APPENDIX

G

Surface Water Quality Technical Report

PART 1 OF 2

Main Report

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

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

Inland Rail North Star to NSW/QLD Border

Appendix G: Surface Water Quality Technical Report

Australian Rail Track Corporation

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Abbreviations

Abbreviation	Explanation
AIAM	Adverse Impact Assessment Methodology
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZECC/ARMCANZ 2000	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ARTC	Australian Rail Track Corporation Limited
CIA	cumulative impact assessment
DPI	New South Wales Department of Primary Industries
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
FFJV	Future Freight Joint Venture
GDP	Gross domestic product
GIS	Geographical Information System
Inland Rail	Melbourne to Brisbane Inland Rail
km	kilometres
m	metre
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
NS2B	North Star to Border
NSW	New South Wales
PAH	Polycyclic aromatic hydrocarbons
SEARs	Secretary's Environmental Assessment Requirements
the proponent	Australian Rail Track Corporation Limited
WQOs	Water Quality Objectives
GDE	groundwater dependent ecosystems
CMA	Catchment Management Authority
BoM	Bureau of Meteorology
LGA	Local Government Area
NHMRC	National Health and Medical Research Centre
MDBA	Murray Darling Basin Authority

Glossary

Term	Explanation
Acid sulfate soils	Soils containing iron sulphides (Pyrite) which can produce sulphuric acids when disturbed (exposed to oxygen) through conversion of Pyrite.
Australian height datum	The national vertical datum for Australia, acting as a vertical control for height above sea level
Ballast	Rock placed under the rail ties (sleepers) to provide stable support for a rail line.
Catchment	Catchment at a particular point is the area of land that drains to that point.
Chainage	A measure of distance along the rail corridor. The values are progressive from the start of each package (from Melbourne to Brisbane) with the terminus of each being the alignment at the interface with the next package leading to Brisbane. For readability, chainage is noted in approximate kilometre throughout the document and noted in metres for figures.
Dispersive	A characteristic of soil indicating the potential for the breakdown of clay minerals into single clay particles in solution.
Ephemeral	Temporary, short-lived. An ephemeral watercourse is one that flows following periods of heavy rainfall.
Greenfield	An undeveloped site
Hydraulic	Water movements in regard to velocity and flow regime
Hydrology	The study or rainfall and runoff process
Limit of Reporting	The smallest concentration of analyte that can be reported by a laboratory
Megalitres	A metric unit of capacity equal to 1 million litres
Perennial	Lasting or enduring. A perennial watercourse has continuous flow all year round during years of normal rainfall.
Permanent operational footprint	The areas of the proposal that will be permanently and directly impacted by the operation of the rail line and associated facilities
Proposal	The construction and operation of the North Star to Border Project
Runoff	The amount of rainfall from a catchment that actually ends up as flowing water in the river or creek
Salinity	Refers to the amount of salt present in the soil solution.
Stream order	A measure of the relative size of a watercourse.
Temporary construction footprint	The areas of the proposal that will be directly impacted by the construction of the rail line, lay down areas, borrow pits, and other areas that will only be used during construction and will be rehabilitated prior to operation and will only be used temporarily.
Track	The combination of rails, rail connectors, sleepers, ballast, points, crossings and any substitute devices
Watercourse	A watercourse is a river, creek or other stream, including a stream in the form of an anabranch or a tributary, in which water flows permanently or intermittently, regardless of the frequency of flow events, specifically excluding drainage features
Water quality study area	The total area that may be impacted by construction and operation of the proposal.
Velocity	The speed at which the floodwaters are moving.

Executive summary

Purpose

This surface water quality technical report has been prepared to assess potential impacts of the proposed North Star to New South Wales (NSW)/Queensland (QLD) Border (NS2B) alignment of the Inland Rail Program on surface water quality. A summary of the assessment is to be included in the EIS submission. This assessment fulfils the requirements of the Department of Planning, Industry and Environment Secretary's Environmental Assessment Requirements (SEARs) pertaining to water quality, in particular SEARs 8. Flooding, Hydrology and Geomorphology - 8.1 (d, e, f), SEARs 9. Water Hydrology 9.1, 9.2, 9.3 (a- f), 9.4, and SEARs 10. Water Quality 10.1 (a – i).

Proposal description

The proposal will comprise approximately 30 km of new track between the town of North Star and the NSW/QLD border. The proposal is located within the NSW Border Rivers Catchment where the alignment is oriented approximately south to north and anticipated to cross four ephemeral creeks and the perennial Macintyre River at the northern end of the alignment, near the NSW border. The rivers of the catchment start at the Great Dividing Range and run westward, gradually merging to become the Barwon River about 150 km downstream of the proposal. The proposal site was based on a 1 km buffer extending horizontally from both sides of the proposed alignment, as such, increasing the extent where multiple design options exist to account for an increased investigation area. The proposal site was established to delineate the spatial extent of potential intersection of watercourses with temporary and permanent impact footprints of the proposal.

Existing environment

The catchment has the following characteristics:

- Climate is sub-tropical
- Rainfall is summer dominant
- The catchment is underlain by the Great Artesian Basin
- Land use in the catchment is dominated by grazing (67 per cent of the catchment) and dryland cropping (18 per cent of the catchment). Approximately 2 per cent of the land has been developed for irrigation, mostly cotton, in the west of the catchment.
- Conservation and native vegetation account for 5 per cent of land use
- Surface water is used for: stock watering, irrigation, drinking water, household use, recreation (primary and secondary) as well as for environmental and aesthetic purposes
- There are no wetlands of international importance (Ramsar wetlands) within 10 km of the proposal site
- The proposal site passes through an area with a very high salinity hazard.

A number of watercourses and waterbodies occur within the proposal site, including:

- The Macintyre River - a perennial waterway with a well vegetated riparian flood plain on either side of the river, it has highly sensitive fish habitats and is known to support threatened species such as the Murray Cod (*Maccullochella peelii*), Silver Perch (*Bidyanus bidyanus*) and Purple-Spotted Gudgeon (*Mogurnda adspersa*). The Macintyre River is a major hydrological input of the Darling River Endangered Ecological Community.
- Whalan Creek - an ephemeral waterway, larger than other creeks in the area and with a well-defined channel that is likely to flow seasonally
- Mobbindry Creek and Back Creek - ephemeral waterways with well-defined channels with fringing rushes and sedges present

- Forest Creek - an ephemeral, highly modified waterway with a poorly defined channel and limited or poor riparian vegetation
- An unnamed tributary of Mobbindry Creek - which is ephemeral.

The Sustainable Rivers Audit Report (MDBA 2012) reported that the overall health of the rivers in the Border Rivers Catchment was poor. Most sites assessed during the August 2018 field survey demonstrated low flow or dry conditions, likely due to lack of substantial preceding rainfall. Water quality data indicates that the watercourses intersecting the proposal site are not fully meeting water quality objectives.

This assessment established the existing fluvial geomorphological conditions based on the AUSRIVAS Physical Assessment Protocol and includes factors such as channel shape and modifications, bank shape and slope, bedform features, bed compaction and stability, sediment matrix and angularity, factors affecting bank stability, type and extent of bars and riparian zone structure and composition.

Water Quality Objectives

Water Quality Objectives (WQOs) established by the NSW Government for the catchment have been identified for the uncontrolled and major regulated rivers (the Macintyre River) in the Border Rivers Catchment. These Water Quality Objectives are designed to protect the following values: aquatic ecosystems, visual amenity, secondary contact recreation, primary contact recreation, livestock water supply, irrigation water supply, homestead water supply, drinking water at point of supply – disinfection only, drinking water at point of supply – clarification and disinfection, drinking water at point of supply – groundwater, and aquatic foods (cooked). Local water quality trigger values designed for the protection of these objectives have also been identified for the watercourses proximal to the proposal. The most stringent applicable trigger values were those that confer the highest protective status, being the protection of aquatic ecosystems (with the exception of arsenic (V), where the more stringent Australian Drinking Water Guideline was applied).

Potential impacts

Potential impacts were grouped into two categories:

- Increased water turbidity and sedimentation
- Changes to water chemistry.

The potential impacts of the proposal upon the existing geomorphology are addressed in the Hydrology and Flooding technical report prepared for the North Star to NSW/QLD Border EIS (FFJV 2020b). Impacts are addressed through detailed hydraulic modelling of the floodplain and waterways. The hydraulic modelling identifies changes in peak water levels, flood distribution and/or velocities that may alter the geomorphological conditions. Each of these impacts was quantified and mitigated through the design process.

Construction phase impacts

Potential impacts to water quality from the proposal during the construction phase include:

- Increased water turbidity and sedimentation as a consequence of: vegetation clearing, topsoil stripping and earthworks, and excavation/trenching, which could expose soils that could be eroded, and
- Changes to water chemistry resulting from:
  - Accidental spills and leaks of chemicals or fuels from construction equipment or fuel storages, which could contaminate surface water during direct runoff
  - Overland runoff and improper practice, and, disturbance of saline soils during construction, which could increase salinity in runoff
  - Overland runoff and the erosion of stockpiled materials, which could lead to increased nutrient concentrations in runoff.

Water requirements during the construction phase would be met with water sourced from the Boggabilla Weir. Any impacts associated with this water extraction would be assessed as part of the water use approval. with the Border Rivers Commission.

Operation phase impacts

Potential impacts during operation include:

- Increases in water turbidity and sedimentation resulting from: repair or maintenance of roads or tracks, increased runoff, which could result in erosion, from the rail formation due to the covering of pervious soils with rail ballast, and the creation of concentrated flow paths, which have an increased potential to erode soils
- Potential changes to water chemistry during operation could result from: materials deposited on to the railway formation such as potential spillages of fuel or chemicals from freight or trains, wear of tracks or compounds formed from the dissolution of the ballast materials, repair or maintenance of roads or tracks, which could lead to the introduction of chemicals/materials to waterways.

The quantity of these pollutants that might discharge to the receiving environment is likely to be negligible. Due to the distributed nature and likely stable landforms for the operation of these projects, it is unlikely that pollutants would be discharged beyond the rail corridor.

Significance assessment method

A qualitative significance assessment was undertaken. The significance assessment was based on the following elements:

- The initial impact significance assessment rating assumes that the design considerations to reduce impacts would be implemented
- The residual impact significance incorporates any additional mitigation measures that would be required to decrease the impacts of the assessed action
- The sensitivity of the aquatic receiving environments were assessed to be moderate i.e. being important at a regional level, in moderate to good condition, relatively well represented in the areas in which it occurs but its abundance and distribution are exposed to threatening processes
- The magnitude of the potential impacts of the proposal on water quality was assessed based on the spatial extent of the impact and duration of potential impacts.

Construction phase

During the construction phase, the significance assessment revealed that the current controls of the design and proposed impact mitigation measures relevant to surface water quality would be sufficient to mitigate most potential conceivable impacts such as spills, disturbance of saline soils or potential erosion, such that the residual significance of any impacts would be moderate.

The risk of in-stream earthworks leading to changes in water quality is considered to be low where there are existing water way crossings over Back Creek, Mobbindry Creek, an unnamed tributary of Mobbindry Creek, and Forest Creek. For waterway crossings at Whalan Creek and the Macintyre River, it is expected that no substantial vegetation clearing, or earthworks will be required at these locations. Additionally, any in-stream earthworks are expected to have a small footprint and will be undertaken in dry conditions. It is not proposed to construct any piers within the base-flow stream channel.

Operation phase

For the operation phase, the ARTC approved impact mitigation measures were assessed to be sufficient for the purposes of mitigating impacts that could cause increased water turbidity and sedimentation. The operational environment within the rail corridor is expected to comprise a stable and well-vegetated landform, and hence no erosion is expected. The residual significance of any impacts would be low.

Operational impacts to water chemistry could result from rail operation. Therefore, additional operation phase measures to mitigate impacts to water chemistry were considered necessary. The additional mitigation measures proposed include the provision of natural filtration systems for the treatment of stormwater runoff from the railway formation, such as vegetated buffer strips and vegetated open drains/swales. These would be incorporated into the longitudinal drains that form part of the drainage design

Hence, with these measures in place, it is considered that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm have been investigated and would be implemented for the proposal. These mitigation measures would ensure that where the NSW WQOs for receiving waters are currently being met they will continue to be protected, and where the WQOs are not currently being met, the activities of the proposal would not worsen the environmental conditions.

Cumulative impacts

Cumulative impacts for other developments within the catchment of the proposal were assessed. These other projects comprise rail and road upgrades, solar and wind farms, and a gas pipeline. Provided that all these projects apply appropriate mitigation measures during construction, no cumulative impacts are expected during the construction phase. Due to the distributed nature and likely stable landforms for the operation of these projects, it is unlikely that there would be long term cumulative impacts.

Monitoring

Requirements for a monitoring program for surface water are outlined in this report. Monitoring is required to provide an on-going assessment of the potential impacts of the proposal on the identified surface water quality objectives.

1 Introduction

1.1 Purpose

The Future Freight Joint Venture (FFJV) was engaged by Australian Rail Track Corporation Ltd (ARTC) to undertake the surface water quality assessment in support of an Environment Impact Assessment (EIS) submission for the North Star to New South Wales (NSW)/Queensland (QLD) Border (NS2B) section of the Inland Rail project (the proposal). The proposal is a part of the Inland Rail program that will form a national freight network approximately 1,700 kilometres (km) in length from Melbourne to Brisbane. The NS2B section of Inland Rail consists of approximately 25 km of upgraded track between North Star and Whalan Creek, and 5 km of new track from Whalan Creek to the NSW/QLD border.

The objectives and scope of the surface water environmental assessment are in line with meeting the requirements of the NSW Planning and Environment Secretary's Environmental Assessment Requirements (SEARs) (DP&E 2018), as outlined in Section 1.2.

The surface water quality technical report includes a description of the surface water quality only, including an assessment of Water Quality Objectives (WQOs) pertaining to the use of surface waters, and the water quality triggers that have been established to protect these values. The water quality of the existing environment is described, and an assessment is made of the potential impacts of the proposal by application of a significance assessment. A separate technical report addresses impacts to hydrology and flooding (FFJV 2020b).

Potential short- and long-term impacts to local and regional surface water resources were assessed based on a review of the proposal's construction and operation. The results of the significance assessment, and recommended mitigation measures have been described, along with potential cumulative impacts.

1.2 Secretary's Environmental Assessment Requirements

The SEARs set out for the proposal identified key requirements in relation to surface water and hydrology. Table 1.1 identifies the requirements and where within the technical report the requirements have been addressed.

Table 1.1 Secretary's Environmental Assessment Requirements compliance

Desired performance outcome	**Item 8: Flooding, Hydrology and Geomorphology** The project minimises adverse impacts on property, public safety and the environment resulting from alteration of the water flow characteristics of watercourses and overland flowpaths. Where feasible, the project includes remedial measures to mitigate any adverse water flow impacts, geomorphological impacts or flood safety risks caused by the existing rail infrastructure within the project area. Construction and operation of the project avoids or minimises the risk of, and adverse impacts from, infrastructure flooding, flooding hazards, geomorphological impacts or dam failure.
Current guidelines	NSW Government's Floodplain Development Manual (Department of Natural Resources 2005) PS 07-003 New guideline and changes to Section 117 direction and EP&A Regulation on flood prone land Practical Consideration of Climate Change – Flood risk management guidelines (DECC 2007) Australian Disaster Resilience Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia (2017) AS/NZS 3100:2009 Risk Management – Principles and Guidelines

SEARs requirement	EIS section
Item 8.1 The Proponent must:	
(d) assess the existing hydrology, geomorphology and flooding characteristics of all watercourses within and adjacent to the project area. This includes locating and assessing flowpaths emanating from existing culverts, pipes and bridges under the rail formation, or from overtopping of the existing formation in large storms;	Section 5.4 Table 5.1 also refer to Aquatic Biodiversity technical report (FFJV 2020a). The geomorphic assessment (utilising the AusRIVAS assessment methodology) is presented Section 4.3.1 of that report. Hydrology and Flooding technical report (FFJV 2020b), Section 8.2.4
(e) develop and justify quantitative design limits on potential adverse flooding, hydrological and geomorphological impacts resulting from the project. These are to consider land use and include afflux, velocity, extent, duration, hazard, scour potential, etc;	Section 6.2 Hydrology and Flooding technical report (FFJV 2020b), Section 8.2.5
(f) carry out geotechnical and geomorphological investigations to assess the propensity for scour, erosion and geomorphological changes to occur within any watercourses or overland flowpaths affected by the project;	Section 6.2

Desired performance outcome	**Item 9: Water – Hydrology** Long term impacts on surface water and groundwater hydrology (including drawdown, flow rates and volumes) are minimised. The environmental values of nearby, connected and affected water sources, groundwater and dependent ecological systems including estuarine and marine water (if applicable) are maintained (where values are achieved) or improved and maintained (where values are not achieved). Sustainable use of water resources.
Current guidelines	Biodiversity Assessment Method (OEH 2017) Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Volume 2 (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (DECC 2008) NSW Aquifer Interference Policy (DPI 2012) NSW Sustainable Design Guidelines Version 4.0 (TfNSW 2017) Risk assessment Guidelines for Groundwater Dependent Ecosystems (Office of Water 2012)

SEARs requirement	EIS section
Item 9.1 The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project, including stream orders, as per the Biodiversity Assessment Method.	Aquatic Biodiversity technical report (FFJV 2020a), Section 4. 1
Item 9.2 The Proponent must prepare a detailed water balance for ground and surface water including the proposed intake and discharge locations, volume, frequency and duration, sources, security and licensing requirements.	Section 6.1.1
Item 9.3 The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including:	Section 6 and Section 7
(a) natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge;	Section 6.1.2, Section 6.1.3, Section 7.2 and Section 7.3

SEARs requirement	EIS section
(b) impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement;	Groundwater technical report (FFJV 2020c), Section 9.2
(c) changes to environmental water availability and flows, both regulated/licensed and unregulated/rules-based sources;	Section 6.1.1
(d) direct and indirect increases in erosion, siltation, destruction or riparian vegetation or a reduction in the stability of river banks or watercourses;	Section 6.1.2
(e) minimising the effects of proposed stormwater and wastewater management during construction and operation on natural hydrological attributes (such as volumes, flow rates, management methods and re-use options) and on the conveyance capacity of existing stormwater systems where discharges are proposed through such systems; and	Section 6.1.2, Section 6.1.3 and Section 7.2
(f) water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction and operation.	Section 6.1.1
Item 9.4 The Proponent must identify any requirements for baseline monitoring of hydrological attributes.	Section 7.3

Desired performance outcome	**Item 10: Water – Quality** 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).
Current guidelines	NSW Water Quality and River Flow Objectives Using the ANZECC Guidelines and Water Quality Objectives in NSW (DEC 2006) Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ ARMCANZ 2000) Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DECC 2008) Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Volume 2 (A. Installation of Services; B. Wte Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (DECC 2008)

SEARs requirement	EIS section
Item 10.1 The Proponent must:	
(a) state the ambient NSW Water Quality Objectives (WQOs) 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;	Section 3.2
(b) 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;	Section 6.1.2, Section 6.1.3, and Section 7.2.2
(c) identify the rainfall event that the water quality protection measures will be designed to cope with;	Section 6.2 and Section 7.2.2
(d) assess the significance of any identified impacts including consideration of the relevant ambient water quality outcomes;	Sections 7.1 and Section 7.2
(e) demonstrate how construction and operation of the project will, to the extent that the project can influence, ensure that: - where the NSW WQOs for receiving waters are currently being met they will continue to be protected; and - where the NSW Water Quality Objectives are not currently being met, activities will work toward their achievement over time;	Section 7.2.1, Section 7.2.2, and Section 7.3
(f) justify, if required, why the WQOs cannot be maintained or achieved over time;	Section 5.13 and Section 7.2

SEARs requirement	EIS section
(g) demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented;	Section 7.2.1 Section 7.2.2
(h) identify sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments; and	Section 5.7 Chapter 11 Biodiversity Section 11.5.1, Section 11.5.4, and Section 11.6.2
(i) identify proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality.	Section 7.3

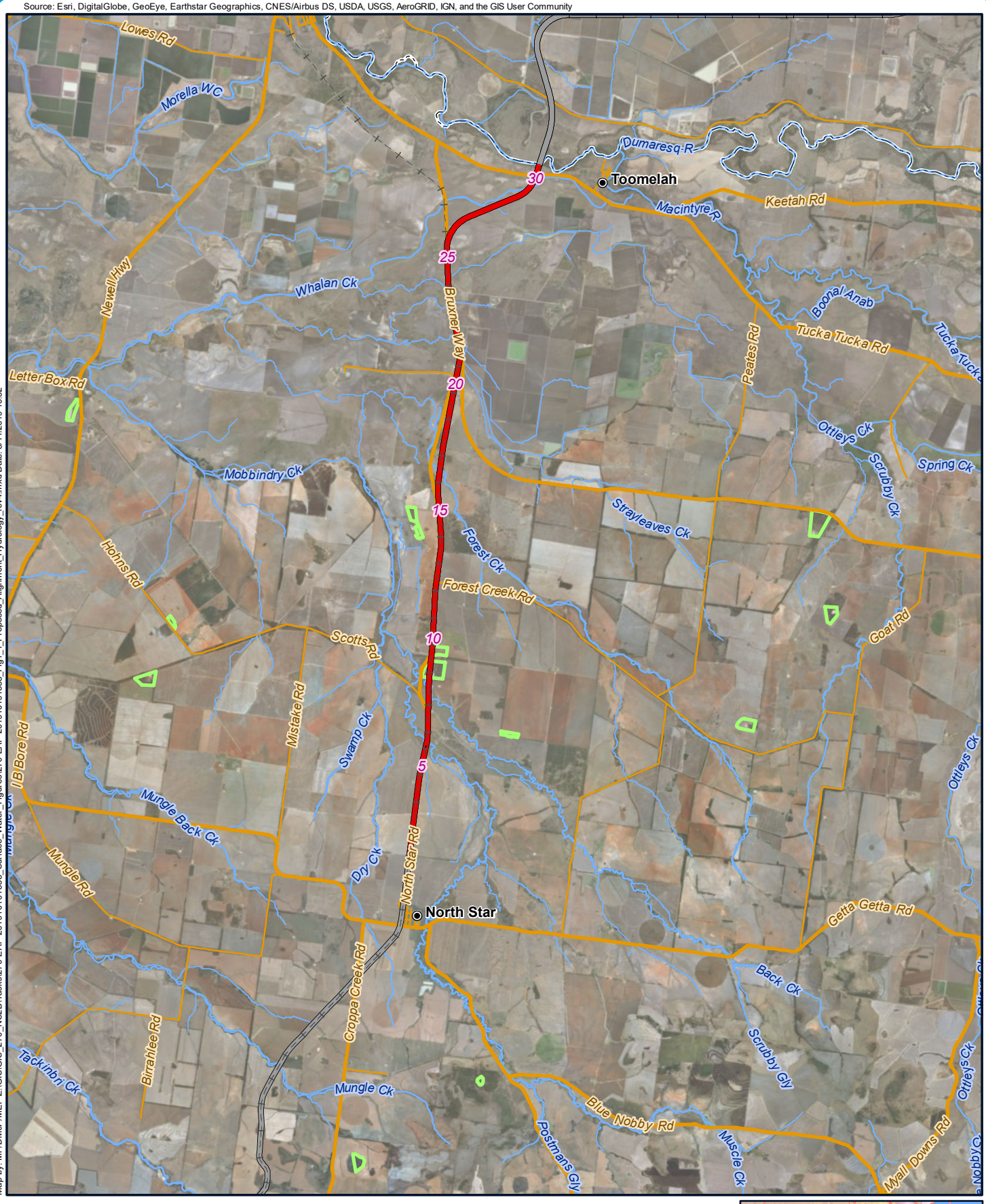
1.3 Overview of surface water environment

The proposal site falls within the Border Rivers catchment management area of NSW. This catchment is one of the northern most catchments within the Murray-Darling Basin and is made up of a group of rivers straddling the NSW/QLD border. The rivers of the catchment start at the Great Dividing Range and run westward, gradually merging to become the Barwon River about 150 km downstream of the proposal. The proposal site was based on a 1 km buffer extending horizontally from both sides of the proposed alignment, as such, increasing the extent where multiple design options exist to account for an increased investigation area. The proposal site was established to delineate the spatial extent of potential intersection of watercourses with temporary and permanent impact footprints of the proposal.

A number of watercourses and waterbodies occur within the proposal site (refer Figure 1.1). This includes the following watercourses which are classified for fish passage through the Policy-and-guidelines-for-fish-habitat NSW (2013):

- The Macintyre River which is a perennial waterway within the proposal site with a well vegetated riparian flood plain on either side of the river, it has high ecological value as a Class 1 Major Fish habitat and is known to support threatened species such as the Murray Cod (*Maccullochella peelii*), Silver Perch (*Bidyanus bidyanus*) and Purple-Spotted Gudgeon (*Mogurnda adspersa*)..
- Whalan Creek which is an ephemeral waterway, larger than other creeks in the area and with a well-defined channel that is likely to flow seasonally, it is mapped as Class 2 Moderate Fish habitat and is known to support fish populations
- Mobbindry Creek and Back Creek which are ephemeral waterways with well-defined channels with fringing rushes and sedges present, both waterways are mapped as Class 4 Unlikely fish habitat
- Forest Creek which is an ephemeral, highly modified waterway with a poorly defined channel and limited or poor riparian vegetation, it is classified as Class 4 Unlikely fish habitat
- An unnamed tributary of Mobbindry Creek, which is ephemeral, it is classified as Class 4 Unlikely fish habitat.

There is one Endangered Ecological community listed under the *Biodiversity Conservation Act 2016* (NSW): The Darling River Endangered Ecological Community.



Future Freight
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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 1.1: Watercourses associated with the North Star to Border railway proposal alignment

1.4 Sensitive environmental areas

The following section provides a summary of sensitive environmental areas known within the proposal site. Within the current proposal, sensitive environmental areas are wetlands areas, identified fish habitat and groundwater dependent areas within receiving waters.

1.4.1 Endangered Ecological Communities

The Darling River Endangered Ecological Community is sensitive to impacts with the following listed as key threatening processes for the community: degradation of the riparian zone, clearing of vegetation and the use of chemicals which impact on water quality. These impacts have the potential to occur during the construction phase of the proposal, with some continuing risk during operation (refer Section 6.1). Impacts to the Darling River EEC are considered in detail in the Aquatic Biodiversity technical report prepared for the North Star to NSW/QLD Border EIS (FFJV 2020a).

2 Legislation, policy, standards and guidelines

2.1 Commonwealth and state legislation

This section describes the legislative, policy and management framework for the proposal with regards to surface water, including:

- Legislative framework which applies to the assessment of surface water applicable to the proposal at the Commonwealth, State and local levels, and provides the statutory context for which the surface water assessment has been undertaken
- Discusses statutory approvals that may be required as a result of potential impacts to surface water quality, based on consideration of the overall approvals pathway for the proposal
- Discusses ARTC's existing management plans and protocols, and their relevance to the proposal

An overview of the Commonwealth and State legislation that is relevant to the proposal, outlining the intent of the legislation and applicability to the proposal is presented in Table 2.1.

Table 2.1 Summary of legislation and policies

Legislation and policy	Intent	Relevance to the proposal
Commonwealth		
Water Act 2007 (Cth)	Provides the legislative framework for ensuring that the Murray-Darling Basin, as Australia's largest water resource, is managed in the national interest.	This Act applies to the proposal as it occurs within the Murray Darling Basin
State		
Water Management Act 2000 (NSW)	Establishes a statutory framework for the sustainable and integrated management of water in NSW. This Act applies to the proposal as the protection, enhancement and restoration of water resources is recognised as a key objective of the Act and this needs to be considered in the design process. The key objectives are as follows: ■ To apply the principles of ecologically sustainable development ■ To protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality ■ To recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including – Benefits to the environment – Benefits to urban communities, agriculture, fisheries, industry and recreation – Benefits to culture and heritage – Benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water ■ To recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources ■ To provide for the orderly, efficient and equitable sharing of water from water sources ■ To integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna	This Act applies to the proposal as the protection, enhancement and restoration of water resources is recognised as a key objective of the Act and this needs to be considered in the design process and implemented during the proposal. The main instruments applied to meet these objectives are the Water Management (General) Regulation 2018, Water Sharing Plans and the NSW Aquifer Interference Policy which are discussed further below.

Legislation and policy	Intent	Relevance to the proposal
	▪ To encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users ▪ To encourage best practice in the management and use of water.	
Water Act 1912 (NSW)	The *Water Act 1912* is gradually being phased out across NSW and replaced by the *Water Management Act 2000*. The *Water Act 1912* is relevant where there an activity leads to a take from a groundwater or surface water source not currently covered by a Water Sharing Plan.	As Water Sharing Plans already apply to the proposal site, the *Water Act 1912* does not apply
Water NSW Act 2014 (NSW)	Defines the functions and objectives of WaterNSW. The primary objectives relate to management of water supplies, supply of water with appropriate quality, ensure that works in catchments are managed to protect water quality and health etc.	This Act applies to the proposal as the Act tasks WaterNSW with the protection and enhancement of water quality in declared catchment areas, including in relation to works within catchments such as those proposed for this proposal.
Water Management (General) Regulation 2018 (NSW)	Details procedural, technical and licencing requirements under the *Water Management Act 2000.*	
Protection of the Environment Operations Act 1997 (NSW)	Provides enforcement powers to NSW EPA to penalise polluting activities that may impact on water quality. Key features of this legislation include: ▪ Protection of the environment policies ▪ Environment protection licensing ▪ Regulation of scheduled and non-scheduled activities: ▪ The NSW EPA is the regulatory authority for scheduled activities (activities declared under Schedule 1 of the *Protection of the Environment Operations Act 1997*) ▪ The NSW EPA is also the regulatory authority for non-scheduled activities, where activities are undertaken by a public authority.	The proposal will be a scheduled activity (railway systems activities under Schedule 1) during construction and an environment protection licence would be required for this activity.

2.2 Water quality guidelines

2.2.1 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) provide an agreed framework for assessing water quality in terms of whether the water is suitable for range of environmental values/water quality objectives (including human uses). The framework guides users through the necessary steps for planning and managing water quality and sediment quality. The guidelines provide detailed approaches, identifying indicators and values for selected indicators to protect management goals. The ANZECC (2000) guidelines have recently been revised as the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018). This assessment has been done in accordance with the SEARs, which makes specific reference to ANZECC (2000).

2.2.2 Australian Drinking Water Guidelines

The Australian Drinking Water Guidelines 2011 (National Health and Medical Research Council (NHMRC) and Natural Resource Management Ministerial Council (NRMMC) 2018) are intended to provide a framework for good management of drinking water supplies to ensure safety at point of use. They have been developed for use by the Australian community and all agencies with responsibilities associated with the supply of drinking water, including catchment and water resource managers, drinking water suppliers, water regulators and health authorities.

2.2.3 Guidelines for Managing Risks in Recreational Waters

The Guidelines for Managing Risks in Recreational Water. National Health and Medical Research Council (NHMRC 2008) were developed to provide a consistent approach to protecting the health of humans from threats posed by the recreational use of coastal, estuarine and fresh waters. Threats may include those with an artificial aspect, such as discharges of wastewater. These guidelines should be used to ensure that recreational water environments are managed as safely as possible so that as many people as possible can benefit from using the water.

These guidelines are not mandatory; rather, they have been developed as a tool for state and territory governments to develop legislation and standards appropriate for local conditions and circumstances. The aim of the guidelines is to encourage the adoption of a nationally harmonised approach for the management of the quality of coastal, estuarine and fresh waters used for recreation.

2.2.4 New South Wales Water quality objectives

For each catchment in NSW, the state government has endorsed the community's environmental values for water, known as WQOs. The NSW WQOs are the environmental values and long-term goals for consideration when assessing and managing the likely impact of activities on waterways. The WQOs provide goals that help in the selection of the most appropriate management options. The guiding principles are that:

- Where the WQOs are being achieved in a waterway, they should be protected, and
- Where the WQOs are not being achieved in a waterway, all activities should work towards their achievement over time.

The WQOs have indicators to assess whether current conditions of the waterways support the identified values and uses. The Objectives are consistent with the national framework for assessment water quality as set out in the ANZECC/ARMCANZ 2000 (refer Section 2.2.1). The WQOs for NSW waterways refer to the ANZECC/ARMCANZ (2000) technical guidelines to assess the water quality to protect these values.

Twelve WQOs may be applied to waterways, depending on the categorisation of the waterway, and each is based on providing the right water quality for the environment and for the different uses people have for water. They are based on measurable environmental values for protecting aquatic ecosystems, recreation, visual amenity, drinking water and agricultural water. Noting this, objectives for water quality collected under the current proposal have been assessed using local catchment and NSW WQO objectives for the protection of aquatic systems for both uncontrolled streams and regulated watercourses. The WQO of protection of aquatic ecosystems is associated with the most stringent trigger values. Hence, the achievement of this WQO, would also mean that the other relevant WQOs within the proposal would be achieved. An exception was arsenic (V), where the more stringent Australian Drinking Water Guideline was applied ((NRMMC) 2018).

3 Methodology

3.1 Surface water quality assessment

3.1.1 Study area

The study area for the purposes of this surface water technical report includes the catchments through which the proposal is to be developed. The waterways are within the Border Rivers catchment. Specific focus is given to watercourses that cross the proposed alignment, which includes the Macintyre River, Whalan Creek, Mobbindry Creek, Back Creek, Forest Creek, and an unnamed tributary of Mobbindry Creek, (refer Figure 3.1).

3.1.2 Literature and database review

This section details the desktop analysis undertaken to identify existing information pertaining to the surface water quality values of the study area. Details of the relevant information sources, search area parameters and type of information considered for the desktop study are summarised in Table 3.1.

Table 3.1 Information review summary

Database/data source name	Database search areas	Data type
Watercourse Identification Mapping	Study area	Known extent of watercourses and drainage features (NSW Government Spatial Services 2018)
Climate data from the Bureau of Meteorology (BoM)	Study area	Includes climate data for the study area, including rainfall, evaporation and temperature data (BoM 2018a)
Water Resource Plans	Study area	Water Resource Plans which provide information on how water is managed and accessed in the water plan area (NSW Department of Industry 2018a)
Land use mapping	Study area	Land use mapping which identifies soil landscapes, land use patterns and changes
Groundwater dependent ecosystems (GDEs) from BoM	Study area	The GDE Atlas is a web-based mapping application of a national dataset of Australian GDEs (BoM 2018b)
Water Monitoring Information Portal	Study area	Streamflow and water quality data (WaterNSW 2018).
Water NSW Register	Study Area (Groundwater, regulated and unregulated watercourses)	Water Access Licences (Water Allocation). NSW Water Register (2018).

Details of the existing literature and previous study reports which have been reviewed for the desktop study are summarised in Table 3.2.

Table 3.2 Assessments and reports related to the proposal

Document title	Reference
North Star to NSW/QLD Border Project Study Area Selection Report	ARTC 2018
Melbourne to Brisbane Inland Rail, 2016 Phase 1 Continuity Alignment Report, North Star to Yelarbon	WSP/PB 2017
Melbourne to Brisbane Inland Rail, 2016 Phase 2 Preparatory Alignment Assessment Report, North Star to Yelarbon	WSP/PB 2017a
Water resources and management overview, Border Rivers Catchment	NSW DPI 2012

3.1.3 Field assessment

The surface water quality field assessments have been designed to provide sufficient information (in conjunction with the desktop assessment outlined in Section 3.1.2) to produce a Surface Water Quality Technical Report, inform an EIS for the proposal and provide existing WQOs for the feasibility design. The data collection approach is consistent with what has been employed for the four Inland Rail alignments which occur within Queensland. The surface water quality field assessment methodology is described in further detail below.

3.1.3.1 Assessment timing

The timing of water quality monitoring was constrained by the project timeframes. The baseline water quality monitoring occurred between 20 August and 25 August 2018 and consisted of one monitoring round carried out. It was initially proposed that two monitoring rounds be conducted between September and October 2018 however the surveys found that the majority of the proposed water quality sampling sites were dry and there was little to no rain after the August survey was undertaken, therefore a repeat round of monitoring was not considered to be feasible within the timeframe of the EIS process. The area had been declared as drought affected in August 2018 (NSW DPI 2018c).

3.1.3.2 Assessment sites

The surface water quality monitoring locations are presented in Table 3.3 and illustrated in Figure 3.1. These locations are the same as the aquatic ecology field survey sites and monitoring data was collected for both surface water and aquatic ecology at the same time. The location of these sites was initially identified during a gap analysis conducted as part of the desktop assessment for the proposal. Sites were located to target watercourses which cross the proposal site, with additional sites located upstream and downstream of the proposal site. The location of the monitoring sites was refined in the field, following ground truthing of the watercourse alignment and confirmation of land access being granted for the field survey. Some potential sites were not investigated due to access restrictions.

Table 3.3 Aquatic ecology and surface water quality field assessment sites

Site ID	Waterway	Location and distance (m, +/-100m) in relation to proposal site	Site location		
			Zone	Easting	Northing
Site 1	Mobbindry Creek	A (0)	56 J	246684.00 m E	6803707.00 m S
Site 2	Mobbindry Creek	D/S (2000)	56 J	245894.00 m E	6804807.00 m S
Site 3	Mobbindry Creek	U/S (1600)	56 J	247113.00 m E	6803292.00 m S
Site 4	Back Creek	A (0)	56 J	246781.00 m E	6806005.00 m S
Site 5	Back Creek	D/S (750)	56 J	246424.00 m E	6806400.00 m S
Site 6	Back Creek	U/S (1150)	56 J	247098.00 m E	6805323.00 m S
Site 7	Whalan Creek	D/S (3550)	56 J	247409.00 m E	6824885.00 m S
Site 8	Whalan Creek	A (0)	56 J	250661.00 m E	6825475.00 m S
Site 9	Whalan Creek	U/S (1150)	56 J	251714.00 m E	6825686.00 m S
Site 10	Macintyre River	A (0)	56 J	251053.00 m E	6826350.00 m S
Site 11	Macintyre River	U/S (1500)	56 J	251883.00 m E	6826097.00 m S
Site 12	Macintyre River	D/S (1100)	56 J	249936.00 m E	6826516.00 m S
Site 13	Unnamed tributary of Mobbindry Creek	A (0)	56 J	246495.00 m E	6802878.00 m S
Site 14	Unnamed tributary of Mobbindry Creek	U/S (1700)	56 J	246779.00 m E	6801163.00 m S
Site 15	Unnamed tributary of Mobbindry Creek	D/S (550)	56 J	246277.00 m E	6803590.00 m S

Site ID	Waterway	Location and distance (m, +/-100m) in relation to proposal site	Site location		
			Zone	Easting	Northing
Site 16	Forest Creek	A (0)	56 J	247179.00 m E	6814447.00 m S
Site 17	Forest Creek	U/S (1250)	56 J	247672.00 m E	6813616.00 m S
Site 18	Forest Creek	D/S (550)	56 J	246835.00 m E	6814875.00 m S

Table note:

A, D/S & U/S denotes 'Alignment, Downstream and Upstream', respectively.

It was not possible to collect water samples from all 18 locations during the August sampling round due to many being dry and/or inaccessible at the time of the site visit. As a result, water quality samples were collected from the following sites only:

- Site 5 (Back Creek)
- Site 11 (Macintyre River)
- Site 12 (Macintyre River)
- Site 16 (Forest Creek).

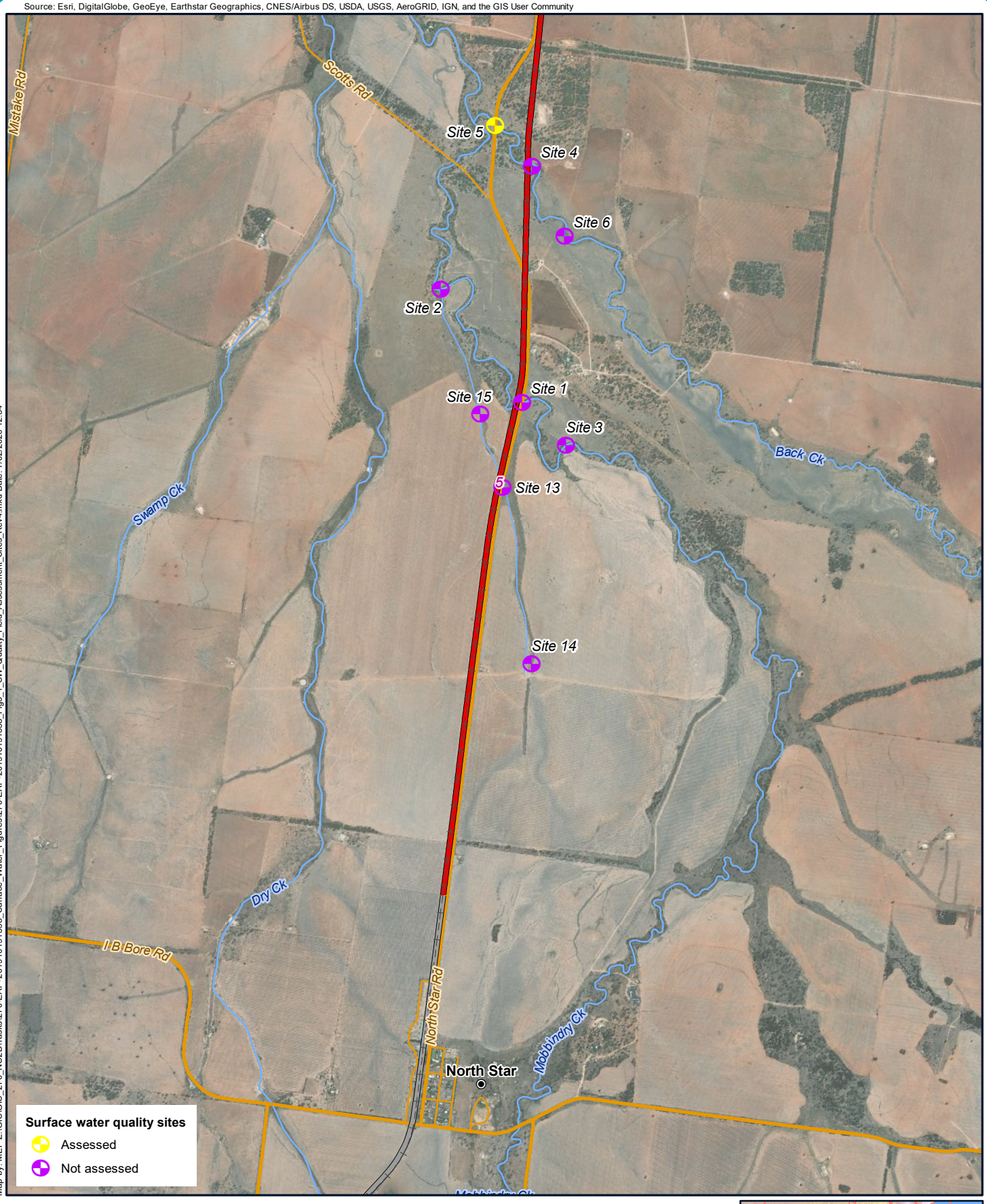
3.1.3.3 In situ analysis of surface water quality

A fully serviced and calibrated YSI Professional Plus water quality meter and a TPS WP-88 Turbidity Meter were employed to record the following in situ water quality parameters:

- pH
- Temperature
- Electrical conductivity (actual and specific)
- Dissolved oxygen (dissolved and saturated)
- Turbidity.

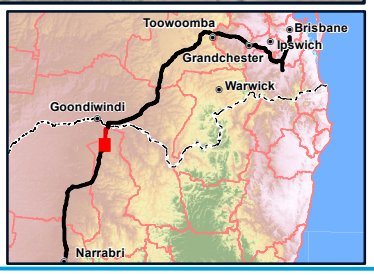
Additionally, the following qualitative data was recorded:

- Time
- Water flow (none/low/mod/high/flood/dry)
- Water clarity (clear/slight/turbid/opaque/other)
- Odour (normal/sewage/hydrocarbon/chemical)
- Surface condition (none/dust/oily/leafy/algae)
- Algae cover (none/some/lots)
- Other visual observations/comments (colour, fish, presence of litter).



Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Existing rail (non-operational)
- North Star to NSW/QLD border alignment
- Adjoining alignments
- Major roads
- Minor roads
- Watercourses



A4 scale: 1:50,000

0 0.3 0.6 0.9 1.2 1.5km

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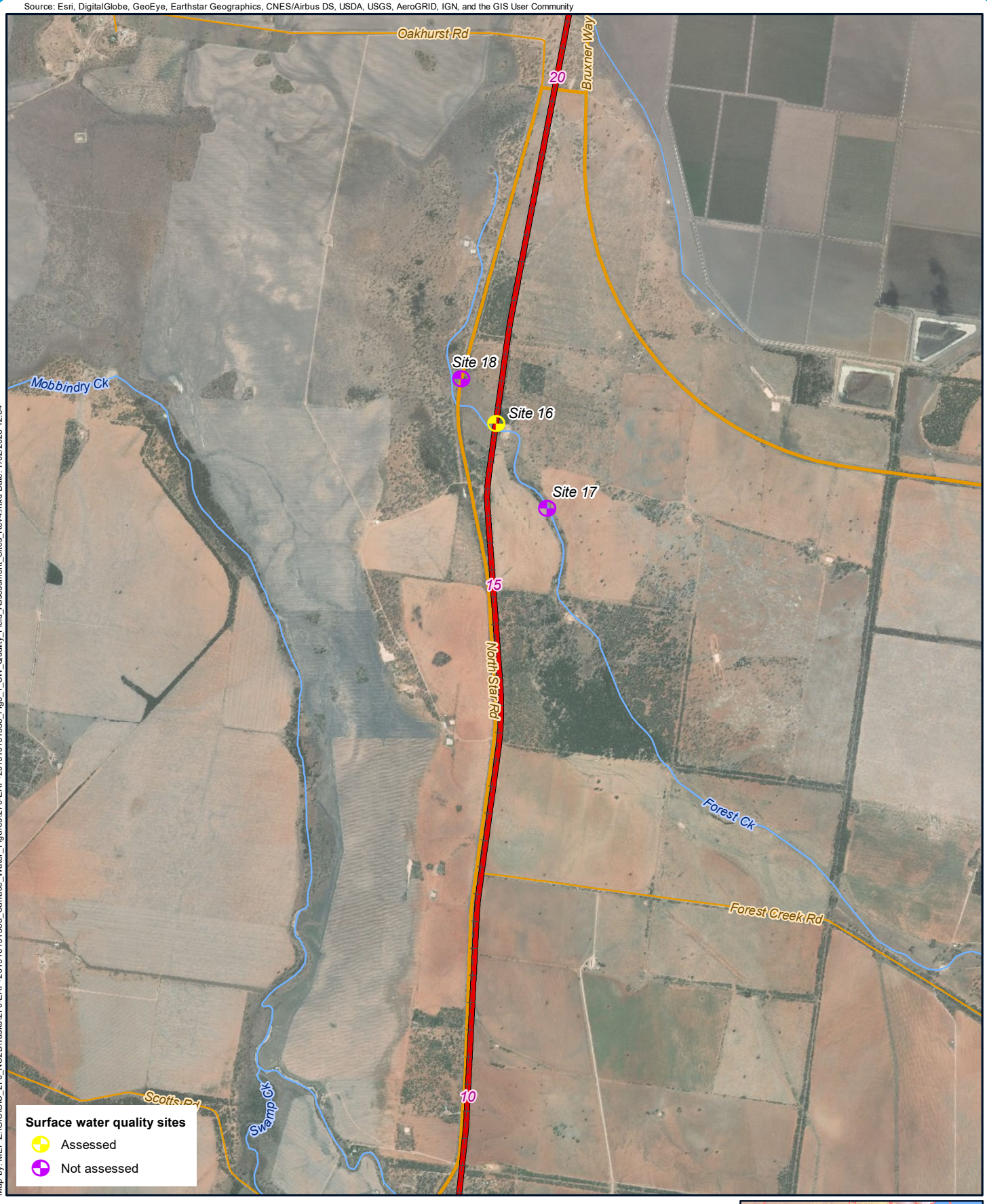
Coordinate System: GDA 1994 MGA Zone 56

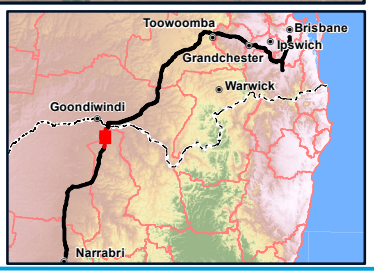
North Star to NSW/QLD border

Figure 3.1a: Surface water quality field assessment sites



Legend

- 5 Chainage (km)
- Existing rail (non-operational)
- North Star to NSW/QLD border alignment
- Major roads
- Minor roads
- Watercourses



A4 scale: 1:50,000

0 0.3 0.6 0.9 1.2 1.5km

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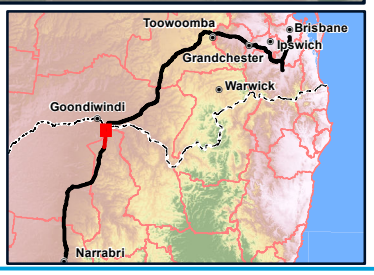
North Star to NSW/QLD border

Figure 3.1b: Surface water quality field assessment sites

Legend

- 5 Chainage (km)
- Existing rail (non-operational)
- North Star to NSW/QLD border alignment
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border



A4 scale: 1:50,000

0 0.3 0.6 0.9 1.2 1.5km

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.1c: Surface water quality field assessment sites

3.1.3.4 Collection of water samples

In situ water quality field data was collected each monitoring round in addition to samples collected for laboratory analysis. All in situ water quality field data and laboratory samples were collected by a suitably qualified and experienced environmental scientist.

Surface water quality samples were collected in accordance with industry-accepted standards and quality assured procedures, including the Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DECC 2008). Where possible, surface water samples were collected from the centre of the watercourse, where the velocity was the highest. The mouth of the sampling container was held above the base of the channel to avoid disturbing or collect any settled solids or materials.

The surface water samples were collected directly into the appropriate laboratory-supplied sampling bottles to avoid potential contamination associated with the use of intermediate containers. Where a sampling pole was required to be used to enable safe sample collection, the sampling bottle was placed on the pole and the sample was collected directly into the sampling bottle. Syringes and filters were flushed with water from the sampling site prior to use.

The surface water samples were placed directly into a clean, insulated box and kept cool via the use of ice and freezer blocks.

A photograph and the GPS point were collected from each sampling site.

3.1.3.5 Laboratory analysis of surface water quality

Surface water samples were collected at each monitoring location listed in Table 3.3 and submitted to a National Association of Testing Authorities (NATA) accredited laboratory (Eurofins) for analysis of the following water quality parameters:

- pH (Limit of Reporting (LOR) – 0.1 pH units)
- Suspended solids (LOR – 1 mgL^{-1})
- Turbidity (LOR – 1 NTU)
- Total phosphorus (LOR – 0.01 mgL^{-1})
- Reactive phosphorus (LOR – 0.01 mgL^{-1})
- Speciated nitrogen (ammonia (LOR – 0.01 mgL^{-1}), nitrate (LOR – 0.02 mgL^{-1}), nitrite (LOR – 0.02 mgL^{-1}), organic nitrogen (LOR – 0.2 mgL^{-1}), total kjeldahl nitrogen (LOR – 0.2 mgL^{-1}), total nitrogen (LOR – 0.2 mgL^{-1}))
- Dissolved metals (field filtered): arsenic (V) (LOR – 0.001 mgL^{-1}), cadmium (LOR – 0.0002 mgL^{-1}), chromium (VI) (LOR – 0.001 mgL^{-1}), copper (LOR – 0.001 mgL^{-1}), lead (LOR – 0.001 mgL^{-1}), mercury (LOR – 0.0001 mgL^{-1}), nickel (LOR – 0.001 mgL^{-1}), zinc (LOR – 0.005 mgL^{-1})
- Salinity (LOR – 20 mgL^{-1})
- Electrical conductivity (LOR – 1 μscm^{-1})
- Chlorophyll a (LOR – 5 ugL^{-1})
- Polycyclic aromatic hydrocarbons (universal LOR – 0.001 mgL^{-1}).

One duplicate sample was collected per sampling event for Quality Assurance/Quality Control (QA/QC) purposes.

For water quality parameters collected in-situ and analysed by the laboratory (pH, salinity and electrical conductivity) priority was given to the in-situ readings as these would be considered more representative of field conditions.

3.1.4 Assessment of results

Field and laboratory results were compared against WQOs and trigger values for the Border Rivers (NSW DPI 2006). The Border Rivers trigger values were developed by NSW DPI (2006) from relevant criteria from the following guidelines:

- ANZECC and ARMCANZ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000):
  - Slightly-moderately disturbed ecosystems (freshwater) criteria were used based on identified catchment values and condition
  - Irrigation (long-term values and short-term values) criteria
  - Livestock watering criteria
- National Health and Medical Research Centre:
  - Australian Drinking Water Guidelines (2011) – updated August 2018 (NRMMC 2018)
- Water quality objectives and assessment of surface water quality monitoring results against the relevant WQOs are discussed in further detail in Section 3.2.

3.2 Water quality objectives

Water quality objectives have been developed for each NSW Catchment Management Authority and associated waterways and waterbodies based on community values and uses for the area (refer Section 2.2.4), as well as local conditions and waterway characteristics. Achieving each WQO is required to maintain existing good water quality, where present.

3.2.1 Border Rivers catchment

The proposal site falls within the Border Rivers catchment; WQOs for the communities using the rivers within the catchment have been identified. These objectives included the provision of water for uses such as drinking water, recreation, agriculture, domestic uses and conservation. The identified objectives are dependent on the local waterway categorisation, which in turn are dependent on the characteristics of the waterway.

The WQOs for uncontrolled streams and for major regulated rivers are shown in Table 3.4.

Table 3.4 Water quality objectives for waterways within the proposal site

Objective	Uncontrolled streams[1]	Major regulated rivers[1]
The protection of:	■ Aquatic ecosystems ■ Visual amenity ■ Secondary contact recreation ■ Primary contact recreation ■ Livestock water supply ■ Irrigation water supply ■ Homestead water supply ■ Drinking water at point of supply – Disinfection only ■ Drinking water at point of supply – Clarification and disinfection ■ Drinking water at point of supply – groundwater ■ Aquatic foods (cooked)	■ Aquatic ecosystems ■ Visual amenity ■ Secondary contact recreation ■ Primary contact recreation ■ Livestock water supply ■ Irrigation water supply ■ Homestead water supply ■ Drinking water at point of supply – Disinfection only ■ Drinking water at point of supply – Clarification and disinfection ■ Drinking water at point of supply – groundwater ■ Aquatic foods (cooked)

Table note:

1 The Macintyre River is the only major regulated river affected by the proposal.

Source: NSW DPI 2006

3.2.2 Water quality trigger values

Local water quality varies naturally due to a variety of factors including the soils and slopes of the surrounding land, rainfall patterns, runoff patterns, different land uses and different land management practices. For this reason, the ANZECC/ARMCANZ 2000 require that water quality criteria be determined according to the local conditions using local reference data and risk-based decision frameworks and this has been implemented through catchment WQOs.

The majority of the creeks and rivers that the proposal site crosses (excluding the Macintyre River) are classified as 'Uncontrolled streams' within the Border Rivers catchment. This category covers waterways that are not in the other categories such as town supply sub-catchments, streams in mainly forested areas and waterways affected by urban development.

The Macintyre River is the only river that the proposal site will cross that is not considered an Uncontrolled Stream and is classified as a 'Major Regulated River' for catchment management purposes. This category applies to rivers that have large dams supplying irrigation water for substantial distances downstream. Flows are supplemented by releases from dams during the irrigation season leading to fairly stable and unnaturally high water levels. River flow is substantially reduced during the non- or low-irrigation seasons.

As indicated in Section 2.2.4, local water quality trigger values for the watercourses proximal to the proposal were selected to confer the highest protective status (protection of aquatic ecosystems). Regional water quality thresholds for the proposal were sourced from the NSW and Queensland Border Rivers catchment plans (due to the river requiring inter-state department management, and Macintyre River specific-management objectives produced by Queensland (refer Table 3.5 and Table 3.6).

Table 3.5 Water quality trigger values for the protection of aquatic ecosystems applicable to the proposal (*italicised* values expressed as 50th percentile (median) of test data, respectively)

Sub-catchment	Management intent	Secchi depth (m)	Turbidity (NTU)	Total P (µg/L)	FRP (µg/L)[4]	Chlorophyll-*a* (µg/L)	Total N (µg/L)	Oxidised Nitrogen (µg/L)	Ammonium N (µg/L)	Dissolved Oxygen (% saturation)	pH	TSS[3] (mg/L)	Conductivity (µS/cm)
Mobbindry Creek (Sites 1-3, 13-15)	Moderately disturbed – aquatic ecosystems[1]	n/a	6-50	50	20	5	500	60	20	85-110%	6.5-8.5	25	125-2200
Back Creek (Sites 4-6)	Moderately disturbed – aquatic ecosystems[1]	n/a	6-50	50	20	5	500	60	20	85-110%	6.5-8.5	25	125-2200
Whalan Creek (Sites 7-9)	Moderately disturbed – aquatic ecosystems[1]	n/a	6-50	50	20	5	500	60	20	85-110%	6.5-8.5	25	125-2200
Mid Macintyre[1] (Sites 10-12)	Moderately disturbed[2]	n/a	*30*	*70*	*20*	*3*	*575*	*10*	*20*	65-110% >5.0 mg/L	*7.4-8.0*	*25*	*245*
Forest Creek (Sites 16 – 21)	Moderately disturbed – aquatic ecosystems[1]	n/a	6-50	50	20	5	500	60	20	85-110%	6.5-8.5	25	125-2200

Table notes:

1 Source: NSW Water Quality Objectives (Border Rivers Objective) and ANZECC/ARMCANZ 2000 Guidelines. Lowland river objectives applicable.
2 Source: Draft water Quality Objectives for Queensland Murray-Darling Basin – Border Rivers Basin (Macintyre – Barwon Floodplain catchment waters – low flow) Sourced from HWMP and MDB Plan targets – all but DO% from HWMP [health waterway management plan]
3 Total Suspended Solids (TSS) thresholds for watercourses other than Macintyre, as per Macintyre catchment waters
4 FRP Water quality trigger values are below LOR for laboratory analysis

Table 3.6 Water quality trigger values for 95 per cent level of species protection for heavy metals and other toxic contaminants for the proposal (Border Rivers Catchment)

Sub-catchment	Arsenic (V)[2] (µg/L)	Cadmium[1] (µg/L)	Chromium (VI)[1] (µg/L)	Copper[1] (µg/L)	Lead[1] (µg/L)	Mercury (µg/L)[3]	Nickel[1] (µg/L)	Zinc[1] (µg/L)	Naphthalene[1] (µg/L) (PAH)
Mobbindry Creek (Sites 1-3, 13-15)	10	0.2	1.0	1.4	3.4	0.06	11	8.0	16
Back Creek (Sites 4-6)	10	0.2	1.0	1.4	3.4	0.06	11	8.0	16
Whalan Creek (Sites 7-9)	10	0.2	1.0	1.4	3.4	0.06	11	8.0	16
Mid Macintyre[1] (Sites 10-12)	10	0.2	1.0	1.4	3.4	0.06	11	8.0	16
Forest Creek (Sites 16 – 21)	10	0.2	1.0	1.4	3.4	0.06	11	8.0	16

Table notes:

1 Trigger values applies to moderately disturbed watercourses Source: NSW Water Quality Objectives (Border Rivers Objective) and ANZECC/ARMCANZ 2000 Guidelines. Lowland river objectives applicable
2 For arsenic (V), the more stringent Australian Drinking Water Guideline was applied ((NRMMC) 2018); 10 µg/L in place of ANZECC's 13 µg/L
3 Species level protection set at 99 per cent to account for potential bioaccumulation

3.3 Impact assessment methodology

The surface water quality assessment of the proposal uses a significance-based impact assessment framework to identify and assess impacts in relation to environmental receptors.

For the purpose of assessment, a significant impact depends upon the sensitivity of the surface water value, the quality of the environment which is impacted, and upon the intensity, duration, magnitude and potential spatial extent of the potential impacts. Determination of the sensitivity or vulnerability of the surface water value/receptor and the magnitude of the potential impacts facilitate the assessment of the significance of potential surface water impacts. The following sections discuss and define impact magnitudes, receptor sensitivity and impact significance.

3.3.1 Magnitude of impacts

The magnitude of a potential impact is essential to the determination of its level of significance on sensitive values/receptors. For the purposes of this assessment, impact magnitude is defined as being comprised of the nature and extent of the potential impacts, including direct and indirect impacts. The impact magnitude is divided into five categories (refer Table 3.7). The magnitude of impacts is determined using an estimation of the extent, duration and frequency of the impacts.

Table 3.7 Criteria for magnitude

Magnitude	Description
Major	An impact that is widespread, **permanent** and results in substantial irreversible change to the environmental value. Avoidance through appropriate design responses or the implementation of environmental management controls are required to address the impact.
High	An impact that is widespread, **long lasting** and results in substantial and possibly irreversible change to the environmental value. Avoidance through appropriate design responses or the implementation of site-specific environmental management controls are required to address the impact.
Moderate	An impact that extends beyond the area of disturbance to the surrounding area but is contained within the region where the proposal is being developed. The impacts are **short term** and result in changes that can be ameliorated with specific environmental management controls.
Low	A localised impact that is **temporary** or **short term** and either unlikely to be detectable or could be effectively mitigated through standard environmental management controls.
Negligible	An extremely localised impact that is barely discernible, and is effectively mitigated through standard environmental management controls.

Table 3.8 Timeframes for duration terms

Duration term	Timeframe – to be defined for each receptor type if required
Temporary	Days to months (e.g. 1 to 2 seasons; 3 to 6 months)
Short term	Up to 1 year (i.e. 6 to 12 months)
Medium term	From 2 to 10 years[1]
Long term/long lasting	From 11 to 20 years[2]
Permanent or irreversible	More than 21 years[3]

Table notes:

1 Derived from the term 'moderate' EAM Risk Management Framework 2009 (GBRMPA 2009)
2 Derived from the term 'major' EAM Risk Management Framework 2009 (GBRMPA 2009)
3 Derived from the term 'catastrophic' EAM Risk Management Framework 2009 (GBRMPA 2009)

3.3.2 Sensitivity

To assess the significance of potential impacts on sensitive values/receptors, sensitivity categories are applied to each of the features. The sensitivity categories are split into five discrete groups as described in Table 3.9. These groupings are based on qualitative assessments utilising information related to the sensitivity of the receptor, in addition to the potential of a sensitive receptor's occurrence within the receiving environment.

Through the determination of sensitivity categories for each of the values/receptors, the features are then able to be assessed through a matrix against the magnitude of the potential impact type to indicate the level of significance for each of the impact types on the values/receptors.

Table 3.9 Sensitivity criteria for sensitive values/receptors within the study area

Sensitivity	Description
Major	■ The sensitive value is listed on a recognised or statutory state, national or international register as being of conservation significance and/or ■ The sensitive value is entirely intact and wholly retains its intrinsic value and/or ■ The sensitive value is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region, state, country or the world and/or ■ It has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the environmental value. ■ Proposal activities would have an adverse effect on the value.
High	■ The sensitive value is listed on a recognised or statutory state, national or international register as being of conservation significance and/or ■ The sensitive is intact and retains its intrinsic value and/or ■ The sensitive value is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region and/or ■ The sensitive value has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the sensitive value. ■ Proposal activities would have an adverse effect on the sensitive value.
Moderate	■ The sensitive value is recorded as being important at a regional level, and may have been nominated for listing on recognised or statutory registers and/or ■ The sensitive value is in a moderate to good condition despite it being exposed to threatening processes. It retains many of its intrinsic characteristics and structural elements and/or ■ The sensitive value is relatively well represented in the systems/areas in which it occurs, but its abundance and distribution are exposed to threatening processes and/or ■ Threatening processes have reduced the sensitive value's resilience to change. Consequently, changes resulting from proposal activities may lead to degradation of the prescribed value and/or ■ Replacement of unavoidable losses is possible due to its abundance and distribution.
Low	■ The sensitive value is not listed on any recognised or statutory register. It might be recognised locally by relevant suitably qualified experts or organisations e.g. historical societies and/or ■ The sensitive value is in a poor to moderate condition as a result of threatening processes, which have degraded its intrinsic value and/or ■ It is not unique or rare and numerous representative examples exist throughout the system/area and/or ■ It is abundant and widely distributed throughout the host systems/areas and/or ■ There is no detectable response to change or change does not result in further degradation of the environmental value and/or ■ The abundance and wide distribution of the sensitive value ensures replacement of unavoidable losses is achievable.
Negligible	■ The sensitive value is not listed on any recognised or statutory register and is not recognised locally by relevant suitably qualified experts or organisations and/or ■ The sensitive value is not unique or rare and numerous representative examples exist throughout the system/area and/or ■ There is no detectable response to change or change does not result in further degradation of the sensitive value.

3.3.3 Significance of impact

The significance of a potential impact is a function of the significance of the sensitive value and its sensitivity of the receptor/value and the magnitude of the potential impact. Although the sensitivity of the value/receptor will not change (i.e. is generally determined qualitatively by the interaction of the receptor's condition, adaptive capacity and resilience), the magnitude of the potential impact is variable and may be categorised quantitatively to facilitate the prediction of the significance of the potential impact.

Once the sensitive value/receptor has been identified, and the sensitivity of the value/receptor and the magnitude of the potential impact have been determined, this will facilitate the assessment of the significance of the potential impact through use of a five by five matrix (refer Table 3.10).

Following the identification of the level of significance, mitigation measures were then applied to the potential (unmitigated) impacts to identify the residual (mitigated) impacts. Significance categories as identified in Table 3.10 are defined in Table 3.11. Magnitude categories are defined in Table 3.7.

Table 3.10 Significance assessment matrix

Magnitude of impact	Sensitivity				
	Major	**High**	**Moderate**	**Low**	**Negligible**
Major	Major	Major	High	Moderate	Low
High	Major	Major	High	Moderate	Low
Moderate	High	High	Moderate	Low	Low
Low	Moderate	Moderate	Low	Negligible	Negligible
Negligible	Moderate	Low	Low	Negligible	Negligible

Table 3.11 Significance classifications

Significance rating	Description
Major	Arises when an impact will potentially cause irreversible or widespread harm to an environmental value that is irreplaceable because of its uniqueness or rarity. Avoidance through appropriate design responses is the only effective mitigation.
High	Occurs when the proposed activities are likely to exacerbate threatening processes affecting the intrinsic characteristics and structural elements of the environmental value. While replacement of unavoidable losses is possible, avoidance through appropriate design responses is preferred to preserve its intactness or conservation status.
Moderate	Results in degradation of the environmental value due to the scale of the impact or its susceptibility to further change even though it may be reasonably resilient to change. The abundance of the environmental value ensures it is adequately represented in the region, and that replacement, if required, is achievable.
Low	Occurs where an environmental value is of local importance and temporary or transient changes will not adversely affect its viability provided standard environmental management controls are implemented.
Negligible	Does not result in any noticeable change and hence the proposed activities will have negligible effect on environmental values. This typically occurs where the activities are located in already disturbed areas.

3.4 Cumulative impact assessment

Cumulative impacts are the successive, incremental and combined impacts of an activity, added to other existing or planned projects and activities (IFC 2013). The cumulative impact assessment (CIA) with regards to surface water quality was conducted based on the following principles:

- The CIA considered 'state significant' or 'strategic' projects outside of the proposal site that are in the public domain as being planned, constructed or operated at the time the SEARs for the proposal were finalised
- The Inland Rail projects immediately adjacent to the proposal have been included in the CIA

- The area of influence for the purposes of the CIA for surface water quality and surface water hydrology were defined by the hydrological catchment area for the proposal site
- A whole-of-program CIA has not been incorporated into the CIA
- Current operational projects and commercial or agricultural operations that are in the areas of influence around the proposal site, and considered in the CIA, are accounted for, where appropriate, in this technical baseline study
- The CIA is not retrospective. The CIA does not take into account impacts from past land use (e.g. vegetation clearing). The environment at the time of the SEARS finalisation is the baseline for CIA.

The CIA process is summarised below:

- A list of applicable projects and operations for consideration in the CIA was prepared. Figure 3.2 illustrates the areas of spatial influence of the proposal being assessed in the CIA, demonstrating the overlap of potential cumulative impact with the projects and/or operations identified above
- The temporal impact zone of influence was identified via preparation of a timeline (illustrating construction and operational phases) which presents the temporal relationship between the proposal and the projects and/or operations identified above
- The CIA was conducted to determine the significance of cumulative impacts with respect to beneficial or detrimental effects.

3.5 Limitations of assessment

This report has been prepared based on publicly available information and field water sampling results. The description of existing surface water values in this report is primarily a desktop study with most of the data sources being publicly available. These data sources are supplemented by visual observations gained during the water quality sampling field investigations. As such, inherent limitations exist within the current assessment and should be noted.

Limited water quality water studies have been undertaken in regard to the proposal area, specifically in regard to water quality parameters beyond basic information obtained with watercourse-flow gauging.

Most notably, the limited time available for field sampling has coincided with drought conditions within the proposal area of interest, resulting in limitations to obtaining proposed water quality sampling. During sampling events, no base-flow was evident within most of the watercourses during the first round of monitoring, and no follow-up monitoring was conducted due to prolonged dry conditions continuing from the first round of monitoring. Noting this, median water quality data calculated from observations of Macintyre River, follow the field assessment of water quality values and indicate that the field assessment identified typical low flow conditions, as typically experienced within the catchment.

Given the limited water quality information available, further monitoring is recommended for the construction and operational phases as part of the proposal (refer Section 7.3).

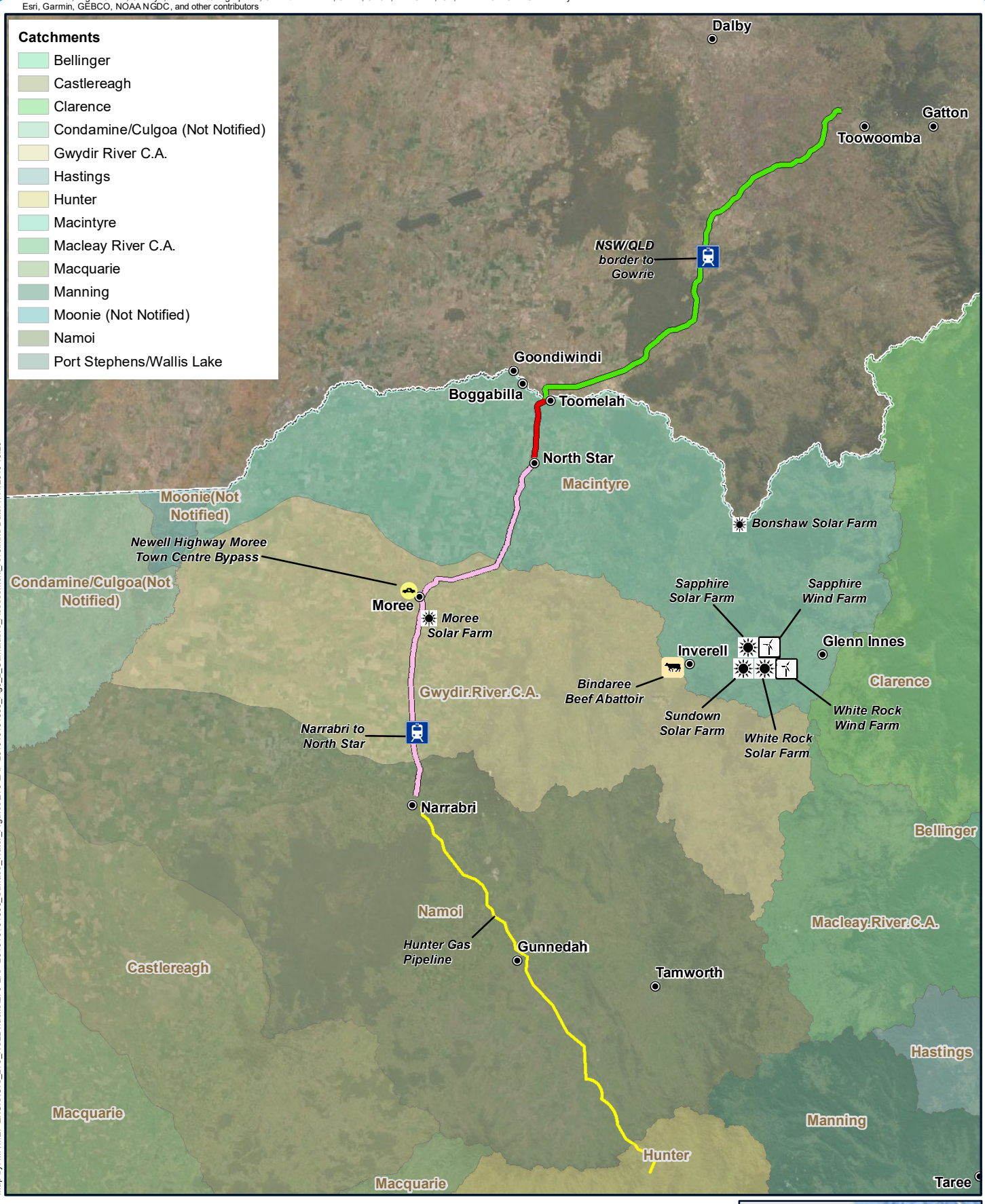


Figure 3.2: Area of spatial assessment subject to the proposal cumulative impact assessment for surface water quality

4 Proposal description

The Inland Rail route (refer Figure 4.1), which is approximately 1,700 km long, will involve:

- Using the existing interstate rail corridor through Victoria and southern NSW
- Upgrading approximately 400 km of existing corridor, mainly in western NSW
- Providing approximately 600 km of new corridor in northern NSW and southeast Queensland.

Inland Rail has been divided into 13 sections, 7 of which are located in NSW.

The proposal consists of the following key features:

- Twenty-five kilometres of new track within the existing, non-operational Boggabilla rail corridor, between North Star heading north towards Whalan Creek
- Approximately 5 km of new track within a greenfield rail corridor, between the greenfield deviation and the NSW/QLD border
- One crossing loop, one maintenance siding and three associated turn outs
- Waterway crossings including 13 bridges, 43 reinforced concrete pipe (RCP) locations (multiple cells in places) and seven reinforced concrete box culvert (RCBC) locations (multiple cells in places) are proposed. A 1,750 m long rail bridge is provided over the Macintyre River and Whalan Creek (an anabranch of the Macintyre River), which are major water courses.
- Sixty-three rail crossing locations, including six new grade separated crossings and eleven new level crossings
- Ancillary works including road and utility realignments, constructing rail maintenance access roads, fencing, signage, signalling enabling works and land acquisition.
- Construction phase facilities such as construction camp, laydown facilities and borrow pits.

4.1.1 Construction phase

Subject to approval of the proposal, land acquisitions are planned to occur between mid-2019 and late-2020. Following this, construction is planned to occur between 2021 and 2025.

4.1.2 Operational phase

Subject to approval of the proposal, construction of the proposal is planned to occur between 2021 and 2025 The proposal will be managed and maintained by ARTC; however, train services will be provided by a variety of operators. Trains will be double stacked (up to 6.5 m high) and operate on a 24/7 basis. Train services are not expected to commence until all 13 sections of Inland Rail are complete, which is planned to be in 2025.

The proposal will be trafficked by an estimated 14 trains per day in 2025, increasing to an estimated 21 trains per day in 2040. Annual freight tonnages will increase in parallel, from approximately 12 million tonnes per year in 2025 to 20 million tonnes per year in 2040.

The new track is designed to support double-stacked, 21 to 25 tonne axle load intermodal (i.e. container) trains up to 1,800 m long and 6.5 m high. Tonne axle load refers to the total weight felt by the track due to passing trains. Depending on the tonne axle load, train speeds will vary between 80 kilometres per hour (km/hr) and 115 km/hr. In addition, the new track footprint is future-proofed to accommodate 30 tonne axle load intermodal trains up to3,600 m long and 6.5 m high, travelling at 80 km/hr.

Figure 4.1 **Inland Rail alignment**

5 Description of existing conditions

5.1 Local government areas

The proposal site falls within the Moree-Plains Local Government Area (LGA) and the Gwydir LGA. The Moree-Plains LGA covers the area from the NSW and Queensland border to approximately 15 km south of Boggabilla at which point the Gwydir LGA starts.

5.2 Catchment areas

The proposal site falls within the Border Rivers catchment management area of NSW. This catchment is one of the northern most catchments within the Murray-Darling Basin and is made up of a group of rivers straddling the NSW/QLD border. The rivers of the catchment start at the Great Dividing Range and run westward, gradually merging to become the Barwon River.

The rivers and waterways within the catchment provide habitat for a range of native fish species including Murray Cod, Silver Perch and Purple-Spotted Gudgeon (refer Aquatic Biodiversity technical report prepared for the North Star to NSW/QLD Border EIS (FFJV 2020a)). The nationally significant Morella Watercourse, Boobera Lagoon and Pungbougal Lagoon are located on the Macintyre Floodplain within the catchment although this wetland is outside of the proposal site. These two significant lagoons are located approximately 30km downstream of the proposal alignment along the Morella Watercourse at 25 km and 12 km, respectively. Hydrological flow comparisons are presented within the Hydrology and Flooding technical report prepared for the North Star to NSW/QLD Border EIS (FFJV 2020b).

The catchment has the following characteristics:

- Climate is described as sub-tropical on the plains (i.e. the proposal site)
- Rainfall is summer dominant
- The area of the catchment where the proposal site is located is underlain by the Great Artesian Basin
- The Commonwealth Scientific and Industrial Research Organisation (CSIRO) reported in 2008 that 34 per cent of available surface water was extracted for use which was considered high in comparison with other catchments in the Murray-Darling Basin
- The Sustainable Rivers Audit Report (MDBA 2012) reported that the overall health of the rivers in the Border Rivers Catchment was poor. The hydrology of the river system was rated as good; the fish community, macroinvertebrate community and physical form was rated as moderate; and the riverine vegetation was rated as poor
- Land use in the catchment is dominated by extensive agriculture with approximately 67% of the catchment used for grazing and 18 per cent for dryland cropping. Approximately 2 per cent of the land has been developed for irrigation, mostly in the west of the catchment. Conservation and native vegetation account for 5 per cent of land use. (Murray Darling Basin Authority (MDBA) 2018)
- Surface water is used for stock watering, irrigation, drinking water, household use, recreation (primary and secondary) as well as for environmental and aesthetic purposes.

5.3 Climate

5.3.1 Context

The proposal site is located in northern NSW. This area is classified as sub-tropical using the Koppel classification (BoM 2018a).

5.3.2 Rainfall

The proposal site receives an average of 350 to 650 mm of rainfall each year with a low degree of variability. Rainfall is primarily received in summer with rain significantly increasing from October and the summer months averaging around 100 mm per month (Green et al 2012). The area has an average of 50 days a year with rainfall greater than 1 mm (BoM 2018). Monthly rainfall data was sourced from the New Kildonan TM (<5 km from the alignment) located downstream of the Dumaresq – Macintyre River confluence (BoM 2018c). Rainfall for 2018 was typically lower than the long-term average (2001-2017), with the first half of 2018 demonstrating rainfall typically below 75 per cent of typical rainfall. The preceding 3-month period before field assessment demonstrated rainfall at 10 per cent to 21 per cent of average rainfall (May to July 2018). The area had been declared as drought affected in August 2018 (NSW DPI 2018c).

5.3.3 Evaporation

The total average pan evaporation in the vicinity of the proposal is approximately 1,800 to 2,000 mm per annum (BoM 2018a).

5.3.4 Temperature

The mean monthly maximum temperature is between 18 degrees (July) and 34 degrees (January) Celsius (°C), the mean monthly minimum temperature is between 6 degrees (July) and 20 degrees°C (January) (Bureau of Meteorology 2020a),

5.4 Watercourses and waterbodies

A number of watercourses and waterbodies occur within the proposal site (refer Aquatic Biodiversity technical report (FFJV 2020a)). These are described in Table 5.1 (including an overview of geomorphological features) and mapped in Figure 1.1. Watercourses within the proposal typically consist of gravel and/or sandy bed composite and are not expected to be resistant to scour if exposed to high velocity waters. The full geomorphic assessment (utilising the AusRIVAS assessment methodology) is presented within the Existing Aquatic Environment section of the Aquatic Biodiversity technical report prepared for the North Star to NSW/QLD Border EIS (FFJV 2020a). The Hydrology and Flooding technical report prepared for the North Star to NSW/QLD Border EIS (FFJV 2020b) includes assessments of water levels, flowpaths, and flow velocities. These assessments were used as input for the drainage design and drainage assessments of scour, the results of which are presented in the Hydrology and Flooding technical report prepared for the North Star to NSW/QLD Border EIS (FFJV 2020b). Further detailed drainage design will be undertaken to detail scour protection (as an engineering standard) in regard to expected velocities from culverts.

Table 5.1 Watercourses within the proposal site

Watercourse	Description
Macintyre River:	The Macintyre River is the major river that begins in the Northern Tablelands between Glen Innes and Guyra. The river is 321 km long and is a tributary of the Barwon River. The proposed rail crossing location is situated between the confluence of the Dumaresq River and Macintyre River and Boggabilla. The only permanent waterway within the proposal site. There is a broad well vegetated riparian flood plain on both sides of the river. Impacts of human disturbance were high. There is an extensive riparian cover along both banks with an over story of *Eucalyptus* sp. and *Melaleuca* sp. The banks were 50 to 100 m wide, and have a substantial cover of weedy species. The river bed includes gravel and sand beds with some mud banks and snags. The river level was low but flowing at the time of the survey and provides high value fish habitat. Emergent (*Phragmites australis*) macrophytes were along the banks.  Macintyre River downstream of Site 11 (Low flow at time of assessment – August 2018)
Whalan Creek:	Whalan Creek is a is a major creek approximately 60 km long that discharges in a westerly direction into the Macintyre River, downstream of Goondiwindi. Whalan Creek is an anabranch of the Macintyre River and appears to also receive flows from the Macintyre River during over bank flow events. This creek is ephemeral but larger than other creeks in the area, with a well-defined channel likely to flow seasonally. The creek is about 50 to 70 m wide, is situated within a broad agricultural landscape with a mix of grazing and cropping on both banks. The width of the floodplain was undetermined as there were no distinctive features or changes in vegetation to identify the floodplain extent. However, the entire area adjacent to the creek is a flood plain. These sites were highly disturbed/modified with significant impacts to the waterway and the riparian zone. Riparian vegetation cover was highly degraded/modified, with an overstory of *Eucalyptus sp.* and *Acacia sp.* providing sparse cover. There was limited evidence of tree regeneration and shrub/ground cover was low. The bed of the creek is stable and is dominated by silt and some sand and there was limited fish habitat visible at the site. A large pool was visible outside of the assessment reach; however, the creek was otherwise dry at the time of the site inspection.

Watercourse	Description
	 Whalan Creek upstream of Site 7 (Dry at time of assessment – August 2018)
Mobbindry Creek	Mobbindry Creek is a tributary of Whalan Creek and is approximately 55km long. The headwaters of the Creek are situated southeast of the township of North Star and flows parallel to the North Star Rd in a north westerly direction and appears to discharge into Whalan Creek within the vicinity of the Newell Highway. The proposed rail crossing location is adjacent to the Boggabilla-Warialda Rd. The creek is ephemeral, with a well-defined channel. The floodplain is broad and undefined adjacent to Mobbindry Creek. The local land use and the broader catchment are highly modified and impacted by agricultural activities (grazing and cropping). The creek is 26 to 30 m wide. The riparian corridor comprised of an overstory of *Eucalyptus sp.* and Brigalow with some shrub cover and a good understory cover. The creek bank vegetation included a continuous cover of fringing rushes and sedges. The creek bed was stable and includes silts and some sand. The channel form was varied but was dominated by run habitat with some pools expected to be present during flow. Obstructions to the waterway include the existing rail and road crossing and there were some natural barriers in the form of large snag piles.  Mobbindry Creek downstream of Site 1 (Dry at time of assessment – August 2018)

Watercourse	Description
Back Creek	Back Creek is a tributary of Mobbindry Creek and is approximately 25km long. There is a well vegetated riparian zone along both sides of the creek at the crossing location. There was recent evidence of stock presence at the sites investigated. This creek is ephemeral, with a well-defined channel. Riparian vegetation was dominated by *Eucalyptus sp.* and Brigalow with shrubs present and good understory of dominated by native species. The creek is about 18 to 30 m wide. The top of the banks along the creek are covered by *Carex* sp. The creek channel was approximately 1 m deep and 3 m wide. The substrate is unconsolidated silt and there is a large number of snags present in the creek. There was a slight sheen to the water and there was an anaerobic odour generated from the sediment when disturbed.  Back Creek upstream of Site 5 (Low flow at time of assessment – August 2018)
Forest Creek	Forest Creek is over 20 km long and discharges in a north westerly direction and appears to discharge into Whalan Creek although the flow path is not clearly defined. The floodplain is broad and poorly defined along the Creek. There is a mixed coverage of riparian vegetation dominated by *Casuarina sp.* along the creek. The channel was variable in form and 31 to 40 m wide at the sites surveyed. It has a broad shallow (0.2 m) bed dominated by silt and sand with some gravel. The creek bed is vegetated with a mixture of terrestrial species with evidence of aquatic species in some shallow depressions. This creek is ephemeral, with a highly modified waterway and poorly defined channel. An on-stream dam has been constructed and all flows diverted to the dam. Two levees have been constructed that divert overland flow the creek to the on-stream dam before excess water is able to bypass the dam. Downstream of the dam the existing rail line has formed a barrier to flows. The rail line and levee banks have altered the hydrology of the site between the dam and the rail line that has allowed a stand of *Casuarina sp*. to establish.

Watercourse	Description
	 Forest Creek downstream of Site 16 at the rail crossing (Isolated pool at time of assessment – August 2018)
Unnamed tributary of Mobbindry Creek	The unnamed tributary of Mobbindry Creek is a short drainage line approximately 5km long. The creek line is highly modified and impacted by agricultural land use. The creek is 9 to 30 m wide. It was narrow and shallow (<0.5 m) in parts with a uniform sand bed, and in other reaches contained highly mobile silt and sand that has a scoured low flow channel within it. The overstorey riparian zone is non-existent with highly degraded understorey and ground cover riparian vegetation. Levees have been constructed along both banks.  Unnamed tributary of Mobbindry Creek downstream of Site 15. Dry at the time of assessment in August 2018.

Source: Aquatic Biodiversity technical report (FFJV 2020a).

5.5 Licensed water uses

Licensed water usage from unregulated and alluvial groundwater sources proximal to the proposal alignment throughout the 2018-2019 reporting period indicates that both surface water takes and groundwater use are important water sources in this catchment (refer Table 5.2).

Surface water use within the proposal alignment is restricted to riparian offtake within the Croppa Creek and Whalan Creek watercourses (refer Table 5.1). Croppa Creek is located about 30 km south and west of the alignment and does not cross the alignment. Licensed groundwater use within 5 km of the proposal site is separated into two broad regions; the northern section and the southern section of the proposal alignment.

Table 5.2 Summary of 2018-2019 Water Access Licence Allocations relevant to the Study Area

Water source	Licence type	No of WALs	Water made available (ML/yr)
NSW Border Rivers Downstream Keetah Bridge (Alluvial Aquifer Source)	Aquifer	2	485
Croppa Creek and Whalan Creek (Surface Water Source)	Domestic and Stock	9	65.5
	Domestic and Stock (Domestic)	1	2
	Domestic and Stock (Stock)	2	10
	Unregulated River	22	15,674
GAB - Eastern Recharge Groundwater Source	Aquifer	79	17,487
	Domestic and Stock (Town Water)	1	32

Table note:

Under Water sharing plan for the NSW Borders Rivers Unregulated and Alluvial Water Sources 2012

Source: WaterNSW

5.6 Aquatic ecosystem values

The proposed alignment intersects a number of watercourses of varying size, condition and ecological value (for detailed assessment, refer to Section 5.5. of the Aquatic Biodiversity technical report prepared for the North Star to NSW/QLD Border EIS (FFJV 2020a).

The Border Rivers Water Resources and Management Overview (Green *et al.* 2012) identifies three threatened aquatic species as potentially occurring within the broader catchment; the River snail (*Notopala sublineata*), Silver perch (*Bidyanus bidyanus*) and the Southern purple spotted gudgeon (*Mogurnda adspersa*). There is one endangered population, Olive perchlet (*Ambassis agassizii*) western population. The Macintyre River is a perennial waterway known to support threatened species such as the Murray Cod (*Maccullochella peelii*) (FFJV 2018a).

There is one Endangered Ecological community listed under the *Fisheries Management Act 1994* (NSW); 'The aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River' (Green *et al.* 2012). The Darling River Endangered Ecological Community includes all native fish and aquatic invertebrates within the natural creeks, rivers and streams, lagoons, billabongs, lakes, flow diversions to anabranches and the flood plains of the Darling River and includes the Macintyre River within the rail corridor. The community has a diverse assemblage of native species including 21 native fish species and hundreds of native invertebrates.

5.7 Sensitive environmental areas

The following section provides a summary of sensitive environmental areas known within the proposal site. Within the current proposal, sensitive environmental areas are wetlands areas, identified fish habitat and groundwater dependent areas within receiving waters.

5.7.1 Endangered Ecological Communities

The Darling River Endangered Ecological Community is sensitive to impacts with the following listed as key threatening processes for the community: degradation of the riparian zone, clearing of vegetation and the use of chemicals which impact on water quality. These impacts have the potential to occur during the construction phase of the proposal, with some continuing risk during operation (refer Section 6.1). Impacts to the Darling River EEC are considered in detail in the Aquatic Biodiversity technical report prepared for the North Star to NSW/QLD Border EIS (FFJV 2020a).

5.7.2 Wetlands

There are no Wetlands of International Importance (Ramsar wetlands) within, or within 10 km of the proposal site.

It is noted that a wetland complex consisting of Morella watercourse, Pungbougal Lagoon and Boobera Lagoon are part of a remnant channel of the Macintyre River south of Goondiwindi. This wetland complex is listed as a site of national importance in the Directory of Important Wetlands in Australia (an inventory of nationally important wetlands maintained by Environment Australia). It is not located within the proposal site, with the watercourse system at a minimum of 8 km downstream from the proposal site, and hydraulically connected only during flood events.

5.7.3 Fish habitat

Aquatic habitat is based on key fish mapping prepared by NSW Department of Primary Industries. Mapping classifies habitats based on the likelihood of key fish habitat occurring (class), and the sensitivity of that habitat (type). This is discussed in detail in the Aquatic Biodiversity technical report prepared for the North Star to NSW/QLD Border EIS (FFJV 2020a) with a summary presented here. Class refers to a classification for fish passage, and type refers to habitat sensitivity from Policy-and-guidelines-for-fish-habitat NSW (2013):

- The Macintyre River is a perennial waterway within the proposal site with a well vegetated riparian flood plain on either side of the river. It is known to support threatened species such as the Murray cod, Silver Perch and Purple-spotted gudgeon. It has high ecological value as a Class 1 Major Fish habitat, and Type 1, highly sensitive fish habitat.
- Whalan Creek is an is an anabranch of the Macintyre River, an ephemeral waterway, larger than other creeks in the area and with a well-defined channel that is likely to flow seasonally. It is known to support fish populations and is mapped as Class 2 Moderate Fish habitat, Type 1, highly sensitive fish habitat.
- Mobbindry Creek and Back Creek are ephemeral waterways with well-defined channels with fringing rushes and sedges present. They are ephemeral with some semi-permanent pools. Breeding or feeding habitat is available for some aquatic species. Both waterways are mapped as Class 4 Unlikely fish habitat, but since they are mapped by the Department of Primary Industries (DPI) fish habitat maps as possible habitat for Eel-tailed catfish, Type 1 highly sensitive fish habitat.
- Forest Creek is an ephemeral, highly modified waterway with a poorly defined channel and limited or poor riparian vegetation; it is classified as Class 4 Unlikely fish habitat, and Type 3 minimal sensitivity fish habitat.
- An unnamed tributary of Mobbindry Creek, which is ephemeral, is classified as Class 4. Unlikely fish habitat; and Type 3 minimal sensitive habitat.

These habitats would be sensitive to the following key threatening processes: degradation of the riparian zone, clearing of vegetation and the use of chemicals which impact on water quality. These impacts have the potential to occur during the construction phase of the proposal, with some continuing risk during operation (refer Section 6.1).

5.7.4 Groundwater dependent ecosystems

The Groundwater Dependent Ecosystems Atlas (GDE Atlas, BoM 2018b) identifies three types of ecosystems:

- Aquatic ecosystems that rely on the surface expression of groundwater – this includes surface water ecosystems which may have a groundwater component (i.e. rivers, wetlands, springs)
- Terrestrial ecosystems that rely on the subsurface presence of groundwater – this includes all vegetation ecosystems
- Subterranean ecosystems – this includes cave and aquifer ecosystems.

The proposal site passes through, or in the vicinity of, the several aquatic GDEs (refer Figure 5.1 and Table 5.3).

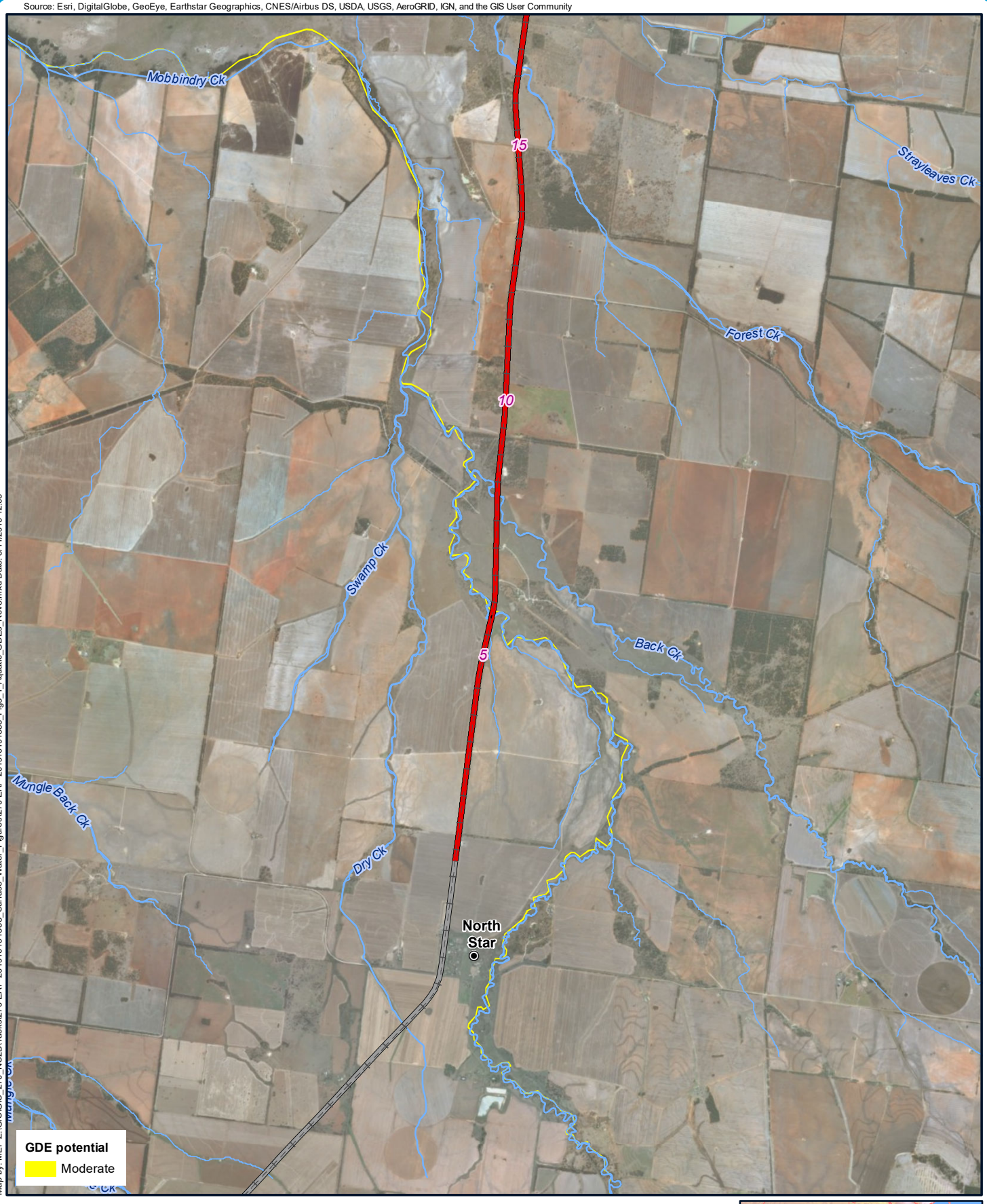
Table 5.3 Summary of aquatic groundwater dependent ecosystems

Chainage	GDE Category	Aquatic GDE Description
KP 5.70 km	Moderate	A narrow moderate potential aquatic GDE is identified in Mobbindry Creek. Proposed construction at this location is cut and fill. Classified ecosystem type is river.
KP 28.0 km	High	A high potential aquatic GDE is identified at Malgarai Lagoon located 1km to the southeast the alignment and 2.5km south of the Macintyre River. Classified ecosystem type is wetland. No construction activity in proximity to this feature.
KP 30.5 km	Moderate	A moderate potential aquatic GDE is identified within the active Macintyre River channel and will be crossed by the alignment via a cut and fill as well as a bridge structure. Classified ecosystem type is wetland.
KP 30.5 km	High	High potential aquatic GDEs are identified 2.5km east of the alignment where it intersects the Macintyre River. No construction activities proposed in proximity to this GDE. Classified ecosystem type is wetland.

Source: BoM GDE Atlas

Regional assessments of surface water-groundwater interactions have identified the Macintyre River and other water courses region to be in a losing condition (Parson et al. 2008). This means that surface water typically infiltrates vertically to groundwater to recharge local groundwater within the alluvium.

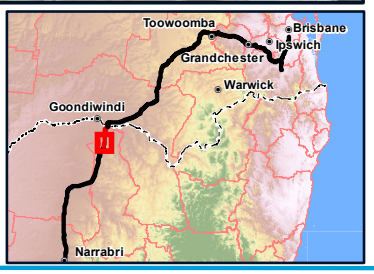
The Glenlyon and Pindari Dams in the upper reaches of the Border Rivers Catchment result in regulated flows to the Severn and Macintyre Rivers (DPI 2012). Consequently, there is likely to be an artificial influence on recharge to alluvial aquifers during low flow periods (periods of dam discharge to the rivers).



Map by: MEF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20191019155 8_Surface_Water_Figures\270-EAP-20191019155 8_Fig5_1_Aquatic_GDEs_Rev3.mxd Date: 8/11/2019 12:05

Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Existing rail (non-operational)
- North Star to NSW/QLD border alignment
- Adjoining alignments
- Watercourses



A4 scale: 1:100,000

0 0.6 1.2 1.8 2.4 3km

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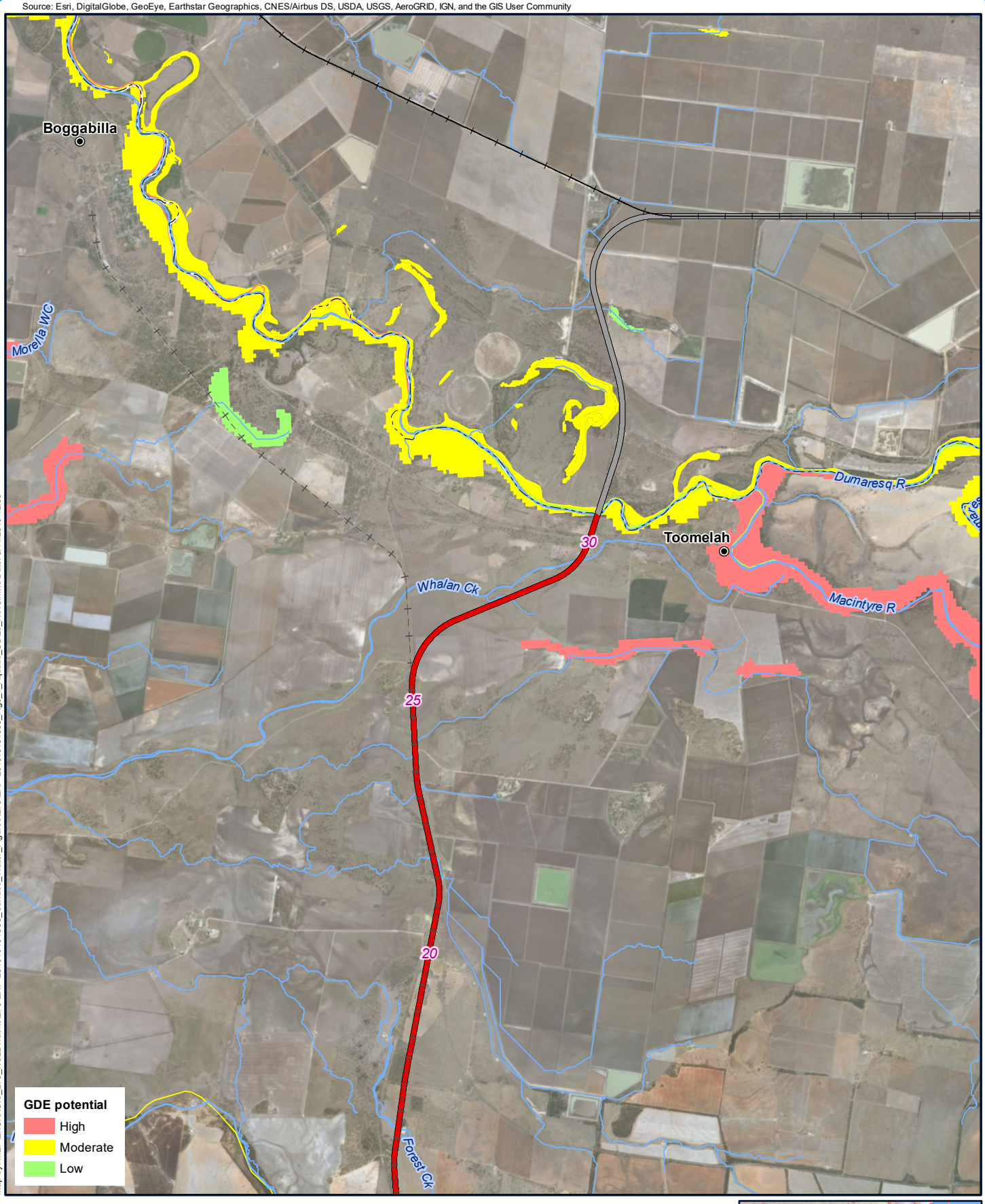
Integrating Community, Environment and Engineering

Date: 08/11/2019 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

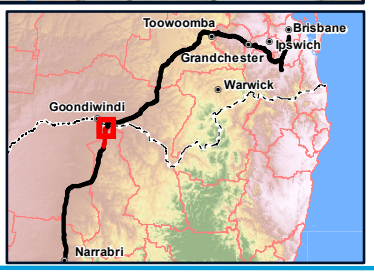
Figure 5.1a: Aquatic groundwater dependent ecosystems in the vicinity of the proposed alignment



Map by: MEF Z:\GIS\GIS_270_NS2BITasks\270-EAP-20191019155 8_Surface_Water_Figures\270-EAP-20191019155 8_Fig5_1_Aquatic_GDEs_Rev3.mxd Date: 8/11/2019 12:05

Legend

- 5 Chainage (km)
- Localities
- Existing rail (non-operational)
- North Star to NSW/QLD border alignment
- Adjoining alignments
- Watercourses
- NSW/QLD border



A4 scale: 1:100,000

0 0.6 1.2 1.8 2.4 3km

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 5.1b: Aquatic groundwater dependent ecosystems in the vicinity of the proposed alignment

5.8 Salinity

Salinity is a major land degradation issue and can impact on land salinisation, in-stream salt load and in-stream salt concentration (NSW DPI 2013). The Catchment Management Authorities within NSW are required to develop Catchment Action Plans and in 2012 - 2013 a salinity tool was developed by NSW DPI (2013) for integration into these plans. As part of the development of this tool, areas within each catchment management area were given a salinity hazard ranking based on a number of variables such as salt stores, salinity outbreaks, water quality, salt loads, onsite and offsite impacts, presence of acid sulphate soils, presence of highly sodic soils, aquifer systems, ground water quality and ground water depth (NSW DPI 2013).

The proposal site passes through an area with a very high salinity hazard ranking from North Star north for approximately 15 km (refer Figure 5.2). The NSW DPI has determined that this is a result of:

- Flat lying sediments and soils with a very high salt store
- Semi-confined shallow aquifers containing marginal to saline groundwater
- The area responding climatically and seasonally, with large saline sites developing across large sections of the landscape after wet periods
- The heavy textured soils containing a very high salt store
- Soil textures changing downslope initiating salinity development.

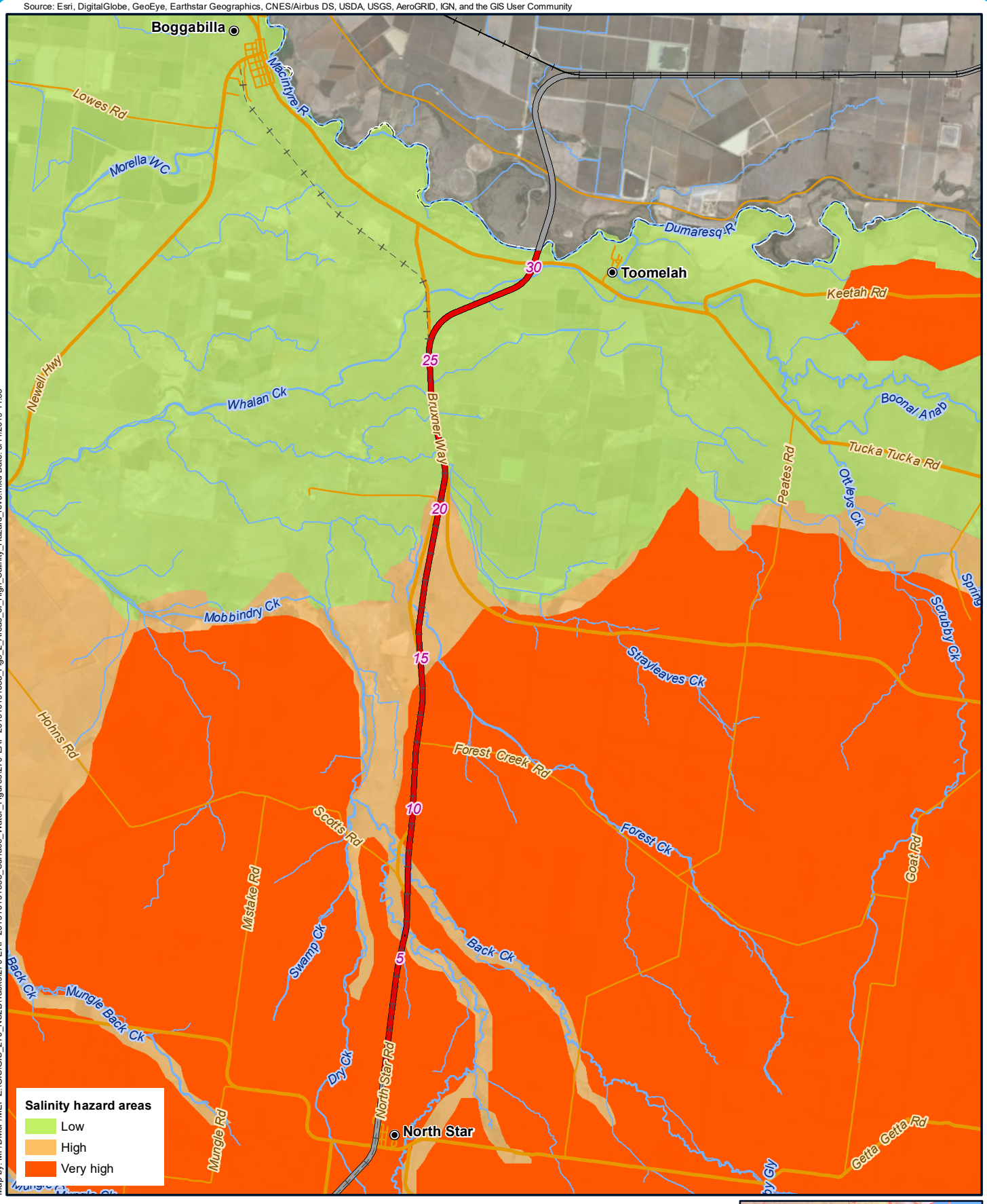
The risks of salinity development within the proposal alignment are largely associated with agricultural land management practices and climatic/seasonal events (NSW DPI 2012). Targeted salinity hazard and the corresponding resilience statement of the landscape by NSW DPI notes that salinity increases are associated within high salinity risk areas due to soil health issues and intensive cropping, and with marginal-saline semi-confined shallow aquifers.

Shallow saline watertables can pose a risk to water quality. Effects on surface water systems at discharge points would be expected at the interface between the semi-confined aquifers and watercourses where saline groundwater could be expressed. Noting this, the technical groundwater assessments (Groundwater Assessment, FFJV 2018d) indicates that the watercourses appear to be mostly in a losing condition to groundwater systems. Therefore, the salinity risk from shallow groundwater is expected to be rare, and would be expected to occur after periods of high rainfall, and associated increases in groundwater level (when groundwater increases to within 2 m of ground surface). Spikes in salinity are known to occur in drainage systems especially during wet climatic cycles when the local system becomes saturated (NSW DPI 2013). During such conditions, unconfined, shallow aquifers such as the alluvium within Mobbindry and Back Creeks could experience spikes in salinity from surface water recharge as a result. Increases in recharge from irrigation also have the potential to increase salinity risks in these high-risk areas.

Saline soils can pose a risk to surface waters. A key threatening process to surface water could result from the direct exposure of disturbed saline soils to surface runoff, and the consequent entrainment of those salts to the receiving environment. This can lead to a decline in water quality from increased salt loads and localised electrical conductivity (EC) increases (NSW DPI 2013).

Between North Star and CH20.0, a high to very high risk ranking exists along the proposal site and is associated with the flat lying Jurassic aged strata and residual soils of the Kumbarilla Beds and the Walloon Coal Measures (NSW DPI 2013). These high-risk areas are particularly evident where stratigraphic changes or breaks in slope occur.

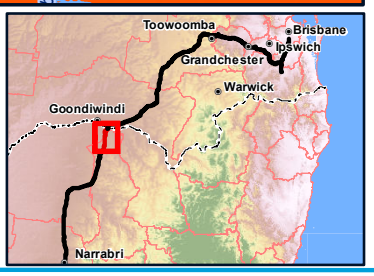
North of the ‘very high’ salinity hazard ranking area, the proposal site passes through areas with low salinity hazard (NSW DPI 2012). Noting that sensitive receiving environments (refer Section 5.7) are proximal to the low salinity hazard areas at the northern section of the proposal alignment, salinity issues may arise during proposal works from highly localised risk areas that may be below the resolution of available salinity hazard risk mapping.



Map by: MF/DMcP/MEF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20190191558_Surface_Water_Figures\270-EAP-20190191558_Fig5_2_Areas_of_High_Salinity_Hazard_rev3.mxd Date: 8/11/2019 11:53

Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Existing rail (non-operational)
- North Star to NSW/QLD border alignment
- Adjoining alignments
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border



A4 scale: 1:170,000

0 1 2 3 4 5km

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North Star to NSW/QLD border

Figure 5.2: Salinity hazard ranking for areas within the proposal site

5.9 Surface water quality assessment

5.9.1 Desktop review of water quality of the Border Rivers

Water quality in the Border Rivers catchment has been assessed by the NSW Department of Industry (2018b). This report concluded that water quality in the Border Rivers varies from poor to good. The water quality index used for this assessment returned a condition rating of 'fair' (a score of between 60-79/100) for the upland catchments surrounding the proposal site, as follows:

- Upstream of the proposal site at Holdfast Crossing (about 40 km upstream) had a rating of 77/100
- Downstream of the proposal site at Boggabilla (about 5 km downstream) had a poorer rating of 66/100.

Within the unregulated catchments, water quality degradation is attributed to sediment and nutrients entering waterways as a result of poor land, soil and vegetation management. This report recommends reducing stream bank erosion to improve water quality by maintaining groundcover, vegetated buffer strips, and riparian vegetation, and good agronomic practices.

Within regulated reaches problems include: dissolved oxygen issues, contribution of sediment and nutrients through bank slumping, dissolved organic carbon transport and cold water pollution. It is recommended that these can be addressed through the implementation of flow rules; water supply works approvals, improvements in infrastructure and strategic environmental watering.

The NSW Office of Water, on behalf of the Border Rivers Commission, monitored water quality on a monthly basis in the Border Rivers. Results for the years 2011 to 2016 are presented in Table 5.4 and Table 5.5. Macintyre River regulated watercourse monitoring sites are presented in Figure 5.3.

Table 5.4 Summary of electrical conductivity data for the Macintyre River

Location	Median electrical conductivity (µs/cm)				
	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Macintyre River @ Holdfast	300	280	280	270	260
Macintyre River @ Salisbury Bridge (Boggabilla)	280	220	250	230	230

Source: BRC 2012a, 2013, 2014, 2015, 2016

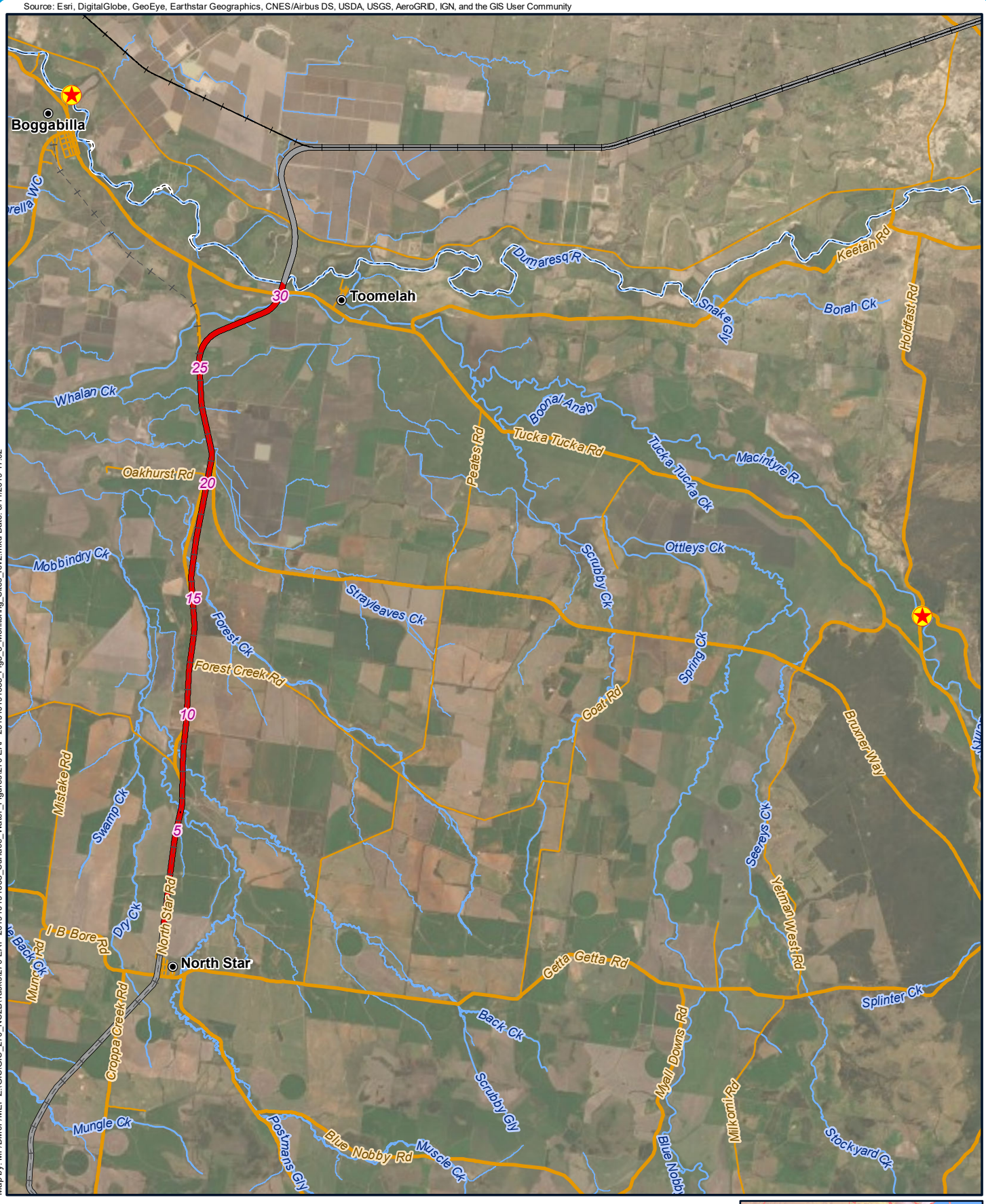
Table 5.5 Summary of water quality data for the Macintyre River

Location	Median values for 2010-2011, and 2011-2012		
	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)	Total Turbidity (NTU)
Macintyre River @ Holdfast	0.15 / 0.137	0.73 / 0.63	36.5 / 28.5
Macintyre River @ Salisbury Bridge (Boggabilla)	0.09 / 0.11	0.88 / 0.72	36 / 29.8

Source: BRC 2012b

The Borders Rivers Commission makes the following observations regarding water quality in the catchment:

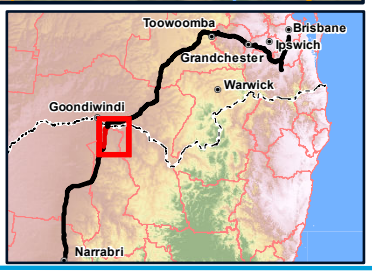
- Electrical conductivity measurements In the Border Rivers system have revealed that salt concentrations were generally suitable for the irrigation of most salt sensitive crops. The trigger value for the irrigation of salt sensitive crops and for aquatic ecosystems in upland rivers is 350µs/cm (BRC 2014).
- The total phosphorus concentrations in the rivers generally increased toward the west. The Macintyre River at times has had median concentrations (0.11 mg/L at Holdfast Crossing, BRC 2014) that surpassed the Murray-Darling Basin Plan's water quality target for total phosphorus.
- At most sites, under optimal circumstances such as good light availability, and warm still days, algal growth would not likely be limited by nutrient availability as nutrients are often in abundant supply (BRC 2014). However, turbidity in the lower end of the Border Rivers is generally high, with median values over 600 NTU. High turbidity is likely to inhibit algal growth, as well as in-stream aquatic plant growth and diversity.



Map by: MF/DMcP/MEF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20191019158_Surface_Water_Figures\270-EAP-20191019158_Fig5_3_Monitoring_Sites_rev2.mxd Date: 6/11/2019 17:02

Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Existing rail (non-operational)
- North Star to NSW/QLD border alignment
- Adjoining alignments
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border
- Monitoring sites



A4 scale: 1:220,000

0 1 2 3 4 5km

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North Star to NSW/QLD border

Figure 5.3: Macintyre River regulated watercourse monitoring sites

5.9.2 General conditions and observations

The general conditions and observations at each of the field assessment sites (refer Figure 3.1) during the August 2018 site visit are detailed in Table 5.1 and Table 5.6. The majority of sites assessed during the August 2018 field survey demonstrated low flow or dry conditions and are likely an effect of a lack of substantial preceding rainfall (< 45 mm) in the 111 days preceding the field survey period. Only the Macintyre River was flowing, and sampling from other sites was limited to isolated pools. Water quality data derived from the field assessment and electrical conductivity data derived from interrogation of water gauging stations on relevant watercourses, the Dumaresq and Macintyre River upstream from the proposal (DPI Water Monitoring Portal) are shown in Table 5.7. Field data sheets are presented in Appendix B.

5.10 Laboratory results

The samples that were collected at the four locations were sent to Eurofins for analysis as per the method described in Section 5.11. Within Table 5.9, heavy metal and Naphthalene results from the laboratory analysis are indicated. Note that Naphthalene was used as an indicator for indication of PAHs, as the simplest aromatic, in lieu of display of the remaining 18 analysed PAHs. Full laboratory results are provided in Appendix A.

Table 5.6 General water quality site condition during August 2018 survey period

Site number	Surface water body	Description	Flow at assessment	Sample collection	Site condition
1	Mobbindry Creek	Low gradient stream	Dry at assessment	No Water Chemistry	Channel form was varied but was expected to be dominated by run habitat with some pools present under base flow conditions. Riparian vegetation disturbed with overstorey, understorey and trailing bank vegetation present. Proximal floodplain is broad and undefined. Evidence of stock pressure.
2	Mobbindry Creek				
3	Mobbindry Creek				
4	Back Creek	Low gradient stream	Dry at assessment	No Water Chemistry	Channel form appears that it would be expected to be dominated by run habitat under base flow conditions. Riparian vegetation disturbed with overstorey, understorey and trailing bank vegetation present. Proximal floodplain is broad and undefined. Evidence of stock pressure and artificial features.
5	Back Creek	Low gradient stream	Low flow/Deep pool (1.5 m)	Full Assessment	
6	Back Creek	Low gradient stream	Dry at assessment	No Water Chemistry	
7	Whalan Creek	Low gradient stream	Dry at assessment	No Water Chemistry	Observed channel form would be expected to be split between pool and run habitat (under base flow conditions). Highly disturbed riparian vegetation. Proximal floodplain is broad and undefined. Evidence of stock pressure and artificial features.
8	Whalan Creek	Not assessed			
9	Whalan Creek	Low gradient stream	Dry at assessment	No Water Chemistry	
10	Macintyre River	Not assessed			Observed channel would be expected to be dominated by run and pool habitat (under base flow conditions). Riparian vegetation disturbed but well represented. Proximal floodplain appears a matrix of remnant channels and scroll systems. Evidence of human infrastructure impact.
11	Macintyre River	Major low gradient river	Low flow	Full Assessment	
12	Macintyre River	Major low gradient river	Low flow	Full Assessment	
13	Unnamed tributary of Mobbindry Creek	Not assessed			Observed channel would be expected to be dominated by channelised run habitat (under base flow conditions). No riparian vegetation associated with watercourse. Proximal floodplain is broad and undefined. High degree of hydrological impact from artificial impacts, including in-stream dam and watercourse channelization.
14	Unnamed tributary of Mobbindry Creek	Modified creek	Dry at assessment	No Water Chemistry	
15	Unnamed tributary of Mobbindry Creek	Low gradient stream	Dry at assessment	No Water Chemistry	
16	Forest Creek	Undefined floodway	Isolated pool	Full Assessment	Variable channel form due to high degree of human impact. Disturbed riparian associated with watercourse. Proximal floodplain is broad and undefined but impacted by infrastructure. High degree of hydrological impact from artificial impacts, including in-stream dam and watercourse diversion.
17	Forest Creek	Shallow (0.2 m) floodway	Dry at assessment	No Water Chemistry	
18	Forest Creek	Undefined floodway			

Table 5.7 Water quality site data measured in-situ from watercourses within the proposal

Site	Watercourse	Turbidity (NTU)	DO (mg/L)	DO (% saturation)	pH	Electrical conductivity (µs/cm)[1]	Water temperature (°C)	Salinity (g/L or PSU)	Alkalinity (mg/L)
5	Back Creek	119 (71)	3.9 (8.5)	34 (92)	7.2 (7.7)	261 (320) [1]	8.3	0.12	35 (71)
11	Macintyre River	13 (6.8)	9.4 (9.2)	90 (100)	7.9 (8.3)	429 (520) [1]	11.7	0.21	65 (200)
12	Macintyre River	13 (4.1)	8.8 (9.3)	84 (100)	7.7 (8.2)	410 (490) [1]	12	0.2	55 (200)
16	Forest Creek	75 (40)	9.3 (9.2)	97 (100)	8.2 (8.6)	516 (630) [1]	15.7	0.25	90 (278)
Water quality trigger values									
Sites 1-9, 13-21	Back Creek, Forest Creek	<50		85-110	6.5-8.5	125-2200	-	-	-
Sites 10-12	Macintyre River	<30		65-110	7.4-8.0	245	-	-	-

Table notes:

Where available, laboratory data is shown in brackets for comparison. Comparison also made to other available datasets.
Highlighted orange colour where value is above WQO or outside WQO range where applicable

1 Guideline derived by NSW DPI from values recorded at DPI (NSW) Water Gauging Station Macintyre River at Holdfast. Long-term average EC (µs/cm corrected for 25°C) June 2002 to November 2018 = 294; Max = 643.7 (total n = 5903).

Table 5.8 Laboratory results for water quality monitoring sites

Site	Date	pH	Conductivity (µs/cm)	Total Phosphorus (mg/L)	FRP (mg/L)	Suspended solids (mg/L)	Turbidity (NTU)	Ammonia (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Oxidised Nitrogen (mg/L)	Total Kjeldahl nitrogen (mg/L)	Total nitrogen (mg/L)
Sampling sites													
NS2B 5	Aug-2018	7.7	320	0.15	<0.05*	65	71	0.11	0.11	<0.02	0.11	0.6	0.7
NS2B 11	Aug-2018	8.3	520	0.08	<0.05*	14	6.8	0.03	<0.02	<0.02	<0.05	0.5	0.5
NS2B 12	Aug-2018	8.2	490	0.06	<0.05*	9.1	4.4	0.03	0.03	<0.02	<0.05	0.4	0.4
NS2B 16	Aug-2018	8.6	630	0.1	<0.05*	56	40	0.05	<0.02	<0.02	<0.05	1	1
Water quality trigger values													
Sites 1-9, 13-21	-	6.5-8.5	125-2200	0.050	0.02	25	<50	0.02	-	-	0.06	-	0.500
Sites 10-12	-	7.4-8.0	245	0.07	0.02	25	<30	0.02	-	-	0.01	-	0.575

Table notes:

Highlighted denotes parameters that exceeded relevant WQO threshold
*LOR exceeds WQO, therefore it is not possible to assess whether concentrations exceed the WQO

Table 5.9 Heavy metal (dissolved) and indicative polycyclic aromatic hydrocarbon laboratory results for water quality monitoring sites

Site	Date	Arsenic (V) (µg/L)	Cadmium[1] (µg/L)	Chromium (VI) (µg/L)	Copper (µg/L)	Lead (µg/L)	Mercury (µg/L)	Nickel (µg/L)	Zinc (µg/L)	Naphthalene (µg/L) (PAH)
Sampling sites										
NS2B 5	Aug-2018	<1	<0.2	<1	<1	<1	<0.1	4	<5	<1
NS2B 11	Aug-2018	1	<0.2	<1	<1	<1	<0.1	3	<5	<1
NS2B 12	Aug-2018	8	<0.2	2	2	<1	<0.1	12	5	<1
NS2B 16	Aug-2018	1	<0.2	<1	3	<1	<0.1	7	<5	<1
Water quality trigger values										
All sites	-	10	0.2	1.0	1.4	3.4	0.06	11	8.0	16

Table note:

Highlighted denotes parameters that exceeded relevant WQO threshold

5.11 Quality assurance and quality control

5.11.1 Sampling quality review

As each sample was collected for the laboratory it was labelled with a unique sample identifier, the initials of the sampler, the date and the project number. All sample jars were filled leaving no headspace and placed immediately into ice-filled cooler boxes. All samples were transported in ice-filled coolers to prevent degradation of organic compounds. Chain of Custody documentation was completed, with data including sample identification, date sampled, matrix type, preservation method, analyses required and name of sampler.

In-situ readings for the water quality were made using a YSI Professional Plus water quality meter and a TPS WP-88 portable turbidimeter. Regular field calibrations were undertaken for these probes.

One duplicate sample was collected per sampling visit for QA/QC purposes. The surface water quality samples were submitted to a NATA accredited laboratory for analysis.

5.11.2 Data quality review

Laboratory QA/QC included analysis of laboratory duplicates, method blanks, laboratory control samples, matrix spikes and surrogates. All laboratory QA/QC were within the acceptance range. All samples were collected into the appropriate sample containers for the analysis required and arrived at the laboratory chilled and within the relevant holding times.

5.11.3 Analytical data validation summary

Overall the reported analytical results are considered to be valid and representative of the concentrations of the analysed compounds at the sample locations. On the basis of the analytical data validation process, the overall quality of the analytical data collected is considered to be of an acceptable standard for interpretive use.

5.12 Surface water quality variability

Only a limited assessment of temporal and spatial variability in surface water quality can be made as only one round of surface water quality monitoring has been conducted at four monitoring locations. In addition, it is noted that monitoring was conducted during spring which is outside the peak rainfall period for the area. Therefore, surface water monitoring results may not be representative of average conditions. Given that there was < 2 mm rain for a period of approximately 40 days prior to the August 2018 sampling event, evaporation of the pooled water is likely to have occurred, potentially resulting in increased concentrations of some water quality parameters.

The habitats of the Border Rivers Catchment are known for their diversity of hydrological environments and the varied responses of different species to varying dryness or flood (as discussed in DES 2018). These ecosystems are well represented with species adapted to ephemeral water availability. Many aquatic organisms in this environment are adapted to these drying phases and persist in pools/waterholes which act as refugia (DES 2018). As water availability changes, so does water quality since the compounds in the water column (such as salts) may become more concentrated as pools dry. Persistence in the waterholes would be determined by physiological thresholds of individual species. Floods and floodplain connectivity act to relieve these physiological stressors and are typically triggers for migration and breeding. Therefore, increased concentrations or decreased water availability may reduce the viability of some species if floods recur at infrequent intervals.

5.13 Comparison with water quality trigger values

Back Creek and Forest Creek - Physico-chemical data and laboratory assessment of water quality indicate that there is an observable anthropogenic impact at these sites. Both of these watercourses had elevated total phosphorus and nitrogen loads exceeding regional water quality trigger values (refer Table 5.8).

Macintyre River - The two Macintyre River monitoring sites were closer to regional water quality trigger values for nutrients, however the site downstream of the proposal alignment exceeded water quality trigger values for three heavy metals, Chromium (VI), Copper and Nickel (refer Table 5.9).

Long term electrical conductivity data from the gauging stations located upstream of the proposal alignment, at the Dumaresq River and Macintyre River site indicated that the values observed within the single field survey were comparable to long term datasets (refer Table 5.7 and Table 5.8).

Laboratory analysis of PAH concentrations at all sites were below detection limits, indicating no continued point source contamination of sampled sites, though it is recognised that these compounds are volatile and may not be very persistent in the environment.

In summary, noting the constraint of limited field data, it is evident that during dry conditions, the watercourses that cross the proposed alignment have water quality values that are not fully meeting WQOs. It should be noted that conditions for the Forest and Back Creek (pools) during sampling do not constitute base-flow conditions used for an objective basis, and hence these data should to be compared with caution for the assessment of water quality trigger values.

6 Potential impacts

The location and type of the primary infrastructure associated with the proposal has been determined through the feasibility design process. In order to have a consistent assessment process to determine impacts associated with the proposal, ARTC has developed a standardised approach to impact assessment (refer Section 3.3).

Potential impacts to surface water are described in the following sections. These impacts are then assessed against the sensitive receptors, with standard mitigation considered as part of 'pre-mitigation' impact assessment. Identification of additional mitigation measures and assessment of the residual risk of impact with all mitigation in place is also provided within this section.

Through information gathered during the assessment process, sensitive receptors (features) within the receiving environment which have the potential to be subject to significant impacts, have been identified. Mitigation measures have been developed to reduce the potential magnitude of impacts.

6.1 Nature of impacts

6.1.1 Proposal water requirements and usage

Water requirements for the construction period of the proposal are summarised in Table 6.1 and include an estimate of volumes anticipated. These are documented in more detail in the Inland Rail: Phase 2 – NS2B Constructability Assessment March 2019 (FFJV 2019).

Table 6.1 Estimated water requirements during construction activities

Construction activity/process	Uses/requirement	Approximate volume (Total ML)[a]	Quality	Flow rate	Potential sources[a]
Earthworks	Material and soil conditioning, and general dust suppression	High 130 ML – material conditioning 62 ML – dust suppression Haul road/laydown areas – 49 ML	Low	High	River, dam or bore
Construction camp	Drinking water, showers, toilets, washing and cooking facilities	Low – provided by ARTC from mains supply (1 ML/month of operation)	High	Low	Town supply and water harvesting
Concrete	Bridge and culvert locations	Medium	High	Low	Town mains due to quality requirements
Trackworks	Ballast dust suppression during ballasting and regulating activities	Low (0.36 ML)	Low	Low	River, dam or bore

Table note:

a Potential water sources and estimated volumes as per the Inland Rail: Phase 2 – NS2B Constructability Assessment (Draft) October 2019.

Water requirements for earthworks and trackworks during the construction phase would be met with water sourced from the Boggabilla Weir, located on the Macintyre River approximately 9 km upstream of Goondiwindi. The weir has a storage capacity of 5,850 ML and is used to re-regulate releases from Glenlyon Dam and to conserve unregulated inflows. There is an opportunity to apply for an approval or licence to take construction water from this water source to fulfil the construction water requirements. It is assumed the licence would be for approximately 100 ML per year (1.7 % of the weir's storage capacity) for a duration of approximately 3 years. The township of Boggabilla is currently supplied with water from the Boggabilla Weir. The township has a current entitlement of 120 ML per year (2% of the storage capacity) (FFJV 2019).

This proposal will have to be progressed with the Border Rivers Commission. Any impacts associated with this water extraction would be assessed as part of the water use approval (FFJV 2019).

A Water Access Licence from WaterNSW is generally required to extract water from rivers or aquifers to use for irrigation, industrial or commercial purposes. The *Water Management Act 2000* governs the issue of Water Access Licences and approvals for water sources (rivers, lakes, estuaries and groundwater) in New South Wales where water sharing plans have commenced. There is a water sharing plan for the NSW Border Rivers Regulated River Water source, dated 2009.

Potential impacts to surface water associated with the use of water during the construction phase are assumed to be minimal due to the following:

- Potential for generation of construction water runoff is considered to be low, as most water will infiltrate into the ground or evaporate after being applied
- The quality and volume of runoff will be controlled through a soil and water management plan, and erosion and sediment control management plan.

6.1.2 Construction phase impacts

The proposal related activities associated with construction, commissioning and reinstatement phase are listed in Table 6.2.

Potential impacts to water quality from the proposal during the construction phase include:

- Increased water turbidity and sedimentation as a consequence of:
  - Vegetation clearing, which could leave exposed soils prone to erosion
  - Topsoil stripping and earthworks, and excavation/trenching for infrastructure and material borrow pits, which could expose soils that could be eroded
  - Erosion of stockpiled materials, if these are not contained
- Changes to water chemistry resulting from:
  - Accidental spills and leaks of chemicals or fuels from construction equipment or fuel storages, which could contaminate surface water if proper practices were not followed during direct runoff, overland runoff or after a spill.
  - Disturbance of saline soils during construction, which could increase salinity in runoff
  - Subsoil exposure within excavations and borrow pits, which could leach salts or other chemicals from the soil into overland runoff the erosion of stockpiled materials, which could lead to increased nutrient concentrations in runoff.

The impact of sediment loads to be washed or deposited into downstream watercourses includes 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.

Changes to the water chemistry of overland flow could create toxic conditions for downstream aquatic environments.

Wastewaters from wastewater provisions made for the construction camp would be treated by package treatment plants. Approvals related to the running of the accommodation camp will be provided by ARTC, or their nominated service provider selected to run the camps.

The proposal seeks to manage waste water in accordance with the principles of the waste hierarchy outlined in the Waste Avoidance and Reuse Recovery Act 2007. The reuse of waste water is beneficial to the environment, as it draws on a resource that would otherwise be discarded and wasted. It also reduces water usage, which is an on-going concern within the local government areas of Gwydir and Moree Plains as they experience prolonged periods of drought. The effluent derived from the package sewage treatment system is proposed to be managed through irrigation. The fields to the north and south of the construction camp have been identified as a potential effluent disposal location, subject to further investigation in a future phase of the proposal.

The sewage treatment plant will only manage domestic sewer/wastewater produced by the proposed camp. Wastewater generated will be from the site kitchen, laundries, toilet and shower required to service the 350-person camp. All wastewater will be captured onsite and will be treated by a sewage treatment plant. The design and operation of the plant must ensure that the performance of the wastewater infrastructure meets the minimum requirements for human health and the environment relevant for the end use of the treated effluent, achieving water quality suitable for reuse in non-potable applications, e.g. irrigation.

The risk of in-stream earthworks leading to changes in water quality is considered to be low where there are existing water way crossings over Back Creek, Mobbindry Creek and Forest Creek as existing infrastructure will be retained where possible. Where new culverts are required, culvert installation will involve placing scour protection around the culvert, and restoring and revegetating disturbed areas. Scour protection measures may also be installed upstream and downstream of culverts, on disturbed stream banks, and around waterfront land to avoid erosion. The placement of scour protection measures will minimise obstructions to fish passage (Constructability Assessment (Draft) FFJV 2019).

New bridges are proposed, including an approximately 1.8 km long viaduct that crosses Whalan Creek, Tucka Tucka Road and the Macintyre River. The anticipated methodology for bridge construction works includes installation of scour protection including protective measures in downstream areas to prevent erosion and sedimentation of watercourses, and restoring and revegetating disturbed areas the following works. The placement of protective measures will minimise obstructions to fish passage.

A 1,750m viaduct will be constructed over Whalan creek and the Macintyre River. For these waterway crossings, it is expected that no substantial vegetation clearing or earthworks will be required at these locations. Where a new viaduct is proposed across a perennial stream (the Macintyre River), bridge piers will be constructed on the banks of the river, outside the established waterline during baseflow conditions. Potential impacts to surface water during construction will be controlled through a soil and water management plan, and sediment control management plan All other constructed crossings are above ephemeral streams, and works will be undertaken when the stream beds are dry.

Where vegetation clearance occurs, erosion risks would be controlled through replanting that will occur as part of the works. Salinity issues would be controlled with topsoil stripping, so that any exposed potentially saline soils can be covered prior to re-establishment of vegetation.

Changes to turbidity and chemistry could also result from localised change in overland flow regimes to proximal watercourses. Impacts could arise from diversions to surface water flow regimes that may be required i.e. around borrow pits. If the diversions do not have sufficient conveyance capacity or stabilisation, these could lead to erosion, turbidity and sedimentation in waterways. Clearing activities may increase the amount runoff and hence the volume and rate of water entering waterways, which could lead to erosion. Where borrow pits need to be dewatered, the water will not be discharged directly to waterways.

Table 6.2 Description of proposal related activities associated with construction, commissioning and reinstatement and operational phase

Phase	Infrastructure activity	Description of activities	Duration of disturbance
Construction	Site preparation	Vegetation clearing	Permanent
		Topsoil stripping	Temporary/ Permanent
		Construction of temporary site compounds	Temporary
		Construction of rail access roads	Permanent

Phase	Infrastructure activity	Description of activities	Duration of disturbance
		Installation of offices, hardstands etc.	Temporary
		Stockpiling	Temporary
	Utility diversions	Excavation	Temporary
		Trenching	Temporary
		Modification, diversion and realignment of utilities and associated infrastructure	Temporary/ Permanent
	Drainage	Culvert installation	Permanent
	Structures	Construction of bridges over main waterways	Permanent
		Road/rail bridge construction	Permanent
	Civil works	Cutting construction	Permanent
		Embankment construction using cut to fill from rail alignment and borrow to fill from external borrow sources, where required	Permanent
		Construction of temporary haul roads	Temporary
		Drainage controls	Temporary/ Permanent
	Road works	Road realignment	Permanent
		Construction of permanent rail maintenance access roads	Permanent
	Rail logistics	Sleeper stockpiling	Temporary
		Rail stockpiling	Temporary
	Rail construction	Drilling	Temporary
		Ballast installation	Temporary
		Sleeper placement	Temporary
		Rail placement	Temporary
		Installation Train signals and communications infrastructure	Temporary
		Demobilising site compounds	Temporary
Commissioning and Reinstatement	Demobilisation/ Reinstatement	Establish permanent fencing	Permanent
		Restoration of disturbed areas, including revegetation where required	No disturbance
	Spoil mounds	Storage of excess or unsuitable cut and fill material used in the conversion of haul roads and construction access roads into permanent roads	Permanent
	Restoration	Minor maintenance works	Temporary
	Road works	Bridge and culvert inspections	No disturbance
		Sleeper replacement	Temporary
		Rail welding	Temporary
		Rail grinding	Temporary
		Ballast dropping	Permanent
		Track tamping	Permanent
		Major periodic maintenance	Permanent
Operation	Train operations	Train movement along rail	Permanent
	Operational maintenance	Ongoing vehicle movement within rail corridor	Permanent

Pollutants that may be introduced into the water cycle include:

- Sediments, resulting from earthworks and erosion of exposed soils. Could also lead to potential salinity issues
- Chemicals, including fuels and oils used for construction machinery, heavy metals from rail grinding and welding, compounds leaching from ballast materials, and salts mobilised from surface soils or shallow groundwater.

The quantity of these pollutants that might discharge to the receiving environment is likely to be negligible, meaning of such a small quantity that if any were released to the environment, then remediation or clean-up could be immediately undertaken with equipment and materials kept on site. Many of the mitigation measures proposed for the management of the construction works have been specifically developed to limit the release of these pollutants to the environment (refer Section 6.2).

All construction phase works would be conducted in accordance with the Construction Environmental Management Plan (CEMP), which includes guiding the stripping, stockpiling and management of topsoil where it contains seedbank or weed material, and a soil and water management plan, and erosion and sediment control management plan. Borrow pits, construction laydown areas and camps are construction phase works that will be modelled by the contractor during the detailed design phase. No point source discharges are proposed.

6.1.3 Operational phase impacts

The proposal-related activities associated with the operation phase are listed in Table 6.2. Potential impacts during operation include:

- Increases in water turbidity and sedimentation resulting from:
  - Repair or maintenance of roads or tracks requiring the removal of vegetation, which in turn could result in erosion and/or sedimentation of waterways
  - Increased runoff, which could result in erosion, from the rail formation due to the covering of pervious soils with rail ballast
  - The creation of concentrated flow paths, which have an increased potential to erode soils
- Potential changes to water chemistry during operation have been identified by Vo *et al*, 2015, and these include:
  - Materials deposited on to the railway formation such as potential spillages of fuel or chemicals from freight or trains
  - Wear of tracks or compounds formed from the dissolution of the ballast materials
  - Repair or maintenance of roads or tracks, which could lead to the introduction of chemicals/materials to waterways.

Pollutants that may be introduced into the water cycle include:

- Sediments, resulting from erosion of exposed soils as a result of ad hoc maintenance works
- Chemicals, including fuels and oils used for machinery and railstock, heavy metals from rail or machine wear, compounds leaching from ballast materials, and salts mobilised from surface soils or shallow groundwater if earthworks are required, or flow paths diverted.

Materials may be deposited on the rail formation, which could build up over time and be washed off with stormwater runoff. The quantity of pollutants that might discharge to the receiving environment from surface runoff from the rail corridor was estimated using computer modelling software, Model for Urban Stormwater Improvement Conceptualisation (MUSIC). MUSIC is the industry standard software for the estimation of pollutant generation in runoff, and treatment in stormwater treatment devices. This has been specifically addressed in Section 7.2.2.

6.1.4 Cumulative impacts

For the proposed NS2B alignment, a CIA was undertaken where potential surface water impacts of the proposal were assessed together with existing or planned surrounding activities. Since the proposal could potentially impact Whalan Creek and the Macintyre River, the area of influence was considered to be the Border Rivers catchment. There is the potential for cumulative impacts to water quality arising from:

- Increasing sediment loads from earthworks with a small impact locally, but due to the length of the rail corridor and extent across the landscape, could have an impact at the bottom of the catchment
- Changes to water chemistry that could place increasing stress on organisms in the receiving aquatic environment.

Further, cumulative impacts to water quality may only be apparent during wet periods of a large enough magnitude that allows broad flow connection across the floodplain. Cumulative impacts are specifically addressed in EIS Chapter 26: Cumulative impacts.

6.2 Mitigation measures – current controls

Impacts to receptors will be reduced to acceptable levels through the following hierarchical process: avoid wherever possible, minimise as far as is practical and then mitigate where avoidance and minimisation is not possible. ARTC has committed to applying impact mitigation measures to minimise project related impacts upon environmental attributes. The mitigation measures are environmental management measures that have been incorporated as standard to the proposal, and as such, are incorporated into the impact assessment at a pre-mitigation impact assessment level. The current controls from the design relevant to water quality are listed in Table 6.3.

Mitigation for the construction phase includes environmental management measures to prevent or limit erosion and sedimentation through the design, planning and construction process, including:

- The preparation of erosion and sediment control plans, and soil management plans
- Siting of works to minimise the disturbance footprint
- Hydraulic modelling and analysis to confirm that measures are sized appropriately
- Earthworks guidelines and controls
- Implementation of erosion and sediment control measures
- Rehabilitation and reinstatement plans and works proposed for disturbed areas.

Construction phase protection measures would be designed in accordance with the 'Blue Book' (Landcom 2004, Managing Urban Stormwater: Soils and Construction). The design and sizing of construction phase water quality control measures varies depending on the soil types, and protection is typically provided for design events ranging between 0.5 to 4 events per year (*i.e.* between the 3 month ARI event or about 13 mm in one hour to the 2 year ARI event or about 31 mm in one hour)). This would be documented as a soil and water management plan and erosion and sediment control management plan, a part of the CEMP.

Impacts to hydrology as a result of the construction phase are assessed in the Hydrology and Flooding technical report prepared for the North Star to NSW/QLD Border EIS (FFJV 2020b). Assessments are undertaken for flow velocities, potential for scour, afflux, change in time of submergence, change in flow distribution. This reports that flood impacts are similar across all phases of the proposal, including construction.

Construction phase activities with the potential to impact water chemistry, such as maintenance and refuelling, would be carried out with appropriate bunding or containment measures to avoid impacts to waterways, aquatic habitats, and groundwater in accordance with regulatory requirements, legislation and regulations relevant to permissible works in/near watercourses and the release of contaminants to waters. Australian Standards relating to the storage and handling of hazardous substances would be adhered to where applicable. Mitigation for impacts arising from saline soils would be captured in soil management plans.

Water consumption during the operation phase would be guided by the Sustainable Design Guidelines (version 4.0) by Transport for New South Wales, which requires projects to reduce potable water consumption where practicable.

Mitigation for the operation phase includes measures to prevent or limit changes to geomorphology, erosion and sedimentation by providing for hydraulic modelling and analysis, to guide the design of flow controls and site stabilisation measures so that they are sized appropriately for the expected conditions. The Hydrology and Flooding technical report prepared for the North Star to NSW/QLD Border EIS discusses the criteria which have been adopted for the design of rail drainage structures, many of which serve to minimise any alterations to existing flow characteristics (FFJV 2020b). Most notably, flow velocities at drainage structure outlets have been limited so as to minimize erosion and scour. Section 4.2 of the Hydrology and Flooding technical report prepared for the North Star to NSW/QLD Border EIS elaborates further on the velocity criteria, stating that soil properties are used to calculate allowable outlet velocities (FFJV 2020b). Where no such values are available, conservative limits are adopted. Another key criterion has been the minimisation of changes to existing flood flow distributions. Table 39 of the Hydrology and Flooding technical report prepared for the North Star to NSW/QLD Border EIS shows design and existing case peak flows for the 1% AEP design event at various locations around the Border Rivers floodplain. Maximum changes are still under 2% (FFJV 2020b).

Operation phase measures to mitigate impacts to water chemistry include the implementation of ARTC's spill and contamination procedures and managing the proposal in accordance with ARTC's Environmental Management System/applicable licences/conditions of approval.

Further, to assess that the operation of the proposed rail alignment does not impact water quality, surface water monitoring is proposed. This will include the relevant WQOs, parameters, and criteria from the EIS surface water quality chapter, for the specific monitoring locations and frequency described therein. Provision has been made for corrective actions should the outcomes of rehabilitation and/or reinstatement/stabilisation not achieve to the trigger values adopted for water quality.

Table 6.3 Current controls from the reference design for the protection of surface water quality

Delivery phase	Aspect	Proposed mitigation measures
Construction	Increased water turbidity and sedimentation	■ A soil and water management plan, and erosion and sediment control management plan will be developed as part of the construction environmental management plan, which complies with the project conditions of approval, relevant regulatory requirements and industry guidelines (e.g. Managing Urban Stormwater – Soils and Construction - NSW, etc.). This is expected to include: – Water quality and soil/land conservation objectives for the project – Temporary erosion and sediment control measures (including progressive Erosion and Sediment Control Plans that allow for staging of erosion and sediment controls as construction progresses) – Rainfall monitoring requirements across the project area – Workplace health and safety requirements relating to management of contamination and unexploded ordnance risk – Management of problem soils (e.g. acid sulphate soils, erosive, dispersive, reactive, acidic, sodic, alkaline soils) – Stockpiling and management/segregation of topsoil where it contains native plants seedbank or weed material – Vehicle, machinery and imported fill hygiene protocols and documentation – Measures to prevent/minimise mud and dirt being tracked onto public roadways by trucks and any equipment leaving the site – Requirements for training, inspections, corrective actions, notification and classification of environmental incidents, record keeping, monitoring and performance objectives for handover on completion of construction – Any other requirements necessary to comply with conditions of approval, subsequent approvals or regulatory requirements. ■ The construction of bridges, waterway crossings and waterway realignment/diversions is scheduled and/or staged to minimise impacts to bed, banks and environmental flows, in accordance with relevant regulatory requirements. ■ Design and construction of waterway realignments considers staging requirements/temporary works, in accordance with relevant regulatory requirements. ■ The siting of temporary construction facilities compounds, stockpiles, fuel storage, laydown areas, temporary access roads and staff parking will be in accordance with the project conditions of approval, and sited to minimise the extent of disturbance. ■ Temporary waterway crossings are rehabilitated in accordance with conditions of approval and the Reinstatement and Rehabilitation Plan. Riparian vegetation and aquatic habitats are identified and avoided where possible ■ The project must be designed, constructed and operated so as to maintain the *NSW Water Quality Objectives* where they are being achieved within the locality of this project, unless an EPL in force in respect to the project contains different requirements in relation to the *NSW Water Quality Objectives,* in which case those requirements must be complied with. These outcomes will be identified within the construction environmental management plan.
Operations		■ The project boundary requirements defined for the project allow sufficient room for provision of the required temporary and permanent erosion and sediment control measures/pollution control measures, where identified, as a mitigation measure for an identified environmental impact or risk

Delivery phase	Aspect	Proposed mitigation measures
Construction	Changes to water chemistry	▪ The siting and scale of stockpiles, construction compounds, fuel storage and laydown areas and other construction areas shall be informed by a flood risk assessment, relevant conditions of approval and relevant regulatory requirements. ▪ Opportunities to re-use/recycle construction water are identified and implemented where feasible during construction. ▪ Requirements for construction water (volumes, quality, demand curves, approvals requirements and lead times) will be defined during design. e.g. water used for dust suppression will not result in adverse environmental or health impacts. ▪ A surface water monitoring framework will be developed as part of the soil and water management sub-plan in the construction environmental management plan. It will identify monitoring locations at discharge points, and selected locations in watercourses where works are being undertaken. ▪ Water quality should be monitored during construction in accordance with the surface water monitoring framework. ▪ Demolition of bridges and waterway crossing structures does not introduce pollutants or waste materials into waterways.
Operations		▪ Maintenance activities and refuelling must be carried out at an appropriate distance from riparian vegetation and waterways, with appropriate measures in place to avoid impacts to waterways, aquatic habitats, and groundwater in accordance with relevant regulatory requirements. Specifically, relevant legislation and regulations that specify requirements about permissible works in/near watercourses and release of contaminants to waters should be referred to. Additionally, relevant Australian Standards should be considered and adhered to, where applicable and relevant. ▪ ARTC will implement its spill and contamination procedures during the operational phase of the project

7 Impact assessment

7.1 Significance assessment and mitigation measures

A significance assessment has been undertaken following the ARTC impact assessment framework. In summary, potential impacts were grouped into two categories:

- Increased water turbidity and sedimentation
- Changes to water chemistry.

Accordingly, suitable management measures to mitigate significant impacts have been identified during the environmental assessment. The ARTC approved impact mitigation measures, relevant to surface water quality, which will be implemented for the proposal, are provided in Table 6.3.

Impacts were assessed using the significance assessment method. Table 7.1 summarises the assessment undertaken for the potential impacts of the proposal on the surface water quality objectives. For each identified potential impact, the assessment considered the following:

- The initial impact significance assessment rating assumes that the design considerations to reduce impacts would be implemented.
- The residual impact significance incorporates any additional mitigation measures that would be required to decrease the impacts of the assessed action.
- The sensitivity of the receiving environments was assessed to be ‘high’. The Macintyre River and the other waterways within the study area form part of an Endangered Ecological Community and are currently exposed to the threatening processes associated with rural land use, land clearing and disturbance, which are widespread and have compromised the integrity of this ecological community. The high sensitivity was selected reflecting a conservative approach used through this report in assessment. Specific strategies for this sensitive environment receptor have not been implemented as construction surface water monitoring is expected to be used to identify any realised potential impact (from the moderate residual risk of impact). The key waterway considered in the significant residual impact is the Macintyre River (due to the perennial nature) and surface water monitoring will be used during construction.
- The magnitude of the initial impact was assessed to be moderate as impacts would likely be contained within the region of the project. Application of appropriate project controls is expected to reduce the magnitude, resulting in a lower residual significance.

Table 7.1 Significance assessment including mitigation measures relevant to surface water quality

Potential impact	Phase	Initial impact significance			Mitigation measures required in addition to design considerations	Residual significance	
		Sensitivity	Magnitude	Significance		Magnitude	Significance
Increased water turbidity and sedimentation	Construction	High	Moderate	High	Current controls are considered sufficient to mitigate potential impact magnitude (refer Table 6.3)	Low	Moderate
	Operations		Low	Moderate	Current controls are considered sufficient to mitigate potential impact magnitude (refer Table 6.3)	Negligible	Low
Changes to water chemistry	Construction	High	Moderate	High	Current controls are considered sufficient to mitigate potential impact magnitude (refer Table 6.3)	Low	Moderate
	Operations		Low	Moderate	Drainage design (as part of detailed design) to incorporate vegetated embankments to treat surface water runoff. Otherwise, current controls are considered sufficient to mitigate potential impact magnitude (refer Table 6.3)	Negligible	Low

7.2 Impact assessment summary

7.2.1 Construction phase stormwater quality management

The sensitivity of the aquatic receiving environments were assessed to be 'high' principally due to being listed on a recognised or statutory State, national or international register as being conservation significance, in moderate to good condition, relatively well represented in the areas in which it occurs although its abundance and distribution are exposed to threatening processes. The pre-mitigation magnitude of the potential impacts of the proposal on water quality were assessed to be high for the construction phase as avoidance through appropriate design responses or the implementation of site-specific environmental management controls are required to address the impact.

The significance assessment identified that the current controls and impact mitigation measures relevant to surface water quality, which would be implemented for the proposal, would be sufficient to mitigate a high degree of potential conceivable impacts during the construction phase, such that the residual significance would be moderate.

Hence, it is considered that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm have been investigated and would be implemented through the mitigation proposed for the proposal.

With the proposed mitigation measures in place, the proposal construction impacts are considered transient the activities of the proposal would not be considered to worsen environmental conditions (where WQOs are not currently being met). The construction impacts are considered that no activities that would compromise the ability of catchment management initiatives or activities to work toward the achievement of WQOs over time, considering that construction is transient and has the potential to improve the WQOs through the operational phase. For example, where in-stream works need to be done to areas (for the purposes of the project) that are currently eroded or eroding, in-stream works will stabilise any erosion during the construction phase, following by rehabilitation works to ensure long-term stability, thus contributing to an improvement in stream conditions over time during the operational phase.

7.2.2 Operation phase stormwater quality management

For the operation phase, the ARTC-approved impact mitigation measures relevant to surface water quality were assessed to be sufficient for the purposes of mitigating impacts that could cause increased water turbidity and sedimentation. There is a risk of erosion that could result from changes to landform and overland flow paths. This risk would be managed by hydraulic modelling and analysis for any areas where flowpaths would be altered to ensure that mitigation measures were sized appropriately. Further, many stabilisation measures are recommended (refer Table 6.3). Thus, the operational environment within the rail corridor is expected to comprise a stable and well-vegetated landform, and no erosion is expected.

Similarly, for changes to water quality related to changes to flow and drainage paths, mitigation measures have been assessed to be sufficient. The drainage design for the proposal for both longitudinal and cross-drainage has been designed to convey the 1 per cent annual exceedance probability event. The conveyance for these events has been based on flows estimated for the local and drainage catchments. Where regional floods could influence flows, these have also been considered. Therefore, any changes to water quality resulting from changes to overland flow are expected to be minor and limited in extent.

Changes to flow within the rail corridor could be caused by the introduction of rail formation, which may reduce infiltration to subsoils. However, runoff from the rail formation would be designed to be spread as distributed flow along the length of the rail corridor. Therefore, no impacts to flow are expected beyond the rail corridor.

Impacts to water chemistry from the rail formation are expected due to the documented impacts of rail operation on water chemistry (Vo *et al.* 2015). Therefore, additional operation phase measures to mitigate impacts to water chemistry were considered necessary.

The requirements of the SEAR 10.1 (e) are:

> Demonstrate how construction and operation of the project will, to the extent that the project can influence, ensure that:
>
> - Where the NSW WQOs for receiving waters are currently being met they will continue to be protected
> - Where the NSW WQOs are not currently being met, activities will work toward their achievement over time.

In order to meet these requirements, runoff from the railway formation would need to be filtered. Filtration can be provided with designs typical for rail in rural areas such as vegetated embankments and vegetated longitudinal drains/swales. Runoff from the rail formation is typically discharged as distributed flow from the rock ballast to the surrounding landform. When this flow interacts with vegetation on the embankments and surrounding soils, pollutants in runoff are treated through the processes of physical settling and screening, chemical sorption and biological uptake. Vegetated embankments are considered part of the drainage design. If required where the terrain requires it, vegetated longitudinal drains can also provide a similar filtration function. However, such longitudinal drainage has not currently been identified as a requirement for drainage for the proposal.

For the rail corridor, vegetated embankments are most complementary to the drainage design; they allow for even, distributed flow along the length of the rail corridor. Vegetated longitudinal drains would be used where long drainage is required, as these keep water on the surface, minimising the need to disturb soil through excavation. Other treatment devices such as bioretention systems or constructed wetlands were considered unsuitable for the rail corridor since they require concentrated flow and considerable excavation.

Further, the requirements of the SEAR 10.1 (b) are:

> 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

In order to meet this requirement, the proposed rail formation and the proposed stormwater treatment systems were modelled using stormwater quality modelling software (MUSIC) to assess if the proposed treatments would be sufficient to ensure that the quality of runoff would not be impacted. Modelling was based on the following assumptions:

- A typical scenario of rail corridor of 1 km length was modelled (refer Figure 7.1)
- The rail formation was modelled as an impervious surface with losses of 15 mm. Rail formations are considered unlikely to generate runoff for events less than 15 to 20 mm (Vo et al. 2015).
- The rail corridor was modelled as pervious rural residential land for pollutant generation (as per the SEQ MUSIC modelling guidelines, Water by Design (2010) MUSIC Modelling Guidelines. Version 1.0 – 2010. South East Queensland Healthy Waterways Partnership
- Buffer strips were continuous alongside the rail corridor
- The buffer area was 50% of the upstream impervious catchment. This is the maximum that the MUSIC software will allow (i.e., the MUSIC model assumes that a rail formation 7 m wide will have a buffer strip 3.5 m wide). This matches the proposed design where the rail corridor is located on embankment.

The model is conservative in several ways:

- In many locations, space allocations for buffer areas were double the modelled buffer provision i.e. buffers were equivalent in area to the contributing catchment area. On flat terrain, the rail formation will drain to both sides. Therefore, 3.5 m wide formation will drain to 3.5 m width of buffer.
- Soil infiltration of 1.8 mm/h (representative of medium clay) was assumed for buffers strips and swales. Typically, soil infiltration may be higher than this in vegetated landscapes due to soil macropore flow
- Swales in some locations would provide additional treatment. This scenario was modelled with 500 m of swale for 1 km of rail corridor.

- The existing conditions may contain areas of localised erosion. These would be stabilised as part of the project during the construction phase.

This assessment determined that with such treatment measures in place, water quality leaving the rail corridor is expected to be similar to or better than the existing rural conditions. The pollutants assessed were Total Suspended Solids (TSS), Total Phosphorus (TP), and Total Nitrogen (TN). These parameters were chosen because they form the basis for the pollutant load reduction targets for stormwater runoff in NSW (Department of Environment and Climate Change (DECC) 2007). Managing urban stormwater: environmental targets) and throughout Australia (Engineers Australia 2006). They are also the pollutants that can be represented in the software used. Although other pollutants may be present in runoff (refer Sections 6.1.2 and 6.1.3), if treatment devices are designed to treat suspended solids, phosphorus, and nitrogen, they are likely to be effective for a range of particulate and dissolved contaminants.

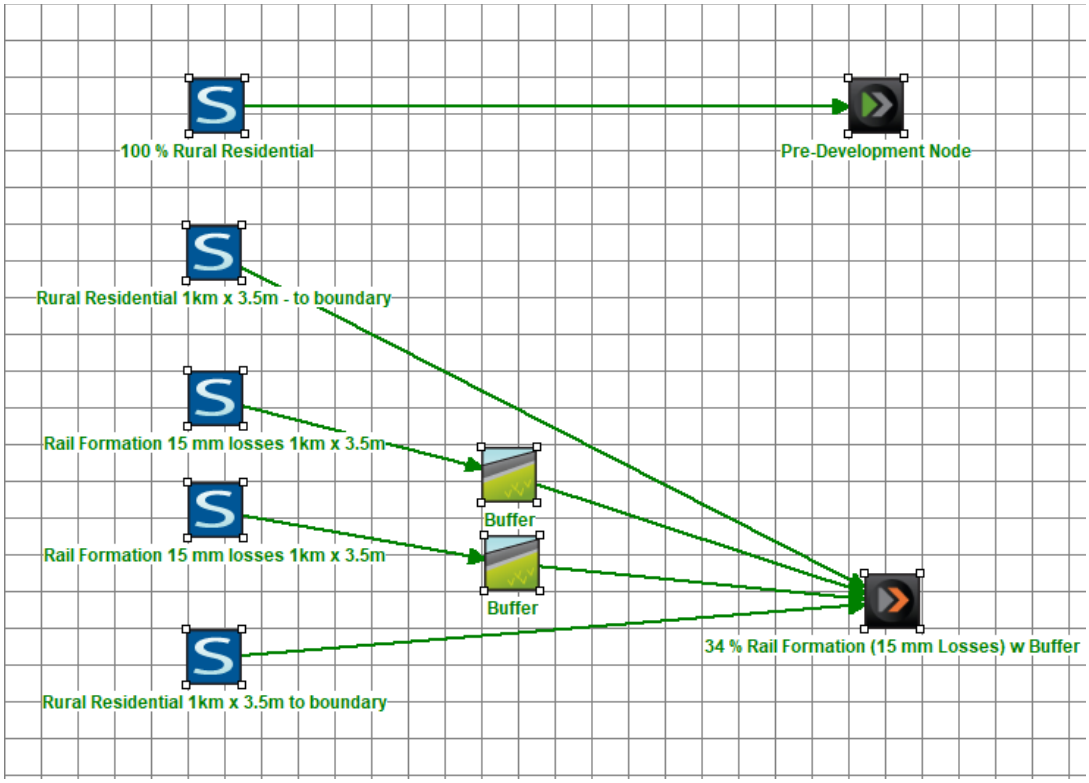

Figure 7.1 MUSIC model configuration

The modelling results (refer Table 7.2) that buffer strips alone would treat runoff such that TSS loads leaving the corridor were predicted to be lower than the existing conditions. Small increases in TP (11 per cent) and TN (17 per cent) would be expected. In practice, no worsening of runoff quality is expected. Although the model predicts small increases, MUSIC is limited to modelling buffer strips up to only 50 per cent of the size of the upstream catchment, and in most cases a wider buffer strip (~100 per cent of the catchment) would be provided. It is not possible to model the full extent of the proposed buffer strips, but it is expected that wider buffer strips would provide a higher standard of treatment and that detrimental impacts to water quality are unlikely.

A second scenario modelling buffer strips with additional treatment in the form of a downstream swale (refer Table 7.3) predicted decreases in runoff pollutant loads for all constituents TSS, TP and TN when compared to the existing conditions.

Table 7.2 Pollutant loads and pollutant removal effectiveness of scenario with proposed buffer strips

Pollutant	Existing conditions (kg/yr)	Proposal – unmitigated (kg/yr)	Pollutants remaining after treatment - buffer strip (3.5 m) (kg/yr)	Relative change compared to existing (per cent)
Total Suspended Solids	491	815	365	-25.7 per cent
Total Phosphorus	0.42	0.79	0.468	11.4 per cent
Total Nitrogen	3.71	5.87	4.35	17.3 per cent

Table 7.3 Pollutant loads and pollutant removal effectiveness of scenario with proposed buffer strips + swales

Pollutant	Existing conditions (kg/yr)	Proposal – unmitigated (kg/yr)	Pollutants remaining after treatment with buffer strip (3.5 m) and swale (500 m) (kg/yr)	Relative change compared to existing (per cent)
Total Suspended Solids	491	815	240	-51.1 per cent
Total Phosphorus	0.42	0.79	0.366	-12.9 per cent
Total Nitrogen	3.71	5.87	3.53	-4.9 per cent

Hence, with these measures in place (as part of the drainage design), it is considered that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm have been investigated and would be implemented for the proposal. These mitigation measures would ensure that where the NSW WQOs for receiving waters are currently being met they will continue to be protected, and where the WQOs are not currently being met, the activities of the proposal and the stabilised landscape created by the proposal would be a lower risk to water quality than the surrounding rural and agricultural landscapes. For the operation phase of the proposal, the stable and well vegetated railway corridor is not likely to be a source of pollutants that would compromise catchment works designed to work towards the achievement of WQOs.

7.3 Monitoring

7.3.1 Surface water quality monitoring objectives

The construction phase has the highest potential to impact water quality, when rainfall during construction activities may result in the transport of sediment and particulates through runoff into receiving watercourses. Therefore, a Water Quality Monitoring Program is proposed to monitor the effectiveness of mitigation measures for surface water quality that would be implemented for the construction phase.

The water quality monitoring program would be developed in accordance with the Conditions of Approval, and would form part of the CEMP. Water quality objectives would be established prior to construction, and would be developed in consultation with relevant agencies such as the NSW Environment Protection Authority, and the NSW Office of Water. The water quality criteria and trigger levels would be similar to and / or consistent with NSW Water Quality Objectives established by the Border Rivers Commission for the Macintyre River (refer Table 5.4 and Table 5.5) and trigger values appropriate to the location of the proposal (listed in Table 5.7 and Table 5.8).

7.3.2 Surface water quality monitoring sampling

Monitoring would be undertaken at the existing monitoring sites. Water quality sampling should be undertaken upstream, at the site (where practicable) and downstream in waterways, during the construction phase at locations where construction work is taking place.

The Macintyre River is a perennial stream and can be sampled on a regular basis (*i.e.* monthly) during baseflows throughout the construction phase. However, the other watercourses are ephemeral, and likely to be flowing only for a short duration after rain. Therefore, for ephemeral streams, an opportunistic event-based sampling program is proposed. Samples would be taken within 24 hours of a rainfall event (where feasible), when there is surface water flow. The Macintyre would also be sampled at the same time if construction work was taking place nearby.

The surface water monitoring program would include:

- Surface water quality samples are to be collected in accordance with industry-accepted standards and quality assured procedures, including the Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DECC 2008)
- Representative background monitoring data (including but not necessarily limited to representative data collected by the relevant councils, where readily available) for surface water quality would be used to inform an understanding of baseline water conditions prior to the commencement of construction
- A risk management framework, for the evaluation of the risks to surface water resources and ecosystems in the receiving environment, including definition of impacts that trigger contingency and ameliorative measures
- Identification of works and activities during construction and operation of the proposal, including runoff, emergencies and spill events, that have the potential to impact on surface water quality of potentially affected watercourses and riparian land
- The identification of environmental management measures relating to surface waters during construction and operation including erosion and sediment control and stormwater management measures
- Contingency and ameliorative measures in the event that adverse impacts to water quality are identified, with reference to the impact triggers defined as part of the water quality monitoring program
- Procedures for annual reporting of the monitoring results to the Secretary, EPA.

7.3.3 Monitoring parameters

A risk to water quality during the construction phase is the mobilisation of sediments from erosion of exposed soil during earthworks. This could result in high turbidity, decreases in dissolved oxygen and increases in salinity, which could lead to catastrophic events such as fish kills. Therefore, it is recommended that the following parameters be monitored:

- pH
- Turbidity (NTU)
- Electrical conductivity (EC)
- Dissolved Oxygen (DO).

Provided that monitoring can demonstrate that these parameters remain within the water quality criteria and trigger levels for the proposal, it is expected that the mitigation measures proposed for the construction phase are adequate. Discharge and runoff management

A surface water monitoring framework will be developed as part of the soil and water management plan in the CEMP. It will identify monitoring locations at discharge points, and selected locations in watercourses where works are being undertaken.

In the event that WQOs cannot be achieved for waters to be released, alternate treatment/ disposal options are to be implemented in accordance with any relevant and applicable condition of approval or legislation and regulations in place.

8 Conclusions

The surface water quality assessment addressed a range of SEARs relating to surface water resources: SEARs 8. Flooding, Hydrology and Geomorphology - 8.1 (d, e, f), SEARs 9. Water Hydrology 9.1, 9.2, 9.3 (a- f), 9.4, and SEARs 10. Water Quality 10.1 (a – i).

Potential impacts of the proposal to water quality were grouped into two categories:

- Increased water turbidity and sedimentation
- Changes to water chemistry.

A significance assessment was undertaken. The significance assessment was based on the following elements:

- The initial impact significance assessment rating assumes that the design considerations to reduce impacts would be implemented
- The residual impact significance incorporates any additional mitigation measures that would be required to decrease the impacts of the assessed action.

Findings are summarised below:

- During the construction phase, the significance assessment revealed that the ARTC's current controls, the impact mitigation measures that form part of the design relevant to surface water quality, would be sufficient to mitigate the high significance of potential conceivable impacts such that the residual significance would be moderate. With the proposed mitigation measures in place, the proposal construction impacts are considered transient and the activities of the proposal would not be considered to worsen environmental conditions (where WQOs are not currently being met). The construction impacts are considered such that no activities that would compromise the ability of catchment management initiatives or activities to work toward the achievement of WQOs over time, considering that construction is transient and has the potential to improve the catchment water quality through the operational phase.
- For the operation phase, the ARTC approved impact mitigation measures were assessed to be sufficient for the purposes of mitigating impacts that could cause increased water turbidity and sedimentation. The operational environment within the rail corridor is expected to comprise a stable and well-vegetated landform, and hence no erosion is expected.
- Operational impacts to water chemistry could result due to the potential impacts of rail operation on water chemistry. Therefore, additional operation phase measures to mitigate impacts to water chemistry were considered necessary. The additional mitigation measures proposed include the provision of natural filtration systems for the treatment of stormwater runoff from the railway formation, such as vegetated buffer strips and vegetated open drains/swales. These would be incorporated into the longitudinal drains that form part of the drainage design.

Hence, with these measures in place, it is considered that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm have been investigated and would be implemented for the proposal. These mitigation measures would ensure that where the NSW WQOs for receiving waters are currently being met they will continue to be protected, and where the WQOs are not currently being met, the activities of the proposal would not worsen the environmental conditions.

A CIA was undertaken where potential surface water impacts of the proposal were assessed together with existing or planned surrounding activities. The cumulative impact assessment identified a low significance due to the physical distance of each project from the proposal and via adoption and implementation of recommended mitigation measures.

Requirements for a monitoring program for surface water are outlined in this report. Monitoring is required to provide an on-going assessment of the potential impacts of the proposal on the identified surface WQOs.

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