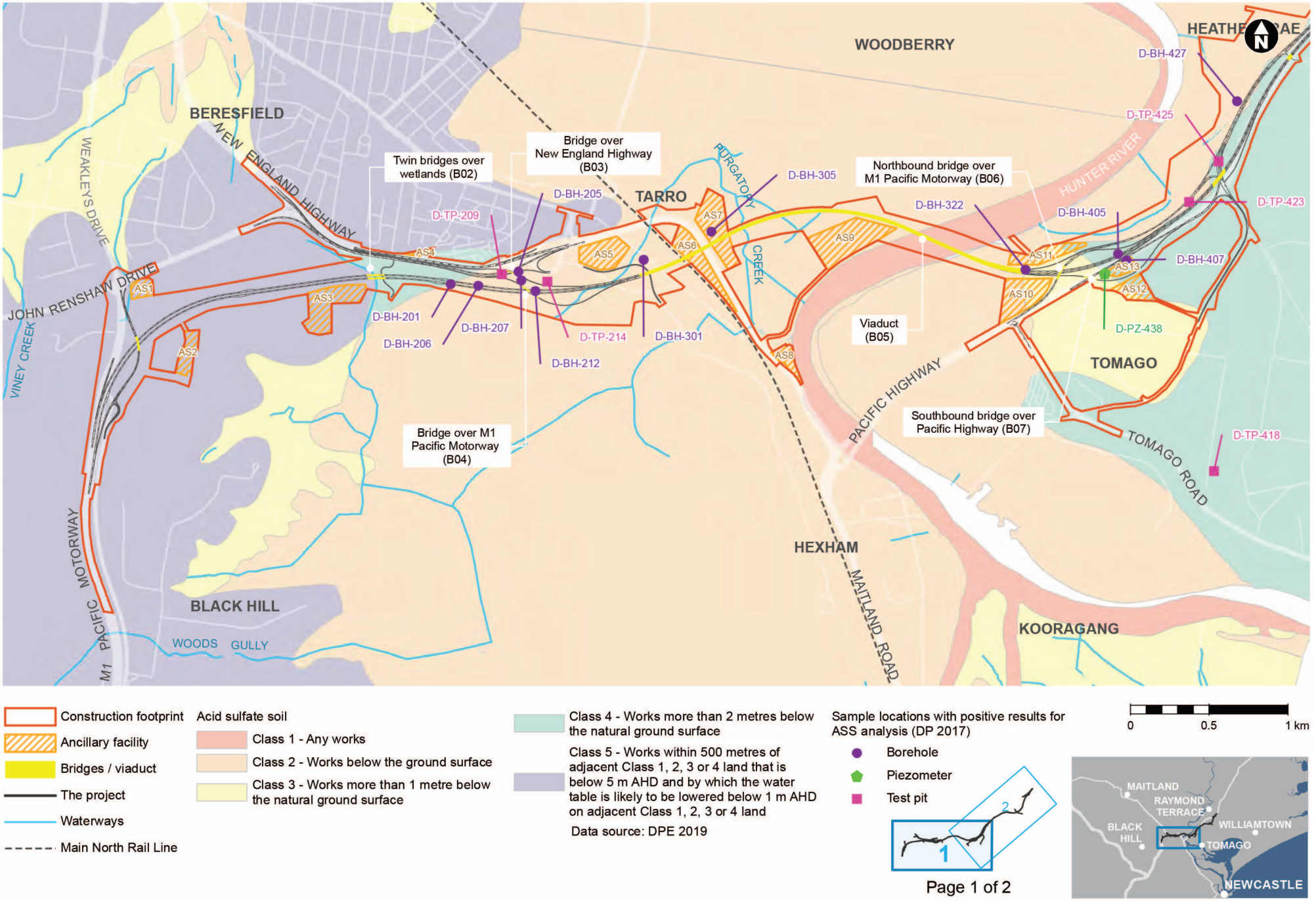
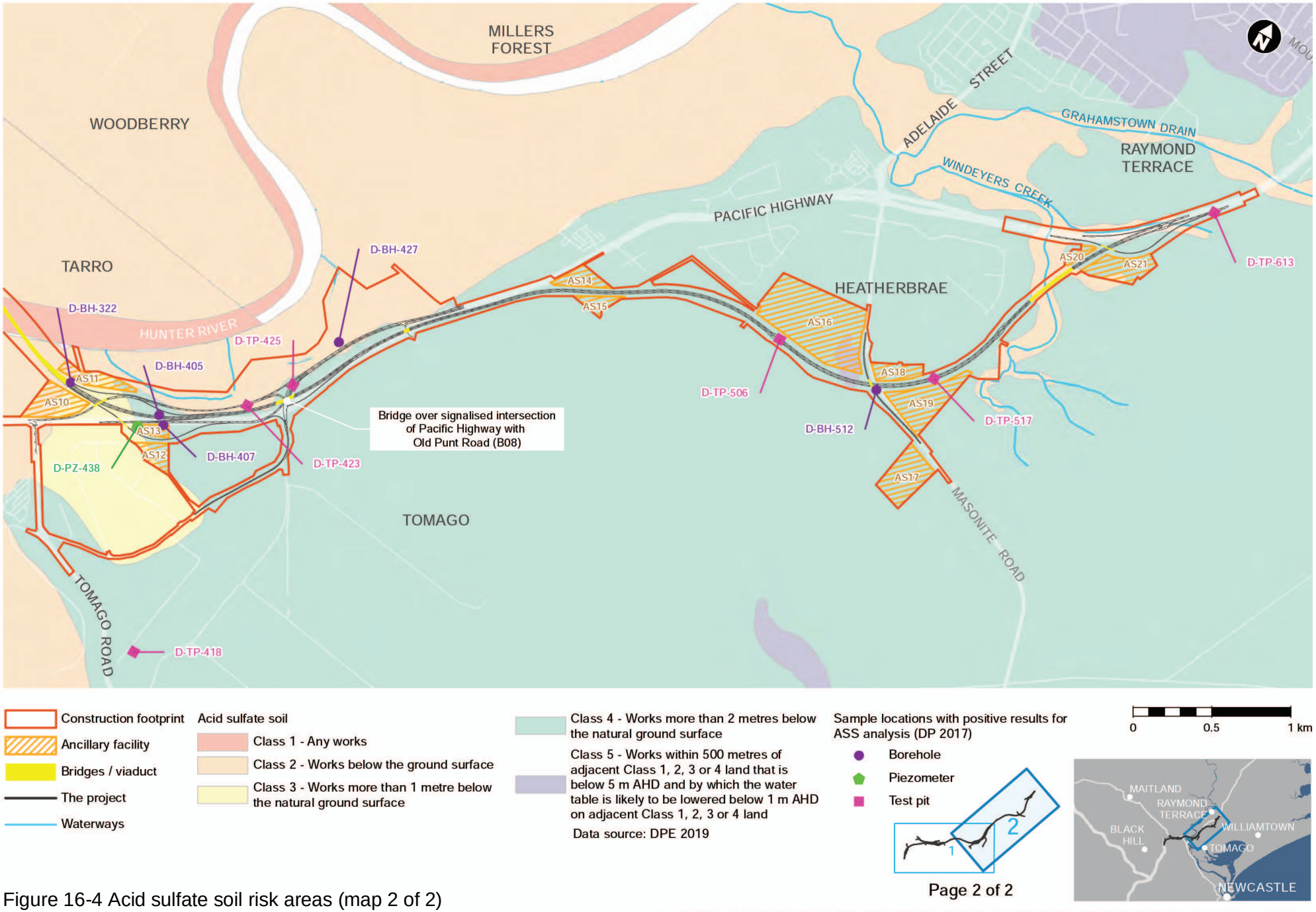


Figure 16-4 Acid sulfate soil risk areas (map 1 of 2)



Page 2 of 2

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

16.3.3 Contamination

Historic land use

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

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

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

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

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

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

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

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

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

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

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

Results of register searches

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

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

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

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

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

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

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

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

Previous contamination investigations

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

Table 16-7 Findings of previous contamination investigations

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

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

16.3.4 Soil salinity

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

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

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

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

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

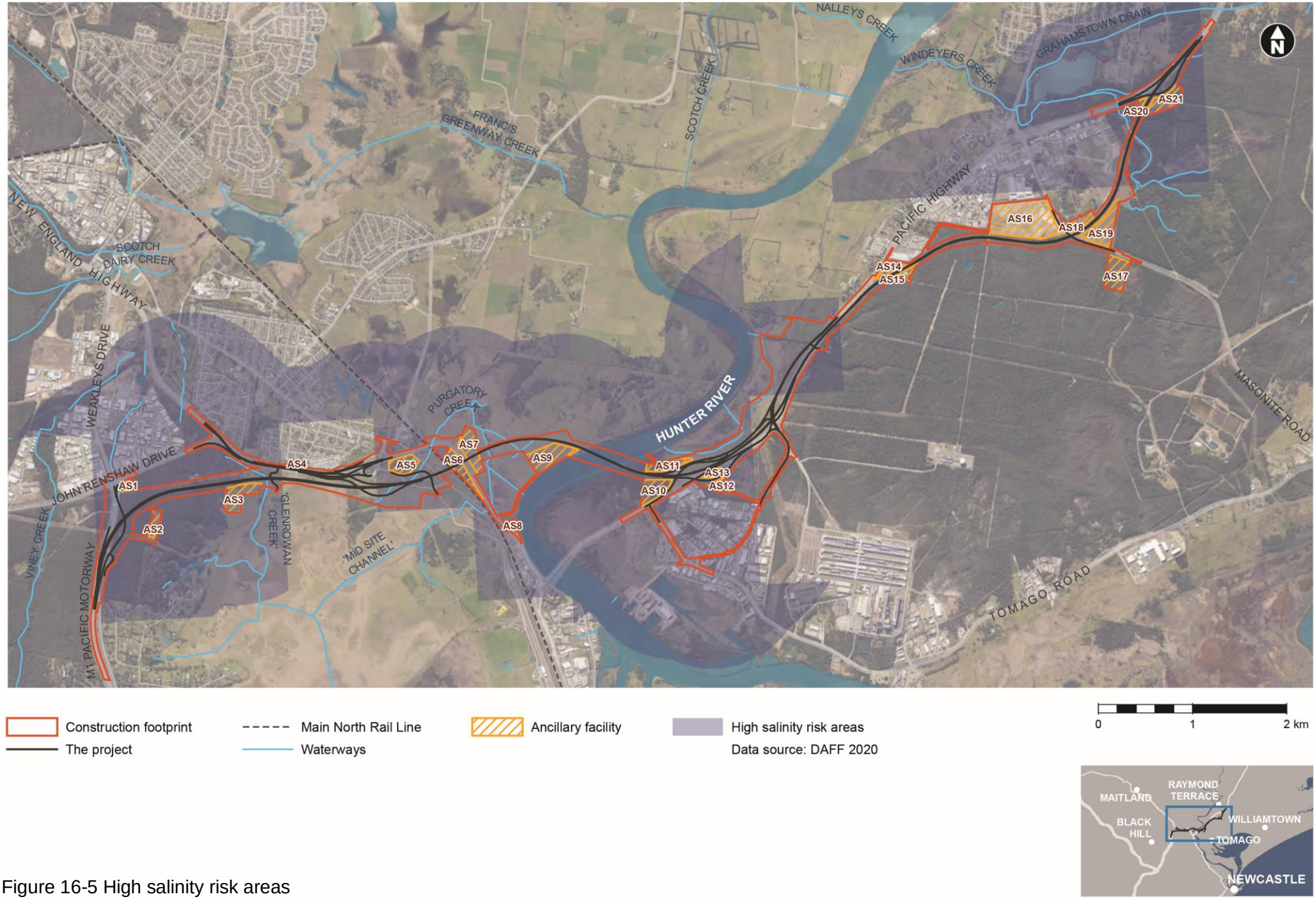


Figure 16-5 High salinity risk areas

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16.3.5 Sensitive receiving environments

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

Table 16-8 Sensitive receiving environments in the study area

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

16.3.6 Areas of potential contamination risk

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

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

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

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

Table 16-9 Areas of potential contamination risk

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

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

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

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

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

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

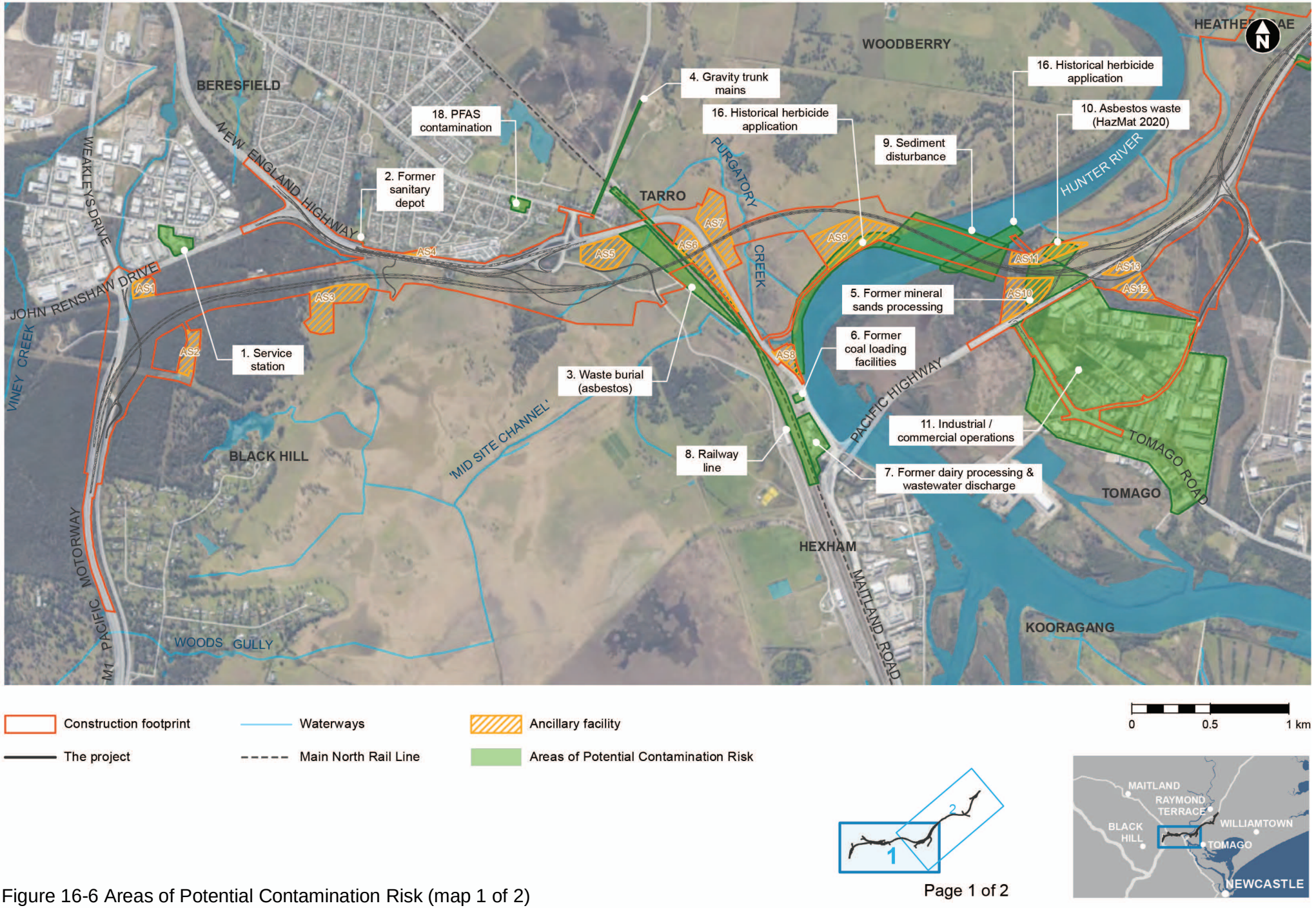
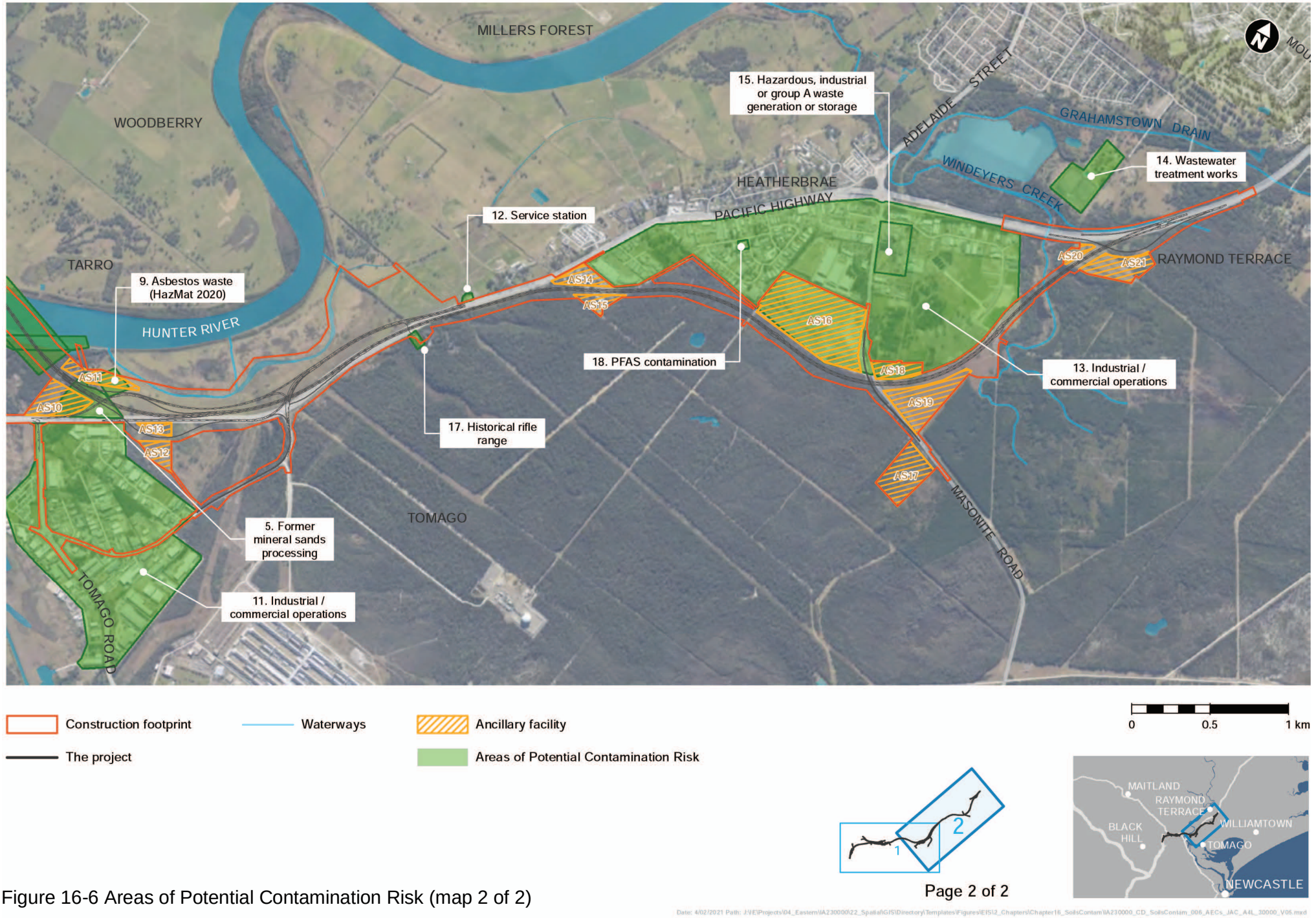


Figure 16-6 Areas of Potential Contamination Risk (map 1 of 2)

Page 1 of 2



Page 2 of 2

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

16.4 Assessment of potential impacts

16.4.1 Construction impacts

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

Topography and geology

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

Soil erosion

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

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

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

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

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

Acid sulfate soil and acid rock

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

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

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

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

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

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

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

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

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

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

Soil contamination

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

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

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

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

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

Soil salinity

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

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

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

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

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

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

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

Water contamination

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

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

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

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

16.4.2 Operational impacts

Topography and geology

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

Soil erosion

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

Acid sulfate soil and acid rock

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

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

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

Soil contamination

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

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

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

Salinity

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

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

Water contamination

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

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

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

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

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

16.5 Environmental management measures

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

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

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

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

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