APPENDIX I

Lachlan River Bridge Modification Project

Surface Water Impact Assessment

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ARTC INLAND RAIL

STOCKINBINGAL TO PARKES (S2P) – LACHLAN RIVER BRIDGE

SURFACE WATER IMPACT ASSESSMENT

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GLOSSARY

AEP	Annual Exceedance Probability. The probability that a design event (rainfall or flood) has of occurring in any 1 year period.
Afflux	With reference to flooding, afflux refers to the predicted change, usually in flood levels, between two scenarios. It is frequently used as a measure of the change in flood levels, between an existing scenario and a proposal scenario.
AHD	Australian height datum
ANZECC	Australian and New Zealand Environment Conservation Council
ANZG	Australia New Zealand Guidelines for Fresh and Marine Water Quality
ARR	Australian Rainfall and Runoff
AIDR	Australian Institute for Disaster Resilience
The Blue Book	The *Managing Urban Stormwater – Soils and Construction* (Landcom, 2004) series of handbooks, also known as the Blue Book, are an element of the NSW Government's urban stormwater program specifically applicable to the construction phase of developments. These provide guidance for managing soils in a manner that protects the health, ecology and amenity of urban streams, rivers estuaries and beaches through better management of stormwater quality.
BoM	Bureau of Meteorology
Catchment	The area drainage by a stream or body of water or the area of land from which water is collected.
DO	Dissolved oxygen
EC	Electrical conductivity
Earthworks	All operations involved in loosening, excavating, placing, shaping and compacting soil or rock.
Erosion	A natural process where wind or water detaches a soil particle and provides energy to move the particle.
Flood prone land	Land susceptible to flooding by the probable maximum flood. Note that the flood prone land is also known as flood liable land.
Floodplain	Area of land which is inundated by floods up to and including the probable maximum flood event (i.e. flood prone land).
GDE	Groundwater dependent ecosystems (GDEs) are defined as ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services'.
Groundwater	Water found in the saturated zone below the water table or piezometric surface
Hydrology	Term given to the study of the rainfall and runoff process, including surface and groundwater interaction; with particular focus on the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.

Impact	Influence or effect exerted by a proposal or other activity on the natural, built and community environment.
km	kilometres
NSW	New South Wales
PMF	Probable maximum flood. The flood that occurs as a result of the probable maximum precipitation on a study catchment. The probable maximum flood is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The probable maximum flood defines the extent of flood prone land (i.e. the floodplain).
Pollutant	Any measured concentration of solid or liquid matter that is not naturally present in the environment.
(the) proponent	Australian Rail Track Corporation (ARTC)
(the) proposal	The construction and operation of the Lachlan River Bridge enhancement section of Inland Rail.
proposal site	The area that would be directly affected by construction works (also known as the construction footprint). It includes the location of proposal infrastructure, the area that would be directly disturbed by the movement of construction plant and machinery, and the location of the storage areas/compounds sites etc., that would be used to construct that infrastructure.
study area	The area that may be directly or indirectly affected by the proposal including receptors downstream of the proposal site.
Runoff	The amount of rainfall that ends up as streamflow, also known as rainfall excess.
TN	Total Nitrogen
TP	Total Phosphorous
TSS	Total Suspended Solids
WM Act	*Water Management Act 2000* (NSW)
Waterway	Any flowing stream of water, whether natural or artificially regulated (not necessarily permanent).

EXECUTIVE SUMMARY

The Stockinbingal to Parkes (S2P) project will enhance approximately 170km of existing ARTC Rail Corridor between Stockinbingal and Parkes.

Enhancement works are required to be undertaken for S2P at discrete sites to achieve the vertical and horizontal clearances and includes modifications, construction or removal of various structural and track assets along the alignment.

This report relates to Lachlan River Bridge (i.e. the proposal) that is located within the S2P section of Inland Rail. Lachlan River Bridge is a multi-span bridge that comprises a single steel span truss crossing Lachlan River.

The bridge was originally constructed in 1912 with the approach spans replaced in 1996. The height of the braces in the truss structure do not provide enough vertical clearance and sections of handrail encroach on horizontal clearance. The proposal involves the modification to the truss structure of the Lachlan River bridge including:

- removal of members within the end frames and along the top of the truss structure and replacement with alternative members
- strengthening of structure with new vertical bracing frames
- strengthening of members at the base of the structure
- patch painting areas of life expired paintwork or complete replacement of coating system.

The purpose of this report is to assess the potential surface water impacts (i.e. including flooding, drainage and water quality impacts) from constructing and operating the proposal.

The proposed works at Lachlan River bridge do not result in changes to existing catchments and existing waterways as there are no changes to the existing height of the structure. The proposed works are above the 0.5% Annual Exceedance Probability (AEP) flood level so waterway flows will not be impacted. As such, no flood impacts are anticipated as part of the proposal in the operation phase. No change the existing rail flood immunity is expected as part of the proposed works.

Presence of construction compounds, stockpiles and the crane pad during construction may temporally impact overland flow paths in the proposal site. This may cause changes to drainage regimes and potential impacts to construction areas. Any construction impacts to overland flow paths will be addressed through construction planning during detailed design. Impacts to drainage and flood behaviour are likely to be temporary, localised, minor and limited to the duration of the construction activities.

Flood emergency management procedures will be prepared, including the evacuation of personnel, to minimise impacts to the construction work as a result of flooding.

The construction of the proposal has the potential to impact water quality of the study area, largely during the construction phase. Vegetation clearing and disturbance of the proposal site has the potential to case erosion and release sediment into the river. Disturbance of lead-based paint on the bridge during construction has the potential to release lead into the river. If construction management and mitigation strategies (i.e. Blue Book and AS4361.1 Guide to Hazardous Paint Management) are applied during the construction of the proposal it is anticipated that there would be limited risk of impacts to water quality.

Given that the proposal is located on an existing operational rail line, there would not be anticipated to be any additional drainage or water quality impacts as a result of the operation of the proposal.

1 INTRODUCTION

1.1 OVERVIEW

The Australian Government has committed to delivering a significant piece of national transport infrastructure that will provide a safe, sustainable solution to the freight challenge that exists on Australia's east coast. The Inland Rail Program is a 1,700-kilometre interstate freight rail corridor that will connect Melbourne and Brisbane, via central-west New South Wales (NSW) and Toowoomba in Queensland QLD). The Stockinbingal to Parkes (S2P) section, is an enhancement project for Inland Rail Program. It is a 173-kilometre section of existing rail corridor located in regional NSW between the towns of Stockinbingal and Parkes.

A number of enhancement works (which do not constitute a complete upgrade of the track alignment) are required to be undertaken in this section, including modifications to, construction or removal of various structural and track assets along the alignment. Due to the number of enhancement works required along the S2P corridor, the environmental approvals have been split into four Review of Environmental Factors (REF) packages.

This Surface Water Impact Assessment has been prepared for the modification works to the Lachlan River Bridge (the proposal) in Forbes, NSW.

1.2 PURPOSE OF REPORT

The purpose of this report is to:

- assess the likely impacts of the proposal on the surface water environment (including flooding and drainage and stormwater/surface water quality) at the proposal site and within adjacent land; and
- identify control measures to reduce the likely impacts of the proposal.

1.2.1 BASIS OF DESIGN

Table 1.1 below summarises relevant criteria considered in this report extracted from the Basis of Design.

Table 1.1 Project requirements – BoD

ITEM	PERFORMANCE CRITERIA	SECTION IN THE REPORT
Flood Immunity	Enhancement works must retain existing; track drainage, flood immunity and flood impacts must be no worse than existing.	Section 5.1
Damage to Infrastructure	— The design must minimise the damage to the railway infrastructure, resulting from overtopping and scour. — If the formation is designed for overtopping with a flood immunity of less than AEP 2%, the railway must be designed to convey overtopping flows without damage. All bridges and culverts shall be designed to reduce the risk of scour. The scour risk will depend on the flow velocity as well as soil and vegetation types. Within upgrade and enhancement projects observational data should be used. — In the absence of soil data, the outlet velocity for all culverts should be less than 2.5m/s. In cases where there is a risk of scour, the design should incorporate scour protection measures to protect the infrastructure. Any design solutions must not inhibit maintenance activities.	Section 5.1.2.1, 5.1.2.2, 5.1.2.3 and 5.1.2.4

ITEM	PERFORMANCE CRITERIA	SECTION IN THE REPORT
Afflux	— For all drainage structures, the afflux must be determined and any impacts outside the railway corridor assessed. — The increase in flood level above the floor level of buildings must be less than 0.01m and this impact criterion must also apply to other sensitive infrastructure. In rural areas or where there is no flooding of buildings, infrastructure or other sensitive locations, this limit will depend on the local circumstances and a higher afflux may be permitted. — The afflux must be calculated at all drainage structures and waterways affected by the rail Infrastructure, including changes to any associated roads, and the changes in flood levels and impacts on properties outside the Rail corridor must be justified.	Section 5.1.2.1
Flood Assessment Procedures	The design must assess afflux produced by the drainage structures. This afflux should be acceptable to stakeholders including local authorities and government agencies, property owners, business operators and any other stakeholders. The allowable afflux will vary depending on specific circumstances, however some guidance is as follows: **a** where there are existing flood prone buildings (habitable and non-habitable), the afflux should be close to zero, with an afflux of 0.01 metre allowed above floor levels of existing buildings **b** the allowable afflux for neighbouring infrastructure such as roads, should generally also be no more than 0.01 metre unless specific permission is obtained **c** in other land use areas, the allowable afflux should be determined based on specific assessments, with a higher afflux possible in particular situations, but a lower afflux is required for specific sensitive locations **d** any relaxation of the allowable afflux will require agreement from all stakeholders and will generally require a risk assessment as well as consultation with affected stakeholders.	Section 5.1.2.1
Climate Change	The ARR interim guidelines may be revised in the future, so the impact of climate change on the design must be assessed considering the possibility that there may be changes in the future via a waiver and/or deviation.	Section 5.1.3
Water Quality	Design to be developed to achieve relevant water quality objectives (WQO) for the receiving waters.	Section 5.2
Environmental Impact	The railway infrastructure will impact on the environment in a number of ways, which must be mitigated. The design of drainage structures must ensure that scour and flow velocities should meet environmental criteria. Other environmental impacts associated with the drainage infrastructure include causing breaks in riparian corridors and impacts on fauna movement, including fish passage. The drainage infrastructure must be designed to meet environmental criteria established by the environmental advisors for the project.	Section 5.2

1.3 PROPOSAL AND LOCATION

The proponent is seeking to modify the Lachlan River Bridge in Forbes, NSW (the proposal). The proposal site shown in Figure 1.2 is located in the township of Forbes, approximately 2km to the south-east of the Forbes Railway Station.

The existing bridge at the proposal site has a truss structure which spans the Lachlan River as shown in Figure 1.1. The bridge was originally constructed in 1918, with the approach spans replaced in 1996. The height of the truss structure does not provide sufficient vertical clearance for double stack freight trains and sections of handrail encroach on horizontal clearance.

The proposal involves modifying the truss structure of the Lachlan River Bridge by removing metal sections from along the top of the structure and installing new angled frames to maintain structural integrity.

Ancillary works include utilities on the bridge and establishing construction compounds, laydown areas, a crane pad and environmental controls. Patch painting would also be required where lead-based paint has been disturbed by the works.

Inland Rail would operate 24-hours per day and would initially accommodate double-stacked freight trains of up to 1,800m in length and up to 6.5m high. Train speeds would vary according to axle loads and range from 80km to 115km per hour. It is estimated that S2P would be trafficked by an average of around 12 trains per day in 2027, increasing to 18 trains per day in 2039.

Figure 1.1 Existing Lachlan River Bridge truss structure from the south

1.3.1 BRIDGEWORKS

The modification works to the bridge structure include:

- removing diagonal and horizontal sections from along the top of the truss structure including the diagonal bracing at each end
- installing replacement sections along the top of the truss structure
- installing six angled frames along the truss structure
- strengthening of the underside of the bridge
- making adjustments to short sections of existing handrail adjacent to the truss structure.

Installation of frames and strengthening the bridge is required to ensure the structural integrity of the bridge is not compromised due to removal of existing sections of the truss structure. All cutting and welds to the metalwork would be treated to protect them from corrosion. Patch painting would be completed on the bridge structure where lead-based paint is disturbed by the proposed work. No work is proposed to the track or existing bridge piers.

1.3.2 UTILITIES

A water main and telecommunications cable are attached to the bridge. The supports on the existing water main attached to the bridge would be modified if required. Any works proposed to the water main would be undertaken in consultation with the utility owner, Forbes Shire Council. No permanent changes to the telecommunications cable are proposed.

Stockinbingal to Parkes Lachlan River Bridge

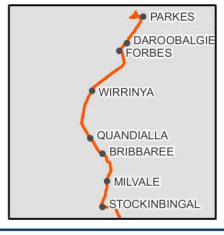
Figure 1.2 Proposal Site

0 10 20 m

Coordinate System: GDA 1994 MGA Zone 55

Date: 4/08/2021
Author: WSP
Paper: A3
Scale: 1:500
Data Sources: ARTC, NSWSS

- Existing railway
- Local road
- Track
- Watercourse
- Cadastre
- Proposal site



INLAND RAIL

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

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2 LEGISLATION, POLICY AND GUIDELINES

2.1 COMMONWEALTH LEGISLATION AND POLICY

2.1.1 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is administered by the Australian Department of the Environment and Energy and provides a legal framework to protect and manage nationally important flora, fauna, ecological communities and heritage places defined as 'matters of national environmental significance' (MNES).

Under the EPBC Act, proposed actions (i.e. activities or proposals) with the potential to significantly impact matters protected by the EPBC Act must be referred to the Australian Minister for the Environment to determine whether they are controlled actions, requiring approval from the Minister. The following matters are defined as protected matters by Part 3 of the EPBC Act:

- matters of national environmental significance
- the environment of Commonwealth land; and
- the environment in general, if proposed actions are being carried out by an Australian Government agency.

There are no impacts to MNES or the environment of Commonwealth land as part of the proposal in relation to the matters assessed in this surface water impact assessment report.

2.1.2 NATIONAL WATER QUALITY MANAGEMENT STRATEGY (ANZECC / ARMCANZ 2018)

The National Water Quality Management Strategy (ANZECC / ARMCANZ 2018) has been developed by the Australian and New Zealand governments in cooperation with state and territory governments. Endorsed by the Australian and New Zealand Environment and Conservation Council (ANZECC), the strategy establishes objectives to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development.

The National Water Quality Management Strategy includes guidelines for protection of water resources across Australia. These guidelines have been used to determine the existing condition of rivers and water quality objectives for the proposal.

2.1.3 AUSTRALIAN AND NEW ZEALAND GUIDELINES FOR FRESH AND MARINE WATER QUALITY (ANZG 2018/ ANZECC 2000)

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) is a key guideline within the National Water Quality Management Strategy that is used to identify catchment and waterway specific water quality management goals. These guidelines are an updated version of the previous guidelines referred to as the ANZECC 2000 guidelines.

The ANZG 2018 provide a risk-based process for assessing existing water quality condition and developing water quality objectives to sustain current or likely future environmental values for natural and semi-natural water resources. The ANZG 2018 provides default guideline values for water quality indicators for different environmental values. These guideline trigger values are considered as generic starting points for assessing water quality in areas where site specific information is not available and have been considered when describing the existing environment. The ANZG 2018 provide decision frameworks that help users tailor water quality guidelines to local environmental conditions.

2.2 STATE LEGISLATION AND POLICY

2.2.1 ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979 AND ENVIRONMENTAL PLANNING AND ASSESSMENT REGULATION 2000

The NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) provides a framework for environmental planning and assessment in NSW. The EP&A Act also determines the consent authority for the project. The Act allows for the development to occur as exempt, with consent or without consent. The proposal is assessed under Division 5.1 of the EP&A Act and Section 5.5 of the EP&A Act requires a determining authority to examine and consider to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity. ARTC is required to complete an REF and is both the proponent and the determining authority. Where the outcome of the environmental assessment is the decision that the proposal is not likely to significantly affect the environment, the proposal can proceed without consent under Division 5.1.

Clauses 244D to 244J of the EP&A Regulation was amended in September 2004 to include special provisions relating to ARTC operations within NSW, including application of the ARTC Code of Practice for Environmental Impact Assessment of Development Projects in New South Wales (2006) (the 'Code') in relation to activities not requiring an Environmental Impact Statement (EIS). In accordance with the Code, this project is considered a Class 4 project, requiring formal assessment in accordance with Division 5.1 of the EP&A Act and therefore requiring the preparation of an REF.

Clause 228 (2) of the EP&A Regulation identifies the factors that must be taken into account when consideration is being given to the likely environmental impact of the proposed activity. These factors are addressed and summarised in Section 8.1 of the REF.

2.2.2 STATE ENVIRONMENTAL PLANNING POLICY (INFRASTRUCTURE) 2007

The State Environmental Planning Policy (Infrastructure) (Infrastructure SEPP) guides the delivery of key infrastructure development across the state including rail infrastructure facilities. Clause 79(1) of the Infrastructure SEPP permits development for the purpose of a 'railway or rail infrastructure facilities' to be carried out on any land by or on behalf of a public authority without consent. As the proposal falls under the definition of 'Rail Infrastructure Facilities', development consent is not required.

Part 2 of the Infrastructure SEPP contains provisions for public authorities to consult with local prior to the commencement of certain types of development. Consultation undertaken with Forbes Shire Council and other relevant public authorities for the proposal is described in Chapter 5 of the REF.

2.2.3 WATER MANAGEMENT ACT 2000

The *Water Management Act 2000* (WM Act) recognises the need to allocate and provide water for the environmental health of NSW rivers and groundwater systems, while also providing license holders with access to water. The WM Act focuses on protecting, enhancing and restoring water resources and encouraging best practice management and use of water.

Under Section 91 of the WM Act a controlled activity approval is required for certain types of developments and activities that have the potential to affect water quality that are carried out at a specified location in, on or under waterfront land (i.e. land that is 40 metres either side of the bed of any river, lake or estuary, including the bed itself). The design and construction of the proposal would consider the NSW Office of Water's guidelines for controlled activities on waterfront land to enable the mitigation of potential impacts to water quality.

2.2.4 PROTECTION OF THE ENVIRONMENT OPERATIONS ACT 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) establishes, amongst other things, the procedures for issuing licences for environmental protection on aspects such as waste, air, water and noise pollution control. The proposal is classified as a 'scheduled activity' and the POEO Act provides that environment protection licences (EPL) are generally required for scheduled activities or scheduled development work.

ARTC currently holds a licence to carry out railway systems activities on other parts of the NSW rail network (licence number EPL3142). Construction for the proposal would be carried out under this EPL as required. In relation to operation, with reference to Clause 33 and Schedule 1 of the POEO Act, the proposal is consistent with the description of 'railway systems activities' and does not meet the description of any other scheduled activity. As such, the proposal would be subject to the conditions of the EPL.

2.2.5 NSW WATER QUALITY OBJECTIVES

Consistent with the ANZG 2018 framework, the NSW Government has endorsed environmental values for surface waterbodies and identified water quality objectives for each catchment in NSW. These are presented in the NSW Water Quality and River Flow Objectives ('NSW WQO') (Office of Environment and Heritage, 2006). These were adopted following extensive consultation with the community in 1998. The NSW WQO set out:

- the community's values and uses for rivers, creeks, estuaries and lakes (i.e. healthy aquatic life, water suitable for recreational activities like swimming and boating, and drinking water); and
- a range of water quality indicators to help assess the current condition of waterways and whether they support those values and uses.

The water quality objectives are the specific water quality targets agreed between stakeholders, or set by local jurisdictions, that become the indicators of management performance. These limits or descriptive statements are selected to support and maintain the environmental values of the catchment. They are consistent with the agreed national framework for assessing water quality set out in the ANZG 2018. Essentially, the NSW WQO provide the environmental values, water quality objectives and indicators for NSW water and refers to the ANZG 2018 for default guideline trigger values technical guidance in applying these values.

The guideline trigger values are concentrations that, if exceeded, would indicate a potential environmental problem, and so 'trigger' a management response, e.g. further investigation and subsequent refinement of the guidelines according to local conditions. Assessing whether the exceedance means a risk of impact to the water quality objective requires site-specific investigation, using decision trees provided in the ANZG 2018. If the trigger values are not exceeded, a very low risk of environmental damage can be assumed.

2.2.5.1 ENVIRONMENTAL VALUES

The NSW WQO categorise and map the rivers and streams within NSW catchments. The catchment affected by the proposal is the Lachlan River catchment. The Lachlan River is categorised as a Major regulated river, that is, a river or creek where water is released from storage to meet diversion requirements downstream. The environmental values applicable to the proposal are:

- aquatic ecosystems
- visual amenity
- primary contact recreation
- secondary contact recreation
- livestock water supply
- irrigation water supply
- homestead water supply
- drinking water at point of supply – Disinfection only, Groundwater, Clarification and disinfection; and
- aquatic foods (cooked).

All criteria and water quality indicators associated with the environmental values for the proposal are shown in Appendix A. It is noted that the NSW WQO were completed prior to the ANZG 2018 update and as such still reference the ANZECC 2000 guidelines.

2.2.6 MURRAY-DARLING BASIN PLAN 2012

The Murry Darling Basin Plan (the Basin Plan) was developed in 2012 to manage water in the Basin as a connected system. The aim of the Basin Plan is to bring the Basin back to a healthier and sustainable level while supporting farming and other industries.

New water quality targets for catchments were developed under the Basin Plan because the State of the Environment report (NSW, EPA, 2012) noted that there was little relationship between standard water quality targets and aquatic ecosystem health, due to the highly variable nature of natural water quality regionally (Department of Primary Industries – Water, 2015).

The Basin Plan water quality targets for turbidity, total phosphorus, total nitrogen, dissolved oxygen and pH were developed following the methods outlined in the ANZECC Guidelines (2000). Water quality data for rivers and streams in ‘reference’ condition from each of the water quality zones were used to develop the target values for each zone (Tiller and Newall 2010). Where there were no reference sites, the appropriate default trigger value from the ANZECC Guidelines (2000) for slightly to moderately disturbed systems were used.

Schedule 11 of the Basin Plan 2012 outlines water quality zones and provides water quality targets which are used to assess water quality at inland monitoring stations. These replace the previous default trigger values for slightly disturbed ecosystems listed in the National Water Quality Management Strategy and are reproduced in the water resource plans for each sub catchment of the Murray Darling Basin along with water quality objectives for each catchment.

The Basin Plan 2012 requires the preparation of water resource plans (WRP). The water resource plans set rules on how much water can be taken from the Basin, ensuring that the sustainable diversion limit is not exceeded over time. The Murray-Darling Basin Authority (MDBA) is responsible for monitoring and enforcing compliance with water resource plans. The proposal will be governed by the NSW Lachlan surface water resource plan (NSW DPI, 2018a). As of January 2021, the Lachlan WRP is under revision, however, reference has been made to the WRP as prepared in 2018.

The WRP provides a water quality management plan to support water quality management within the catchments. These management plans provide a framework to protect, improve and restore water quality. The NSW Lachlan surface water WRP divides the Lachlan catchment into a number of zones. The proposal is in zone B3 Lachlan Valley Upland zone. The WRP includes water quality objectives and associated targets for the zone as shown in Table 2.1. Electrical conductivity targets are not described for each water quality zone of the Murray-Darling Basin Plan. Instead, the Plan adopts End-of-Valley salinity targets, as described in Schedule B Appendix 1 of the Commonwealth Water Act 2007 and shown in Table 2.2.

Table 2.1 Water quality targets under the Basin Plan for B3 Lachlan Valley, Upland zone

INDICATOR	TARGET
Turbidity (NTU) (Annual median)	20
Total Phosphorus (µg/L) (Annual median)	35
Total Nitrogen (µg/L) (Annual median)	600
Dissolved oxygen (mg/L; or saturation (%) (Annual median within the range)	90–110% or >8mg/L
pH (Annual median within the range)	7.0–8.0
Salinity	End-of-Valley targets for salinity
Temperature (Monthly median within the range)	Between the 20%ile and 80%ile of natural monthly water temperature
Pesticides, heavy metals and other toxic contaminants (values in table 3.4.1 of the ANZECC Guidelines for) (Must not be exceeded)	The protection of 95% of species

Table 2.2 End of valley salinity targets

WATER QUALITY ZONE	ECOSYSTEM TYPE	END OF VALLEY TARGETS (AS ABSOLUTE VALUES)		
		Salinity (EC µS/cm)		Salt load (t/yr)
		Median (50%ile)	Peak (80%ile)	Mean
Lachlan River	Streams, rivers, lakes, wetlands	460	693	275,500

2.3 RELEVANT GUIDELINES

Table 2.3 Other relevant guidelines for the hydrology assessment

AUTHORITY	NAME	DESCRIPTION
Commonwealth, Geoscience Australia	Australian Rainfall and Runoff 2019 (Ball et al. 2019)	Australian Rainfall and Runoff (ARR, 2019 prepared by Ball et al 2019) is a national guideline for the estimation of design flood characteristics in Australia. The aim of the guide is to provide the best available guidance and information on design flood estimation in a manner suitable for use by Australian practitioners to be able to estimate the design flood problem, flood processes, and engineering hydrology.
Commonwealth, Australian Institute for Disaster Resilience	Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia, Handbook 7, 2017	This guide prepared by the Australian Institute for Disaster Resilience (AIDR) has been developed to provide guidance on the national principles supporting disaster reliance in Australian through the management and publication of this Handbook and others for other types of hazards. This Handbook is supported by six additional guidelines that cover specific aspects of flood risk management and a practice note to assist with land use planning. This Handbook has been considered when developing criteria for managing flood risk from the proposal and compliments the NSW Floodplain Development Manual (DIPNR 2005) by outlining current best practices for flood risk management.
NSW, Department of Natural Resources	NSW Government's Floodplain Development Manual, 2005	This is the NSW Government's Manual relating to the management of flood liable land in accordance with Section 733 of the Local Government Act 1993. The manual supports the NSW Government's Flood Prone Land Policy in providing for the development of sustainable strategies for managing human occupation and use of the floodplain. The manual applies to floodplains across NSW, in both urban and rural areas. It is also used to manage major drainage issues in local overland flooding areas.
NSW Office of Environment and Heritage	Floodplain Risk Management Guide: Incorporating 2016 Australian Rainfall and Runoff in studies, 2019	The Floodplain Risk Management Guide defines the principles to understand and manage flood risk. The guide provides specific advice on when to consider ARR2016 in studies and how to consider the outcomes of assessments of ARR2016 in decisions. It discusses model selection, runoff routing application and provided advice on the limitations of using the ARR.
NSW, Department of Primary Industries	Guidelines for controlled activities on waterfront land, 2012	Provide guidance on development and activities on waterfront land.
NSW, Office of Environment and Heritage	Guidelines for developments adjoining land and water, 2013	Managed by the Department of Environment, Climate Change and Water it provides guidance on development and activities on waterfront land.

AUTHORITY	NAME	DESCRIPTION
Forbes Shire Council	Forbes Development Control Plan 2013	The purpose of the Forbes Development Control Plan 2013 (DCP) is to guide development within the Forbes LGA. Chapter 4 outlines the development guidelines with respect to flooding and flood affected land.
Landcom, 2004	Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition (The Blue Book)	The Managing Urban Stormwater – Soils and Construction (Landcom, 2004) series of handbooks are an element of the NSW Government's urban stormwater program which provide best practice for management of stormwater during construction works for a wide variety of proposals. They provide guidelines, principles, and recommended minimum design standards for good management practice in erosion and sediment control during construction works. Of particular relevance to the proposal is Volume 1, 4th Edition (commonly known as The Blue Book).
ARTC	Forbes Flood Study (Lyall & Associates 2018) and Flood investigations for Lachlan River at Forbes (Lyall & Associates 2020)	Flood investigation undertaken by Lyall & Associates on behalf of ARTC as part of the proposed bridge replacement over the Lachlan River at Forbes.

3 METHODOLOGY

This chapter outlines the methodology undertaken to assess potential water quality and flood impacts and identify mitigation measures for the proposal.

3.1 STUDY AREA

The study area for the hydrology, flooding and water quality impact assessment is considered to be the area that may be directly or indirectly affected by the proposal including receptors downstream of the proposal site. The proposal site (see Figure 1.2) is within the Lachlan River catchment. Based on review of aerial photographs, topography and other relevant data sources, the study area was considered to be the proposal site with an initial buffer area of 200 metres.

3.2 FLOODING AND DRAINAGE

The drainage and flood impact assessment has been undertaken based on the tasks indicated below:

- review of flooding information available to identify the extent of the flood plain at the proposal sites (i.e. Forbes Flood Study (Lyall & Associates, 2018) and flood investigation undertaken by Lyall & Associates on behalf of ARTC (6 April 2020))
- review of any historic information and other studies to inform flood behaviour and also inform existing waterway health and flood risks/mechanisms across the study area
- review of the proposed works to identify changes that might affect the existing waterways, drainage and flood conditions that may cause impacts (during construction and operation)
- identification of mitigation and management strategies to address impacts.

3.3 WATER QUALITY

The following methodology has been used to understand the existing water quality environment in the study area and to assess potential construction phase (including the risk of potential contaminants), operation phase and cumulative water quality impacts.

3.3.1 DESKTOP REVIEW

A desktop review was carried out to assess the potential water quality impacts of the proposal.

This included:

- review of relevant legislation and guidelines
- establish existing environmental conditions; publicly available catchment data and reports was used to establish the existing environment and likely water quality of the waterways surrounding the proposal site
- cross reference to the Hydrogeology, Contaminated Land and biodiversity impact assessment being prepared concurrently for the proposal; and
- review of the proposal design features near waterways.

3.3.2 IMPACT ASSESSMENT

As no site-specific water quality data is available for this site, a qualitative assessment has been carried out for this report. The proposal involves work over and around the Lachlan River which is considered a sensitive receiver as it is the major waterway in the area.

It is considered that best practice mitigation and management measures will be implemented during construction and operation which will mean that there will be neutral to minimal impacts to water quality as a result of the proposal.

The qualitative assessment of the potential water quality impacts considers:

- the existing water quality environment
- the potential pollutants and impacts to the water quality environment from construction and operation activities
- the effectiveness of the identified mitigation measures; and
- any residual impacts post-mitigation and the likely performance against the water quality objectives.

The construction impact assessment aims to identify potential water quality impacts based on current understanding of the likely construction approach and construction methods.

The operational impact assessment identifies potential impacts to water quality during operation of the proposal.

Based on these assessments, this report provides recommendations for mitigation measures during operation to minimise and manage potential impacts to waterways. These are detailed in Chapter 6.

4 EXISTING ENVIRONMENT

4.1 CATCHMENT

The proposal is located in the Lachlan River catchment of the Murray-Darling Basin. Figure 4.1 shows the major catchment areas in NSW.

Figure 4.1 Major catchments in NSW (NSW Office of Water, 2011)

The Lachlan catchment occupies an area of around 90,000 km^2. The major watercourse of this catchment is the Lachlan River which runs for 1339 kilometres in a general westerly direction from the Breadbane Plain between Goulburn and Yass, to the Murrumbidgee River near Oxley (Murray Darling Basin Authority, 2021).

The Lachlan River is regulated by the Wyangala Dam and a number of other dams and weird along its length. The alteration of natural river flows through the construction of dams and weirs, and erosion from land clearing affect riverine health and contribute to water quality problems, such as salinity (NSW Department of Industry, 2021).

4.2 WATERWAYS CROSSED BY THE PROPOSAL

The proposal site on adjacent to and over the Lachlan River as shown in Figure 4.2. Water from the Lachlan River is also used to support agriculture and the Forbes town water supply (Forbes Shire Council, 2021).

4.3 FARM DAMS

There is one farm dam located about 450m to the south-east of the proposal site, however the farm dam does not receive runoff from the proposal site.

4.4 FLOOD RISK

The review of the historical records of flooding showed that Forbes and the surrounding areas experienced on average a major flood every seven years from 1887 to 2007 (source: Forbes Shire Council, 2007). The proposal crosses Lachlan River which represents the main source of flood risk. The flood conditions at the site and surrounding areas were defined using the hydraulic model developed in 2020 by Lyall & Associated. The flood extent at and around the proposal site is shown in Figure 4.3 below.

The hydraulic model results from the Forbes Flood Study (Lyall & Associates, 2020) were used to define the maximum water levels in the proximity of Lachlan bridge for different AEP events in order to estimate the bridge flood immunity. Table 4.1 reports the maximum flood level at Lachlan bridge. As indicated in Table 4.1 the bridge soffit level is not affected by flooding up to and including the 0.2% AEP flood event.

Table 4.1 Maximum flood level at Lachlan Bridge from Lyall & Associates, 2020 flood model

DESIGN FLOOD EVENT	MAXIMUM FLOOD LEVEL	BRIDGE SOFFIT LEVEL
0.5% AEP	239.33mAHD	239.56mAHD
0.2% AEP	239.48mAHD	239.56mAHD

Table 4.2 below includes the peak flow and maximum flood velocities at Lachlan Bridge.

Table 4.2 Peak flow and flood velocity at Lachlan Bridge from Lyall & Associates, 2020 flood model

DESIGN FLOOD EVENT	PEAK FLOW	MAXIMUM FLOOD VELOCITY
0.5% AEP	320m^3/s	1.29m/s
0.2% AEP	330m^3/s	1.34m/s

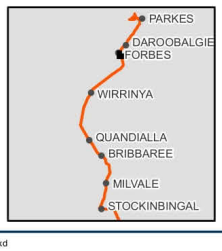
Stockinbingal to Parkes Lachlan River Bridge Figure 4.2 Waterways and Farm Dams Located in the Proposal Site

0 100 200 m

Coordinate System: GDA 1994 MGA Zone 55

Date: 4/08/2021
Author: WSP
Paper: A3
Scale: 1:5,000
Data Sources: ARTC, NSWSS

- KM post
- Existing railway
- Main road
- Local road
- Track
- Cadastre
- Proposal site
- Waterbodies



INLAND RAIL ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

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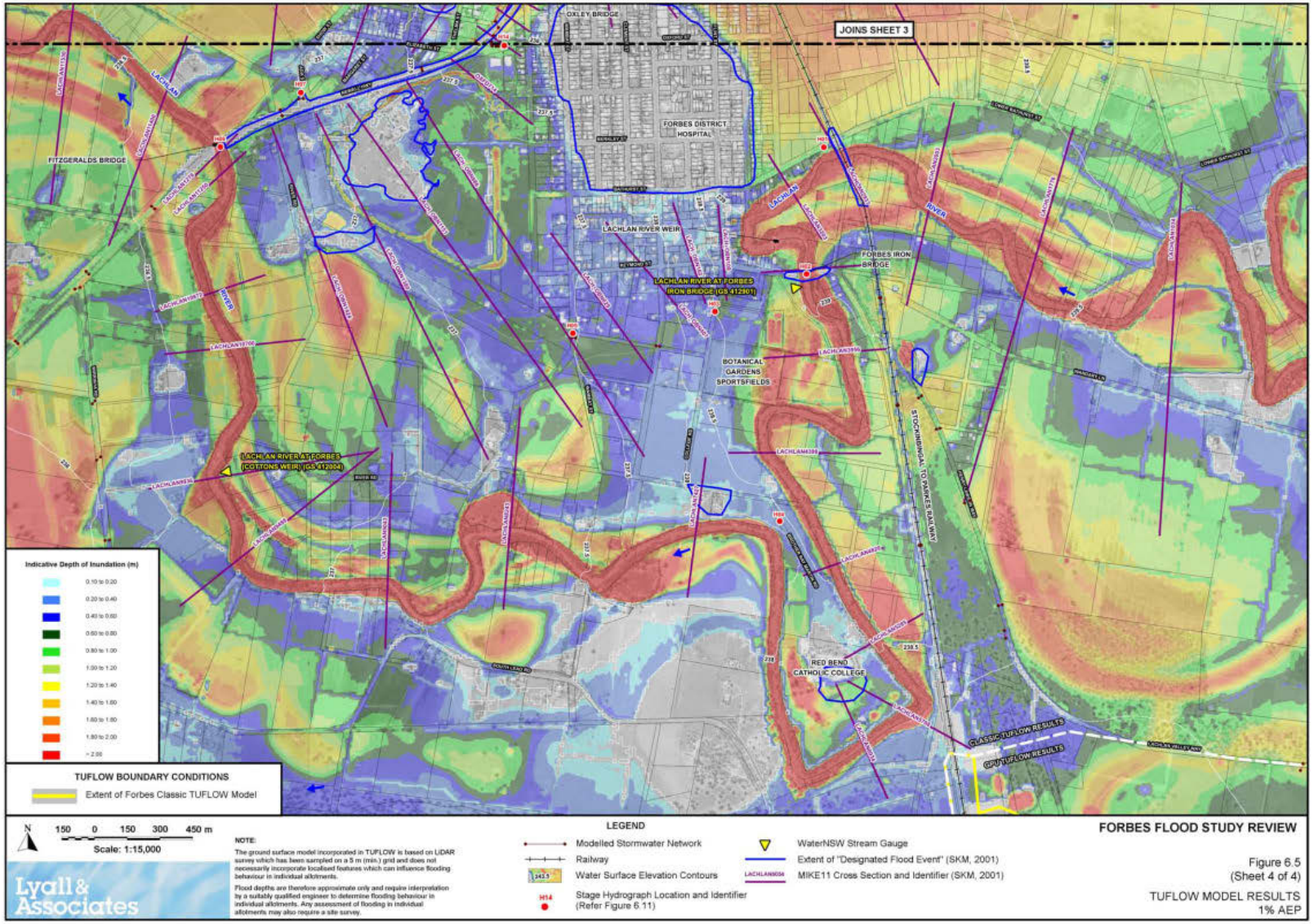


Figure 4.3 Flooding extent

4.5 CLIMATE AND RAINFALL

The climate of the area is described as being temperate, zone 4 (i.e. hot summers and cool winters). There is large temperature variation across the year with temperatures ranging from an average high of 32.7 degrees in summer to an average low of 2.7 degrees in winter months (source: BoM, Forbes (Camp Street), station no: 065016).

Rainfall is usually low with slightly higher rainfall from October to March and lower rainfall in the winter months. The average annual rainfall for Forbes is 496.9 millimetres (source: BoM, Forbes (Muddy Water) station no: 65039). There are on average 6.2 days with rainfall per month and the average daily rainfall based on data from 1969 to 2020 (BoM, 2021) is 6.6mm. Mean monthly rainfall is shown in Figure 4.4.

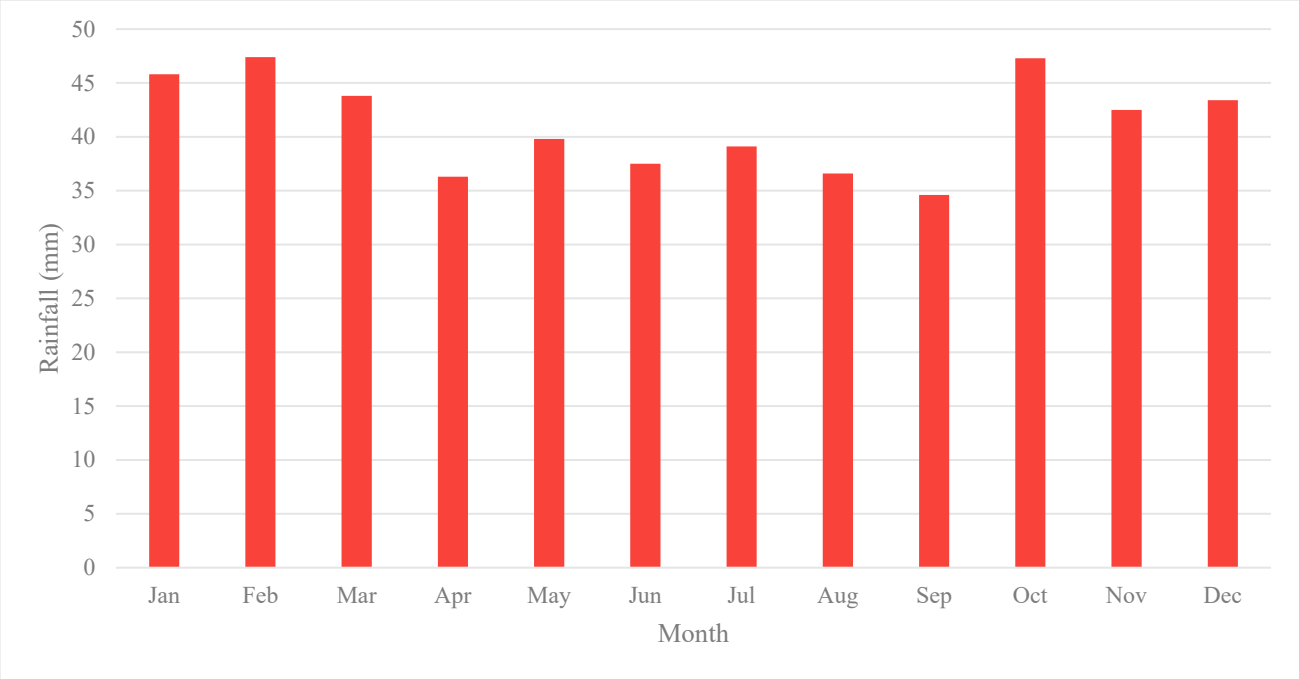


Figure 4.4 Mean monthly rainfall at Forbes (Muddy Water) weather station

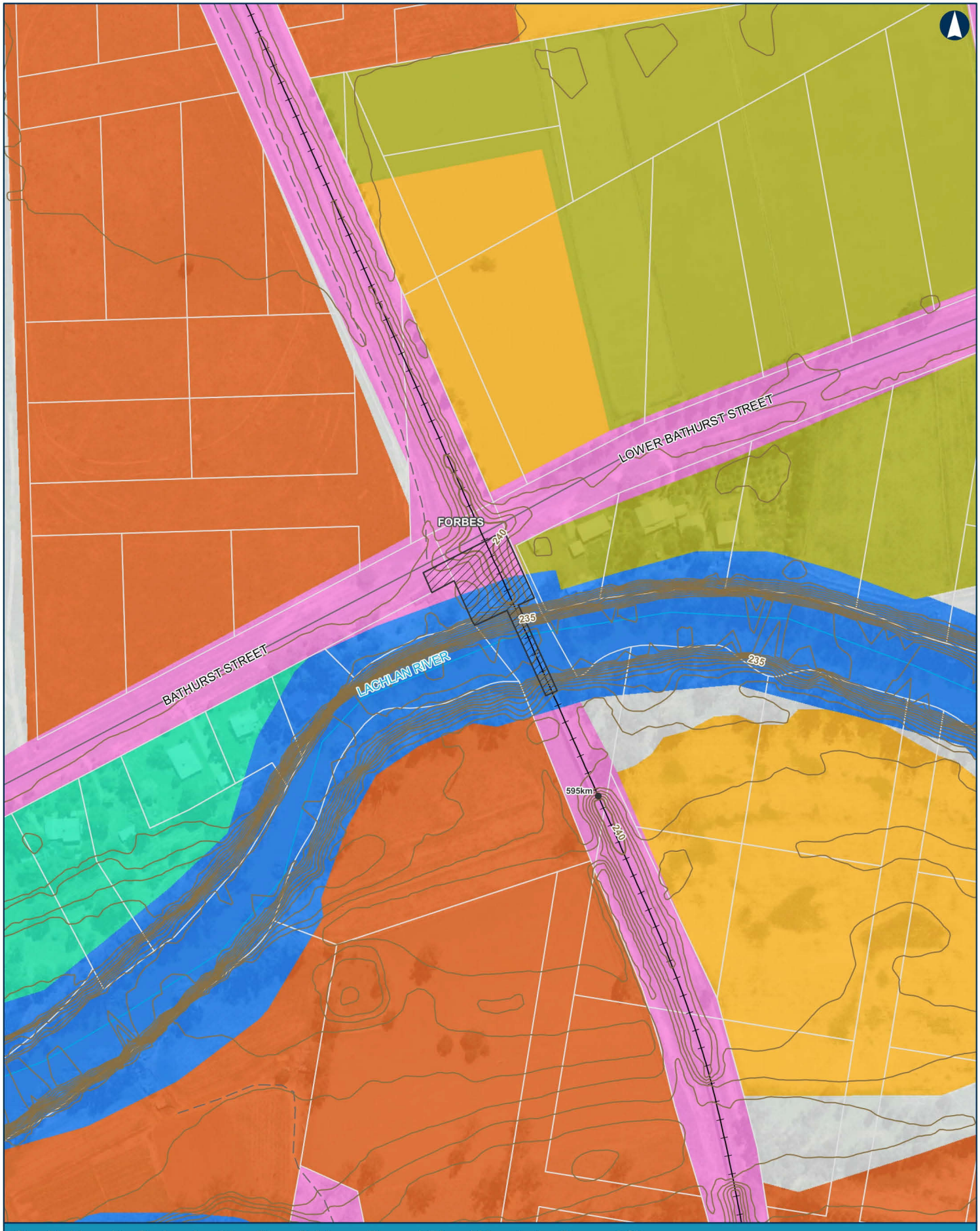
4.6 TOPOGRAPHY

The topography of the site is generally flat at an elevation of about 240mAHD along the existing rail line. The topography generally slopes towards the Lachlan River which is at an elevation of about 233mAHD as shown in Figure 4.5.

4.7 LAND USES

The land uses surrounding the proposal site to the south and north of the Lachlan River is zoned as RU4 Primary Production Small Lots and RU1 Primary production and consists of agricultural land with some remnant vegetation, particularly close to the Lachlan River.

There are a few residences located immediately to the south of the Lachlan River and to the west of the proposal site is additional low density residential streets zoned as R1 General Residential. Figure 4.5 shows the land use areas along the proposal site.



Stockinbingal to Parkes Lachlan River Bridge

Figure 4.5 Land Uses in the Proposal Site

0 50 100 m

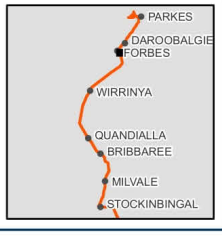
Coordinate System: GDA 1994 MGA Zone 55

Date: 3/08/2021
Author: WSP
Paper: A3
Scale: 1:2,000
Data Sources: ARTC, NSWSS

- KM post
- Existing railway
- Local road
- Track
- Watercourse
- 0.5m contours
- 5m contours
- Cadastre
- Proposal site

NSW Land Use Categories - 2017 v1p2

- Cropping
- Grazing modified pastures
- Grazing native vegetation
- Intensive farming and industry
- Irrigated forestry and horticulture
- Services and utilities
- Water use



INLAND RAIL

ARTC

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4.8 WATER QUALITY

A desktop review was carried out to establish the existing water quality condition in the area. As site specific water quality data was not available, water quality data from the broader catchment areas was reviewed to provide an understanding of the general water quality of the proposal area. The following reports were reviewed:

- Lachlan Water Quality Management Plan (NSW DPI, 2018b)
- Water quality technical report for the Lachlan surface water resource plan area (SW10) (NSW DPI, 2018c); and
- NSW State of the Environment, 2018 (NSW EPA, 2018).

These reports generally use Total Nitrogen (TN), Total Phosphorous (TS), Total Suspended Solids (TSS) and salinity as key indicators of water quality. The water quality technical report also considered turbidity, pH and Dissolved Oxygen (DO).

4.8.1 LACHLAN RIVER WATER QUALITY MANAGEMENT PLAN

The Lachlan River Water Quality Management Plan (WQMP) (NSW DPI, 2018b) reviewed water quality data along the Lachlan River for the periods 2010–2011 and 2014–2015. Forbes and the proposal site are located in the upland region of the Lachlan River catchment as described by the WQMP. The water quality scores given in the report are based on the WaQI water quality index for NSW. The WaQI is a tool to communicate complex water quality data in a simple and consistent way. The WQMP gives an overall integrated score based on the Murray Darling Basin Plan values for DO, turbidity, pH, TN and TS. Poor water quality is defined in this plan as elevated levels of nutrients, turbidity, blue-green algae, salinity, toxicants and pathogens or temperature, pH and DO outside specified ranges.

The monitoring site nearest the proposal site (Forbes (site 412004)) is located about 10km downstream of the proposal site. This site recorded and overall ‘Poor’ score for water quality, however sites downstream of this at Condobolin Bridge and Lake Cargelligo both recorded overall ‘Good’ scores as shown in Figure 4.6.

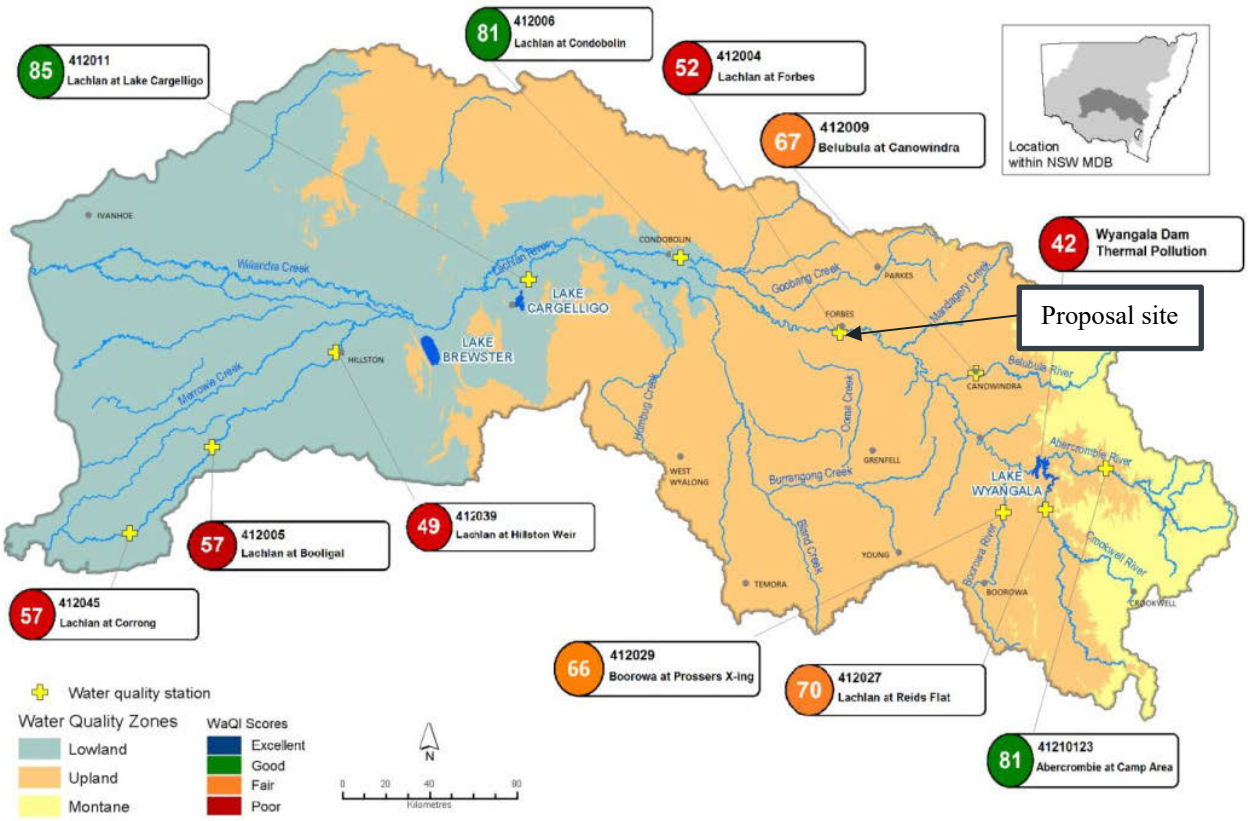

Figure 4.6 Water quality indicators in the Lachlan River catchment from the Lachlan WRP Water Quality Management Plan, 2018

The Forbes monitoring site recorded WAQI scores of "poor' for TN, TP and turbidity, and 'good' scores were recorded for both pH and DO (NSW DPI, 2018c).

The WQMP also identifies and describes the key causes of water quality degradation in the Lachlan. The key issues identified in the Lachlan and Forbes area are shown in Table 4.3.

Table 4.3 Water quality issues in the Lachlan River catchment (NSW DPI, 2018c)

WATER QUALITY IMPACT	CAUSE	WHERE IT OCCURS
Elevated levels of suspended sediment	Land management practices including: — loss of vegetation in the catchment and/or riparian zones — inappropriate frequency, timing and location of cultivation — overgrazing of catchments and grazing of riverbanks and floodplains — poor soil conservation practices.	All areas In unregulated tributaries, land management is the key cause of sediment entering the waterways
	Water management practices: — rapid drawdown of water within a surface water resource — the volume or manner of release of water, resulting in bank or bed erosion.	Suspended sediments are linked to flow volumes. Turbidity and TSS typically increase with distance along the catchment
	Presence of invasive noxious fish Carp (*Cyprinus carpio*)	All areas

WATER QUALITY IMPACT	CAUSE	WHERE IT OCCURS
Elevated nutrient levels	Nutrients entering Lachlan water resources through both point and diffuse sources. The key sources of nutrients are: — soil and organic matter — animal waste — fertilisers — sewage and industrial discharge.	All areas
Elevated levels of salinity (Electrical conductivity - EC)	Landscape situation: — geology — rainfall 400–800mm zone – risk area. Land management practices, largely clearing and cropping, that replace deep-rooted vegetation with shallow rooted crops and pastures, resulting in increased rainfall recharge displacing saline groundwater to surface water systems. The following processes and activities relating to water flow or water management: — saline groundwater and surface water discharges into surface water systems — increased deep drainage below irrigated agricultural land displacing saline groundwater to surface water systems — saline surface and shallow groundwater drainage from irrigated agricultural land into surface water systems — irrigation at high salinity risk locations without adequate drainage management — de-watering of saline groundwater which mobilises salt into surface water systems — reduction in stream flows, limiting the dilution of salinity.	All areas
Dissolved oxygen outside natural ranges	Micro-organisms consuming organic matter and depleting oxygen at a rate faster than it can be replenished, particularly during extended periods of low or no flows.	All areas
	Eutrophication leading to excessive plant growth causing high diurnal variations in dissolved oxygen levels, both above and below natural ranges.	All areas
	Hypoxic low flow or blackwater events due to release of water following extended dry or low flow periods. Less frequent flooding due to flow management allows increased organic material to accumulate on river banks and floodplains.	Lachlan River – Blackwater events following major flooding have been identified as an issue in the Lachlan.
pH outside natural ranges	The exposure to the air of soils containing iron sulphide minerals. Eutrophication leading to excessive plant growth causing high diurnal variation in pH.	All areas

4.8.2 NSW STATE OF THE ENVIRONMENT, 2018

The NSW State of the Environment report is prepared every three years and reports on the status of key environmental issues facing NSW including river health and water quality. The 2018 State of the Environment reported water quality data against the water quality criteria set out in the Murray Darling Basin Plan 2012. This report showed that 50 to 75% of samples exceeded the water quality criteria for TN and TP at the site located nearest the proposal as shown in Figure 4.7.

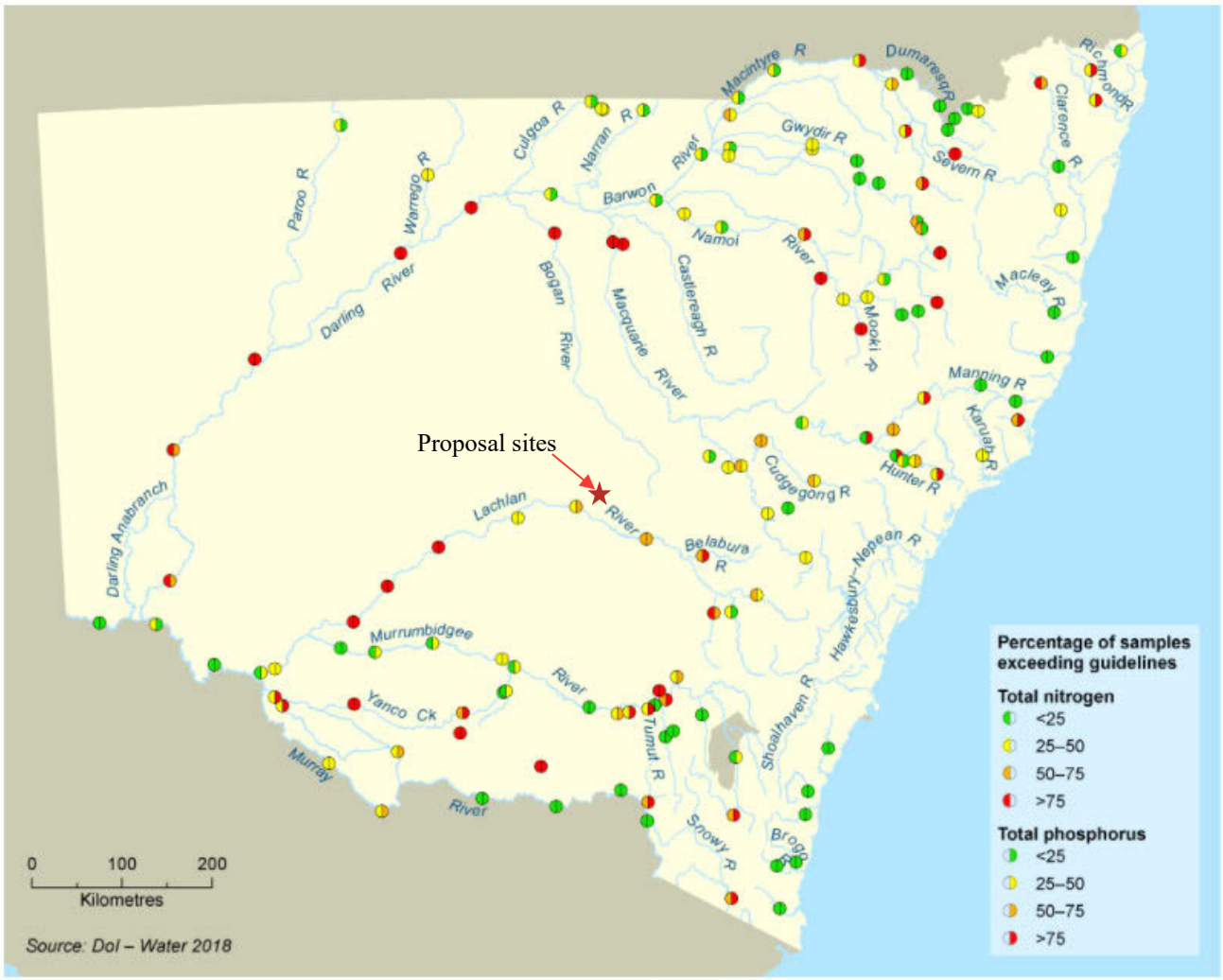

Figure 4.7 Compliance of water quality samples for TP and TN in NSW, State of the Environment 2018

4.8.3 SUMMARY OF WATER QUALITY DATA IN THE AREA

Based on the 2018 State of the Environment, the Lachlan River site was not achieving the water quality criteria for nutrients as laid out in the ANZG 2018 and Murray Darling Basin Plan 2012. The sources of the high nutrient levels are likely to be diffuse and related to current and historical agricultural activities within the study area.

The 2018 Lachlan River Water Quality Management Plan also reported a WaQI of 'Poor' at the monitoring site located downstream of the proposal site. This index recorded 'Poor' scores for TN, TP and turbidity and 'good' scores for both pH and DO.

4.9 SENSITIVE RECEIVERS

4.9.1 WETLANDS AND SENSITIVE HABITAT

The Lachlan River catchment features several significant wetlands that are considered of national significance, particularly for waterbird habitat. These include Lake Cowal near Forbes, Lake Brewster, and the Booligal wetlands and Great Cumbung Swamp in the lower Lachlan valley. The closest of these features is Lake Cowal which is located about 55km south-west of the proposal site.

One endangered ecological community listed under the *Fisheries Management Act 1994* occurs in the study area: lower Lachlan River aquatic ecological community.

4.9.2 GROUNDWATER DEPENDENT ECOSYSTEMS

Groundwater Dependent Ecosystems (GDEs) are communities of plants, animals and other organisms that depend on groundwater for survival (Department of Land and Water Conservation, 2002). A GDE may be either entirely dependent on groundwater for survival or may use groundwater opportunistically or for a supplementary source of water (Evans and Hatton, 1998).

The Lachlan River is identified as a low potential aquatic GDE in the Groundwater Dependent Ecosystems Atlas (Bureau of Meteorology, 2020). PCT 11: River Red Gum - Lignum very tall open forest or woodland wetland on floodplains of semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion) along the banks of the Lachlan River is identified as a high potential terrestrial GDE Groundwater Dependent Ecosystems Atlas (Bureau of Meteorology, 2020).

While GDEs are present, the proposal does not involve interference with groundwater so is considered unlikely to directly or indirectly interfere with subsurface or groundwater flows associated with any GDEs in or adjacent to the study area.

4.10 SOILS

The Forbes 1:250,000 geological series sheet SI55-7 indicates that the site is located within Quaternary Age colluvial sheet wash and scree slope deposits with minor Aeolian climbing dunes. The soils are a clay and clayey gravel fill layer up to 1.4m thick over an alluvium silty clay.

Acid Sulfate Soils (ASS) are naturally occurring soils containing iron sulfides that when exposed to air react with oxygen and water to produce a variety of iron compounds and sulfuric acid. The resulting acid may be released to the environment and can release other substances, including heavy metals, from the soil into groundwater and the surrounding environment. The Australian Soils Resource Information System (Commonwealth Department of Agriculture, Fisheries and Forestry, 2014) shows that there is low probability (with very low confidence) of presence of ASS at the proposal site.

4.11 CONTAMINATION

A review of the NSW EPA Contaminated Land Public Record and the POEO Act Public Register were undertaken on 20 April 2021. The review did not identify a contaminated site within 500 metres of the proposal site, nor has the site been subject to any regulation under the CLM Act. A review of the ARTC Contaminated Sites Register did not identify any potential contamination sites near or within the proposal site.

The existing paint on the Lachlan River Bridge is lead based. Other undiscovered contamination associated with the rail line may be present in the proposal site. Contaminants present in the rail line may include heavy metals, painting, total recoverable hydrocarbon (TRH), benzene, toluene, ethylbenzene and xylene (BTEX), polycyclic aromatic hydrocarbons (PAH) and/or asbestos. Further detail is provided on contamination in Section 5.8 of the REF.

5 IMPACT ASSESSMENT

5.1 DRAINAGE AND FLOODING

The proposed works at Lachlan River Bridge involve the modification to the truss structure of the Lachlan River Bridge including patch painting areas of disturbed lead-based paintwork.

There are no changes to proposed to the track and only minor earthworks associated with establishing a crane pad and compounds during construction. No instream works are proposed. The proposed works on the bridge are above the 0.5% AEP flood level so flows within the Lachlan River would not be impacted.

There are no roads or drainage infrastructure impacted by the proposed works.

5.1.1 CONSTRUCTION

The following construction activities are considered in the flood risk impact assessment:

- construction of access tracks for construction machinery and materials
- establishment of construction compounds to the west side of the rail track (i.e. 20x20m)
- establishment of construction compounds to the east side of the rail track (i.e. 10x10m)
- stockpiles and crane pad; and
- installation of scaffolding onto the bridge to allow access under the bridge.

The proposal site is located in a flood prone area. As such the construction work is subject to impacts from flooding and may change impacts to surrounding land from flooding. A flood event during construction would present a risk to construction site staff and may cause damage and wash out of construction materials, machinery and equipment.

Flood emergency management procedures will be prepared, including the evacuation of personnel, to minimise impacts to the construction work as a result of flooding.

Construction compounds, stockpiles and the crane pad are proposed within the site area at the north of the river as indicated in Figure 5.1. The construction area is exposed to river flooding for 10% AEP flood events and greater with portions of the site inundated by up to one metre.

Stockpiles and construction compounds may result in changes to local flood behaviour within the proposal site. For the construction area at the west of the rail corridor, the rail track acts as hydraulic control structure. Flood water flows from west to east towards the rail where is blocked by the rail embankment (rail embankment is higher than the 1% AEP flood level) and diverted to the surrounding areas. The presence of the compounds, stockpiles and crane pad would cause a loss in flood storage but no change to the flood mechanisms which are controlled by the rail embankment. The loss in flood storage caused by the construction facilities is negligible in comparison to the surrounding flooded area. As such flood impacts are expected to be minor.

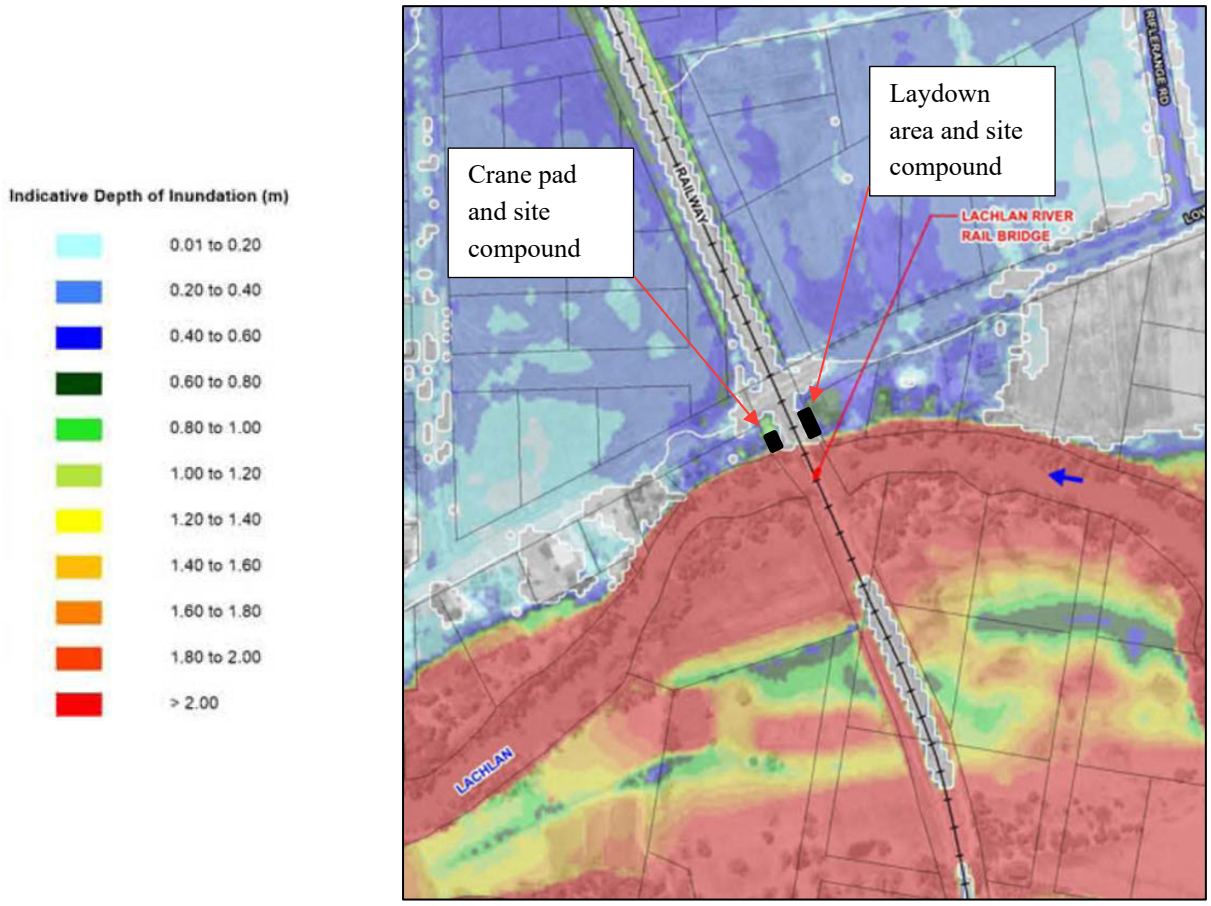

Figure 5.1 Construction zone and 1% AEP flood extent

Construction planning during detailed design would consider how these temporary changes would be managed to prevent significant impacts occurring.

As such during construction, the impacts to flood behaviour are likely to be temporary, localised and minor.

5.1.2 OPERATION

The proposed works are above the 0.5% AEP flood level so waterway flows will not be impacted. No change to the height of the bridge are proposed, therefore there would be no impacts to flooding behaviour from the proposal.

There will be no change to existing catchments, existing waterways or drainage design proposed as part of the proposal.

5.1.2.1 AFFLUX

The proposal is not expected to generate any afflux. Proposed works do not affect the existing drainage and flood regime.

5.1.2.2 CHANGE IN VELOCITY

The proposal is not expected to generate any change in velocity. Proposed works do not affect the existing drainage and flood regime.

5.1.2.3 CHANGE IN FLOOD HAZARD

The proposal is not expected to generate any change in flood hazard. Proposed works do not affect the existing drainage and flood regime.

5.1.2.4 FLOOD IMMUNITY

There is no change to the existing flood immunity as the proposed works do not affect the existing drainage and flood regime.

5.1.3 CLIMATE CHANGE

A climate change sensitivity assessment has been completed using the hydraulic model results produced for the Forbes Flood Study (Lyall & Associates, 2018). The climate change assessment considers a rainfall/flow increase of 20.2% in the year 2090 based on RCP 8.5 for the 1% AEP flood event. The key findings of the climate change sensitivity analysis are as follows:

- maximum flood levels upstream Lachlan River Bridge is expected to increase up to 187mm; and
- maximum flood velocities within the river are expected to increase up to 0.3m/s.

The proposal would not impact flooding considering the above climate change scenario as the bridge level would remain above the 1% AEP.

5.2 WATER QUALITY

The key pollutants that are likely to impact the surrounding environment as a result of the construction of the proposal include:

- nutrients (nitrogen and phosphorus) – commonly present in agricultural areas, and may become mobilised as a result of disturbance of agricultural land
- accidental spills and subsequent water pollution from removal of lead-based paint and repainting
- sediments and soils – present in run-off from construction areas
- chemicals, oils, grease and hydrocarbons – from use of plant and equipment during construction and train movements and operations
- heavy metals – associated with the rail line and present in the paint on the Lachlan River Bridge
- contaminants of concern related to the existing rail line – TRX, BTEX, PAHS and potential asbestos containing material (ACM); and
- gross pollutants and litter – from construction staff.

5.2.1 CONSTRUCTION PHASE

Table 5.1 shows construction activities for the proposal and the associated potential water quality impacts. There is risk of water quality impacts due to the proximity of the proposal site with the Lachlan River. However, with the application of the mitigation measures water quality impact is considered minor. If construction management and mitigation strategies are applied during the construction of the proposal it is anticipated that there would be limited risk of impacts to water quality. Refer to Chapter 6 for detail in mitigation measures. Erosion and sediment controls in accordance with Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004), and Volumes 2A and 2C (NSW Department of Environment, Climate Change and Water, 2008) are commonly applied to construction sites to minimise sediment disturbance, mobilisation and runoff during construction.

Table 5.1 Potential construction activities and associated water quality risks

CONSTRUCTION ACTIVITY	POTENTIAL IMPACTS
Vegetation clearing and grubbing	Clearing of approximately 0.1 hectares of vegetation consisting mainly of grassland during site establishment would expose and may destabilise soils increasing potential for erosion and runoff of materials to waterways. Increased erosion may lead to increased turbidity, lowered dissolved oxygen levels and increased nutrients in waterways. It may also lead to increased deposition of materials and contaminants in waterways which may reduce aquatic ecology channel habitat.
Construction compounds and crane pad	Grading of the site to establish the compounds and crane pad may destabilise soils increasing potential for erosion and runoff of materials to the Lachlan River. Installation of temporary impervious surfaces would increase surface runoff volumes and velocities. This may lead to changes in scour and erosion and sediment mobilisation in waterways.
Disturbance and removal of lead-based paint	As the bridge works would disturb patches of the lead-based paint, there is potential for release of small amounts of lead-based paint flakes to enter to the Lachlan River and subsequent ecological impacts. Patch painting would be completed on the bridge structure where lead-based paint is disturbed by the proposed work.
Dust suppression	Use of water on site for dust suppression which may increase run off and erosion potential and may increase the sediment load to the Lachlan River.
Handling, stockpiling and storage of hazardous materials and chemicals.	During construction on waterfront land and on the bridge there is a risk of run off or accidental spills carrying chemical contaminants to the Lachlan River which would have subsequent impacts to turbidity and waterway health. The site compounds would be used for storage of material and equipment including safe storage of small amounts of: — fuel and mechanical fluids for plant and equipment (oils, degreaser, lubricants, coolants etc.) — oxygen gas, acetylene (for welding activities) and liquid propane gas — safe-working rail detonators (for worksite protection).
Use of machinery and heavy vehicles	
Dust suppression	Use of water on site for dust suppression which may increase run off and erosion potential and may increase the sediment load to the Lachlan River.
Staff activity	Gross pollutants and litter entering receiving waterways.

5.2.2 OPERATION PHASE

Maintenance activities would not change as a result of the proposal. Standard ARTC maintenance activities would be undertaken during operations. Typically, these activities would involve minor maintenance works through to major maintenance such as reconditioning of track and topping up of ballast as required. Works within the rail corridor would be undertaken in accordance with ARTC's standard operating procedures and in accordance with the EPL 3142.

The potential water quality impacts are limited to spills or litter generated from operation and maintenance activities along the rail line near the Lachlan River. These impacts would be minor and localised. Provided correct operation procedures and safeguards are implemented the residual likelihood of impacts would be low. The proposed modifications to Lachlan River bridge are not expected to generate change to the existing water quality conditions in the operation phase.

The proposed upgrade of the existing rail line will not generate water quality impacts in the operation phase. As such operation of the proposal would not cause significant changes to the water quality environment.

6 MITIGATION MEASURES

Chapter 5 identified a range of impacts as a result of the proposal during construction and operation. The impacts are largely related to water quality. The following sections provide the mitigation measures which would be implemented for the proposal.

6.1 DRAINAGE AND FLOODING

6.1.1 CONSTRUCTION

Table 6.1 Drainage and flooding mitigation measures during construction

ID	MITIGATION MEASURE
FH1	Detailed construction planning would consider flood risk at construction areas. This will include identification of measures to not worsen flood impacts downstream and on other property and infrastructure during construction up to and including the 1% AEP flood event, and review of site layout and staging of construction works to avoid or minimise obstruction of overland flow paths and to limit the extent of flow diversion required.
FH2	A flood and emergency response plan would be prepared and implemented as part of the CEMP. The plan would include measures, process and responsibilities to minimise the potential impacts of construction activities on flood behaviour as far as practicable. It would also include measures to manage flood risks during construction including the evacuation protocol of personnel and monitoring of weather forecasts. The plan would be developed in consultation with emergency services and key affected landholders/ managers.

6.2 WATER QUALITY

6.2.1 CONSTRUCTION

Table 6.2 Water quality mitigation measures

ID	MITIGATION MEASURE
WQ1	An erosion and sediment control plan and a Soil and Water Management Plan (SWMP) would be prepared as part of the Construction Environmental Management Plan (CEMP). The SWMP would comply with the existing EPL3142 and be in accordance with best on site practice, reflected in Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004), and Volumes 2A and 2C (NSW Department of Environment, Climate Change and Water 2008), commonly referred to as the 'Blue Book'. The SWMP and erosion and sediment control plan would include: — surface controls to promote ground stability, limit runoff lengths and reduce runoff velocities within the construction areas — sediment and erosion controls would be built to a design storm that will ensure non-erodible velocities — inspection and maintenance of erosion and sediment controls throughout the works to ensure they are operating effectively — rainfall monitoring requirements — management protocols of problem soils (e.g. erosive, dispersive, reactive, acidic, saline, sodic, alkaline soils) — management protocols for any contaminated soils — vehicle, machinery and imported fill hygiene protocols and documentation — measures to prevent/minimise mud and dirt being tracked onto public roadways by trucks and any equipment leaving the site — provision of a spill contaminant kit — requirements for training, inspections, corrective actions, notification and classification of environmental incidents, record keeping, monitoring and performance objectives for handover on completion of construction.
WQ2	Dangerous goods and hazardous material and chemicals would be stored in a designated and bunded area (with 110% storage capacity) away from the Lachlan River within the proposal site.
WQ3	Capture any potential release of lead base paint into the Lachlan River in accordance with AS/NZS 4361.1:2017 Guide to Hazardous Paint Management.

7 CONCLUSION

The proposal is located within the Lachlan River catchment. The assessment has identified Lachlan River as the key potential sensitive receivers.

The site lies with flood prone land around the Lachlan River.

7.1 DRAINAGE AND FLOODING

The hydraulic model results available in the Forbes Flood Study (Lyall & Associates, 2020) report shown that Lachlan bridge soffit level is not affected by flooding up to an including the 0.2% AEP flood event.

Operation:

There will be no change to existing catchments and existing waterways as part of the proposal. There is no drainage design proposed as part of the proposal. The proposed works are above the 0.5% AEP flood level so waterway flows will not be impacted.

Thus, there are no impacts to the existing drainage and flood conditions. There also no change to the existing rail flood immunity.

Construction:

Stockpiles and construction compounds may cause minor changes to local flood behaviour within the proposal site; no non-compliant flood impacts are expected outside the construction area.

A flood event during construction would present a risk to construction site staff and may cause damage and wash out of construction materials, machinery and equipment. Flood emergency management procedures will be prepared, including the evacuation of personnel, to minimise impacts to the construction work as a result of flooding.

7.2 WATER QUALITY

The water quality of the existing environment was assessed based on existing data available and is considered to be generally poor, particularly with relation to nutrients.

The construction of the proposal has the potential to impact water quality of the study area, largely during the construction phase.

Construction activities that may cause water quality impacts are installation of construction compounds, stockpiles and removal of lead-based paint. These activities may cause increased sediment and pollutant mobilisation which may lead to erosion and sedimentation and run off the receiving waterways.

If construction management and mitigation strategies identified in this report are applied during the construction of the proposal it is anticipated that there would be limited risk of impacts to water quality. Erosion and sediment control in accordance with the Blue book would minimise sediment disturbance, mobilisation and runoff during construction.

Given that the proposal is located on an existing operational rail line, there would not be anticipated to be any additional drainage or water quality impacts as a result of the operation of the proposal. Operation activities that may cause water quality impacts would include, spills of chemicals and contaminants from trains, dust of carriages and maintenance works which may include minor vegetation clearing and disturbance of sediment and pollutants. The proposal would be operated in line with ARTC's standard operating procedures and as such impacts from the operation of the proposal would be low to negligible.

8 REFERENCES

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APPENDIX I

Lachlan River Bridge Modification Project

Surface Water Impact Assessment

Appendix A NSW water quality objectives, environmental values and criteria

STOCKINBINGAL TO PARKES REVIEW OF ENVIRONMENTAL FACTORS

Table A.1 Water quality objectives and trigger values for environmental values in the Lachlan River catchment

WATER QUALITY OBJECTIVE	INDICATOR	TRIGGER VALUE OR CRITERIA
Aquatic ecosystems (Upland rivers)		
Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term	Total phosphorus	20µg/L
	Total nitrogen	250µg/L
	Chlorophyll-a	Not applicable
	Turbidity	2–25 NTU
	Salinity (electrical conductivity)	30–350µS/cm
	Dissolved oxygen	90–110%
	pH	6.5–8.0
Visual amenity		
Aesthetic qualities of waters	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%. Natural hue of the water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.
	Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter.
	Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae and sewage fungus.
Secondary contact recreation		
Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed	Faecal coliforms	Median bacterial content in fresh and marine waters of < 1000 faecal coliforms per 100mL, with 4 out of 5 samples < 4000/100mL (minimum of 5 samples taken at regular intervals not exceeding one month).
	Enterococci	Median bacterial content in fresh and marine waters of < 230 enterococci per 100mL (maximum number in any one sample: 450–700 organisms/ 100mL).
	Algae & blue-green algae	< 15 000 cells/mL
	Nuisance organisms	Use visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreation. Toxic substances should not exceed values in Tables 5.2.3 and 5.2.4 of the ANZECC 2000 Guidelines.
	Visual clarity and colour	Use visual amenity guidelines.
	Surface films	Use visual amenity guidelines.

WATER QUALITY OBJECTIVE	INDICATOR	TRIGGER VALUE OR CRITERIA
Primary contact recreation		
Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed	Turbidity	A 200mm diameter black disc should be able to be sighted horizontally from a distance of more than 1.6m (approximately 6 NTU).
	Faecal coliforms	Beachwatch considers waters are unsuitable for swimming if: — The median faecal coliform density exceeds 150 colony forming units per 100 millilitres (cfu/100mL) for five samples taken at regular intervals not exceeding one month, or — The second highest sample contains equal to or greater than 600cfu/100mL (faecal coliforms) for five samples taken at regular intervals not exceeding one month. ANZECC 2000 Guidelines recommend: — Median over bathing season of < 150 faecal coliforms per 100mL, with 4 out of 5 samples < 600/100mL (minimum of 5 samples taken at regular intervals not exceeding one month).
	Enterococci	Beachwatch considers waters are unsuitable for swimming if: — The median enterococci density exceeds 35cfu/100mL for five samples taken at regular intervals not exceeding one month, or — The second highest sample contains equal to or greater than 100cfu/100mL (enterococci) for five samples taken at regular intervals not exceeding one month. ANZECC 2000 Guidelines recommend: — Median over bathing season of < 35 enterococci per 100mL (maximum number in any one sample: 60–100 organisms/100mL).
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water. (Note, it is not necessary to analyse water for these pathogens unless temperature is greater than 24 degrees Celsius).
	Algae & blue-green algae	< 15 000 cells/mL
	Nuisance organisms	Use visual amenity guidelines.
	Faecal coliforms	Large numbers of midges and aquatic worms are undesirable.
	pH	5.0–9.0
	Temperature	15°–35°C for prolonged exposure.
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation. Toxic substances should not exceed the concentrations provided in Tables 5.2.3 and 5.2.4 of the ANZECC 2000 Guidelines 2000.
	Nuisance organisms	Use visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable
	Visual clarity and colour	Use visual amenity guidelines
	Surface films	Use visual amenity guidelines

WATER QUALITY OBJECTIVE	INDICATOR	TRIGGER VALUE OR CRITERIA
Livestock water supply		
Protecting water quality to maximise the production of healthy livestock	Algae & blue-green algae	An increasing risk to livestock health is likely when cell counts of microcystins exceed 11 500 cells/mL and/or concentrations of microcystins exceed 2.3µg/L expressed as microcystin-LR toxicity equivalents.
	Salinity (electrical conductivity)	Recommended concentrations of total dissolved solids in drinking water for livestock are given in Table 4.3.1 (ANZECC 2000 Guidelines).
	Thermotolerant coliforms (faecal coliforms)	Drinking water for livestock should contain less than 100 thermotolerant coliforms per 100mL (median value).
	Chemical contaminants	Refer to Table 4.3.2 (ANZECC 2000 Guidelines) for heavy metals and metalloids in livestock drinking water. Refer to Australian Drinking Water Guidelines (NHMRC and NRMMC 2004) for information regarding pesticides and other organic contaminants, using criteria for raw drinking water.
Irrigation water supply		
Protecting the quality of waters applied to crops and pasture	Algae & blue-green algae	Should not be visible. No more than low algal levels are desired to protect irrigation equipment.
	Salinity (electrical conductivity)	To assess the salinity and sodicity of water for irrigation use, several interactive factors must be considered including irrigation water quality, soil properties, plant salt tolerance, climate, landscape and water and soil management. For more information, refer to Chapter 4.2.4 of ANZECC 2000 Guidelines.
	Thermotolerant coliforms (faecal coliforms)	Trigger values for thermotolerant coliforms in irrigation water used for food and non-food crops are provided in Table 4.2.2 of the ANZECC Guidelines.
	Heavy metals and metalloids	Long term trigger values (LTV) and short-term trigger values (STV) for heavy metals and metalloids in irrigation water are presented in Table 4.2.10 of the ANZECC 2000 Guidelines.
Homestead water supply		
Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing	Blue-green algae	Recommend twice weekly inspections during danger period for storages with history of algal blooms. No guideline values are set for cyanobacteria in drinking water. In water storages, counts of < 1000 algal cells/mL are of no concern. >500 algal cells/mL – increase monitoring. >2000 algal cells/mL – immediate action indicated; seek expert advice. >6500 algal cells/mL – seek advice from health authority.
	Turbidity	5 NTU; <1 NTU desirable for effective disinfection; >1 NTU may shield some micro-organisms from disinfection. (see supporting information).
	Total dissolved solids	< 500mg/L is regarded as good quality drinking water based on taste. 500–1000mg/L is acceptable based on taste. >1000mg/L may be associated with excessive scaling, corrosion and unsatisfactory taste.

WATER QUALITY OBJECTIVE	INDICATOR	TRIGGER VALUE OR CRITERIA
	Faecal coliforms	0 faecal coliforms per 100mL (0/100mL). If micro-organisms are detected in water, advice should be sought from the relevant health authority. See also the Guidelines for Microbiological Quality in relation to Monitoring, Monitoring Frequency and Assessing Performance in the Australian Drinking Water Guidelines (NHMRC & ARMCANZ 2004).
	pH	6.5-8.5 (see supporting information)
	Chemical contaminants	See Guidelines for Inorganic Chemicals in the Australian Drinking Water Guidelines (NHMRC & NRMMC 2004).
Drinking water at point of supply - Disinfection only, Groundwater, Clarification and disinfection		
Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment	Blue-green algae	Recommend twice weekly inspections during danger period for storages with history of algal blooms. >500 algal cells/mL – increase monitoring. < 2000 algal cells/mL – water may be used for potable supply. >2000 algal cells/mL – immediate action indicated; seek expert advice. >6500 algal cells/mL – seek advice from health authority. >15 000 algal cells/mL – may not be used for potable supply except with full water treatment, which incorporates filtration and activated carbon. Source: Australian Drinking Water Guidelines (NHMRC & NRMMC 2004).
	Turbidity	Site-specific determinant.
	Salinity (electrical conductivity)	<1500µS/cm > 800µS/cm causes a deterioration in taste.
	Faecal coliforms*	0 faecal coliforms per 100mL (0/100mL)
	Total coliforms*	95% of samples should be 0 coliforms/100mL throughout the year. Up to 10 coliform organisms may be accepted occasionally in 100mL. Coliform organisms should not be detected in 100mL in any two consecutive samples.
	Dissolved oxygen	> 6.5mg/L (> 80% saturation)
	pH	6.5-8.5
	Chemical contaminants	See ANZECC 2000 guidelines, Section 6.2.2.

WATER QUALITY OBJECTIVE	INDICATOR	TRIGGER VALUE OR CRITERIA
Aquatic foods (cooked)		
Refers to protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities. (Note: The ANZECC 2000 Guidelines lists this environmental value as Aquaculture and human consumption of aquatic foods)	Algae & blue-green algae	No guideline is directly applicable, but toxins present in blue-green algae may accumulate in other aquatic organisms.
	Faecal coliforms	Guideline in water for shellfish: The median faecal coliform concentration should not exceed 14 MPN/100mL; with no more than 10% of the samples exceeding 43 MPN/100mL. Standard in edible tissue: Fish destined for human consumption should not exceed a limit of 2.3 MPN E Coli /g of flesh with a standard plate count of 100,000 organisms /g.
	Toxicants (as applied to aquaculture activities)	Copper: less than 5µgm/L. Mercury: less than 1µgm/L. Zinc: less than 5µgm/L. Organochlorines: Chlordane: less than 0.004µgm/L (saltwater production) PCB's: less than 2µgm/L.
	Physico-chemical indicators (as applied to aquaculture activities)	Suspended solids: less than 40 5µgm/L (freshwater) Temperature: less than 2 degrees Celsius change over one hour.