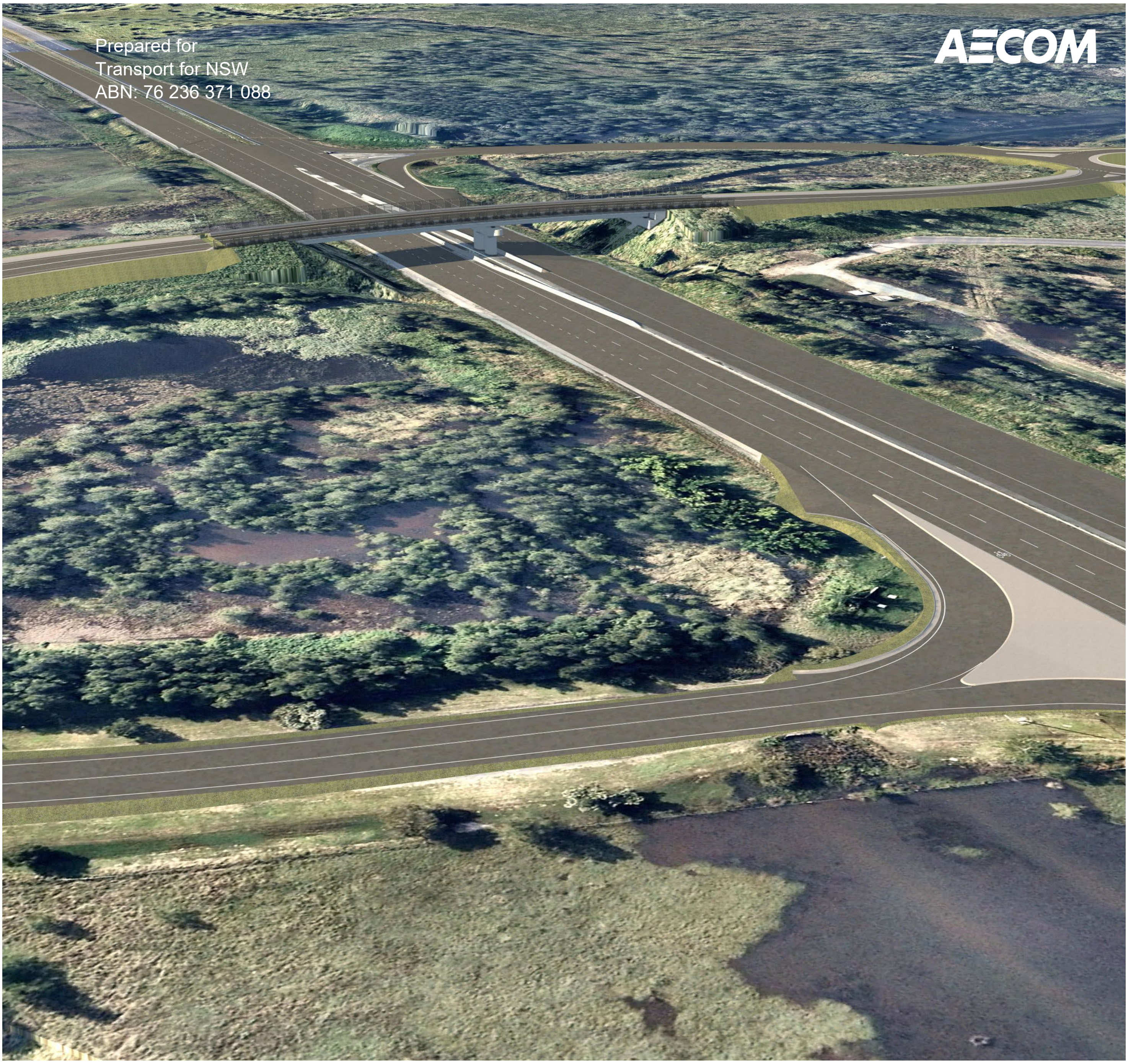

Surface and Groundwater Assessment

HW10 Pacific Highway / Harrington Road Interchange Upgrade

06-Sep-2023
HW10 Pacific Highway / Harrington Road Interchange Upgrade
Doc No. 60684355_REP_EV_017
Commercial-in-Confidence

Surface and Groundwater Assessment

HW10 Pacific Highway / Harrington Road Interchange Upgrade

Client: Transport for NSW

ABN: 76 236 371 088

Prepared by

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Quality Information

Document Surface and Groundwater Assessment

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Prepared by Heather Mylan and Neil Standen

Reviewed by Amanda Kerr

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D	29-Aug-2023	Final	Dan Wyse Project Manager	
E	06-Sep-2023	Final	Dan Wyse Project Manager	

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Acronyms/Glossary

Term	Description
AECOM	AECOM Australia Pty Ltd
ACM	asbestos containing material
AEP	annual exceedance probability
AHD	Australian Height Datum
ANZG	Australian and New Zealand guidelines for fresh and marine water quality guidelines
ARI	average recurrence interval
ASL	above sea level
ASRIS	Australian Soil Resource Information System
ASS	acid sulfate soils
BoM	Bureau of Meteorology
BTEXN	benzene, toluene, ethylbenzene, xylenes and naphthalene
CEMP	construction environmental management plan
CLM Act	Contaminated Land Management Act 1997
Council	MidCoast Council
CoPC	contaminants of potential concern
DGV	default guideline value
DO	dissolved oxygen
EC	electrical conductivity
EIS	environmental impact statement
EPA	Environment Protection Authority
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
GDE	groundwater dependant ecosystems
LEP	Local Environmental Plan. A type of planning instrument made under Part 3 of the EP&A Act.
LGA	Local Government Area
Mbgl	metres below ground level
NLTN	National Land Transport Network
NWQMS	National Water Quality Management Strategy
OCP	organochlorine pesticides
OPP	organophosphorus pesticides
PAH	polycyclic aromatic hydrocarbons
PASS	potential acid sulfate soils

Term	Description
PMF	probable maximum flood
PSI	preliminary site investigation
REF	review of environmental factors
RTA	Roads and Transport Authority
TDS	total dissolved solids
TN	total nitrogen
TP	total phosphorus
TfNSW	Transport for New South Wales
TRH	total recoverable hydrocarbons
TSS	total suspended solids
WSUD	water-sensitive urban design

Executive Summary

Transport for NSW (Transport) proposes to upgrade the intersection of Harrington Road, Coopernook Road, and the Pacific Highway (HW10),12 km north of Cundletown and Taree. The proposed upgrade would improve the safety of the road network and the reliability of the Pacific Highway by reducing the occurrence of crash-related delays.

This technical paper assesses the potential surface and groundwater impacts of the proposal. It has been prepared to support the Review of Environmental Factors (REF) addressing the construction and operational impacts of the proposal.

Surface water and flooding

Construction activities associated with the proposal may represent a risk to local receiving waters, including the Coopernook Creek, Lansdowne River, and Manning River. These risks relate to sediment, chemicals stored on-site, and construction waste, which have the potential to mobilise and enter waterways during runoff events or flood conditions.

Increases in sediment load within surface water can also occur during construction activities from activities including clearing and grubbing, stockpiling of materials, civil earthworks, temporary works (i.e., access roads, compounds, laydown areas, and pads), construction of bridge piers abutments, and the placement of fill for embankments.

Erosion control and sediment management mitigation measures, nominated as part of the assessment, are intended to reduce the risk of sediment-impacted discharge water and that posed by potential acid-sulfate soils (PASS). The proposed measures include localised treatments such as temporary erosion controls, sediment capture, and separation of on-site and off-site water.

A potential impact on surface water quality during the operation of the proposal includes pollutants and contaminants from the road surface being conveyed in runoff to receiving waters. The design and construction of permanent erosion and sediment control management measures will mitigate this risk.

An assessment of the regional flooding conditions compared the changes in flood conditions for various return periods between existing conditions and the proposed design. The evaluation concluded that the proposal will not likely result in significant adverse changes to the current flood regime of the locality. The proposal would be designed to maintain existing stormwater flow paths and provide appropriately sized drainage structures where required.

Potential impacts associated with flooding could occur due to construction activities and ancillary facilities in flood-affected zones. Impacts include changes in flood behaviour and risk to construction plant, equipment, and personnel. However, flood behaviour of the study area is well understood, with adequate advance flood warning likely to be available to remove staff and equipment and protect the work prior to inundation. Mitigation measures include the controlled management of stormwater and drainage patterns within the construction footprint, stockpiles located outside the floodplain and drainage lines, implementation of flooding evacuation and response protocols, and maintaining access for all workers, residents and livestock.

Groundwater

While there is a low potential for interaction with groundwater during operation, there may be some potential interaction with groundwater during the construction of bridge piles which can result in localised changes in groundwater levels and properties. The removal of highly permeable aquifer material during pile construction will not likely result in a marked alteration of the overall aquifer hydraulic properties. The potential impact of construction activities is limited based on the non-continuous nature of the piles and the large aquifer zone. To minimise exposure, the pile holes can be installed by advancing steel casing into the ground as they are drilled.

There is no likely reduction in aquifer recharge due to most of the construction footprint being located on existing disturbed or built road areas. Earthworks cuts in the topography have the potential to intercept groundwater, given the anticipated depth of groundwater within the study area, resulting in a moderate potential for interaction during construction.

Potential sources of chemical contamination are from leaching of spills into groundwater and disturbed acid sulfate soils. Impacts could potentially occur from fuel and oils used by construction plant and

equipment, concrete curing compounds, waste, fertilisers, herbicides and pesticides (used in site landscaping), paint and paint wastes, acid from acid-based washes and the disturbance of acid sulfate soils.

Spill occurrences would be contained and cleaned up as part of routine construction activities. The potential for impacts to groundwater from surface spills is considered low with the implementation of management measures and safeguards.

There is a ‘high potential for groundwater dependent ecosystems’ (GDE) located in connectivity with Coopernook Creek, Lansdowne River and Manning River, which may receive runoff, both directly and indirectly, from the proposal. These environments are considered sensitive receiving environments, where there is potential for environmental harm in the event of an incident. However, these potential impacts would be mitigated by implementing appropriate environmental management measures, including erosion and sediment control measures and spill management retention facilities.

1.0 Introduction

1.1 Context and background

The Pacific Highway (A1/M1) is a 960-kilometre-long route along the central east coast of New South Wales between the Warringah Freeway in North Sydney and the Queensland state border. It is the primary north-south transport corridor that connects two major Australian cities, being Sydney and Brisbane. The Pacific Highway forms the East Coast National Land Transport Network (NLTN) road transport link and is a nationally significant infrastructure link. Along the corridor the highway provides connection to several major regional cities including Newcastle, Port Macquarie, Coffs Harbour, Tweed Heads and many rapidly growing coastal communities.

Over a period of 30 years, the Australian and New South Wales Government have progressively completed duplication of the Pacific Highway between Hexham and the Queensland border. Following completion of the highway's duplication in 2020, for various reasons and particularly in the southern end of the corridor, some intersections remain at-grade.

During 1997, the Coopernook Bypass project planned for approximately 4.5 km of dual carriageway highway bypassing the village of Coopernook with a new bridge over the Lansdowne River. The project considered the option for grade-separation of the then proposed Pacific Highway intersection with Harrington Road. However, the assessment concluded, that although grade-separation would provide increased safety benefits, an at-grade solution was sufficient for the 2026 design year.

In 2002, the Pacific Highway Coopernook Bypass project commenced construction of the highway deviation. The scope of works included implementation of the current at-grade "staggered-T" intersection arrangement, as shown in Figure 1-1. In 2004, the project was delayed for treatment and settlement of soft soils. Later, in 2005 the project scope was amended to address the need for a future grade-separated interchange. As such, a strategic design was prepared, and initial pre-loading was undertaken to accommodate the approaches to a grade-separated overpass. A second stage of pre-loading was placed during 2012.

Figure 1-1: Pacific Highway (A1) intersection with Harrington and Coopernook Road - current at-grade 'Staggered-T' intersection arrangement (Nearmap, 2012)

In 2016, Transport for NSW (Transport) Regional Planning prepared the draft Pacific Highway Post Duplication Strategy. The strategy includes a thorough investigation of the highway's current performance and future challenges to meet the agreed corridor vision. A key issue identified within this document was for safety at the remaining at-grade intersections along the length of the highway. Urban development has since continued along the coast, with the Pacific Highway remaining the primary access for interstate and inter-regional traffic for Harrington and Coopernook. Therefore, with increased traffic volumes it is proving more difficult for traffic to enter and exit the highway at this particular location.

The intersections of Harrington and Coopernook Road with the Pacific Highway provide a local connection between the communities of Harrington and Coopernook. Harrington is a coastal centre and popular tourist destination located 22 km north-east of Taree at the northern entrance of the Manning River. Coopernook is a small village township located 17 km north of Taree and 9 km west of Harrington. The two intersections currently operate as staggered at-grade intersections, separated by the highway. Consequently, a contributing factor for the sites high-severity crash history has been attributed to the need for local traffic to complete a weaving manoeuvre across the high-speed high-volume Pacific Highway. There have been ten crashes at this intersection between October 2016 and August 2022, including one fatality recorded in 2021.

Transport is now progressing planning for upgrade of the Harrington and Coopernook Road intersections with the Pacific Highway. Introduction of the grade-separated crossing is a critical element to enable a step-change improvement in safety at the interchange and enhanced connectivity for the townships of Harrington and Coopernook. Respectively, there is strong community advocacy for the proposed grade-separated upgrade and a recently announced Federal Government funding commitment of $48M towards the project, with a further $12M commitment by the State.

Transport has engaged AECOM to complete the Concept Design, REF, Detailed Design, Final Business Case and Economic Appraisal for the Harrington Road Interchange Project. This project involves developing the design for the grade-separated interchange at the junction between the Pacific Highway and roads connecting to Harrington and Coopernook. The solution will seek to provide a safe, constructable design that addresses the safety issues inherent in the existing layout, whilst minimising environmental impacts and improving the lives of the local community.

1.2 Proposal area

The proposal area includes the intersections of Harrington and Coopernook Road with the Pacific Highway, as shown in Figure 1-2. The proposal area is located approximately 12 km north of the Princes Street, Cundletown and Taree interchange.

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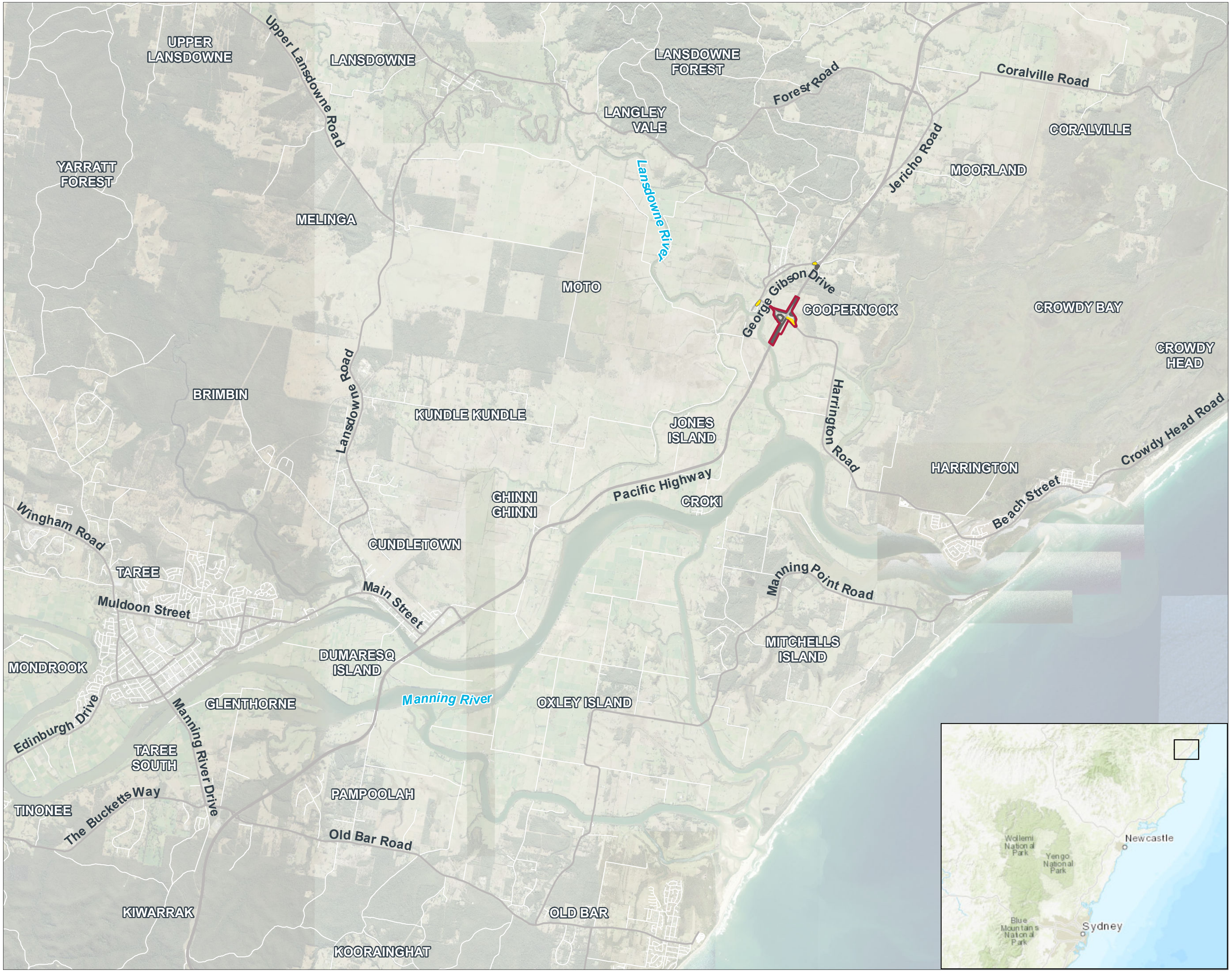
FIGURE 1-2:

REGIONAL CONTEXT



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Legend

- Proposal area
- Construction footprint
- Ancillary facilities*

Ancillary facilities are subject to change during the final design refinements.

As defined in Figure 1-3, the proposal area includes the ancillary sites, acceleration/deceleration lanes along the Pacific Highway, the proposed overpass and intersections with Harrington and Coopernook Road.

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N

0 100 200 m

FIGURE 1-3: PROPOSAL AREA EXTENT

Legend

Proposal area

Construction footprint

Ancillary facilities

Road design

Ancillary facilities are subject to change during the final design refinements.

The two intersections are located within an approximate 12 km section of a 100 km/h speed zone, being the only section not signposted at 110 km between Taree and Port Macquarie.

1.3 Study area

A study area has been defined to assess the surrounding areas of the proposal area and potential ancillary facilities. A 500 m buffer around the proposal and ancillary facilities was adopted. This is shown in Figure 1-4.

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0 100 200 m

FIGURE 1-4:

STUDY AREA

Legend

- Study area
- Proposal area
- Construction
- Ancillary facilities
- Road design
- Watercourse
- Drainage line

Ancillary facilities are subject to change during the final design refinements.

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1.4 Project objectives

The future transport outcomes and strategic directions for the project were developed through an Investment Logic Mapping exercise. The outcomes from this exercise include:

- Connecting our customers' whole lives
- Our transport networks are safe
- Successful places for communities
- Transport infrastructure makes a tangible improvement to places
- Enabling economic activity
- The transport network enables strong, sustainable economies in NSW.

1.5 Purpose of this report

The Surface and Groundwater Assessment aims to identify potential impacts on regional water resources during the project's construction and operational phases and recommend mitigatory measures to limit the effects identified.

1.6 Background documents

The reference documents, including previous investigations, relevant studies, inputs, and consultations that informed this report, include:

- Preferred option memo, Transport (19/07/2022)
- HW10 Pacific Highway Interchange Upgrade at Harrington – design departures for heavy vehicle merge speed and confirmation of bridge clearance standards, Transport (05/06/2022)
- Coopernook Interchange Planning Advice, WolfPeak (02/12/2021)
- Pacific Highway Bypass of Coopernook Environmental Impact Statement, Connell Wagner (1997)
- Geotechnical, Acid Sulphate and Contamination Investigation for Proposed Route Coopernook Bypass, Robert Carr and Associates (1997)
- Biodiversity Assessment Report, WolfPeak, (2022)
- Geotechnical Investigation Factual Report (Draft), Douglas Partners (2022).

1.7 Legislative context

The following NSW legislation and statutory requirements apply to the surface and groundwater assessment:

- Protection of the Environment Operations Act 1997 (POEO Act)
- Protection of the Environment Administration Act 1991
- Local Government Act 1993
- NSW Fisheries Management Act 1994
- Water Management Act 2000 and the Water Management (General) Regulation 2011
- NSW Aquifer Interference Policy 2012
- National Environment Protection (Assessment of Site Contamination) Measure 2013
- State Environmental Planning Policy (Resilience and Hazards) 2021.

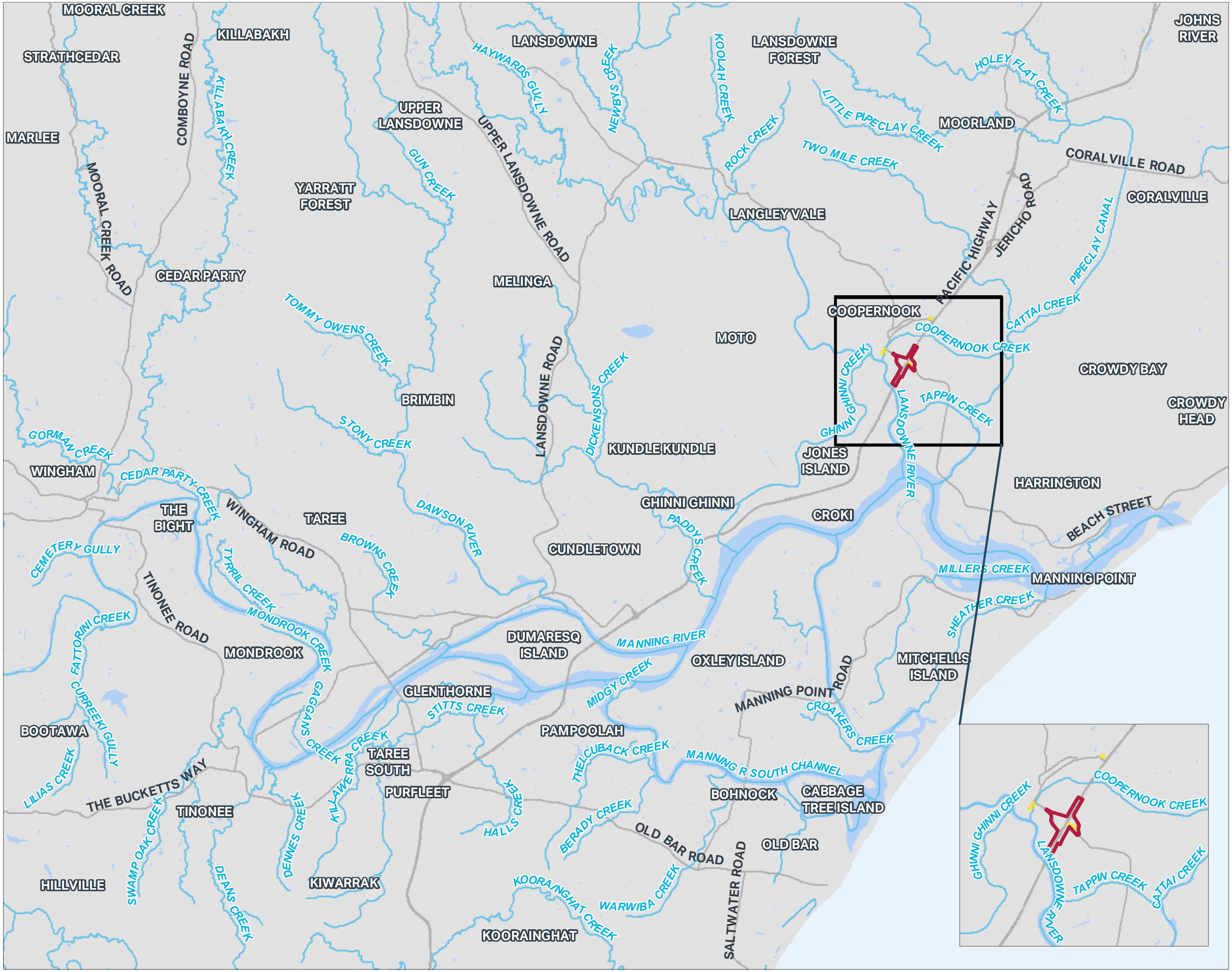

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FIGURE 1-5:

MANNING RIVER ESTUARY MAP DEMONSTRATING ESTUARINE WATERS INCLUDING THE LANSDOWNE RIVER AND COOPERNOOK CREEK

Legend

- Proposal area
- Ancillary facilities
- Manning River Estuary

Ancillary facilities are subject to change during the final design refinements.

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1.7.1 Water sharing plans

Water Sharing Plans are legal instruments developed under the *Water Management Act 2000* to manage water sources associated with rivers and groundwater across New South Wales. These plans protect the health of our rivers and groundwater while also providing water users with perpetual access licences, equitable conditions, and increased opportunities to trade water through the separation of land and water.

The Manning River flows for 250 km, rising in the Great Dividing Range to the west of the basin and flowing southeast through a coastal floodplain to Taree, where it splits in two. The southern arm meets the Pacific Ocean at Old Bar, and the northern arm is joined by the Dawson and Lansdowne Rivers, meeting the ocean at Harrington. The Manning River and estuaries, including the Lansdowne River and Coopernook Creek, are managed following the ‘Water Sharing Plan for the Lower North Coast Unregulated and Alluvial Water Sources’ (2022). The following water sources under the plan are relevant to the study area:

- Manning Estuary Tributaries Water Source
- Lower North Coast Coastal Floodplain Alluvial Groundwater Source.

Section 56 of the Water Management Act 2000 establishes access licences for taking water within a particular water management area. Under section 18(1) of the *Water Management (General) Regulation 2011* and schedule 5 part 1, Transport, as a ‘roads authority’, is exempt from requiring an access licence in relation to road construction and road maintenance.

1.7.2 Water quality guidelines

The relevant water quality guidelines were reviewed to identify the obligations of the construction of the proposal with respect to the catchment water quality objectives. In assessing the surface water quality and protecting aquatic ecosystems in this region, the Australian and New Zealand guidelines for fresh and marine water quality guidelines (ANZG 2018) apply.

These guidelines were developed in 2000 as part of Australia’s National Water Quality Management Strategy (NWQMS) and New Zealand’s National Agenda for Sustainable Water Management (then known as the ANZECC Guidelines 2000). The 2018 revision of the ANZG water quality guidelines provides authoritative guidance on managing water quality in natural and semi-natural water resources in Australia and New Zealand.

The NSW Department of Environment and Heritage booklet titled ‘Using the ANZECC Guidelines and Water Quality Objectives in NSW’ (DEC, 2006) guides technical practitioners with applying the ANZECC guideline in NSW (the NSW guideline).

The NSW guideline defines the ‘environmental values’ of receiving water as those values or uses of water that the community believes are important for healthy ecosystems. The environmental values of the Manning River receiving waters are:

- Primary and secondary contact recreation
- Aquatic ecosystem
- Irrigation water supply
- Livestock water supply
- Production of shellfish and crustaceans
- Visual amenity.

The ANZG guideline specifies three levels of protection, from stringent to flexible, corresponding to whether the condition of the particular ecosystem is:

1. Of high conservation value
2. Slightly to moderately disturbed
3. Highly disturbed.

This report assesses the proposal against the environmental values of the water quality guidelines.

1.7.3 Construction phase guidelines

The following documents are relevant in identifying the appropriate water quality management and mitigation measures to be implemented during the construction phase of the proposal:

- NSW DECC 2008 'Managing Urban Stormwater-Volume 2D Main Road Construction', NSW Department of Environment, Climate Change and Water (known as the Blue Book Volume 2)
- Landcom, 2004 'Managing Urban Stormwater- Soils and Construction, Volume 1', 4th Edition (known as the Blue Book Volume 1)
- Roads and Traffic Authority 2009, 'Erosion and Sediment Management Procedure'
- Roads and Traffic Authority 2012, 'Environmental Direction: Management of Tannins from Vegetation Mulch'
- Roads and Traffic Authority 2005' Guidelines for the Management of Acid Sulphate Materials: Acid Sulphate Soils, Acid Sulphate Rock and Monosulfidic Black Ooze'
- Roads and Maritime 2011 'Technical Guideline: Temporary Stormwater Drainage for Road Construction'
- Roads and Maritime 2011 'Technical Guideline – Environmental Management of Construction Site Dewatering'
- Roads and Maritime 2015 'Guideline for Batter Surface Stabilisation using vegetation'.

1.7.4 Operational phase guidelines

The following documents are relevant in identifying the appropriate water quality management and mitigation measures to be implemented during the operational phase of the proposal:

- Roads and Traffic Authority 2003 Procedure for selecting treatment strategies to control road runoff
- Austroads, 2001 Road Runoff and Drainage: Environmental Impact and Management Options, Austroads AP-R180
- Austroads, 2003 Guidelines for Treatment of Stormwater Runoff from the Road Infrastructure, Austroads AP-R232
- Austroads, 2021 Guide to Road Design, Part 5: Drainage – General and Hydrology Considerations
- Austroads, 2021 Guide to Road Design, Part 5A: Drainage – Road Surface, Networks, Basins and Subsurface
- Austroads, 2013 Guide to Road Design, Part 5B: Drainage – Open Channels, Culverts and Floodways
- Department of Primary Industries, '2012 NSW Aquifer Interference Policy'.

2.0 Methods

This surface and groundwater assessment adopted the following methodology:

1. Review available water quality, flooding data, and existing conditions to obtain background information on catchment history and land use and define the existing environment.
2. Review of the legislative context within which the proposal sits and relevant guidelines.
3. Collation of registered bores from the NSW Department of Industry – Water Division groundwater database.
4. Collation of groundwater-dependent ecosystems (GDE) from the National Atlas of Groundwater Dependant Ecosystems (Australian Bureau of Meteorology (BoM)).
5. Define the area that influences both the surface and groundwater environments.
6. Review existing flood conditions and the design flood simulations.
7. Identify the potential impact of construction and operation and the potential cumulative impact on water quality with reference to the ANZECC/ARMCANZ (2000) water quality guidelines.
8. Nominate water quality treatment measures to mitigate the impact of construction on water quality, following the principles of the Managing Urban Stormwater: Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (DECC 2008).
9. Identify water quality treatment measures to mitigate the impact of the operation of the proposal on water quality following the principles set out in Procedure for Selecting Treatment Strategies to Control Road Runoff (RTA 2003) and Roads and Maritime Water Policy (RTA 1997).
10. Nominate any additional measures to manage the potential cumulative impact resulting from the proposal.
11. Provide a consolidated list of measures to be applied during the construction and operational phase to mitigate potential impact on surface water and groundwater.
12. Undertake an accidental spills assessment to identify potential spills that may impact water quality in the receiving environment during the construction and operation phases of the proposal. Assess if an incident could be managed appropriately with standard emergency response procedures or if additional control measures are required.
13. Develop and initiate a water quality monitoring plan to establish the baseline water quality conditions of watercourses that the proposal could potentially impact. Undertake a flood risk assessment to establish the study area’s pre- and post-project flood conditions and identify associated potential flood impacts.

Potential flood impacts that were considered included:

- Changes in peak flood level
- Changes in peak flood velocity
- Scour potential associated with proposed infrastructure.

Flood behaviour in the lower Manning River floodplain is described in the ‘Manning River Floodplain Risk Management Study and Plan’ (BMT, 2020) and earlier ‘Manning River Flood Study’ (BMT, 2016), which were both prepared by BMT for MidCoast Council (“Council”).

The latest versions of the hydrologic model and TUFLOW hydraulic model (BMT, 2020) form the Council’s currently adopted flood models for this area. Council provided permission to use these models for the flood assessment of the proposal. The TUFLOW model was used to undertake flood simulations based on Australian Rainfall and Runoff (ARR) 2019 for a range of design events, including the 1 in 20, 1 in 50, 1 in 100, 1 in 2000 Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF) events as required in ‘*PS261 Bridge and Structure Design’* and ‘*PS271 Hydrology and Drainage Design’*.

3.0 Existing environment

3.1 Climate

Harrington is located in a region with a temperate climate. The closest BoM weather station is at Harrington (Oxley Anchorage Caravan Park, site number 060023), located about 7.5 km southwest of the proposal area. The mean annual precipitation at this station is 1344 mm, based on a data series between May 1887 and September 2007, with monthly totals relatively higher in the late spring, summer, and early autumn months.

Taree Airport (site number 060141) is located about 19 km southwest of the study area. The mean annual precipitation at this station is 1145 mm, based on a data series between July 1997 and November 2022. Monthly totals are relatively higher in the late spring, summer, and early autumn months. The average monthly rainfall for both the Harrington (Oxley Anchorage Caravan Park) and the Taree (Taree Airport) gauges is presented in Table 3-1.

The average temperature statistics for Harrington (Oxley Anchorage Caravan Park) are presented in Table 3-2. Evaporation data is not measured at the meteorological stations referenced. However, the Climatic Atlas of Australia – Evaporation (BoM 2003) indicates that the annual average potential evaporation is about 1400 mm.

Table 3-1: Monthly Rainfall Statistics (mm)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Harrington (Oxley Anchorage Caravan Park) (060023)												
Mean	117.6	147.8	157.7	138.3	119.1	131.7	90.6	79.1	72.5	85.2	92.2	105.5
Median	99	118.4	134.9	101.7	102.8	93.4	71	55.8	51.4	63.3	72.6	91.6
Highest Daily	221	231.6	214	248.7	140.7	260	161.5	174	190.5	154	215.9	128.3
Taree Airport (060141)												
Mean	94.8	156.1	198.7	98.4	81.8	96.5	65.4	45.3	49.3	82.3	109	90.9
Median	96.5	136.3	164.4	69	49.8	90.5	48	30.2	35.6	66	100.2	64.9
Highest Daily	111.4	138	211	158	115.6	163	304.4	60	68	102.4	116.8	100

Table 3-2: Monthly Temperature Statistics (ºC) – Harrington (Oxley Anchorage Caravan Park) (060023)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Highest monthly mean	26.1	25.9	25.1	22.9	20.1	17.9	17.4	18.4	20.5	22.3	24.1	25.3
Lowest monthly mean	18.1	18.2	16.8	13.9	10.7	8.5	7.2	8	10.1	12.9	15	17
Highest Daily	39.1	32.5	32	33.3	27.7	24	28.5	30	35.7	38.2	43.3	42.2
Lowest Daily	11.2	6.2	7.2	5.7	-0.6	-1.1	-1.7	1.1	-0.3	4.4	4.4	7.8

3.2 Topography

The topography for the study area is relatively flat and typically between 0 – 1 m Australian Height Datum (AHD) outside the road formations and the preloaded areas (as demonstrated in Figure 3-1). The flooding behaviour within the proposal area is categorised as "Flood Storage", which is generally driven by flood volume rather than conveyance due to the nature of this topography. The low-lying surface levels and the existing wetland environment limit options for draining the study area and mitigating flood impacts.

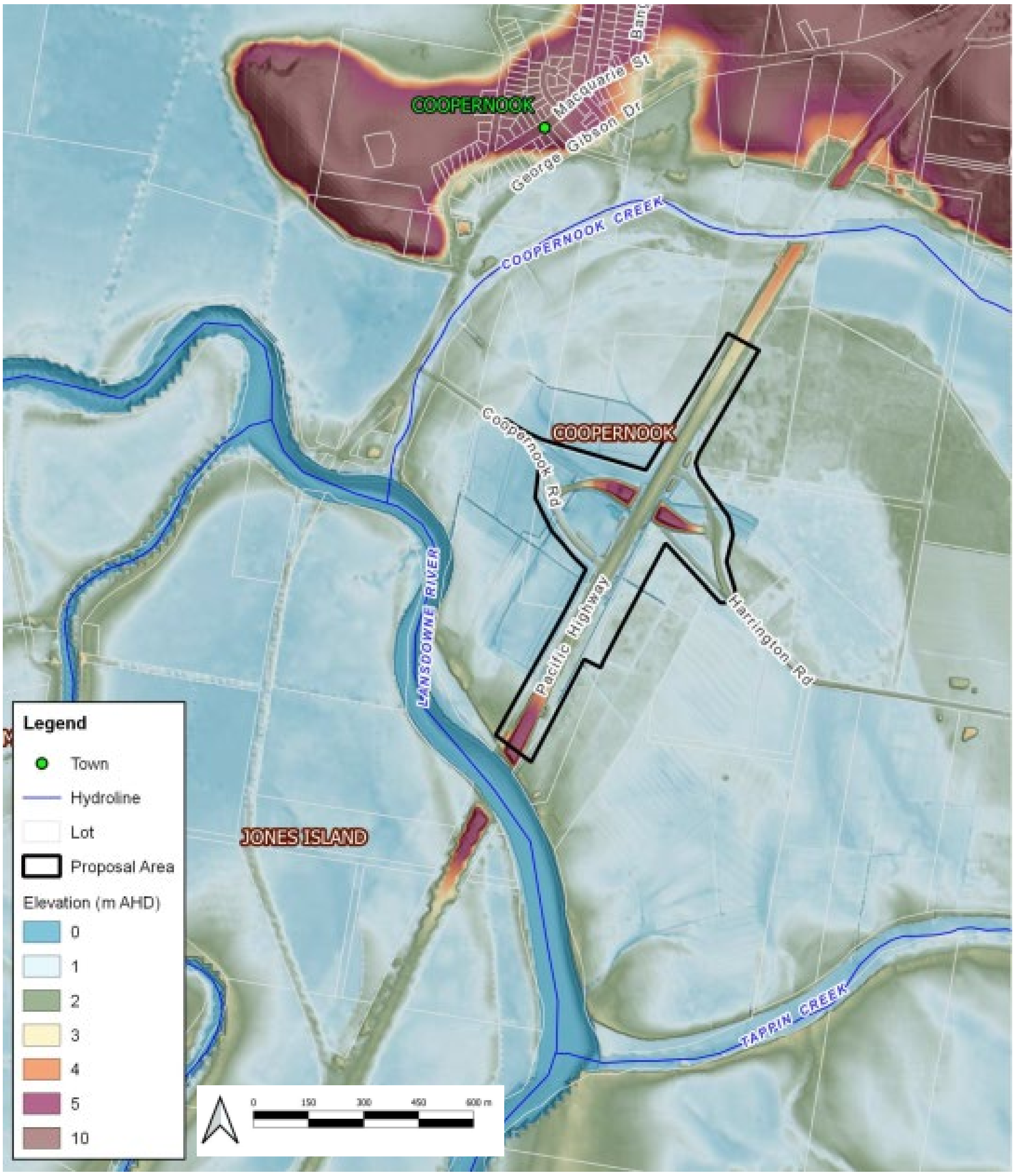


Figure 3-1: Site topography

3.3 Geology and soil

According to the Department of Primary Industries, 1:100 000 Taree Area Coastal Quaternary Geology (2007), the study area is underlain by alluvial and estuarine plain deposits consisting of the following geological units:

1. Qhap – Holocene floodplain: silt, fluvial sand, clay
2. Qhea – Holocene estuarine paleochannel fill: organic mud, peat, clay, silt, marine sand

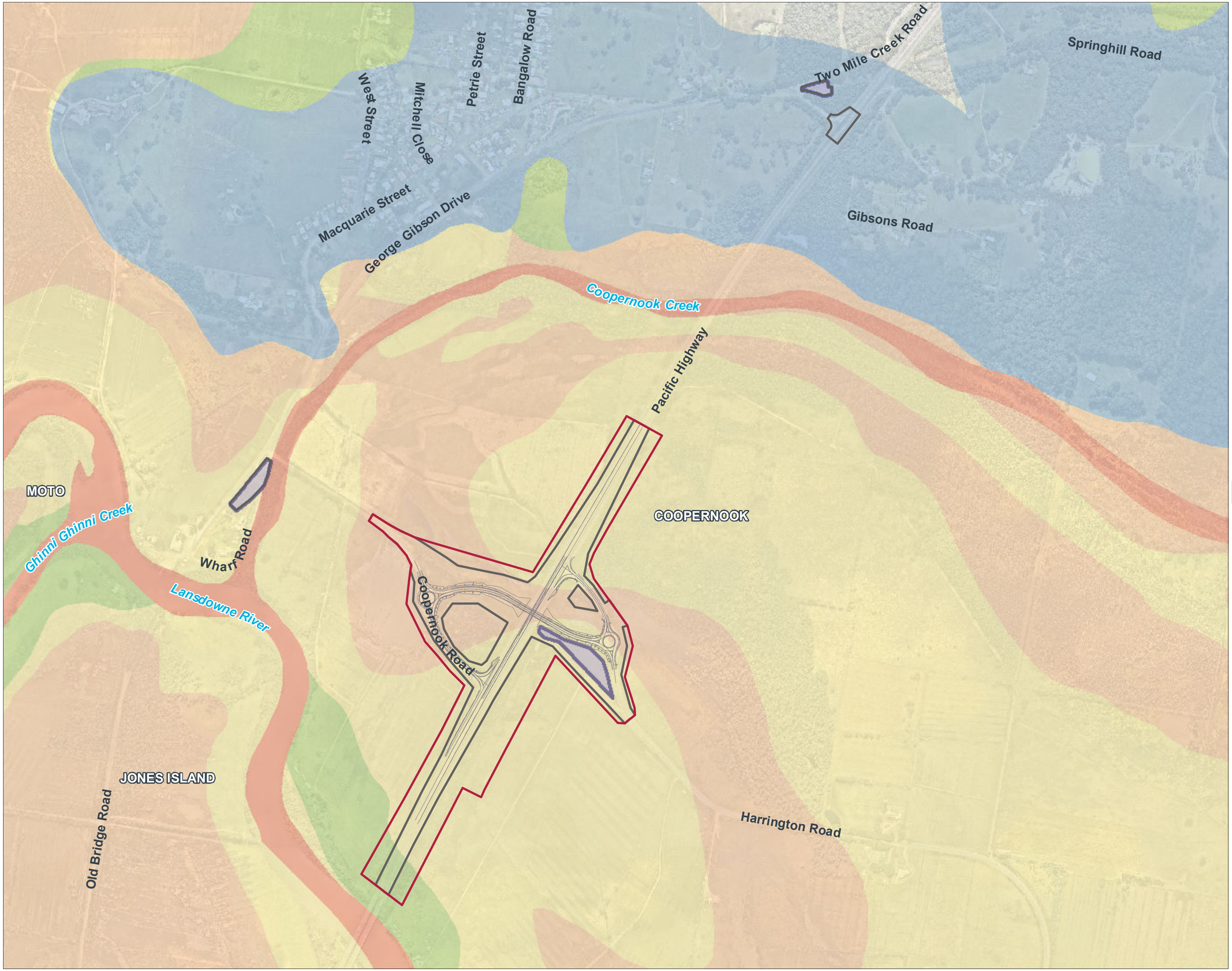
Pedological mapping (Australian Soil Classification, 2021) indicates that the soils across the lowland areas are relatively uniform. They are classified on the basis of order, suborder, greater group, subgroup and family as:

- Hydrosols, redoxic, sulphuric, humose acidic (medium, non-gravelly, clayey (some sandy), giant).

The term hydrosol (Wagner, 1997) refers to a range of seasonally or permanently wet soils, with key criteria being saturation of the profile for prolonged periods in most years. The soils may not experience reducing conditions for all or part of the period of saturation, and reducing and oxidising conditions can co-exist within the soil profile. Redoxic refers to the presence of a seasonal or permanent groundwater table. Sulphuric indicates the presence of sulphuric materials in the upper 1.5 m of the profile. Humose-acidic signifies a humose (topsoil) horizon, and the major part of the B2 horizon (subsoil) is strongly acid.

The majority of the study area is mapped as Class 2a and 2b, indicating a high probability of occurrence for acid sulfate soils, as shown in Figure 3-2. A key consideration for any proposed earthworks will be to avoid the disturbance and possible oxidisation of Potential Acid Sulfate Soils (PASS). Natural soils may require substantial treatment (e.g., lime stabilisation) following excavation to minimise the potential for acid leachate runoff, e.g., construction of any proposed open drains or installation of piles/pierheads. Allocating sufficient area for the treatment process and material stockpiling will be a key consideration for the contractor's methodology.

FIGURE 3-2: ACID SULFATE SOILS CLASS



Legend

- Proposal area
- Construction footprint
- Ancillary facilities
- Road design

Acid Sulfate Soils Class

- Class 1
- Class 2a
- Class 2b
- Class 3
- Class 5

Ancillary facilities are subject to change during the final design refinements.

Draft to be informed by the Specialist Study

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3.4 Site condition and surrounding environment

The environmental setting of the study area is summarised in Table 3-3.

Table 3-3: Environmental Setting

Item	Description
Topography and drainage	The highest point on the proposal area is the pre-loaded areas for the proposed approaches to the overpass bridge on either side of the Pacific Highway. The central portion of the proposal area adjacent to existing roads are the lowest lying areas that form a freshwater wetland, as shown in Figure 3-8. Modelled drainage patterns show water movement in a general eastern direction, away from sensitive waterbodies.
Surrounding land use	Surrounding land uses primarily consist of road infrastructure and grazing land or agriculture.
Geology	Study area geology (as shown in Figure 3-3) comprises the following formations: 1. Alluvial floodplain deposits from the alluvium group generally comprising of clastic sediments, described as: silt, very fine to medium-grained lithic to quartz-rich, sand, and clay. 2. Estuarine paleochannel fill from the estuarine deposits group generally comprising of organic-rich sediment, described as: organic mud, peat, clay, silt, and fine to medium-grained lithic-carbonate-quartz sand (marine deposited).
Soil landscapes	The soil landscapes comprise a level plain on Holocene estuarine and alluvial sediments in the central east and northeast of the Manning River Basin. Slopes are generally lower than 1%, the local relief is typically less than 1 m, and the elevations range from 1 to 5 m AHD. The surrounding landscape has extensively cleared open woodland and soils, which are characteristic of deep (100 - <150 cm) and poorly drained redoxic/oxyaquic hydrosols (Humic Gleys).
Acid sulfate soils	The majority of the proposal area is mapped as Class 2a and 2b, indicating a high probability of occurrence for acid sulfate soils (NOEH, 2022).
Hydrology	The proposal area is located in a riverine floodplain area enclosed by a number of watercourses. The nearest surface water body is the Lansdowne River, which flows from west to east 300 m southwest of the proposal area. Several tributaries (including Coopernook Creek, approximately 380 m west of the proposal area) flow into the Lansdowne River, part of the protected riparian corridor. The study area is prone to flooding, with the study area being characterised as flood storage (BMT 2020).
Hydrogeology	There are no registered groundwater bores within the study area. Approximately 30 registered groundwater bores exist within a 2 km radius of the project. The majority of groundwater bores are registered for livestock water supply. The aquifer beneath the proposal area is sandy and considered to be highly productive, with an anticipated groundwater depth of less than 1.0 metre below ground level (mbgl). Due to the shallow groundwater within the area, it is likely to be in continuity with the Lansdowne River. No groundwater-dependent ecosystems (GDE) have been identified within the study area, but regional studies identified areas within a 500 m radius of the project with a high potential to be GDEs (BoM, 2023).

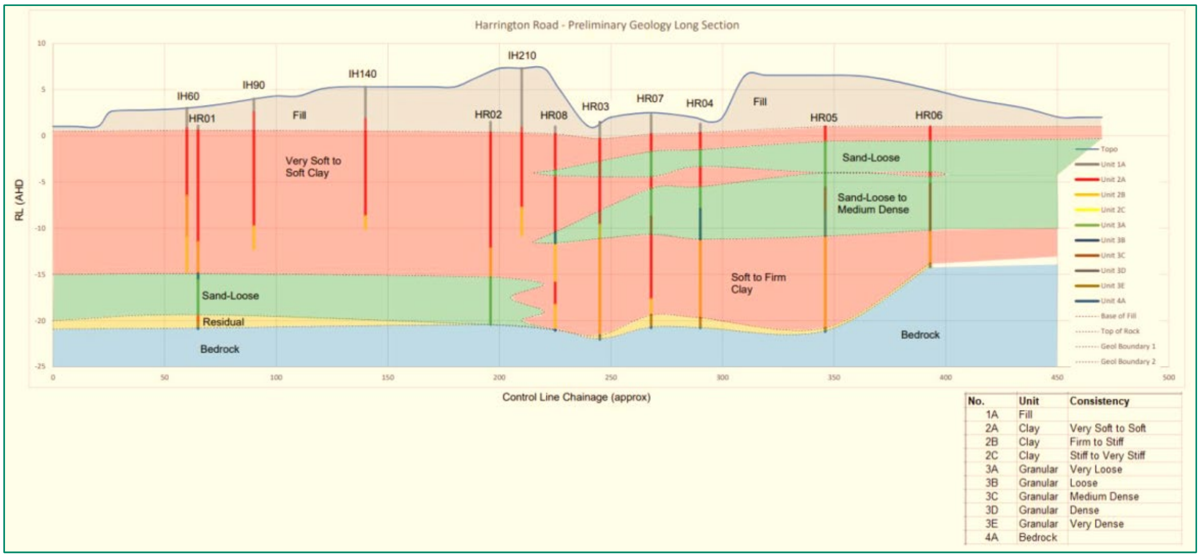

Figure 3-3: Preliminary geological model (indicative model based on historical data)

3.5 Land use and contamination

A Preliminary Site Investigation (PSI) for the proposal was completed by AECOM in February 2023. The land use within the study area comprises predominantly agricultural land use with a combination of pastoral open grazing land and some rural residential properties. The land use beyond the study area includes:

1. North: rural residential and agricultural properties (cropping and grazing), market gardens and pastoral land
2. South: agricultural properties, pastoral land, and the Manning River
3. East: some pastoral land and wetland areas leading to the coastline
4. West: agricultural properties and rural land with the Lansdowne River a short distance from the study area boundary.

The PSI identified current and historical sources within the study area that potentially contain contamination, namely the existing Pacific Highway and associated connecting roads. Contamination from such sources would be from prolonged traffic use and may include tyre degradation, litter, hydrocarbon leaks and spills.

Other potential contamination sources and activities identified within the study area include agricultural land use, former road construction, and operational maintenance of road network assets.

A summary of potentially contaminating activities is provided in Table 3-4.

Table 3-4: Potentially contaminating activities

Potentially contaminating activity (former or current)	Contaminants of potential concern (CoPC)	Release and transport Mechanism
Agricultural land use, including pastoral land and dairy farm: • Chemical storage • Application of herbicides, pesticides and fertilisers • Spills associated with the maintenance and use of mobile plant and machinery (lubricants and fuels) • Livestock dip or spray operations • Demolished structures containing Asbestos Containing Materials (ACM)	• Herbicides • Organochlorine pesticides (OCP)/ organophosphorus pesticides (OPP) • Carbamates • Synthetic pyrethroids • Metals • Total recoverable hydrocarbons (TRH) • Benzene, toluene, ethylbenzene, xylenes and naphthalene (BTEXN) • ACM	• Soil - Direct application (herbicides and pesticides) - Accidental spills and leakages to ground - Potential ACM within fill material • Surface Water - Stormwater runoff to the receiving environment • Groundwater - Leaching and infiltration of contaminant into groundwater.
Road Construction: • Application of herbicides • Spills associated with the maintenance and use of mobile plant and machinery (lubricants and fuels) • Importation of fill material from unknown sources	• Herbicides • OCP/OPP • Metals • TRH • BTEXN • ACM • Polycyclic Aromatic Hydrocarbons (PAH) • Polychlorinated Biphenyls (PCBs) • Coal tar	• Soil - Direct application (herbicides and pesticides) - Accidental spills and leakages to ground - Potential ACM within fill material • Surface Water - Stormwater runoff to the receiving environment • Groundwater - Leaching and infiltration of contaminant into groundwater.
The Pacific Highway and associated side streets: • Application of herbicides • Spills associated with the maintenance and use of mobile plant and machinery (lubricants and fuels)	• Herbicides • Metals • TRH • BTEXN • Coal tar (within road material)	• Soil - Direct application (herbicides) - Accidental spills and leakages to ground • Surface Water - Stormwater runoff to the receiving environment • Groundwater - Leaching and infiltration of contaminant into groundwater.

The following potential contamination migration pathways between sources and receptors were identified in the PSI:

1. Direct contact (dermal, oral ingestion, or inhalation) of contaminated soil and dust, particularly during maintenance or construction activities.
2. Direct contact with shallow contaminated groundwater during maintenance and or construction activities.
3. Surface water runoff, potentially mobilising any contaminants on the surface or in soil towards sensitive water bodies.
4. Possible leaching and off-site migration of mobile contaminants from soils to groundwater beneath the study area, which result from disturbance of the surface of the study area during maintenance or construction activities.
5. Vapour inhalation of volatile contaminants derived from impacted soil or groundwater media.
6. Ingestion of potentially contaminated water by water users.

The PSI concluded a moderate risk of contamination from these potential sources. Based on the findings of the assessment and with due regard to the proposed construction of the overpass, a contaminated lands unexpected finds procedure would be developed as part of the Construction Environmental Management Plan (CEMP) for the proposal and implemented during the construction phase.

3.6 Surface water

3.6.1 Flooding

The Manning River Flood Study, Reviewed and Updated Report (MidCoast Council, 2016) indicates that the study area would likely experience 0.6 m depth of flooding during a 1 in 50 AEP event and 0.8 m depth of flooding during a 1 in 100 AEP event. During a Probable Maximum Flood (PMF) flood event, at the Pacific Highway, the flood depth would likely reach 3.5 m.

The Manning River Floodplain Risk Management Plan (BMT, 2020) identified that the Pacific Highway between the Coopernook and Harrington Road intersections are flood free for events up to a 1 in 20 AEP, and the Pacific Highway is subject to inundation in events starting from 1 in 50 AEP.

Figure 3-4, Figure 3-5, Figure 3-6 and Figure 3-7 show the 1 in 5 AEP, 1 in 50 AEP, 1 in 100 AEP and 1 in 100 AEP with climate change flood model maps. The maps demonstrate that flooding in this area is a key consideration and constraint for the proposal.

During a PMF event at existing conditions, the flood drainage path across the proposal area would typically flow from Lansdowne River and Coopernook Creek and would flow to the east.

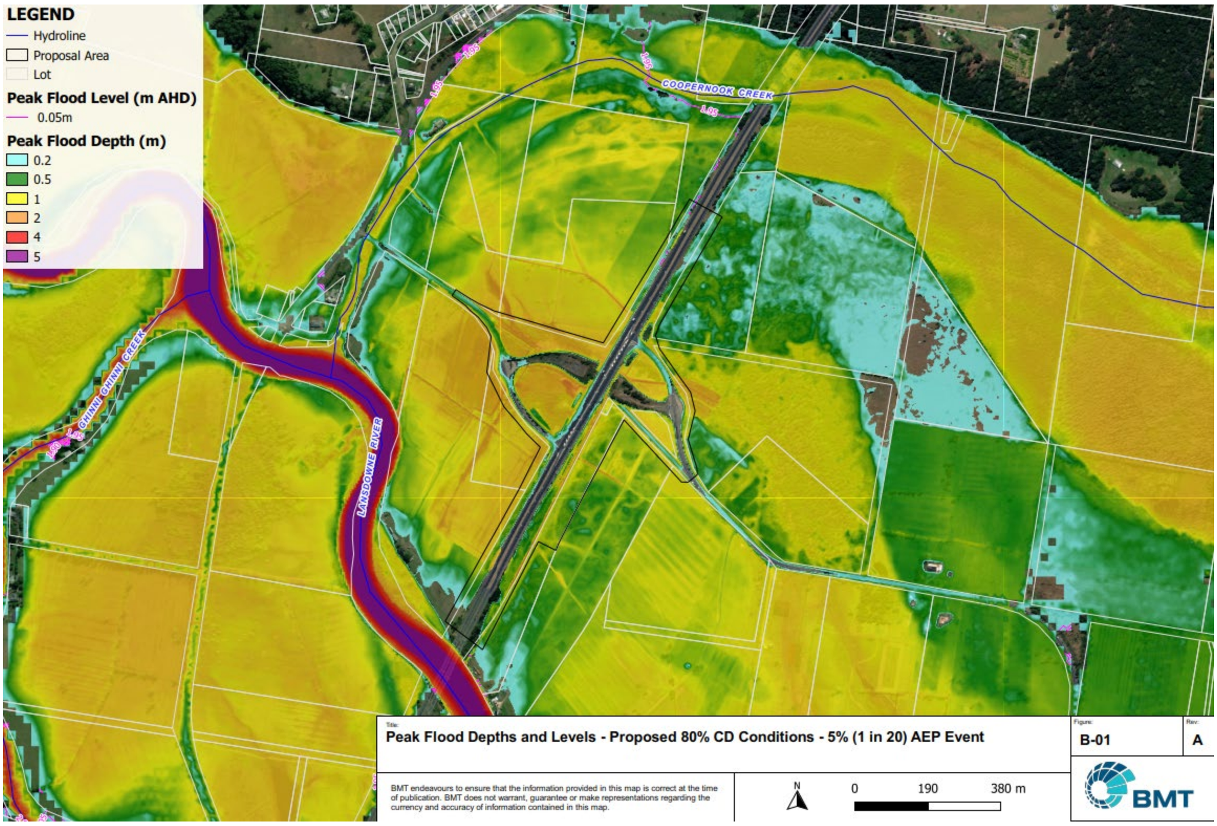

Figure 3-4: Peak flood depths and levels – Proposed 80% concept design conditions – 5% (1 in 20) AEP Event

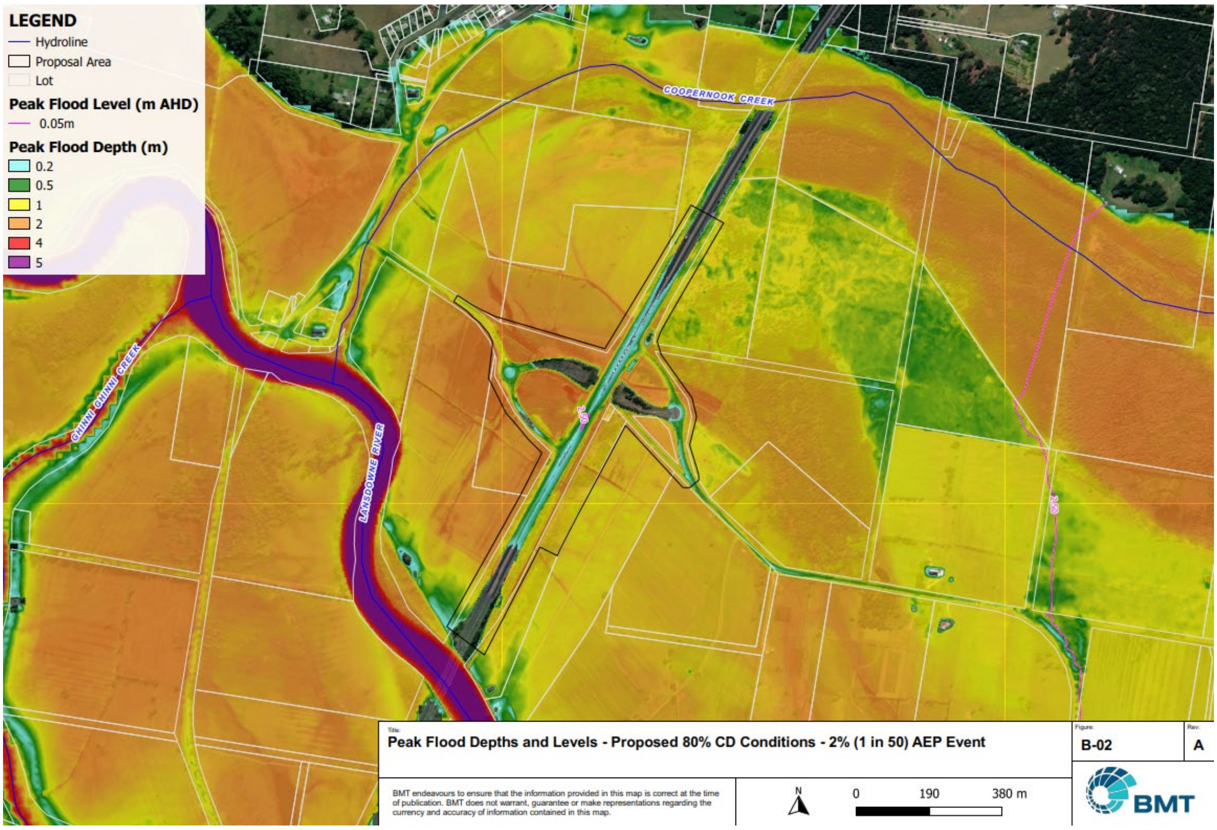

Figure 3-5: Peak flood depths and levels – Proposed 80% concept design conditions – 2% (1 in 50) AEP Event

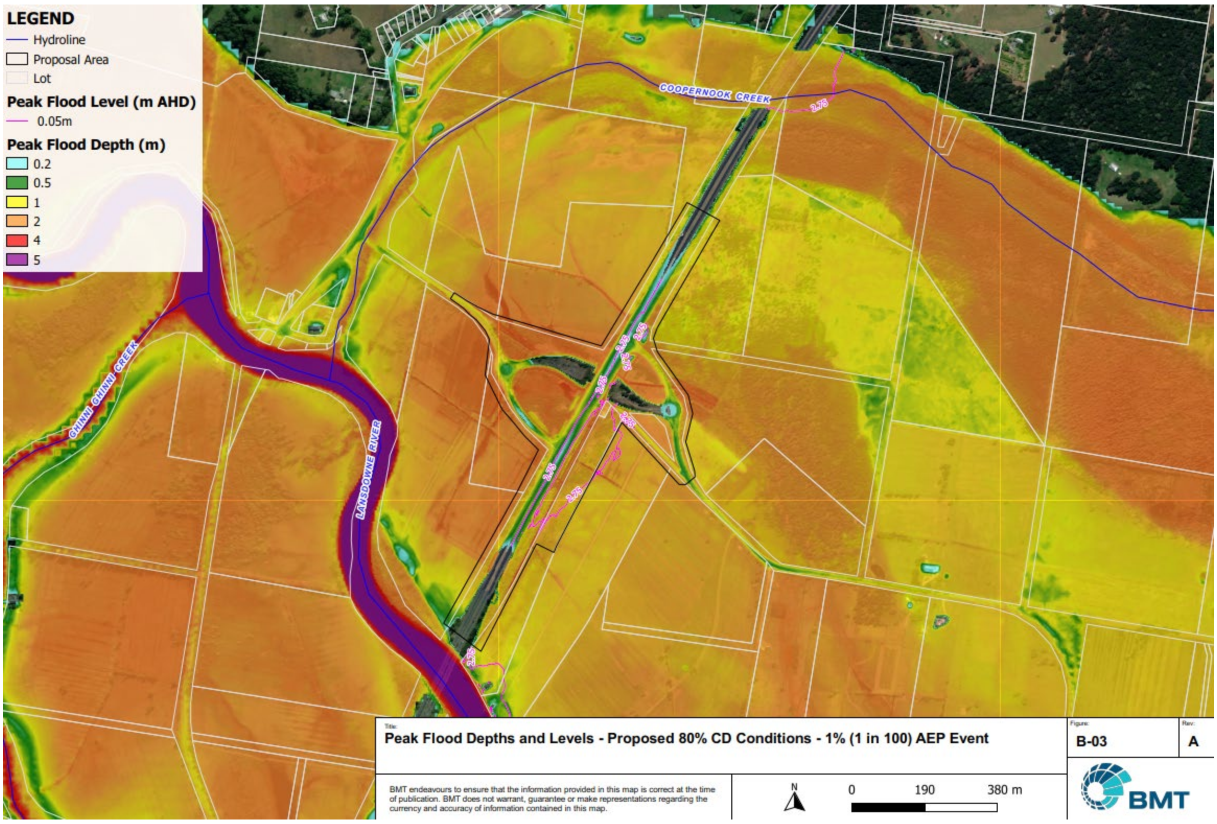

Figure 3-6: Peak flood depths and levels – Proposed 80% concept design conditions – 1% (1 in 100) AEP Event

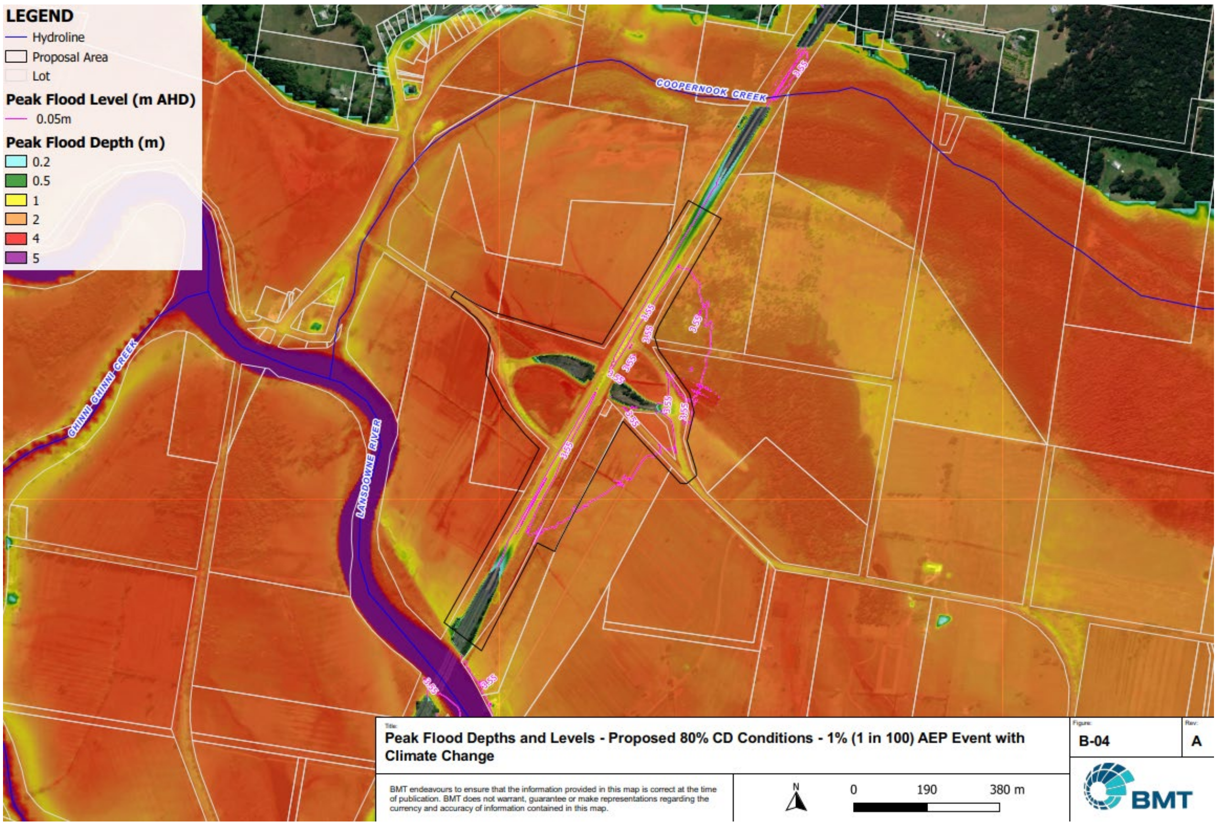

Figure 3-7: Peak flood depths and levels – proposed 80% concept design conditions – 1% (1 in 100) AEP Event with climate change

3.6.2 Drainage

There are significant areas of surface water present within and adjacent to the proposal area, as shown on Figure 3-8 based on an aerial impact captured on 23 March 2022. Ponding water was observed east of Coopernook Road during a site inspection in May 2022 as shown on Figure 3-9.

The ponding water suggests that drainage is a key consideration and constraint for the proposal.

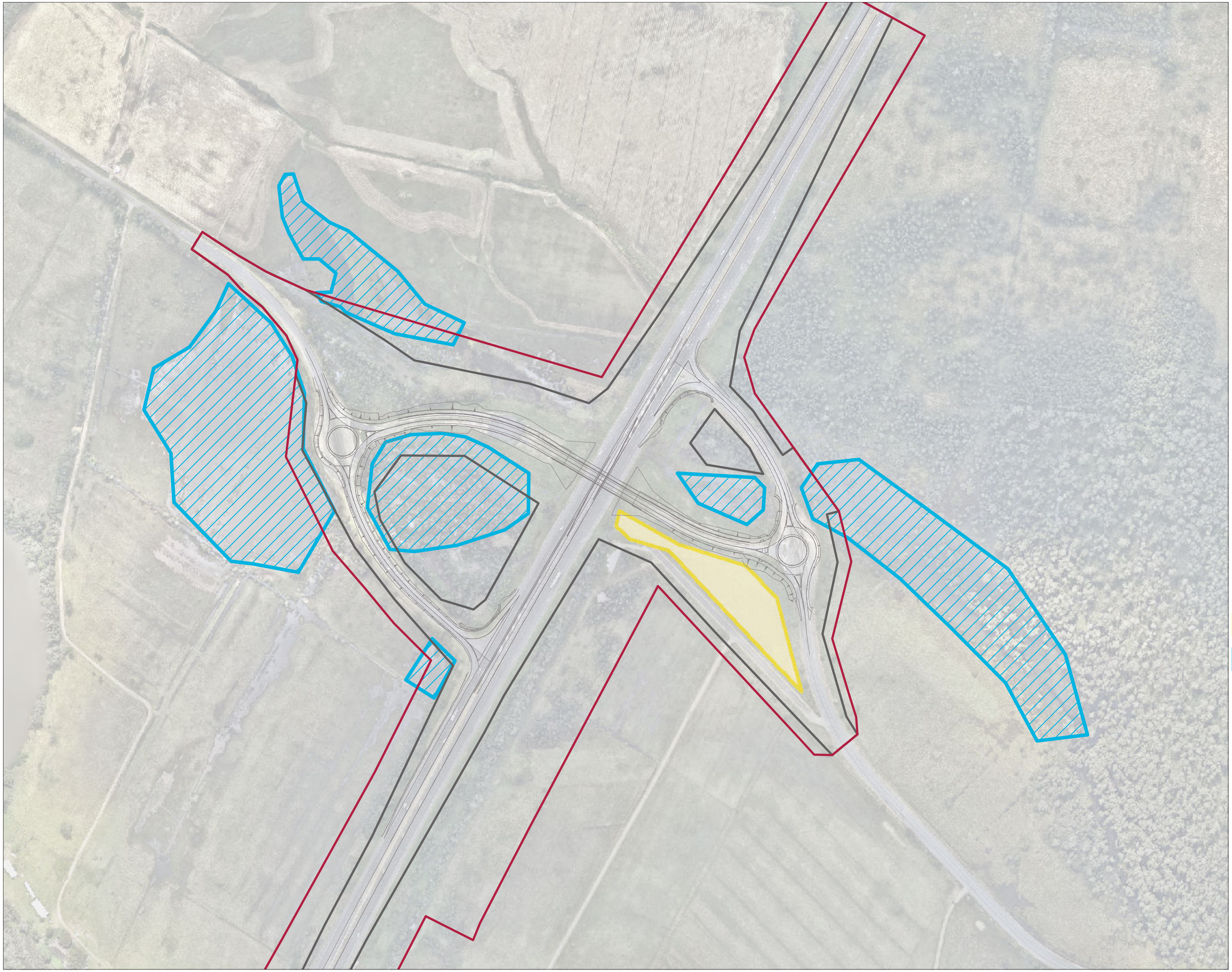

FIGURE 3-8:
PONDING WATER AROUND THE PROPOSAL AREA

Ancillary facilities are subject to change during the final design refinements.

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Figure 3-9: Ponding water – view south-east along southern side of Coopernook Road from eastern project extent

Numerous existing culverts are located along the Pacific Highway, Coopernook Road and Harrington Road. Many of these are partially or completely submerged by surface water. As such, it is anticipated the culverts support balancing surface water levels across the area.

Figure 3-10: Culvert under Coopernook Road – between Pacific Highway and proposed roundabout

Only one culvert located under the pre-loaded area adjacent to Coopernook Road is expected to be impacted by the proposed works. This culvert passes beneath the proposed Link Road, which connects the proposed Coopernook Road roundabout and Harrington Road roundabout. The culvert appears to be cast *in situ* concrete in a single box configuration. Physical limitations of the ponded water and overgrown vegetation prevented visual inspection of this culvert by normal means, as is evident in Figure 3-11. Only the top of the headwall was visible, with the structure submerged underwater.

Figure 3-11: Culvert under pre-loaded area adjacent to Coopernook Road (Nearmap, 23 March 2022)

Topographical survey demonstrates that this culvert has been impacted by the settlement of the pre-loaded areas. As a result, there is a high risk of differential settlement damaging the culvert or reducing its structural capacity. The proposal would install one new transverse culvert in this location and longitudinal drainage in the form of kerb outlet drains and batter chutes along the remaining road near the roundabouts on either end of the Interchange Link Road. The existing drainage within the study area is shown in Figure 3-12.

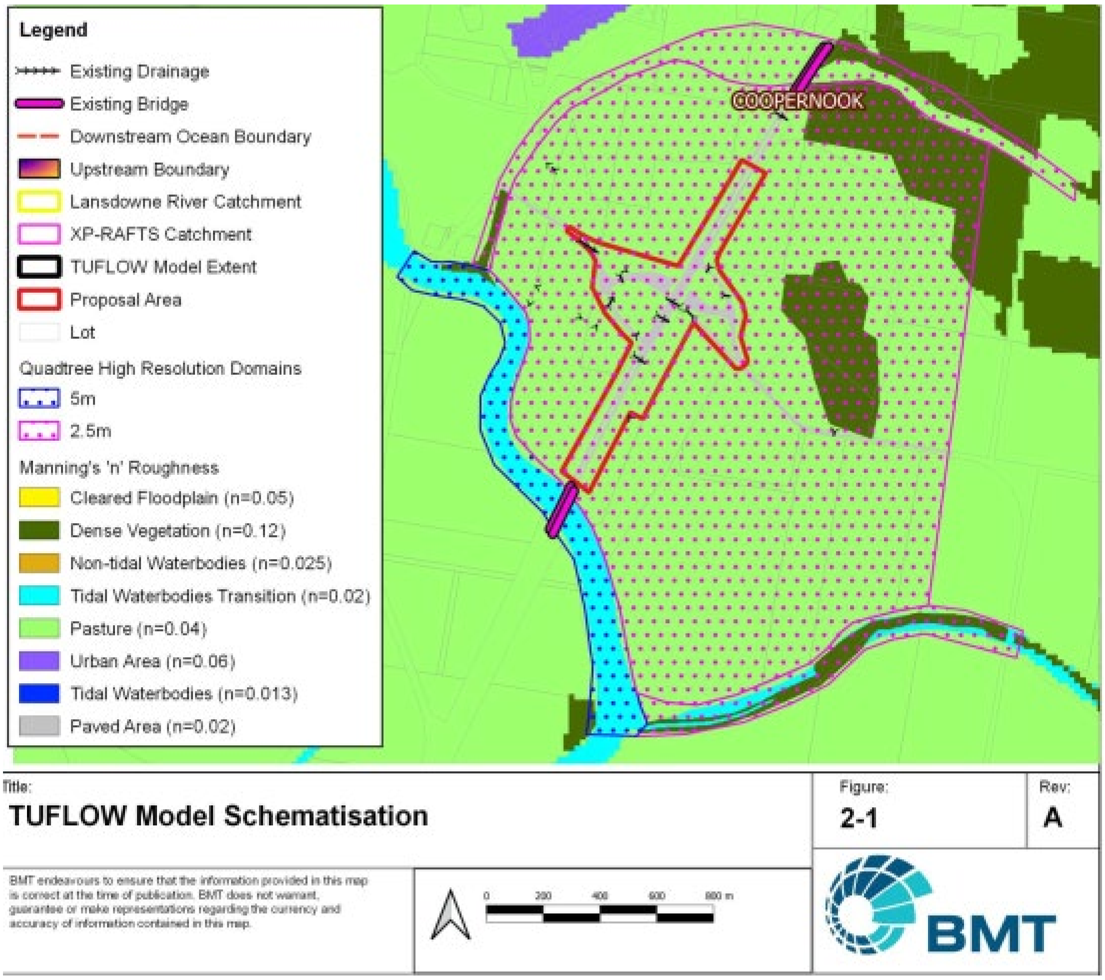

Figure 3-12: Existing drainage

The several culverts, as shown in Figure 3-12, around the interchange help balance water until it is conveyed to the Lansdowne River via a series of open drainage channels.

3.7 Surface water quality

The Pacific Highway Bypass of Coopernook Environmental Impact Statement (EIS) dated 1997 described the surface water quality testing undertaken in and around the study area, which aligns with this proposal's study area. The five sampling sites are as follows (refer also to Figure 3-13):

1. Site 1 – Spring Hill Dam (fresh water)
2. Site 2 – Coopernook Creek (fresh water)
3. Site 3 – Constructed Channel into Lansdowne River (estuary salt/brackish)
4. Site 4 – Lansdowne River (estuary)
5. Site 5 – Lansdowne River from Bridge (estuary).

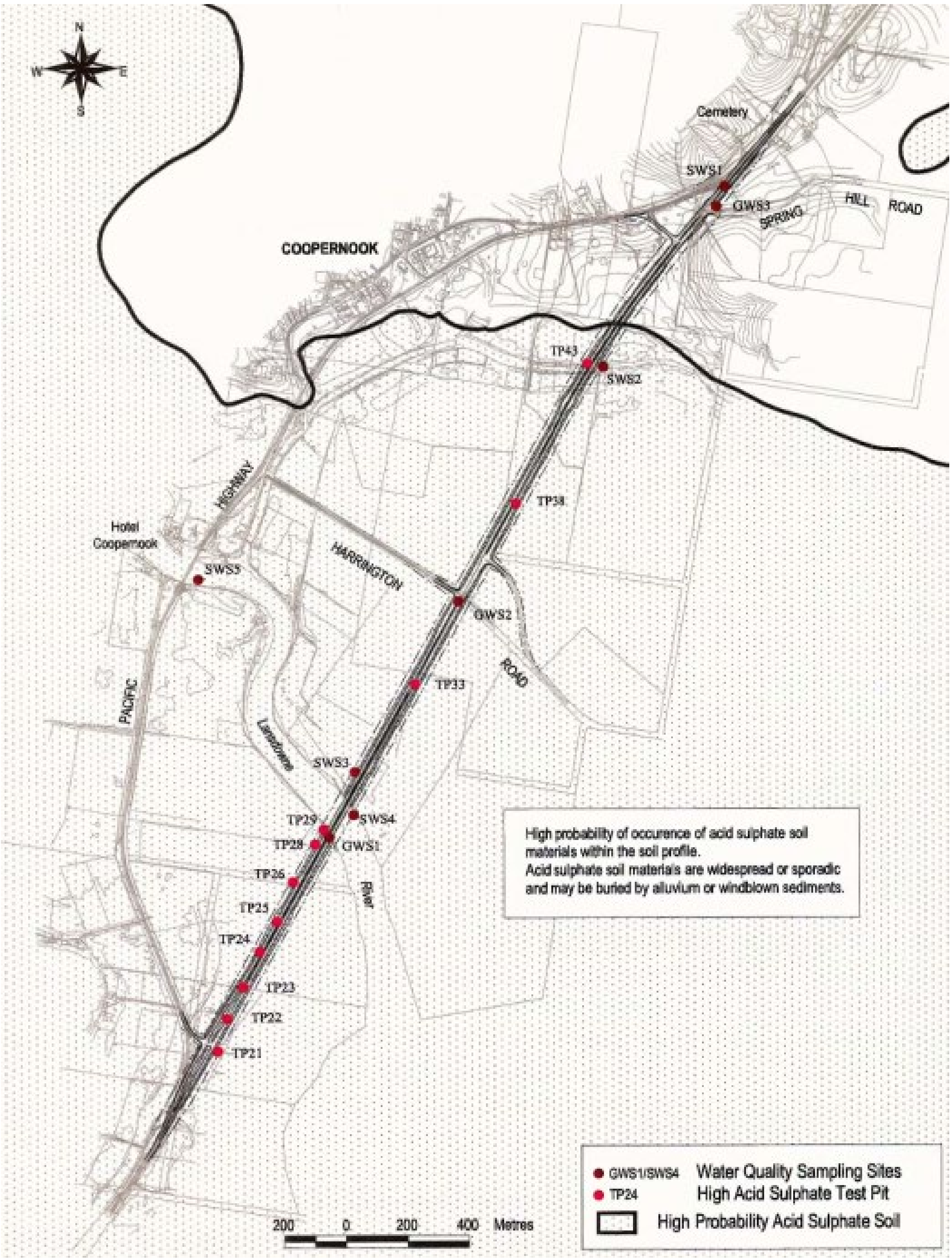

Figure 3-13: Historic water quality testing sites (Wagner et al. 1997)

The results from testing of these subject sites are shown in Figure 3-14.

Parameters	Site 1	Site 2	Site 3	Site 4	Site 5			ANZECC Guidelines Values for Fresh and Marine Waters
					0.8m depth	2m depth	4m depth	
Dissolved Oxygen (mg/L)	14.26	5.26	15.51	12.34	15.96	15.03	13.57	> 6 (>80 - 90% saturation)
pH	8.09	6.34	6.43	6.18	6.22	6.74	6.95	Fresh: 6.5 - 9; Marine: 8 - 8.2
Temperature (°C)	19.19	17	17.65	18.22	18.28	18.81	19.19	Increase <2
Salinity (ppt)	0.25	4.74	30.10	31.58	30.01	48.5	55.72	Fresh: 1ppt; Marine: 30 - 35ppt
Electrical Conductivity (EC) (µs/cm)	463	6 400	39 800	42 088	40 200	63 000	70 600	Fresh: 1 500µs/cm; Marine: NV
Turbidity (NTU)	7.2	22	NA	7.8	NA	NA	NA	<10% change in seasonal mean concentration
Suspended Solids (mg/L)	<2	16	NA	4	NA	NA	NA	<10% change in seasonal mean concentration
Total Dissolved Solids (g/L)	0.34	6.617	30.13	31.38	29.95	44.6	52.46	If EC: 280 - 800 then TDS: 1.75 - 5 If EC: >5500 then TDS: >35
Aluminium (µg/L)	NA	NA	NA	190	NA	NA	NA	If pH: <6.5 then Aluminium: <5µg/L If pH: >6.5 then Aluminium: <100µg/L
Lead (µg/L)	NA	NA	NA	86	NA	NA	NA	Fresh: 1 - 5µg/L; Marine: <5µg/L
NH4 (mg/L)	0.149	9.3	21.17	25.82	20.78	32.5	38.01	Fresh: measured as a function of pH and temperature; Estuarine: <0.005 mg/L
NO3 (mg/L)	2.608	9.840	19.65	19.72	20.89	24.8	25.56	Fresh: NV; Estuarine: 0.01 - 0.1 mg/L
Ortho-Phosphate (µg/L)	15	28	NA	15	NA	NA	NA	NV
Total-Phosphorus (µg/L)	56	87	NA	39	NA	NA	NA	Fresh: 10 - 100µg/L; Estuarine: 5 - 15µg/L
Organochlorine (µg/L)	NA	NA	NA	<LOQ (0.1 µg/L)	NA	NA	NA	Limits for individual pesticides, total < 0.1
Organophosphate (µg/L)	NA	NA	NA	<LOQ(0.2 µg/L)	NA	NA	NA	Limits for individual pesticides, total<0.18
Faecal Coliform	NA	NA	NA	13/100ml	NA	NA	NA	No faecal coliform for drinking water 1000/100ml faecal coliform for agriculture use

Notes: NA = Not Analysed, LOC = Limit of Quantisation, NV = No Value specified

Figure 3-14: Coopernook Bypass EIS surface water quality testing results

The water quality testing results demonstrated that surface water quality appeared to be impacted primarily by agricultural land runoff. Key points in the discussion of results from the EIS are as follows:

- Site 1 – Deemed reasonably acceptable results.
- Site 2 – Relatively poor water quality, salinity, conductivity, TDS, turbidity and suspended solids were extremely high and dissolved oxygen low, reflecting the brackish and stagnant nature of Coopernook Creek at that time. The low dissolved oxygen concentration recorded was related to the low water flow rate and proliferation of algal growth potentially related to nutrient-laden runoff from agricultural activities.
- Site 3 - The samples were brackish and extremely high in nitrate and ammonia.
- Site 4 - Lead, aluminium, faecal coliform and nutrient concentrations were high and pH slightly low, indicating a poorer water quality than expected for a pristine estuary. It is likely that the water quality at the site was affected by any local discharges from the constructed channel and runoff from agricultural land.
- Site 5 - Results suggest that the water quality of the Lansdowne River is influenced by two sources: intruding seawater and agricultural runoff. The increase in conductivity (salinity) and total dissolved solids with depth is related to the intrusion of seawater upriver and the process of stirring, re-suspension and mobilisation of bottom sediments (and contaminants) into the water column as tidal currents move up and down the river. High levels of ammonia and nitrate in the water are usually indicative of runoff from agricultural activities or other human sources.

Whilst the surface water environment sits within highly modified landscapes with a relatively low value in supporting aquatic ecosystems, some higher-value areas exist. For this reason, a precautionary approach has been adopted, and the ecosystem condition category is assumed to fall into the 'slightly to moderately disturbed' category.

The ANZG (2018) provides the following guidance on water quality indicator types for slightly to moderately disturbed systems:

- For physical and chemical stressors, where local reference site data are not yet gathered, apply regional default guideline values (DGVs).

- For toxicants in water, apply 95 per cent species protection DGVs, or 99 per cent species protection for highly bioaccumulating toxicants if local biological-effects data are unavailable.
- For toxicants in sediment, use toxicant DGVs for sediment quality.

Therefore, the default trigger values for physical and chemical stressors for 'South-East Australian slightly to moderately disturbed lowland rivers', have been adopted. The individual trigger values for each indicator is used to assess the risk to an environmental value within receiving waterbodies.

The default trigger values are considered conservative and precautionary, owing to the proposal setting and surrounding land use (i.e. agricultural land, dairy farms). Where exceedances are observed, these are assessed in terms of the proposal activities (i.e. construction and operation) and potential load contribution from surrounding influences (i.e. cumulative considerations).

Over the past 25 years, the land use within the study area remains largely unchanged and the data presented by Wagner et al. (1997) would be used as baseline data for comparative purposes to assess water quality during construction and operation of the proposal. However, this water quality data may be different to present day water quality conditions due to the construction of the Pacific Highway. It is recommended that water quality sampling is undertaken prior to construction to confirm the baseline environment.

Trigger values would be used to assess the condition of the surrounding water bodies prior to, during and following construction of the proposal. The trigger values for key indicators applied in the assessment of surface water quality are shown in Table 3-5.

Table 3-5: Trigger values – Southeast Australian lowland rivers

Key Indicators	Units	Trigger Values for Lowland River Ecosystems
Chlorophyll a (Chl a)	µg/L	3 ug/L[1]
Total phosphorus (TP)	µg/L	25 µg/L[1]
Filterable reactive phosphorous	µg/L	20[1]
Total nitrogen (TN)	µg/L	350 µg/L[1]
Nitrogen oxides (NOx)	µg/L	25[4]
Ammonium (NH4)	µg/L	20[4]
Dissolved oxygen (DO)[2]	per cent saturation	Aquatic ecosystems (Lowland rivers): 85% Drinking water: >80%
pH	-	6.5 – 8.0
Salinity (EC)	µS/cm	125 – 2 200[3]
Turbidity	NTU	6 – 50[4]
Temperature	degrees Celsius	Aquatic ecosystems: >80%ile / <20%ile Primary contact recreation: 15 – 35°C Aquatic foods (cooked): <2°C change over one Hour
Chemical contaminants	µgm/L	Livestock water supply: See Table 4.3.2 ANZECC 2000 Irrigation water supply: See Table 4.2.10 ANZECC 2000 Secondary contact recreation and primary contact recreation: no chemicals that are either toxic or irritating to the skin or mucous membranes Homestead water supply: See Guidelines for Inorganic Chemicals in the Australian Drinking Water Guidelines Drinking water: see ANZECC 2000 guidelines Aquatic foods (cooked): Copper <5 µgm/L, mercury <1 µgm/L, zinc <5 µgm/L, chlordane <0.004 µgm/L, PCBs <2 µgm/L

Key Indicators	Units	Trigger Values for Lowland River Ecosystems
Faecal coliforms	Colony Forming Units (cfu)	Primary contact recreation: < 150 cfu/100mL Irrigation water supply: <100 cfu/ 100mL (raw human food crops, no direct contact) <1000 cfu/ 100mL (pasture and fodder for grazing animals) Secondary contact recreation: <1000 cfu/100mL, with 4 out of 5 samples < 4000 cfu /100 mL Homestead water supply and drinking water: 0 cfu/ 100mL Aquatic foods (cooked): 14 MPN/100mL (shellfish), 2.3 MPN/g (fish).
Algae and blue green algae	cells/mL	Visual amenity: not present in unsightly amounts Livestock water supply: < 11500 microcystins <2.3 µg/L cells/ mL Irrigation water supply: not visible Secondary contact recreation and primary contact recreation: <15000 cells/mL Homestead water supply: <1000 algal cells/mL Drinking water: <2000 algal cells/mL
Visual clarity and colour	Munsell colour Scale	Visual amenity and secondary contact recreation and primary contact recreation: Natural visual clarity not reduced more than 20%. Natural hue not to be changed more than 10 points on the Munsell Scale. The natural reflectance not to be changed more than 50%.
Enterococci	cfu	Secondary contact recreation: < 230 enterococci per 100 mL Primary contact recreation: 35 cfu/100mL
Protozoans	Presence / absence	Primary contact recreation: Absent

[1] Values for east flowing coastal rivers.

[2] Dissolved oxygen values were derived from daytime measurements. Dissolved oxygen concentrations may vary diurnally and with depth. Monitoring programs assess this potential variability.

[3] Lowland rivers may have higher conductivity during low flow periods and if the system receives saline groundwater inputs. NSW coastal rivers are typically in the range of 200-300 µS/cm.

[4] Turbidity in lowland rivers can be extremely variable. Values at the low end of the range would be found in rivers flowing through well vegetated catchments and at low flows. Values at the high end of the range would be found in rivers slightly disturbed catchments and in many rivers at high flows.

3.8 Groundwater

3.8.1 Regional hydrogeology

The surficial alluvial sediment aquifer dominates the hydrogeology of the Harrington/Coopernook region with a hydrostratigraphic unit characteristic of porous unconsolidated mud, silt, clay and fine gravel from Quaternary age alluvial deposits.

Groundwater from this aquifer is typically used for agricultural, stock, and domestic purposes. It is recharged predominantly through percolated rainwater through unsaturated soils and discharges to the Manning River (and tributaries) as baseflow. Disconnected perched groundwater may occur over areas of localised clay during periods of high rainfall, draining laterally and downward to the alluvial aquifer.

The alluvial aquifer dips at a shallow gradient towards the Manning River, influenced by the amount of rainfall recharge, the permeability of the sand and gravel beds, and the level at the discharge zone along the Manning River. Water table fluctuations occur due to recharge, effective storage, and abstraction from bores and wells.

3.8.2 Local hydrogeology

An unconfined alluvial aquifer characterises the local hydrogeology within the study area. It is a highly productive aquifer with a groundwater depth of less than 1.0 mbgl. This aquifer is considered to be in continuity with the Lansdowne River.

The groundwater is slightly acidic, with pH ranging from 6.0 to 6.2, and fresh, with an electrical conductivity of 18.30 to 18.89 µS/cm (Douglas Partners, 2022). The average groundwater temperature is 20.3 ^{o}C.

3.8.3 Registered groundwater bores

A search of available information relating to the study area was conducted on 5 December 2022 through the WaterNSW website. The search identified zero registered groundwater extraction bores within the proposal area, although there are up to 30 within 2 km of the proposal area Most of these groundwater bores are registered for agricultural water supply, specifically for livestock.

3.8.4 Groundwater users

Groundwater users within the study area utilise the shallow alluvial aquifer for agricultural purposes. Water quality in this aquifer is generally fresh, making it potable or suitable for stock watering purposes.

3.8.5 Groundwater dependant ecosystems

Groundwater dependant ecosystems are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater (Department of Land and Water Conservation, 2002). The groundwater dependence (or interaction) of vegetation communities within the study area is determined by aligning them with the GDE types identified by Eamus et al. (2006).

The Biodiversity Assessment Report (WolfPeak 2023) (Appendix D to the REF) found no high potential GDEs within the study area. However, habitats around the study area would have some likely groundwater dependence.

Areas of high-potential to support GDEs within the study area are shown in Figure 3-15 and include terrestrial vegetation associated with subsurface groundwater located at:

- Lansdowne River
- Southern bank of Coopernook Creek northeast of the proposal area
- The stand of vegetation to the east of the proposal area
- Patches within the south-western extent of the proposal area.

AECOM

N

0 200 400 m

FIGURE 3-15:

POTENTIAL GDE NEARTHE PROPOSAL AREA

Legend

- Study area
- Proposal area
- Construction footprint
- Ancillary facilities
- Road design
- Watercourse
- Drainage line

Potential Groundwater Dependent Ecosystems

- High
- Medium
- Low

Ancillary facilities are subject to change during the final design refinements.

3.8.6 Groundwater quality alteration

Based on the PSI (AECOM 2022), potential contamination sources within the study area include agricultural land use (pastoral and dairy farming), road constructions, Pacific Highway and associated local roads. These locations have the potential to leach contaminates into the groundwater, although no evidence of this was found in the publicly listed data reviewed for this assessment.

4.0 Impact assessment

4.1 Construction impacts

This chapter discusses the potential impact of the construction phase activities on surface water and groundwater.

Although early works may be required, it is expected that the construction of the final scheme will commence in 2027. The proposal is anticipated to involve the following general work methodologies and sequencing:

- Potential early works (i.e. additional pre-loading)
- Site establishment work, including set up of ancillary facilities and compound areas
- Utility relocations
- Vegetation clearing
- Earthworks and drainage
- Bridge construction, including approaches and roundabouts
- Pavement construction, including local roads
- Landscaping and finishing work
- Removal of ancillary facilities and site rehabilitation.

The bridge construction will interface with the Pacific Highway and local roads, where both routes may require temporary diversions, night work, and temporary barriers to manage safety.

Constructability considerations include:

- Bridge abutment and pier construction – the space available for plant and machinery to access the abutment and pier locations, may also impact pile types and numbers.
- Batter treatments – the height and slope of the batters will affect stormwater management, revegetation and safety of the maintenance and public access around the area.
- Existing ponding and drainage – there are existing drainage challenges on site. For the installation of new drainage infrastructure and elements below the water table, there is the potential for dewatering measures to be required. These can be costly and generate environmental management requirements.
- Soft soils – working in and around soft soils creates challenges in designing infrastructure and undertaking construction. The selection of equipment, the ability to resume work after wet weather and how staging can be managed are all affected.
- Excavation into Potential Acid Sulfate Soils (PASS) – piling and excavation (e.g. culverts) into PASS may require treatment of excavated materials or removal from the site, both of which can be costly and generate environmental management requirements.

Detailed work methodologies will be developed during detailed design and construction planning. Activities may vary to suit the construction staging plans, which the construction contractor would determine.

A range of construction activities could impact water resources. These include:

- Impacts to surface water quality due to construction and operational activities
- Impacts of accidental oil or fuel spills or leaks
- Impacts on groundwater
- Flooding and drainage impacts.

Groundwater impacts could be associated with:

- Piling activities (soil and water generation)
- Groundwater quality affecting construction materials
- Construction vehicles accidental oil or fuel spills or leaks
- Interaction with PASS.

Proposed management or mitigation measures are provided in Section 5.0.

4.1.1 Surface water quality

Construction activities represent a risk to surface water quality within local receiving waters, including Coopernook Creek, Lansdowne River and Manning River. During runoff events or flood conditions, sediment-laden waters, chemicals stored on-site, and construction waste have the potential to mobilise and enter waterways.

Generation of sediment-laden waters and off-site discharge can occur during construction activities such as:

- Clearing and grubbing
- Stockpiling of materials
- General earthworks
- Temporary works (i.e. access roads, compounds, laydown areas and pads)
- Construction of bridge piers and abutments along the Pacific Highway
- Placement of fill for embankments.

Sediment-laden waters pose a potential risk to downstream surface water quality. Water quality impacts include (but are not limited to) increased turbidity, elevated concentration of nutrients and other pollutants, such as heavy metals and organic chemicals.

Other potential sources that may impact surface water quality during construction activities include:

- Fuel or oils used by construction equipment
- Concrete wastes
- Concrete curing compounds
- Waste and litter from building activities and personnel
- Release of nutrients from fertilisers, herbicides and pesticides (e.g. used in site landscaping)
- Paint and paint wastes
- Acids from acid-based washes
- Disturbance of contaminated or acid sulfate soils may adversely affect water chemistry, including pH and dissolved solids.

A description of the potential impacts of construction, with reference to the water quality indicators provided in Table 3-5, is provided in Table 4-1.

Table 4-1: Assessment of the impact of HW10 Harrington intersection upgrade on environmental values and associated indicators of the NSW WQOs

Key indicator	Trigger value	Discussion	Likelihood of impact
Chlorophyll-a	Aquatic ecosystems (upland rivers): 3 ug/L	Increased Chlorophyll-a in the water indicates that plants, algae or cyanobacteria are growing. This is usually measured in a waterbody and is not a typical stormwater pollutant.	Chlorophyll-a is not expected to be present in runoff from construction activities, and therefore, the proposal is expected to have ***negligible*** impact on Chlorophyll-a in receiving waters.
Total Phosphorus (TP)	Aquatic ecosystems (lowland rivers): 25 µg/L	Excessive phosphorus could lead to the stimulation and growth of nuisance plants, which could dominate and change the dynamics of the aquatic ecosystem (e.g. eutrophication, algae and macrophytes). Agricultural activities in the surrounding areas would also contribute TP to the Lansdowne River, with these activities disturbing the ground.	Road construction programming typically involves clearing vegetation and stripping topsoil as one of the first activities. The majority of TP is expected to be available in topsoil. Mobilisation of topsoil in runoff may occur during construction of the proposal, therefore, can cause an increase in TP in receiving waters if not appropriately managed during construction. Environmental safeguards are discussed in Section 5.0. Local erosion and sedimentation controls should be provided before the commencement of disturbance for topsoil stockpiles (e.g. cover crops and bunds). Where required, excess runoff from disturbed topsoil areas should be captured by construction sedimentation controls as outlined in the CEMP that reduce TP by retention, settlement, removal, and management of deposited sediment. Elevated TP in receiving waters has the potential to cause harm to the health of aquatic environments. Implementing recommended management measures and safeguards would minimise the risk of this occurring to ***low***.

Key indicator	Trigger value	Discussion	Likelihood of impact
Total Nitrogen (TN)	Aquatic ecosystems (lowland rivers): 350 µg/L	Excessive nitrogen could lead to the stimulation and growth of nuisance plants which could dominate and change the dynamics of the aquatic ecosystem (e.g. algae and macrophytes). Agriculture activities in the area surrounding the proposal would contribute TN to the Lansdowne River, with these activities disturbing the ground.	Road construction programming typically involves clearing vegetation and stripping topsoil as one of the first activities. The majority of TN is expected to be available in topsoil. Mobilisation of topsoil in runoff may occur during the construction of the proposal, therefore, can cause an increase in TN in receiving waters if not appropriately managed during construction. Environmental safeguards are discussed in Section 5.0. Local erosion and sedimentation controls should be provided before the commencement of disturbance for topsoil stockpiles (e.g. cover crops and bunds). Elevated TN in receiving waters has the potential to cause harm to aquatic environments. With the implementation of management measures and safeguards, the risk associated with construction activities increasing nitrogen levels is considered ***low***.
Dissolved Oxygen (DO)	Aquatic ecosystems (Lowland rivers): 85% Drinking water: >80%	The dissolved oxygen concentration in a water body is highly dependent on temperature, salinity, biological activity (microbial, primary production) and rate of transfer from the atmosphere.	Construction of the proposal would not likely result in increased runoff from the site or increased agricultural or urban activities, which may increase DO concentration. Based on the level of ponding water in the surrounding landscape, no substantial change is expected in DO concentrations from proposed site runoff compared to receiving waters; therefore, the likelihood of direct impacts is considered low. Indirectly, a reduction in DO concentrations downstream could occur if site runoff contains elevated levels of nutrients (TN, TP) or total suspended sediments (TSS). With the implementation of management measures (Section 5.0) and safeguards contained herein, the risk associated is considered ***low***.

Key indicator	Trigger value	Discussion	Likelihood of impact
pH	Aquatic ecosystems (lowland rivers): 6.5 – 8.0	pH is a measure of the acidity or alkalinity of water and has a scale from 0 (extremely acidic) to 7 (neutral) through to 14 (extremely alkaline).	Construction activities have the potential to adversely alter the pH of receiving waters. Based on the study area's geological properties and soil landscape, the site has a high probability of encountering PASS, which can release acid if disturbed. With the implementation of safeguards in Section 5.0, the construction activities would have a ***low*** likelihood of impacting the pH of receiving waters.
Electrical Conductivity (EC)	Lowland rivers may have higher conductivity during low flow periods with saline surface water and groundwater inputs. 125 – 2200µS/cm	Conductivity is one way to measure the inorganic materials, including calcium, bicarbonate, nitrogen, phosphorus, iron, sulphur and other ions dissolved in a water body. Salinity is the component of conductivity that is critical to the survival of some aquatic plants and animals.	Construction activities have the potential to adversely alter the EC of receiving waters. The EC of site runoff is likely consistent with the range of salinity historically observed in the Lansdowne River. Therefore, the construction activities have a ***low*** likelihood of impacting EC of receiving waters, and specific mitigations are not required.
Turbidity	Aquatic ecosystems (lowland rivers): 6 – 50 NTU Primary contact recreation: 6 NTU Homestead water supply: 5 NTU Drinking water: Site specific determinant	Turbidity is the presence of suspended particulate and colloidal matter consisting of suspended clay, silt, phytoplankton and detritus. It is measured by a technique called nephelometry which measures the fraction of light scattered at right angles to the light path of water. Increased turbidity can reduce light penetration through the water column and reduce photosynthetic activity. Turbidity increases with sediment load. Agriculture activities in the area surrounding the proposal would contribute to the turbidity of the Lansdowne River.	Construction activities have the potential to increase turbidity and TSS in local waterways through the exposure of topsoils and subsoils (e.g. as a result of the removal of vegetation, general earthworks, temporary works, instream works, placement of fill, and stockpiling of materials). Turbidity and TSS are the principal pollutants of concern associated with road construction projects and occur due to mobilisation (through erosion) and transportation of sediments in runoff. As described in Section 3.7, existing TSS levels are generally high within the surrounding waterbodies. Environmental safeguards are discussed in Section 5.0. A number of mitigation measures would be implemented to manage site runoff and minimise the risk of mobilisation of turbid site water.

Key indicator	Trigger value	Discussion	Likelihood of impact
			Therefore, whilst elevated turbidity and TSS in surface waters have the potential to cause harm, with the implementation of management measures and safeguards, the residual risk associated with the construction of the proposal is considered ***low***.
Temperature	Aquatic ecosystems >80%ile <20%ile Primary contact recreation: 15 – 35°C	Aquatic ecosystem functioning is regulated by temperature. Temperature changes can occur naturally as part of regular daily and seasonal cycles or because of human activities (anthropogenic).	Negligible temperature differences in relative temperature between site runoff and the nearby waterways is expected. The difference in relative volume will also help to disperse differences in temperature in the receiving natural waterway. The construction of the proposal has the potential to adversely increase the temperature of receiving waters. The temperature of surface water run off may be warmer than receiving waters, which when mixed, may increase the temperature of receiving waters. However, with the implementation of safeguards in Section 5.0, the potential impact of temperature changes from site runoff is considered to be ***low*****.**
Chemical contaminants	Livestock water supply: See Table 4.3.2 ANZECC guidelines 2000 Irrigation water supply: See Table 4.2.10 ANZECC 2000 Secondary contact recreation and primary contact recreation: no chemicals that are either toxic or irritating to the skin or mucous membranes Homestead water supply: See Guidelines for Inorganic Chemicals in the Australian Drinking Water Guidelines	Chemical contaminants are likely from spills during construction or toxicants made soluble when runoff occurs over disturbed soils. The Coopernook Creek and Lansdowne River are subject to runoff from Coopernook township, which can be contaminated by households and businesses that use fertilisers and other potential chemical contaminants. Agriculture activities in the area surrounding the proposal would potentially contribute to the mobilisation of contaminants in soils	The construction of the proposal has the potential to contaminate surrounding receiving waters through the use of various chemicals on-site. Potential sources of chemical contamination from spills or mobilisation in runoff include fuel and oils used by construction plant and equipment, concrete curing compounds, waste, fertilisers, herbicides and pesticides (used in site landscaping), paint and paint wastes, acid from acid-based washes and the disturbance of contaminated soils. Management measures and safeguards to reduce the risk of spills or contaminants reaching the receiving water bodies include safe storage and containment of chemicals, management of temporary drainage or bunding where required, and containment and clean-up procedures in the event of a spill/pollution incident.

Key indicator	Trigger value	Discussion	Likelihood of impact
	Drinking water: see ANZECC 2000 guidelines. Aquatic foods (cooked): Copper <5 µgm/L, mercury <1 µgm/L, zinc <5 µgm/L, chlordane <0.004 µgm/L, PCBs <2 µgm/L.	and from the use of fertilisers, herbicides and pesticides.	Spill occurrences would be readily cleaned up as part of pollution and incidence responses detailed within the proposal CEMP. Therefore, whilst contamination in surface waters from spills or other sources has the potential to cause harm, with the implementation of management measures and safeguards would reduce the risk of contamination to ***low***.
Faecal coliforms	Primary contact recreation: < 150 cfu/100mL Irrigation water supply: <100 cfu/ 100mL (raw human food crops, no direct contact) <1000 cfu/ 100mL (pasture and fodder for grazing animals) Secondary contact recreation: <1000 cfu/100mL, with 4 out of 5 samples < 4000 cfu /100mL Homestead water supply and drinking water: 0 cfu/100mL Aquatic foods (cooked): 14 MPN/ 100mL (shellfish), 2.3 MPN/ g (fish).	Coliforms are bacteria present in the digestive tracts of animals (including humans) and are found in their wastes. Coliforms are used as an indicator of faecal contamination.	There is potential or faecal coliforms to contaminate receiving environments surrounding the proposal through use of temporary amenities within Ancillary facilities during construction. With the implementation of appropriately managed amenities by the contractor, there is a ***low*** likelihood of environmental impact due to faecal coliforms in surface water from construction activities associated with the proposal.
Algae and blue green algae	Visual amenity: not present in unsightly amounts Livestock water supply: < 11,500 microcystins <2.3 µg/L cells/ mL Irrigation water supply: not visible Secondary contact recreation and primary contact recreation: <15000 cells/mL	Blue-green algae are a type of bacteria known as cyanobacteria. They photosynthesise using sunlight to produce oxygen. Low levels of blue-green algae are present in freshwater all the time. However, a series of favourable environmental factors can lead to a blue-green algae bloom, including warm water temperatures, sunny days, and	Construction activities can potentially increase favourable conditions for blue-green algae to grow within receiving waters. Elevated temperature and nutrients (TN and TP) in discharge from construction activities can contribute to algal blooms in the receiving waters downstream of the proposal. However, this increased likelihood is minimal when comparing the relatively small contributing catchment associated with the study area, to the Lansdowne River sub-catchment (215 km^2), Manning River

Key indicator	Trigger value	Discussion	Likelihood of impact
	Homestead water supply: <1000 algal cells/mL <u>Drinking water:</u> <2000 algal cells/mL	nutrients. Blooms lead to environmental and visual impact.	catchment (8420 km^2), and other contributing land uses (i.e. agriculture, urban development). Further, given the proposed management measures and safeguards proposed herein, the likely risk of this potential impact is considered ***low***.
Visual clarity and colour	Visual amenity and secondary contact recreation and primary contact recreation: Natural visual clarity not reduced more than 20%. Natural hue not to be changed more than 10 points on the Munsell Scale. The natural reflectance is not changed more than 50%.	Clarity is a measure of how clear or transparent water is. It indicates how much light is available for photosynthesis at different depths.	This indicator is largely assessed above in relation to turbidity and TSS. There is potential for discoloured or turbid water to enter receiving waterways from surface water runoff from the proposal area or Ancillary facilities. However, given the proposed mitigation of surface water quality risks to reduce erosion and sediment loads in construction site discharges, there is a ***low*** likelihood that site discharge would adversely impact this environmental value.
Enterococci	<u>Secondary contact recreation:</u> < 230 enterococci per 100 mL Primary contact recreation: 35 cfu/100 mL	Intestinal enterococci are a functional group of organisms from the Enterococcus and Streptococcus genera that are excreted in human and animal waste and are used as an indicator of faecal contamination.	There is potential for construction activities to contribute to the level of enterococci within receiving waterbodies though the introduction of temporary amenities use by contacted staff within Ancillary facility areas. With the implementation of appropriately managed amenities by the contractor, there is a very ***low*** likelihood of environmental impact due to enterococci in surface water from construction activities.
Protozoans	Primary contact recreation: Absent	Protozoans are waterborne pathogens that indicate water contaminated with human or animal waste.	Construction activities have the potential to contribute to the level of protozoans within receiving waterbodies. There is a very ***low*** likelihood of environmental impact due to protozoans in surface water from construction activities.

4.1.2 Flooding

Flood impacts due to the construction of the ancillary facilities for the proposal have not been modelled, however, the proposal has the potential to impact on the flood regime in the surrounding area. The proposal has the potential to increase flood levels, redistribute drainage flows, increase inundation time, and increase velocities by altering the local topography. These impacts can be caused by both the location of construction ancillary facilities and construction work within the proposal area as earthworks and drainage systems progress.

A potential impact associated with flood prone areas, involves the movement of materials, fuel, chemicals and equipment stored in an ancillary site, which may impact the surrounding environment. To reduce the risk, the ancillary sites would be located outside flood-prone areas. Recommended safeguards would further reduce the construction impacts on flooding.

Further impacts may arise from the establishment and use of ancillary facilities. The placement of ancillary facilities has the potential to redistribute flood waters into the surrounding areas or has the potential to be inundated during a flood event. The impact of construction ancillary facilities on flooding and drainage pathways would be investigated further in the detailed design phase of the proposal to minimise the risk of this occurring.

4.1.3 Groundwater

The proposal would not likely directly or indirectly interfere with groundwater flows associated with identified or potential GDEs within the study area, as none have been previously identified.

Piling activities required for the overpass foundation construction have the potential to disturb the soil and water within the aquifer, either by increasing turbidity or dewatering. The potential impact of this is considered high given the shallow depths of groundwater (from 1.0 mbgl). With the implementation of mitigation measures and safeguards below, the likely impacts from piling works would be minimised.

PASS contamination may also occur from piling activities, where works are inappropriately managed within a PASS risk area, where PASS may oxidise to ASS and alter the acidity of the groundwater. As the proposal area is located within an area mapped as having PASS, the risk of PASS contamination would be considered high. The risks and impacts of this would be managed in accordance with a ASS Management Plan prepared for the proposal prior to construction. With the implementation of the ASS Management Plan, the likely risk of PASS contamination would be minimised.

The high potential GDE mapped in the areas within the study area (near Lansdowne River and Coopernook Creek) would unlikely be directly impacted by the proposal based on the distance from the proposal area and ancillary facilities. The proposal has the potential to indirectly impact these GDEs through sedimentation and changes to hydrology. Mitigation measures would be included in the proposal to reduce impacts on GDEs, including minimising interruptions to water flows during detailed design.

Rainfall recharge is recognised to occur across the proposal area and within the surrounding land. The addition of an overpass and alteration of road design to include roundabouts would not likely significantly alter the recharge area.

Any excavation or cuts in the topography required to accommodate the proposal can result in groundwater discharge (dewatering) if the cuts extend below the water table. Based on the information presented in Section 3.6, there is potential for groundwater interception as the groundwater level has been recorded from 1.0 mbgl.

Potential sources of chemical contamination include oil and fuel leaks (construction plant and vehicles) and chemical spills into groundwater. Impacts could potentially occur from the concrete curing compounds, waste, fertilisers, herbicides and pesticides (used in site landscaping), paint and paint wastes, acid from acid-based washes, and disturbance of PASS. With the implementation of recommended safeguards, the likely risk of this would be low.

Spills would be readily cleaned up as part of pollution and incident responses detailed within the proposal CEMP and would be addressed by the proposed discharge limits (pH criteria and visible oils and grease). The potential for impacts to groundwater from surface spills is considered low with the implementation of management measures and safeguards.

4.2 Operational impacts

Operational impacts which have the potential to arise from the proposal include:

- Impacts on surface water quality due to operational activities
- Impacts on surface water quality due to accidental oil or fuel spills or leaks
- Impacts on operational drainage
- Impacts on groundwater
- Impacts of the proposal on existing flooding regimes
- Flood immunity of the proposal.

These are assessed respectively below.

4.2.1 Surface water quality

A potential impact on surface water quality during the operation of the proposal is pollutants and contaminants from the surface of the road being conveyed during runoff events to receiving waters. Potential contaminants include litter, sediment and suspended solids, nutrients, heavy metals and toxic organics, oils and surfactants.

Potential sources include:

- Exhaust particles from vehicle engines
- Wear products from brakes, tyres and other mechanical parts
- Minor discharges from vehicle engines, including fluids, lubricants and other similar materials
- Minor discharges from leaking or damaged loads
- Litter or other waste
- Loss of goods and other materials due to vehicle incidents and accidents.

4.2.2 Accidental spills

An assessment was undertaken to review the risk of accidental spills during operation of the proposal. The assessment was a qualitative assessment of the risk and potential impact on the environment (refer to Table 4-2). This assessment does not address the risk posed to road user safety following a spill.

Table 4-2: Assessment of operational accidental spills

Item	Assessment
Mode of conveyance	The two primary modes of conveyance are: • Stormwater drainage systems • Liquids The speed of travel through these modes of conveyance is dependent on the slope of the area and the viscosity of the liquid. This assessment assumes the worst-case scenario, and it would be expected that a liquid spill would have a low viscosity.
Hazard identification	The primary source of chemical spills during operation would be the loss of tankered chemicals following a crash.
Environment at risk	Environmentally sensitive receivers include Lansdowne River, Coopernook Creek and Manning River. At the closest point, the proposal area is ~50 m north of Lansdowne River, and the southern George Gibson Drive Ancillary facility is about 10 m of Coopernook Creek.

Item	Assessment
Risk assessment	The probability of a potential spill is low as the intersection upgrade provides a safer road design, reducing the risk of accidents. Additionally, legislative controls require safeguards to be installed on vehicles transporting hazardous liquids, further minimising the risk of accidental spills.
Spill containment	Operational drainage pathways are to the east during a flood event, creating storage in the floodplain. The potential impact of spills on nearby waterways is considered low. The gently sloping land would provide enough attenuation and storage for the spill to be contained and treated through emergency response procedures. With the low flow velocities across the associated river floodplains in high flow conditions, the mixing and dispersion of contaminants would be attenuated. Therefore, the potential for spills to reach and adversely impact Lansdowne River and Manning River is considered low.

Since the project would improve safety through safer circulation and improved roads, the risks of spills after the implementation of the project are expected to be lower than the existing design.

4.2.3 Impact of the proposal on drainage flows

The proposed drainage arrangement would utilise existing drainage culverts and ponding areas to manage surface water flows. At the proposed roundabouts, kerb outlet drains and batter chutes would convey water from the kerb and gutters to the areas around the roundabouts which are subject to water storage. Along the bridge, water flows along the road shoulder where the water is eventually captured by pits at the end of the approach slabs.

Similar to the existing operation of the road, drainage from the road surface would ‘pond’ in the areas around the interchange.

4.2.4 Impact of the proposal on flood regime

The operation of the proposal would have a minimal impact on natural drainage flows. The flood risks to life and properties around the proposal area remain relatively unchanged from existing conditions as shown in Figure 4-1 to Figure 4-5. Flooding across the study area is categorised as flood storage, as the topography of the area is relatively flat and existing culverts and pipes around the proposal area were at full capacity at both existing and proposed design conditions.

A summary of the potential flood impacts resulting from the proposal includes:

- Peak flood level changes by less than 0.02 m around the proposal area
- A general minor change to the flow distribution across the floodplain (less than 1%)
- Inundation duration across the flood plain remains largely unchanged (except for the roundabouts, which have raised elevations compared to existing conditions).

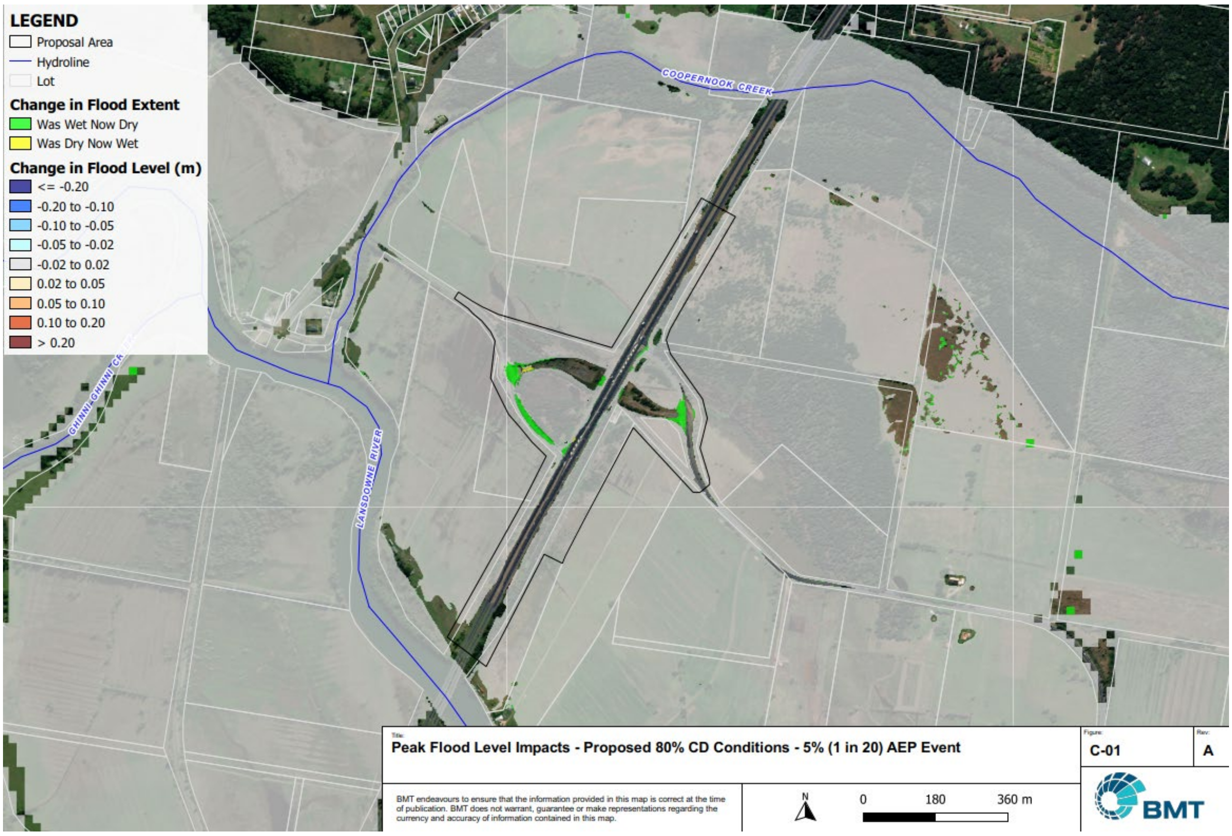

Figure 4-1: Peak flood level impacts – Proposed 80% CD conditions – 5% (1 in 20) AEP event

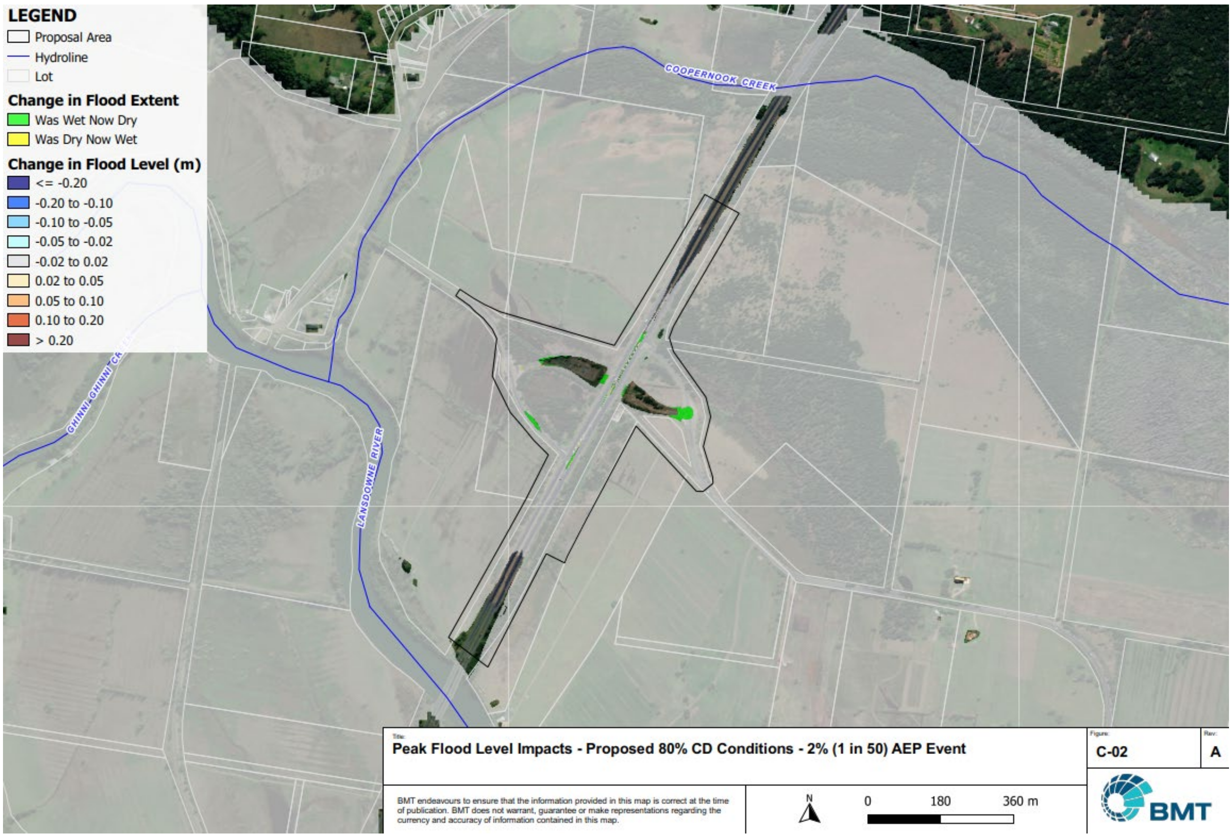

Figure 4-2: Peak flood level impacts – Proposed 80% CD conditions – 2% (1 in 50) AEP event

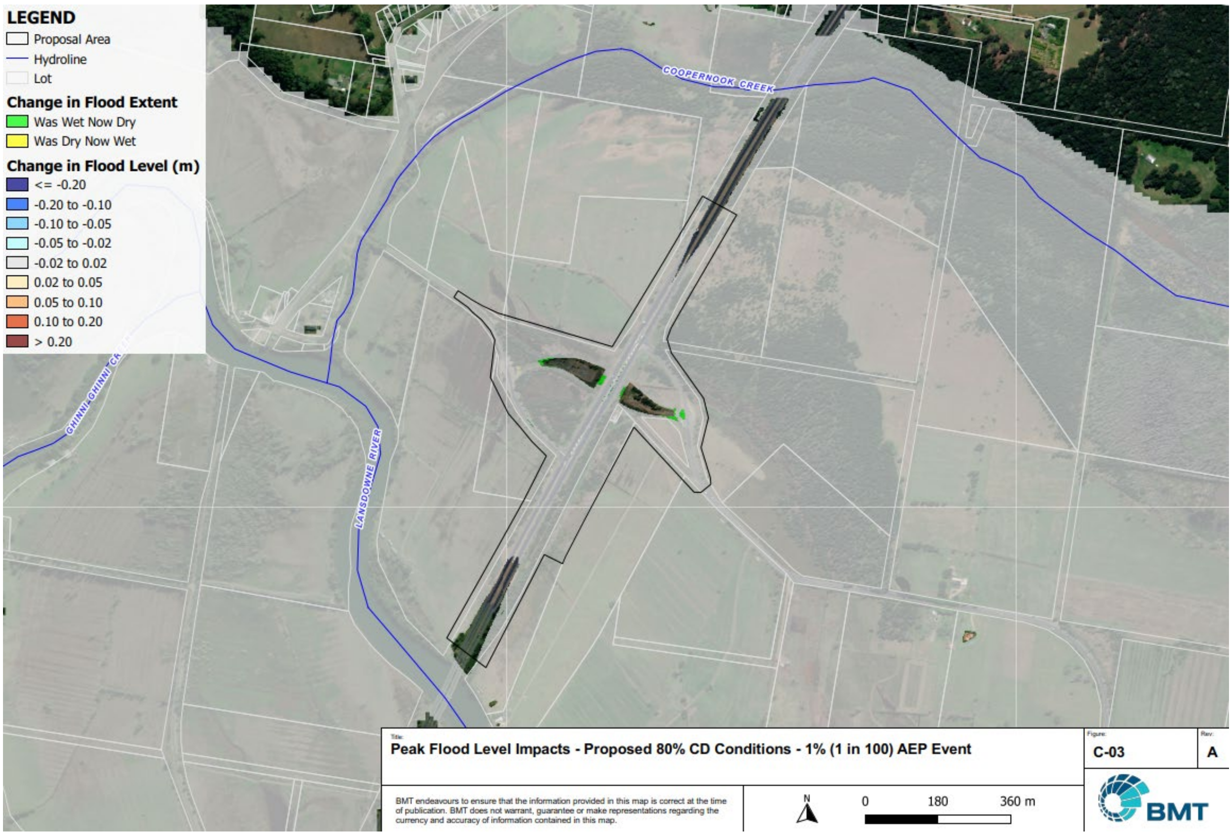

Figure 4-3: Peak flood level impacts – Proposed 80% CD conditions – 1% (1 in 100) AEP event

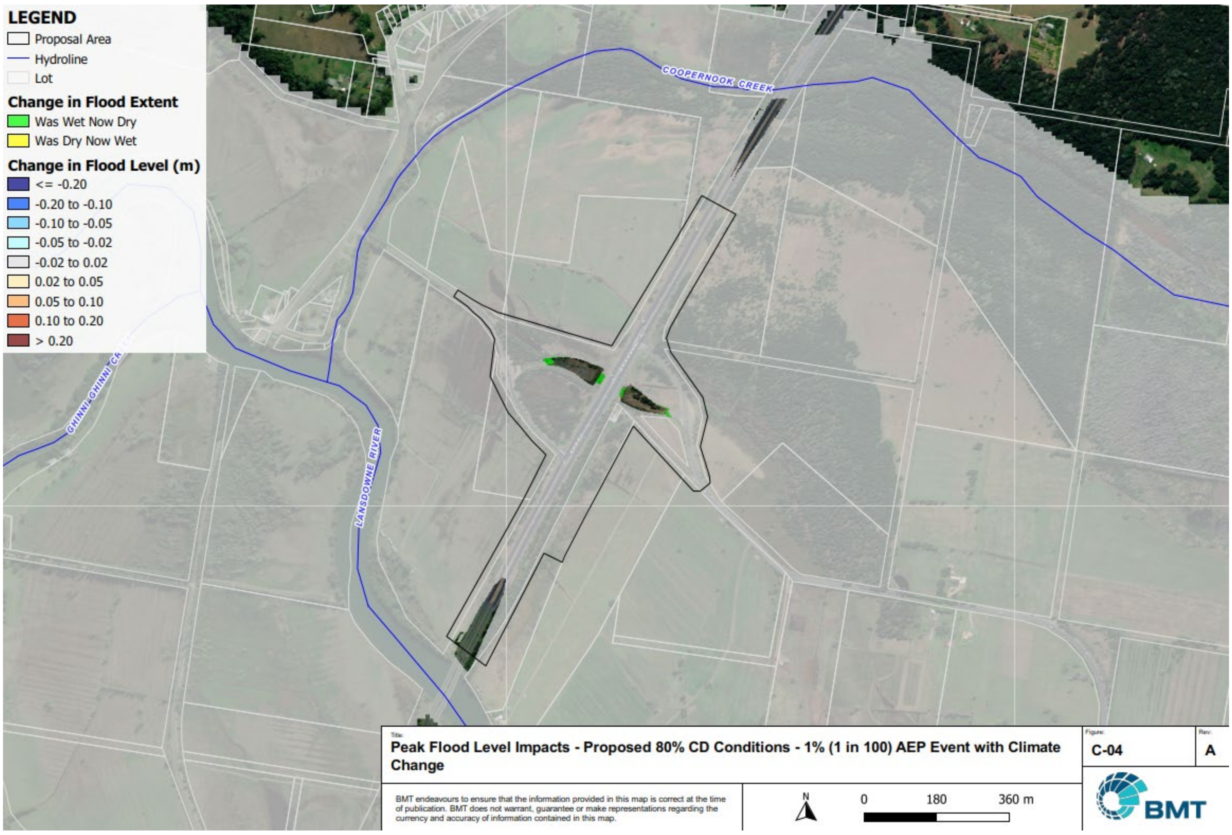

Figure 4-4: Peak flood level impacts – Proposed 80% CD conditions – 1% (1 in 100) AEP event with Climate Change

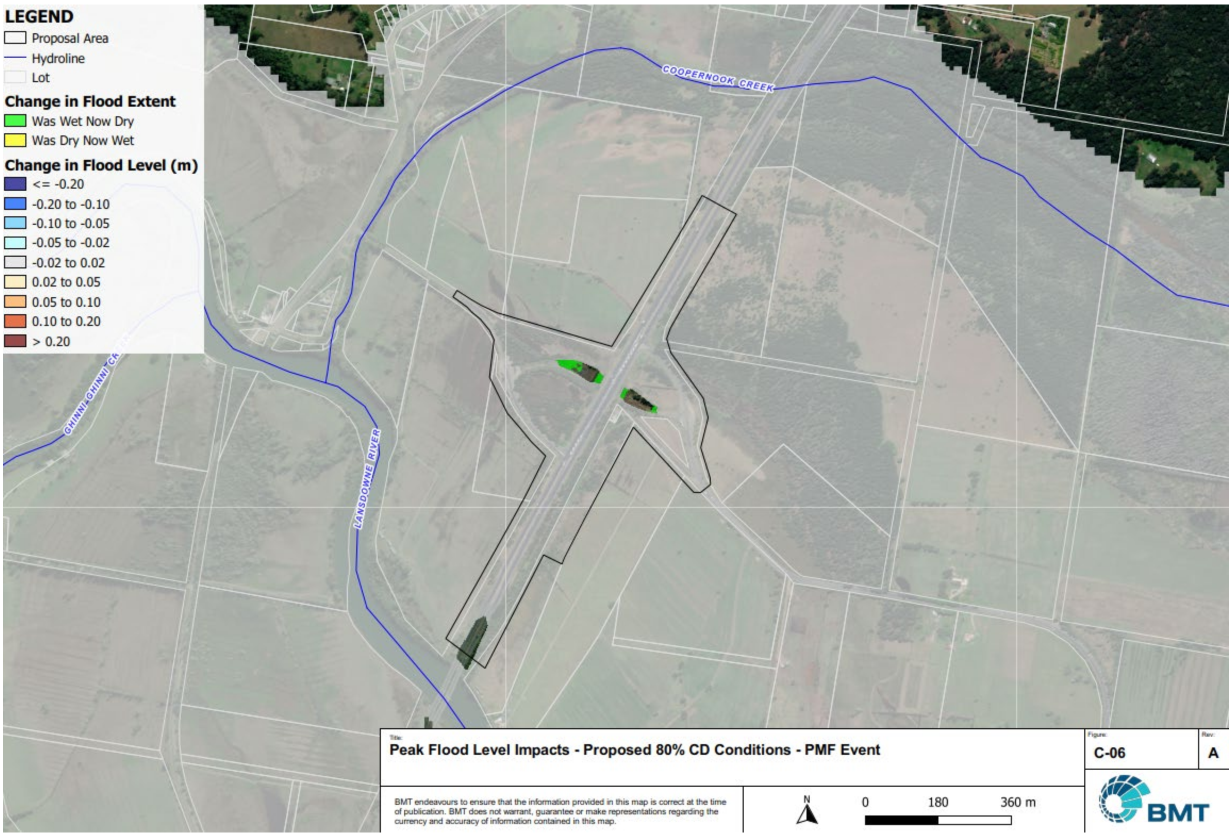

Figure 4-5: Peak flood level impacts – Proposed 80% CD conditions – PMF event

4.2.5 Flood immunity of the proposal

The existing Pacific Highway between Coopernook Creek and Lansdowne River would generally be flood free up to 1 in 20 AEP events. Minor encroachment of flood waters on the northbound Pacific Highway Road carriageway is likely. However, this section of the highway would only be overtopped and completely subject to flood inundation during events from 1 in 50 AEP.

The proposed eastern roundabout and embankment would be flood free for the 1 in 20 AEP event, while the proposed western roundabout would be inundated in the same event, but not the embankment. The eastern roundabout would be fully inundated at the 1 in 100 AEP event and greater.

The proposed overpass over the Pacific Highway would not be inundated in the PMF event, and flood waters would not reach the soffit of the bridge deck. As the flood immunity criteria based on Transport's specifications are met, and minimal adverse changes to flood immunity and risk are likely, no additional mitigation measures are recommended (BMT, 2022).

During a PMF flood event, the drainage path would remain generally the same as existing conditions, where overland flows would travel from the west to the east. The operation of the proposal would not likely significantly impact on drainage flows within the locality.

4.2.6 Groundwater

The potential GDEs within the study area may be impacted by runoff, both directly and indirectly, from the proposal. The potential for interaction with groundwater during operation is considered to be moderate, given the expected depth of groundwater in the study area.

If a pollution incident (refer to Section 4.1) were to occur, there is potential for environmental harm.

However, under normal operating conditions, the proposal is not expected to result in any changes to the quality of groundwater in the local or regional aquifers. Similarly, impacts on groundwater availability would be negligible as the proposal does not require any significant groundwater extraction. Nor would it inhibit recharge. The operation of the proposal would not likely impact GDEs.

5.0 Avoid, minimise and mitigate impacts

The safeguards and management measures for the management of potential surface water, groundwater and flooding impacts are summarised in Table 5-1 below.

Table 5-1: Summary of Safeguard and Management Measures

Impact	Environmental safeguards	Responsibility	Timing
General	A Soil and Water Management Plan will be prepared in accordance with QA Specification G38 and implemented as part of the CEMP. The Plan will identify all reasonably foreseeable risks relating to soil erosion and water pollution associated with undertaking the activity and describe how these risks will be managed and minimised during construction. That will include arrangements for managing pollution risks associated with spillage or contamination on the site and adjoining areas and monitoring during and post-construction.	Construction Contractor	Preconstruction / Construction
Acid Sulfate Soils	An ASS Management Plan would be prepared and implemented as part of the CEMP to minimise the risk of PASS contamination in soils, waterways and groundwater in the site and adjoining areas. The ASS Management Plan will address, but not limited to: • Identification process for PASS • Management of identified PASS • Maintenance of plant and equipment in contact with PASS • Emergency management, including notification, response and clean-up procedures.	Transport Construction Contractor	Preconstruction / Construction
Contamination	A contaminated lands unexpected finds procedure would be developed as part of the Construction Environmental Management Plan (CEMP) for the proposal and implemented during the construction phase.	Construction Contractor	Preconstruction / Construction
Erosion and sediment control mitigation			
Erosion and sediment control	A site-specific Erosion and Sediment Control Plan will be prepared and implemented. The plan will identify detailed measures and controls to be applied to minimise erosion and sediment control risks, including, but not limited to: runoff, diversion and drainage points; Sediment management devices, such as fencing, hay bales, sandbags or sumps; scour protection; stabilising disturbed areas as soon as possible, fencing and swales; and staged implementation arrangements.	Construction Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	The plan will also include arrangements for managing wet weather events, including monitoring potential high-risk events (such as storms) and specific controls and follow-up measures to be applied in the event of wet weather.		
Erosion and sediment control	Stockpiles will be designed, established, operated and decommissioned per the RTA Stockpile Site Management Guideline 2011.	Construction Contractor	Construction
Erosion and sediment control	The rehabilitation of disturbed areas will be undertaken in accordance with: • Landcom's Managing Urban Stormwater: Soils and Construction series • RTA Landscape Guideline (2018) • RMS Guideline for Batter Stabilisation using Vegetation (2015).	Construction Contractor	Construction
Erosion and sediment control	Consistent with any specific requirements of the approved Soil and Water Management Plan, control measures will be implemented to minimise risks associated with erosion and sedimentation and entry of materials to drainage lines and waterways. That will include, but not limited to: • Sediment management devices, such as fencing, hay bales or sandbags • Measures to divert or capture and filter water before discharge, such as drainage channels and first flush • Scour protection and energy dissipaters at locations of high erosion risk • Installation of measures at work entry and exit points to minimise movement of material onto adjoining roads, such as rumble grids or wheel wash bays • Appropriate location and storage of construction materials, fuels and chemicals, including bunding where appropriate.	Construction Contractor	Construction
Erosion and sediment control	Batters will be designed and constructed to minimise the risk of exposure, instability and erosion and to support long-term, ongoing best practice management per Roads and Maritime 'Guideline for Batter Surface Stabilisation using Vegetation' (2015).	Transport Project Manager / Construction contractor	Detailed design / construction
Water quality			
Surface water	A Spill Management Plan will be prepared and implemented as part of the CEMP to minimise the risk of pollution arising from spillage or contamination on the site and adjoining areas. The Spill Management Plan will address, but not necessarily be limited to: • Management of chemicals and potentially polluting materials • Any bunding requirements • Maintenance of plant and equipment	Construction Contractor	Preconstruction / construction

Impact	Environmental safeguards	Responsibility	Timing
	• Emergency management, including notification, response and clean-up procedures		
Surface water	During the development of the detailed design, there is to be consideration of additional water quality measures within the drainage design, including (but not limited to): • Grassed embankments as buffer strips • Grass-lined channels as swales • Existing ponded areas as wetlands.	Transport	Preconstruction
Surface water	If an EPL is required, water quality requirements as stipulated under the EPL will be implemented.	Construction Contractor	Construction
Acid Sulfate Soils	If encountered, PASS would be managed in accordance with the RTA Guidelines for the Management Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze (2005).	Construction Contractor	Construction
Groundwater			
Groundwater	Any dewatering activities will be undertaken in accordance with the RTA Technical Guideline: Environmental Management of Construction Site Dewatering (2011) in a manner that prevents pollution of water.	Construction Contractor	Detailed design / Construction
Flooding			
Flood	A Flood Response Management Plan will be prepared as part of the CEMP. The Flood Response Management Plan will address, but not necessarily be limited to: • Processes for monitoring and mitigation of flood risk. • Steps to be taken in the event of a flood warning, including removal or securing of loose material, equipment, fuels and chemicals.	Construction Contractor	Construction

6.0 Conclusion

This report has assessed and identified surface water and groundwater impacts that may occur as a result of the construction and operation of the proposal.

6.1 Surface water quality

Construction activities represent a risk to surface water quality within local receiving waters. Rainfall events during construction activities can potentially mobilise contaminants from the proposal area or ancillary facilities to the receiving waterways. Through appropriate mitigation and management measures, the water quality impacts resulting from construction activities is low. These measures include implementation of the CEMP, erosion and sedimentation controls and spill management.

A potential impact to surface water quality during operation as a result of contaminants entering receiving waters would be appropriately mitigated through the formal implementation of various spill management measures and associated civil infrastructure.

6.2 Flooding

The flood behaviour of the study area is well understood. The proposal is unlikely to significantly impact on flood regimes within construction or operational phases of the proposal.

Mitigation measures would be implemented to minimise the impacts of construction on flooding, including the preparation of a Flood Response Management Plan containing environmental controls in the event of a significant weather event. This would include the appropriate method of handling, storage or removal of loose materials, equipment, fuels and chemicals.

With the assessment of existing flood regimes, flood immunity of the project design was evaluated. The design has considered the requirement to minimise potential flooding impacts on upstream and downstream properties and has factored in an increase in rainfall intensity to evaluate the effects of climate change. During flood events, the drainage path was modelled to flow in a general west to east direction, away from Coopernook Creek and Lansdowne River. No additional flood risks to surrounding properties and biodiversity were considered likely, and as such, no further mitigation measures have been recommended.

6.3 Groundwater

The groundwater system within proximity of the proposal is an alluvial aquifer. Minimal interaction with groundwater may occur during piling and excavation activities for the proposal. No GDEs are expected to be impacted by the proposal. Potential impacts to groundwater from contamination activities, including leaks or spills of fuel, lubricants and other chemicals, would be appropriately mitigated through appropriate emergency response protocols in the CEMP.

Under normal operating conditions, the proposal is not expected to result in any changes to the quality of groundwater in the local or regional aquifers. Similarly, impacts on groundwater availability would be negligible.

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