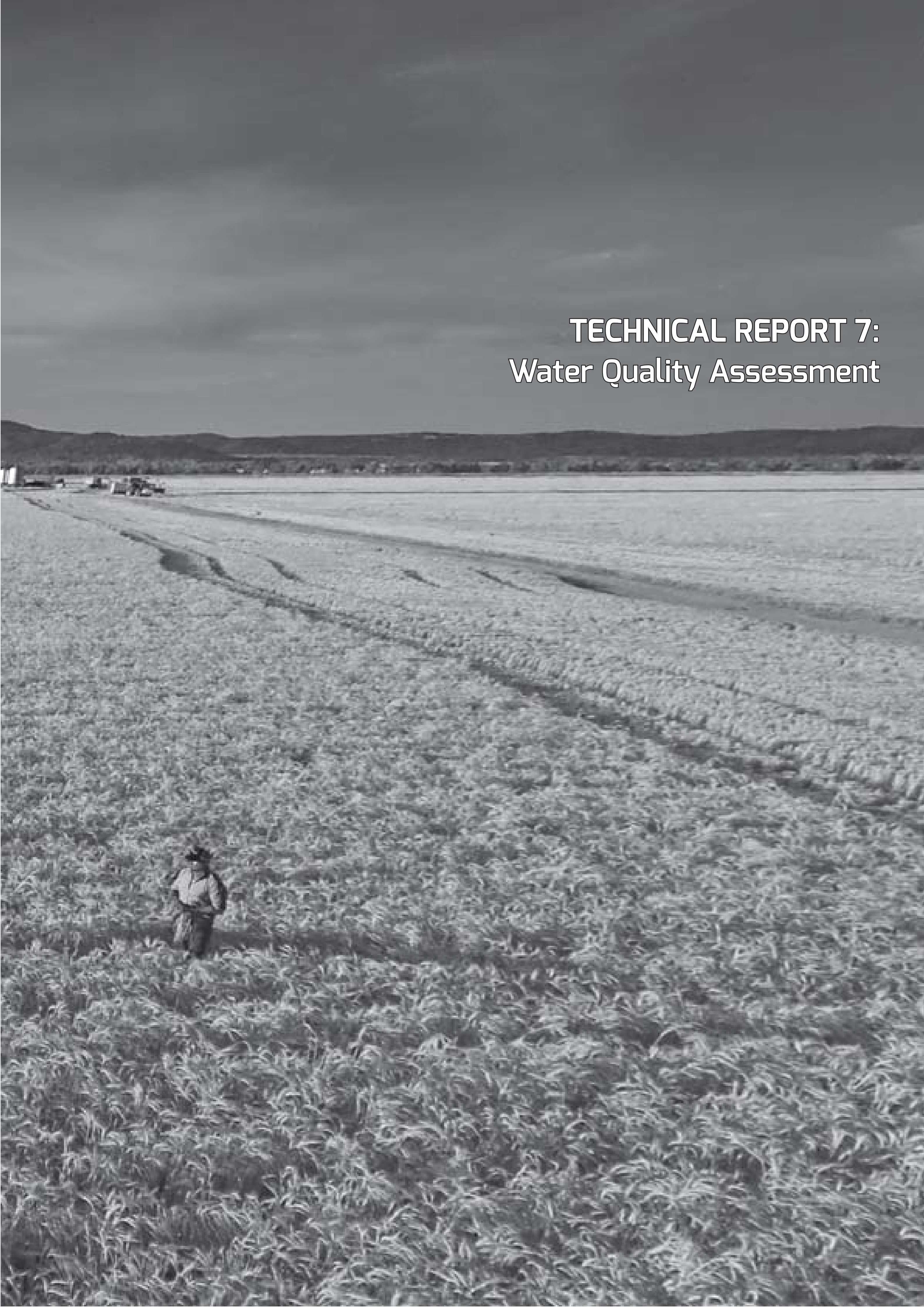
# TECHNICAL REPORT 7:
## Water Quality Assessment



# Australian Rail Track Corporation

## Inland Rail - Parkes to Narromine

## Water Quality Assessment

June 2017

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# Abbreviations

| Abbreviation | Explanation |
|---|---|
| AEP | Annual exceedance probability |
| AHD | Australian Height Datum |
| ANZECC | Australian and New Zealand Environment and Conservation Council |
| ARI | Average recurrence interval |
| ARMCANZ | Agriculture and Resources Management Council of Australia and New Zealand |
| ARR | Australian Rainfall and Runoff |
| ARTC | Australian Rail Track Corporation |
| BoM | Bureau of Meteorology |
| DPI | NSW Department of Primary Industries |
| EIS | Environmental Impact Statement |
| EMP | Environment Management Plan |
| EPA | Environmental Protection Agency |
| GHD | GHD Pty Ltd |
| LiDAR | Light Detection and Ranging |
| MDB | Murray Darling Basin |
| NARCLiM | NSW and ACT Regional Climate Model |
| NSW | New South Wales |
| NWQMS | National Water Quality Management Strategy |
| OEH | Office Environment and Heritage |
| RCBC | Reinforced Concrete Box Culvert |
| SEARs | Secretary's Environmental Assessment Requirements |
| SRTM | Shuttle Radar Topography Mission |
| WQO | Water Quality Objectives |

# Glossary

| Term | Explanation |
| --- | --- |
| Afflux | A rise in flood level as a result of an obstruction to flow |
| Alluvial plain | A large relatively flat area formed by deposition of sediment over an extended period |
| Alluvial sediment | Loose sediments mobilised and deposited by non-marine water actions (e.g. floodplain soils) |
| Annual Exceedance Probability (AEP) | The change of a flood of a nominated size occurring in a particular year. The chance of the flood occurring is expressed as a percentage and, for large floods, is the reciprocal of the ARI. For example, the 1 per cent AEP flood event is equivalent to the 100 year ARI flood event |
| Australian Height Datum (AHD) | National survey datum closely corresponding to mean sea level |
| Average Recurrence Interval (ARI) | The long term average number of year between the occurrence of a flood of a nominated size |
| Ballast | Rock placed under the rail ties (sleepers) to provide stable support for a rail line. |
| Bidirectional | Allowing train travel in either direction according to the infrastructure and system of safe working in use |
| Brownfield | Development areas that have been previously developed. |
| Calcic soil | A soil containing a relatively high concentration of secondary calcium carbonate |
| Catchment | the catchment at a particular point is the area of land that drains to that point |
| Cell | Culvert design termed meaning single opening |
| Cess | Space between the outermost rail and the rail corridor boundary |
| Chainage | A measure of distance along the rail corridor from Sydney. The nominated values are not exact distances as there are some local adjustments made to reflect progressive changes to the rail as works are progressively implemented to, for example, ease bends |
| Channelized fill | Channelized fill systems are generally laterally, stable channels of low sinuosity incised within flat and featureless floodplains |
| Chert | A hard, dark opaque rock composed of silica with a microscopically fine grained texture |
| Design flood | A flood event, based on a design storm of a specific duration (critical duration) that creates the greatest volume of rainfall-runoff for a given probability of occurrence |
| Design storm | A synthetic storm event used for modelling purposes, derived using the methods outlined in ARR |
| Dispersive | A characteristic of soil indicating the potential for the breakdown of clay minerals into single clay particles in solution |
| Embankment | An earth or stone bank, built to support a rail line or provide flood protection |
| Ephemeral | Temporary, short-lived |
| Existing rail corridor | The area of land that is identified for the continued operation of the rail line between Parkes and Narromine |
| Flood | Relatively high river, creek or water way flow which overtop the natural or artificial banks to inundate surrounding areas in an uncontrolled manner |

| Term | Explanation |
|---|---|
| Flood depth | The depth of floodwater above ground level |
| Flood plain | Land adjacent to a river, creek or water way that is periodically inundated due to floods. The floodplain includes all land that is susceptible to inundation be the probable maximum flood event |
| Flood prone land | Land susceptible to inundation by the probable maximum flood |
| Flood storage | Floodplain area that is important for the temporary storage of floodwaters during a flood |
| Floodway | A flow path natural or artificial that carries floodwater during a flood |
| Formation | The earthen embankment that supports the ballast, ties and rail associated with a railway |
| Hardsetting | A soil in which the topsoil sets hart when dry |
| Hillslope | An area of land that flanks a valley and the margins of upslope steeper areas |
| Historical flood | A flood that has occurred at some point in the past |
| Hydraulic | The study of water flow in natural or artificial water ways |
| Hydrograph | A graph showing water flow of a river, creek or water way over time |
| Hydrology | The study or rainfall and runoff process |
| Kaolin | A mineral within clay |
| Lithosol | A group of soils that lack a defined soil structure |
| Loam | A fertile soil comprising a mix of sand, silt and clay |
| Local catchment | The area of land that lies upslope from a specified point |
| Major under track structure | Has a design flow greater than 50 m3/s – design for 1 per cent AEP event |
| Minor structure | Has a design flow less than 50 m3/s – design for 2 per cent AEP event |
| Morphology | A particular form, shape or structure |
| Mulitcell | Multiple number of openings within a structure |
| Permeability | A measure of the ability of the soil to transmit water |
| Pineena | The NSW Government water database |
| Probable maximum flood | An extreme flood deemed to be the maximum flood likely to ever occur |
| Proposal | The construction and operation of the Parkes to Narromine project |
| Proposal site | The area that would be directly affected by construction works. The proposal site is considered to have a width of 30 metres, providing for a 15 metre buffer on each side of the alignment centreline. 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 that would be used to construct that infrastructure |
| Rail overtopping | Flood waters rising above the level of the rail |
| Regional flood frequency | A method of estimating flood flows for small ungauged basins |
| Reinforced concrete box culvert | A drainage structure that has a rectangular cross sectional shape and is manufactured from concrete with steel reinforcing in the concrete walls |
| River style | A classification of a watercourse based on character, behaviour, condition and recovery potential |
| Runoff | The amount of rainfall from a catchment that actually ends up as flowing water in the river or creek |

| Term | Explanation |
|---|---|
| Salinity | Refers to the amount of salt present in the soil solution |
| Salting | The formation of a salt layer on the soil surface |
| Sandstone | A sedimentary rock composed mainly of sand |
| SIltstone | A sedimentary rock composed mainly of silt |
| Sinuosity | Capacity to curve |
| Sodic soil | Sodicity is a term that indicates the amount of sodium present in a soil |
| Soffit | Underside of a bridge |
| Stable channel | A watercourse that is not subject to significant changes in channel geometry |
| Stage-storage | The relationship between water depth and storage volume within a dam or other water storage |
| Stoniness | The tendency for presence of stones in soil |
| Stream order | A measure of the relative size of a watercourse |
| Structure | An underbridge or culvert under the rail line passing over a watercourse, pathway, floodway or some other similar feature |
| Study area | The total area that may be impacted by construction and operation of the proposal |
| Track | The combination of rails, rail connectors, sleepers, ballast, points, crossings and any substitute devices |
| Subsoil | The layer of soil below the topsoil |
| Topsoil | The upper or outermost soil layer. Typically 5 to 20 cm thick |
| Underbridge | A bridge supporting the track and passing over a watercourse, roadway, pathway, floodplain or some other similar feature |
| Unidirectional | Allowing train travel in a single direction according to the infrastructure and system of safe working in use |
| Watercourse | A flow path that may operate during times of surface runoff. Generally the flow path will have a defined cross sectional shape |
| Waterlogging | A soil that contains the maximum practical amount of water |
| Water take | The extraction of surface or groundwater interception |
| Weir | A structure that partially retains water, regulating water levels upslope of the structure |
| Valley fill | Unconsolidated deposits of sediment within a valley, typically eroded from the surrounding hillslopes |
| Velocity | The speed at which the floodwaters are moving |

# Executive summary

### *The proposal*

Australian Rail Track Corporation Ltd (ARTC) is seeking approval to construct and operate the Parkes to Narromine section of Inland Rail ('the proposal').

The proposal would involve upgrading the existing rail line between Parkes and Narromine for a distance of 106 kilometres, including new crossing loops, some track realignment and replacement of culverts. The proposal also includes a new north to west connection between Inland Rail and the Broken Hill line (Parkes north west connection).

Ancillary work would include works to level crossings, signalling and communications, signage, fencing, and services and utilities.

### *This report*

This report provides the results of the water quality impact assessment of the proposal. It includes an analysis of the existing and design condition hydrology, hydraulics/flooding and water quality conditions within the proposal site. This analysis forms supporting documentation for the Environmental Impact Statement for the proposal and addresses the requirements of the Secretary of the Department of Planning and Environment. This report builds on findings from the hydrology and hydraulic/flooding assessment, which are assessed in a separate report.

### *Water quality*

The proposal site is located within the Lachlan and Macquarie-Bogan river catchments and crosses several named watercourses. The majority of the watercourses are ephemeral and there is a minimal amount of water quality data to describe the existing conditions along the corridor. Soils are generally identified as being highly erodible.

Water quality objectives for the Lachlan and Macquarie-Bogan river catchments have been reviewed. For water quality parameters that are commonly reported, the water quality objectives are similar to the ANZECC water quality targets.

### *Risk assessment and mitigation*

A risk assessment of water quality impacts has been carried out, and measures are proposed to mitigate the risks and adverse impacts on water quality, as much as practical.

These recommended mitigation measures are described below. The implementation of the complete range of mitigation measures would protect the water quality of both surface waters and groundwater in accordance with the water quality objectives for the proposal.

Risks have been separately identified for the construction phase and the operational phase for the proposal. For the construction phase the risks are primarily litter, sediments or nutrients being exported off site leading to downstream pollution of watercourse. In addition, spills of oils or grease could pollute the nearby soil, groundwater or surface water. Use of significant amounts of concrete could also lead to a short term change in water pH during the first few runoff events.

For the operational phase the risks have been identified as being the potential for failure of the formation leading to downstream pollution as well as wear of rolling stock potentially leading to metals on the track, possible spills of oil or grease from rolling stock or dust off carriages. Maintenance works required during the life of the proposal could also impact the environment through fragments of metals getting onto the soil the soil surface, minor spills of chemicals or soil disturbance resulting from access and minor earthworks.

### *Design phase*

The following mitigation measures are proposed during the design phase:

- The proposed formation level and formation profile have been selected to achieve the targeted flood immunity while minimising adverse flooding, maximising the reuse of excavated material and reducing adverse water quality impacts resulting from the construction.
- The proposed culverts would be located under the rail line at locations generally consistent with the existing structure locations, and consistent with the existing watercourse invert level. This would maximise the potential fish passage and minimise excavation that could impact the water quality, and maintain existing ecological function.
- The proposed culvert form has been selected to facilitate as much offsite concrete work as possible while minimising the anticipated construction phase and water quality risks as well as minimising the demand for construction period water demand.
- The proposed provision of rock rip rap immediately downstream of culverts would provide protection against erosion adjacent to the culvert aprons and in the watercourse through the downstream properties. While this measure has been detailed there is a predicted residual erosion risk in the area downstream of culverts, and risk would need to be considered for each site to achieve appropriate site specific designs.
- Existing pipes or culverts that removed in a sound condition would be stored for potential future reuse.
- Precast culvert segments would be used, where practical, to minimise construction periods over watercourses that contain water at the time of construction.

The following mitigation measures are recommended during the construction phase:

- A Construction Environmental Management Plan (CEMP) would be prepared to address site management measures so that adverse water quality impacts are mitigated as much as practical. This plan would specifically address spill containment measures, culvert construction measures over water (as required) and waste minimisation measures to protect the water quality impacts as required by the water quality objectives.
- A Soil and Water Management Plan would be prepared to detail the erosion control measures to be implemented and maintained for the duration of the construction phase. The plan would be consistent with requirements in the *Managing Urban Stormwater: Soils and Construction Manual.* It would identify required implementation measures to protect water quality downstream and down gradient of the proposal.
- Activities which have the potential to impact water quality, including construction compounds and vehicle washdown sites, would be located a minimum of 50 metres from any watercourse and any wastewater from these activities would be captured and discharge or disposed of in accordance with relevant requirements.

The following mitigation measures are recommended during the operational life of the project:

- Train speeds would be controlled to not exceed the design value.
- Track inspections would be undertaken after significant flood events to identify any required repairs or maintenance prior to recommencing services.

Application of appropriate environmental protection measures during maintenance works along the route of the proposal.

# 1. Introduction

## 1.1 Overview

The Australian Government has committed to delivering a significant piece of national transport infrastructure by constructing a high performance and direct interstate freight rail corridor. The Inland Rail programme (Inland Rail) involves the design and construction of a new inland rail connection, about 1,700 kilometres long, between Melbourne and Brisbane, via central-west New South Wales (NSW) and Toowoomba in Queensland. Inland Rail would enhance Australia's existing national rail network and serve the interstate freight market.

Australian Rail Track Corporation Ltd (ARTC) has sought approval to construct and operate the proposal.

The proposal requires approval from the NSW Minister for Planning under Part 5.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

This report has been prepared by GHD Pty Ltd (GHD) as part of the environmental impact statement (EIS) for the proposal. The EIS has been prepared to accompany the application for approval of the proposal, and address the environmental assessment requirements of the Secretary of the Department of Planning and Environment (the SEARs), issued on 8 November 2016 and the terms of the assessment bilateral agreement between the Commonwealth and the State of New South Wales under the EPBC Act.

## 1.2 The proposal

### 1.2.1 Location

The proposal is generally located in the existing rail corridor between the towns of Parkes and Narromine, via Peak Hill. In addition, a new connection to the Broken Hill rail line ('the Parkes north west connection') is proposed outside the existing rail corridor at the southern end of the proposal site near Parkes. The location of the proposal is shown in Figure 1-1.

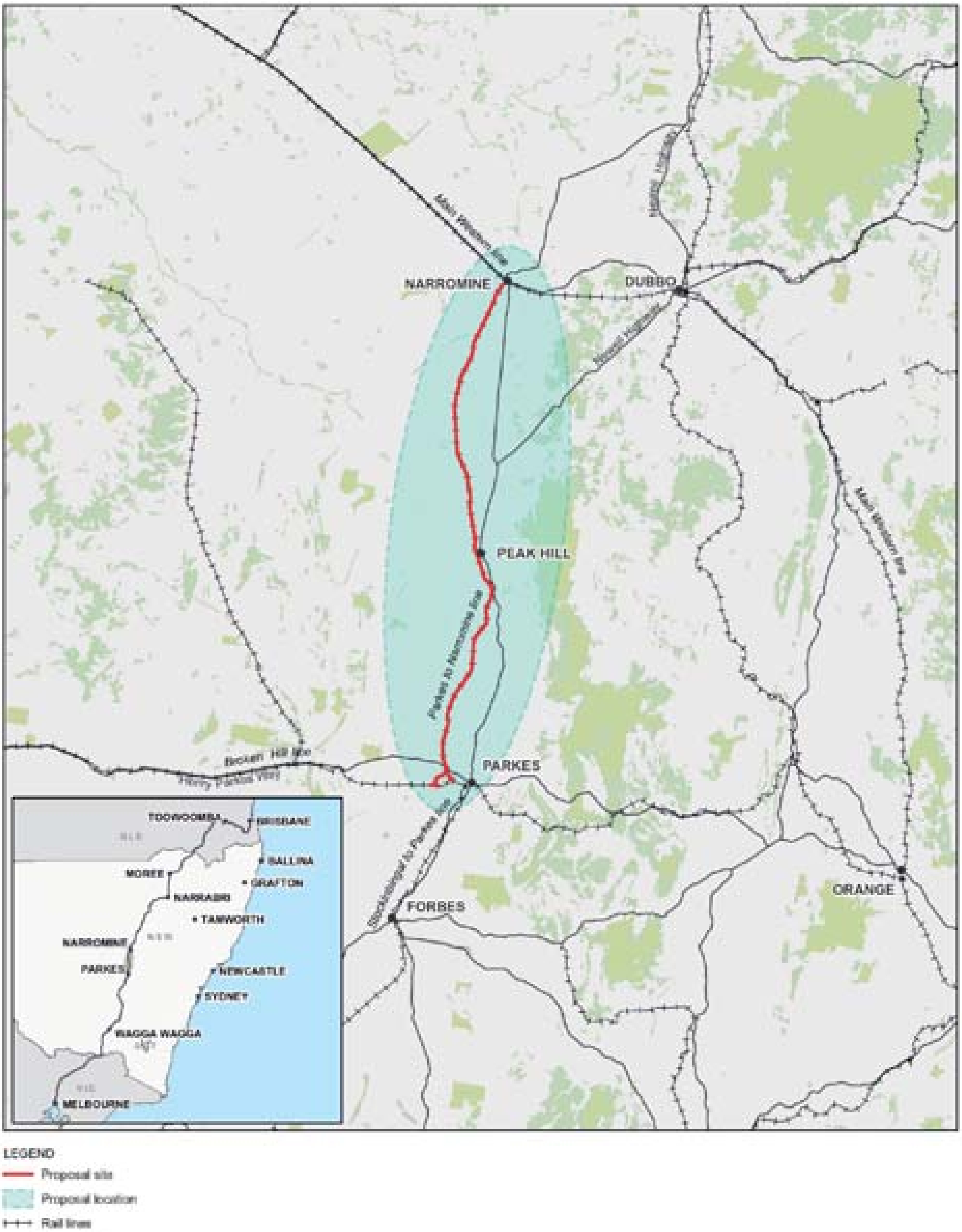
### 1.2.2 Key features

The key features of the proposal involve:

- Upgrading the track, track formation, and culverts within the existing rail corridor for a distance of 106 kilometres between Parkes and Narromine
- Realigning the track where required within the existing rail corridor to minimise the radius of tight curves
- Providing three new crossing loops within the existing rail corridor, at Goonumbla, Peak Hill, and Timjelly
- Providing a new 5.3 kilometre long rail connection to the Broken Hill Line to the west of Parkes ('the Parkes north west connection'), including a road bridge over the existing rail corridor at Brolgan Road ('the Brolgan Road overbridge').

The key features of the proposal are shown in Figure 1-2.

Ancillary work would include works to level crossings, signalling and communications, signage and fencing, and services and utilities.




LEGEND

Proposal site

Proposal location

Rail lines

Main roads

Paper Size A4

0 5 10 20 30

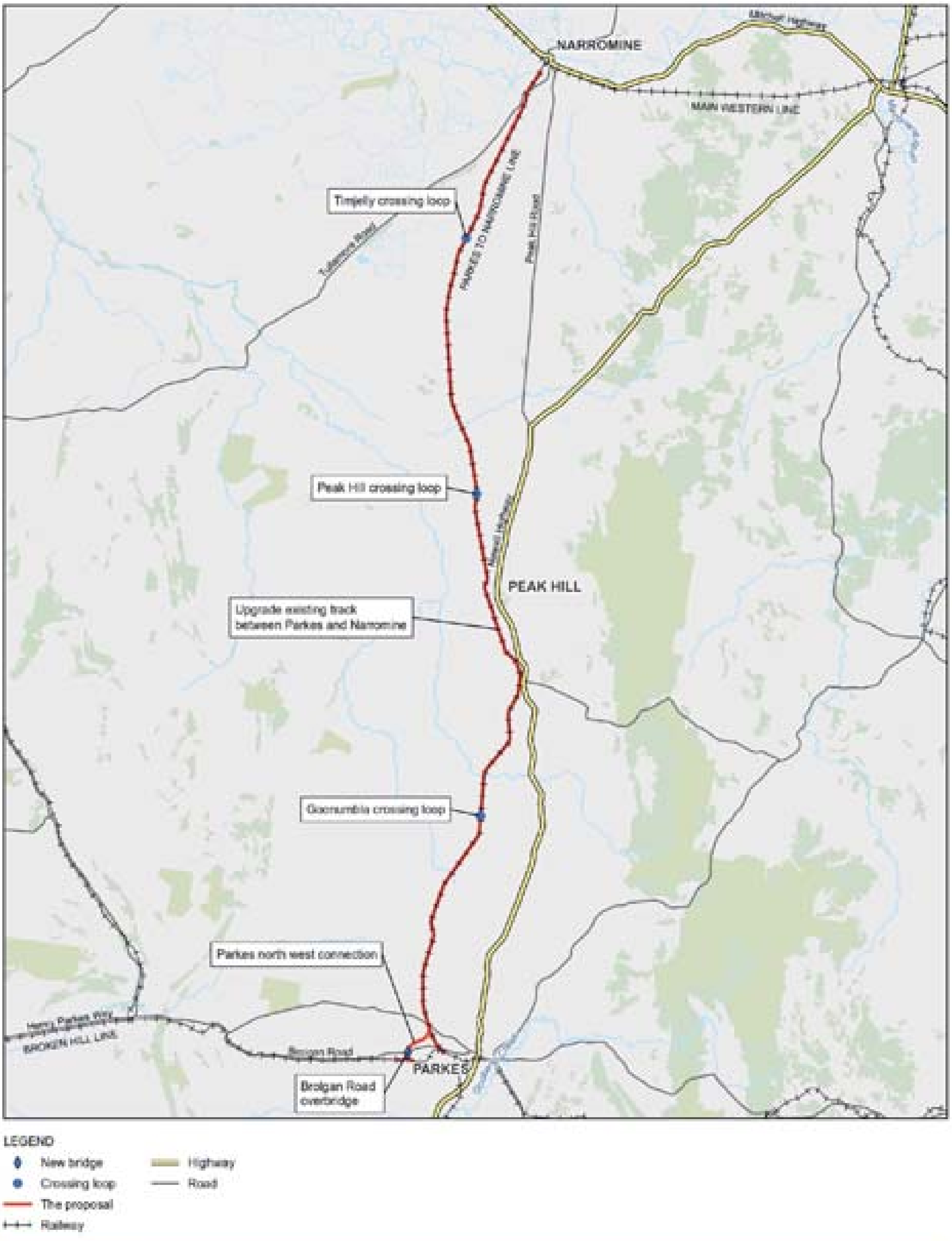
Kilometers

Australian Rail Track Corporation
Inland Rail Track Alignment

| | |
|---|---|
| Job Number | 2217016 |
| Revision | 0 |
| Date | 30 Nov 2016 |

Location of the proposal

Figure 1-1




Australian Rail Track Corporation
Inland Rail Track Alignment

Job Number 2217316
Revision 0
Date 19 Jun 2017

**Key features of the proposal** — **Figure 1-2**

Further information on the proposal is provided in the EIS.

### 1.2.3 Operation

Prior to the opening of Inland Rail as a whole, the proposal would be used by existing rail traffic, which includes trains carrying grain and ore at an average rate of about four trains per day. It is estimated that the operation of Inland Rail would involve an annual average of about 8.5 trains per day in 2025, increasing to 15 trains per day in 2040. The trains would be a mix of grain, intermodal (freight), and other general transport trains.

### 1.2.4 Timing

Subject to approval of the proposal, construction is planned to start in early to mid 2018, and is expected to take about 18 months. Existing train operations along the Parkes to Narromine line would continue prior to, during, and following construction. Inland Rail as a whole would be operational once all 13 sections are complete, which is estimated to be in 2025.

## 1.3 Purpose and scope of this report

This report provides the results of the water quality impact assessment of the proposal as required by the SEARS, Section 2.5.2. Specifically, this report:

- Provides a brief overview of the proposal.
- Provides a brief overview of the hydrologic and hydraulic impacts of the proposal. These are assessed in detail in the *ARTC Inland Rail – Parkes to Narromine Hydrologic and Flooding Report* (GHD 2016).
- Describes the existing environmental conditions.
- Establishes and documents the water quality impacts of the proposal, including consideration of the existing water quality regime and predicted impacts during the construction and operational life of the proposal.
- Identifies proposed ongoing monitoring programs for the verification of predicted water quality impacts.

## 1.4 Structure of this report

The structure of the report is provided in Table 1-1.

**Table 1-1 Report structure**

| Section | Details |
|---|---|
| 1 | Provides an introduction to the report |
| 2 | Describes the methodology for the assessment |
| 3 | Provides available data and a summary of the physical characteristics of the proposal site |
| 4 | Describes the existing water quality of the proposal site |
| 5 | Provides a water quality risk assessment |
| 6 | Provides an evaluation of the proposed impact mitigation measures and the residual risks |
| 7 | Describes the proposed monitoring program |
| 8 | Gives the conclusions from the investigation |

# 2. Assessment approach and methodology

## 2.1 Definitions

### 2.1.1 Study area

The study area for the water quality investigation is considered as being the area that may be directly or indirectly affected by the proposal in a significant way. Additional downstream areas could potentially be impacted as a result of a regional flood in either the broader Lachlan River basin or the Macquarie-Bogan River basin, as detailed in Section 3.7.1.

### 2.1.2 Terminology

#### *Hydrology*

The term 'hydrology' refers to the estimation of runoff generated from a catchment after rain hits the ground. For any given catchment, the relationship between rainfall and runoff can predict peak flow rates at a nominated discharge point through consideration of the catchment's characteristics. These characteristics include its terrain, soil type, shape, land use, vegetation coverage, areas of inundation and water storage.

Surface water flow paths within the study area are understood to mainly comprise ephemeral watercourses and a small number of perennial major river systems that pass through the study area.

#### *Flood event*

The term 'flood event' can refer to either:

- A historical flood event, being an actual event that has occurred for which flood levels and rainfall data may have been gauged.
- A design flood event, which is generated based on a design storm of a specific duration (critical duration) that creates the greatest volume of rainfall-runoff for a given probability of occurrence.

#### *Structure*

The term 'structure' usually refers to a circular or rectangular culvert or underbridge that allows water to pass under an embankment (e.g. a rail embankment). Structures may be either single cell (generally one opening) or multi-cell (multiple openings).

## 2.2 Design objectives

The design objective of the proposal can be summarised as being an upgrade of the existing rail line from near Parkes through to Narromine to achieve an acceptable performance standard, while remaining cost effective for the forecast increased loadings considering both an anticipated increase in the train frequency and also an increase in the axle loading of carriages. Achieving these objectives would require:

- Reconstructing embankments
- Replacing structures
- Easing curves
- Building new sidings.

The availability targets for the proposal (Parsons Brinkerhoff 2015) identified the need for:

- 98 per cent reliability for freight delivery as per agreed freight availability times
- 90 per cent of daily train throughout
- 90 per cent of heavy services arriving within 15 minutes of schedule.

### 2.2.1 Adopted drainage performance requirements

The design requirements, as related to hydraulics performance, are:

- The flood immunity is defined as the one per cent annual exceedance probability (AEP) flood which is taken as being equivalent in magnitude to the 100 year average recurrence interval (ARI) event.
- The flood immunity and serviceability limit state AEP are taken as being the one per cent AEP at the shoulder corner of the formation capping.
- Key infrastructure should not be located within the one per cent AEP flood prone area, or, where this is not possible, to design for a flood immunity greater than one per cent AEP.

These requirements are applicable to local catchment flood events but not to regional flood events. A regional flood event is considered as being one in the Macquarie, Bogan or Lachlan rivers and areas where floods in these rivers spill onto the adjacent floodplains.

## 2.3 Design

### 2.3.1 Form

Engineering features of the proposal that would impact the hydrology and hydraulics and, thus, the water quality, would primarily be the raising of the existing rail embankment along the majority of the proposal site across the floodplain. The embankment and upgraded structures would be required to permit an appropriate flow to minimise adverse flooding impacts.

The upgraded structures are designed to pass all flows up to the one per cent AEP magnitude and thus restrict the rail line from overtopping in all but extreme rainfall local catchment events. Regional flood events could still be expected to overtop the rail line in at the northern end near Narromine.

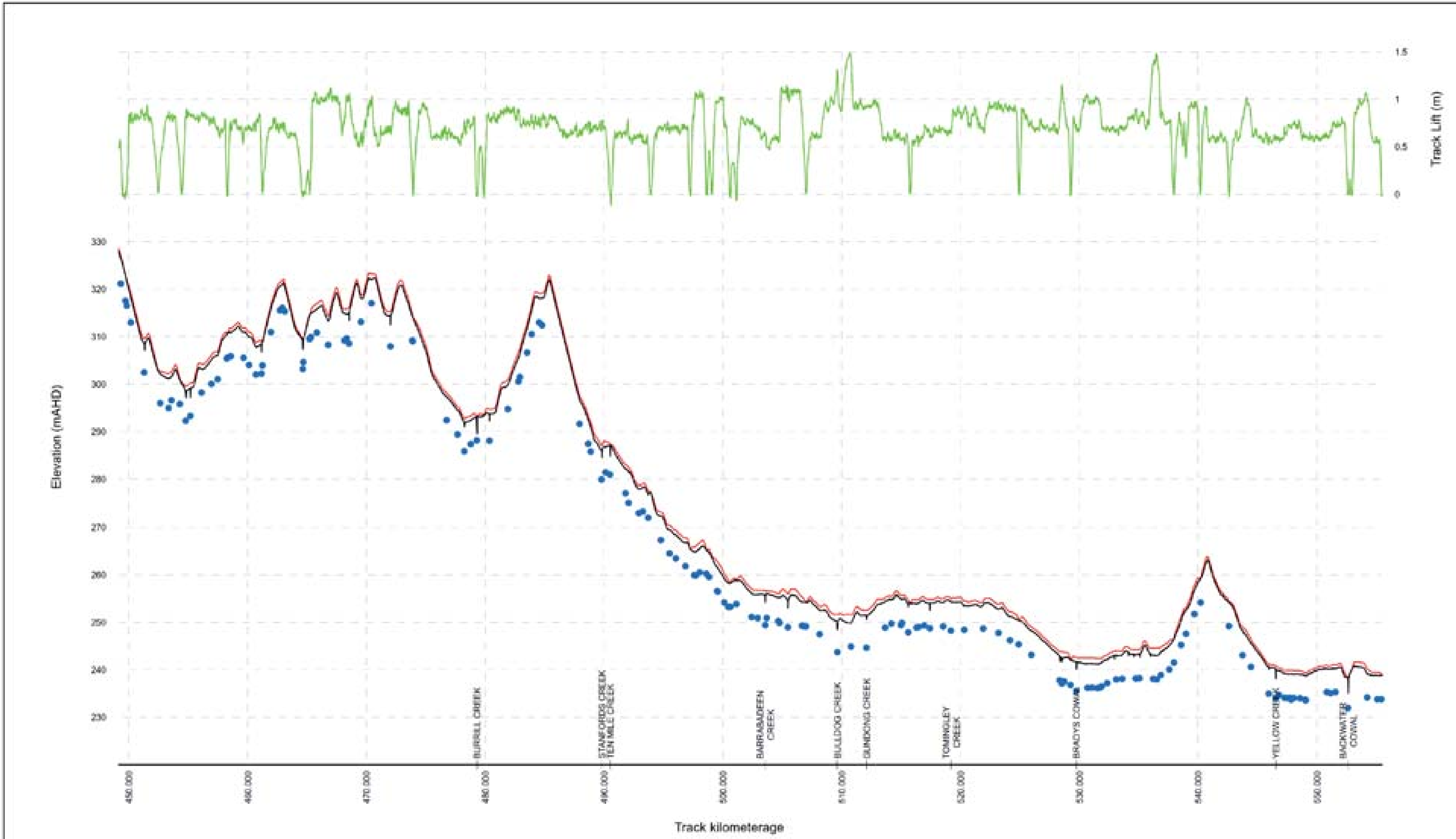
Changes to the hydrological and hydraulic regime could impact the water quality during both construction and operation of the proposal.

Details of the process used to select structure sizes for the proposal are described in accompanying *ARTC Inland Rail – Parkes to Narromine Hydrology and Flooding Assessment* (GHD 2017).

Figure 2-1 shows the existing natural surface along the proposal site and the design track long section between Parkes and Narromine together with the location and quantities of lift between the existing track level and the design track level. No (or minimal) lift would be applied at existing level crossings and, over the majority of the proposal, the track lift would generally be between 0.3 metres and 1.0 metres, with a number of locations being raised up to about 1.5 metres..

The proposed locations of structures (culverts and underbridges) along the length of the proposal between Parkes and Narromine are shown in Figure 2-1. The structures are offset eight metres below their invert level for clarity of presentation. A plan view of the proposed culvert locations for the same portion of track are shown in Figure 2-2. Culverts proposed for the Parkes north west connection will be placed in natural low points to maintain existing flow paths.

The proposed Parkes north west connection would include three structures sized to match the corresponding main line culvert.




Paper Size A3

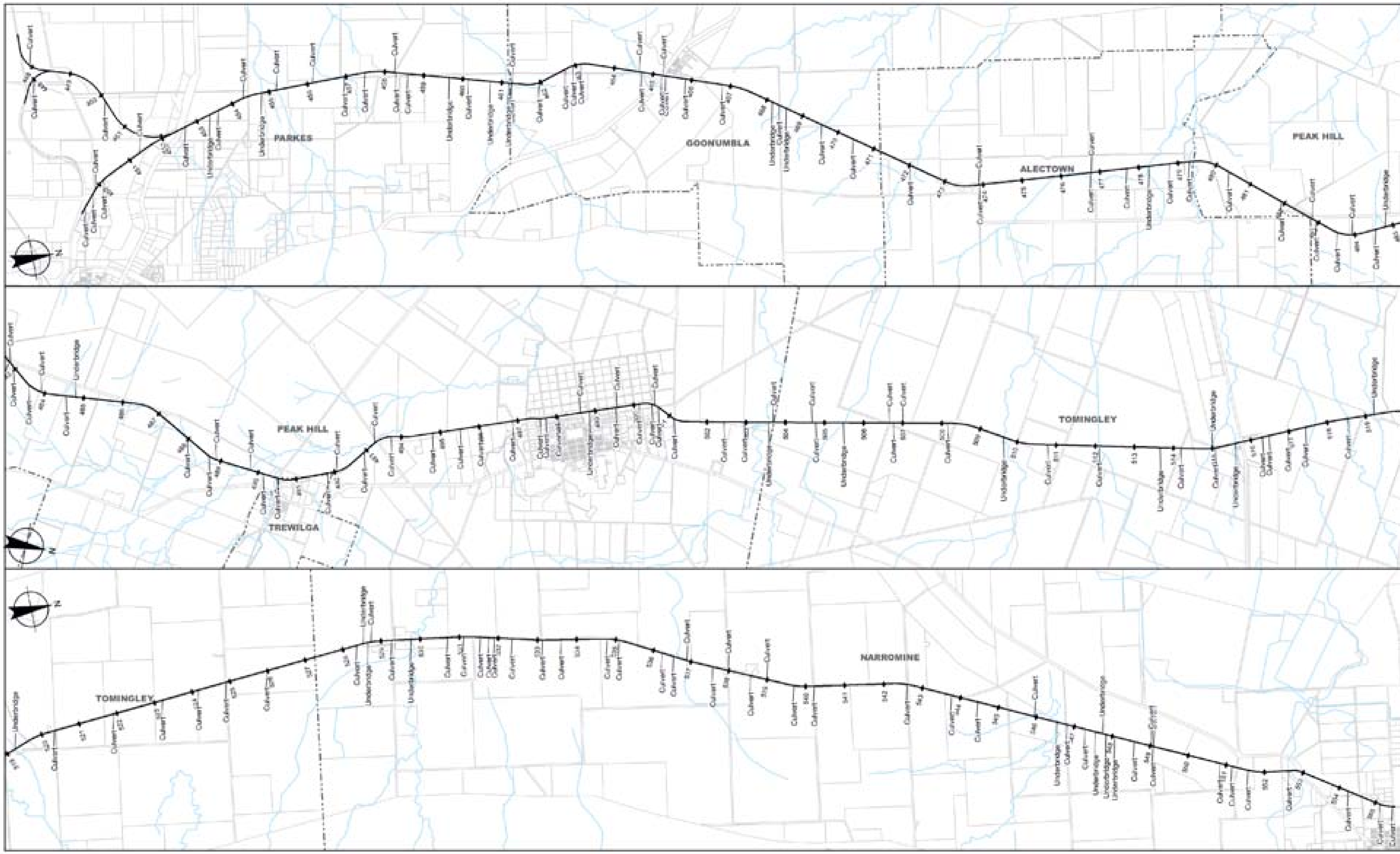
LEGEND
- Design
- Natural Surface
- Track Lift
- Culvert

Australian Rail Track Corporation
Inland Rail - Parkes to Narromine

| | |
|---|---|
| Job Number | 22-17916 |
| Revision | 0 |
| Date | 23 Nov 2016 |

**Design Track Alignment** **Figure 2-1**

180 Lonsdale Street Melbourne VIC 3000 T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com.au




Paper Size A3

0 0.5 1 2 3 4

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

- Rail Centreline
- Watercourse
- Lot boundary
- Suburb boundary

Australian Rail Track Corporation
Inland Rail - Parkes to Narromine

| | |
|---|---|
| Job Number | 22-17916 |
| Revision | 0 |
| Date | 23 Nov 2016 |

## Proposed Culvert Locations

## Figure 2-2

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au

### 2.3.2 Proposal end points

The local catchment flooding and water quality assessment extends from near Parkes (about chainage 484 to near Narromine (about chainage 550).

## 2.4 Hydrologic and hydraulic assessment

### 2.4.1 Surface water hydrologic impacts – overview

An assessment of the surface water hydrologic impacts of the proposal are provided in the Technical Report 5. This assessment predicts that the proposal would have the following impacts on surface water hydrology as:

- The existing low-flow culvert crossing locations along the existing rail corridor would be retained because of replacing or retaining culverts at, or very close to, their existing location.
- There would be a concentration of flows with all flows crossing the existing rail line only at culverts, without track overtopping for events up to the one per cent AEP local catchment event, except for a minimal number of level crossings. In larger events, there could be flow through ballast and in extreme events, there could also potentially be track overtopping at locations away from culverts.
- There would be a concentration of flows downstream of the existing culverts between Parkes and Narromine, since flows would not overtop the rail for events up to the one percent AEP local catchment event.
- There would be an increase in the duration of flow through culverts for local catchment storm events.
- Figure 2-1 shows the proposed culvert and underbridge locations along the proposal.

### 2.4.2 Groundwater hydrologic impacts – overview

A groundwater hydrologic assessment is provided in the *ARTC Inland Rail – Parkes to Narromine Hydrology and Flooding Assessment* (GHD 2017). The assessment indicates that the proposal is unlikely to have any significant impact on the long-term groundwater hydrology.

### 2.4.3 Hydraulic and flooding impacts – overview

A comprehensive assessment of the hydraulic and flooding impacts of the proposal are provided in the *ARTC Inland Rail –Parkes to Narromine Hydrology and Flooding Assessment* (GHD 2017). This assessment predicts that the proposal would have the following hydraulic impacts:

- The proposal would reduce the extent of track length that currently overtops during flood events. This would be achieved through a combination of raising the track level and increasing culvert capacity for events up to the local catchment one per cent AEP local catchment event magnitude, except at a few level crossing locations.
- The proposal would create a slightly larger flood affected area upstream of the proposal.
- The proposal would lead to an increase in the flood levels and flooding duration upstream of the existing rail corridor.

## 2.5 Water quality assessment

### 2.5.1 Methodology

The potential water quality impacts of the proposal were qualitatively assessed. Proposed impact mitigation strategies adopt recommendations from relevant guideline documents to mitigate known impacts. The assessment included:

- A review of existing literature, including the following reports:
  - Lachlan River Water Quality and River Flow Objectives (DECCW 2006a)
  - Macquarie-Bogan River Water Quality and River Flow Objectives (DECCW 2006b)
- A review of existing conditions using GIS mapping to identify locations of sensitive receiving environments such as channels, watercourses, wetlands, national parks, conservation areas and nature reserves.
- A review of publicly available catchment-scale water quality conditions.
- A review of the existing and proposed rail corridor hydrological conditions to establish risks through the relationships between hydrology and water quality.
- The identification of water quality treatment measures that could be used to mitigate the impact of construction on water quality, following the principles of best practice.
- An assessment of the impact of the proposal during its operation.
- A review of quality treatment measures that could be used to mitigate the impact of operation on water quality based on guidelines issued by ARTC and the NSW Office of Environment and Heritage (OEH).

### 2.5.2 Outcomes sought in relation to water quality

Water quality outcomes sought, as summarised from the SEARs issued for the proposal, from the assessment and design are listed in Table 2-1 and identified against the agency requesting the documentation outcome.

**Table 2-1 Required water quality outcomes**

| Agency | Desired performance outcome | Requirements | Where Addressed |
|---|---|---|---|
| DP&E | The project is designed, constructed and operated to protect the NSW Water Quality Objectives where they are currently being achieved, and contribute towards achievement of the Water Quality Objectives over time where they are currently not being achieved, including downstream of the project to the extent of the project impact including estuarine and marine waters (if applicable). | The Proponent must:<br>• State the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the project, including the indicators and associated trigger values or criteria for the identified environmental values<br>• Identify and estimate the quality and quantity of all pollutants that may be introduced into the water cycle by source and discharge point and describe the nature and degree of impact that any discharge(s) may have on the receiving environment, including consideration of all pollutants that pose a risk of non-trivial harm to human health and the environment<br>• Identify the rainfall event that the water quality protection measures would be designed to cope with<br>• Assess the significance of any identified impacts including consideration of the relevant ambient water quality outcomes<br>• Demonstrate how construction and operation of the project will, to the extent that the project can influence, ensure that:<br>– Where the NSW WQOs for receiving waters are currently being met they would continue to be protected, and<br>– Where the NSW WQOs are not currently being met, activities would work toward their achievement over time<br>• Justify, if required, why the WQOs cannot be maintained or achieved over time<br>• Demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented<br>• Identify sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments<br>• Identify proposed monitoring locations, monitoring frequency and indicators of surface water quality. | Section 2.6.1<br>Section 5.2<br>Section 6.2.1<br>Sections 2.6.2, 5 and 6<br>Sections 2.6.1 and 5.2.2<br>Section 6<br>Sections 5 and 6<br>Sections 4 and 5<br>Section 7 |
| EPA | Soil and Water Management. The EPA recommends that the SEARs provide further details on the requirements for assessment and management of water quality impacts. | The Proponent must:<br>• Identify the potential sources and volumes of discharges to waters (such as stormwater runoff and seepage)<br>• Identify the need for off-site discharges during construction and any associated treatment requirements<br>• Describe receiving waters, including background water quality<br>• Assess potential impacts on receiving waters<br>• Identify measures and strategies to minimise/manage impacts on receiving waters<br>• The need for preparation of an erosion and sediment control plan, to be prepared in accordance with *Managing Urban Stormwater: Soils and Construction, Vol 1, 4th Ed* (Landcom 2004). | Section 3.10 and Section 5<br>Section 5.2<br>Section 4.4<br>Sections 5 and 6<br>Section 6<br>Section 6.2.5 |
| OEH | Soils and water | The Proponent must:<br>• Map the following features relevant to water and soils including: | Sections 3.5, 3.7 and 3.8 |

| Agency | Desired performance outcome | Requirements | Where Addressed |
|---|---|---|---|
| | | – Rivers, streams, wetlands, estuaries (as described in Appendix 2 of the Framework for Biodiversity Assessment)<br>– groundwater<br>– groundwater dependent ecosystems<br>– proposed intake and discharge locations | |
| | | • Describe background conditions for any water resource likely to be affected by the project, including:<br>– Existing surface and groundwater<br>– Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations<br>– Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters<br>– Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC / ARMCANZ (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government | Sections 2.6.1, 4.2 and 4.4 |
| | | • Assess the impacts of the project on water quality, including:<br>– The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the project protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction<br>– Identify proposed monitoring of water quality | Sections 5.2.2 and 6 |
| | | • assess the project impact on hydrology, including:<br>– Water balance including quantity, quality and source<br>– Effects to downstream rivers, wetlands and floodplain areas<br>– Effects to downstream water dependent fauna and flora including groundwater dependent ecosystems<br>– Impacts to natural processes and functions within rivers, wetlands and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (eg river benches)<br>– Changes to environmental water availability, both regulated/licenced and unregulated/rules – based sources of such water<br>– Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options<br>– Proposed monitoring of hydrological attributes. | See separate Hydrology and Flooding Assessment (Technical Report 6) |

## 2.6 Legislation, policy and guideline context

This section provides a review of the legislation and environmental planning instruments that are relevant to the water quality assessment of the proposal.

### *Water Management Act*

Two key pieces of legislation for management of water within NSW are the *Water Management Act 2000* and the *Water Act 1912*. These Acts control the extraction of water, the use of water, the construction of works such as dams and weirs and the carrying out of activities in or near water sources in NSW. The *Water Management Act 2000* recognises the need to allocate and provide water for the environmental health of NSW Rivers and groundwater systems. The provisions of the *Water Management Act 2000* are being progressively implemented to replace the requirements of *Water Act 1912*. Since 1 July 2004, the new licensing and approvals system has been in effect in those areas of NSW covered by commenced water sharing plans.

A controlled activity approval under the *Water Management Act 2000* is required for certain types of developments and activities that are carried out in or near waterfront land that have the potential to affect water quality. However, under section 115ZG of the EP&A Act, an activity approval (including a controlled activity approval) under section 91 of the *Water Management Act 2000* is not required for State significant infrastructure. The design and construction of the proposal would take into account the NSW Office of Water's guidelines for controlled activities on waterfront land to enable the mitigation of potential impacts to water quality.

The assessment of land use changes on floodplains in NSW is managed under Part 8 of the *Water Act 1912.* Part 8 makes provisions for 'controlled works' – defined as works that affect, or are likely to affect, flooding and/or floodplain functions. Consideration of floodplain management aspects of the project will be addressed in the *ARTC Inland Rail – Parkes to Narromine Hydrology and Flooding Assessment* (GHD 2017).

Following the introduction of the *Water Management Act* 2000 water sharing plans have been developed for the Lower Macquarie Groundwater Sources; Lachlan Regulated River; Lachlan Unregulated and Alluvial Water Sources; Macquarie Bogan Unregulated and Alluvial Water Sources; Macquarie and Cudgegong Regulated Rivers. All of these cover part or the entire proposal site.

To preserve water resources in river and groundwater systems for the future, the competing needs of the environment and water users are to be balanced. Water sharing plans establish rules for sharing water between the environmental needs of the river or aquifer and water users (for town water supply, rural domestic water supply, stock watering, industry and irrigation).

### *Australian Rainfall and Runoff*

Australian Rainfall and Runoff (Pilgrim et al 1987, Ball et al 2015) is a national guideline for the estimation of design flood characteristics in Australia. The approaches presented in Australian Rainfall and Runoff are essential for policy decisions and projects involving:

- Infrastructure such as roads, rail, bridges, dams and storm water systems.
- Flood management plans for urban and rural communities.
- Flood warnings and flood emergency management.
- Estimation of extreme flood levels.
- Australian Rainfall and Runoff has been referenced in developing the assessment framework for the hydrology, flooding and water quality impacts associated with the proposal.

### 2.6.1 Water quality

#### *Water quality guidelines*

The National Water Quality Management Strategy (ANZECC / ARMCANZ 2000) 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 strategy contains healthy river guidelines for the protection of lowland river aquatic ecosystems. These guidelines have been used to determine the existing condition of rivers and water quality objectives for the proposal.

#### *Water quality objectives*

Water quality objectives for the Lachlan and Macquarie-Bogan Rivers have been extracted from the NSW Environment Protection Authority (EPA) website and are provided in Table 2-2. Table 2-2 also includes an assessment of the proposal against water quality objectives for the Lachlan and Macquarie-Bogan catchments to determine impacts to water quality due to construction and operation. The drinking water objectives for the Lachlan and Macquarie-Bogan Rivers were not considered due to the predominantly rural land use in the study area and the potential for water to be extracted for multiple uses. Drinking water objectives apply to all current and future licensed offtake points for town water supply and to specific sections of rivers that contribute to drinking water storages or immediately upstream of town water supply offtake points. The objectives also apply to sub-catchments or groundwater used for town water supplies. No drinking water supply points were identified within the proposal site.

**Table 2-2 Water quality objectives for lowland rivers**

| Water quality objective | Indicator | Lachlan River Trigger value or criteria | Macquarie-Bogan River Trigger value or criteria | Relevance to the proposal |
|---|---|---|---|---|
| **Aquatic ecosystems** | | | | |
| Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term | Total phosphorous | 50 µg/L | 50 µg/L | Construction of the proposal would comply with the construction EPL for the proposal and operation would comply with ARTC's existing EPL and standard procedures for the operation of the proposal. This would result in the proposal having minimal impacts on surface water receivers.<br><br>Vegetation removal within riparian zones would be undertaken in accordance with a biodiversity management plan, resulting in revegetation to an equivalent state. |
| | Total nitrogen | 500 µg/L | 500 µg/L | |
| | Chlorophyll-a | 5 µg/L | 5 µg/L | |
| | turbidity | 6–50 NTU | 6–50 NTU | |
| | Salinity (Electrical conductivity) (µS/cm) | 125–2200 µS/cm | 125–2200 µS/cm | |
| | Dissolved oxygen | 85–100% | 85–100% | |
| | pH | 6.5–8.5 | 6.5–8.5 | |
| **Visual amenity** | | | | |
| Aesthetic qualities of waters | Visual clarity and colour | Natural visual clarity should not be reduced by more than 20%.<br>Natural hue of the water should not be changed by more than 10 points on the Munsell Scale.<br>The natural reflectance of the water should not be changed by more than 50%. | Natural visual clarity should not be reduced by more than 20%.<br>Natural hue of the water should not be changed by more than 10 points on the Munsell Scale.<br>The natural reflectance of the water should not be changed by more than 50%. | Construction activities would be managed to minimise the potential for contaminated runoff to enter surface waterbodies.<br>Visual inspections of the aesthetic quality of waters would be undertaken during construction work within waterbodies.<br>Use of herbicides and pesticides during construction work would be undertaken in accordance with the CEMP and best guidance.<br><br>There are drainage structures within the proposal area that are not operating effectively, causing increased sedimentation of adjacent watercourses. These structures would be replaced as part of the proposal, which would improve water quality. |
| | 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.<br>Waters should be free from floating debris and litter. | Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour.<br>Waters should be free from floating debris and litter. | |
| | Nuisance organisms | Macrophytes, phytoplankton scums, | Macrophytes, phytoplankton scums, | |

| Water quality objective | Indicator | Lachlan River<br>Trigger value or criteria | Macquarie-Bogan River<br>Trigger value or criteria | Relevance to the proposal |
|---|---|---|---|---|
| | | filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts. | filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts. | |
| **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 100 mL, with 4 out of 5 samples <4000/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month). | ANZECC 2000 Guidelines recommend: Median over bathing season of <150 faecal coliforms per 100 mL, with 4 out of 5 samples <600/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month). | Construction activities would be managed to minimise the potential for contaminated runoff to enter surface waterbodies.<br>Construction of the proposal would comply with the construction EPL for the proposal and operation would comply with ARTC's existing EPL and standard operating procedures. This would result in the proposal having minimal impacts on surface water receivers. |
| | Enterococci | Enterococci Median bacterial content in fresh and marine waters of <230 enterococci per 100 mL (maximum number in any one sample: 450-700 organisms/100 mL). | ANZECC 2000 Guidelines recommend: Median over bathing season of <35 enterococci per 100 mL (maximum number in any one sample: 60–100 organisms/100 mL). | There are drainage structures within the proposal area that are not operating effectively, causing increased sedimentation of adjacent watercourses. These structures would be replaced as part of the proposal, which would improve water quality.<br>The immediate receiving watercourses are not currently used for secondary contact recreation as the majority of watercourses within the study area are ephemeral. The discharge water quality would enable the potential for secondary contact recreation to be undertaken downstream of the proposal. |
| | Algae & blue-green algae | <15 000 cells/mL. | <15 000 cells/mL | |
| | Nuisance organisms | Use visual amenity guidelines.<br>Large numbers of midges and aquatic worms are undesirable. | Use visual amenity guidelines.<br>Large numbers of midges and aquatic worms are undesirable. | |
| | Surface films | Use visual amenity guidelines. | Use visual amenity guidelines. | |
| **Primary contact recreation** | | | | |
| Maintaining or improving water quality for activities | Turbidity | A 200 mm diameter black disc should be able to be | A 200 mm diameter black disc should be able to be | |

| Water quality objective | Indicator | Lachlan River Trigger value or criteria | Macquarie-Bogan River Trigger value or criteria | Relevance to the proposal |
|---|---|---|---|---|
| such as swimming in which there is a high probability of water being swallowed | | sighted horizontally from a distance of more than 1.6 m (about 6 NTU). | sighted horizontally from a distance of more than 1.6 m (about 6 NTU). | Construction works would be managed to minimise the potential for contaminated runoff to enter surface waterbodies.<br>Construction of the proposal would comply with the construction EPL for the proposal and operation would comply with ARTC's existing environment protection licence and standard operating procedures. This would result in the proposal having minimal impacts on surface water receivers.<br><br>There are drainage structures within the proposal area that are not operating effectively, causing increased sedimentation of adjacent watercourses. These structures would be replaced as part of the proposal, which would improve water quality.<br>The immediate receiving watercourses are not currently used for primary contact recreation as the majority of watercourses within the study area are ephemeral. The maintaining of current water quality within the proposal area would enable the potential for primary contact recreation to be undertaken downstream of the proposal. |
| | Faecal coliforms | ANZECC 2000 Guidelines recommend: Median over bathing season of <150 faecal coliforms per 100 mL, with 4 out of 5 samples <600/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month). | ANZECC 2000 Guidelines recommend: Median over bathing season of <150 faecal coliforms per 100 mL, with 4 out of 5 samples <600/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month). | |
| | Enterococci | ANZECC 2000 Guidelines recommend: Median over bathing season of <35 enterococci per 100 mL (maximum number in any one sample: 60–100 organisms/100 mL). | ANZECC 2000 Guidelines recommend: Median over bathing season of <35 enterococci per 100 mL (maximum number in any one sample: 60–100 organisms/100 mL).. | |
| | 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). | 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 | <15 000 cells/Ml | |
| | Nuisance organisms | Use visual amenity guidelines. | Use visual amenity guidelines. | |
| | pH | 5.0–9.0 | 5.0–9.0 | |

| Water quality objective | Indicator | Lachlan River<br>Trigger value or criteria | Macquarie-Bogan River<br>Trigger value or criteria | Relevance to the proposal |
|---|---|---|---|---|
| | Temperature | 15°–35°C for prolonged exposure. | 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.<br>Toxic substances should not exceed the concentrations provided in Tables 5.2.3 and 5.2.4 of the ANZECC 2000 Guidelines 2000. | Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation.<br>Toxic substances should not exceed the concentrations provided in Tables 5.2.3 and 5.2.4 of the ANZECC 2000 Guidelines 2000. | |
| | Visual clarity and colour | Use visual amenity guidelines. | Use visual amenitguidelines. | |
| **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 2.3 μg/L expressed as microcystin-LR toxicity equivalents. | An increasing risk to livestock health is likely when cell counts of microcystins exceed 11,500 cells/mL and/or concentrations of microcystins exceed 2.3 μg/L expressed as microcystin-LR toxicity equivalents. | Construction activities would be managed to minimise the potential for contaminated runoff to enter surface waterbodies.<br>Construction of the proposal would comply with the construction EPL for the proposal and operation would comply with ARTC's existing environment protection licence and standard operating procedures. This would result in the proposal having minimal impacts on surface water receivers.<br>There are drainage structures within the proposal area that are not operating effectively, causing increased sedimentation of adjacent watercourses. These structures would be replaced as part of the proposal, resulting in an improvement to water quality.<br>The potential for waterbodies within the proposal area to be used for livestock water supply is considered low. |
| | Salinity (electrical conductivity) | Recommended concentrations of total dissolved solids in drinking water for livestock are given in Table 4.3.1 (ANZECC 2000 Guidelines). | 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 | Drinking water for livestock should contain less than 100 thermotolerant coliforms | |

| Water quality objective | Indicator | Lachlan River<br>Trigger value or criteria | Macquarie-Bogan River<br>Trigger value or criteria | Relevance to the proposal |
|---|---|---|---|---|
| | | per 100 mL (median value). | per 100 mL (median value). | |
| | Chemical contaminants | Refer to Table 4.3.2 (ANZECC 2000 Guidelines) for heavy metals and metalloids in livestock drinking water.<br>Refer to Australian Drinking Water Guidelines (NHMRC and NRMMC 2004) for information regarding pesticides and other organic contaminants, using criteria for raw drinking water. | Refer to Table 4.3.2 (ANZECC 2000 Guidelines) for heavy metals and metalloids in livestock drinking water.<br>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. | Should not be visible. No more than low algal levels are desired to protect irrigation equipment. | Construction activities would be managed to minimise the potential for contaminated runoff to enter surface waterbodies.<br>Construction of the proposal would comply with the construction EPL for the proposal and operation would comply with ARTC's existing environment protection licence and standard operating procedures. This would result in the proposal having minimal impacts on surface water receivers.<br>There are drainage structures within the proposal area that are not operating effectively, causing increased sedimentation of adjacent watercourses. These structures would be replaced as part of the proposal, which would improve water quality. |
| | Salinity (electrical conductivity) | To assess the salinity and sodicity of water for irrigation use, a number of 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. | To assess the salinity and sodicity of water for irrigation use, a number of 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 | Trigger values for thermotolerant coliforms | Trigger values for thermotolerant coliforms | |

| Water quality objective | Indicator | Lachlan River<br>Trigger value or criteria | Macquarie-Bogan River<br>Trigger value or criteria | Relevance to the proposal |
|---|---|---|---|---|
| | (faecal coliforms) | in irrigation water used for food and non-food crops are provided in Table 4.2.2 of the ANZECC Guidelines. | 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. | 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.<br>>500 algal cells/mL – increase monitoring.<br>>2000 algal cells/mL – immediate action indicated; seek expert advice.<br>>6500 algal cells/mL – seek advice from health authority. | 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.<br>> 500 algal cells/mL – increase monitoring.<br>>2000 algal cells/mL – immediate action indicated; seek expert advice.<br>>6500 algal cells/mL – seek advice from health authority. | Construction activities would be managed to minimise the potential for contaminated runoff to enter surface waterbodies.<br>Construction of the proposal would comply with the construction EPL for the proposal and operation would comply with ARTC's existing environment protection licence and standard operating procedures. This would result in the proposal having minimal impacts on surface water receivers.<br>There are drainage structures within the proposal area that are not operating effectively, causing increased sedimentation of adjacent watercourses. These structures would be replaced as part of the proposal, which would improve water quality.<br>Based on the ephemeral nature of the majority of watercourses within the vicinity of the proposal it is considered unlikely that surface water would be extracted for domestic use in homesteads, however through undertaking works in accordance with standard construction practices the EPLs, and ARTC's existing standard operating procedures, the current water quality would be maintained if not improved. |
| | Turbidity | 5 NTU; <1 NTU desirable for effective disinfection; >1 NTU may shield some | 5 NTU; <1 NTU desirable for effective disinfection; >1 NTU may shield some | |

| Water quality objective | Indicator | Lachlan River<br>Trigger value or criteria | Macquarie-Bogan River<br>Trigger value or criteria | Relevance to the proposal |
|---|---|---|---|---|
| | | micro-organisms from disinfection. (see supporting information). | micro-organisms from disinfection (see supporting information). | |
| | Total dissolved solids | <500 mg/L is regarded as good quality drinking water based on taste.<br>500–1000 mg/L is acceptable based on taste.<br>>1000 mg/L may be associated with excessive scaling, corrosion and unsatisfactory taste. | <500 mg/L is regarded as good quality drinking water based on taste.<br>500–1000 mg/L is acceptable based on taste.<br>>1000 mg/L may be associated with excessive scaling, corrosion and unsatisfactory taste. | |
| | Faecal coliforms | 0 faecal coliforms per 100 mL (0/100 mL). If micro-organisms are detected in water, advice should be sought from the relevant health authority.<br>See also the Guidelines for Microbiological Quality. | 0 faecal coliforms per 100 mL (0/100 mL). If micro-organisms are detected in water, advice should be sought from the relevant health authority.<br>See also the Guidelines for Microbiological Quality. | |
| | pH | 6.5–8.5 | 6.5–8.5 | |
| | Chemical contaminants | See Guidelines for Inorganic Chemicals in the Australian Drinking Water Guidelines (NHMRC & NRMMC 2004). | See Guidelines for Inorganic Chemicals in the Australian Drinking Water Guidelines (NHMRC & NRMMC 2004). | |

# 3. Physical characteristics of the proposal site

## 3.1 Local government areas

The proposal is located within the Parkes Shire Council and Narromine Shire Council local government areas.

## 3.2 Climate

The Central West Region of NSW has a warm temperate climate, with large variations between summer and winter temperatures. Summers are hot and sunny with rainfall typically occurring as thunderstorms or short and intense storm events. Winters are cool and sunny with occasional cold fronts that bring periods of prolonged light rainfall.

A number of long-term Bureau of Meteorology (BoM) meteorological recording stations are located within or adjacent to study area, as listed in Table 3-1.

The mean annual rainfall recorded at these stations, as reported by the BOM, varies along the rail corridor, with the annual average rainfall about 540 millimetres, with the rainfall occurring relatively uniformly throughout the year.

**Table 3-1 Long term meteorological recording stations**

| Region | Name | Number | Latitude | Longitude | Starting year |
|---|---|---|---|---|---|
| Parkes | Goonumbla (Coradgery) | 050016 | 32.97 | 148.06 | 1882 |
| Parkes | Parkes Airport AWS | 065068 | 33.13 | 148.24 | 1941 |
| Parkes | Alectown (Cawdor) | 065100 | 32.99 | 148.23 | 1992 |
| Narromine | Bowling Club | 054120 | 30.32 | 149.78 | 1870 |
| Narromine | Alagalah Street | 051037 | 32.24 | 148.24 | 1886 |
| Narromine | Mumble Peg | 051005 | 32.06 | 148.24 | 1881 |

### 3.2.1 Design rainfall data

Design rainfall data was obtained from the BoM Intensity Frequency Duration (IFD) generation process based on Australian Rainfall and Runoff (Pilgrim (Ed) 1987). A comparison between the resulting IFD rainfall pattern developed for Parkes and for Narromine indicates that the rainfall IFD patterns were effectively the same for both end points of the proposal site. Therefore, the proposal site could be adequately represented by a single rainfall IFD pattern.

Updated design rainfall data has been provided as part of the revision to Australian Rainfall and Runoff (Ball et al., 2016). A comparison of the 1987 IFD data and the 2013 IFD data showed only minor and insignificant differences in intensity.

### 3.2.2 Climate change impacts

The NSW and ACT Regional Climate Model (NARCLiM) provides recent projections for the potential climate change impacts for the greater Central West and Orara regions, which include the study area. Of particular importance is the predicted precipitation (rainfall) changes from 1990–2009 through to 2020–2039 and 2060–2079, summarised in Table 3-2.

**Table 3-2 NARCLiM data summary**

| Parameter | Projected change (%) to 2020–2039 | Projected change (%) to 2060– 2079 |
|---|---|---|
| Annual mean rainfall change | -5 to 0 | 5 to 10 |
| Summer rainfall | 5 to 10 through -5 to 0 | 10 to 20 |
| Autumn rainfall | 5 to 10 | 10 to 20 |
| Winter rainfall | -5 to 0 through -10 to -5 | 5 to 10 |
| Spring rainfall | -20 to -10 through -10 to -5 | -10 to -5 |

From the available NARCLiM modelling, climate change has been assessed by adopting an increase in adopted rainfall IFD intensity varying from 10 to 30 per cent design suitably accounts for estimated rainfall changes.

This estimate is consistent with advice from the Department of Environment and Climate Change (DECC 2007).

The 0.5 per cent and 0.2 per cent ARI events were used as a surrogate for the specific evaluation of climate change impacts.

## 3.3 Terrain

The topographic data used for the preparation of the design and the associated hydrologic and hydraulic analysis is described in detail in the *ARTC Inland Rail – Parkes to Narromine Hydrology and Flooding Assessment* (GHD 2017).

In summary, three sets of topographical data covering the study area have been obtained:

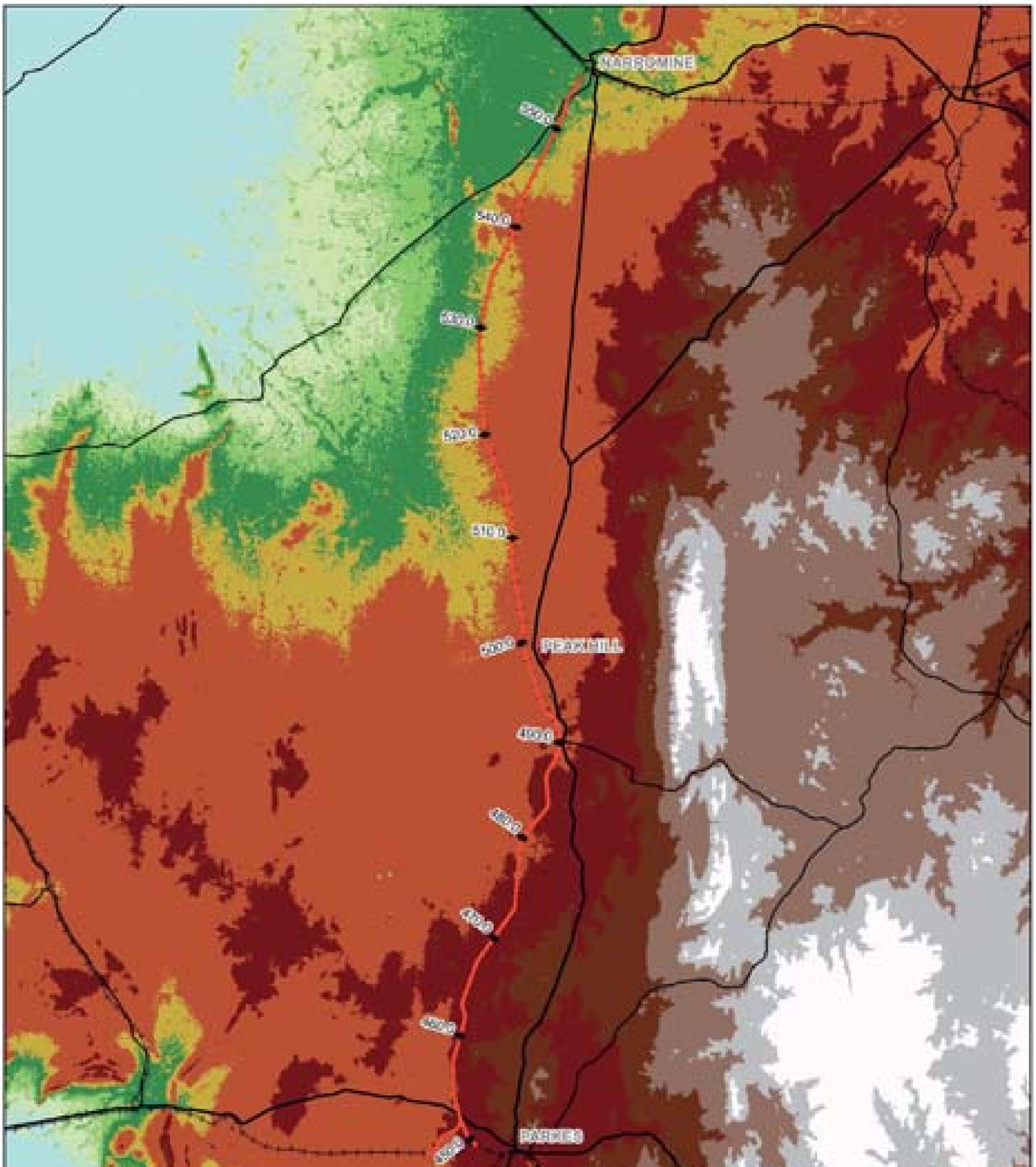
- Survey model obtained through LiDAR survey and aerial imaging.
- Digital Elevation Model (DEM) obtained through Shuttle Radar Topography Mission (SRTM).
- Localised site survey was available for a limited number of culvert locations.
- The adopted terrain model is presented in Figure 3-1. It shows the general landform adjacent to the study area. This was formed from LiDAR (where available) and SRTM outside the LiDAR corridor. The terrain is higher toward the southern end of the proposal site.

## 3.4 Licensed water extraction locations

A search of the NSW Water Register (DPI – Water 2016c) was undertaken to identify the number of Water Access Licences available for each surface water source. The information available on the NSW Water Register does not identify the location of the Water Access Licence and does not provide any information regarding licences issued under the *Water Act 1912.* The results of the search of the NSW Water Register are summarised in Appendix A.

The search of the NSW Water Register found that the surface water sources intersected by the proposal are potentially utilised for stock, domestic and town water supply. There are also a number of water access licences for extraction of water from unregulated rivers.

The licensed extraction locations (groundwater bores) within the proposal area are shown in Figure 3-2.




LEGEND

- The proposal
- Principal road
- Secondary road
- Railway

< 220
220 - 225
225 - 230
230 - 240
240 - 250
250 - 300
300 - 350
350 - 400
400 - 500
500 - 600
> 600

Paper Size A4

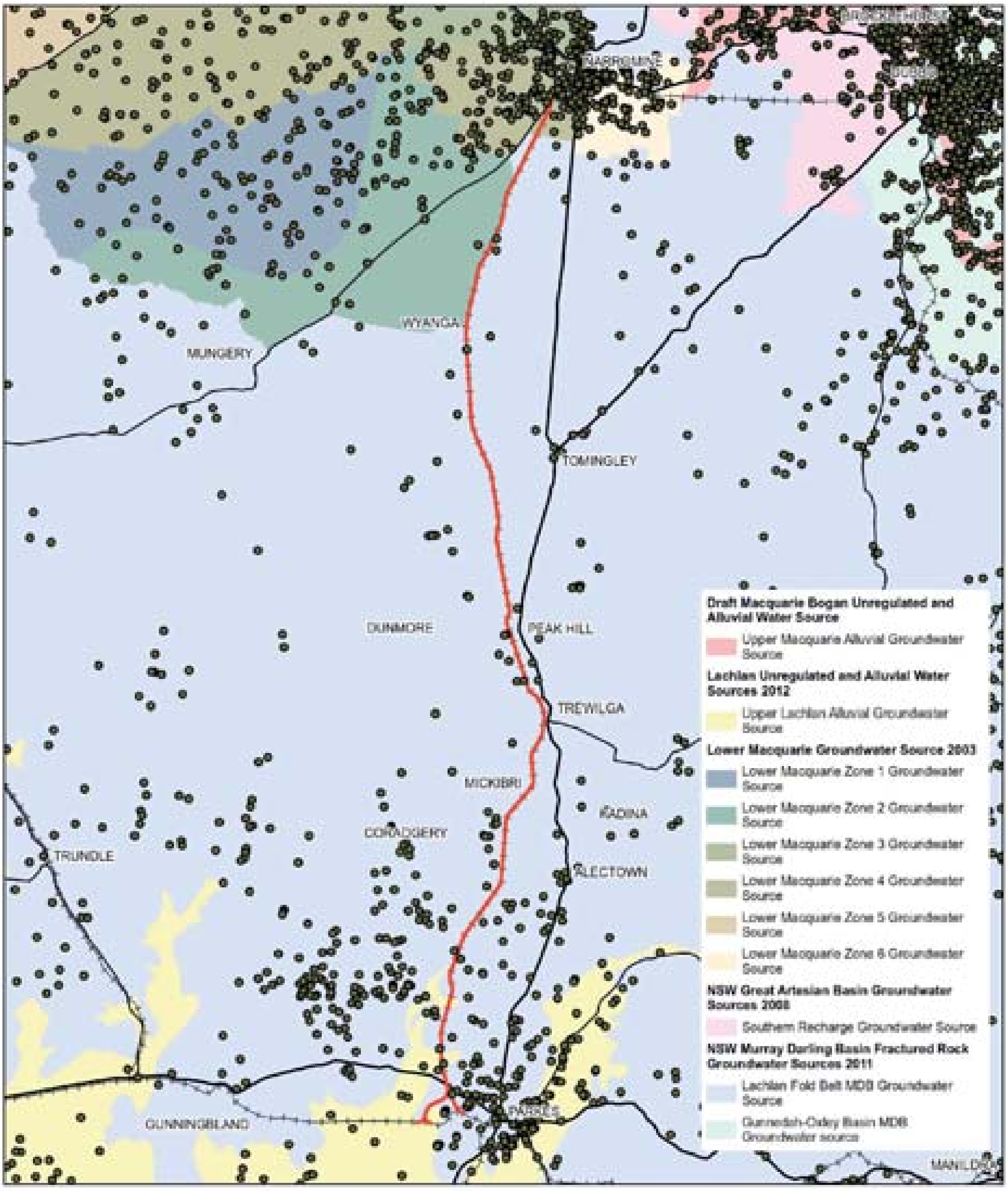
Kilometres

Australian Rail Track Corporation
Inland Rail - Parkes to Narromine

Job Number 22-17316
Revision 0
Date 23 Nov 2016

Corridor and
Catchment Topography

Figure 3-1




LEGEND

- The proposal
- Principal road
- Secondary road
- Railway
- Licensed Groundwater Bore

Paper Size A4

0 2 4 8 12 16

Kilometres

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Inland Rail - Parkes to Narromine

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Licensed Groundwater Bores

Figure 3-2

## 3.5 Geology and soils

### 3.5.1 General

The study area is located generally within the Central Lachlan Fold Belt. Near surface materials include Tertiary to Quaternary aged red silty alluvium over folded and faulted Silurian and Ordovician aged sedimentary and minor metamorphic sequences, which outcrop intermittently along the rail corridor.

Thick reactive brown and grey clay soils are predominantly associated with the near level terrain north of Peak Hill, while moderately thick red and brown sandy and silty clay soils are typically associated with the undulating terrain south of Peak Hill.

### 3.5.2 Soil groups and characteristics

Soil characteristics within the proposal site have been determined from the eSpade database. The dominant Great Soil Groups along the length of the proposal are shown in Figure 3-3.

Table 3-3 provides a summary of the soil landscape groups along the proposal area while Table 3-4 provides information on dominant soil groups along length of the proposal.

### 3.5.3 Acid sulfate soils

No acid sulfate soils are expected to be encountered in the proposal site.

## 3.6 Land uses

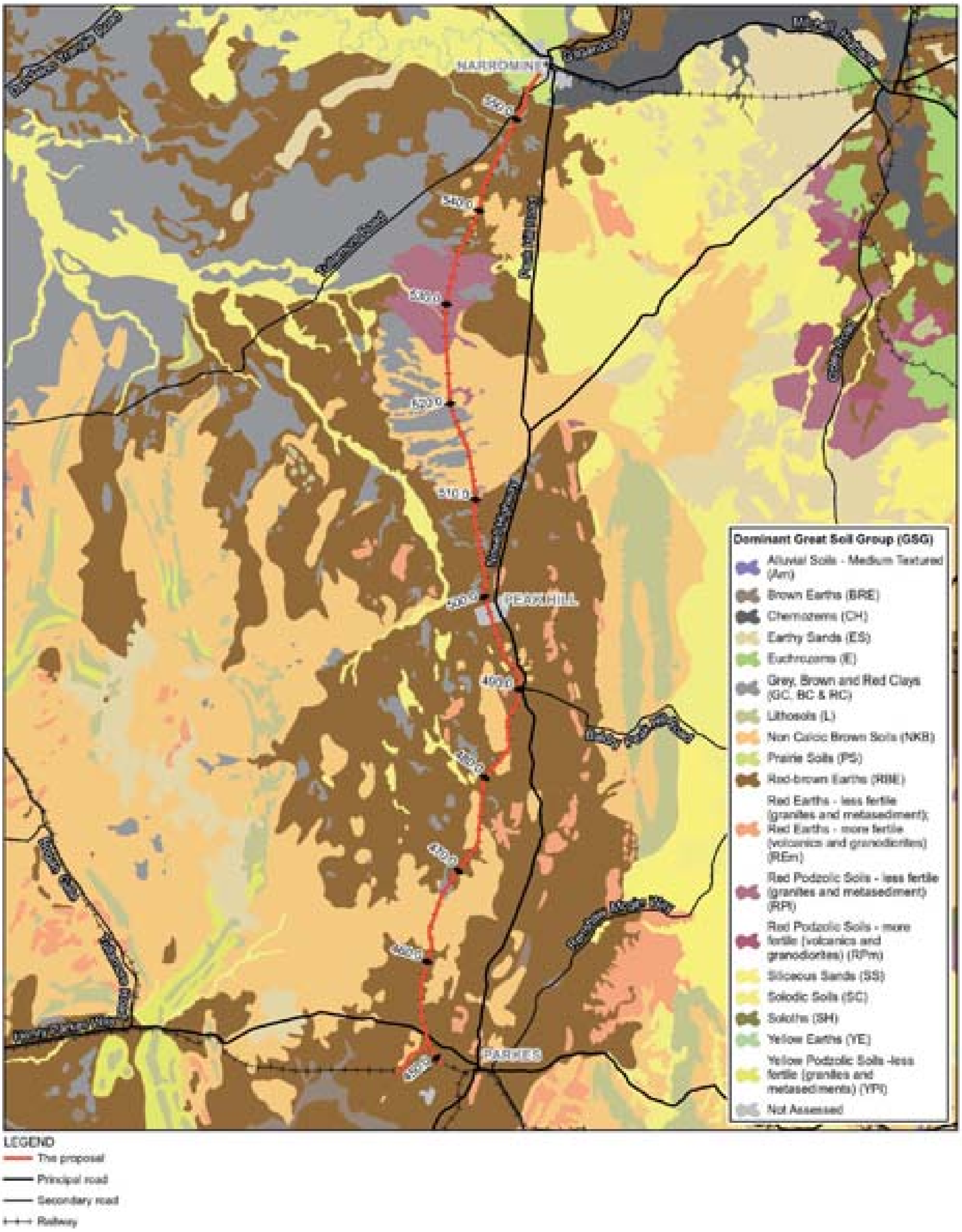
The majority of construction activities for the proposal would occur within the existing rail corridor of the Parkes to Narromine line, with the exception of the Parkes north west connection.

Beyond the rail corridor, the study area and surrounding land is dominated by agricultural industries, with significant cotton, wheat, and livestock industries. These industries have resulted in a significant amount of cleared land compared to the remaining native bushland. This clearing has an impact on the resulting storm flows as it lowers the catchment roughness (a measure by which surface flow is impaired by the surface type), which quickens the catchment's response time to rainfall and results in shorter and more intense catchment flow.

The relatively small pockets of uncleared native vegetation within the contributing catchments are mostly found in national parks and State forest.

Relatively small and localised urban areas exist around the regional townships of Parkes, Peak Hill and Narromine. There are also some mine and quarry sites within the contributing catchments. The urban, mining and quarrying land uses are well cleared.

Figure 3-4 shows the land uses along the rail corridor along with forestry reserves, conservation reserves and national parks.

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Kilometres

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| Revision | 0 |
| Date | 23 Nov 2016 |

Soil Landscape

Figure 3-3

**Table 3-3 Soil landscape groups**

| Range Soil Type Occurs | Classification / Profile No. | Location | Soil types | Soil Landscape | Erosion / Salinity |
|---|---|---|---|---|---|
| 450–455 | Parkes | Parkes and Forbes | Shallow to moderately deep (<60 cm), moderately well drained Red Earths, and Red Podzolic Soils on side slopes.<br>Lower slopes have moderately deep (>80 cm) imperfectly drained Red Brown Earths.<br>Narrow drainage lines have deep (>150 cm) poorly drained Brown Solodic Soils. | • Stoniness<br>• Sodicity / dispersibility<br>• Hardsetting surfaces (localised)<br>• Low permeability | • High water erosion hazard<br>• Salinity (localised)<br>• Moderate to high erodibility |
| 450–460 | Brolgan Plain | Plains west of Parkes, including Brolgan Plain | Deep (>100 cm) imperfectly drained Red Brown Earths and Non-calcic Brown Soils.<br>Deep (>100 cm) moderately well drained Red Podzolic. Soils and Red Earths also occur on some plains. | • Sodicity / dispersibility<br>• Hardsetting surface (localised)<br>• Flood hazard<br>• Foundation hazard<br>• Seasonal waterlogging (localised) | • Low to moderate erosion hazard<br>• Topsoils have high erodibility<br>• Clay-rich subsoils have moderate erodibility |
| 450–465 | Goonumbla | Vicinity of Goonumbla and Cooks Myalls | Shallow (<10 cm) well drained Lithosols and shallow (<50 cm) moderately well drained Red Podozlic Soils occur on crests.<br>Shallow (<50 cm) moderately well drained Red Earths / Euchronsems and Red Podzolic Soils occur on upper and mid-slopes<br>Moderately deep (>80 cm) moderately well drained Non-calcic Brown Soils occur on lower slopes. | • Stoniness<br>• Hardsetting surfaces (localised)<br>• Rock outcrop | • Moderate to high water erosion hazard<br>• Moderate topsoil erodibility<br>• Very low subsoil erodibility |
| 460–480 | Cooks Myalls | Between Parkes and Bogan Gate | Soils are moderately deep (>50 cm), moderately well drained Red Podzolic Soils, deep (>100 cm) poorly drained Red Solodic Soils along drainage lines and lower slopes.<br>Shallow to moderately deep (<80 cm) well-drained Terra Rossa Soils, Red Podzolic Soils and Red Earths / calcareous Red Earth intergrades occur on limestone and sandstone/chert/siltstone bedrock.<br>Moderately deep (>60 cm), moderately well drained Non-calcic Brown Soils occur on some slopes.<br>Small areas of gilgai soils. | • Alkalinity (localised)<br>• Sodicity / dispersibility (localised)<br>• Hardsetting surfaces (localised)<br>• Seasonal waterlogging (localised) | • High water erosion hazard<br>• Salinity (localised)<br>• High erodibility (localised) |

**Table 3-4 Major soil groups**

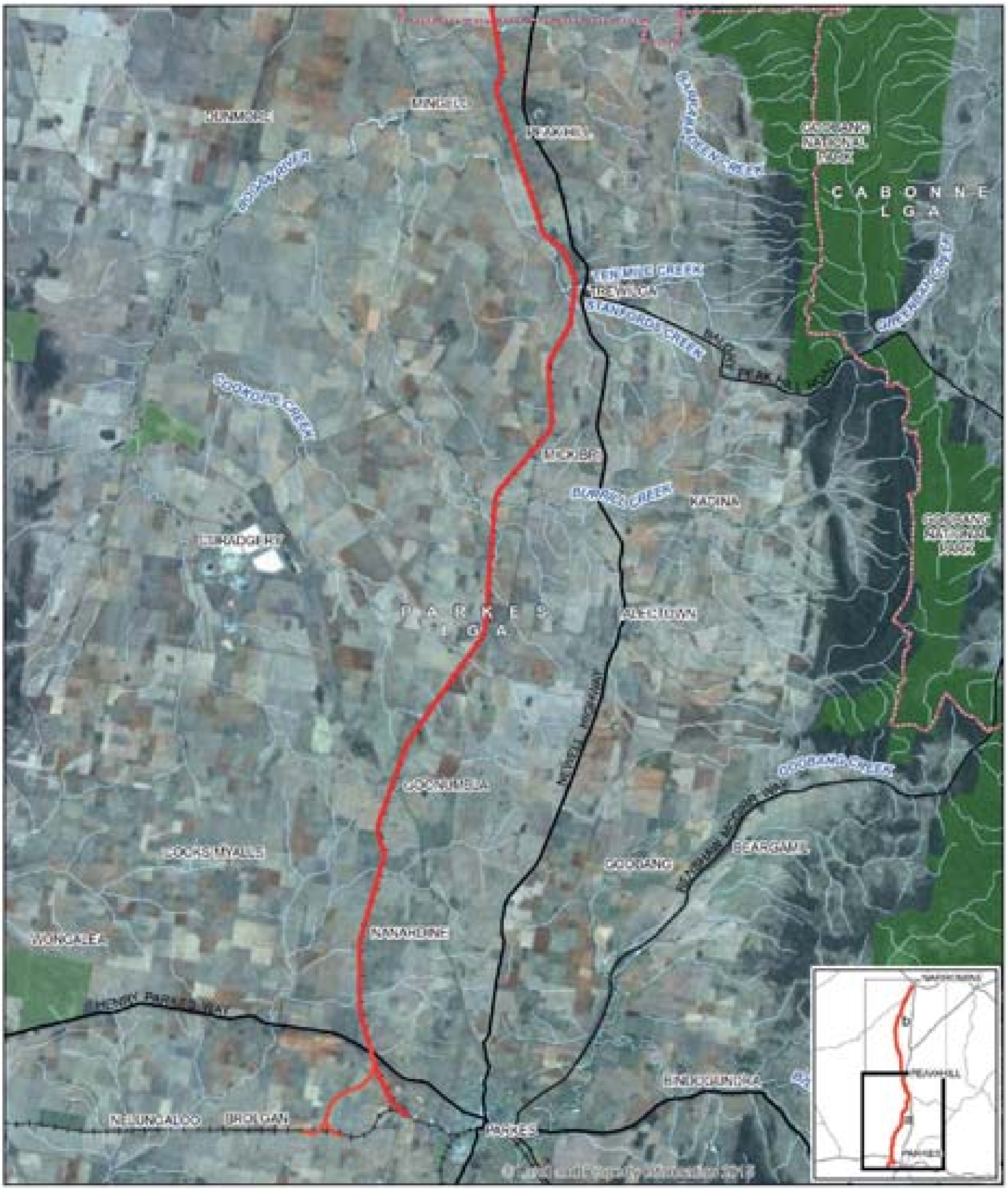
| Chainage | Location | Soil types | Soil Characteristics | Erosion / Salinity |
|---|---|---|---|---|
| 465–470 | North of Goonumbla | Shallow (<40 cm) imperfectly drained Red Clays occur on flat alluvial plains. | • Low permeability<br>• Seasonal cracking when dry<br>• Low runoff | • High erosion hazard<br>• No salting evident<br>• Moderate soil erodibility |
| 470–480 | North of Goonumbla | Shallow (<40 cm) moderately well drained Red Podzolic Soils occur on lower and upper hillslopes. | • Slowly permeable<br>• Hardsetting when dry<br>• Moderate runoff | • Moderate erosion hazard<br>• Moderate soil erodibility<br>• No salting evident |
| 475–485 | Between Trewilga and Parkes | Moderately deep (<105 cm) reddish brown sand acts as topsoil on flat topography.<br>Very deep (>170 cm) moderately well drained Red Clay and Red Podzolic Soils occur on flats and hillslope depressions. | • Moderate to high soil erodibility<br>• Permeability varies<br>• Moderate to high runoff | • Very high to high erosion hazard<br>• Minor (<150 cm) active gully erosion<br>• No salting evident |
| 480–490 | | Shallow (<5 cm) sandy loam topsoils, and shallow (<40 cm) imperfectly drained Red Podzolic Soils occur on upper and lower hillslopes. | • Moderate soil erodibility<br>• Hardsetting when dry<br>• Moderate to high runoff | • High erosion hazard<br>• No salting evident |
| 485–490 | | Shallow (<20 cm) sandy loam topsoil occur on upper slopes, and silty loam and sandy clay loams occur on lower slopes.<br>Shallow to moderate depth (<60 cm) poorly drained Non-calcic Brown Soils and moderately drained Red Podzolic Soils occur on lower slopes, and moderately well drained Grey-brown Podzolic Soils occur on upper slopes. | • Moderate soil erodibility<br>• Hardsetting when dry<br>• Low to moderate runoff | • Slight–moderate erosion hazard<br>• No salting evident |
| 490–500 | Between Trewilga and Peak Hill | Moderately shallow (<35 cm) moderately well drained brown clay loam topsoils occur on batters and within gullies.<br>Moderately deep(<80 cm) brown medium to heavy clay Red Podzolic Soils occur on batters and within gullies.<br>On lower slopes, moderate (<50 cm) moderately well drained Non-calcic Brown Soils | • Moderate to high soil erodibility<br>• Hardsetting when dry<br>• Moderate runoff | • Very high to high erosion hazard on batters and within gullys<br>• Moderate erosion hazard on lower slopes<br>• Moderate (<1.5m) active gully erosion |

| Chainage | Location | Soil types | Soil Characteristics | Erosion / Salinity |
|---|---|---|---|---|
| | | and moderately deep (<95 cm) Yellow Podzolic Soils. | | • No salting evident |
| 500–510 | North of Peak Hill | Shallow (<20 cm) topsoil layers of silty clay loam and sandy clay loam.<br>Moderately deep (<90 cm) moderately well drained Non-calcic Brown Soils, and moderate depth (<40 cm) moderately well drained Red and Brown Podzolic Soils occur on hillslopes and flat plains. | • Moderate soil erodibility<br>• Hardsetting when dry<br>• High to moderate runoff on hillslopes<br>• Low runoff on flat plains | • High erosion hazard near Peak Hill (CH 500), moving to moderate erosion hazard<br>• No salting evident |
| 510–520 | South west of Tomingley | Shallow (<15 cm) layers of fine sandy loam topsoil.<br>Moderate (<50 cm) layers of moderately well drained Non-calcic Brown Soils and Red Brown Earth. | • Moderate to high soil erodibility<br>• Hardsetting when dry<br>• Moderate runoff | • Slight erosion hazard<br>• No salting evident |
| 510–520 | South west of Tomingley | Moderately deep (<70 cm) very poorly drained Grey Clay occurs within depressions (gilgai) on flat plains. | • Moderate soil erodibility<br>• Seasonal cracking<br>• No runoff | • Moderate erosion hazard<br>• No salting evident |
| 520–525 | West of Tomingley | Moderately shallow (<40 cm) moderately well drained loamy sand top soils.<br>Moderately deep (<95 cm) moderately well drained Earthy Sands and Red Podzolic Soils occur on flat plains. | • Moderate to high soil erodibility<br>• Hardsetting when dry<br>• Moderate to low runoff | • Earthy sands have high erosion hazard<br>• Moderate erosion hazard for Red Podzolic Soils<br>• No salting evident |
| 525–535 | North west of Tomingley | Shallow (<25 cm) poorly drained sandy clay and silty clay loam topsoil on flat plains.<br>Moderately deep (<90 cm) imperfectly drained Yellow Podzolic Soils occur in depressions. Poorly drained deep (<150 cm) brown chromosol and moderately deep (<90 cm) solodic soils occur on flat plains. | • Moderate to high soil erodibility<br>• Hardsetting when dry<br>• High to moderate runoff | • Solodic soils on flat plains have high erosion hazard<br>• Moderate erosion hazard for Brown Chromosol and Yellow Podzolic Soils<br>• No salting evident |
| 535–545 | South of Narromine | Shallow (<30 cm) silty loam topsoil on lower slopes and shallow (<10 cm) clay loam topsoil on flat plains. | • High to moderate soil erodibility<br>• Hardsetting when dry<br>• Low to moderate runoff | • High erosion hazard<br>• No salting evident |

| Chainage | Location | Soil types | Soil Characteristics | Erosion / Salinity |
|---|---|---|---|---|
| | | Moderately deep (<110 cm) moderately well drained Red Brown Earth on lower slopes and flat plains. | | |
| 540–550 | South of Narromine | Shallow (<10 cm) topsoil layer of poorly drained Red Brown Earth occurring on plains.<br>Deep (<120 cm) layers of moderately well drained Brown Clay and imperfectly drained Grey Clay occur on flat plains and floodplains.<br>Moderately deep (<95 cm) poorly drained Grey Clay occurs in depressions (such as Backwater Cowal). | • High to moderate soil erodibility on flat plains and floodplains<br>• Low soil erodibility in depressions<br>• Hardsetting when dry<br>• Low to moderate runoff | • Slight erosion hazard<br>• No salting evident |
| 550–555 | Narromine | Shallow (<28 cm) topsoil layer of silty clay loam occur on flat plains.<br>Moderately deep (<65 cm) imperfectly drained Red Brown Earth and deep (<100 cm) layers of Non-calcic Brown Soils. Drainage of Non-calcic Soils varies from poorly drained to moderately well drained. | • High to moderate soil erodibility<br>• Hardsetting when dry<br>• Low to moderate runoff | • High erosion hazard<br>• No salting evident |
| 465–470 | North of Goonumbla | Shallow (<40 cm) imperfectly drained Red Clays occur on flat alluvial plains. | • Low permeability<br>• Seasonal cracking when dry<br>• Low runoff | • High erosion hazard<br>• No salting evident<br>• Moderate soil erodibility |
| 470–480 | North of Goonumbla | Shallow (<40cm) moderately well drained Red Podzolic Soils occur on lower and upper hillslopes. | • Slowly permeable<br>• Hardsetting when dry<br>• Moderate runoff | • Moderate erosion hazard<br>• Moderate soil erodibility<br>• No salting evident |
| 475–485 | Between Trewilga and Parkes | Moderately deep (<105cm) reddish brown sand acts as topsoil on flat topography.<br>Very deep (>170cm) moderately well drained Red Clay and Red Podzolic Soils occur on flats and hillslope depressions. | • Moderate to high soil erodibility<br>• Permeability varies<br>• Moderate to high runoff | • Very high to high erosion hazard<br>• Minor (<150cm) active gully erosion<br>• No salting evident |
| 480–490 | | Shallow (<5cm) sandy loam topsoils, and shallow (<40cm) imperfectly drained Red Podzolic Soils occur on upper and lower hillslopes. | • Moderate soil erodibility<br>• Hardsetting when dry<br>• Moderate to high runoff | • High erosion hazard<br>• No salting evident |

| Chainage | Location | Soil types | Soil Characteristics | Erosion / Salinity |
|---|---|---|---|---|
| 485–490 | | Shallow (<20 cm) sandy loam topsoil occur on upper slopes, and silty loam and sandy clay loams occur on lower slopes.<br>Shallow to moderate depth (<60 cm) poorly drained Non-calcic Brown Soils and moderately drained Red Podzolic Soils occur on lower slopes, and moderately well drained Grey-brown Podzolic Soils occur on upper slopes. | • Moderate soil erodibility<br>• Hardsetting when dry<br>• Low to moderate runoff | • Slight to moderate erosion hazard<br>• No salting evident |
| 490–500 | Between Trewilga and Peak Hill | Moderately shallow (<35 cm) moderately well drained brown clay loam topsoils occur on batters and within gullies.<br>Moderately deep(<80 cm) brown medium to heavy clay Red Podzolic Soils occur on batters and within gullies.<br>On lower slopes, moderate (<50 cm) moderately well drained Non-calcic Brown Soils and moderately deep (<95 cm) Yellow Podzolic Soils. | • Moderate to high soil erodibility<br>• Hardsetting when dry<br>• Moderate runoff | • Very high to high erosion hazard on batters and within gullys<br>• Moderate erosion hazard on lower slopes<br>• Moderate (<1.5m) active gully erosion<br>• No salting evident |
| 500–510 | North of Peak Hill | Shallow (<20 cm) topsoil layers of silty clay loam and sandy clay loam.<br>Moderately deep (<90 cm) moderately well drained Non-calcic Brown Soils, and moderate depth (<40 cm) moderately well drained Red and Brown Podzolic Soils occur on hillslopes and flat plains. | • Moderate soil erodibility<br>• Hardsetting when dry<br>• High to moderate runoff on hillslopes<br>• Low runoff on flat plains | • High erosion hazard near Peak Hill (CH 500), moving to moderate erosion hazard<br>• No salting evident |
| 510–520 | South west of Tomingley | Shallow (<15 cm) layers of fine sandy loam topsoil.<br>Moderate (<50 cm) layers of moderately well drained Non-calcic Brown Soils and Red Brown Earth. | • Moderate to high soil erodibility<br>• Hardsetting when dry<br>• Moderate runoff | • Slight erosion hazard<br>• No salting evident |
| 510–520 | South west of Tomingley | Moderately deep (<70 cm) very poorly drained Grey Clay occurs within depressions (gilgai) on flat plains. | • Moderate soil erodibility<br>• Seasonal cracking<br>• No runoff | • Moderate erosion hazard<br>• No salting evident |
| 520–525 | West of Tomingley | Moderately shallow (<40 cm) moderately well drained loamy sand top soils.<br>Moderately deep (<95 cm) moderately well drained Earthy Sands and Red Podzolic Soils occur on flat plains. | • Moderate to high soil erodibility<br>• Hardsetting when dry<br>• Moderate to low runoff | • Earthy sands have high erosion hazard |

| Chainage | Location | Soil types | Soil Characteristics | Erosion / Salinity |
|---|---|---|---|---|
| | | | | • Moderate erosion hazard for Red Podzolic Soils<br>• No salting evident |
| 525–535 | North west of Tomingley | Shallow (<25 cm) poorly drained sandy clay and silty clay loam topsoil on flat plains.<br>Moderately deep (<90 cm) imperfectly drained Yellow Podzolic Soils occur in depressions. Poorly drained deep (<150 cm) brown chromosol and moderately deep (<90 cm) solodic soils occur on flat plains. | • Moderate to high soil erodibility<br>• Hardsetting when dry<br>• High to moderate runoff | • Solodic soils on flat plains have high erosion hazard<br>• Moderate erosion hazard for Brown Chromosol and Yellow Podzolic Soils<br>• No salting evident |
| 535–545 | South of Narromine | Shallow (<30 cm) silty loam topsoil on lower slopes and shallow (<10 cm) clay loam topsoil on flat plains.<br>Moderately deep (<110 cm) moderately well drained Red Brown Earth on lower slopes and flat plains. | • High to moderate soil erodibility<br>• Hardsetting when dry<br>• Low to moderate runoff | • High erosion hazard<br>• No salting evident |
| 540–550 | South of Narromine | Shallow (<10 cm) topsoil layer of poorly drained Red Brown Earth occurring on plains.<br>Deep (<120 cm) layers of moderately well drained Brown Clay and imperfectly drained Grey Clay occur on flat plains and floodplains.<br>Moderately deep (<95 cm) poorly drained Grey Clay occurs in depressions (such as Backwater Cowal). | • High to moderate soil erodibility on flat plains and floodplains<br>• Low soil erodibility in depressions<br>• Hardsetting when dry<br>• Low to moderate runoff | • Slight erosion hazard<br>• No salting evident |
| 550–555 | Narromine | Shallow (<28 cm) topsoil layer of silty clay loam occur on flat plains.<br>Moderately deep (<65 cm) imperfectly drained Red Brown Earth and deep (<100 cm) layers of Non-calcic Brown Soils. Drainage of Non-calcic Soils varies from poorly drained to moderately well drained. | • High to moderate soil erodibility<br>• Hardsetting when dry<br>• Low to moderate runoff | • High erosion hazard<br>• No salting evident |




LEGEND

- The proposal
- Local Government Area
- Principal road
- Secondary road
- Railway
- Watercourse
- Forestry reserve
- Conservation reserve

Paper Size A4

0 1 2 4 6 8

Kilometres

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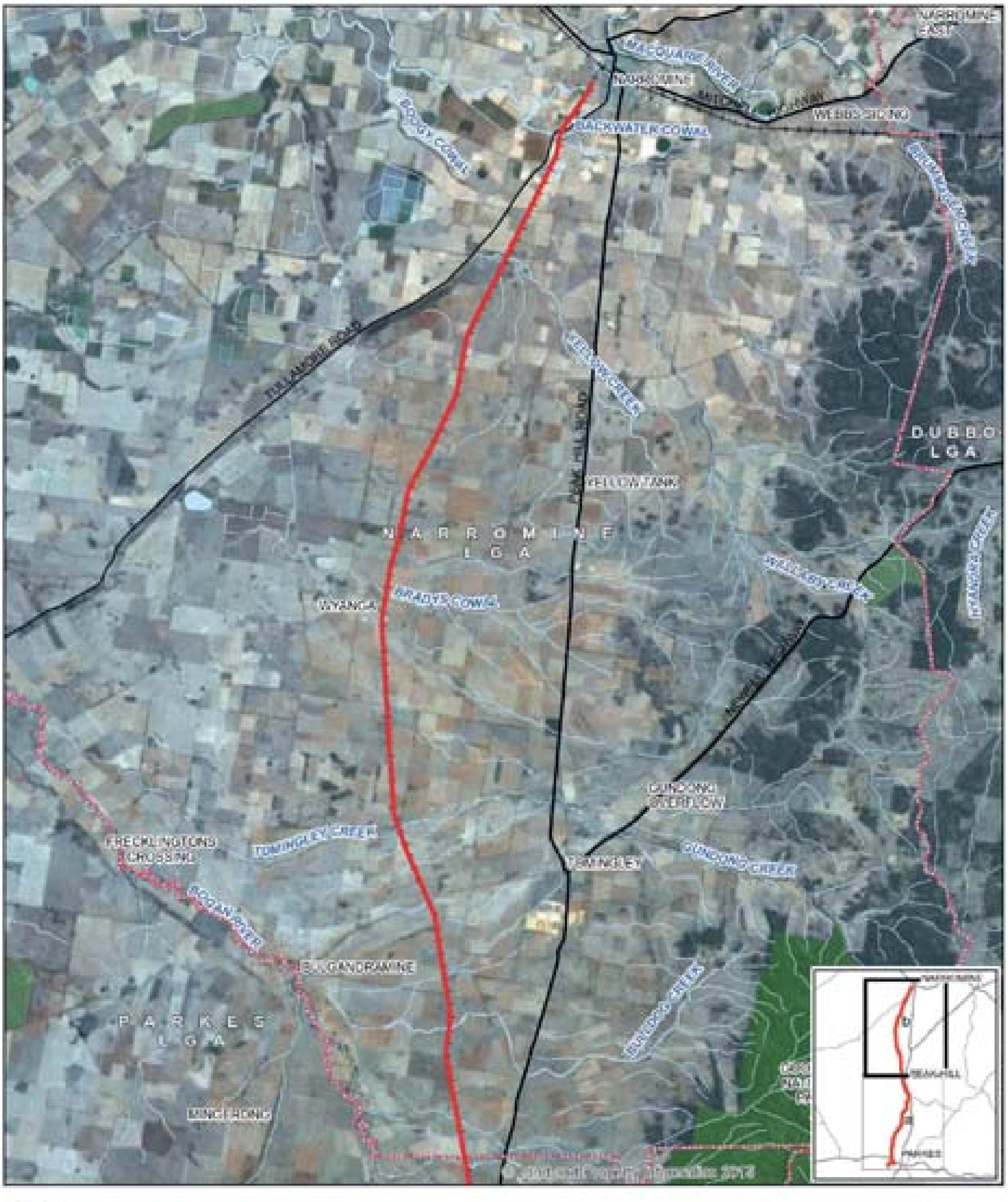
Revision 0
Date 23 Nov 2016

Land Use - Sheet 1

Figure 3-4a




LEGEND

- The proposal
- Local Government Area
- Principal road
- Secondary road
- Railway
- Watercourse
- Forestry reserve
- Conservation reserve

Paper Size A4

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Kilometres

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| Revision | 0 |
| Date | 23 Nov 2016 |

Land Use - Sheet 2

Figure 3-4b

## 3.7 Watercourses

### 3.7.1 Major river and basin systems

The proposal is located within the major water catchments of the Lachlan River Basin and the Macquarie-Bogan River Basin (formed by the Macquarie and the Bogan rivers).

The Lachlan River starts in the east as a chain of lakes formed by the confluence of the Hannans Creek and Mutmutbilly Creek catchments. Heading west, the river system passes south of Parkes and the proposed rail corridor. Ridgey Creek, one kilometre east of the proposal, is the closest of the significant Lachlan River tributaries. The Lachlan River, while a tributary of the Murrumbidgee River and a contributor to the Murray-Darling Basin (MDB), effectively terminates in the west as a large, expansive system of wetlands known as the Great Cumbung Swamp. The Lachlan River Basin therefore connects only to the MDB during periods of major flood (NSW Fisheries Scientific Committee 2005).

The Macquarie River starts in the east at the confluence of the Cambells River and Davies Creek, within Bathurst and travels north west past the towns of Wellington, Dubbo and Narromine (passing 900 metres north of the proposal site) to the Macquarie Marshes. The Macquarie Marshes drain via the lower Barwon River into the Darling River and the broader MDB. The waters of the Macquarie River and its tributaries are impounded for flood control and irrigation by Burrendong Dam, a large reservoir with a capacity of 1,188 gigalitres near Wellington and the Cudgegong Dam.

The Bogan River lies within the Macquarie-Bogan River Basin and is located west of the proposal, making it a receiving environment rather than a potential contributor to flooding. The Bogan River drains via the Lower Barwon River into the Darling River and the broader MDB.

### 3.7.2 Watercourses

Surface water within the study area is predominately comprised of ephemeral watercourses, excluding the major perennial river systems identified in Section 3.7.1. This is due to the relative size of the contributing catchment areas, the regional rainfall pattern, and the lack of base flow. Minor rivers (those less than 1,000 square kilometres along the existing rail corridor include:

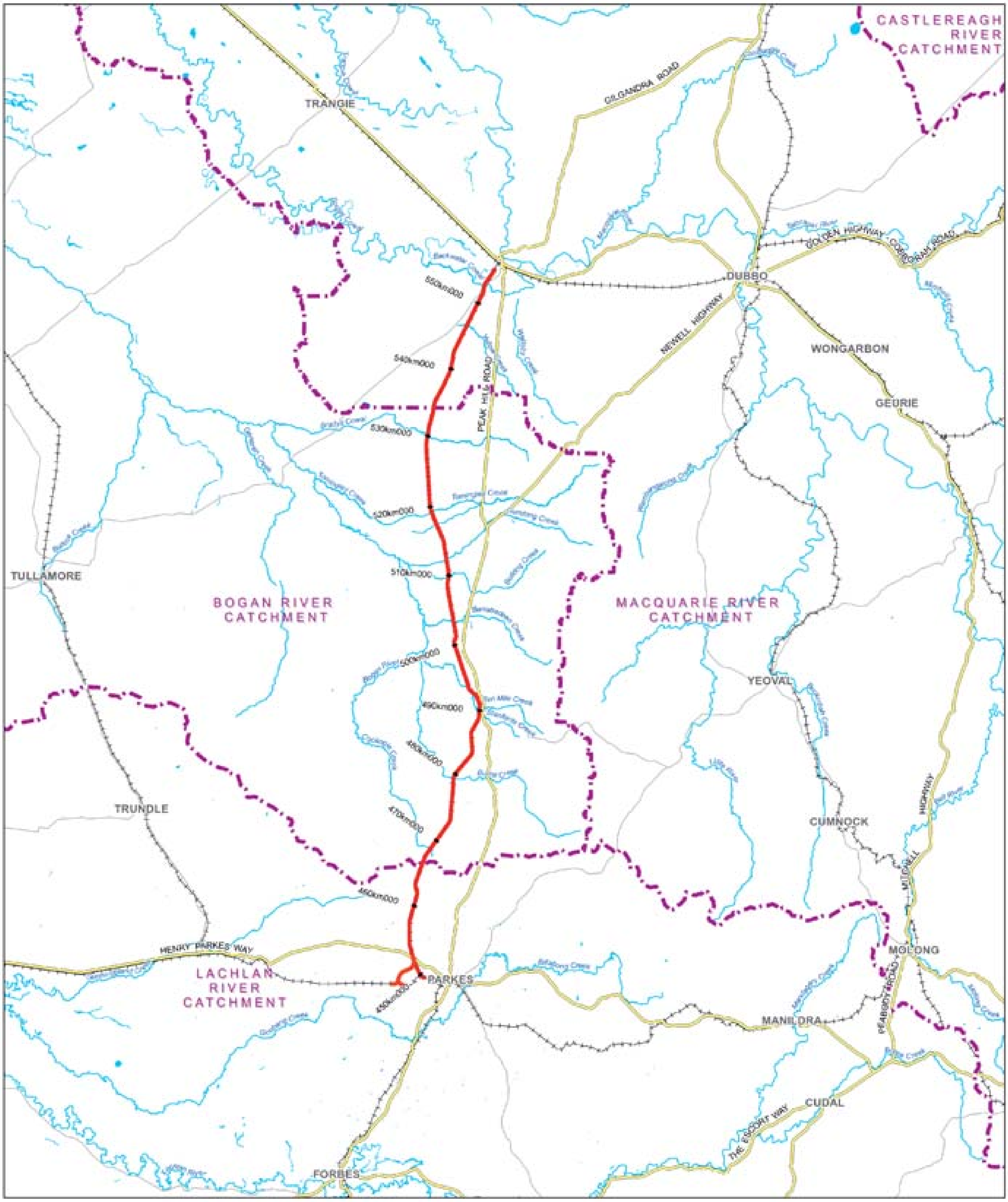
- Burrill Creek
- Stanfords creek
- Ten Mile Creek
- Barrabadeen Creek
- Bulldog Creek
- Gundong Creek
- Tomingley Creek
- Bradys Cowal
- Yellow Creek

Figure 3-5 shows the locations of the named watercourses that are crossed by the proposal.

Table 3-5 provides details on the main watercourses crossed by the proposal including:

- Stream order as derived from the topographic LPI Hydroline dataset.
- The form and geomorphic condition of watercourses as assessed from aerial imagery and based on the River Styles framework (Brierley and Fryirs 2005).

The watercourses assessed include all named watercourses and all un-named watercourses with stream order greater than third order.




LEGEND

- Parkes to Narromine Rail Line
- Major Road
- Secondary Road
- Railway
- Watercourse
- Waterbody
- Major river catchment

Paper Size A3
0 2,500 5,000 10,000 15,000 20,000
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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# Major Watercourses

Figure 3-5

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au

**Table 3-5 Details of third order and higher watercourses crossed by the proposal**

| Catchment | Chainage (km) | Watercourse | Flow regime | Stream order | River style | Condition | Comments |
|---|---|---|---|---|---|---|---|
| Lachlan | 455.2 | Un-named | Ephemeral | 3 | Valley fill | Poor | Stable although modified to flow within floodway. |
| Lachlan | 461.15 | Un-named | Ephemeral | 3 | Channelised fill | Moderate | Stable, grass lined trapezoidal channel. |
| Bogan | 472.05 | Un-named | Ephemeral | 3 | Channelised fill | Moderate | Stable, grass lined trapezoidal channel. |
| Bogan | 478.25 | Un-named | Ephemeral | 3 | Valley fill | Moderate | Some channelisation downstream. |
| Bogan | 479.3 | Burrill Creek | Ephemeral | 5 | Low sinuosity fine grained | Good | Stable channel with near permanent ponds. |
| Bogan | 489.8 | Stanfords Creek | Ephemeral | 4 | Channelised fill | Poor | Incised channel with minor levels of bank erosion downstream. |
| Bogan | 490.55 | Ten Mile Creek | Ephemeral | 4 | Low sinuosity fine grained | Moderate | Stable, grass lined trapezoidal channel. |
| Bogan | 503.6 | Barrabadeen Creek | Ephemeral | 5 | Low sinuosity fine grained | Poor | Incised system with unvegetated upper banks, although relatively stable. Near permanent pools. |
| Bogan | 509.65 | Bulldog Creek | Ephemeral | 4 | Valley fill | Moderate | Large pool immediately downstream of existing rail corridor. Mound to the south indicates the pool was likely excavated. |
| Bogan | 512.1 | Gundong Creek | Ephemeral | 4 | Channelised fill | Poor | Excavated straight channel downstream with moderate levels of bank erosion. Upstream valley fill in moderate condition. |
| Bogan | 517.43 | Unnamed | Ephemeral | 4 | Valley fill | Poor | Relatively stable, minimal vegetation and watercourse shape converts to floodplain downstream of culvert |
| Bogan | 519.2 | Tomingley Creek | Ephemeral | 4 | Valley fill | Good | Stable, well vegetated creek in narrow valley set within a Gilgai landscape. |
| Bogan | 529.8 | Brady's Cowal | Ephemeral | 4 | Low sinuosity fine grained | Moderate | Stable, grassed channel. Large excavated pond on downstream side of existing rail corridor. |

| Catchment | Chainage (km) | Watercourse | Flow regime | Stream order | River style | Condition | Comments |
|---|---|---|---|---|---|---|---|
| Macquarie | 546.55 | Yellow Creek | Ephemeral | 3 | Valley fill | Moderate | Stable, well vegetated system. Online dams. |
| Macquarie | 552.65 | Backwater Cowal | Ephemeral | 5 | Valley fill | Moderate | Stable, broad depression – infilled paleo-channel – well vegetated with ground cover species. Receives flow from Wallaby Creek catchment and flood flows from the Macquarie River. |

The morphology of watercourses is characterised by three stream types:

- Low sinuosity fine grained systems exhibit relatively straight channels surrounded by continuous floodplains. The banks of this stream type are relatively stable due to the presence of cohesive fine grained materials. During periods of low rainfall, the stream type typically holds water in isolated pools.
- Channelised fill systems are generally lateral, stable channels of low sinuosity incised within flat and featureless floodplains. During periods of high flow, unprotected banks are prone to erosion.
- Valley fill systems are relatively flat, featureless valley floor surfaces, lacking a continuous, well defined channel. Typically, the substrate comprises fine alluvial silts and muds vertically deposited out of suspension.

Most watercourses are considered to be in moderate geomorphic condition as a result of historical disturbances associated with agricultural practices. These practices include vegetation clearing, stock grazing impacts, construction of online farm dams and drainage improvements (such as channelising watercourses through excavation or bunding). Typically, poor condition reaches have been channelised to improve drainage and limit the extent of flooding. These reaches can also display evidence of ongoing channel erosion.

The existing rail corridor and associated infrastructure has had only minor localised impacts on watercourse form – primarily an increased propensity for scour and erosion immediately downstream of a few watercourse crossing structures.

### 3.7.3 Watercourses at crossings of the proposal

An inspection of the watercourses that would be crossed by the proposal was undertaken. The form of the watercourses at these crossing locations is discussed in more detail in Table 3-5.

## 3.8 Groundwater sharing plan

The proposal lies within the following Water Sharing Plans:

- The Water Sharing Plan for the Lachlan Unregulated and Alluvial Water Sources (NSW Government 2012a). This commenced in September 2012 and regulates the interception and extraction of water from unregulated rivers and alluvium within the defined Water Sharing Plan area. The proposal lies within the Upper Lachlan Alluvial Groundwater Source of this Water Sharing Plan as shown in Figure 3-2.
- The Water Sharing Plan for the NSW Macquarie-Darling Basin Groundwater Source (NSW Government 2011). This commenced in January 2012 and regulates the interception and extraction of water from fractured rock groundwater sources and from unmapped alluvial sediments that overlay outcropping fractured rock within the defined Water Sharing Plan area. The proposal lies within the Lachlan Fold Belt Macquarie-Darling Basin Groundwater Source of this Water Sharing Plan as shown in Figure 3-2.
- The Water Sharing Plan for the Lower Macquarie Groundwater Source (NSW Government 2003). This commenced in October 2006 and is due for extension/replacement in July 2017 and is currently undergoing a formal review (DPI – Water 2016b). This Water Sharing Plan regulates the interception and extraction of water from the alluvium and Great Artesian Basin within the defined Water Sharing Plan area. The proposal lies within the Lower Macquarie Zone 4 groundwater source and lies on the boundary of the Lower Macquarie Zone 2 groundwater source of this Water Sharing Plan as also shown in Figure 3-2.

- The Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources (NSW Government 2012b). This commenced in October 2012 and regulates the interception and extraction of water from unregulated rivers and alluvium within the defined Water Sharing Plan area.

## 3.9 Sensitive ecological areas

### *Wetlands*

The Macquarie Marshes are on the Macquarie River, between Warren and Carinda. The upstream end is about 100 kilometres downstream of Narromine. They are one of the State's most sensitive inland watercourses.

The marshes have been subjected to extensive hydrological and ecological studies over the last few decades. Some of the more recent studies have included MDBA (2012) and Hogendyk (2007). These studies and the national importance of the wetlands have led to the development of an adaptive management plan for the area (DECCW 2010) that provides a synthesis of information from prior projects and action plans.

### *Vegetation*

A detailed ecologic assessment of the proposal route is reported in the *Aquatic Ecology Assessment* (Umwelt 2017) and *Biodiversity Assessment Report* (Umwelt 2017b). The following is extracted from those reports

Umwelt (2017) indicates that Burrill Creek includes stands of native sedges and river red gums, whilst Backwater Cowal consists of cleared / non-native vegetation on the banks with weed dominated vegetation characterising both the bed and banks.

### *Aquatic ecology*

Key areas of fish habitat have previously been identified and mapped within local government areas traversed by the proposal. The habitat areas, mapped by DPI (undated a, undated b) show the extents of the respective habitat areas.

Goobang Creek, Ridgey Creek, Burrill Creek, Ten Mile Creek, Barrabadeen Creek, Bogan River Bulldog Creek, Gundong Creek, Tomingley Creek, Fiddlers Creek, Bradys Cowal and the Macquarie River have all been identified as being between Class 2 (moderate) and Class 4 (unlikely) *key fish habitat* (Umwelt 2017), in accordance with the *Policy and guidelines for fish habitat conservation and managemen*t (DPI 2013).

### *Groundwater dependent ecosystems*

A review of the Australian Government's National Atlas of Groundwater Dependent Ecosystems identified the watercourses and riparian vegetation either side of the proposal site along Burrill Creek, Tomingley Creek and Wallaby Creek as potentially including groundwater dependent ecosystems in the study area.

A detailed evaluation of the ecology of the area and ecological impacts is being provided in a separate report (Umwelt, 2017).

## 3.10 Water demands

Estimated water demands for construction of the proposal have been provided by ARTC as being in the order of 75 to 100 ML, or about 60 ML per year, for earthworks and dust control. Likely water sources have been provided as being, subject to the gaining of applicable approvals and access agreements and there being sufficient water at each site:

- Parkes Shire Council – 5 ML.
- Private bores near chainages 708, 716, 724, 738, 748 and 778 – 3 ML per bore. Each bore is within 5 km of the proposal alignment.
- Parkes North and Peak Hill mines – 10 to 15 ML for each mine.
- Private dams near chainages 730, 782 and 798 – 10 ML at each site.
- Macquarie River – 10 ML.
- Narromine Shire Council – 5 ML.

The actual water demand at the time of construction will be dependent upon matters including the final design, weather and the adopted construction methodology.

# 4. Existing environment

## 4.1 Regional context

### 4.1.1 Catchments

The study area includes numerous watercourses within portions of the Lachlan River and Macquarie-Bogan River basins. Both river basins eventually drain to the Murray River.

Watercourse catchments crossed by the proposal range in size from small unnamed tributaries of less than a square kilometre to large rivers. These large river catchments (regional catchments) extend in some instances to the Great Dividing Range and encompass large areas.

As discussed in Chapter 3, land use within the catchment areas has undergone significant change, with a progressive move to more intensive cropping, general development and construction of major water storage dams.

Catchments for the major river systems (Lachlan River and Macquarie River) extend east to the Great Dividing Range while most of the small catchments draining under the rail line are located nearer to the rail corridor and have a modest topographic relief.

### 4.1.2 Historical climatic data

The historical rainfall and river flow data indicate the region has experienced a variety of significant climatic conditions, varying from severe droughts to large and significant floods.

An indication of the climatic variability is shown in Figure 4-1, which provides a diagrammatic representation of the years with complete rainfall records for Narromine between 1886 and 2013. The minimum annual rainfall recorded in that period was 217 millimetres while the maximum was about 1,386 millimetres and the average was about 527 millimetres. As shown in Figure 4-1 there have been a number of periods with consecutive years of below average rainfall.

The Narromine site has reported a relatively uniform monthly distribution of the mean rainfalls varying from a high of 56.7 millimetres in January to a low of 36.3 millimetres in September.

Because of the relatively low annual rainfall and a relatively high evaporation rate (about 1,600 to 1,900 millimetres per annum) most of the watercourses are ephemeral. The climatic variability is reflected in the frequency, persistence and magnitude of stream flows.

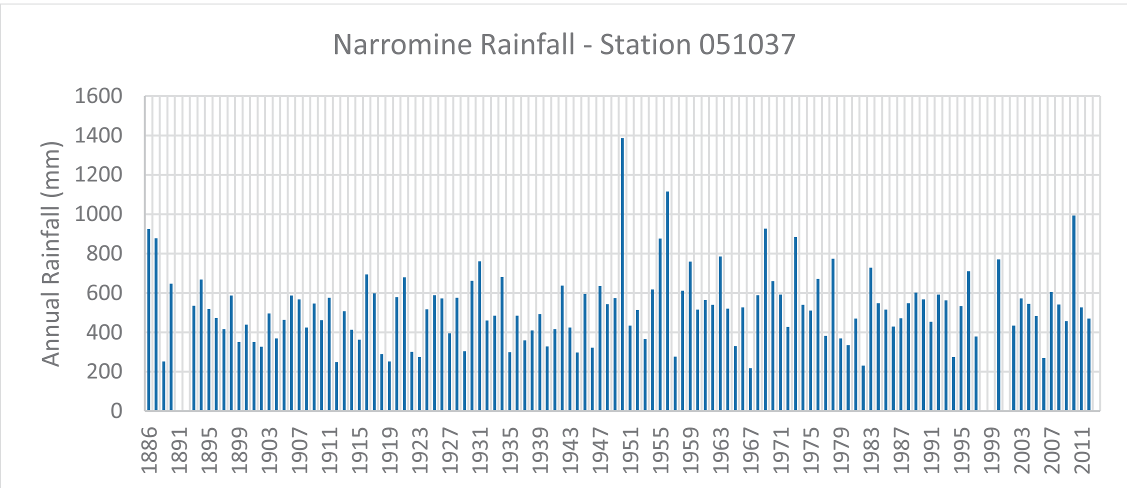


**Figure 4-1 Narromine rainfall**

### 4.1.3 Terrain and land use

The study area is characterised by relatively flat catchments (up to five per cent) with some portions of locally steeper catchments. Floodplain slopes are generally in the order of one-half to one per cent gradient. Along the longitudinal length of the rail corridor, terrain has a gradual fall from Parkes to Narromine from about 330 metres AHD to about 240 metres AHD with regional valleys located along the corridor. The steepest portion of the rail corridor occurs just after the Mickibiri Bridge with a one per cent longitudinal grade, which indicates the generally flat nature of the locality.

Most catchments include cleared areas used for agriculture, grazing and rural residential land uses. Urbanised areas occupy a minor proportion of the overall catchment area, and are mostly located in the vicinity of Parkes, Peak Hill and Narromine.

## 4.2 Hydrology

### 4.2.1 Surface water

The major rivers north of Narromine – the Macquarie and Bogan rivers – are perennial watercourses. The Lachlan River, south of Parkes, is also a perennial watercourse. The remaining watercourses are ephemeral; therefore, the majority of watercourses traversed by the proposal have temporary or intermittent flow. The ephemeral watercourses flow during and after rainfall, and dry out in between rainfall events.

As surface water flow in the study area is primarily related to rainfall, the associated rainfall and runoff process of the catchment is the main contributor to watercourse flow experienced along the Parkes to Narromine rail corridor.

### 4.2.2 Groundwater

The results of a bore search and a review of groundwater sharing plans are summarised in Section 3.9. These results indicate that:

- Groundwater sources in the proposal site include alluvial sediments near Narromine, associated with the Macquarie River.
- The alluvial sediments extend up to 80 metres below ground level.
- Alluvial groundwater associated with the Macquarie River would be recharged by rainfall infiltration and surface flows. Groundwater levels would be expected to rise following periods of above average rainfall and fall following periods of below average rainfall.
- To the south of Narromine, the proposal site is underlain by fractured rock associated with the Lachlan Fold Belt. Groundwater bores intercepting the fractured siltstone and sandstone rock aquifer are deeper than 70 metres below ground level. Groundwater in the fractured rock aquifer is not expected to be present near the ground surface.

Shallow alluvial sediments of depth of less than 10 to 20 metres below ground level may be intercepted along creek lines intercepted by the proposal. These perched shallow groundwater sources would be recharged by rainfall infiltration with groundwater levels expected to rise following rainfall events.

### 4.2.3 Groundwater hydrology

Within the alluvial sediments in the vicinity of Narromine, associated with the Macquarie River, flow direction in the alluvial aquifer would correspond with the flow direction in the Macquarie River; that is, east to west in the vicinity of the proposal site. Within the shallow alluvial sediments along creek lines that may be intercepted by the proposal, groundwater flow would correspond to flow direction in these creek lines. These creeks generally flow east to west. Based on typical hydraulic conductivities for sand and sand and gravel mixes (as reported by Kruseman and de Ridder 1994), the hydraulic conductivity of the alluvial sediments may vary from one to 100 metres per day.

Within the fractured sandstone and siltstone aquifer of the Lachlan Fold Belt groundwater, flow directions are expected to correspond with the dip of the strata and surface elevation from east to west and south to north. Based on typical hydraulic conductivities for sandstone and fractured or weathered rock (as reported by Kruseman and de Ridder 1994), the hydraulic conductivity of the sandstone and siltstone of the Lachlan Fold Belt may vary from 0.001 to one metre per day.

## 4.3 Flooding

### 4.3.1 Culvert locations and levels

Proposed culverts and underbridges would be located as close as practical to the existing locations of culverts and underbridges, which are shown in Figure 2-1.

### 4.3.2 Flood level analysis

Existing condition flood levels, flood behaviour and impacts were assessed through combined hydrological and hydraulic flood modelling and interpretation of the data. Details of the predicted frequency and locations of overtopping of the existing track can be found in the *ARTC Inland Rail – Parkes to Narromine Hydrology and Flooding Assessment* (GHD 2017).

### 4.3.3 Adjacent land impacts

The predicted flood levels for the existing conditions were examined for a range of design events from the 50 per cent AEP through to the Probable Maximum Flood (PMF) event. Within this range, the 0.5 per cent and 0.2 per cent were considered as representing a potential climate change impact.

***Upstream flood effects***

**Flood levels**

Flood levels for the existing conditions were assessed using the method summarised in Section 4.3.2.

The assessment indicated that the existing rail line overtops at several locations between Parkes and Narromine on a relatively regular basis with overtopping being predicted for the 50 per cent AEP design local catchment flood event.

Observations from field interviews with stakeholders confirmed the identified areas of track overtopping and indicated the relative frequency on ballast washout. Available maintenance records from ARTC for historical flood events also confirmed the general areas of washout as being those identified as being at risk from damage.

### Flooded areas

The flooded areas upstream of the proposal have the potential to impact the surface water quality through the mobilisation of pollutants. Changes to flood affected area because of the proposal therefore have the potential to impact on regional surface water quality through an increase/decrease in the mobilisation of pollutants. The existing and predicted total areas of upstream flooding are summarised in Table 4-1 for local catchment flooding for flood events up to the Probable Maximum Flood (PMF). Table 4-1 shows that the area of inundation would decrease for events up to and including the two per cent local catchment event, while the area of inundation would increase for events greater than this.

**Table 4-1 Areas of upstream flooding**

| Design event (% AEP) | Area of inundation (ha) | | |
|---|---|---|---|
| | Existing | Design | Change (design – existing) |
| 50 | 355.9 | 242.0 | -113.9 (-32%) |
| 20 | 480.1 | 363.9 | -116.1 (-24%) |
| 10 | 553.3 | 454.8 | -98.5 (-18%) |
| 5 | 648.2 | 579.9 | -68.3 (-11%) |
| 2 | 840.0 | 821.9 | -18.1 (-2%) |
| 1 | 938.0 | 1,036.5 | +98.5 (+11%) |
| 0.5 | 1,044.8 | 1,146.2 | +101.3 (+10%) |
| 0.2 | 1,146.5 | 1,283.3 | +136.8 (+12%) |
| PMF | 2,720.8 | 3,162.1 | +441.3 (+16%) |

### Flood velocities

During events when the existing track does not overtop, the flow velocities on the floodplain would generally be low. Immediately upstream of a culvert on the floodplain there would be a localised increase in velocity to around 1.5 metres per second as the water approaches and enters the respective structure. The upstream velocity in defined watercourses would be larger than that on broad floodplain areas and is predicted to generally be less than two metres per second except in very localised areas.

When the track overtops, a progressively larger proportion of the flow would pass over the rail embankment, which would be acting as a weir, than through the individual culverts.

### Erosion and stability of watercourses

The predicted low velocities described above are not anticipated to result in watercourse instability.

### *Downstream flood effects*

### Flood levels

Design flood levels downstream of the rail corridor have not been assessed, as other impacts such as conditions further downstream of the proposal site would affect the flood levels.

It is likely there will be localised changes in flood levels adjacent to the replacement culverts, due to altered culvert widths and changed flow velocities through the replacement culverts, but these are expected to be generally confined to within the existing rail corridor.

### Flooded areas

The extent of flooded areas downstream of the rail corridor has not been quantified in this assessment because of the flood levels not being quantified.

### Flood velocities

During events when the rail embankment is not being overtopped, the flow downstream of the culverts would generally be confined within or near to the individual watercourses.

At times when the embankment overtops (assuming the ballast does not erode), there would be a localised relatively high velocity of flow down the downstream face of the embankment. Since the embankment is generally not very high, it is anticipated that the velocity on the face of the embankment is unlikely to exceed a value of about 2.5 metres per second. This could create an erosion of the downstream face of the embankment.

Historical records show the rail ballast would generally fail and wash out, at least for part of the overtopping length, prior to or about the same time as the overtopping of the rail. Under this circumstance, there could be a flow on the downstream formation of the rail line of up to about two metres per second.

### Periods of Inundation

Watercourses downstream of culverts would be inundated for periods similar to the upstream areas.

### Erosion and stability of watercourses

Watercourses located downstream of many existing culverts exhibit signs of erosion. This is inferred as being the result of progressive stream instability due to the increased watercourse flow velocity, the historical increased frequency of flow and the lengthening of the periods of saturation as compared to that prior to construction of the existing rail corridor.

At most locations, the length of the watercourse instability does not exceed about 50 metres. However, there are some localised areas where the effects extend further downstream of the individual structures.

## 4.4 Water quality

### 4.4.1 General

Water quality monitoring data for watercourses within the study area was reviewed. A National Water Quality Assessment (SKM 2011) has classified the water quality within river catchments. Table 4-2 indicates that in both the Lachlan and Macquarie-Bogan River catchments the water quality was relatively poor quality.

The assessment considered data from 15 sites in the Lachlan River catchment and from 17 sites in the Macquarie Bogan river catchment. Some sites in the Macquarie-Bogan river system did not have data for all parameters.

A more recent State of the Environment report (Molino Stewart 2015) indicates that there has been a progressive reduction in recorded electrical conductivity values during the period 2011–12 to 2014–15 in the Central West region of NSW. The same report also indicates a reduction in recorded E. coli counts in watercourses over the period 2012–13 to 2014–15.

No data was collected as part of this assessment due to the ephemeral nature of the watercourses that cross the proposal site.

**Table 4-2 Assessed water quality**

| Parameter | Lachlan River catchment | Macquarie-Bogan River catchment |
|---|---|---|
| Turbidity | Fair<br>31% of samples exceeded guideline values | Good<br>76% of samples complied with ANZECC / ARMCAM guideline values |
| Salinity | Fair<br>50% of samples exceeded guideline values | Poor<br>Median values at sites ranged from 92–1,140 μS/cm |
| pH | Good<br>85% of samples within catchment were within guideline values | Fair<br>A significant variability in the observations was observed. |
| Total Nitrogen | Very poor<br>96% of samples did not meet guideline values<br>Median values at sites ranged from 456–860 μg/L | Very poor<br>Median values at sites ranged from 370–1,200 μg/L |
| Total Phosphorus | Poor<br>72% of samples did not meet guideline values<br>Median values at sites ranged from 12–83 μg/L | Very poor<br>Median values at sites ranged from 21–154 μg/L |

### 4.4.2 Macquarie River

While limited, electrical conductivity data was obtained for the Macquarie River between 27 November 1998 and 26 September 2009 from the NSW Government Waterinfo website. The data shows the electrical conductivity at Dubbo (station 421001) as varying between 120 and 860 micro-siemens per centimetre (μS/cm) corrected for 25° Celsius.

# 5. Water quality risks from proposal

## 5.1 Background

A sensitive receiving environment is one that has a high conservation value, or supports human uses of water that are particularly sensitive to degraded water quality (DECC 2008). In the context of this proposal, sensitive receiving environments are considered to be:

- Nationally Important Wetlands.
- National parks, nature reserves and State conservations areas – an example being the Macquarie Marshes Nature Reserve downstream of Warren, which is also listed as a Ramsar Wetlands site.
- Threatened ecological communities associated with aquatic ecosystems.
- Key fish habitats as identified by the NSW Department of Primary Industry.
- Recreational swimming areas.
- Areas that contribute to drinking water catchments.

The *ARTC Inland Rail – Parkes to Narromine Aquatic Ecology Assessment* (Umwelt 2017) details the threatened ecological communities and key fish habitats relevant to the proposal. The Ramsar listed Macquarie Marshes is an important ecological site located about 200 kilometres downstream of Narromine, within the Macquarie-Bogan River catchment. In addition, the Lachlan River catchment contain the following environmental values (DPI (Water), 2017):

- Nine wetlands which are featured in the Directory of Important Wetlands In Australia, including Lake Cowal, Lake Brewster, Booligal wetlands and Great Cumbung Swamp (Lachlan River catchment). None of these wetlands is located within 100 kilometres of the proposal site.

## 5.2 Water quality risks

Table 5-1 identifies the main construction phase risks that are likely to affect the water quality adjacent to the proposal or in the receiving waters in an area likely to be directly impacted by the proposal.

Table 5-2 provides the risks for the operational phase of the proposal.

### Table 5-1 Water quality risks and potential mitigation measures during construction

| Risk | Potential water quality impacts | Recommended measures to avoid, mitigate or minimise impacts |
|---|---|---|
| Litter dispersion | • Potential for litter to be blown off a construction area or transported off area by runoff and/or floods | • Provide litter bins within construction compounds and regularly empty bins<br>• Implement appropriate practices through a CEMP<br>• Transport all general litter and waste off site to an appropriately licensed waste facility |
| Sediment export | • Potential downstream transportation and deposition of eroded material<br>• Potential increased turbidity or sediment loads in watercourses due to runoff and/or discharge of sediment laden water | • Develop and implement an appropriate erosion and sediment control plan for the CEMP using erosion and sediment measures described in Managing Urban Stormwater – Soils and Construction (Landcom 2008)<br>• Regularly inspect and maintain erosion control measures until vegetation is established or permanent stabilisation measures are established<br>• Undertake discharge in accordance with the EPL, if required |
| Nutrients exported off proposal area | • Potential for export of nutrient into downstream watercourses during rainfall events | • Promptly establish revegetation cover on disturbed areas using erosion and sediment measures described in Managing Urban Stormwater – Soils and Construction<br>• Minimise the application of fertiliser during vegetation reestablishment |
| pH change in watercourses | • Potential for pH to impact downstream waters as a result, primarily, of use of concrete | • Design culverts to minimise onsite concrete work as much as practical |
| Oils and grease exported off proposal area | • Potential transport of spilt oils and grease off site into downstream watercourses or the groundwater | • Undertake plant maintenance and refuelling activities within appropriately bunded areas in construction compounds<br>• Undertake vehicle and equipment maintenance in accordance with manufacturers specifications<br>• Use drip trays under machines to collect spills when refuelling in open areas<br>• No refuelling or equipment maintenances is to be undertaken within 25 m of watercourses<br>• Minimise onsite storage of oils and greases<br>• Implement good housekeeping through implementation of the CEMP<br>• Collect and discharge or dispose of water from vehicle washes in accordance with relevant regulatory requirements |

**Table 5-2 Water quality risks and potential mitigation measures during operation**

| Risk | Potential water quality impacts | Recommended measures to avoid, mitigate or minimise impacts |
|---|---|---|
| Formation failing and causing downstream pollution | • Potential for increased downstream sediment suspended load or bed load with potential localised deposition<br>• Potential for mobilisation of sediments or soil from upstream of the formation being mobilised and depositing downstream of the formation<br>• Potential for mobilisation of detained water from upstream and flushing watercourses leading to ecological or erosional impacts either upstream of downstream of the formation<br>• Potential for erosion downstream of watercourses downstream of new culverts as a result of longer flow durations and more water being directed through culverts | • Selection of a formation level that is generally above the local catchment 1% AEP level to minimise the frequency of overtopping of the formation and potential wash out of ballast<br>• Installation of erosion protection measures at culverts to minimise erosion risk<br>• Minimise potential for creating ongoing moist areas of soil through selection of the proposal formation design<br>• Undertake regular inspections of formation and complete any required repairs promptly to maintain stability<br>• Undertake regular inspections of the downstream watercourses as part of the routine alignment inspections and implement remediation measures if required |
| Spills of oils and grease from rolling stock | • Potential for pollution of the soil or water by spilt oils and grease<br>• Potential spills of hazardous materials or contaminating material from the train | • Clean up all localised significant spills as promptly as possible in accordance with ARTC operating procedures<br>• Undertake the transport of dangerous goods and hazardous materials in accordance with relevant legislation<br>• As part of routine train inspections and maintenance specifically consider inspections for wear or damage to elements that contain any potentially contaminating material |
| Dust off carriages | • Potential dust adjacent to the rail corridor and or progressive blockage of voids within ballast | • Control operational speeds when transporting dusty products<br>• |
| Maintenance activities | • Potential for mobilisation of sediments or soil from disturbed soil areas created by access and other machinery movements or creation of stockpiles<br>• Potential for litter to move off proposal corridor<br>• Potential for metals to be left on soil surface as a result of cutting or working on metal rails<br>• Potential for spills of chemicals and other material onto soil surface with possible transportation off the proposal corridor | • Install temporary bunding around maintenance works area, where practicable<br>• Removal of all litter and debris from the corridor at the end of each day<br>• Manage spills of chemicals using standard ARTC operational protocols<br>• Undertake vehicle and equipment maintenance in accordance with manufacturers specifications.<br>• Undertake an inspection of the maintenance area on completion of work to ensure area is clean of all litter |

### 5.2.1 Potential unmitigated water quality impacts

***Construction***

The impact of unmitigated construction activities on receiving waters could include:

- Increased sediment loads from exposed soil during rainfall events, causing high sediment loads to be washed or deposited into downstream watercourses, with the potential to:
  - Smother aquatic life and inhibit photosynthesis conditions for aquatic and riparian flora
  - Impact breeding and spawning conditions of aquatic fauna
  - Change water temperature conditions due to reduced light penetration
  - Affect the ecosystems of downstream sensitive watercourses, wetlands and floodplains
  - Increase turbidity levels in downstream watercourses at locations where water is extracted for any potable purpose
- Increased sediment loads from discharge of sediment-laden water from dewatering of excavations.
- Increased levels of nutrients, metals and other pollutants transported via sediment to downstream watercourses or via discharge of water to watercourses.
- Chemicals, oils, grease and petroleum hydrocarbon spills from construction machinery directly polluting downstream watercourses.
- Increased levels of litter from construction activities polluting downstream watercourses.
- Contamination of watercourses because of disturbance of contaminated land.
- Spillage of paints, epoxies and herbicides during construction.

Given the limited degree to which the proposal would change the study area hydrology, not all impacts listed above are likely to remain an issue for consideration. The paragraphs below explore key water quality impacts in more detail following a review of the proposal and likely impacts.

**Impacts of changes to surface water quantity on water quality**

Changes to flow regimes, discussed in the *ARTC Inland Rail – Parkes to Narromine Hydrology and Flooding Assessment* (GHD 2017) can impact water quality in watercourses by changing the volumes and flow rates of water. A reduction in flow rate and volume of water could lead to stagnation of a watercourse. An increase in flow rate and volume of water could lead to increased erosion and turbidity of a watercourse. These changes may lead to long term changes in levels of turbidity, nitrogen and phosphorus. These potential impacts relate to the protection of the receiving water quality and may affect the balance of aquatic ecosystems.

**Impact on water quality due to construction in watercourses**

The construction of in-stream structures in watercourses, such as culverts and bridges, may disturb the bed and banks of the watercourse and result in increased erosion, leading to increased volumes of sediment entering and polluting the watercourses.

### Soil erodibility

Highly erodible soils are found throughout the study area (refer Section 3.5).

In areas where erodibility is moderate or high, if mitigation measures are not established prior to and during construction, sediment could be more easily eroded and transported into watercourses than in areas where soil is not as erodible. Inappropriate management may increase the turbidity of watercourses above the objectives, with a resulting effect on receiving environments namely aquatic plants and fauna. This risk to water quality is to be managed in conjunction with those outlined for managing changes in water quantity and working within watercourses given the interrelationship between the issues.

### Impact of earthworks and stockpiling

Construction of large excavations and embankments exceeding a single bench pose an elevated risk to water quality in downstream watercourse through the increased likelihood of movement of sediment off steep slopes. Mitigation to protect water quality during earthworks is required.

Earthworks materials, mulch and vegetation would be stored in stockpiles. Stockpiling is common practice given the volume of material likely to be moved and its timing cannot typically be done in a manner that facilities transport and final placement.

Stockpiling of earthworks poses a risk to downstream water quality during rainfall if the stockpiles are not managed appropriately. Sediments from the stockpiles could wash into watercourses, increasing levels of turbidity if no controls are in place.

Stockpiling of mulched vegetation from clearing of trees and shrubs poses a risk of tannins leaching into watercourses, and increased loads of organics in watercourses. The discharge of water that is high in tannins may increase the biological oxygen demand (BOD) of the receiving environment, which may in turn result in a decrease in available dissolved oxygen. Once discharged to the environment, tannins may also reduce visibility and light penetration, and change the pH of receiving waters. These impacts may affect aquatic ecosystems in receiving environments.

As discussed in Section 4.2.2 there is the potential to encounter perched groundwater during excavation, particularly near creek lines. The volume of water encountered is likely to be minimal and unlikely to exceed three megalitres per year. Dependant on the volume of water encountered dewatering of excavations may be required. Where discharge to surface water bodies is required, discharge water quality would be compliant with the EPL for the proposal. Potential discharge volumes will be confirmed during the detailed design.

The implementation of mitigation measures during earthworks and stockpiling of both soil and vegetation would be required to protect water quality, and identify and minimise the impacts on surface water and groundwater flow regimes and volumes.

### Impact of construction spills on water quality

Chemicals, dangerous goods and hazardous materials that may be used during construction include – but would not be limited to – diesel fuels, oils, greases and lubricants, petrol, paints, epoxies, herbicides, gases (oxyacetylene), cements, and lime. Storage of these materials would be within the construction compounds. Spills of these materials could occur during a storm event or by accident and the consequences could be detrimental to aquatic ecosystems if washed into a watercourse.

The quantities of chemicals, hazardous goods and dangerous materials required during construction are not expected to pose a significant risk, although mitigation would still be required.

Use of vehicle washdown areas could also result in the discharge of wastewater containing oil and petroleum hydrocarbons if not managed properly. All wastewater would need to be captured and recycled or disposed of off-site at an appropriately licensed facility.

### Impacts of surface water on groundwater

In general, construction activities could result in changes to relative groundwater levels and potentially to groundwater quality. That impact is anticipated to be minimal for this proposal as excavation depths to install culverts will be very limited below the existing natural surface level. Potential risks to groundwater quality from surface water during construction include:

- Contamination by hydrocarbons from accidental fuel and chemical spills during construction activities, refuelling or through storage facilities.
- Contamination from contaminants in runoff from unpaved surfaces.
- Intersection of the water table during excavation – this is considered unlikely given the depth to groundwater.
- Infiltration of surface water to groundwater sources. The infiltration process is generally effective in filtering polluting particles and sediment. As such, the risk of contamination of groundwater from any pollutants bound in particulate form in the surface water, such as heavy metals, is generally low.

Insoluble pollutants such as insoluble hydrocarbons (oils, tars, petroleum products) are unlikely to penetrate to the water table given the depth to groundwater. However, mitigation would still be required.

Soluble pollutants, such as pH altering solutes, salts and nitrates, as well as soluble hydrocarbons, may infiltrate through soils potentially into the groundwater system. Under certain pH conditions, metals (natural and anthropogenic) may also become soluble and could infiltrate groundwater. Mitigation measures are required in these circumstances.

### *Operation*

Potential water quality impacts during operation could occur because of changes to hydrology or contamination of runoff.

During the operation of the proposal, the rail formation would have been capped with ballast, the embankments landscaped, the impacted watercourses would have been rehabilitated and the exposed soil would be revegetated thereby minimising the residual risk of soil erosion and transport of eroded sediments to watercourses.

### Surface water

During the operational stage, there is a risk to surface water due to the release of pollutants from accidental spills of petroleum, chemicals or other hazardous materials as a result of leaks from vehicles, surface run-off from tracks and rail maintenance or rail accidents. Spills of this nature could pollute downstream watercourses if unmitigated. As the likelihood of spills is low, specific mitigation measures have not been prescribed. Any clean up of a spill or derailment would be completed in accordance with ARTC operational procedures.

During operation, surface water runoff would be managed through a drainage system that connects to cross drainage infrastructure at existing drainage lines and waterways. The drainage system would include measures such as scour protection at culvert outlets to minimise the potential for scouring and erosion. Where appropriate, culvert outlets would be lined to minimise scouring. This would minimise the potential for water quality impacts during operation.

### Groundwater

No operational impacts are expected on the quality of groundwater during operation or maintenance of the proposal. Any material from wear or maintenance of the rail and rolling stock is expected to be retained on the soil surface or within the ballast and not be transported into the groundwater. Any chemical spill would be cleaned up as promptly as practical and would not be expected to migrate any significant depth into the soil.

### 5.2.2 Water quality objectives and existing water quality

As described above, if inadequately managed, the proposal has the potential to introduce the following pollutants to surrounding watercourses:

- Nitrogen and phosphorous – due to use of pesticides and herbicides for weed control during construction and operation (maintenance).
- Sediment laden run-off increasing turbidity– due to soil erosion and runoff during construction and operation.
- Chemicals, oils, grease and petroleum hydrocarbons – due to use of a vehicle washdown area during construction and leaks and spills during construction and operation.

The water quality objectives and their relevance to the proposal are defined in Table 2-2 for the Lachlan and Macquarie-Bogan river systems. Objectives are summarised in Table 5-3 for those pollutants that the proposal may introduce into the water cycle. The objectives are based upon the default trigger values for chemical and physical trigger values for the protection of aquatic ecosystems in slightly disturbed river ecosystems in south eastern Australia (ANZECC / ARMCANZ 2000).

**Table 5-3 Selected water quality objectives**

| Water quality parameter | Trigger value |
|---|---|
| Turbidity | 6-50 NTU |
| Total nitrogen | 50 μg/L |
| Total phosphorous | 5 μg/L |
| Dissolved oxygen (per cent saturation) | 85–110% saturation |
| Electrical conductivity | 125–2,200 (μS/cm) |
| pH | 6.5–8.0 |
| Oils and petroleum hydrocarbons | Insufficient data to give trigger value although the EPL is likely to require no visible oils or sheen in discharge water |

As described in Section 4.4 water quality information (SKM 2011) shows that the existing water quality is poor and generally does not meet the water quality objectives provided in Table 2-2. The poor quality is likely to reflect existing soil conditions and agricultural land use practices (described in sections 3.5 and 3.6).

The majority of watercourses in the study area are ephemeral and agricultural land uses dominate the study area. Therefore, it is considered unlikely that construction and operation of the proposal would have a significant influence on water quality in surrounding watercourses.

However, as described in Table 2-2, the proposal would be constructed and operated in accordance with the relevant EPLs. This would mean that any discharge water would meet the water quality objectives provided in Table 2-2 and would be of better quality than that within the surrounding watercourses.

Construction and operation would also be undertaken in accordance with the management measures provided in sections 5 and 6, which would minimise the potential for the proposal to reduce the quality of water in the surrounding watercourses.

Additionally, the proposal (particularly the proposed replacement of culverts and raising of track formation to greater than the level of the one per cent catchment flood event) would mean that flow in watercourses is generally maintained and, with suitable erosion and scour protection measures, erosion potential downstream from culverts is generally reduced. This would have a beneficial impact on water quality in the study area, with the quality of water more likely to meet the relevant objectives. Further details of the beneficial impacts associated with the proposed design control measures is provided in section 6.

# 6. Proposed mitigation measures and benefits

## 6.1 Design control measures

### 6.1.1 Selected formation level and formation profile

The proposed formation level has been selected to make the new rail level flood free for the predicted 100 year ARI local catchment flood level (one per cent AEP local catchment event) except at a limited number of level crossings.

The design of the proposed formation level has also considered the volume of materials along the track, the complexity of excavation along the track and the potential for reuse of excavated materials to minimise the need for material importation to create the new formation.

***Benefits***

This measure would:

- Minimise the volume of waste material created by the formation construction.
- Minimise the need for importation of new fill material.
- Decrease the area of flood inundation upstream for the at least half of the potential flood events, when compared to the existing conditions, hence decreasing the potential for mobilisation of pollutants (refer to section 4.3.3).

### 6.1.2 Culvert locations

Culverts would be located at or adjacent to existing structures to avoid the creation of new flow paths across the rail line.

***Benefits***

This measure would:

- Prevent the formation of significant new flow paths and potential soil erosion areas downstream of the existing rail corridor, thereby reducing the potential for increased sedimentation of surrounding waterways.
- Minimise excavation for new structures thereby reducing the potential for increased sedimentation of surrounding waterways.
- Restrict the potential for new scour areas, and the potential for soil erosion, and significantly reduce the extent of existing erosion areas.
- Maintain the ecological and drainage functionality of existing watercourses downstream of the proposal.

***Residual impacts of measure against water quality objectives***

While this measure would have benefits, it would require the implementation of other design measures to restrict the potential for erosion at culvert locations.

### 6.1.3 Culvert form

The proposed culvert form has been selected to facilitate efficient construction and minimising impacts on watercourses. Culverts would be pre-cast off-site, and installed along the proposal site as the track upgrading works progress. The only onsite concrete usage and placement would be for the aprons and headwalls at each culvert structure.

***Benefits***

This measure would:

- Speed the culvert placement process as it would involve less site excavation and foundation preparation, which would minimise the potential for runoff and, erosion hazards at each culvert site.
- Speed the culvert placement process in watercourses, thereby reducing the disturbance time and associated potential for increased turbidity in watercourses.
- Minimise the amount of concrete to be placed on site, thereby minimising the potential impacts from changes in pH of water from the recently placed concrete.
- Reduce the amount of water required for concreting.

***Residual impacts of measure against water quality objectives***

While this measure would have benefits, it would require the implementation of other design measures to enhance the benefits from the measure. In addition, there would still be a short-term minimal change in the pH of water passing through the culverts while the cast in-situ concrete treatments.

To minimise downstream erosion and sedimentation through reduced site disturbance periods there would be a need to implement this measure through the required CEMP.

### 6.1.4 Culvert levels and size

The culvert invert levels have been selected to match the existing invert levels to mitigate the creation of blockages to flow and fish passage (during times of stream flow) at the culverts. The culvert sizes have also been selected to minimise the increase in flow velocity through the culverts.

***Benefits***

This measure would:

- Facilitate fish passage through the structure during times of flow.
- Minimise the risk of downstream erosion by matching the level to the downstream soil level and avoiding a level drop and associated energy loss.
- Minimise the flow velocity through the structures as much as practical while having an appropriate number of culvert barrels.

***Residual impacts of measure against water quality objectives***

A minimal increase in flow velocity through some structures would occur with the predicted increase not exceeding 0.5 metres per second.

### 6.1.5 Culvert erosion control

A rock energy dissipation layer (a stabilisation blanket) would be provided across the full width of the culverts to reduce the flow velocity off the concrete apron prior to flowing over the downstream soil. This would reduce the flow velocity of water exiting the culverts prior to discharging onto the ground surface, and thereby minimise potential downstream soil erosion.

#### *Benefits*

This measure would:

- Stabilise the soil and reduce the amount and extent of downstream soil erosion.
- Improve the transition from the flat concrete apron to the more irregular profile of the ground surface.
- Provide a rock blanket, which would provide a location for the trapping of some of the sediment load and would provide a relatively stable area for seed germination and vegetation establishment adjacent to the apron.

In addition, the area of placement of the rock would be disturbed during construction, and the rock placement would provide quick stabilisation of the immediate area against erosion.

#### *Residual impacts of measure against water quality objectives*

This control measure would reduce, but not eliminate, the potential for downstream erosion.

### 6.1.6 Watercourses downstream of culverts

The proposal would subject the watercourses immediately downstream of some culverts to increased flow rates, flow volumes and flow velocities. This would occur when a replacement culvert locally increases the velocity relative to that for the existing culvert due to its more efficient conveyance of water, or where the replacement culvert is wider than the existing culvert. This effect would be localised and would only occur at a small number of culverts due to the proposed “like for like” replacement of culverts. The rock energy dissipation layer discussed in section 6.1.5 would reduce the velocity immediately downstream of these culverts, thereby mitigating downstream impacts.

Since the rail is not intended to overtop (except at a minimal number of level crossing locations), there will be an increase in the flow volume passing through each culvert for flood events, relative to that which would occur for the same rainfall event under existing conditions. These effects would occur because of:

- A minimisation of the amount of rail overtopping for the local catchment runoff events, except at a limited number of level crossings, for events smaller than the one per cent AEP local catchment peak runoff rate. This effect directs an increased total volume of water through the collective group of culverts.
- An increased flooding level upstream, with a corresponding increase in the duration of flow through the culverts. This effect would not be uniform with the magnitude of the flood events since, for small flood events, some culverts would drain more quickly than currently, but for the large events, the increased runoff volume passing through the culverts would result in a longer flow duration through the culverts.
- The provision of concrete culverts everywhere, to replace bridges with natural surface inverts or bridges with many piers, which would provide more efficient flow conveyance through the culverts and increase the flow velocity in the structures.

Erosion protection would be provided downstream of the culvert aprons. However, there would be a greater amount of flow passing along the relatively small incised watercourses downstream of culverts and this could lead to erosion of those watercourses.

#### *Benefits*

The erosion protection measures would:

- Mitigate the potential erosive effect to some extent; to achieve an enhanced protection it would be necessary to extend the rock protection further toward the boundary of the existing rail corridor.
- Reduce the increase in flow velocity within the rail corridor to 0.5 metres per second, which would reduce the effect on adjacent private property.

During the construction phase, each individual structure would be examined to provide a site specific extent of erosion protection to further mitigate this potential impact.

#### *Residual impacts of measure against water quality objectives*

The assessment has indicated a residual erosion risk at about 12 culvert locations (of the 145 culverts assessed) for a distance of about 100 metres from the extent of the rock protection and after that distance the risk is predicted to become minimal. The predicted widening of the small incised watercourses has been assessed at a maximum of about 0.3 times the watercourse width when the watercourses are narrower than about 10 metres. The predicted potential widening then decreases inversely with the width of the watercourse, to be minimal when the watercourse width exceeds about 20 metres.

The maximum widening is expected to occur over a period of about two to 10 significant floods.

### 6.1.7 Removed culverts

The concept design has allowed for the replacement of all existing culverts.

A very limited number of the existing culverts are relatedly new and comprise reinforced concrete box culvert units (RCBC). Should it be possible during the construction of the proposal to recover any of the RCBCs in a sound condition they would be stored for potential reuse.

Some of the existing culverts comprise segments of reinforced concrete pipes or corrugated steel pipes. Should any segments of these culverts be recovered in a sound condition they would be stored for potential reuse.

#### *Benefits*

This measure would potentially provide some waste minimisation through the reuse of any recovered sound RCBCs or lengths of pipes from the existing culverts.

#### *Residual impacts of measure against water quality objectives*

This measure would only have a minimal benefit on the water quality objectives.

### 6.1.8 Precast culvert segments

It is proposed to construct culverts using pre-cast concrete segments where practical.

*Benefits*

This measure would:

- Reduce the construction time undertaken on and over ephemeral and perennial flowing waterbodies and, hence, reduce both the potential for spills and disturbance of the watercourses, and floods impacting on construction activities.
- Minimise the number of concrete pours at each site.

## 6.2 Construction phase control measures

### 6.2.1 Development and implementation of CEMP

A CEMP would be developed and implemented for the construction of the proposal. A component of the CEMP would be a Soil and Water Management Plan (SWMP; refer to Section 6.2.1).

As part of the CEMP, an Emergency Spill Plan or Emergency Response Plan would be developed. This would include measures to avoid spills of fuels, chemicals and fluids into any watercourses. The storage, handling and use of the materials would be undertaken in accordance with the *Occupational Health and Safety Act 2000* and Workcover's Storage and Handling of Dangerous Goods Code of Practice (Workcover 2005).

The CEMP would include consideration of specific measures, such as:

- Selecting and implementing appropriate erosion and sediment control measures – the SWMP measures would be consistent with requirements of the *Managing Urban Stormwater: Soils and Construction Manual* (Landcom 2008). It is anticipated that construction would include installation and maintenance of silt fences together with other works described below. The design standard for erosion protection using silt fences would be the ten year AEP event while, should a sediment basin be applied, it would have a design criteria based upon the 5 day 80$^{th}$ percentile rainfall.
- Procedures and requirements for minimising the disturbance of watercourse beds during bridge and culvert construction and demolition of the existing bridges.
- Procedures for minimising waste and litter – the recycling of embankment materials would minimise the amount of excess spoil that needs stockpiling, storing or export off site, and minimise the amount of imported fill material required. Any litter would be exported off site and disposed of in an appropriate manner.
- Procedures for minimising the storage of liquids on site and uncontrolled onsite refuelling of machines (refer Section 6.2.2).

### 6.2.2 Spill containment

Storing and accidental spill of materials or liquids within construction compounds would be controlled by:

- Any stored liquids would be located within an appropriately sized container in a designated location within the construction compounds to trap any spill from the primary storage container.
- Machinery refuelling would occur away from water, within an area where spilt fuel can be contained and promptly cleaned up. Whenever possible the refuelling would be undertaken within a construction compound.
- Providing emergency spill containment packs on trucks traversing the proposal site.
- Providing staff training on spill management.

***Benefits***

These measures would:

- Avoid uncontrolled spills of stored chemicals onto and into the soil, surface water or groundwater.
- Minimise the potential for accidental spills of fuels and chemicals onto and into the soil, surface water or groundwater.
- Minimise the potential for adverse water quality impacts.

***Residual impacts of measure against water quality objectives***

While this potential impact on water quality cannot be eliminated, the proposed measures would minimise the potential for adverse water quality impacts as much as practical.

### 6.2.3 Culverts

All culverts will be constructed in a manner that minimises, as far as practical, the potential water quality impacts on the waterway. This would be achieved by:

- Restricting site disturbance for clearing and pier or abutment construction.
- Minimise the construction activities that may block the watercourse and prevent fish passage during times of flow or flood.
- Undertaking works within waterways in accordance with the NSW Office of Water's guidelines for controlled activities.

***Benefits***

These measures would:

- Restrict the amount of disturbed areas and the potential for soil erosion along with the transportation of material away from the proposal site as existing water pollution.
- Maintain the aquatic environment and fish habitat.

***Benefits***

These measures would:

- Provide broad environmental benefits.
- Reduce the potential for litter to be transported off site by water in an uncontrolled manner.

### 6.2.4 Soil and Water Management Plan

- The SWMP is recommended to include the following items relevant to water quality:
- Erosion and Sediment Control Plans for all stages of construction detailing the following:
  - Erosion and sediment control measures required before clearing and grubbing of the site.
  - Appropriate controls to be implemented prior to the removal of topsoil and start of earthworks for construction of the proposal within the catchment area of each structure.
  - Methods to manage upstream water so it does not lead to likely erosion of the construction areas.
  - Scour protection measures for haul roads and access tracks when these are an erosion hazard due to their steepness, soil erodibility or potential for concentrating runoff flow.
  - Methods to remove trees in intermittent watercourses, leaving grasses and small understory species undisturbed wherever possible.
  - Methods to stabilise temporary drains.
  - Methods to minimise erosion of all exposed areas, including (but not limited to) large batters and excavations.
- At-source erosion controls (such as check dams).
- Sedimentation basin construction and management.
- Protection of watercourses.
- Management of stockpiles.
- Water quality monitoring and checklists.
- Detailed consideration of measures to prevent, where possible, or minimise any water quality impacts.

Construction activities are required to incorporate management practices that minimise erosion potential and associated water quality risks. Recommended construction management requirements are:

- Minimising exposure of topsoil.
- Minimising the extent of disturbed areas.
- Minimising stockpiling.
- Minimising the lengths of slopes using diversion drains to reduce water velocity over disturbed areas.
- Installation of physical controls immediately prior to the commencement of other immediately adjacent works, including cross drainage to convey clean water around or through construction areas.
- Revegetation or disturbed areas using methods such as spray mulching or the use of temporary cover crops as soon as works are completed.

Specific measures and procedures for works within watercourses, such as the use of silt barriers and temporary creek diversions, would be implemented. Construction sequencing and temporary diversions of water during construction should be developed and designed to consider the impact of change on flow regimes and to minimise these changes throughout construction.

Physical controls that would be used to reduce the risk of water quality degradation due to erosion and sedimentation during construction could include:

- Sediment fences and filters to intercept and filter small volumes of non-concentrated construction runoff.
- Rock check dams that are built across a swale or diversion channel to reduce the velocity of flow in the channel, thus reducing erosion of the channel bed and trapping sediment.
- Level spreaders to convert erosive, concentrated flow into sheet flow.
- Onsite diversion drains to collect runoff and direct it away from unstable and/or exposed soil to treatment facilities.
- Offsite diversion drains to collect clean runoff from upstream of the proposal site and divert it around or through without it mixing with construction runoff.
- Sedimentation basins to capture sediment and associated pollutants in construction runoff.
- Specific measures and procedures for works within watercourses such as the use of silt barriers and temporary creek diversions.

The SWMP would include consideration of specific measures including:

- Selecting and implementing appropriate erosion and sediment control measures – the measures would be consistent with requirements of the *Managing Urban Stormwater: Soils and Construction Manual* (Landcom 2008). It is anticipated that the works would include installation and maintenance of silt fences together with other works described below.
- Protection of waterways from sediment plumes during bridge construction
- Restricting site access – access to the proposal site would be controlled to minimise the potential for soil disturbance and potential soil erosion.
- Placing any excess material stockpiles or temporary stockpiles in areas away from potential water flow – this would be done to avoid potential erosion of the stockpiles.
- Stabilising disturbed areas – disturbed soils would be revegetated and stabilised as soon as practical after completion of works in localised areas to minimise the length of the risk to surface erosion resulting from either wind or water.
- Stabilising access tracks with gravel, or equivalent – stabilisation of heavily trafficked access tracks would reduce the potential for the tracks to become dusty and subject to potential wind or water erosion.
- Dust control – areas that are becoming dusty would be watered, as required, to minimise dust generation and airborne pollution.

***Benefits***

These measures would:

- Minimise the potential for soil erosion from the proposal area and transportation of the sediment to downstream areas.
- Minimise the creation of dust and airborne pollution.
- Minimise the potential for litter and trash to be exported off site in an uncontrolled manner.
- Minimise the potential for adverse effects of liquid spills.

### *Residual impacts of measure against water quality objectives*

Implementation of the CEMP is intended, in part, to minimise the areas of soil disturbance, the length of the disturbance and thus the potential for sediment export off a construction area. Even with the development, installation and maintenance it is possible for pollutant export during a significant rain or flood event.

The proposed measures are intended to mitigate, as much as practical, adverse impacts. Notwithstanding, there is the potential for some export of sediments and other pollutants off the project area. The proposed measures are expected, except in a large flood event, to create a lesser sediment concentration in any construction area runoff that then off the adjacent rural land uses.

Implementation of the CEMP will assist with the objectives of not adversely impacting the water quality in the watercourses.

### 6.2.5 Vehicle washdown

The location for any vehicle washdown facilities will be determined during the detailed design works for the proposal. All washdown facilities would be expected to be located within the construction compounds. The location of compounds would meet the criteria outlined in section 6.2.6.

All wastewater from vehicle washdown areas would be captured and would either be disposed of to an appropriately licensed facility or treated prior to discharge to surface water bodies. All discharge water would comply with the water quality objectives provided in Table 2-2 and the relevant EPL requirements.

#### *Benefits*

Capturing all wastewater from these activities and discharging in accordance with relevant requirements would ensure the water quality objectives of surrounding watercourses are maintained or improved.

### 6.2.6 Construction compounds

The location of these compounds would continue to be determined considering many criteria including the following:

- Being at least 50 metres from watercourses.
- Where no or only minor clearing would be required, and not within areas identified as threatened communities or species habitat.
- Having no significant impacts to utilities.
- Being at least one kilometre from the nearest residence or other noise sensitive receiver where possible.
- Not being on or near a site with known Aboriginal or non-Aboriginal heritage value.
- Being relatively flat land.

#### *Benefits*

Consideration of these criteria for the selection of compound sites would minimise the probability of the construction compounds being located in areas that could potentially flood and hence minimise the probability of the construction compounds affecting the adjacent water quality for both surface water and groundwater.

### 6.2.7 Minimising construction footprint

The construction footprint for the proposal would be minimised through:

- Restricting vehicular access routes from public roads to the proposal area.
- Planning works prior to construction, such that the length of time excavations remain open or material remains stockpiled is limited.

#### *Benefits*

These measures would restrict the total area of soil disturbance as much as practical and minimise potential adverse water quality impacts as required by the water quality objectives. Minimisation of site disturbance is consistent with accepted construction practice.

#### *Residual impacts of measure against water quality objectives*

The above approach of minimising construction site areas restricts the potential for adverse water quality Impact. In the case of a large rainfall event occurring during the construction period there may still be adverse impacts but these would be significantly reduced, relative to their possible extent without the minimisation of the construction area.

## 6.3 Operational phase control measures

### 6.3.1 Controlling train speed

Trains would be operated at or below the nominated design speed. Operation of trains at a speed greater than the design value could increase the potential for possible train derailments.

A derailment could lead to the spillage of material onto land adjacent to the rail corridor. While ARTC would undertake a site clean up to remove material spilt from the carriages, there would be the possibility of some residual small amounts of material escaping the clean-up process and that material remaining on the land.

#### *Benefits*

Operating the trains so that they travel below the design speed would minimise the potential for accidental derailments and cargo spills.

The avoidance of derailments and thus spills would remove the potential for spilt material to be accidentally left on the land adjacent to the rail corridor following a clean-up.

### 6.3.2 Track inspections after significant flood events

Track inspections would be in accordance with existing ARTC operating procedures. An inspection would be undertaken after each significant flood event, leading to a track shut down, and prior to the track reopening. These inspections would identify any areas of fault along the corridor.

#### *Benefits of measure*

This measure would reduce the potential for train damage and subsequent pollution and allow the controlled maintenance of the rail line.

# 7. Proposed monitoring program

Water quality monitoring is generally recommended to provide assurance of compliance with regulatory requirements and to detect immediately any environmental degradation during construction. The monitoring program would form part of the CEMP.

Because of the ephemeral nature of most watercourses, it would not be practical to implement a routine monitoring program during construction. Instead, an opportunistic event-based sampling program is recommended.

### 7.1.1 Objectives

The water quality objectives should be established prior to construction and following input from relevant agencies including, but not limited to, the NSW EPA and NSW DPI. The water quality criteria and trigger levels would be consistent with those listed in Table 2-2 and Table 5-3.

It is recommended that the objective for water quality is to cause no net change to receiving watercourses quality because of construction or operation of the proposal.

### 7.1.2 Sampling sites and regime

Sampling sites would be selected based on the agreed objectives. Potential locations include any permanent watercourse that may potentially be impacted by the proposal, named watercourses (permanent and perennial), key fish habitats, and known and potential habitats of threatened ecological communities.

The construction phase has the highest potential to impact water quality, particularly because of rainfall events, where construction activities may result in the transport of sediment and particulates through runoff into receiving watercourses.

As part of the development of the CEMP there would be a risk assessment completed to identify the areas of greatest environmental risk when considering the location of construction compounds, specific activity risks and the forecast weather conditions. The risk assessment may focus water quality sampling on specific areas or identify more appropriate sampling frequencies than identified in the generic sampling program given below.

In advance of undertaking the risk assessment, it is intended that upstream and downstream water quality sampling should be undertaken in waterways during the construction phase at a particular culvert location within 24 hours of a rainfall event, when there is surface water flow, to support the effectiveness of implementation of the identified construction management practices. The surface water quality sampling frequency recommended for the proposal is summarised in Table 7-1. If the watercourse continually has water, sampling should be undertaken once each two weeks during the adjacent construction phase.

**Table 7-1 Recommended water quality sampling frequency**

| Proposal phase | Sampling frequency per watercourse |
|---|---|
| Pre-construction | Minimum of three data sets (assuming rainfall generates runoff) for flowing watercourses within 500 m of rail corridor.<br>Samples are to be taken within 24 hours of rainfall that induces a runoff event. |
| Construction | Minimum two samples per month for each sampling point when there is flow present. |

### *Parameters*

It is recommended that the indicators provided in Table 7-2 be monitored.

As per AS/NZS 5667.1 1998 Water Quality Sampling Guidance, laboratory analysis is required to be undertaken by those registered with the National Association of Testing Authorities (NATA).

**Table 7-2 Recommended water quality sampling parameters**

| Analyte | Construction Phase |
|---|---|
| pH | Yes, when flow is occurring |
| Total Suspended Solids (TSS) | Yes, when flow is occurring |
| Oils and grease | Yes, when flow is occurring |
| Electrical conductivity (EC) | Yes, when flow is occurring |
| Dissolved Oxygen (DO) | Yes, when flow is occurring |
| Total Phosphorous (TP) | - |
| Total Nitrogen (TN) | - |

# 8. Conclusions

A range of mitigation measures are proposed to protect the water quality of surface waters and groundwater. With the implementation of these measures, the water quality of surface waters and groundwater would be protected in accordance with the water quality objectives for the proposal. These impact mitigation measures are summarised below.

## 8.1 Design phase

The impact mitigation measures included in the design of the proposal include:

- Selecting the formation level and formation profile to achieve the targeted flood immunity while minimising adverse flooding impacts, maximising the reuse of excavated material and reducing adverse water quality effects of the construction.
- Locating culverts under the rail line at locations generally consistent with the existing structure locations and consistent with the existing watercourse invert level to maximise the potential fish passage, minimise potential adverse water quality impacts and maintain existing ecological function.
- Selecting a culvert form to minimise onsite concrete work and the construction phase, which would minimise the potential water quality risks.
- Providing rock riprap immediately downstream of culverts to provide protection against erosion adjacent to the culvert aprons and in the watercourse through the downstream properties. While this measure has been considered in the design there is predicted to be a residual erosion risk downstream of culverts and this risk would need to be considered for each site to achieve appropriate site-specific designs.
- Using precast culvert segments, where practical, to minimise construction over watercourses that contain water at the time of construction.

## 8.2 Construction phase

The impact mitigation measures during the construction phase include:

- Preparing a CEMP to address site management measures so that adverse water quality impacts are managed. The CEMP would consider a broad range of issues that can help to meet the water quality objectives.
- Preparing a Soil and Water Management Plan to detail the erosion control measures that would be implemented and maintained for the duration of the construction phase. This plan would be consistent with requirements in the *Managing Urban Stormwater: Soils and Construction Manual.* It would consider measures for erosion protection, and construction compounds and tracks that may affect the protection of the downstream water quality.

## 8.3 Operational life of the proposal

The impact mitigation measures for the operational life of the proposal include:

- Controlling train speed not to exceed the design value.
- Completing track inspections after significant flood events to identify any requirements for repairs on maintenance prior to recommencing services.
- Application of appropriate environmental protection measures during maintenance works along the route of the proposal.

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# Appendices

# **Appendix A** - Surface water licences

**Table A-1 NSW Water Register – Surface water licences (Department of Primary Industries, Water, 2016c) accessed 7 June 2016**

| Access Licence Category | No. of WAL's | Total Share Component (ML or units) | Water made Available (ML) | Usage YTD (ML) |
|---|---|---|---|---|
| Macquarie Bogan Unregulated and Alluvial Water Sources 2012 | | | | |
| Backwater Boggy Cowal Water Source | | | | |
| Domestic and stock | 1 | 6 | 6 | 0 |
| Domestic and stock [stock] | 3 | 12 | 16 | 0 |
| Unregulated river | 11 | 2609 | 2609 | 0 |
| Upper Bogan River Water Source | | | | |
| Domestic and stock | 6 | 36 | 42 | 0 |
| Domestic and stock [stock] | 4 | 16 | 16 | 0 |
| Domestic and stock [town water supply] | 2 | 32 | 32 | 0 |
| Unregulated river | 13 | 1463 | 1463 | 0 |
| Unregulated river [special additional high flow] | 1 | 182 | 182 | 0 |
| Lachlan Unregulated and Alluvial Water Sources 2012 | | | | |
| Goobang and Billabong Creeks Water Source | | | | |
| Domestic and stock | 3 | 8 | 8 | 0 |
| Domestic and stock [domestic] | 1 | 2 | 2 | 0 |
| Domestic and stock [stock] | 2 | 8 | 8 | 0 |
| Local water utility | 1 | 1500 | 1500 | 0 |
| Unregulated river | 14 | 2200 | 2200 | 0 |

Note:

WAL: Water Access Licence

YTD: Year to date

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Document Status

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|---|---|---|---|---|---|---|
| | | Name | Signature | Name | Signature | Date |
| 1 | I Joliffe | A Wyatt | | Simon Page | | 21/06/2017 |

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