Bulloo Interlink Pipeline

Environmental Authority

Water Assessment

APA Bulloo Interlink Pipeline Pty Ltd

June 2026



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Executive summary

The project

APA Bulloo Interlink Pipeline Pty Ltd (APA), which is part of the APA group of companies (the APA Group) is planning to develop the Bulloo Interlink Pipeline, an underground high-pressure gas pipeline linking the South West Queensland Pipeline in Queensland with the Moomba to Wilton Pipeline in New South Wales (NSW). The Queensland section of the Bulloo Interlink Pipeline (referred to as 'the project' for the purposes of this document) is approximately 236 kilometres (km) long. Overall, the pipeline has a total length of approximately 339 km and will provide a more direct route for natural gas to travel from Australia's northern production areas to southern gas markets.

This report

This report has been prepared by GHD Pty Ltd (GHD) as part of the environmental authority (EA) for the project. The EA supports an application for approval of the project in accordance with the *Environmental Protection Act 1994* (Qld) (EP Act).

This report assesses the potential surface water quality, hydrology and flooding, wetlands and groundwater impacts of the project in accordance with the environmental assessment requirements of the *Application requirements for activities with impacts to water* (DETSI, 2026).

The assessment has been undertaken in accordance with relevant Queensland legislation, policies and guidance, including the EP Act and Environmental Protection (Water and Wetland Biodiversity) Policy 2019.

Existing environment

The project site is located within the Lake Eyre Basin, which is divided into subbasins, of which the project site is located within the Bulloo River drainage basin and the Cooper Creek drainage basin. Both of which are arid to semi-arid, internally draining (endorheic) systems characterised by low relief, episodic rainfall, and predominantly ephemeral watercourses. Surface water flow is highly event-driven, with long dry periods punctuated by infrequent but sometimes extensive flood events after rainfall.

The pipeline alignment is located within the Lake Eyre Basin and traverses the Bulloo River and Cooper Creek drainage basins. Both basins are arid to semi-arid, internally draining (endorheic) systems characterised by low relief and episodic rainfall. Watercourses are predominantly ephemeral, with surface water flows driven by infrequent but sometimes extensive rainfall events.

The pipeline alignment intersects numerous drainage features ranging from small headwater channels to larger watercourses such as the Wilson River, Tippera Creek and Murrawarra Creek. Flooding is typically shallow and laterally extensive across broad floodplains, meaning that small changes to surface topography can influence overland flow pathways.

Wetlands mapped as general ecological significance and high ecological significance occur along, and downstream of, several waterways intersected by the pipeline alignment. These wetlands are primarily associated with ephemeral creeks, floodouts and floodplain environments and derive their ecological function from episodic inundation rather than permanent surface water.

Groundwater in the study area predominantly occurs within:

– shallow alluvial and unconsolidated sediments associated with watercourses, where groundwater is typically ephemeral or seasonal
– low-yielding, sub-artesian bedrock aquifers (Glendower Formation and Winton Formation), which are generally deeper and exhibit limited hydraulic connectivity with surface waters.

Groundwater dependent ecosystems, where present, are primarily associated with riparian corridors and drainage lines, and are considered to be supported mainly by episodic surface water flows and shallow, perched groundwater rather than regional groundwater systems.

Impacts from the project during construction

Construction represents the phase with the greatest potential interaction with water-related values. Key impact pathways include:

– temporary disturbance of surface drainage patterns and floodplain flow paths
– erosion and sediment mobilisation from cleared and disturbed areas
– localised impacts at watercourse crossings, including potential short-term changes to water quality
– temporary interaction with shallow groundwater at watercourse crossings
– temporary lowering of groundwater levels at existing landholder extraction bores where located within the zone of influence of construction water extraction bores
– risks associated with hydrostatic testing, irrigation of treated wastewater, trench dewatering, and accidental spills.

Hydrological and hydraulic modelling indicates that flooding is characterised by broad, shallow flow paths, and that project-related impacts on flooding and drainage are expected to be localised and temporary, provided that appropriate controls are implemented.

Potential impacts to groundwater during construction are expected to be limited to the short-term, with localised changes in groundwater level or quality where shallow groundwater is encountered, primarily near watercourses. These impacts are not expected to affect groundwater availability, groundwater users, or regional groundwater systems. Potential impacts from groundwater abstraction for construction water will be assessed prior to construction as part of the water servicing strategy.

Impacts from the project during operation

During operation, impacts on surface water, wetlands and groundwater are expected to be minimal due to the buried nature of the pipeline and reinstatement of surface drainage. Operational risks are limited to infrequent maintenance activities and low-probability failure scenarios.

Impacts from the project during decommissioning

During decommissioning, most of the pipeline is expected to remain in situ, significantly limiting disturbance. Any impacts associated with removal of surface infrastructure are expected to be localised, temporary and readily managed through standard controls.

Recommended mitigation measures

A comprehensive suite of mitigation and management measures has been developed in accordance with the mitigation hierarchy. Key measures include:

– avoidance of sensitive water features through alignment refinement and selection of trenchless crossings where appropriate
– implementation of robust erosion and sediment control measures
– maintenance and reinstatement of natural drainage and floodplain flow paths
– controlled management of hydrotest water and any temporary discharges
– spill prevention and response procedures
– irrigation of treated wastewater in accordance with regulatory requirements
– monitoring and adaptive management to respond to unforeseen conditions.

These measures will be implemented through the project Construction Environmental Management Plan and Operational Environmental Management Plan.

Conclusion

The assessment concludes that, with implementation of the proposed mitigation and management measures, the project can be constructed, operated and decommissioned without significant adverse impacts on surface water, wetlands or groundwater. Water-related impacts are expected to be localised, temporary and manageable, with no long-term degradation of water quality, hydrological processes or sensitive water-dependent receptors anticipated.

Acronyms and abbreviations

Acronym/abbreviation	Definition
ADWG	Australian Drinking Water Guidelines
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines
APA	APA Bulloo Interlink Pipeline Pty Ltd
APGA	Australian Pipelines and Gas Association
ARR	Australian Rainfall and Runoff
AS	Australian Standard
BoM	Bureau of Meteorology
BPESC	Best Practice Erosion and Sediment Control
CEMP	Construction Environmental Management Plan
DEA	Digital Earth Australia
CRoW	Construction Right-of-Way
DEM	Digital Elevation Model
DEHP	Former Department of Environment and Heritage Protection
DESI	Former Department of Environment, Science and Innovation (Qld) (now the Department of Environment, Tourism, Science and Innovation)
DETSI	Department of Environment, Tourism, Science and Innovation (Qld)
DLGWV	Department of Local Government, Water and Volunteers (Qld)
EA	Environmental Authority
EC	Electrical Conductivity
EP Act	*Environmental Protection Act 1994* (Qld)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EPP Water and Wetland Biodiversity	Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (Qld)
ESCP	Erosion and Sediment Control Plan
EV	Environmental Value
GAB	Great Artesian Basin
GDE	Groundwater Dependent Ecosystem
GES	General Ecological Significance
GHD	GHD Pty Ltd
HDD	Horizontal Directional Drilling
HES	High Ecological Significance
IECA	International Erosion Control Association
km	Kilometres
L/s	Litres per second
LGA	Local Government Area or Local Government Authority
m	Metres
m/d	Metres per day
m^2/d	Metres squared per day

Acronym/abbreviation	Definition
m/s	Metres per second
mbgl	Metres below ground level
mg/L	Milligrams per litre
ML	Mega Litre
ML/y	Mega litre per year
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
NSW	New South Wales
NTU	Nephelometric Turbidity Unit
OEMP	Operational Environmental Management Plan
PMST	Protected Matters Search Tool
QWQG	*Queensland Water Quality Guidelines 2009* (DEHP, 2009)
RIDA	Regional Interests Development Approval
RPI Act	*Regional Planning Interests Act 2014* (Qld)
SCADA	Supervisory Control and Data Acquisition
SEA	Strategic Environmental Area
SRTM	Shuttle Radar Topography Mission
TDS	Total Dissolved Solids
WMIP	Water Monitoring Information Portal
WQO	Water Quality Objective
µS/cm	Micro-Siemens per centimetre

Glossary

Term	Definition
Construction right-of-way (CRoW)	The area that will be directly disturbed to construct the pipeline within the study area (includes the trench, temporary storage areas and construction maneuvering areas). The nominal corridor width is up to 40 m.
Pipeline alignment	The pipeline centreline.
Pipeline easement (the easement)	The permanent operational easement for the project that will be established to facilitate ongoing access and maintenance. Allows the pipeline operator a legal right to enter land to construct, operate and maintain the pipeline. It is registered on the underlying land title and remains on title. Nominal easement width for the project is 30 m.
Project	The project includes constructing, operating (including maintaining) and decommissioning approximately 236 km of underground natural gas transmission pipeline located in Queensland, and associated above-ground infrastructure to connect to the South West Queensland Pipeline.
Project site	The term project site is used to refer to the land required to construct, operate (including maintain) and decommission the project, and defines the extent of land subject to project approval. The project site comprises the 40 m wide CRoW, within which the permanent 30 m easement and surface operational facilities would be located. It also includes additional land required outside the construction right of way for temporary and ancillary facilities, including construction compounds, temporary workspaces, temporary accommodation facilities, access track works, and land required to support the project's water servicing strategy.
Study area	The full extent of land with the potential to be directly or indirectly affected by the project (e.g., by noise and vibration, visual or traffic impacts), assessed for environmental values, including the project site and surrounding context.

1. Introduction

1.1 Project overview

APA Bulloo Interlink Pipeline Pty Ltd (APA), which is part of the APA group of companies (the APA Group) is planning to develop the Bulloo Interlink Pipeline, an underground high-pressure gas pipeline that will link the South West Queensland Pipeline in Queensland with the Moomba to Wilton Pipeline in New South Wales (NSW).

The Bulloo Interlink Pipeline includes an approximately 236-kilometre (km) long section in Queensland, which will provide a more direct route for natural gas to travel from Australia's northern production areas to southern gas markets. The pipeline has a total length of approximately 339 km, comprising about 103 km in NSW.

The section of the Bulloo Interlink Pipeline located in Queensland (referred to as 'the project' for the purposes of this document) will require an environmental authority (EA) under the *Environmental Protection Act 1994* (Qld) (EP Act). Approval for the NSW section of the Bulloo Interlink Pipeline will be sought under a separate approval process in accordance with NSW legislation and approval requirements.

1.1.1 Location

The project is located within the Bulloo Shire local government area in the vicinity of the Noccundra township within the traditional Country of the Wangkumarra People and Kullilli People. The project site extends south from the tie-in point with the South West Queensland Pipeline for about 186 km, then traverses south-west for about 30 km, and south about 20 km to the Queensland–NSW border. The project location and key project features are shown in Figure 1.1.

1.1.2 Key project features

The project will be designed, constructed and operated in accordance with the *AS 2885 Pipelines – Gas and Liquid Petroleum* series of standards (AS 2885) and the Australian Pipelines and Gas Association (APGA) *Code of Environmental Practice – Onshore Pipelines* (APGA Code of Environmental Practice) (APGA, 2022).

The key operational features of the project include:

– an underground high pressure, steel gas transmission pipeline with a length of about 236 km
– a permanent easement of up to 30 metres (m)
– supporting surface infrastructure, including:
    - beginning of line facility, including a connection to the South West Queensland Pipeline
    - temperature control station, including main line valve
    - cathodic protection units
    - main line valve
    - pipeline marker signs
    - permanent access tracks.

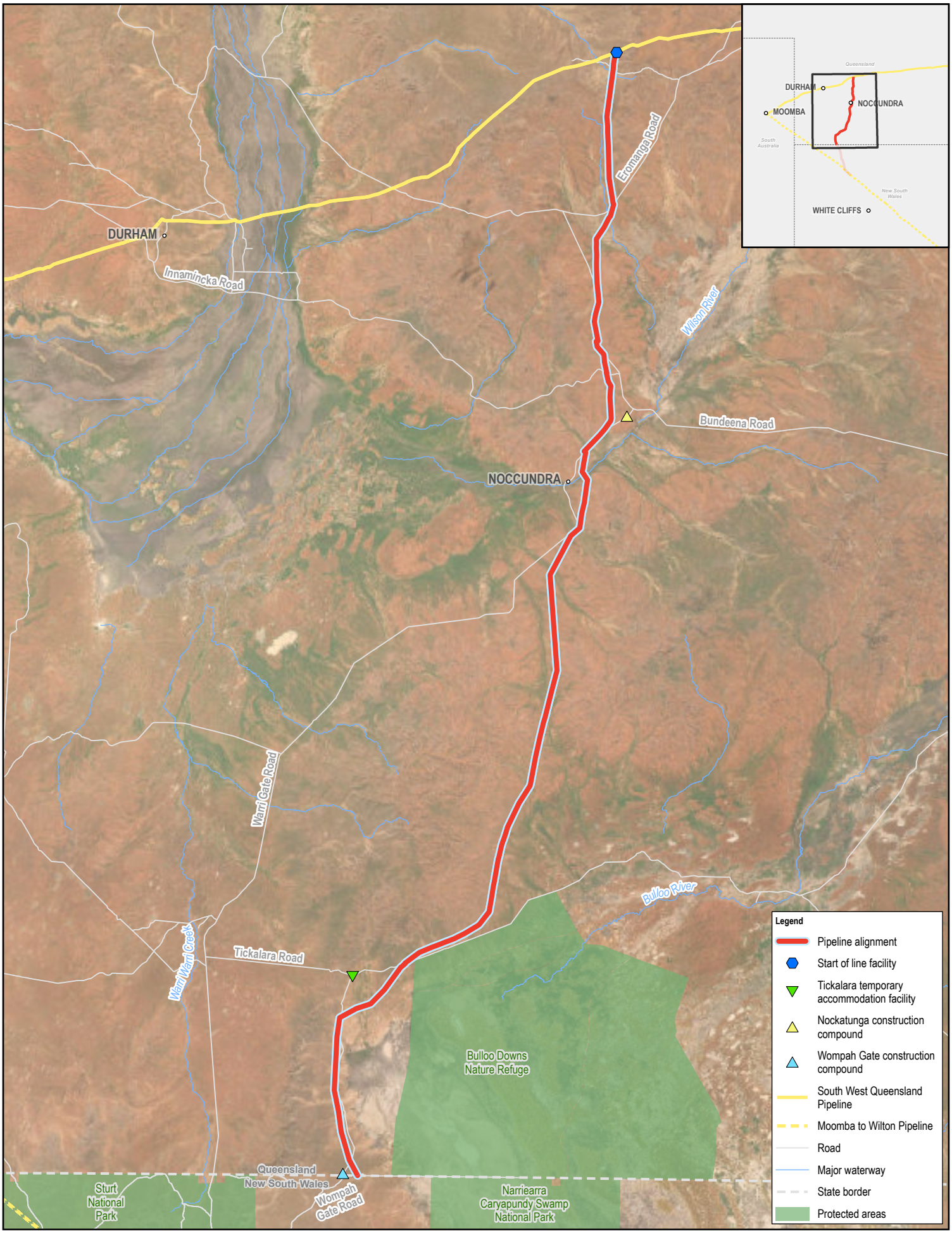
An approximately 40 m wide construction right-of-way (CRoW) will be established to facilitate construction and access.

Key ancillary facilities and infrastructure outside the CRoW would include:

– a temporary accommodation facility located at the intersection of Wompah Gate Road and Tickalara Road
– a construction compound facility to stockpile line pipe located on Wompah Gate Road near the southern end of the project site.

Smaller temporary workspaces are also proposed at regular intervals along the CRoW to support construction activities.

Further information on the project's features and indicative construction methodology is provided in Chapter 4 (Project description) of the Environmental Authority Supporting Information Report.



Paper Size ISO A4

0 4.5 9 13.5 18

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

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APA GHD

APA Group
Bulloo Interlink Pipeline

Project No. **12661648**
Revision No. **0**
Date **15/06/2026**

Project location and key features

Figure 1.1

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Data source: Earthstar Geographics, Esri, CGIARDNRMMRRD: Roads, Watercourse (2023), LGA (2025); GA: State border (2006). APA: Pipeline alignments, infrastructure, pipe stockpiles, camps (2026). NPWS: Estates (2026). Created by: acjackson

1.2 Purpose and scope of this report

This report assesses the potential water related impacts of the project in accordance with the *Application requirements for petroleum activities guideline* (DESI, 2024) and the *Application requirements for activities with impacts to water* (DETSI, 2026). This report:

– identifies the environmental values of receiving waters, including:
  - surface water
  - groundwater.
– identifies and assesses possible impacts to identified environmental values, whether during construction, operation, decommissioning, or cumulatively. These impacts may relate to:
  - discharges and releases, whether planned, unplanned, or uncontrolled
  - temporary or permanent water storages
  - groundwater abstractions or changes to recharge quantities or quality
  - the hydrology, water quality, and ecology of wetlands, lakes or other receiving waters.
– recommends measures to mitigate and manage the impacts and risks identified.
– informs the Regional Interests Development Approval (RIDA) assessment by evaluating potential impacts to water related environmental values within the Channel Country strategic environmental area (SEA).

This report addresses surface water, wetlands and groundwater from a hydrological and hydrogeological perspective only. Terrestrial and aquatic ecological values are assessed separately in Appendix B (Terrestrial Ecology Assessment Report) and Appendix C (Aquatic Ecology Assessment Report) of the Environmental Authority Supporting Information Report. No reassessment of ecological values, impact significance or ecological risk is undertaken in this report. Ecological outcomes are considered only to the extent necessary to identify hydrological pathways and receptors relevant to the assessment of water-related impacts.

1.3 Report structure and content

The structure and content of this report are outlined in Table 1.1.

Table 1.1 Structure and content

Section	Description
Section 1 – Introduction	Outlines the key elements of the project, and the purpose of this report (this section).
Section 2 – Legislative and policy context	Summarises the key legislative requirements and guidelines relevant to water quality, groundwater, water supply and flood studies.
Section 3 – Methodology	Describes the study area and methodology for the assessment.
Section 4 – Existing environment	Describes the existing environmental values of the study area and project site relevant to water.
Section 5 – Construction impacts	Examines the potential for water impacts during construction.
Section 6 – Operation impacts	Examines the potential for water impacts during operation.
Section 7 – Cumulative impacts	Provides an assessment of cumulative impacts.
Section 8 – Decommissioning impacts	Examines the potential for water impacts during decommissioning.
Section 9 – Recommended mitigation and management measures	Provides recommendations for mitigation during construction, operation and decommissioning.
Section 10 – Conclusion	Provides the key findings of the assessment.

1.4 Limitations

This report has been prepared by GHD for APA Bulloo Interlink Pipeline Pty Ltd and may only be used and relied on by APA Bulloo Interlink Pipeline Pty Ltd for the purpose agreed between GHD and APA Bulloo Interlink Pipeline Pty Ltd as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than APA Bulloo Interlink Pipeline Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations and assumptions set out in this report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

2. Legislative and policy context

This section details Queensland legislation considered relevant to water quality, groundwater, water supply and flood studies, as shown in Table 2.1.

Table 2.1 Key legislation and guidelines relevant to water quality, groundwater, water supply and flood studies

Guidelines and legislation	Description	Relevance to project
Environmental Protection Act 1994 (EP Act) Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water and Wetland Biodiversity)	The framework for environmental protection and water quality management establishes comprehensive requirements aimed at safeguarding the ecological integrity of the project site. It emphasises the identification and protection of key environmental values (EVs) and the achievement of water quality objectives (WQOs), focusing on the assessment and management of sediment, turbidity, and other potential contaminants that may arise during construction and operation. This framework includes specific measures for the preservation of wetlands and aquatic ecosystems, recognising their significance in maintaining biodiversity and ecological balance.	The project involves activities that may affect surface waters and wetlands within Queensland. The EPP Water and Wetland Biodiversity establishes EVs and WQOs that inform impact assessment and mitigation measures supporting the EA application.
Environmental Protection Act 1994 (EP Act) Environmental Protection Regulation 2019	The Environmental Protection Regulation 2019 supports the EP Act and prescribes the detail for processes contained in the EP Act. It contains the list of prescribed environmentally relevant activities (ERAs) regulated under the EP Act and the fees to be paid.	The project requires an EA for a resource activity for the pipeline. In addition, the project includes activities to irrigate treated wastewater to land at the temporary accommodation facility. The Environmental Protection Regulation 2019 defines sewage treatment as an ERA in Queensland and requires an EA to operate.
Fisheries Act 1994	The *Fisheries Act 1994* provides for the protection and management of fisheries resources in Queensland, including the conservation of fish habitats (FHAs). The Act regulates activities that may result in the removal, damage or disturbance of marine plants or fish habitat, and establishes approval requirements for works within waterways and wetland environment.	The project includes activities that may interact with watercourses and aquatic habitats, including temporary disturbance associated with construction works and waterway crossings. Consideration of fish habitat, waterway barrier works and requirements under the *Fisheries Act 1994* is addressed within Appendix C (Aquatic Ecology Environmental Assessment) of the Environmental Authority Supporting Information Report .
Regional Planning Interests Act 2014 (RPI Act)	The RPI Act is a key piece of Queensland legislation that safeguards land identified as being of regional significance, including priority agricultural areas, strategic cropping areas, SEAs, and priority living areas. The RPI Act aims to balance the needs of regional development with the protection of these vital land uses, ensuring that projects do not compromise the ongoing viability of agriculture, environmental values, or community interests.	A section of the pipeline alignment crosses the Channel Country SEA (section 4.3.3) as mapped under the RPI Act. As such, the project requires assessment under the RIDA framework to demonstrate that regional environmental values will be protected and that impacts are avoided or minimised to the greatest extent practicable. A separate RIDA application has been made.

Guidelines and legislation	Description	Relevance to project
Water Act 2000	The *Water Act 2000* serves as the primary legislative framework governing water resource management in Queensland. It establishes the requirements and approval processes for any works undertaken in watercourses, lakes, and springs, including the necessity for riverine protection permits. It also sets out the regulatory mechanisms for managing surface water hydrology, ensuring that any watercourse crossings associated with the project are appropriately assessed and approved to minimise environmental impacts. In addition, water plans developed under the *Water Act 2000* address the management of groundwater resources by regulating groundwater take, interference, and impact, requiring proponents to undertake comprehensive assessments to avoid adverse effects on GDEs and other users.	The project includes works located in watercourses, watercourse crossings, changes to surface water hydrology, groundwater interactions, and water supply. The provisions of the *Water Act 2000* apply to this project and are discussed through the report. Water taken to supply water (section 3.4.5) to the project may also trigger requirements for water licences defined in the water plans relevant to this project, under the *Water Act 2000*. The project falls within the following water plans: – *Water Plan (Warrego, Paroo, Bulloo and Nebine) 2016* – *Water Plan (Cooper Creek) 2011* – *Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017*.

3. Methodology

This section sets out how existing surface water and groundwater values will be defined, how potential impacts will be predicted and assessed across construction, operation (including maintenance) and decommissioning, and how practicable mitigation, monitoring and adaptive management will be developed. It follows the guideline for EA applications – *Application requirements for activities with impacts to water* (DETSI, 2026), the EP Act, and EPP Water and Wetland Biodiversity framework for defining EVs, WQOs and the required management hierarchy for surface water and groundwater.

In addition to EA requirements, the assessment approach has been designed to support the RIDA decision-making framework by focusing on outcomes relevant to the Channel Country SEA. This includes explicit consideration of floodplain-scale processes, episodic flow regimes, wetland connectivity and groundwater–surface water interactions characteristic of the Channel Country. Impact pathways have been assessed at an appropriate spatial scale to determine whether project activities could result in lasting changes to regional hydrology or water-dependent environmental values, rather than short-term, localised construction effects.

3.1 Statutory and guidance alignment

This assessment has been designed and documented to demonstrate alignment with relevant statutory requirements, application guidance and technical standards applicable to water-related impacts associated with petroleum pipeline developments in Queensland. The instruments listed in Table 3.1 have informed both the scope of assessment and the methods applied.

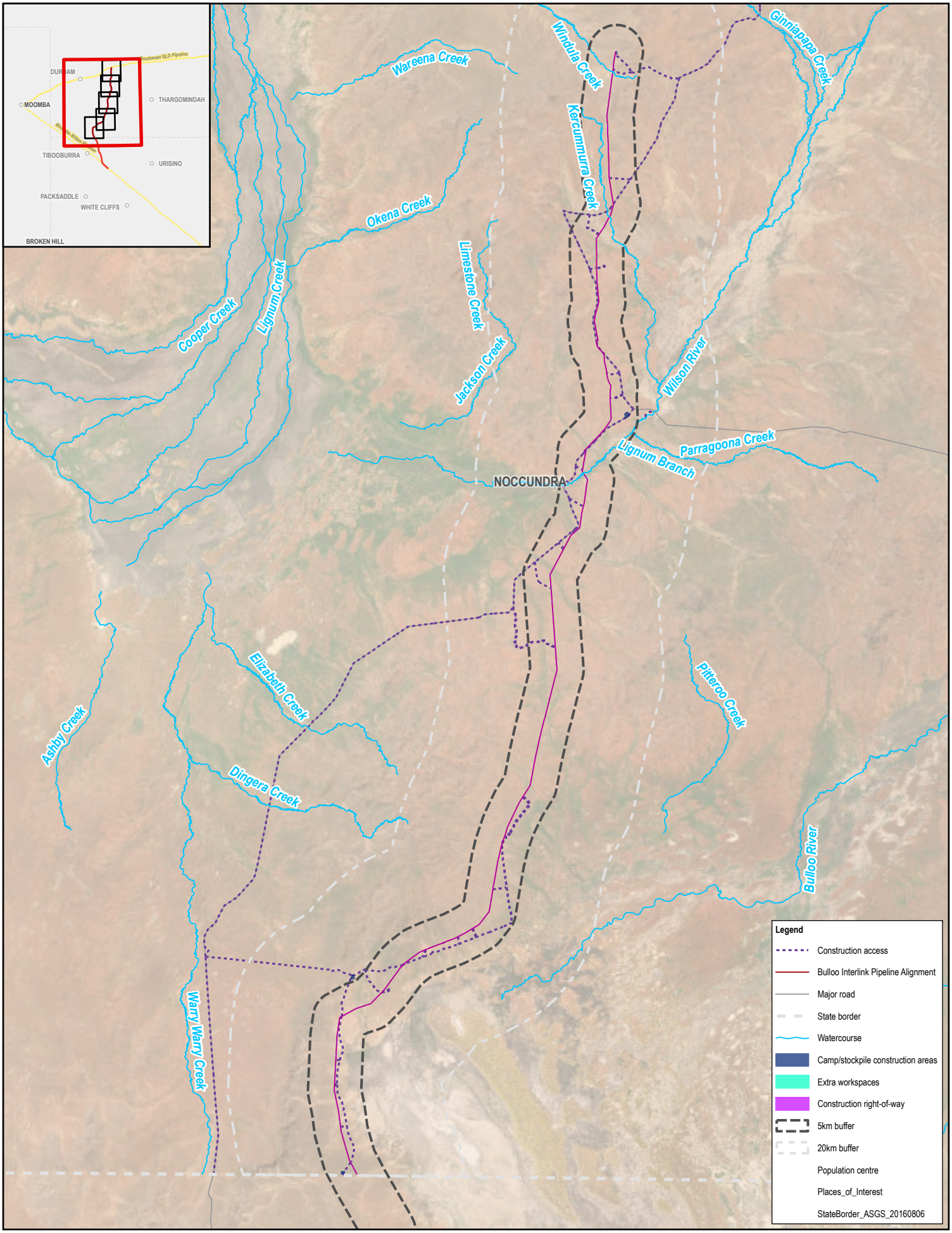
Table 3.1 Statutory, guidance and technical alignment

Category	Statutory instrument or guidance	Relevance to this assessment
Legislation and statutory policy	EP Act Environmental Protection Regulation 2019	Establishes the legislative framework for assessment of water-related environmental impacts, including Schedule 5 performance outcomes for water, wetlands and groundwater.
	EPP Water and Wetland Biodiversity	Defines environmental values, water quality objectives and management intent for surface waters and wetlands relevant to the project site.
Assessment and application guidance	*Application requirements for activities with impacts to water* (DETSI, 2026)	Guides baseline data collection, risk assessment, stormwater management, dam design, groundwater assessment, monitoring and rehabilitation measures for EA applications.
	Application requirements for petroleum activities guideline (DESI, 2024)	Provides pipeline-relevant requirements for water management, dams and ponds, works in watercourses, groundwater monitoring and rehabilitation planning.
	Disposal of effluent using irrigation Technical guideline (DES, 2020a)	Describes the assessment and evaluation principles for wastewater treatment irrigation systems, outlines criteria for risk assessment, and provides guidance for ongoing irrigation monitoring and management to ensure optimal operation with minimal environmental harm.
Technical standards and methods	*Australian Rainfall and Runoff Guideline* (ARR) (Ball et al., 2019)	Applied for hydrological analysis, flood estimation and selection of design rainfall events.
	Queensland Water Quality Guidelines (QWQG) (DEHP, 2009) *Australian and New Zealand guidelines for fresh and marine water quality* (ANZG, 2018)	Used to derive default and site-specific water quality guideline values, including use of reference-site data and percentile-based approaches where local WQOs are not defined.
	Monitoring and sampling manual: Environmental Protection (Water) Policy 2009 (DES, 2018)	Provides guidance on sampling design, quality assurance/control procedures, sample handling and reporting for water quality and monitoring programs.
Construction and industry best practice	*Best Practice Erosion and Sediment Control* (BPESC) (IECA, 2025)	Informs erosion and sediment control measures suitable for arid inland construction environments, including sediment basin design and ESC plan content.
	Code of Environmental Practice – Onshore Pipelines (APGA, 2022)	Provides industry best practice guidance for environmental management of linear pipeline infrastructure.

Category	Statutory instrument or guidance	Relevance to this assessment
Related permitting framework	*Water Act 2000* *Riverine Protection Permit Exemption Requirements* (Department of Regional Development, Manufacturing and Water, 2023)	Relevant to riverine protection permitting and exemption requirements. Specifically, the *Riverine Protection Permit Exemption Requirements* (Department of Regional Development, Manufacturing and Water, 2023) apply to holders of an EA for a resource activity. Used to regulate water take via catchment-specific water plans, watercourse interference and riverine protection, where water take or interference will require the appropriate water licences or approvals. Water will be sourced from a combination of existing and new bores (if required) and water take points on the Wilson River.

3.2 Study area

The study area for this report is defined as the project site and all downstream surface waters and connected groundwater receptors potentially affected by construction, hydrotesting, maintenance and decommissioning as shown in Figure 3.1. Catchment mapping extends to the first major confluence downstream of each crossing or discharge point and to any environmentally sensitive areas (e.g. mapped wetlands, nature refuges, sensitive bores).



Paper Size ISO A4

0 4.5 9 13.5 18

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

N

APA Group
Bulloo Interlink Pipeline

Project No. 12661648
Revision No. 0
Date 18/06/2026

Study area

Figure 3.1

\\ghdnet\ghd\AU\Sydney\Projects\21\12661648\GIS\Maps\Deliverables\Queensland\12661648_GW_1.aprx - StudyArea_1pg_A4P / Print date: 18 Jun 2026 - 09:02

Data source: Earthstar Geographics, Esri, CGIARDNRMMRRD: Roads, Watercourse (2023), LGA (2025), Cadastre (2026); GA: State border (2006); APA: Pipeline alignment, Facility area, Extra workspaces, Construction right of way (2026); GHD: Study area (2026). Created by: mvandermerwe

3.3 Desktop review

3.3.1 Data collection and review

A desktop review of publicly available surface water and groundwater information, geology, GDE and topography mapping, along with available reports prepared for the project was undertaken. This information has been used to inform the description of the existing environment for water (surface water, hydrology, flooding, and groundwater), and the development of the groundwater conceptual model (a simplified representation of groundwater inputs/outputs and processes, described in section 4.7.9).

Public information sources are listed in Table 3.2 and project information sources are listed in Table 3.3.

Table 3.2 Publicly available information sources

Data/information	Owner/source
Detailed 1:100 K geology mapping	Queensland Government, via Queensland Globe (DoR, 2024).
Topography	Geoscience Australia (2011)
GDE mapping	Queensland Government, via Queensland Globe (DoR, 2024).
Queensland groundwater database	Queensland Government, Department of Local Government, Water and Volunteers (DLGWV), Open Data Portal (DLGWV, 2026b); data current as of 12 January 2026.
Water entitlements	Queensland Government, DLGWV, Open Data Portal (DLGWV, 2026a); data current as of 14 January 2026.
Rainfall and weather stations	Commonwealth of Australia, Bureau of Meteorology (BoM), Climate Data Online (BoM, 2026); data current as of 1 February 2026.
Streamflow database	Queensland Government, Water Monitoring Information Portal (Queensland Government, 2026); data current as of 1 February 2026.
Wetlands	Queensland Government, Queensland Spatial Catalogue (QSpatial) (2025); data current as of 1 February 2026.
MNES	Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW), Protected Matters Search Tool (DCCEEW, 2026); data current as of 1 February 2026.
SEAs	Queensland Government, Queensland Spatial Catalogue (QSpatial) (2020); data current as of 1 February 2026.
Culverts	Queensland Government, Open Data Portal (2022); data current as of 1 February 2026.
Soil mapping 1:2,000,000	Queensland Government, Digital Atlas of Australian Soils, via Queensland Globe (DoR, 2024).
Land cover mapping	Digital Earth Australia (DEA), Geoscience Australia (2025)
Land use mapping	Queensland Government, via Queensland Globe (DoR, 2024).
Watercourse mapping	Queensland Government, Queensland Spatial Catalogue (QSpatial) (2026); data current as of 1 February 2026.

Table 3.3 Reports and data sources

Report title	Author	Context
Bulloo Interlink Pipeline – Geotechnical, Hydrogeological, Hydrological, Active-Fault Rupture Desktop Study Report	WSP, 2025	The high-level hydrological assessment was undertaken by this report. It indicates that flood behaviour at watercourse crossings along the pipeline alignment is characterised by shallow flow depths and generally moderate velocities under design events. Peak water depths across most crossings were predicted to be less than 0.6 m, with higher depths and velocities limited to a small number of locations. These results provide a regional context for flood magnitude and hydraulic energy at crossings and have informed identification of higher-risk locations requiring enhanced design controls and mitigation.

3.4 Assessment approach

3.4.1 Surface water quality

Water quality refers to the physical and chemical quality of the water in surface water features within the study area. The assessment involved:

– review of desktop information and collation of data relevant to the existing surface water features and baseline water quality conditions
– identification of relevant water quality assessment criteria (refer to section 3.4.5)
– qualitative assessment of potential impacts to water quality from construction, operation and decommissioning
– mitigation measures to minimise and mange key potential impacts.

3.4.2 Hydrology and hydraulics

This report outlines the methodology adopted to characterise the study area's existing hydrologic and hydraulic environment. The assessment is focused on understanding baseline catchment behaviour, flow regimes and flood processes relevant to ephemeral and arid systems.

Hydrologic characterisation is informed by ARR guidance (Ball et al., 2019), including selection of representative rainfall events, temporal patterns, losses and routing approaches appropriate to data-sparse catchments. The one percent Annual Exceedance Probability (1% AEP) is used to contextualise flood extents and hydraulic connectivity within the existing environment.

Hydraulic assessment methods are applied at watercourse and drainage line crossings to define existing channel conveyance, inundation pathways, velocities and erosion susceptibility. Consideration is given to hydromorphological processes and erosion mechanisms consistent with *Queensland Water Quality Guidelines* (DEHP, 2009) (QWQG).

To support the hydraulic assessment, a two-dimensional hydrologic and hydraulic model was developed using TUFLOW (version 2025.1.1). The model was constructed using a 30 m resolution digital elevation model (DEM) sourced from the ICSM Elevation and Depth – Foundation Spatial Data (ELVIS) platform.

Given the large catchment extent (approximately 310,400 km²), the DEM was resampled to a 120 m grid to optimise computational efficiency. This represents a pragmatic trade-off, noting that channel definition and flood runner routing are inherently limited in low-relief landscapes at the available terrain resolution.

The model employed TUFLOW's HPC solver with sub-grid sampling to maximise use of the underlying terrain data. A uniform Manning's roughness coefficient (n = 0.035) was adopted, representing bare earth conditions typical of low-gradient, backwater-dominated floodplains.

Rainfall losses were represented using an initial–continuing loss approach, with values of 65 mm (initial loss) and 5.4 mm/hr (continuing loss) adopted in accordance with ARR guidance and consistent with the WSP (2025) study. Downstream boundary conditions were applied where required using a normal-depth (HQ) stage–flow boundary to prevent artificial ponding at the model extent.

Calibration was not undertaken due to the unsuitability of available stream gauges, which are affected by local storage effects and are remote from the pipeline alignment. Model results were therefore validated against the WSP (2025) assessment to provide contextual confidence in predicted flood behaviour.

3.4.3 Geomorphology

The geomorphology of the project site was assessed using a variety of government sources including Geoscience Australia and Queensland Government spatial data portals and mapping. Additional sources for Cooper Creek were also used for the assessment (Knighton & Nanson, 1994; Tooth, 1999; Tooth, 2000).

3.4.4 Groundwater

Desktop review of publicly available information (section 3.3.1) along and in the area around the proposed pipeline route was undertaken and used to describe the existing groundwater environment including hydrogeological characteristics, levels, flows, groundwater use and groundwater–surface water and aquifer interactions. These data were used in the development of the groundwater conceptual model and assessment of potential impacts.

Project-specific groundwater monitoring (level and quality) data, seasonal variability and aquifer parameter data were not available to inform preparation of the groundwater assessment, which will be addressed through subsequent project-specific groundwater investigations, where required by approval conditions.

3.4.5 Assessment criteria and performance objectives

This report addresses the assessment criteria and performance objectives as outlined in Table 3.4.

Table 3.4 Assessment criteria and objectives for environmental values

Environmental value	Relevant assessment criteria and guidelines
Surface water quality	Assessment criteria are based on the *Australian and New Zealand guidelines for fresh and marine water quality* (ANZG Guidelines) (ANZG, 2018), which superseded the ANZECC & ARMCANZ (2000) guidelines and represent the current national standard. The ANZG Guidelines retain the scientific basis of the earlier framework and provide default guideline values for receiving-water protection, maintained through a continuously updated online platform. Where available, regional Water Quality Objectives (WQOs) established under the EPP Water and Wetland Biodiversity apply. For the project area, WQOs and Environmental Values (EVs) are defined for the Bulloo River catchment within the *Warrego, Paroo and Bulloo Rivers and Nebine, Mungallala and Wallam Creeks basins Environmental Values and Water Quality Objectives* (DES, 2020d). For the Cooper Creek catchment, where WQOs have not been established, assessment defaults to the QWQG and/or the ANZG Guidelines (2018). Where releases are required (e.g. hydrotest dewatering), criteria would be utilised so that no acute toxicity and no unacceptable impacts to EVs beyond any approved mixing zone occurs.
Groundwater quality	For the Bulloo Basin, EVs/WQOs from groundwater mapping are applied, including alluvial zones (DES, 2020b), sediments overlying the Great Artesian Basin (GAB) (DES, 2020c), and the Upper GAB (DES, 2020d). For the Cooper Basin, where groundwater EVs are not defined, default EVs and guideline values are adopted; for consistency, Bulloo Basin groundwater EVs inform the Cooper Basin portion of the project site, with justification provided.
Hydrology/flooding Geomorphology	Temporary works must maintain flood conveyance and avoid unacceptable alterations to inundation extent and depth or hazard; permanent works (e.g. above-ground facilities) will be designed to avoid material obstruction of floodways.
	Avoid permanent modification of bed and bank profiles at crossings and reinstate to pre-disturbance form and stability.

3.4.6 Impact assessment and mitigation

Pathways and receptors

The impact assessment adopts the source–pathway–receptor approach, commencing with the identification of source–pathway–receptor linkages. This includes sediment pulses to ephemeral creeks; accidental spills; trench dewatering releases; storage overtopping; reduced riparian cover during construction; and any flow regime alteration during hydrotest discharges. Receptors are mapped, including downstream pools/waterholes, wetlands, registered bores and water users.

Significance criteria and matrices

The assessment adopts a likelihood–consequence framework consistent with DETSI guidance, with consequence calibrated to EVs/WQOs and regulatory thresholds (e.g. no direct/indirect release to groundwater that degrades EVs; no adverse wetland impacts). This includes a tiered approach of desktop screening, then targeted field/modelled refinement for higher-risk hazards.

Mixing zones

At this stage, no routine controlled discharges to surface waters are proposed. If any controlled discharge to surface water is proposed, the report defines initial dilution and mixing zones and demonstrate no acute toxicity and no unacceptable EV impacts beyond the zone, referencing the mixing zone principles in the *Australian and New Zealand guidelines for fresh and marine water quality* (ANZG, 2018) and *Queensland Murray–Darling and Bulloo River basins—Groundwater environmental values and water quality objectives* (DES, 2020d).

Impact mitigation

This report follows the management hierarchy from the EPP Water and Wetland Biodiversity, as presented below.

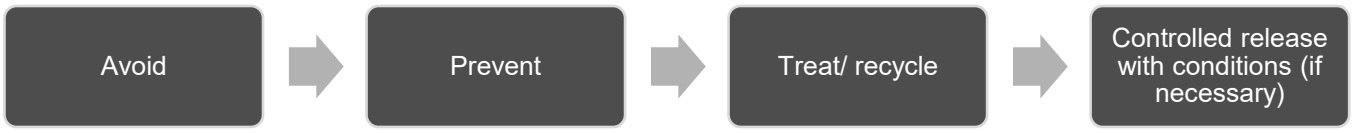


Figure 3.2 Management hierarchy illustration

Controls are embedded in design and specifications; such as trenchless crossings where risk warrants, limit open-cut durations, progressive stabilisation, buffer zones, spill kits, and lined storages with leak detection.

Monitoring, triggers and adaptive management

The report presents monitoring programs for construction and operations phases and suggests a Trigger Action Response Plan (TARP) for any exceedances.

3.5 Water servicing strategy

Approximately 279.7 ML of non-potable water is estimated for use during construction, sourced from a combination of existing groundwater bores and water take points on the Wilson River. Existing dams, where available, may be utilised subject to agreements with landholders and permit requirements.

Source aquifer(s), quality and yields of the existing groundwater bores are to be confirmed. Where insufficient water supply or unsuitable water quality from groundwater is identified, new groundwater bores may be drilled at a nominal spacing of approximately 50 km from each other.

The project will adopt a flexible approach to water sourcing during construction rather than relying on a fixed bore spacing. While a nominal target of one bore approximately every 50 km is used as an initial planning assumption, the final water supply strategy will be determined through on-ground assessment. This will include identification and evaluation of existing bores in the vicinity of the alignment, assessment of their capacity, reliability and suitability for construction demand, and consideration of environmental and land access constraints. Where existing sources are insufficient, the project will optimise between developing additional bores, importing water, or carting from approved external sources, taking into account cost, logistics and regulatory requirements. This adaptive approach ensures that water supply is secured in a practical and efficient manner while minimising unnecessary disturbance and infrastructure development.

The main uses of non-potable water during construction will be:

– dust suppression for stockpiles, access tracks and the CRoW (quantity would vary according to weather conditions)
– horizontal directional drilling (HDD) as a component of drilling fluid
– hydrotesting.

Approximately 13.7 ML of potable water would be used for drinking water and ablutions at construction facilities and temporary accommodation facilities. The potable water would be generated from non-potable water by reverse osmosis (RO) and the RO waste transported to an appropriate facility for disposal.

3.6 Key qualifications

This report relies upon the following key qualifications:

- **Alignment and construction methods:** Assuming trenchless crossing at the Wilson River (via HDD) only and open-cut at minor ephemeral channels; noting that the list of trenchless crossing sites will be refined through constructability and environmental risk reviews.
- **Hydraulic roughness and losses:** Spatially uniform Manning's 'n' values and Initial Loss-Continuing Loss (IL-CL) parameters consistent with ARR Guidelines (Ball et al., 2019) have been adopted at this stage. The adopted approach is conservative. However, local refinement may occur if higher-resolution topography becomes available.
- **Topography:** The best-available 30 m DEM (resampled to 120 m) was used. Small-scale features (e.g. bank levees, micro-relief, small culverts) may be under-resolved; however, this has been mitigated through conservative interpretation and sensitivity checks.
- **Receiving-water criteria:** In the absence of regional WQOs, *Australian and New Zealand guidelines for fresh and marine water quality* (ANZG, 2018) default values have been adopted; noting that site-specific values or monitoring-derived reference percentiles will supersede defaults if approved.
- **Groundwater receptors:** Shallow groundwater is assumed intermittent/perched near channels, with low bedrock–surface-water connectivity except possible localised shallow rock water tables in low-lying areas. Monitoring and management focus on terrestrial GDEs along watercourses.
- **Water sources:** Construction and hydrotest water is to be preferentially sourced from licensed supplies or existing bores/waterholes subject to suitability. No unlicensed take is assumed.

4. Existing environment

4.1 Climate

Table 4.1 summarises rainfall statistics from seven Bureau of Meteorology (BoM) rainfall stations located within approximately 3 km to 124 km of the proposed pipeline alignment. The locations of rainfall stations and the nearest river gauging station are provided in Figure 4.1. The gauges provide a regional context for rainfall variability across the project site and include both long-term stations (opened as early as 1888) and more recently established stations (opened in 2005). All stations listed are currently operational.

Average annual rainfall across the stations ranges from approximately 177 mm at Woomanooka to about 274 mm at Thargomindah Airport, indicating a generally low-rainfall setting with spatial variation across the broader region.

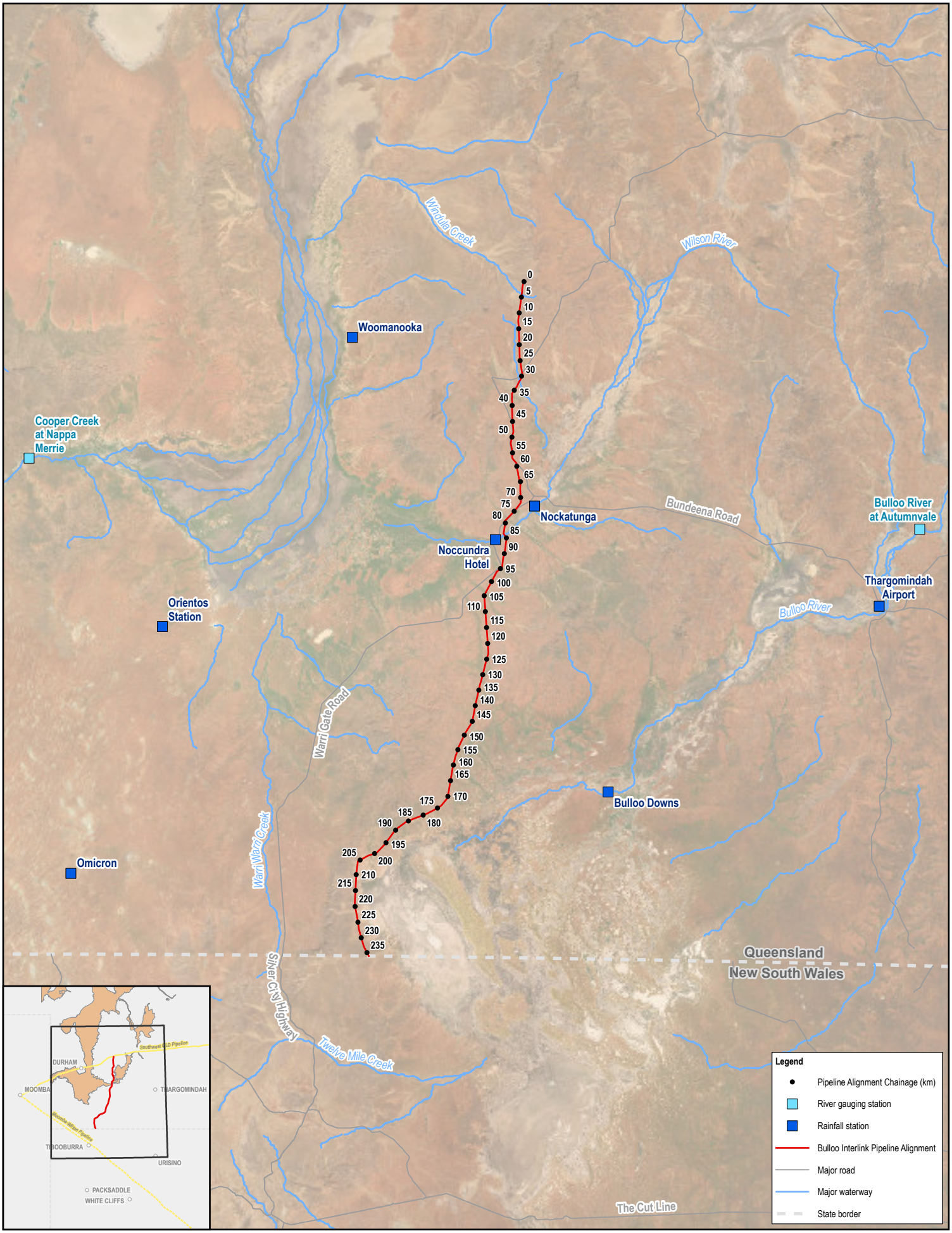
Table 4.1 highlights the influence of occasional wet years. Several gauges report notably high maximum annual rainfall totals, including values exceeding 700 mm at Nockatunga Station, Thargomindah Airport, Orientos Station, and Bulloo Downs. This indicates that, although the regional climate is generally dry, the area can experience infrequent but significant wet years driven by episodic storm activity. In contrast, the lowest annual rainfall totals at some sites fall to very low values (as low as 28 and 29 mm at Bulloo Downs and Orientos Station respectively), demonstrating substantial inter-annual variability.

Rainfall statistics indicate that the project site is characterised by low average annual rainfall, but with high variability between years, including occasional extreme wet years and very dry years including recently in 2025. These characteristics are important considerations for hydrologic assessments, particularly where design outcomes are sensitive to rare high-rainfall events rather than typical annual conditions. Rainfall statistics are provided in Appendix A.

These rainfall characteristics underpin the hydrologic design basis adopted for flood assessment and inform construction risk management, particularly with respect to episodic flooding and short-duration high-intensity rainfall events.

Table 4.1 Weather stations within the study area and associated rainfall data (BoM, 2026)

Station ID	Name	Approximate distance from the pipeline alignment (km)	Year opened	Status	Annual rainfall average (mm)	Annual rainfall highest (mm)	Annual rainfall median (mm)	Annual rainfall lowest (mm)
045026	Woomanooka	52	1999	Open	177.3	266.2	154.8	133.5
045024	Nockatunga Station	5	1888	Open	233.0	729.1	205.5	51.2
045057	Noccundra Hotel	3	1985	Open	208.2	366.8	227.1	73.5
045025	Thargomindah Airport	130	1999	Open	273.9	796.6	244.2	62.5
045029	Orientos Station	101	1965	Open	202.4	739.2	172.7	29.0
045002	Bulloo Downs	50	1914	Open	210.3	723.3	183.8	28.0
045067	Omicron	90	2005	Open	235.9	465.5	187.1	102



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0 7.5 15 22.5 30

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

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BOM rainfall stations and river gauging stations

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Figure 4.1

N:\AU\Sydney\Projects\21\12661648\GIS\Maps\Deliverables\Queensland\12661648_SW_1\12661648_SW_1.aprx - BIL_SurfaceWater_1pg_A4P_QLD / Print date: 18 Jun 2026 - 11:51

Data source: Earthstar Geographics, Esri, CGIAR. DNRMMRRD: River gauging station, Major roads (2021), Major waterway (2023); APA: Pipeline alignment (2026); BOM: Rainfall station (2025); GHD: Chainage (2025) Created by: mvandermerwe

4.2 Topography

An assessment of surface elevations along the pipeline alignment was undertaken using Shuttle Radar Topography Mission (SRTM) DEM data (Geoscience Australia, 2011). The alignment spans elevations of approximately 85 m Australian Height Datum (AHD) to 160 m AHD. The elevation profiles with indicative watercourse names are shown in Figure 4.2.

The pipeline generally crosses flat country with small rises and dips along its length. Most of the land is gently undulating rather than hilly or steep, and changes in ground elevation occur gradually.

In the northern section of the alignment, the ground starts at a relatively higher level and gently rises and falls. Noticeable low points occur where the pipeline crosses creeks such as Windula Creek and Kercummura Creek. These creek crossings sit lower than the surrounding land and are the most obvious changes in topographical height in this section.

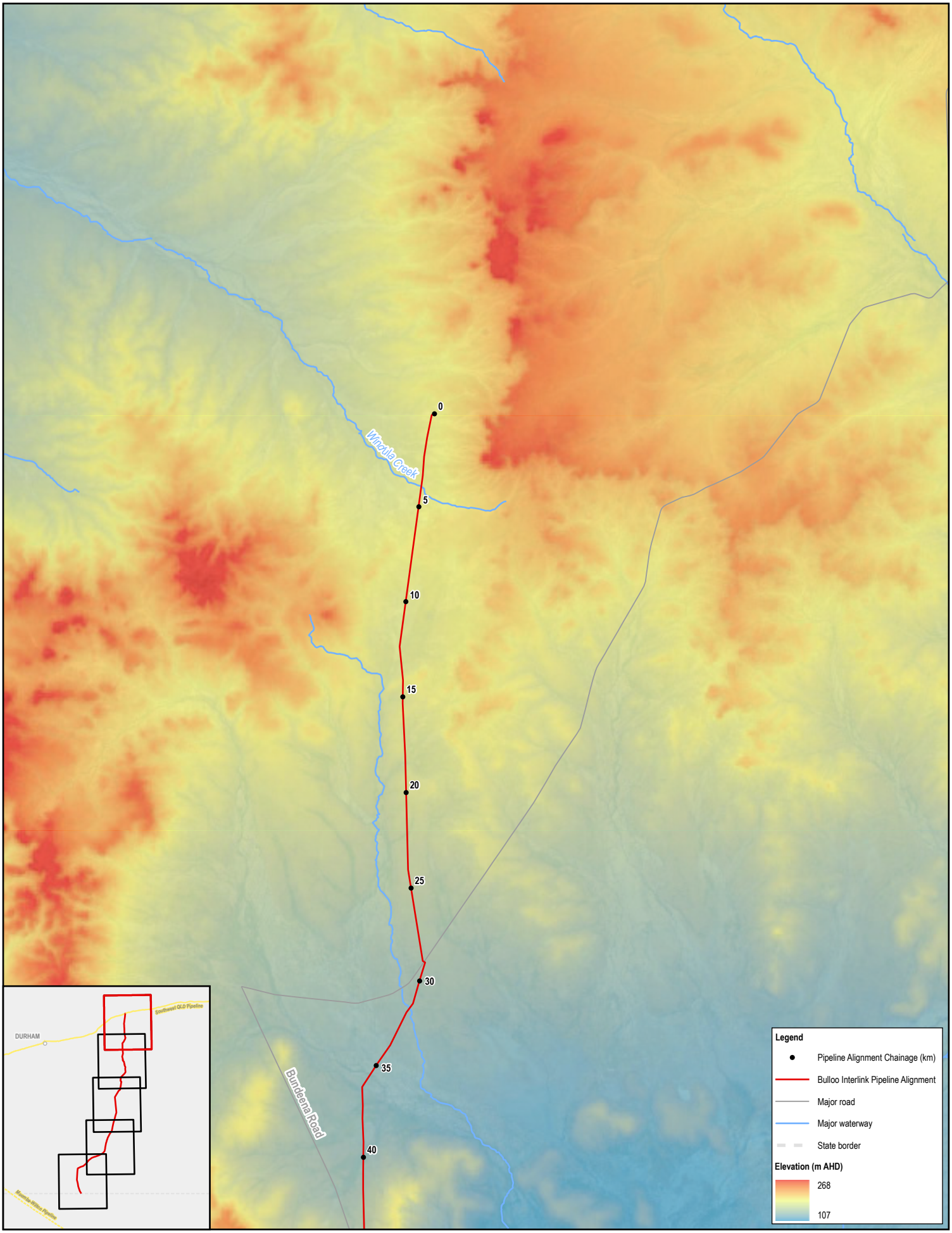
The central section also includes a crossing of the Wilson River, which represents a major watercourse along the alignment. At the location where the alignment crosses the Wilson River, between approximately chainage 83.5 km and 85.0 km, the river exhibits a broad floodplain, with an estimated width of approximately 1.5 km. This crossing reflects the expansive nature of the Wilson River floodplain relative to the smaller tributary crossings elsewhere along the pipeline alignment.

Moving south, the pipeline continues across mostly flat plains. The land here gently rises and falls, with short dips where the alignment crosses several creeks, including Gum Creek and Tirtywinna Creek. These low points reflect shallow creek channels and nearby floodplain areas, while the ground between waterways remains fairly even.

In the central section, the landscape remains low and open, with frequent but small changes in ground level. The pipeline crosses a number of minor creeks and drainage lines, such as Tippera Creek, Murrawarra Creek, Whippa Creek and its tributaries, Parrabinna Creek and Muggera Creek. Each crossing appears as a small dip in the ground surface, but there are no steep slopes between them.

The southern section of the alignment sits at slightly lower elevations overall. The ground continues to be mostly flat with gentle variations in height. Creeks such as Tickalara Creek, Morris Creek, Gidya Creek and Wanka Creek mark the lowest points along this section, while the land between these waterways remains relatively level.

Overall, the pipeline alignment passes through flat to gently rolling terrain. Changes in elevation are mainly associated with creek crossings, and there are no areas of steep or rugged topography along the route.



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0 1 2 3 4

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

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Bulloo Interlink Pipeline

Pipeline alignment elevation profile

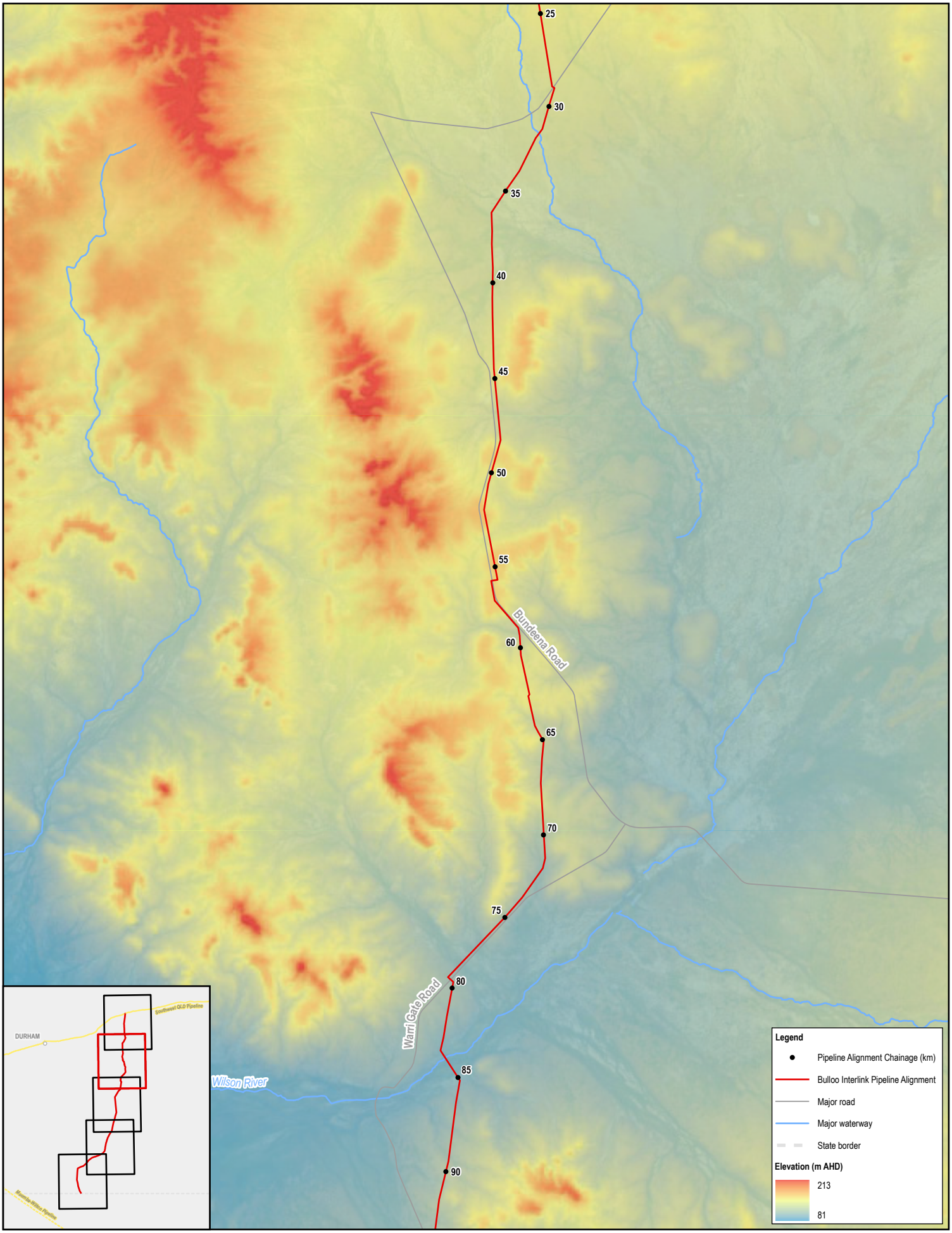
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Figure 4.2

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Data source: Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS. DNRMMRRD: Major roads (2021), Major waterway (2023); APA: Stockpile and camp area, Pipeline alignment (2026); GA: DEM (2025); GHD: Chainage (2025) Created by: mvandermerwe



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

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APA GHD

APA Group
Bulloo Interlink Pipeline

Pipeline alignment elevation profile

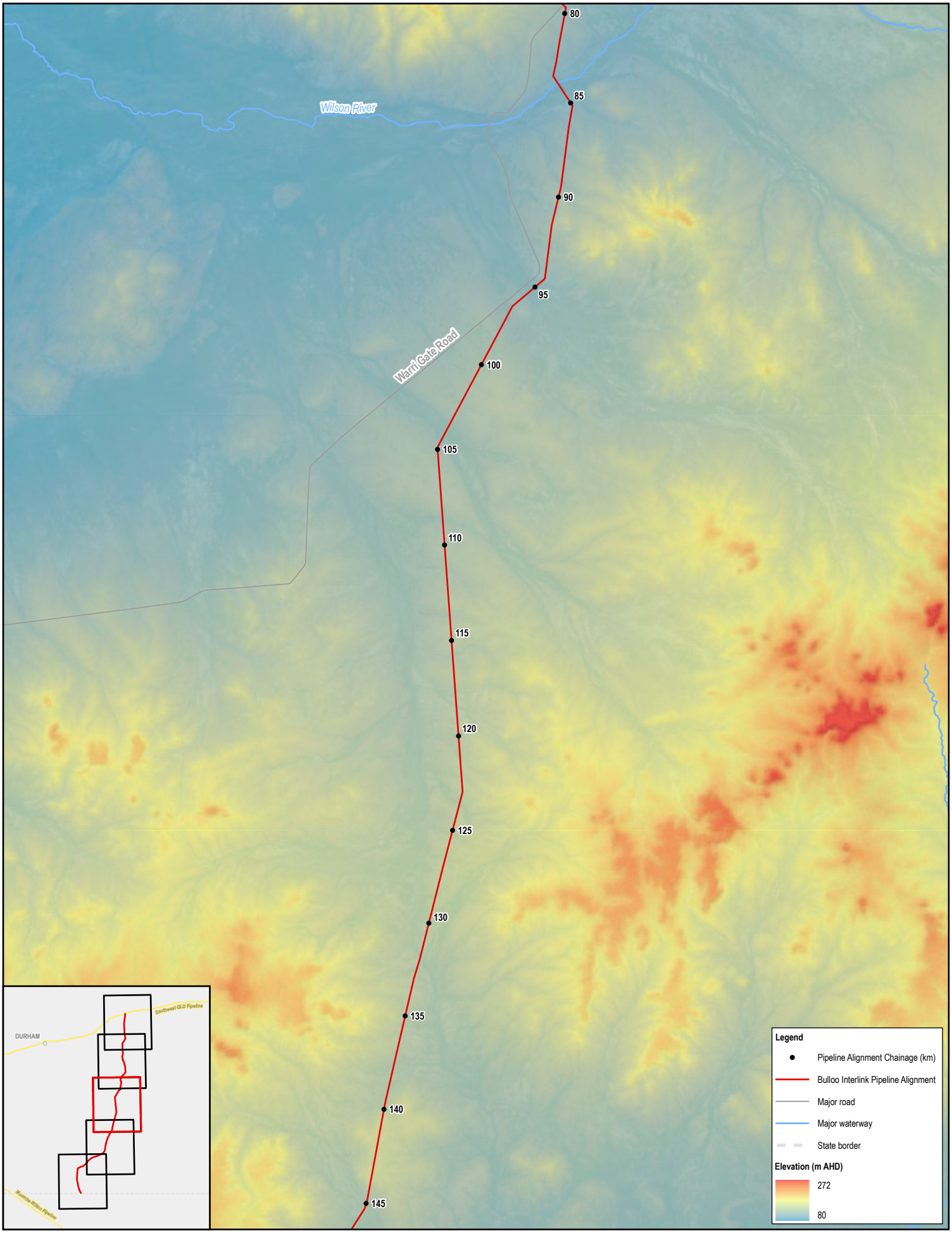
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Figure 4.2

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Data source: Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS. DNRMMRRD: Major roads (2021), Major waterway (2023); APA: Stockpile and camp area, Pipeline alignment (2026); GA: DEM (2025); GHD: Chainage (2025) Created by: mvandermerwe



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

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APA GHD

APA Group
Bulloo Interlink Pipeline

Pipeline alignment elevation profile

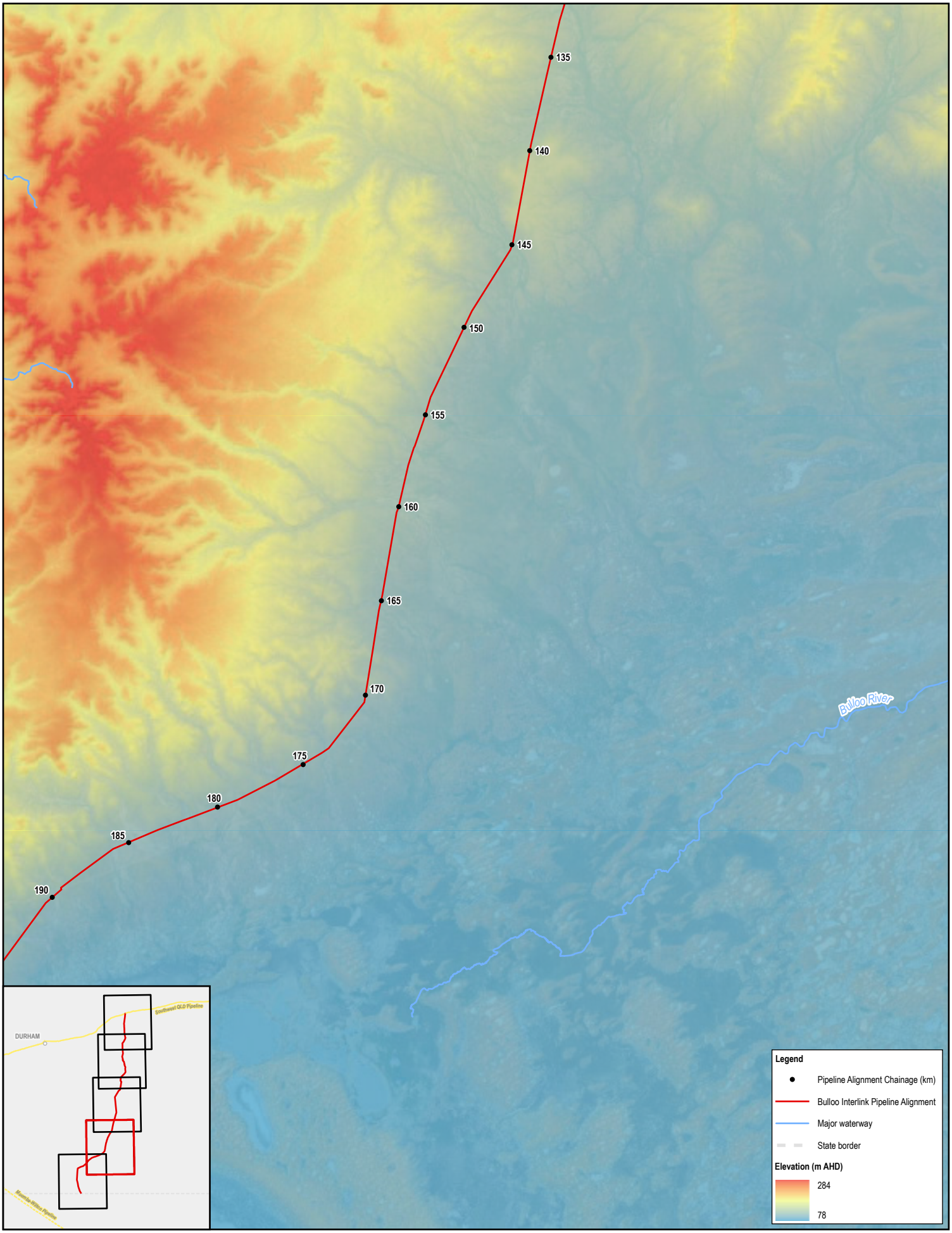
Project No. **12661648**
Revision No. **0**
Date **18/06/2026**

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Figure 4.2

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Data source: Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS. DNRMMRRD: Major roads (2021), Major waterway (2023); APA: Stockpile and camp area, Pipeline alignment (2026); GA: DEM (2025); GHD: Chainage (2025) Created by: mvandermerwe



Paper Size ISO A4

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

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Bulloo Interlink Pipeline

Pipeline alignment elevation profile

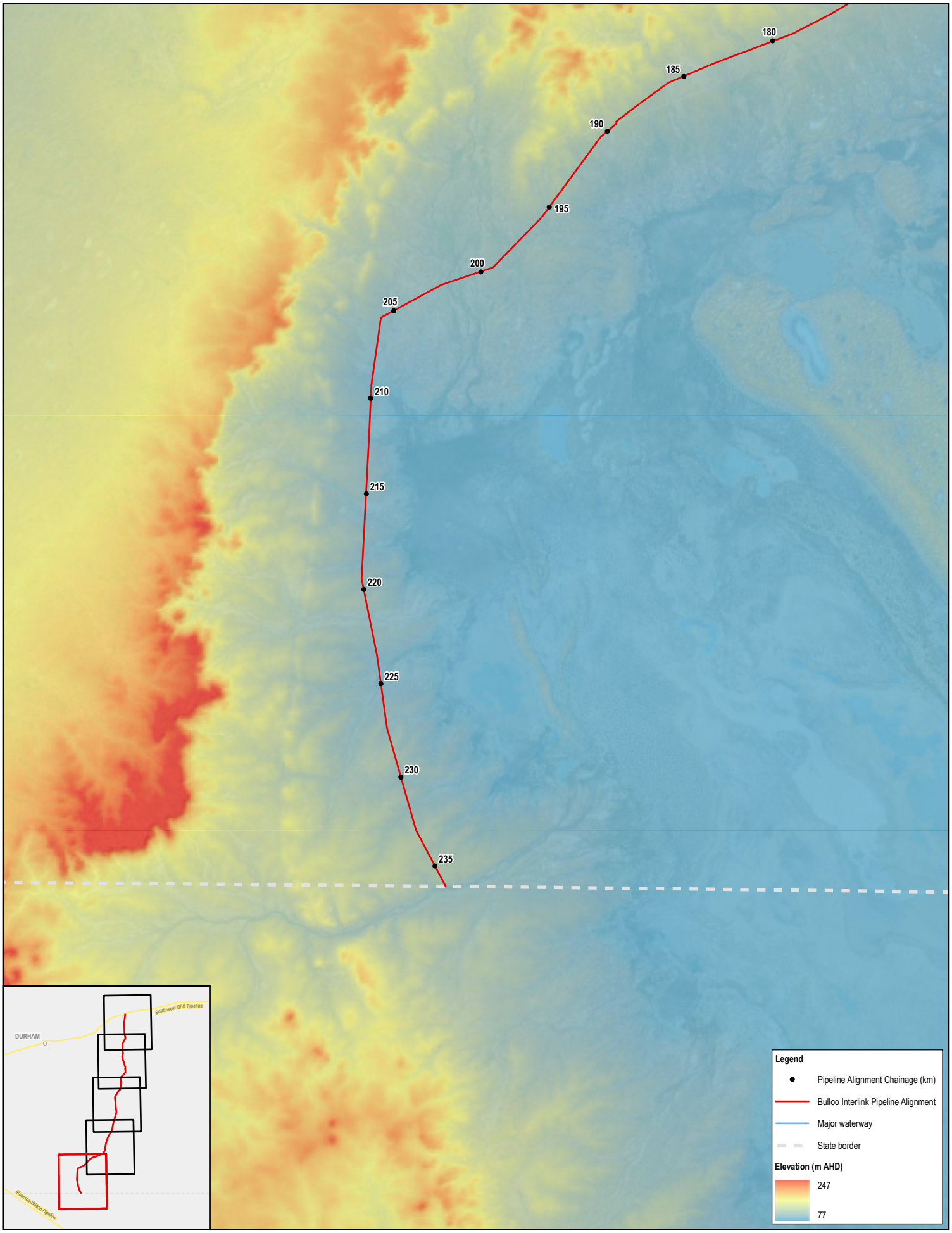
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Figure 4.2

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Data source: Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS. DNRMMRRD: Major roads (2021), Major waterway (2023); APA: Stockpile and camp area, Pipeline alignment (2026); GA: DEM (2025); GHD: Chainage (2025) Created by: mvandermerwe



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0 1 2 3 4

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

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APA GHD

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Pipeline alignment elevation profile

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Figure 4.2

N:\AU\Sydney\Projects\21\12661648\GIS\Maps\Deliverables\Queensland\12661648_SW_1\12661648_SW_1.aprx - BIL_SurfaceWater_1pg_A4P_MB_QLD / Print date: 18 Jun 2026 - 11:35

Data source: Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS. DNRMMRRD: Major roads (2021), Major waterway (2023); APA: Stockpile and camp area, Pipeline alignment (2026); GA: DEM (2025); GHD: Chainage (2025) Created by: mvandermerwe

4.3 Land and soil characteristics

4.3.1 Soil

Soil characteristics influence surface water runoff, infiltration, erosion potential and sediment transport, and therefore represent an important component of the existing environment for the assessment of waterway interactions associated with the project. The soils within the study area have been reviewed with respect to both catchment-scale distribution and proximity to the project site.

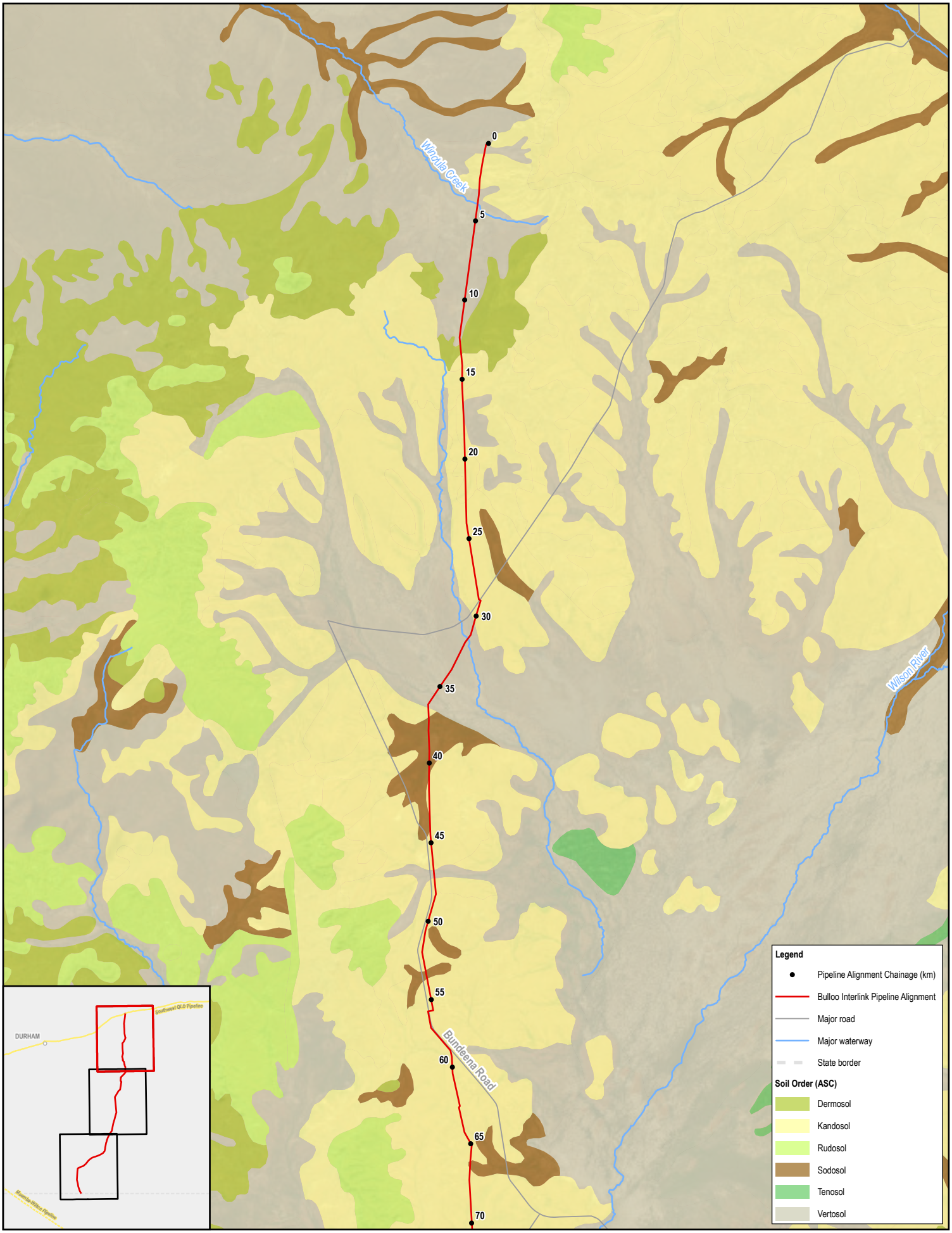
For the purposes of this assessment, the dominant soil order is defined as the soil order that occupies the greatest proportion of a catchment area and is therefore expected to exert the primary control on hydrological response, including runoff generation and drainage behaviour. While the dominant soil order provides a useful indicator of overall catchment behaviour, the presence of other soil orders within or adjacent to the alignment is also relevant, particularly where soils exhibit properties such as poor drainage, and erosion susceptibility when disturbed.

Three dominant soil orders, vertosols, kandosols and sodosols, occur within the study area, as mapped in Figure 4.3 using the *Dominant soil orders of Queensland* dataset from the Queensland Spatial Catalogue (Queensland Government, 2025). Soil classification follows the Australian Soil Classification system (Isbell, 1992).

Vertosols represent the primary soil order intersected by the pipeline alignment. These soils occur from approximately chainage 26 km to 52 km, and again from chainage 63 km to 235 km. Vertosols are characterised by high clay content and pronounced shrink–swell behaviour, with extensive cracking during dry periods and reduced permeability under wet conditions. As a result, vertosols are typically associated with higher surface runoff potential and can influence both natural drainage patterns and soil stability during construction if not appropriately managed.

Kandosols occur along the pipeline alignment from chainage 0 km to 26 km and between chainage 52 km and 63 km. These soils generally exhibit relatively uniform soil profiles with moderate permeability and drainage capacity, and are typically associated with moderate runoff responses and comparatively consistent infiltration behaviour relative to vertosols.

Within the section of the pipeline alignment between chainage 145 km and 220 km, although vertosols remain the dominant soil order intersected by the project, kandosols occur to the east within approximately 350 m and sodosols are present to the west within approximately 3 km of the pipeline alignment. Sodosols are sodic soils that commonly display poor structure, restricted drainage and an elevated susceptibility to erosion and soil dispersion when disturbed. While sodosols are not the dominant soil order along this section of the alignment, their proximity represents a potential risk pathway if surface water flows are altered during construction or operation.



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Kilometres

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Grid: GDA2020 MGA Zone 54

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Dominant soil types

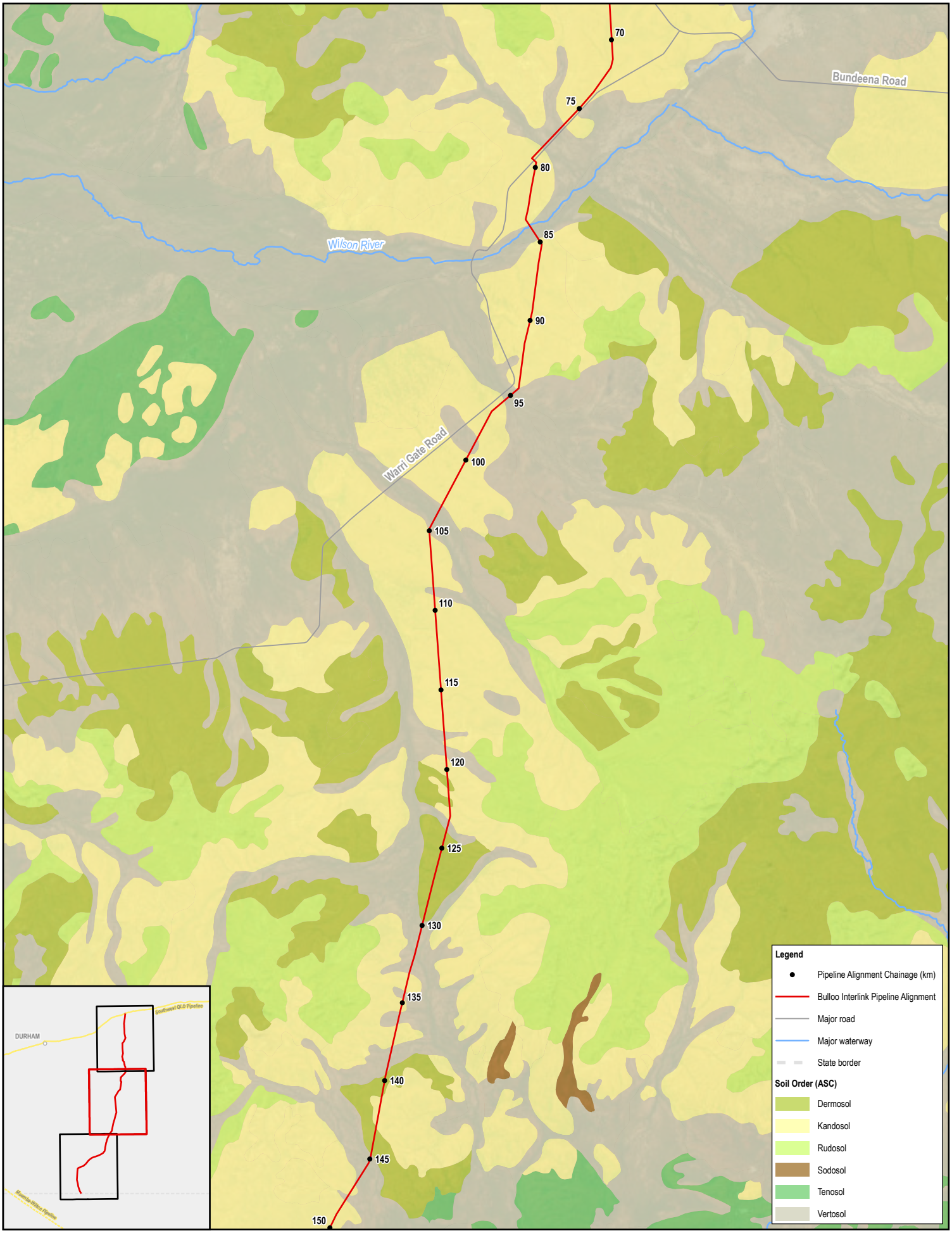
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Figure 4.3

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
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Date 18/06/2026

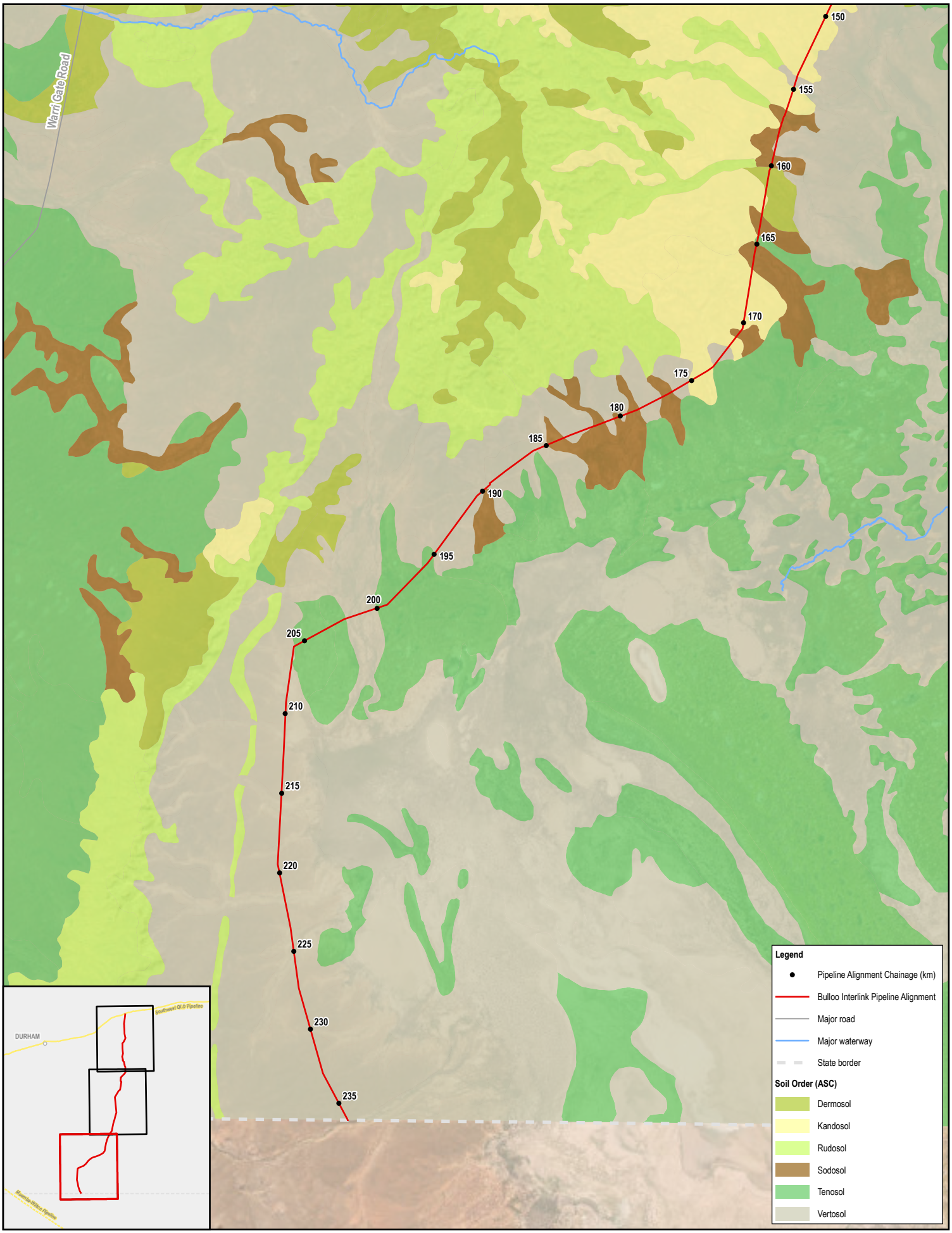
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Dominant soil types

Figure 4.3

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Kilometres

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Grid: GDA2020 MGA Zone 54

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Dominant soil types

Figure 4.3

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4.3.2 Land cover

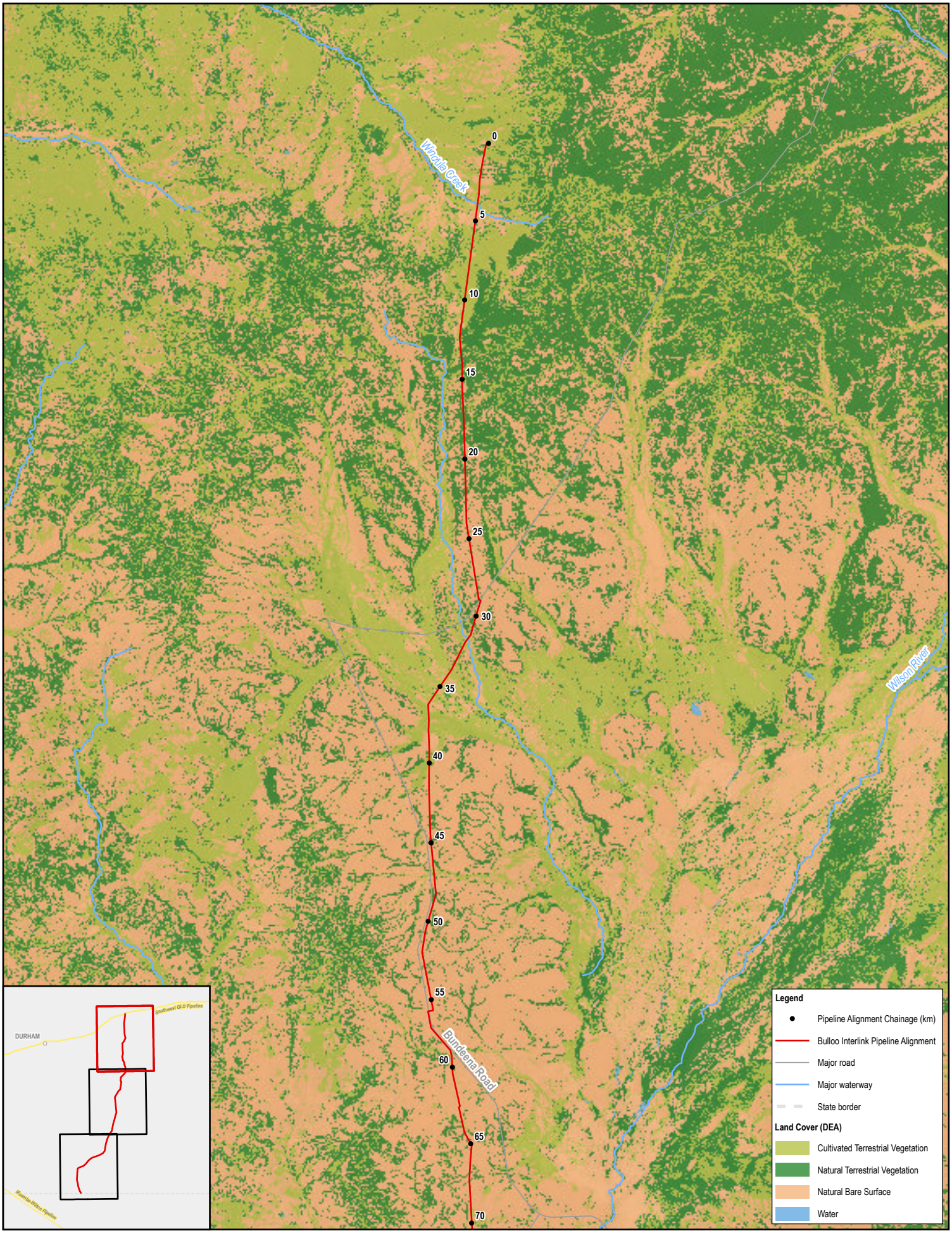
Land cover within the study area was assessed using spatial mapping sourced from Digital Earth Australia (DEA) Map (Geoscience Australia, 2026) with the distribution of land cover types shown Figure 4.4. The mapping classifies land cover into four categories: Natural Bare Surface, Water, Natural Terrestrial Vegetation, and Cultivated Terrestrial Vegetation. The land cover classification is derived from remote sensing data. Accordingly, a qualitative verification of the mapped classes was undertaken through review of high-resolution aerial imagery and consideration of the regional land use context. This review indicates that the study area is predominantly characterised by natural arid landforms, including extensive Natural Bare Surface and sparse Natural Terrestrial Vegetation, consistent with the desert environment. While the DEA dataset includes a “Cultivated Terrestrial Vegetation” class as part of its standard national classification scheme, any minor occurrences mapped under this class are interpreted as artefacts of the automated classification process or may represent disturbed or modified vegetation rather than active cultivation. As such, cultivated land cover within the study area is considered negligible and does not materially influence the hydrological characterisation or model outcomes.

The study area is predominantly characterised by Natural Bare Surface, which is the most extensive land cover type within the project site. This land cover is widespread throughout the project site and reflects sparsely vegetated landscapes typical of semi-arid and arid environments. Areas of Natural Bare Surface are generally associated with exposed soils and limited ground cover, which can increase susceptibility to surface runoff, erosion and sediment mobilisation during rainfall events. An example of Natural Bare Surface land cover located close to pipeline chainage 165 km is provided in Plate 4.1.

Natural Terrestrial Vegetation occurs as discontinuous patches across the study area and is commonly associated with drainage lines, floodplain features and areas of localised topographic relief. These vegetated areas provide important surface roughness and interception, contributing to reduced runoff velocities and enhanced infiltration relative to surrounding bare surfaces. Along the pipeline alignment, intersections with Natural Terrestrial Vegetation are generally localised but coincide with environmentally sensitive landscape features such as ephemeral watercourses. An example of Natural Terrestrial Vegetation land cover located close to pipeline chainage 77 km is provided in Plate 4.2.

Cultivated Terrestrial Vegetation (interpreted as disturbed or modified vegetation) is present in more limited and discrete areas, typically forming clustered patches adjacent to, but generally offset from, the pipeline alignment. These areas likely reflect agricultural land use and modified landscapes, where vegetation cover may vary seasonally. Disturbed or modified areas can influence surface water behaviour by altering soil structure and ground cover, potentially affecting runoff generation during disturbed or fallow periods.

Surface water features within the study area are limited in extent and distribution, comprising predominantly small, localised water bodies and drainage features. These features are generally confined to low-lying areas and defined drainage corridors.



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Kilometres

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Map Projection: Transverse Mercator
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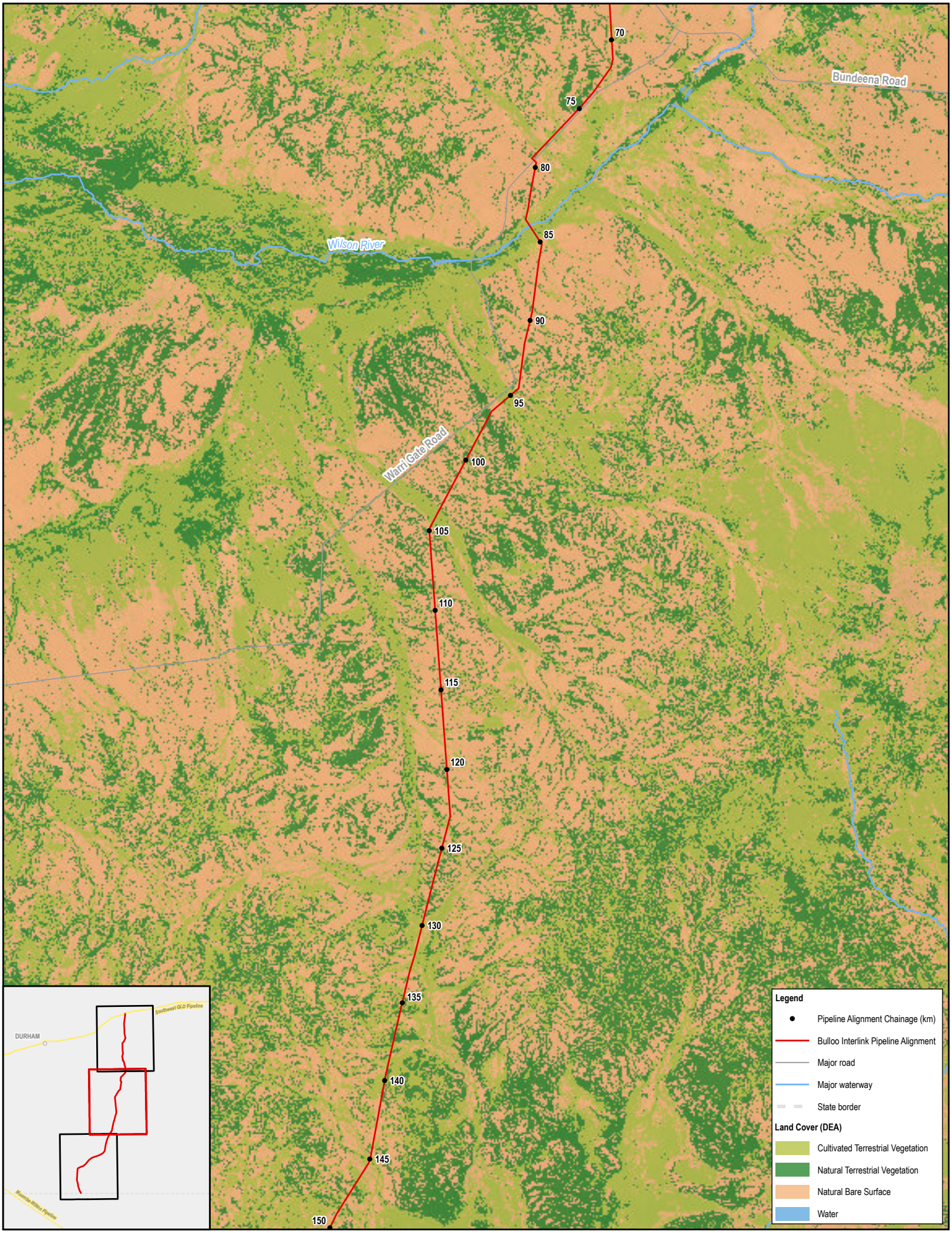
Sheet 1 / 3

Land cover

Figure 4.4

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Kilometres

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Grid: GDA2020 MGA Zone 54

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Bulloo Interlink Pipeline

Land cover

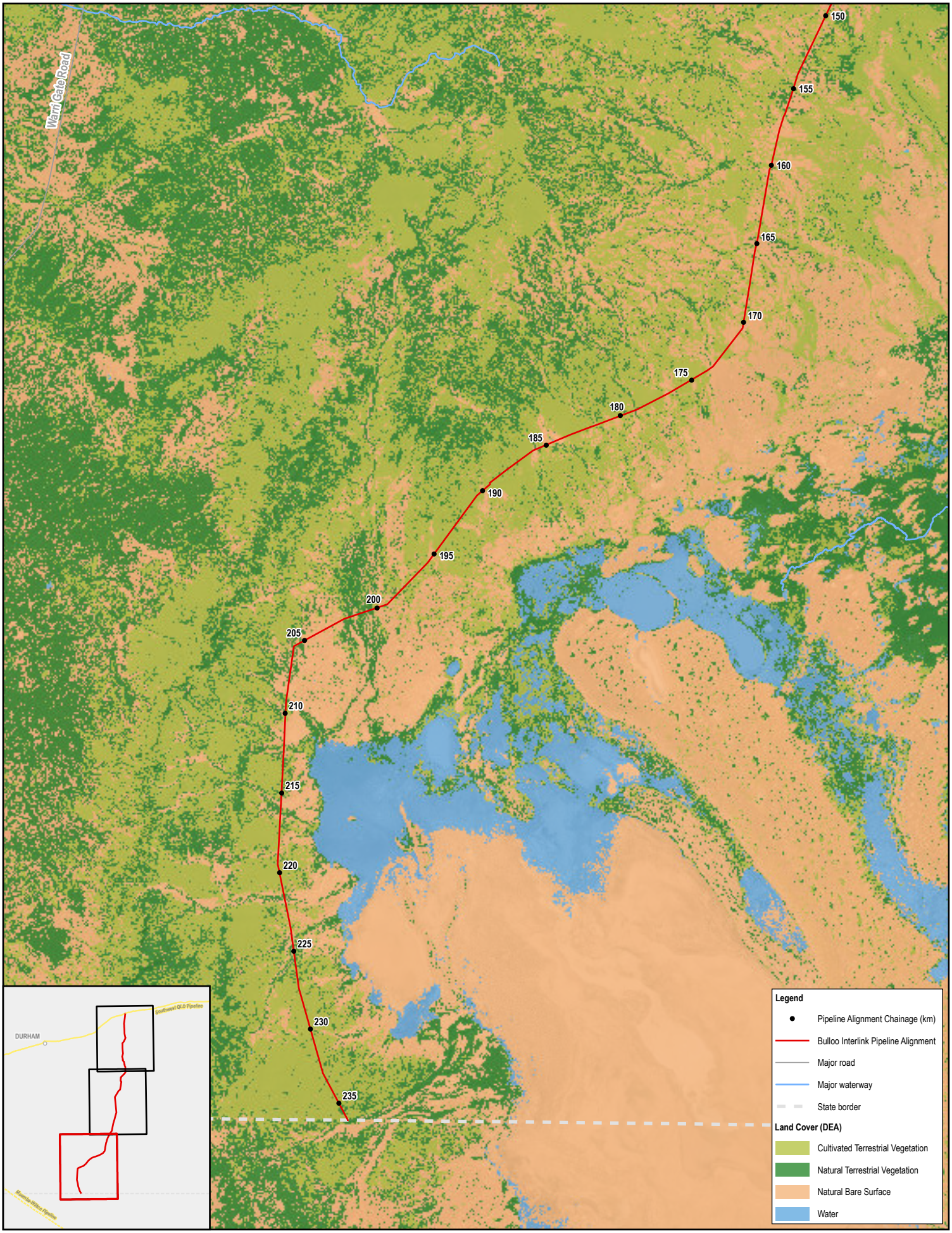
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Figure 4.4

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Data source: GA, Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS. DNRMMRRD: Major roads (2021), Major waterway (2023); GA: DEA Land cover (2026); APA: Construction access, Pipeline alignment (2026); GHD: Chainage (2025) Created by: mvandermerwe



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Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
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Land cover

Figure 4.4

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Plate 4.1 An example of Natural Bare Surface land cover close to pipeline chainage 165 km (WSP, 2025)



Plate 4.2 An example of Natural Terrestrial Vegetation land cover close to pipeline chainage 77 km (WSP, 2025)

4.3.3 Land use

Located on the southern end of the Channel Country bioregion in Qld, land uses within and surrounding the project site predominantly consists of grazing native vegetation (utilised for extensive cattle and sheep grazing), the Bulloo Downs Nature Refuge (managed as resource protection) and lakes including the Bulloo River.

The Channel Country SEA intersects with the project site, situated along the Wilson River and extending upstream and downstream of the project site to the border of South Australia (Figure 4.5). The project footprint does not encroach upon any other areas of regional interest ie priority agricultural areas, strategic cropping areas, or priority living areas. There are also no protected areas present within the project site. The Bulloo Downs Nature Refuge is located south-east of the project site, approximately 0.8 km away at the closest point, along the Qld–NSW border.

Land uses with potential sensitivity (including residences or homesteads) to pipeline construction or operation are generally offset from the pipeline alignment by several kilometres. No major land use features have been identified within the immediate pipeline corridor, and the spatial separation indicates a low likelihood of direct land use conflict associated with the pipeline alignment.

The majority of the project site is located on leasehold land, with the alignment of the project selected based on a desktop assessment of publicly available data and field surveys to minimise impacts on landholders, community and natural environment while also allowing the existing landholders to continue their farming activities.

Land use with the potential to influence surface and groundwater

A review of land uses within a 10 km buffer of the pipeline alignment was undertaken to identify key land use features with the potential to influence the existing characteristics of surface water and, or groundwater. The identified land use features including their approximate chainage locations and minimum distances from the pipeline alignment are listed in Table 4.2 and shown in Figure 4.6.

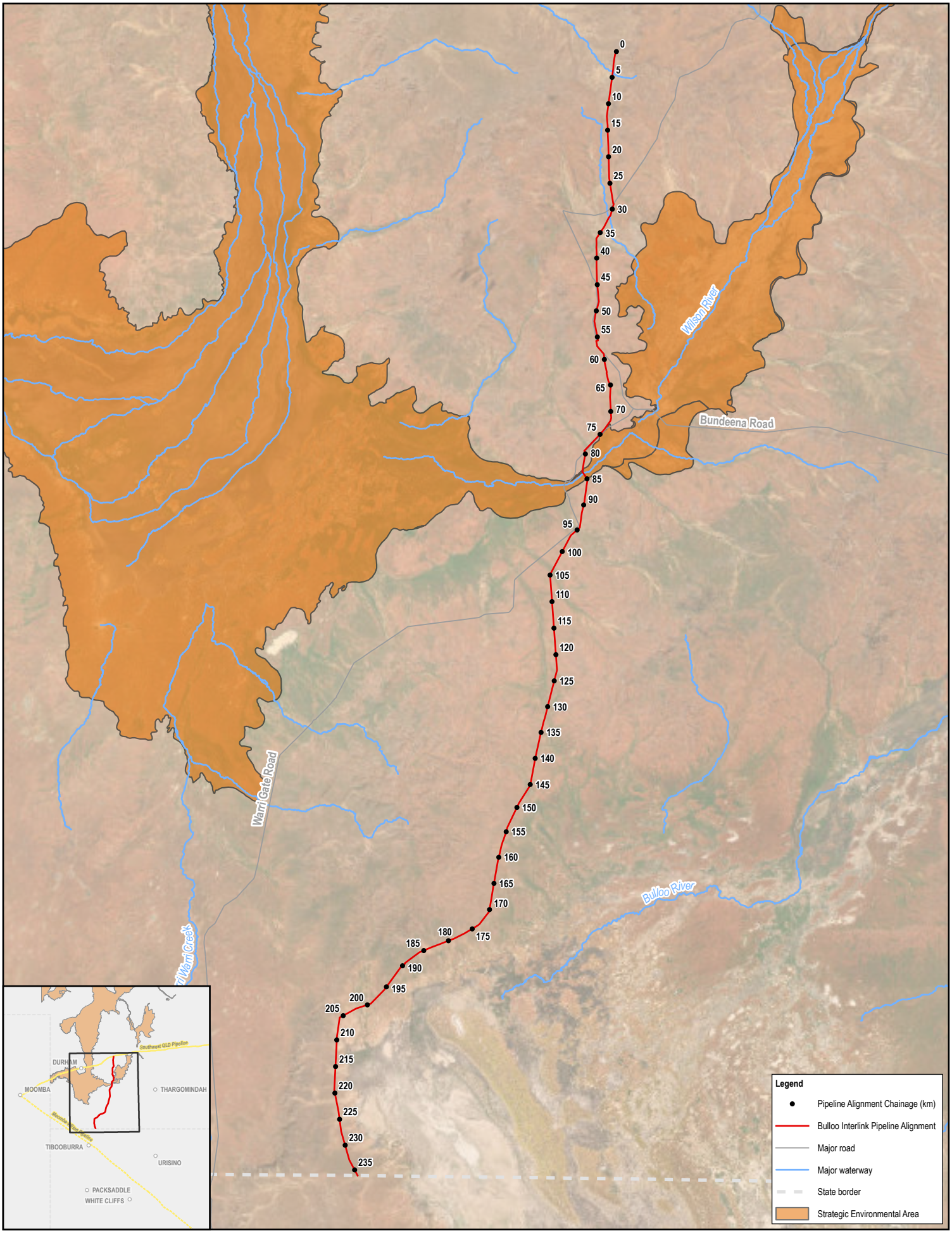
The dominant surrounding land use is mapped as ‘grazing native vegetation’. Developed or potentially sensitive land use features listed in Table 4.2 that could be impacted by changes to runoff rates, volumes, or quality, are generally located several kilometres from the pipeline alignment. The most frequently occurring features within the study area are reservoirs and dams. These features occur at multiple chainage locations, with distances from the alignment typically ranging from about 0.04 km to 4.6 km. The closest reservoir or dam is located near chainage 0 km, at an approximate distance of 0.04 km from the alignment.

Airports and aerodromes are also present at several locations along the pipeline alignment. These facilities are generally situated between about 1.2 km and 5.6 km from the alignment, with the nearest occurring at chainage 35 km. All identified aviation-related land uses are located outside the CRoW.

Table 4.2 Land uses within 10 km distance from the pipeline alignment

Land use feature	Chainage (km)	Distance from pipeline alignment (km)
Reservoir/dam	0	0.04
Airports/aerodromes	27	4.60
Reservoir/ dam	33	2.00
Airports/aerodromes	35	1.20
Reservoir/dam	67	5.60
Airports/aerodromes	72	3.80
Solid garbage	72	4.20
Farm buildings	72	4.40
Mining	75	4.30
Reservoir/dam	75	4.60
Airports/aerodromes	79	5.50
Waste treatment and disposal	85	4.00
Airports/aerodromes	83	2.20
Farm buildings and other infrastructure	85	3.50

Land use feature	Chainage (km)	Distance from pipeline alignment (km)
Recreation and culture	90	4.30
Reservoir/dam	135	3.40
Reservoir/dam	190	0.50
Reservoir/dam	195	4.30
Reservoir/dam	212	1.80
Reservoir/dam	225	4.40
Reservoir/dam	231	3.90
Airports/aerodromes	235	2.40



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Kilometres

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Map Projection: Transverse Mercator
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Grid: GDA2020 MGA Zone 54

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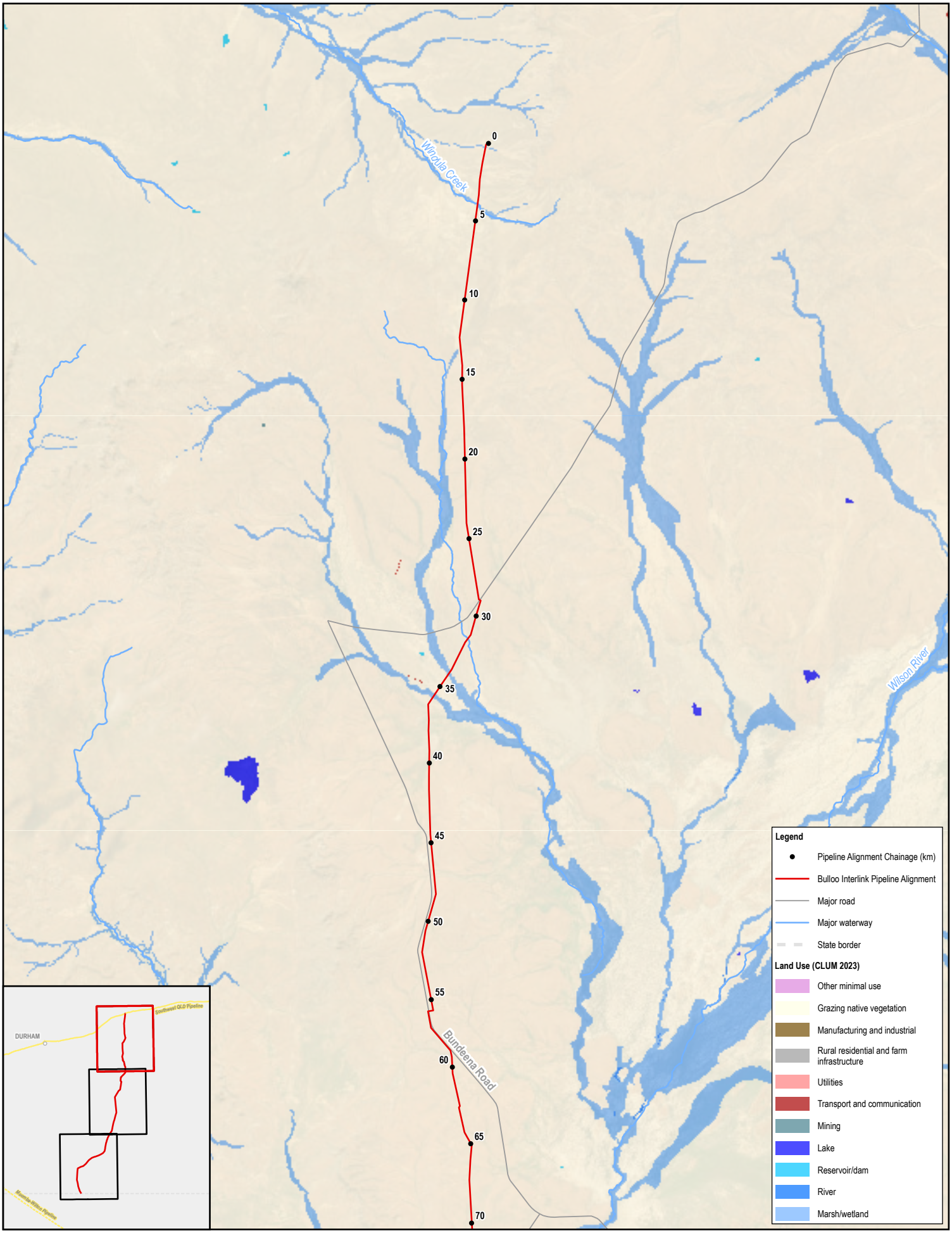
Project No. 12661648
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Strategic environmental areas

Figure 4.5

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Data source: Earthstar Geographics, Esri, CGIAR. DNRMMRRD: Major roads (2021), Major waterway (2023); DETSI: Strategic environmental area (2024); APA: Stockpile and camp area, Pipeline alignment (2026); GHD: Chainage (2025) Created by: mvandermerwe



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Kilometres

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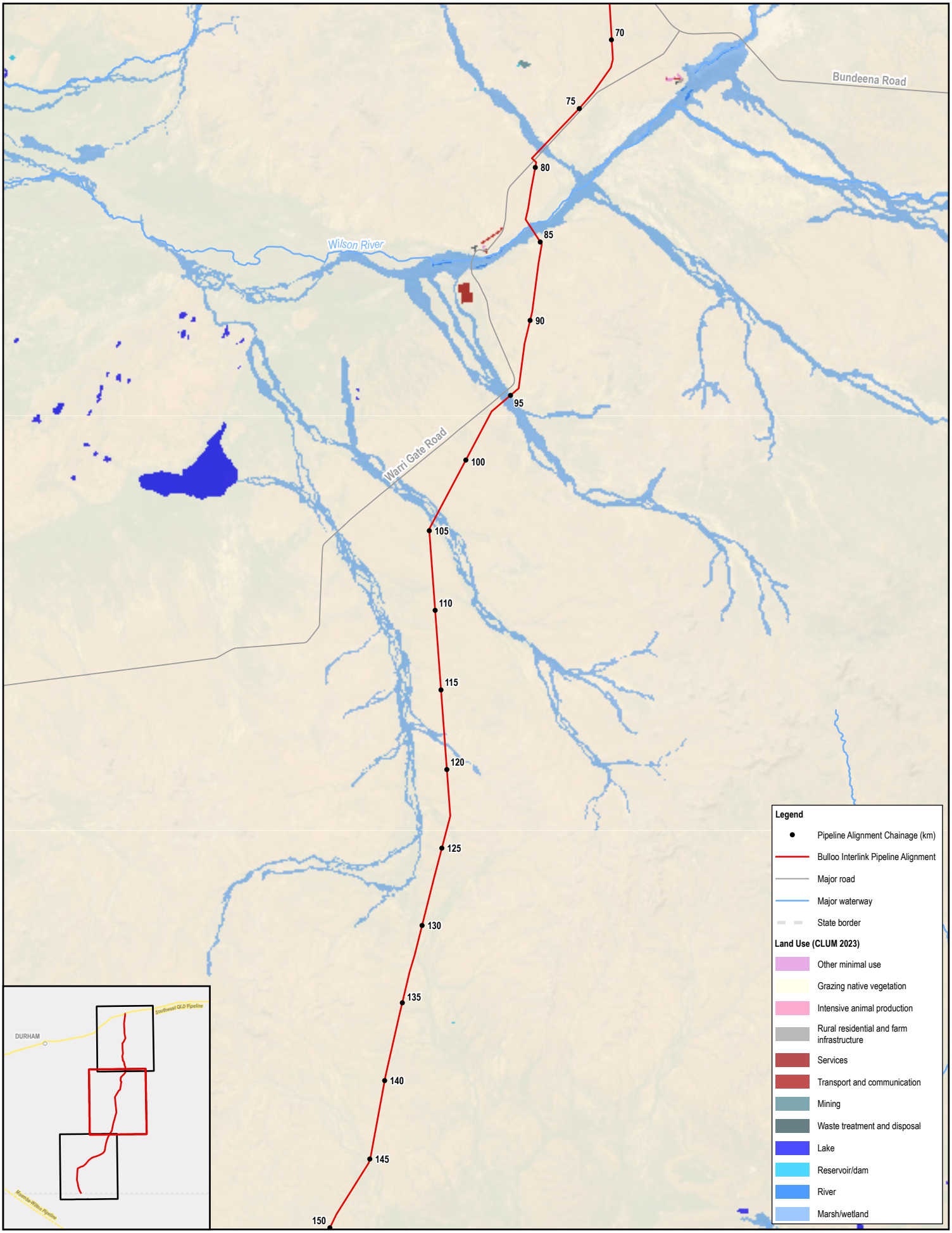
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Land use

Figure 4.6

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Kilometres

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Bulloo Interlink Pipeline

Land use

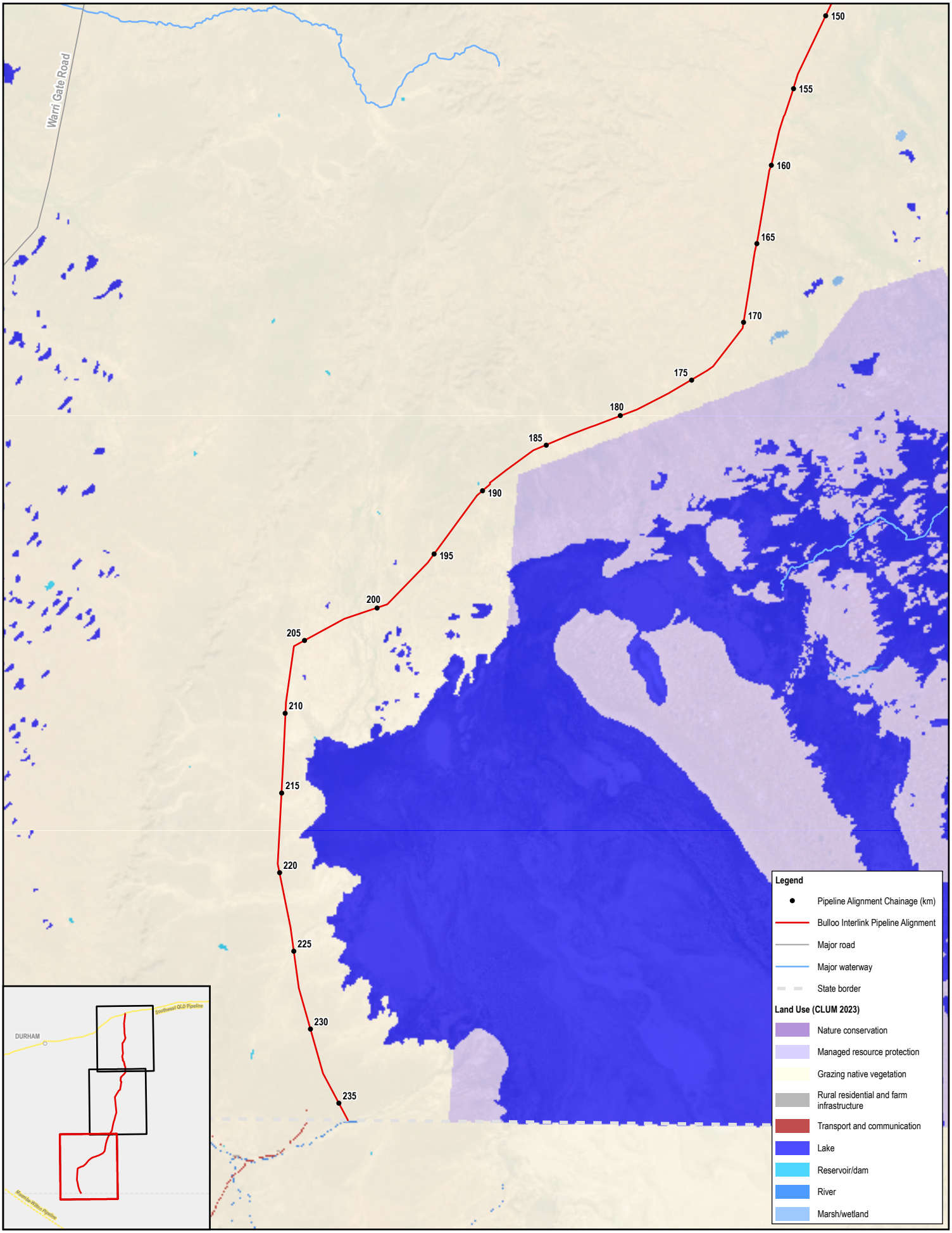
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Figure 4.6

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Data source: Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS, DNRMMRRD: Major roads (2021), Major waterway (2023); ABARES: CLUM 2023 (2025); APA: Construction access, Pipeline alignment (2026); GHD: Chainage (2025) Created by: mvandermerwe



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Kilometres

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Land use

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Figure 4.6

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Data source: Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS, DNRMMRRD: Major roads (2021), Major waterway (2023); ABARES: CLUM 2023 (2025); APA: Construction access, Pipeline alignment (2026); GHD: Chainage (2025) Created by: mvandermerwe

4.4 Surface water

4.4.1 Regional setting

Drainage divisions, basins and major tributaries

The project site lies entirely within the Lake Eyre Basin, which is further divided into three sub-basins: Cooper Creek–Bulloo River, Diamantina–Georgina rivers, and Lake Eyre. The study area falls in Cooper Creek–Bulloo River sub-basin within which there are major and minor tributaries. The location of the Bulloo River and Cooper Creek basins are shown in Figure 4.7. The pipeline alignment is within the Cooper Creek drainage basin between chainages 0 km and 128 km and the Bulloo drainage basin is between chainages 128 km and 236.2 km.

At a finer scale, the pipeline alignment intersects a number of defined watercourses, including major waterways and their associated tributaries. The watercourses crossed by the alignment are identified in section 4.4.2, which describes each watercourse together with the corresponding chainage range of the crossing location of the associated tributaries along the pipeline alignment.

Geomorphology

The project alignment traverses the Cooper Basin from chainage 0–128 km before crossing into the Bulloo Basin for the remainder of the pipeline alignment (refer to Figure 4.7). These two sub-basins form part of the arid inland drainage systems of western Queensland and share several geomorphic characteristics, including extremely low relief, broad alluvial plains and highly variable, event-driven hydrological regimes. Despite these similarities, each basin exhibits distinct geomorphic behaviours shaped by its drainage pattern and long-term sedimentary processes.

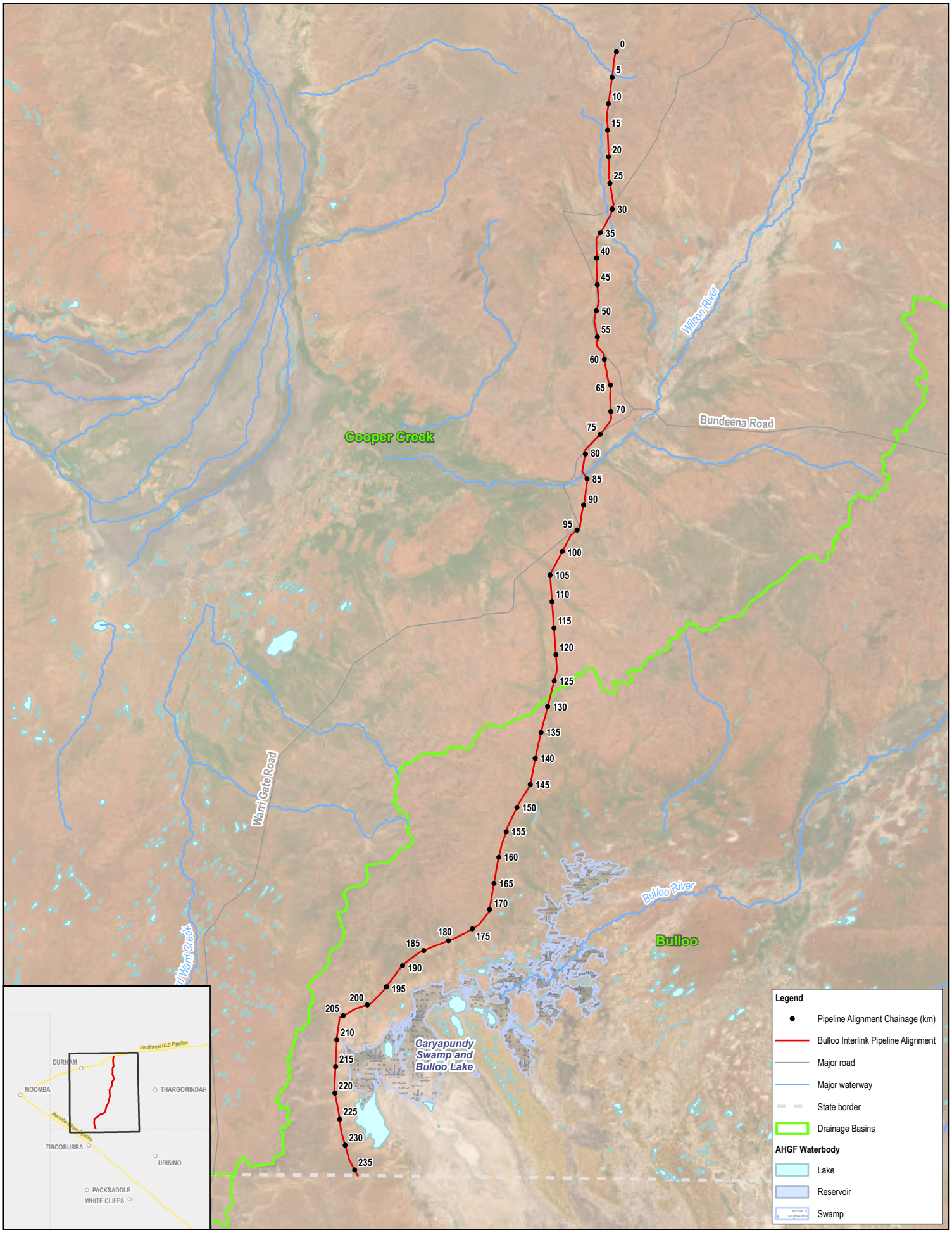
The Cooper Basin is part of the larger Lake Eyre Basin and is characterised by a complex distributary channel network that spreads across wide floodplains. In its upper reaches, channels drain from low ranges and dissected uplands, where flows are episodic and generated by convective storms and monsoonal influences. As the system progresses downstream, channels broaden and divide into multiple shallow flow paths, with floodrunners, swales and depressions distributing water across extensive alluvial plains during major flood events. Floodplain wetlands, waterholes and claypans act as long-term sediment and water storage features, with geomorphic change occurring primarily during infrequent but high-magnitude floods.

The Bulloo Basin, in contrast, is an internally draining endorheic system where the Bulloo River flows south-west across low-gradient plains before terminating in a series of ephemeral lakes and floodouts (i.e. zones where a river or channel losses confinement and spreads out across a broad, low-gradient surface, causing flow to slow down and disperse into multiple shallow pathways).

In the Bulloo Basin upper catchment, channels are narrow and moderately incised, transitioning downstream into a more distributary and anabranching pattern across sandy and clayey alluvial plains. Numerous shallow depressions, floodrunners and swales temporarily store water following rainfall events. The terminal reaches are dominated by broad floodouts, claypans and ephemeral lakes that act as sediment sinks and support wetland habitat when inundated. An example of claypan deposits located close to pipeline alignment chainage 315 km is shown in Plate 4.3.

Across both basins, geomorphic processes are strongly event-driven. Long periods of negligible flow are punctuated by short, high-energy floods that transport sediment, reshape channels and deposit fine material across floodplains. Channel banks, typically composed of cohesive silts and clays, are prone to slumping and lateral adjustment during large events but remain relatively stable during extended dry period, refer to Appendix C (Aquatic Ecology Assessment Report) of the Environmental Authority Supporting Information Report.

Over geological timescales, repeated cycles of floodplain inundation, overbank deposition and localised erosion have produced a diverse mosaic of geomorphic units including levees, backswamps, abandoned channels, claypans and shallow depressions. An example of a relic channel infilled with fine alluvial sediment close to pipeline alignment chainage ~220 km is provided in Plate 4.4. These landforms are characteristic of arid-zone river systems in central Australia and underpin the ecological values associated with episodic wetland inundation. An example of recent inundation and overflows into the wider floodplain is provided in Plate 4.5 from rainfall in early 2025.



Paper Size ISO A4

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

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River basins

Figure 4.7

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Data source: We request attribution as © Commonwealth of Australia (Bureau of Meteorology) 2022, © State of Queensland (Department of Resources) 2021, Earthstar Geographics, Esri, CSIAR, DNRMMRRD: Major roads (2021), Major waterway (2023), Drainage basin (2026); AHGF: Waterbody (2026); APA: Construction access, Pipeline alignment (2026); GHD: Chainage (2025) Created by: mvandermerwe

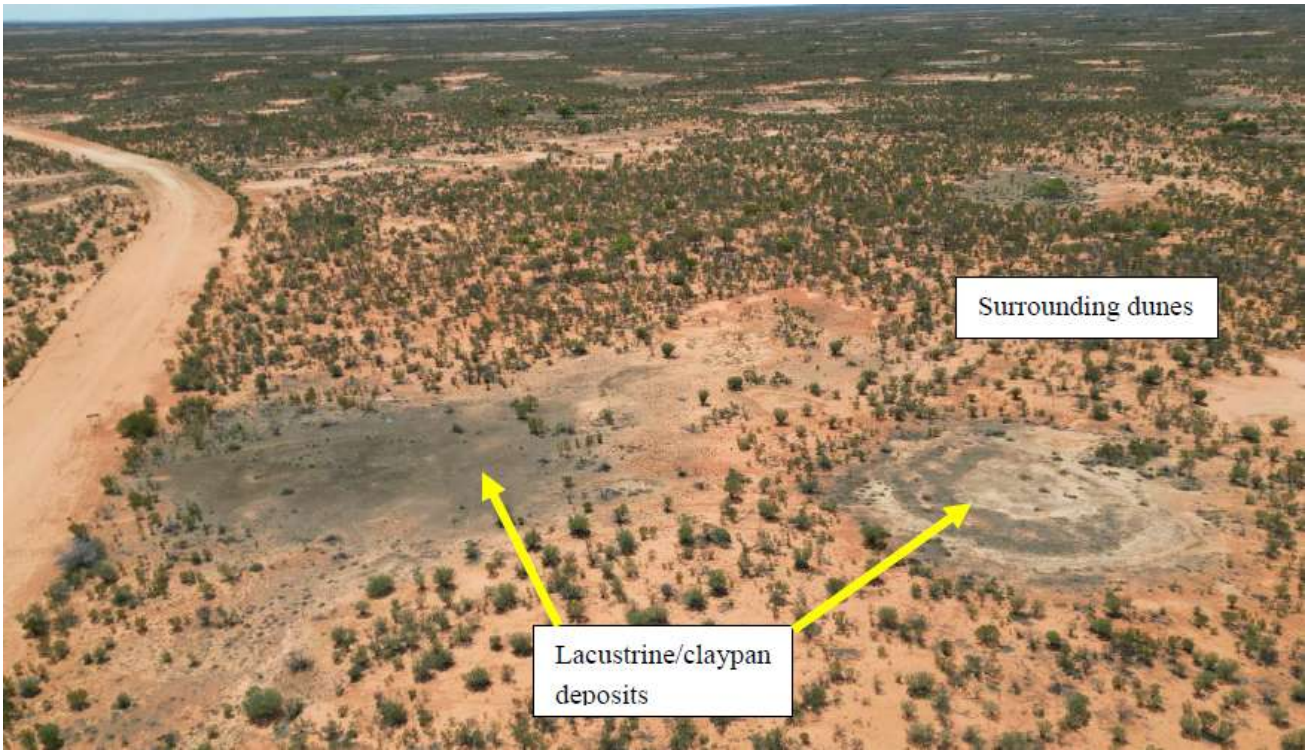


Plate 4.3 An example of claypan deposits located close to pipeline alignment chainage ~315 km (WSP, 2025)

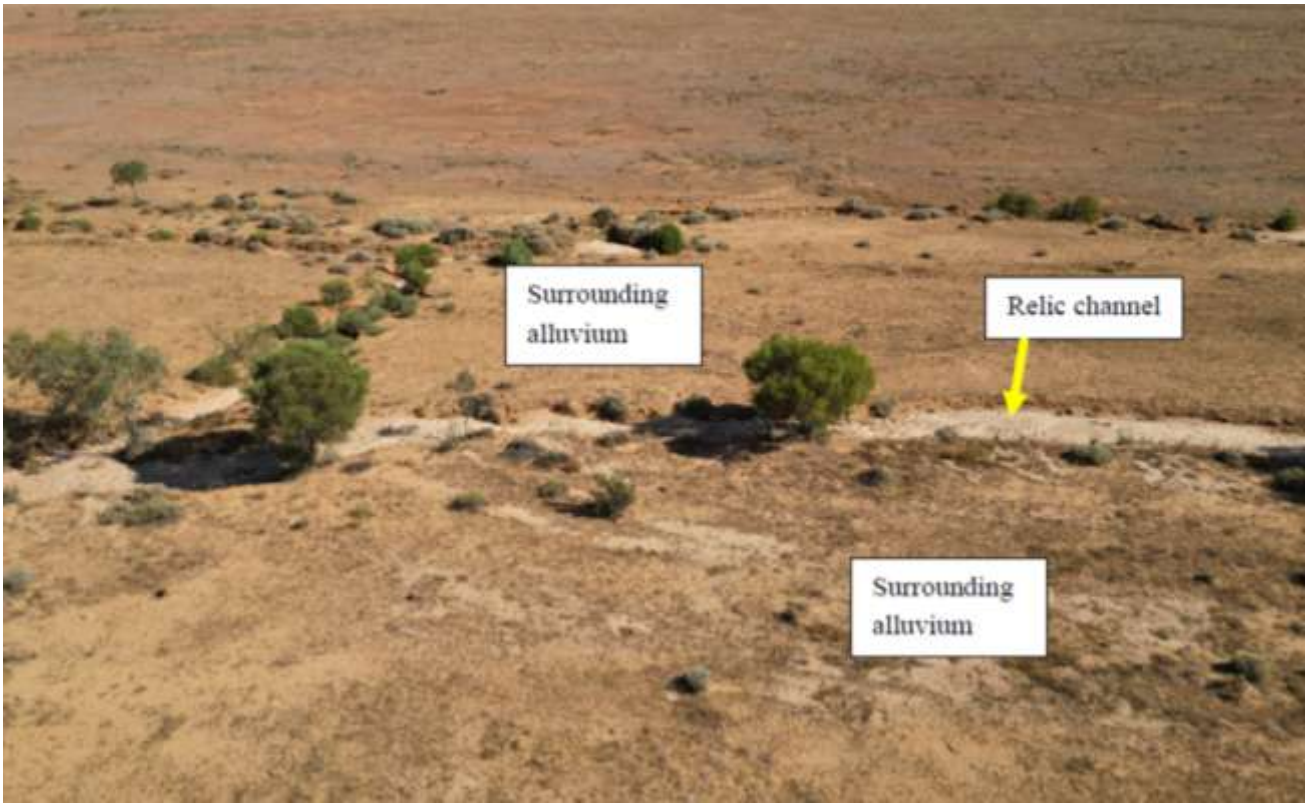


Plate 4.4 An example of relic channel filled with fine alluvial sediment located close to pipeline alignment chainage ~220 km (WSP, 2025)



Plate 4.5 *An example of wetland inundation and overflow into surrounding floodplain from Bulloo Lake in July 2025 south of chainage 187 km (source: GHD 2025)*

4.4.2 Watercourses and waterways

The main watercourses intersected by the pipeline alignment, together with the start and end chainages of each crossing, are summarised in Table 4.3 and shown in Figure 4.8.

Table 4.3 identifies the Strahler stream order and the watercourse classification under the *Water Act 2000* (Qld) (as determined by the Watercourse Identification Map).

Where a watercourse classification has not been made by the Department of Local Government, Water and Volunteers, the classification is noted as unmapped. However, there is potential that the unmapped features meet the definition requirements of watercourses under the *Water Act 2000*.

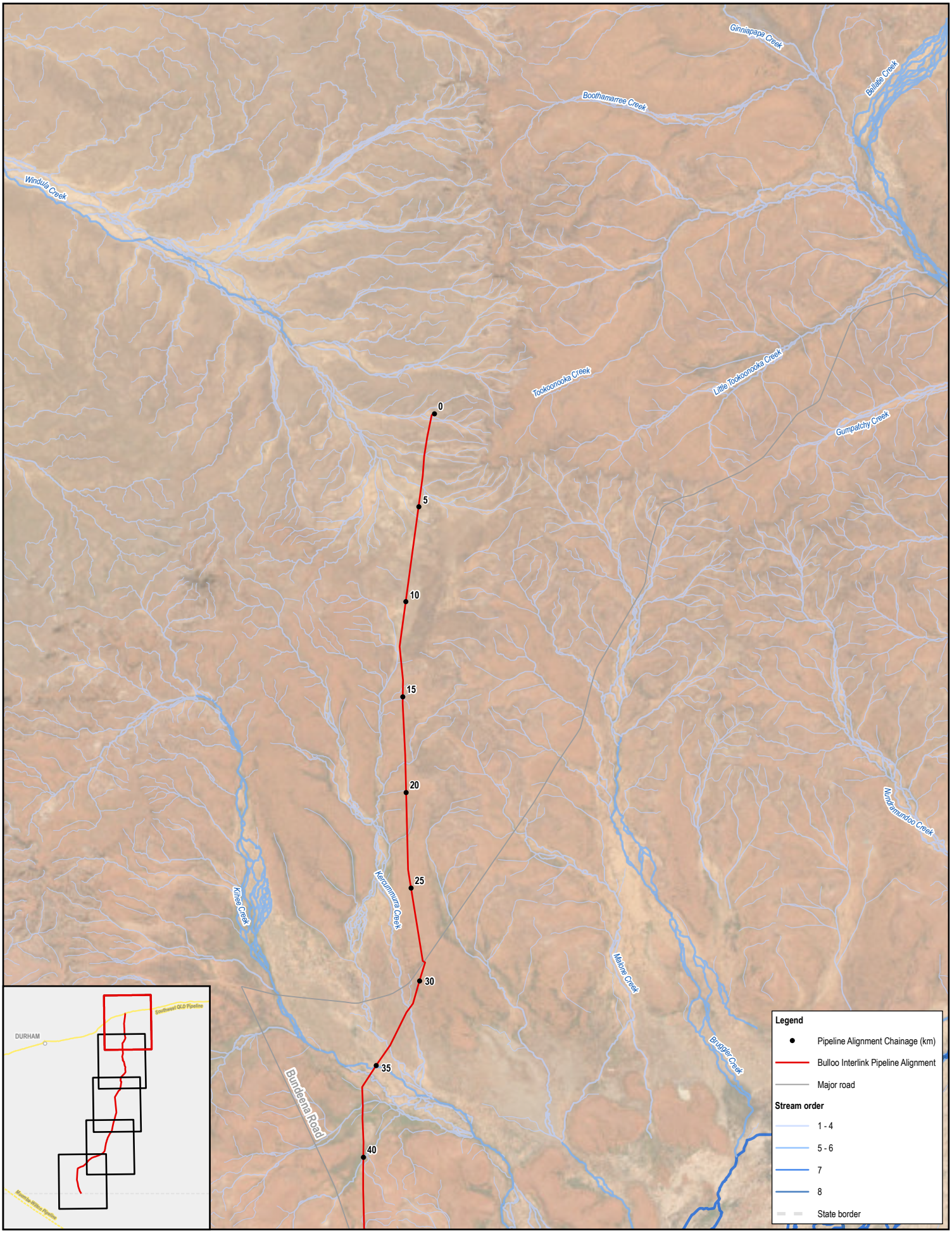
The *Water Act 2000* defines a watercourse as a river, creek or other stream in which water flows either permanently or intermittently, including anabranches and tributaries, whether occurring in a natural channel (modified or unmodified) or an artificial channel that has altered the course of the stream. A watercourse includes in-stream features such as islands, benches and bars, but does not include drainage features. The lateral limits of a watercourse are defined by the outer banks on either side.

Table 4.3 Watercourses crossed by the pipeline alignment

Watercourse name	Watercourse crossing chainage (km)	Strahler stream order[1]	Watercourse classification under the *Water Act 2000*
Windula Creek	0.28–3.95	1, 2, and 3	Watercourse – unmapped
Kercummura Creek	18.44–47.00	1 to 5	Watercourse – unmapped
Gum Creek	59.22–68.21	1, 2, and 4	Watercourse – unmapped
Tirtywinna Creek	71.80–78.63	1, 3, 4, and 5	Watercourse – unmapped
Wilson River	83.76–89.19	1, 3, 5, and 6	Watercourse – unmapped
Tippera Creek	94.61–95.56	4	Watercourse – unmapped
Murrawarra Creek	103.83–104.52	1 and 5	Watercourse – unmapped
Wippo Creek	111.70–118.59	1, 2, and 3	Watercourse – unmapped
Whippa Creek	131.75–139.04	1, 2, and 3	Watercourse – unmapped
Parrabinna Creek	145.00–154.94	1, 2, 3, and 5	Watercourse – unmapped
Muggera Creek	156.74–158.65	1 and 3	Watercourse – unmapped
Tickalara Creek	200.80–207.46	1, 3, 4, and 5	Watercourse – unmapped
Morris Creek	216.09–216.22	4	Watercourse – unmapped
Gidya Creek	221.42–221.69	4	Watercourse – unmapped
Wanka Creek	223.83–224.84	1 to 4	Watercourse – unmapped
Wanpah Creek	236.50	2	Watercourse – unmapped
Un-named streams/creeks	162.88–195.00; 211.62–212.43; 230.14–234.24	Various	Unmapped

Note: 1. Strahler stream order classifies stream segments based on the number of tributaries upstream. For example, a stream with no tributaries is considered a first order stream whereas a segment downstream of the confluence of two first order streams is a second order stream.

In addition to the defined watercourses mentioned above, there are minor watercourses located within the study area that are intersected by the pipeline alignment, refer to Appendix B.



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Grid: GDA2020 MGA Zone 54

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Bulloo Interlink Pipeline

Watercourses

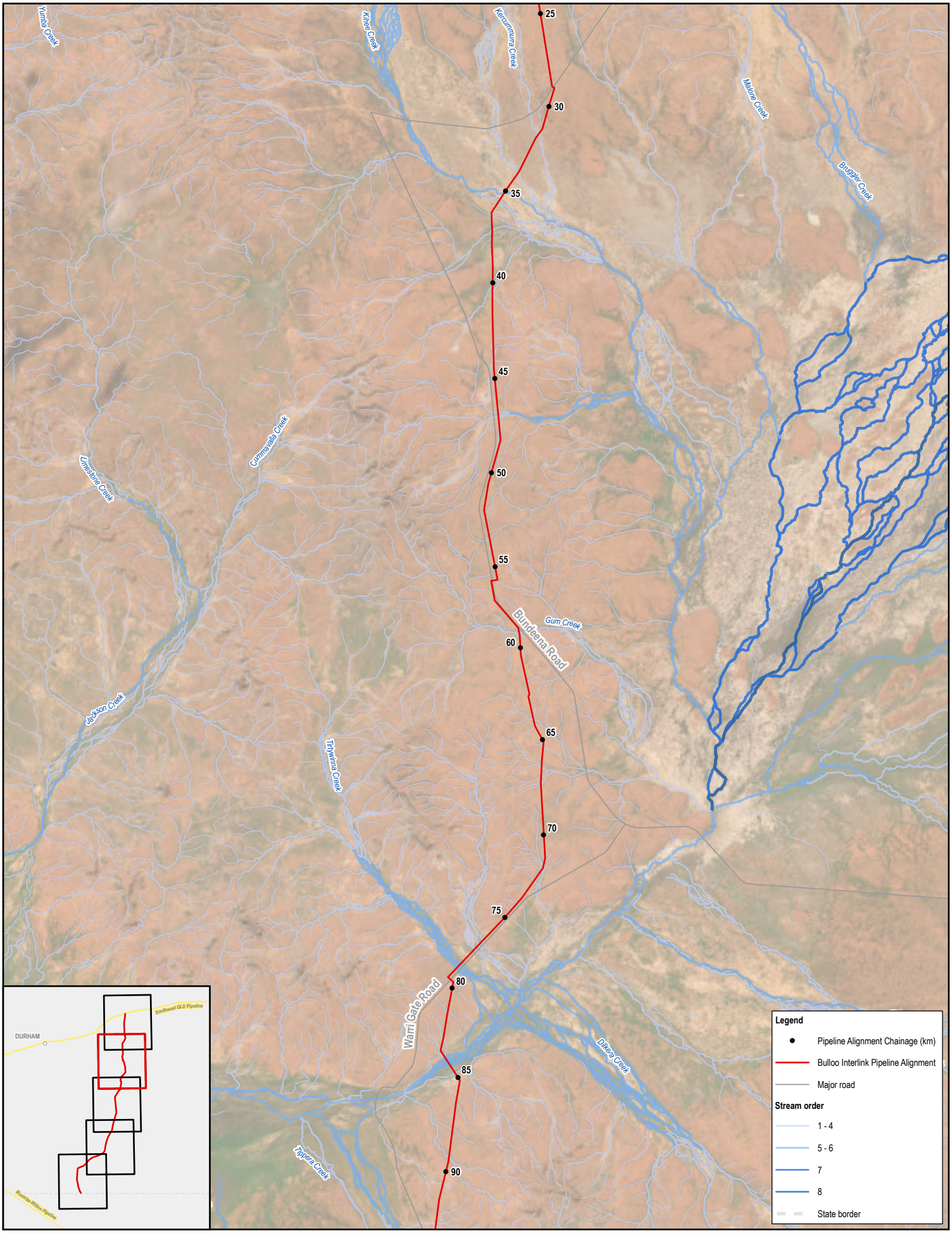
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Figure 4.8

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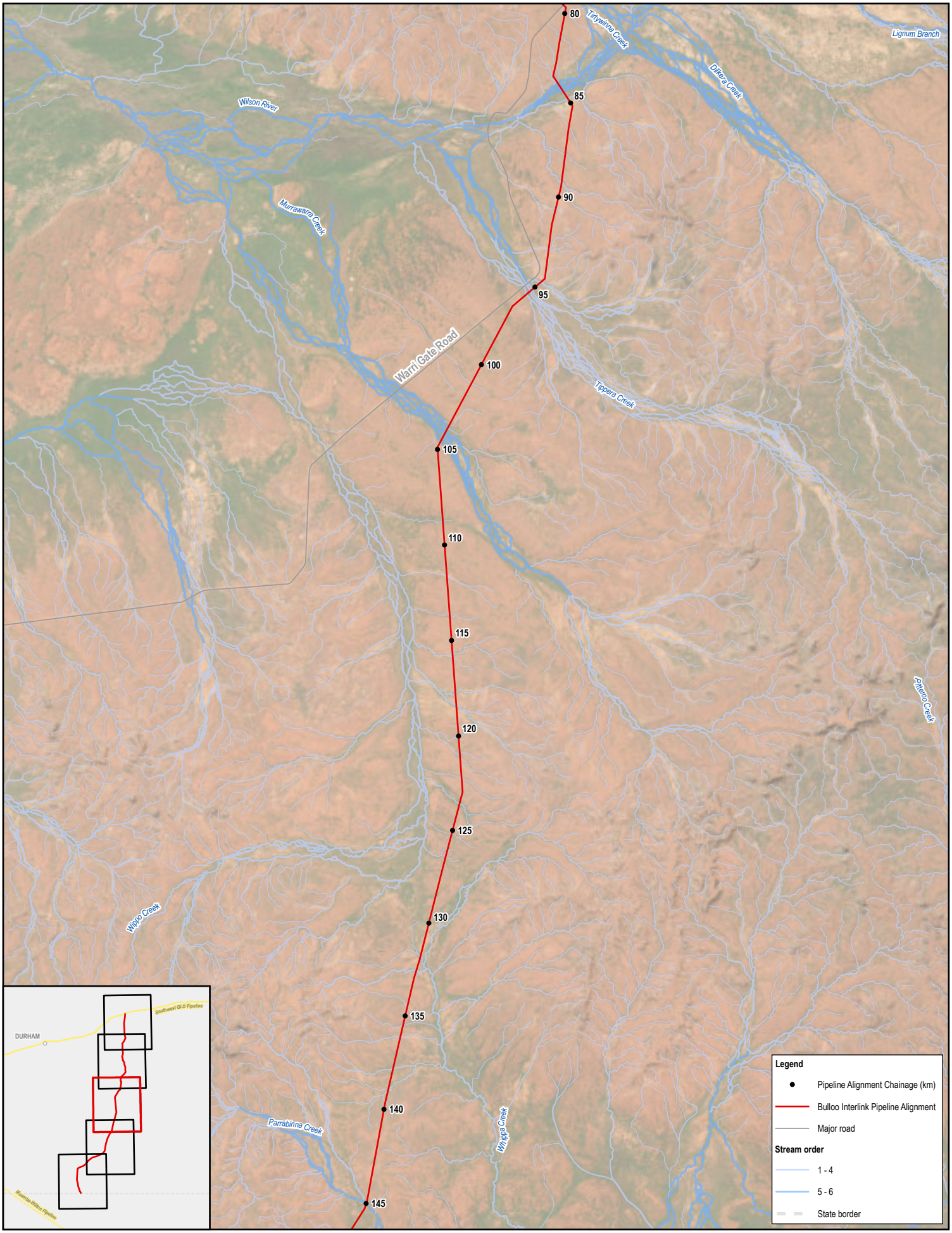
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Figure 4.8

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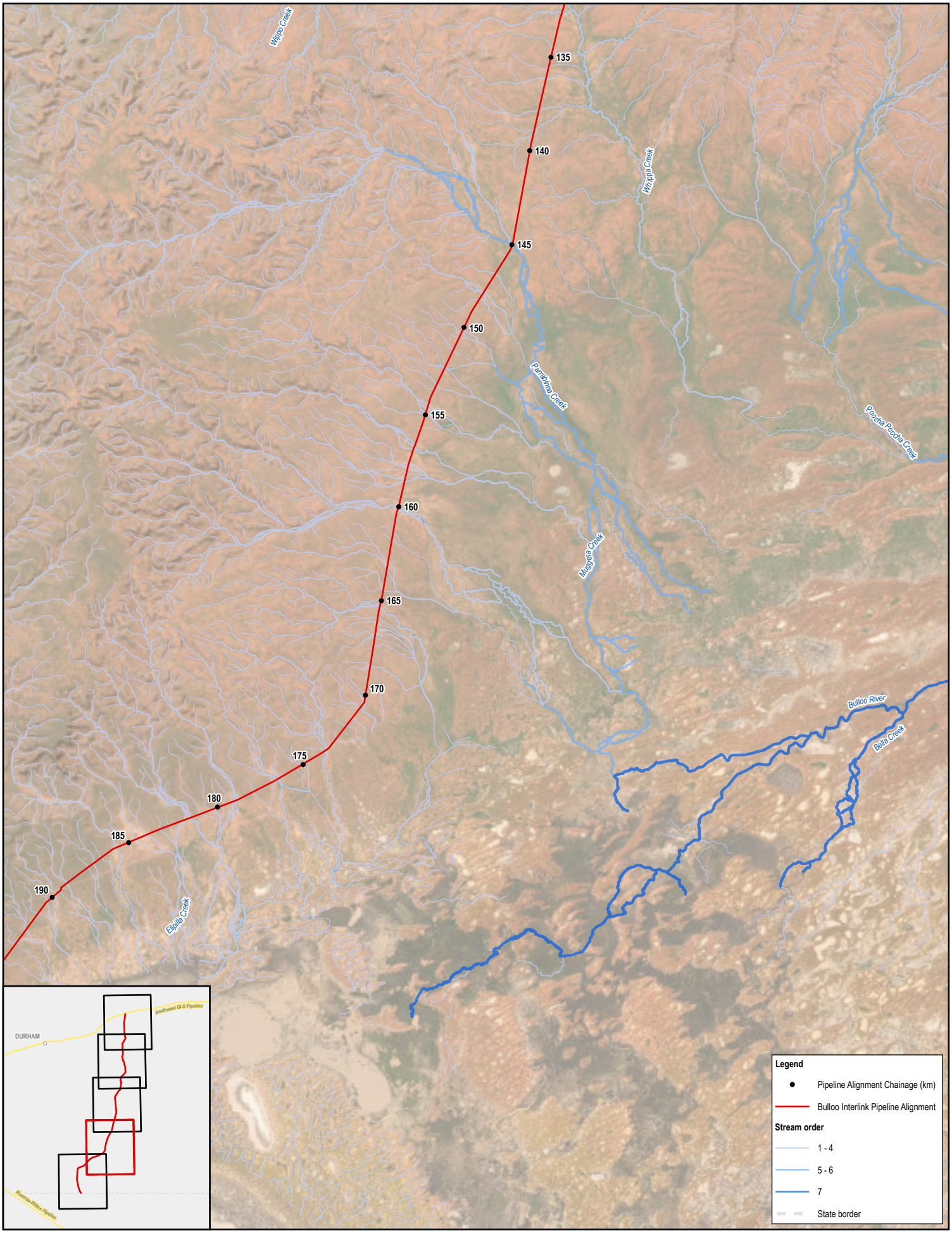
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Figure 4.8

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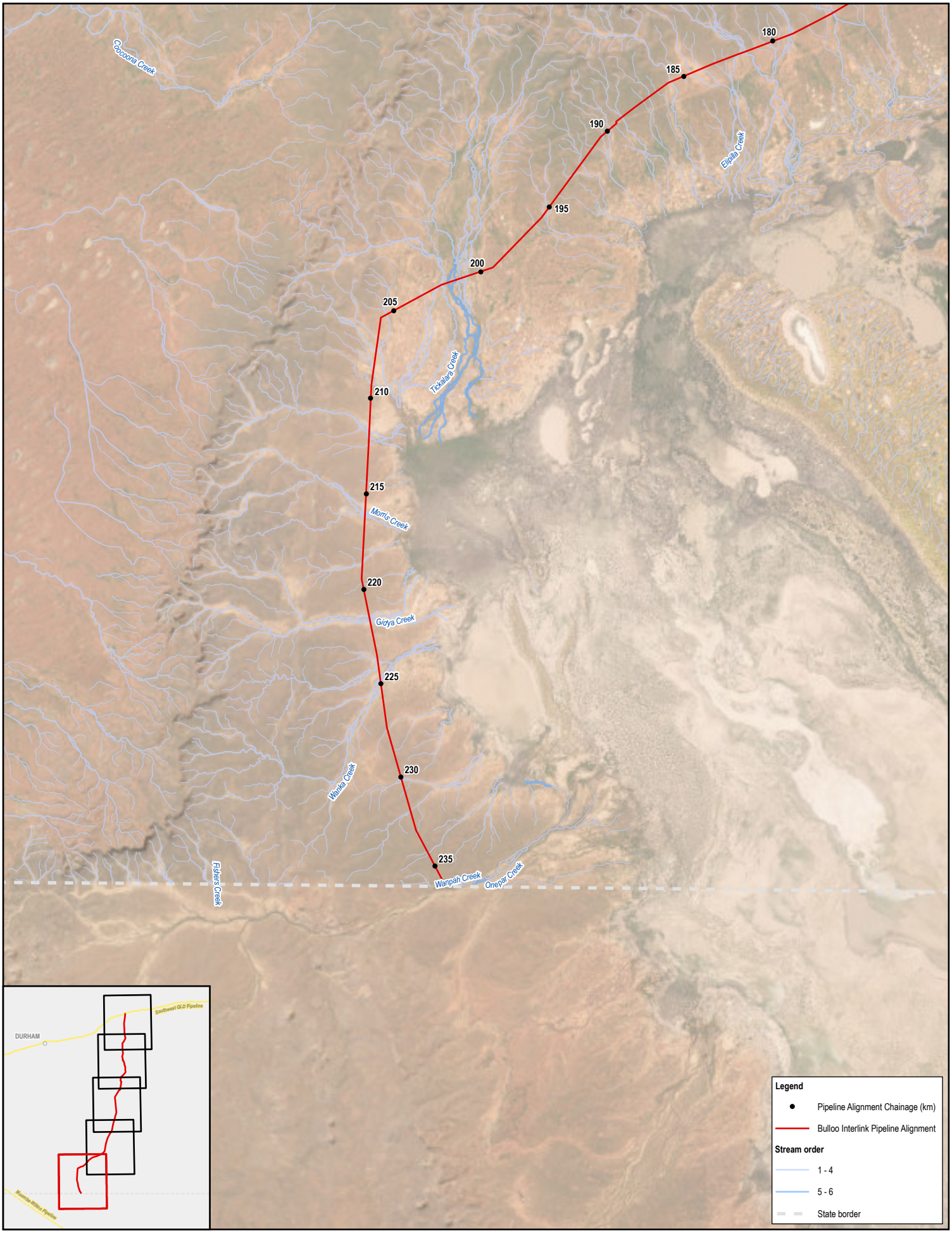
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Figure 4.8

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Figure 4.8

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4.4.3 Surface water flow

The Queensland Government's Water Monitoring Information Portal (WMIP) offers comprehensive water monitoring datasets across Queensland, encompassing archived time series for surface water, groundwater, rainfall and water quality, in addition to discrete water quality results from specific monitoring initiatives. Based on WMIP data extracted from Queensland Spatial Catalogue – QSpatial (Queensland Government, 2025), the nearest streamflow gauging station (011202A: Bulloo River at Autumnvale) is situated approximately 125 km east of the project site (Figure 4.1). Streamflow data from the Bulloo River at the Autumnvale gauging station were used to provide regional context only. Due to the distance from the project site and the influence of downstream floodplain storage and attenuation processes, the recorded flows are not considered representative of site-specific conditions; however, the data provide a useful indication of the episodic and highly variable flow regimes that characterise the broader Bulloo River system and inform understanding of flood behaviour relevant to the project area.

Flow recorded in the Bulloo River at Autumnvale since 2014 indicates short bursts of high flows followed by long periods of low to no flow (Figure 4.9). Whilst flow was typically associated with rainfall, there were instances where rainfall did not produce runoff events (e.g. in November 2018). This pattern is representative of the waterways throughout the project site where runoff only occurs after periods of heavy rainfall. High rates of infiltration into the dry, fine sediments, together with ephemeral depression storage, captures small rainfall events without producing runoff (refer to soils results in section 4.3).

Figure 4.10 shows the time-weighted stream discharge duration curve for this site. Analysis of the recorded period indicates that the Bulloo River at Autumnvale experienced zero flow for roughly 30% of the time, whereas flows equal to or exceeding 30 m³/s were observed about 10% of the time. The highest recorded discharge was about 3,250 m³/s in April 2025, the river was still flowing at the time of the aquatic ecology survey in October 2025 but at a lower rate, refer to Appendix C (Aquatic Ecology Assessment Report) of the Environmental Authority Supporting Information Report.

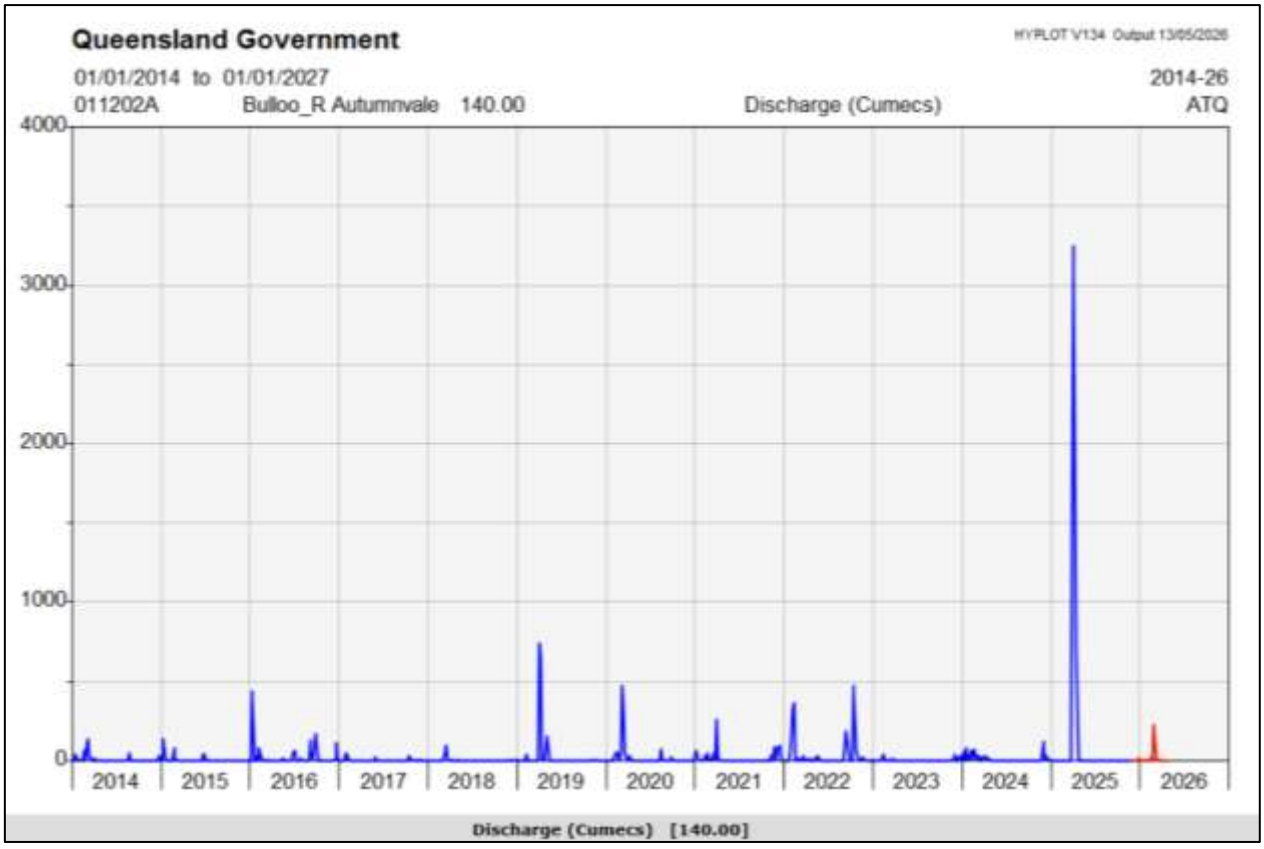


Figure 4.9 Mean daily discharge in the Bulloo River at Autumnvale from 2014 to March 2026

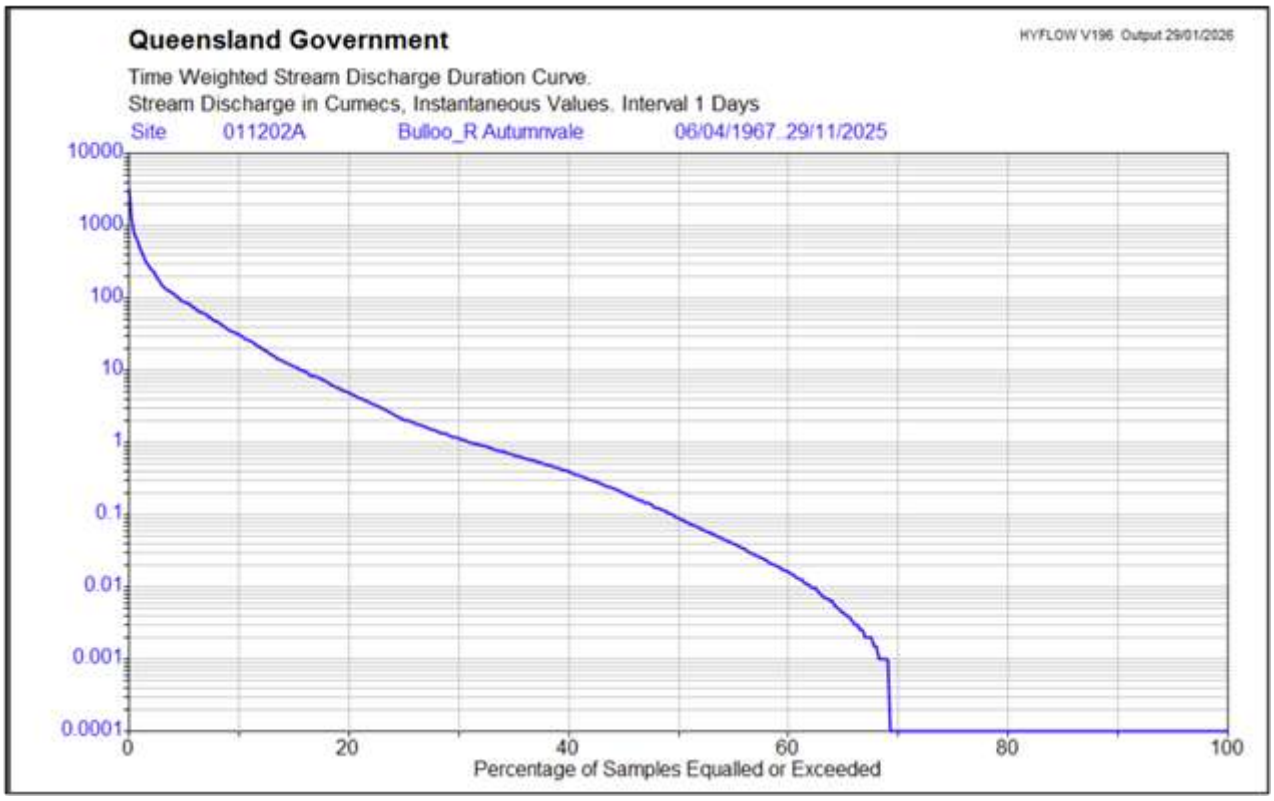


Figure 4.10 Time weighted stream discharge duration curve for Bulloo River at Autumnvale station

4.4.4 Surface water quality

Environmental values and water quality guidelines

In Queensland, surface water environmental values (EVs) and water quality objectives (WQOs) are established under the Schedule 1 of EPP Water and Wetland Biodiversity where available. A review of applicable EVs and WQOs for the project identified that sections of the alignment occur within the Bulloo River catchment, for which EVs and WQOs are defined in the *Warrego, Paroo and Bulloo Rivers and Nebine, Mungallala and Wallam Creeks Basins Environmental Values and Water Quality Objectives* (DES, 2020d).

The EVs relevant to the Bulloo River Basin include:

– aquatic ecosystems
– farm supply/use
– stock water
– aquaculture
– human consumer
– primary, secondary and visual recreation
– drinking water
– industrial use
– cultural, spiritual and ceremonial values.

The remainder of the alignment is located within the Cooper Creek–Bulloo River catchment, where surface water EVs and WQOs have not been developed under the EPP Water and Wetland Biodiversity. In these areas, surface water quality assessment is guided by the Queensland Water Quality Guidelines (DEHP, 2009) and, where state-based objectives are not available, the ANZG Guidelines (2018).

Historical baseline context

Historical surface water quality data was reviewed to establish a baseline understanding of existing environmental conditions within the Bulloo River catchment. Table 4.4 presents a summary of the historical water quality monitoring data available for the Bulloo River at the Autumnvale gauging station (no. 011202A) (Figure 4.1), which represents the only location within the study area with sufficient long-term data to inform baseline conditions. This data was sourced from the Water Monitoring Information Portal (WMIP) (Queensland Government, 2026) and supplemented by publicly available datasets.

The historical data was assessed against the ANZG Guidelines (2018), for the purpose of interpreting baseline conditions. The ANZG Guidelines (2018) provide nationally recognised guideline values that represent conditions consistent with a healthy aquatic ecosystem and are commonly applied to characterise background water quality. For the purposes of assessment under the ANZG Guidelines (2018), surface waters within the study area are considered to comprise lowland rivers/streams and freshwater wetlands. In the absence of evidence demonstrating high ecological value, these systems have been assessed as slightly to moderately disturbed freshwater ecosystems.

Table 4.4 shows that pH and total dissolved solids (TDS) fall within acceptable ranges for slightly to moderately disturbed freshwater ecosystems. Turbidity, total nitrogen and total phosphorus exceed the adopted national guideline values; however, these exceedances are characteristic of arid inland systems such as the Bulloo River catchment; where naturally high sediment loads, episodic flooding and organic material contribute to elevated turbidity and nutrient concentrations. In this context, the results are considered representative of background environmental conditions, rather than indicative of anthropogenic impacts.

Table 4.4 Surface water quality data (existing condition) for the Bulloo River (Autumnvale gauging station; no. 011202A)

Analyte	Total count of readings as at 09/02/2026	Median value	ANZG Guideline (2008) value	Assessment
pH	66	7.055	6.0–8.0 (ecosystem protection)	Meets guideline
Turbidity (NTU)	48	887	2–25	Exceeds guideline (expected for Bulloo)
TDS (mg/L)	61	72	No default guideline value; stock water <500–1000 mg/L	Within acceptable range
Total Nitrogen (mg/L)	43	1.1	0.25–0.30 mg/L	Exceeds guideline
Total Phosphorus (mg/L)	45	0.3958	0.02–0.05 mg/L	Exceeds guideline

Aquatic ecology water quality monitoring results

Surface water quality monitoring was also undertaken as part of the post-wet (July 2025) and pre-wet (October 2025) season aquatic ecology field surveys. Refer to Appendix C (Aquatic Ecology Report) of the Environmental Authority Supporting Information Report for all field data.

The pipeline alignment is located partially within the Bulloo River catchment of the Lake Eyre basin, for which WQOs are prescribed under Schedule 1 of the EPP Water and Wetland Biodiversity within the *Warrego, Paroo and Bulloo Rivers and Nebine, Mungallala and Wallam Creek basins Environmental Values and Water Quality Objectives* (DES, 2020d). The remainder of the alignment is located within the Cooper Creek–Bulloo River catchment of the Lake Eyre Basin, for which site-specific WQOs are not available under the EPP Water and Wetland Biodiversity. Although the QWQG (DEHP, 2009) apply in the absence of WQOs under the EPP Water and Wetland Biodiversity, they note that the limited data availability and highly ephemeral nature of Lake Eyre Basin waterways mean that the default guideline values are unlikely to be appropriate, with the development of specific local guidelines preferred.

Therefore, water quality at all sampling locations was assessed using the EPP Water and Wetland Biodiversity EVs and WQOs for the Warrego, Paroo and Bulloo Rivers and Nebine, Mungallala and Wallam Creek basins (DES, 2020d), which provide the most appropriate Queensland regulatory framework for comparable arid-zone systems. Specifically, WQOs for moderately disturbed waters of the Upper Bulloo River at low flow were applied to majority of sites (Table 4.5); with the exception of the Bulloo River, which is located within the waters of the Lower Bulloo River, and therefore correspond with the WQOs for moderately disturbed waters of the Lower Bulloo River at low flow (Table 4.6).

Across both post-wet and pre-wet season survey periods, median pH and dissolved oxygen values for the Upper and Lower Bulloo River were within the applicable EPP Water and Wetland Biodiversity guideline ranges, indicating generally acceptable conditions for aquatic ecosystems. Electrical conductivity exceeded the guideline values in both July and October, and average turbidity demonstrated minor exceedances in the Upper Bulloo River and higher exceedances in the Lower Bulloo River; reflecting the highly variable and sediment-rich nature of low-flow conditions in these ephemeral waterways.

Table 4.5 Surface water quality monitoring results for the Upper Bulloo River Basin

Analyte	Upper Bulloo River median values (July 2025)	Upper Bulloo River median values (October 2025)	Guideline value for the Upper Bulloo River at low flow (DES,2020d)	Assessment
Electrical conductivity (µS/cm)	230.48	297.27	<100	Exceeds guideline
pH	7.81	8.02	6.5–8.0	Meets guideline (minor exceedance in October)
Dissolved oxygen (% sat)	95.58	85.53	60–110	Meets guideline
Turbidity (NTU)	271.55	270.71	<270	Minor exceedance of guideline

Table 4.6 Surface water quality monitoring results for the Lower Bulloo River Basin

Analyte	Lower Bulloo River median values (July 2025)	Lower Bulloo River median values (October 2025)	Guideline value for the Lower Bulloo River at low flow (DES,2020d)	Assessment
Electrical conductivity (µS/cm)	119.70	171.80	<95	Exceeds guideline
pH	7.15	7.83	6.5–8.0	Meets guideline
Dissolved oxygen (% sat)	96	90.20	60–110	Meets guideline
Turbidity (NTU)	758.45	782	<780	Exceeds guideline

4.5 Ecology and wetlands

Terrestrial and aquatic ecological values relevant to the project have been assessed through separate specialist studies, documented in Appendix C (Aquatic Ecology Assessment Report) of the Environmental Authority Supporting Information Report. From a water-related perspective, ecological features are referenced in this report only where they inform the identification of surface water, wetland and groundwater pathways relevant to hydrological and hydrogeological assessment.

Wetlands are described in this section to establish the hydrological context for surface water and floodplain processes intersected by the project. These systems derive their ecological function from episodic inundation, floodplain connectivity and drainage patterns characteristic of the Channel Country. The identification, classification, ecological significance and assessment of potential impacts to wetlands are addressed in Appendix C (Aquatic Ecology Assessment Report) of the Environmental Authority Supporting Information Report and are not reassessed in this report.

There are no wetlands of international importance (Ramsar wetlands) within the project site. One nationally important wetland, Bulloo Lake, occurs within the broader study area and is hydrologically connected at a regional scale. The project site is located more than 2 km upstream of Bulloo Lake, with no direct disturbance to wetland habitat.

Mapping of Queensland wetland environmental values identifies wetlands of general ecological significance (GES) and high ecological significance (HES) within the wider region. A limited number of wetlands intersect the pipeline alignment at discrete locations (refer to Table 4.7), with crossing extents ranging from approximately 500 m to 1,200 m (Table 4.8; Figure 4.11).

The ecological values of these wetlands, their sensitivity to disturbance, and the significance of potential direct and indirect impacts, including those related to construction disturbance, hydrological connectivity and water quality, are assessed in detail in Appendix C (Aquatic Ecology Assessment Report) of the Environmental Authority Supporting Information Report.

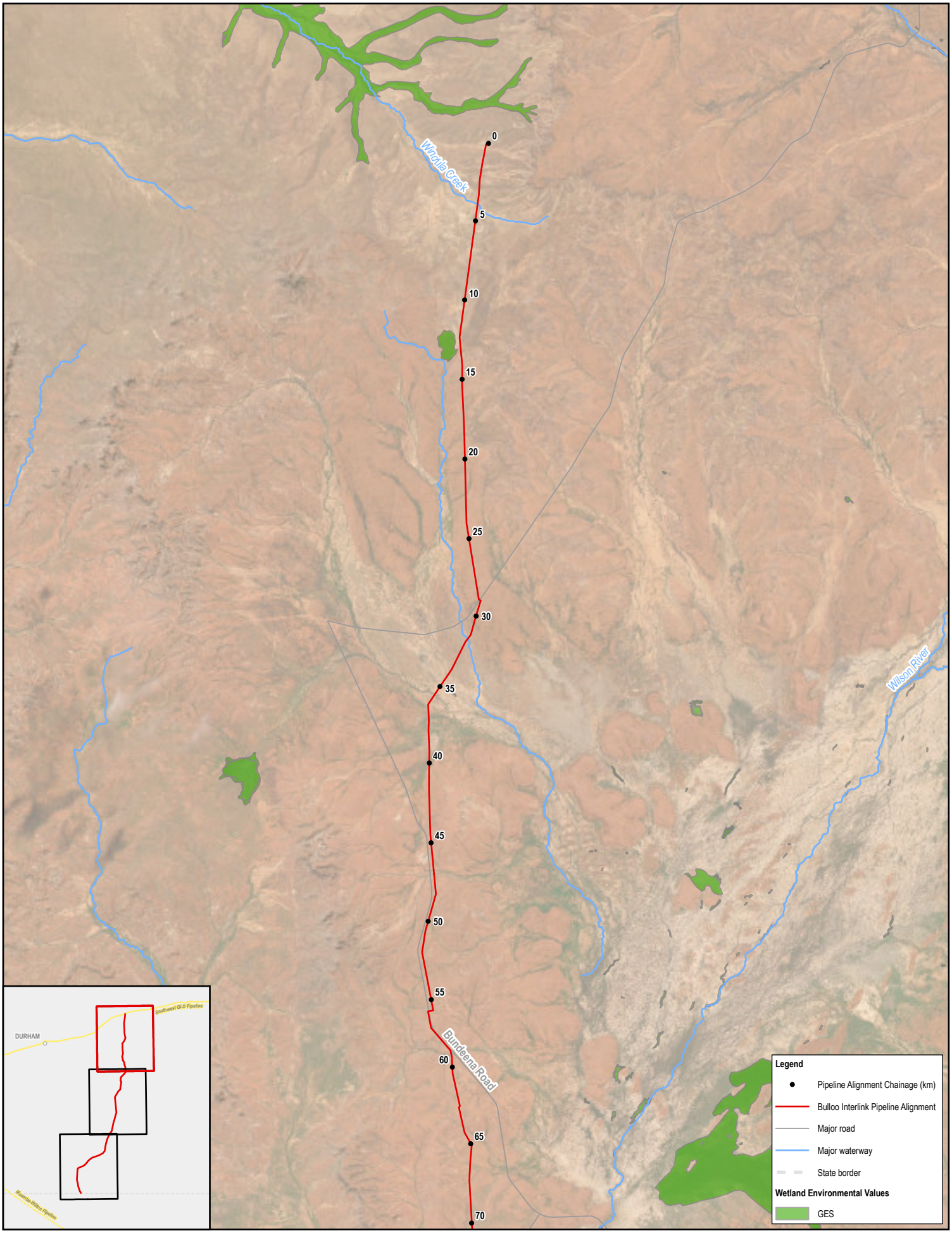
Table 4.7 Waterways connected to wetlands associated with the pipeline alignment

Waterway name	Approximate chainage (km)	Wetland type*
Windula Creek	1, 3, 4	GES
Kercummura Creek	32, 34, 35, 37, 40, 44, 47, 53	GES
Gum Creek	59, 64, 66, 67	GES
Unnamed Creek	72	GES
Tirtywinna Creek	77, 78, 79	GES
Wilson River	83, 84, 85, 89	GES
Tippera Creek	93, 94, 95, 96	GES
Murrawarra Creek	103, 104, 105, 109	GES
Wippo Creek	112, 116, 118, 119, 121, 122, 124	GES
Wippa Creek	132, 133, 134, 135, 136, 138, 139	GES
Parrabinna Creek	145, 147, 148, 150, 152, 153, 155	GES
Muggera Creek	157, 158, 159	GES
Unnamed Creek	160, 163, 164, 165, 167, 169, 170, 171	GES
Unnamed Creek	177	GES
Unnamed Creek	179	GES
Unnamed Creek	174	HES
Unnamed Creek	182, 184, 185, 186, 187, 189, 190, 192,195	HES
Tickalara Creek	200, 201, 202	HES
Unnamed Creek	205, 207, 208, 209, 212	HES
Morris Creek	216	HES
Unnamed Creek	219, 220	HES
Gidya Creek	221, 222	HES
Wanka Creek	224, 225	HES
Unnamed Creek	230, 232, 234	HES
Wanpah Creek	236	HES

Notes: *GES = general ecological significance, HES = high ecological significance.

Table 4.8 Wetlands directly located within the pipeline alignment

Associated waterway name	Wetland width crossed by pipeline alignment (m)
Tippera Creek	~1,100
Murrawarra Creek	~1,200
Tributary of Murrawarra Creek	~500



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Map Projection: Transverse Mercator
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Wetlands associated with the project

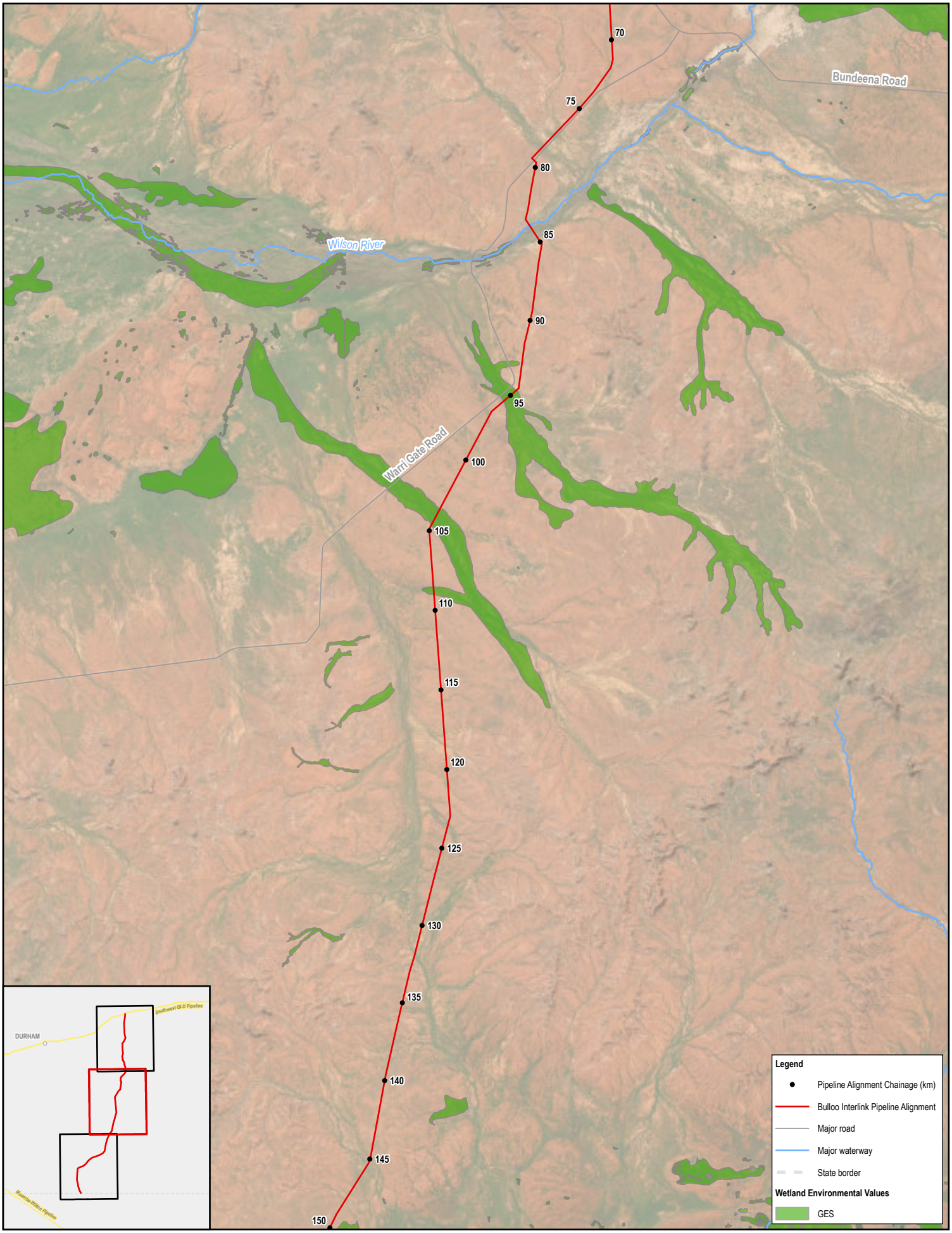
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Figure 4.11

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Wetlands associated with the project

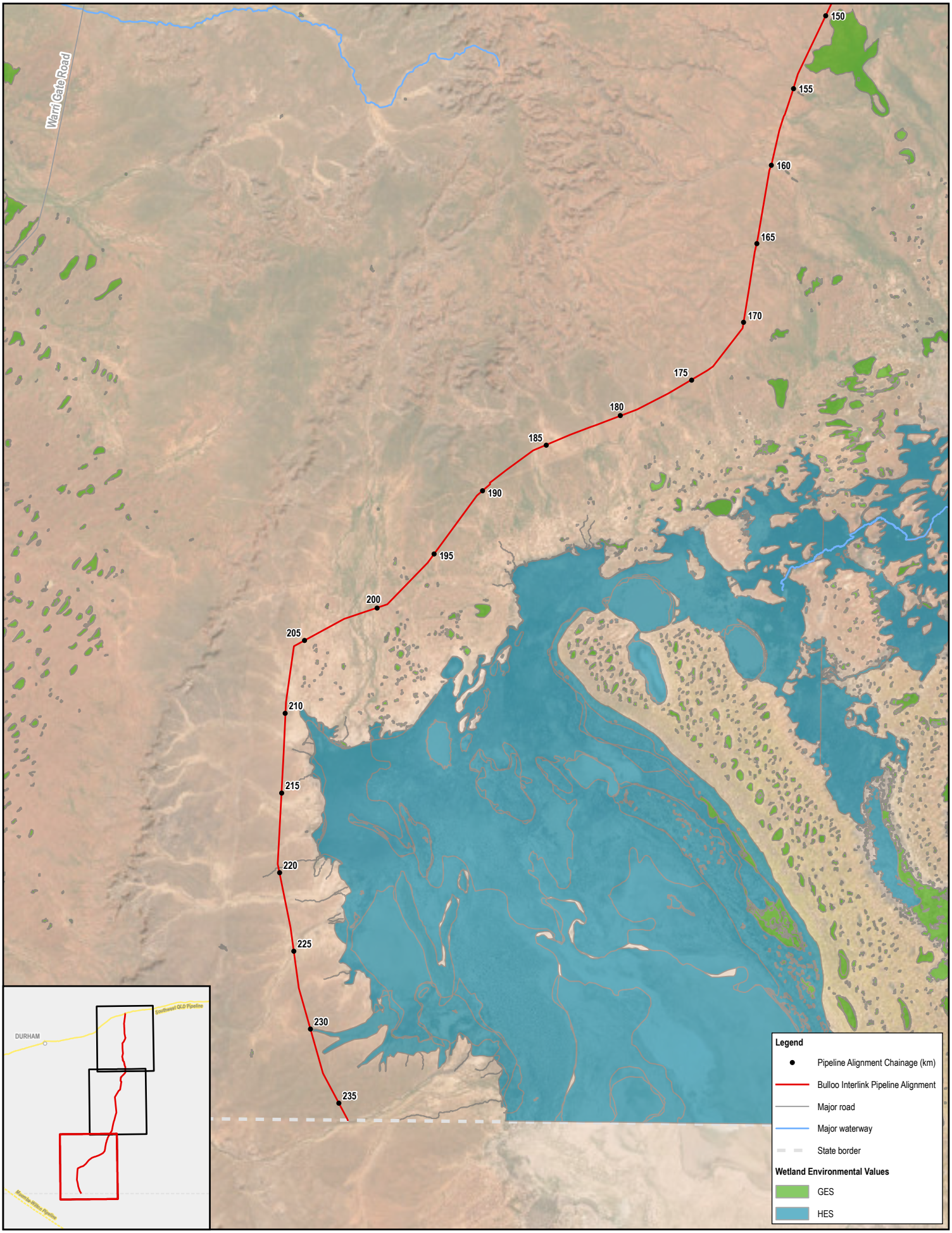
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Figure 4.11

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Wetlands associated with the project

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Figure 4.11

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4.6 Hydrology and flooding

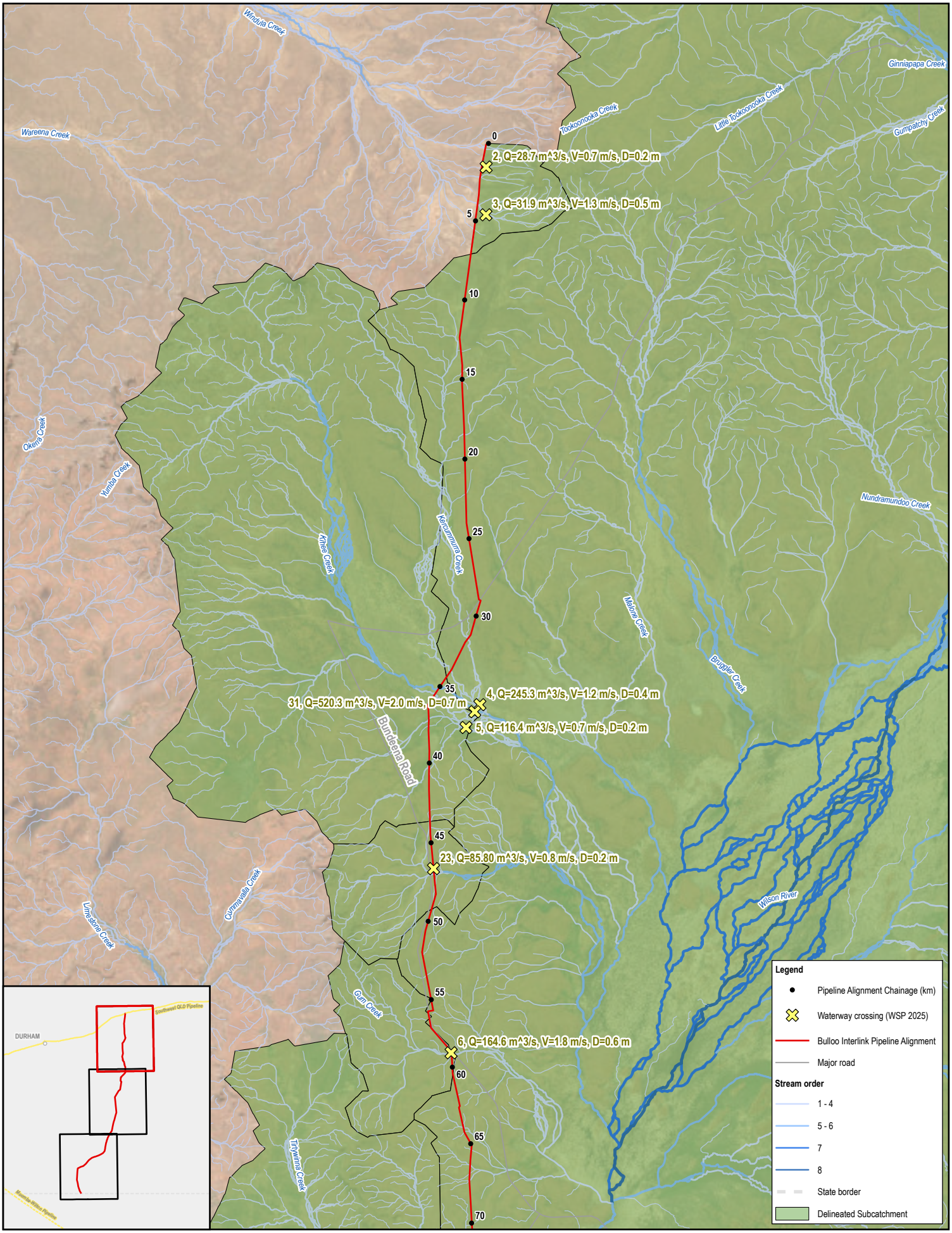
Hydrology and flooding have been assessed with reference to the baseline floodplain processes that govern flow behaviour across the study area. Flooding within the study area is episodic in nature, driven by short-duration, high-intensity rainfall events following prolonged dry periods. Flooding is characterised by broad, shallow inundation across extensive floodplains, with flow spreading laterally beyond defined channel extents. Floodwaters are often conveyed as diffuse sheet flow, guided by subtle topographic gradients rather than confined waterways, with localised concentration occurring along major drainage lines and low-lying depressions.

The pipeline alignment intersects both defined watercourses and floodplain flow paths that become hydraulically active during such episodic events. As a result, flooding along the alignment is not limited to discrete crossing locations but may affect wider sections of the corridor during larger floods. The pipeline alignment is designed so it does not impede flood conveyance, alter natural flow distribution, or exacerbate flood levels, thereby maintaining existing flood behaviour across the study area.

4.6.1 Geotechnical, Hydrogeological, Hydrological, Active-fault Rupture Desktop Study (WSP, 2025)

The Geotechnical, Hydrogeological, Hydrological and Active-fault Rupture Desktop Study undertaken by WSP (2025) included a high-level hydrological assessment of watercourse crossings along the pipeline alignment.

The modelling results indicate that the greatest predicted water depth (0.70 m) occurred at Crossing 31 near chainage 35 km (Figure 4.12), which also recorded the highest predicted velocity of 2.0 m/s. At the remaining crossings, predicted water depths were generally between 0.1 m and 0.6 m. Velocities equal to or exceeding 2.0 m/s were predicted only at Crossing 30, with velocities at all other crossings ranging from approximately 0.4 m/s to 1.8 m/s. Detailed predictions of water depth, velocity and discharge at each crossing are presented in Figure 4.12.



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High-level hydrological assessment results (WSP, 2025)

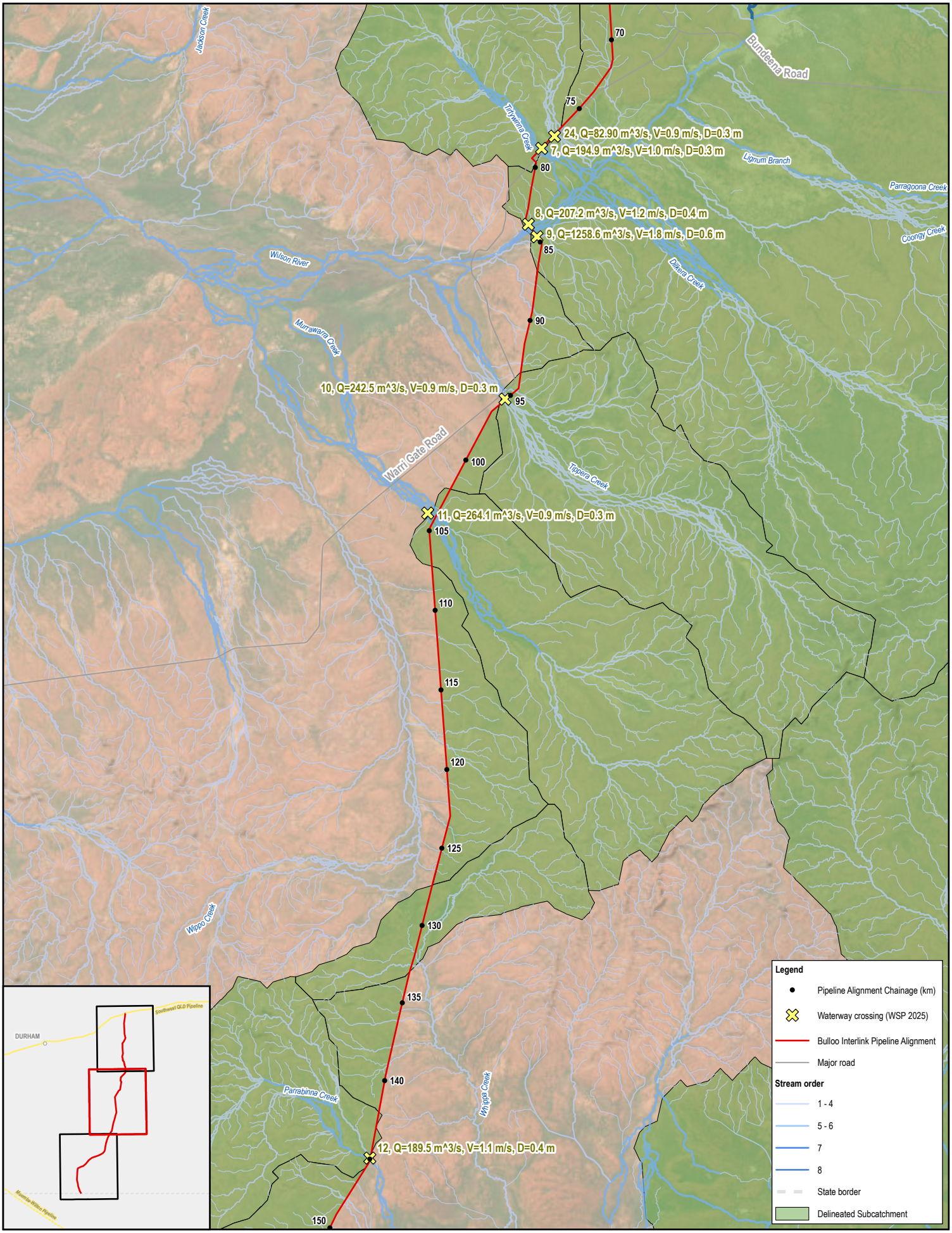
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Revision No.	**0**
Date	**18/06/2026**

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Figure 4.12

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Data source: © State of Queensland (Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development) 2025, Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS. DNRMMRRD: Major roads (2021), VM watercourse/drainage (2026); APA: Stockpile and camp area, Pipeline alignment (2026); WSP: Waterway crossing (2025); GHD: Chainage, Delineated subcatchment (2025) Created by: mvandermerwe



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High-level hydrological assessment results (WSP, 2025)

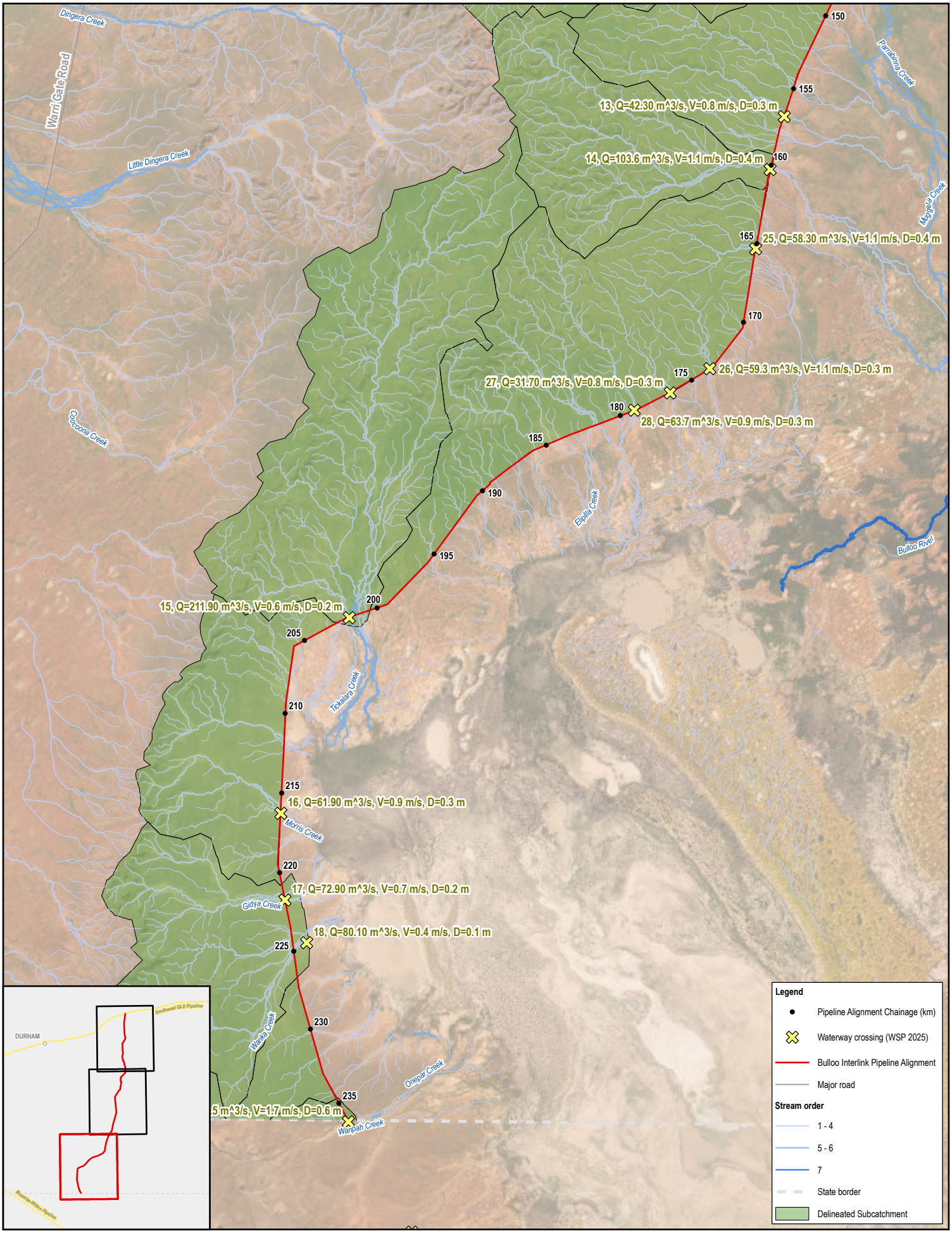
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Figure 4.12

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Data source: © State of Queensland (Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development) 2025, Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS. DNRMMRRD: Major roads (2021), VM watercourse/drainage (2025); APA: Stockpile and camp area, Pipeline alignment (2026); WSP: Waterway crossing (2025); GHD: Chainage, Delineated subcatchment (2025) Created by: mvandermerwe



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High-level hydrological assessment results (WSP, 2025)

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Figure 4.12

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Data source: © State of Queensland (Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development) 2025, Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS. DNRMMRRD: Major roads (2021), VM watercourse/drainage (2025); APA: Stockpile and camp area, Pipeline alignment (2026); WSP: Waterway crossing (2025); GHD: Chainage, Delineated subcatchment (2025) Created by: mvandermerwe

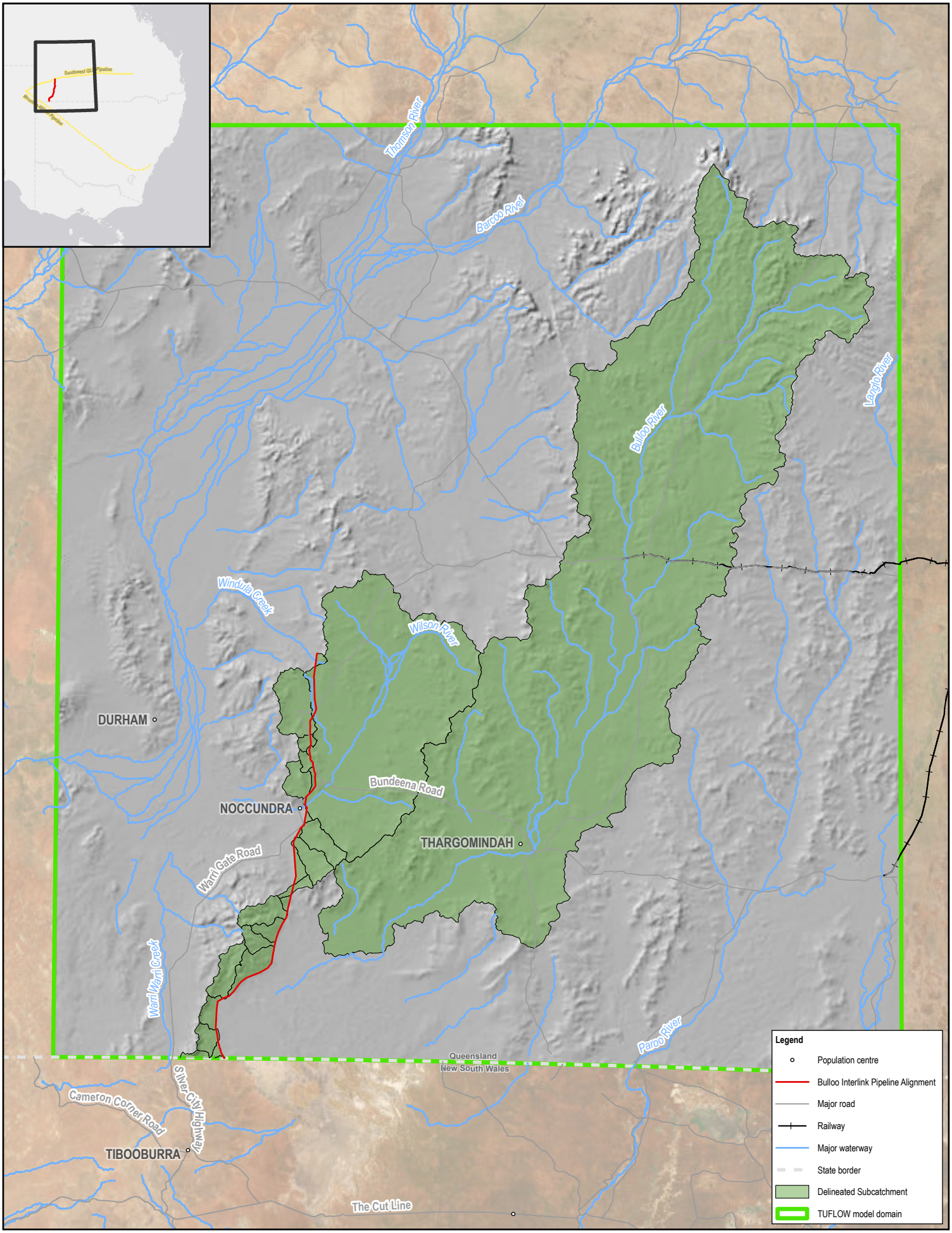
4.6.2 Existing hydrology impacts

State-controlled culvert data from the Queensland Government open data portal were reviewed by GHD. This identified one state-controlled culvert on the access track within the pipeline alignment, located approximately between chainage 58 km and 60 km. In addition, review of the Google Earth basemap within a GIS environment identified several road culverts within a 5 km buffer of the pipeline alignment.

Culverts can constrict water flow and contribute to erosion by accelerating downstream velocities, transporting fine sediments, and reducing water quality. Additional erosion may occur upstream where water is unable to pass freely through a culvert, leading to flow backing-up and the formation of eddies.

4.6.3 Hydraulic assessment of the study area

A separate and independent, project-specific two-dimensional hydraulic assessment was undertaken to characterise baseline flood behaviour across the study area. The hydrological assessment was undertaken to develop an understanding on the flooding characteristics of the study area using a hydraulic model. The model domain extent is shown in Figure 4.13 using the methodology described in section 3.4.2. The aim of the modelling was to characterise baseline flood characteristics such as flood depth, extent, and velocity. The characterisation provides an understanding on the flood behaviour of the study area under 1% AEP design storm events.



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TUFLOW model domain

Figure 4.13

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Data source: Earthstar Geographics, Esri, USGS. DNRMMRRD: Major roads (2021), Major waterway (2023); APA: Pipeline alignment (2026); GHD: Delineated subcatchment, TUFLOW model domain (2025) Created by: mvandermerwe

4.6.4 Modelling results

Sub-catchments were determined using the DEM dataset to understand the size of the upper catchment in relation to the pipeline alignment to estimate the amount of flows to be obstructed or managed or diverted during construction phase, refer to Figure 4.14.

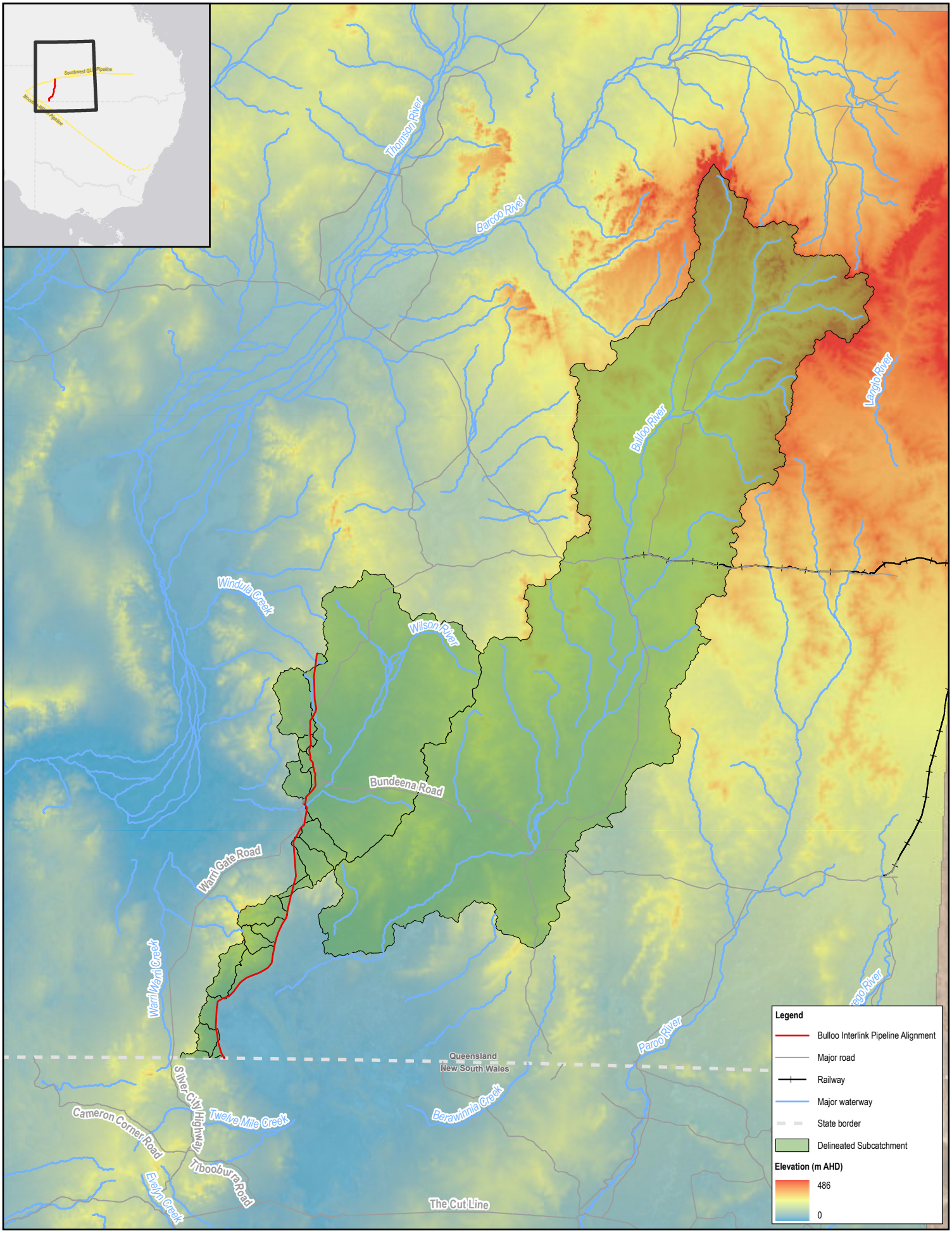
Hydrodynamic modelling was used to develop thematic maps showing water depths and velocities for the 1% AEP rainfall event, which was simulated using the TUFLOW model. The modelling results at key locations within the pipeline alignment are presented and compared with the past study (WSP, 2025) as shown in Table 4.9.

The comparison between the previous study and the current modelling shows broadly consistent flood behaviour across the assessed locations, with only moderate variation in peak flows, flow widths and velocities. Peak flow estimates from the current study generally sit between the earlier RORB and RFFE values, reflecting updated hydrologic inputs and improved catchment representation.

Flow widths produced in this assessment were measured where the depth exceeded a cutoff threshold of 0.05 m. The widths are often slightly narrower than those reported in the past study (WSP, 2025), indicating a more defined flow path driven by refined hydraulic modelling. Maximum velocities remain comparable across both studies.

Figure 4.15 shows the 1% AEP flood depth map generated from the TUFLOW modelling, illustrating the extent of inundation across the catchment and the way flood behaviour interacts with the pipeline alignment.

It is important to note that the DEM used for this assessment was sourced from ELVIS and represents the best available elevation dataset for the project; however, its relatively coarse resolution means that some topographic features may not be fully captured. Higher-resolution elevation data will further improve model accuracy where required, however it was not available during this assessment, and is very unlikely to change the assessment outcomes, impacts, or recommendations.



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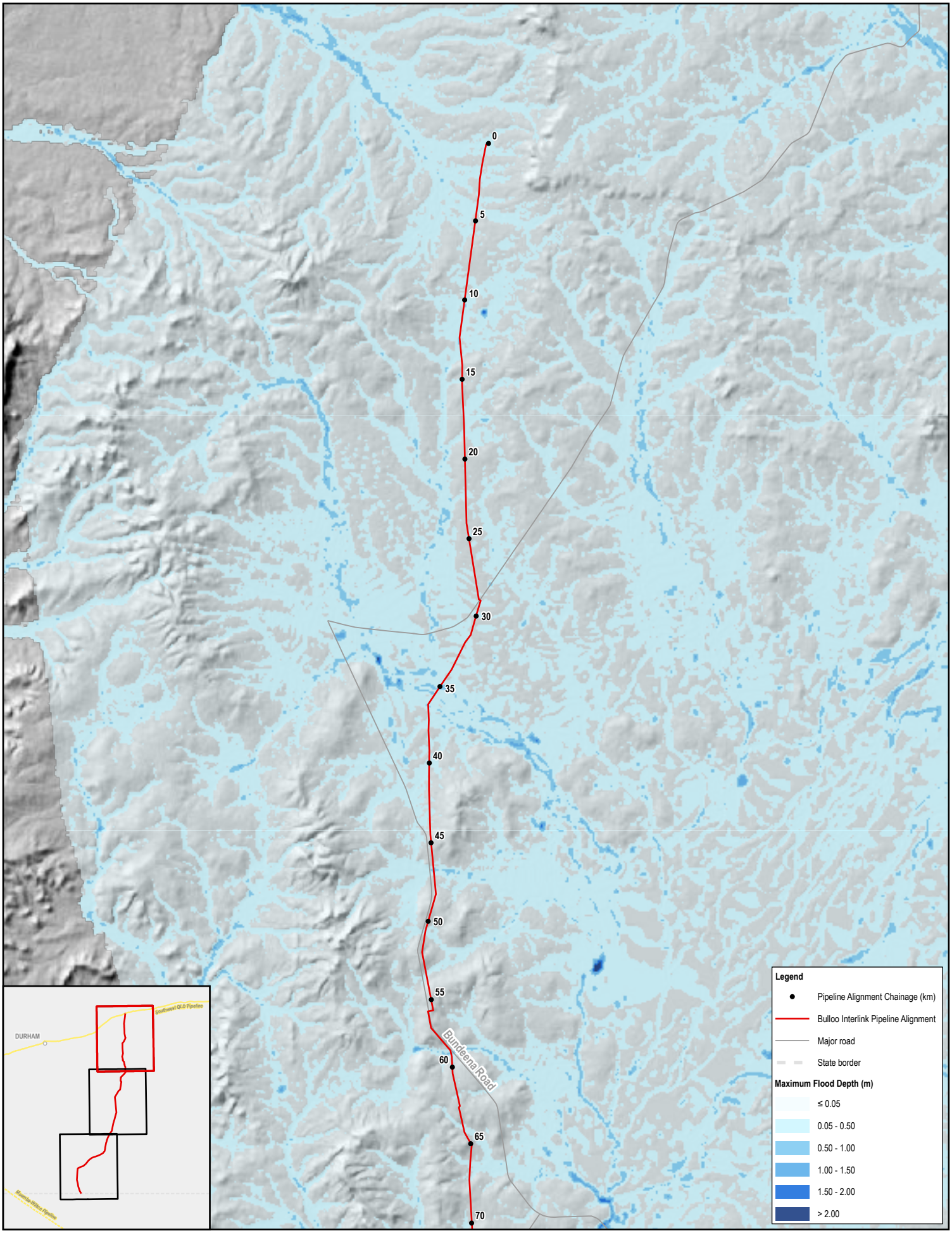
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Watercourses and subcatchments

Figure 4.14

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Map Projection: Transverse Mercator
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1% AEP flood depth map

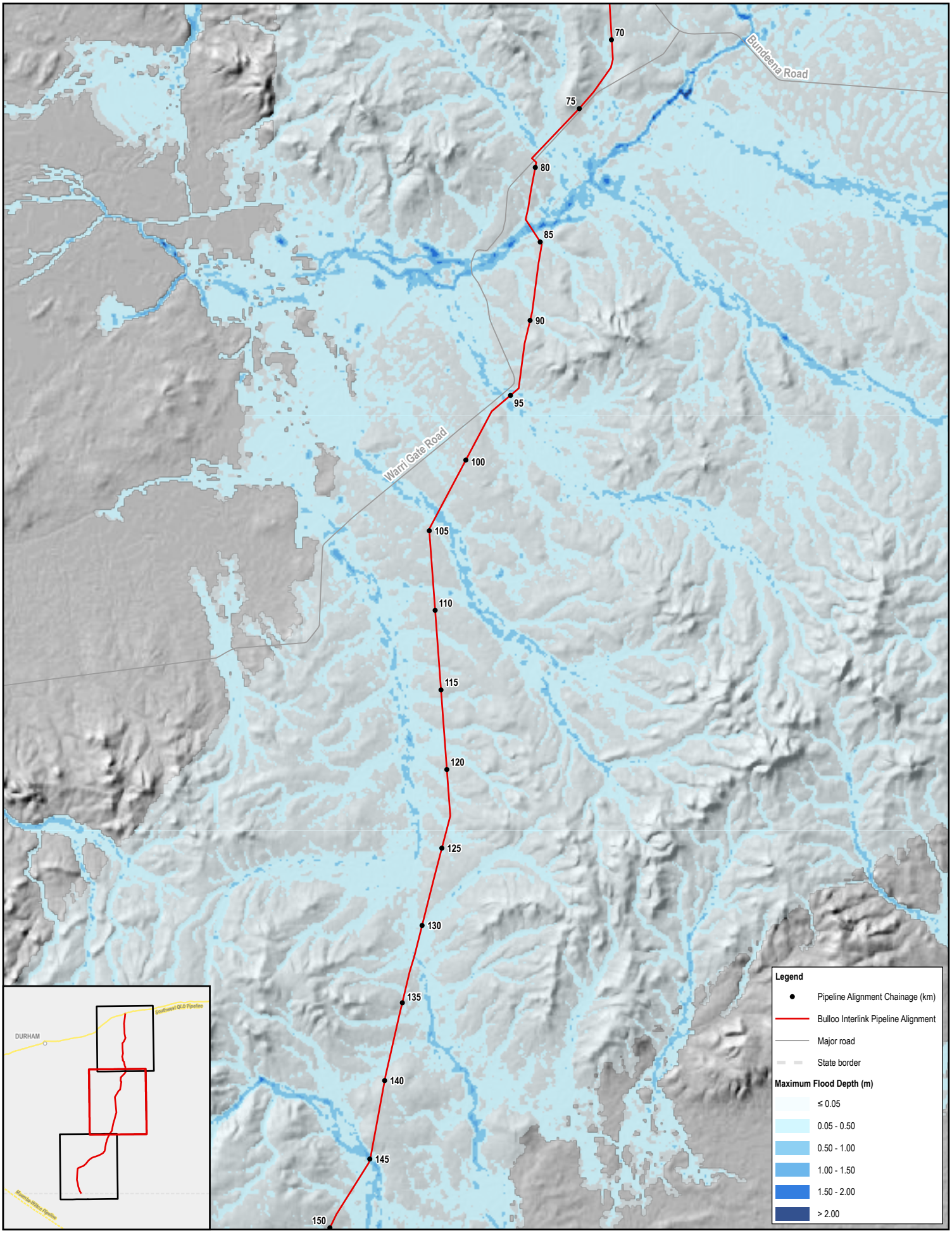
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Figure 4.15

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Data source: Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS. DNRMMRRD: Major roads (2021); APA: Pipeline alignment (2026); GHD: Chainage, Flood extent (2025) Created by: mvandermerwe



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Map Projection: Transverse Mercator
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1% AEP flood depth map

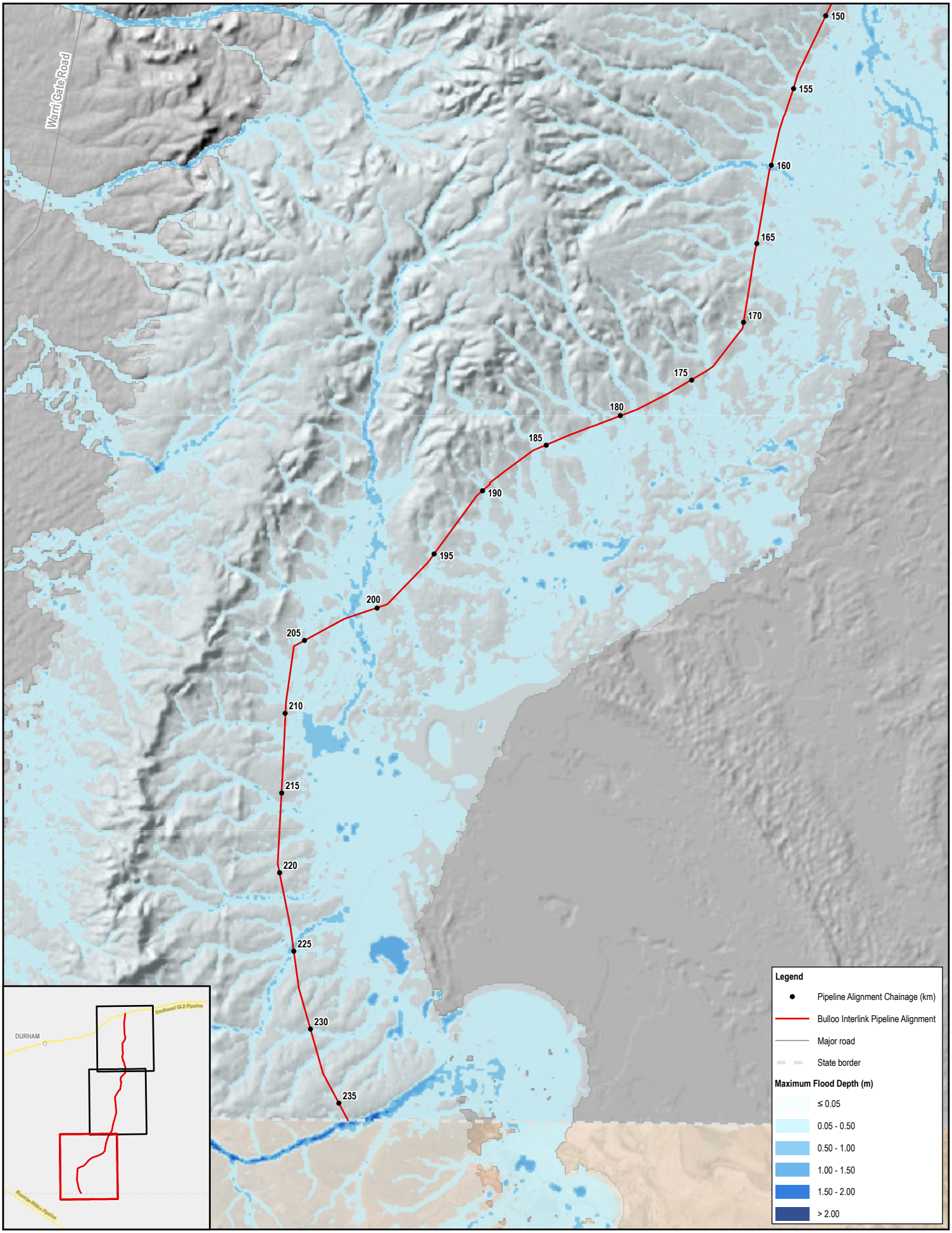
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Figure 4.15

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1% AEP flood depth map

Figure 4.15

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Data source: Earthstar Geographics, Esri, Geoscience Australia, NASA, NGA, USGS. DNRMMRRD: Major roads (2021); APA: Pipeline alignment (2026); GHD: Chainage, Flood extent (2025) Created by: mvandermerwe

Table 4.9 Comparison of modelling results (previous and current study)

Location ID (adopted from WSP, 2025)	Latitude (°)	Longitude (°)	Peak flow (m^3/s) – 1% AEP			Flow width (m)		Maximum velocity (m/s)	
			Peak flow (m^3/s) 1% AEP RORB	Peak flow (m^3/s) 1% AEP RFFE	Peak flow (m^3/s) 1% AEP Current study	Previous study (Flow width (m) (WSP, 2025))	Flow width (m) Current study	Previous study (Maximum Velocity (m/s) (WSP, 2025))	Maximum Velocity (m/s) Current study
1	-29.000	142.2006	322.0	1,330.0	713.0	360	1,080.0	1.67	1.30
2	-27.101	142.6686	28.7	77.1	17.0	230	1,100	0.73	0.30
3	-27.128	142.6689	31.9	83.0	32.0	56	1,100	1.29	0.30
4	-27.405	142.6692	245.0	752.0	89.6	530	3,500	1.22	0.80
5	-27.418	142.6606	116.0	344.0	99.2	990	3,500	0.67	0.80
6	-27.602	142.6539	165.0	306.0	198.0	161	550	1.75	1.30
7	-27.760	142.6249	195.0	479.0	202.0	640	2,200	1.01	0.80
8	-27.803	142.6171	207.0	553.0	323.0	480	1,520	1.18	0.60
9	-27.810	142.6227	1,259.0	8,990.0	24.4	1,250	1,520	1.78	0.30
10	-27.902	142.6037	243.0	739.0	263.0	980	2,000	0.92	1.10
11	-27.967	142.5554	264.0	835.0	279.0	1,130	1,400	0.90	1.10
12	-28.332	142.5237	190.0	918.0	545.0	470	1,900	1.15	1.60
13	-28.429	142.4730	42.3	167.0	71.5	217	900	0.83	0.80
14	-28.459	142.4644	104.0	413.0	386.0	275	1,300	1.11	1.20
15	-28.715	142.1979	212.0	1,028.0	442.0	2,065	2,400	0.63	0.80
16	-28.826	142.1552	61.9	167.0	131.0	240	1,100	0.93	0.80
17	-28.875	142.1584	72.9	208.0	164.0	560	850	0.69	1.10
18	-28.899	142.1726	80.1	370.0	229.0	2,050	2,200	0.42	0.70
19	-29.062	142.2422	80.0	235.0	161.0	205	850	1.12	0.90
20	-29.420	142.3490	387.0	1,540.0	319.0	5,020	5,900	0.56	0.60
21	-29.550	142.3921	63.1	200.0	1.7	62	720	1.68	0.10
22	-29.618	142.4068	161	537.0	68.2	254	520	1.41	0.70
23	-27.498	142.6412	85.8	208.0	137.0	526	630	0.77	0.60
24	-27.753	142.6330	82.9	200.0	114.0	330	2,200	0.92	0.80
25	-28.504	142.4557	58.3	128.0	98.3	160	790	1.09	0.80
26	-28.572	142.4273	59.3	115.0	93.7	170	400	1.07	0.90
27	-28.586	142.4021	31.7	77.0	72.7	155	410	0.84	0.60
28	-28.596	142.3792	63.7	141.0	117.0	303	610	0.85	1.20
29	-29.342	142.3254	497	3,320.0	838.0	1,701	1,900	1.00	0.90
30	-29.682	142.4214	227.0	685.0	0.007	35	250	3.38	0.10
31	-27.409	142.6660	520.0	1,016.0	138.0	390	3,500	2.01	0.80

4.7 Groundwater

4.7.1 Geology and hydrogeological units

The mapped surface geology (1:100,000 scale) along the pipeline alignment is characterised by widespread Quaternary-age and Quaternary/Tertiary-age unconsolidated sediments comprising alluvium (including floodplain deposits) associated with watercourses, dune sands (aeolian deposits) and colluvium (including gravel and sandy soils) (Geoscience Australia, 2015).

The Tertiary-age Glendower Formation (sandstone, sandy siltstone, minor conglomerate and mudstone) unconformably overlies the Late Cretaceous-age Winton Formation (sandstone, siltstone, mudstone, minor coal), which are mapped at outcrops and assumed to underlie the unconsolidated sediments in this area.

The Winton Formation, and overlying geological strata, are hydraulically separated from the underlying layered sedimentary aquifers of the Great Artesian Basin (GAB) by the low permeability Rolling Downs Group aquitard. The geology and hydrogeological units of the GAB are not discussed in detail in this report as the proposed pipeline will not intersect or have the potential to interact with the GAB units.

The published surface geology along and around the proposed pipeline route is shown in Figure 4.16.

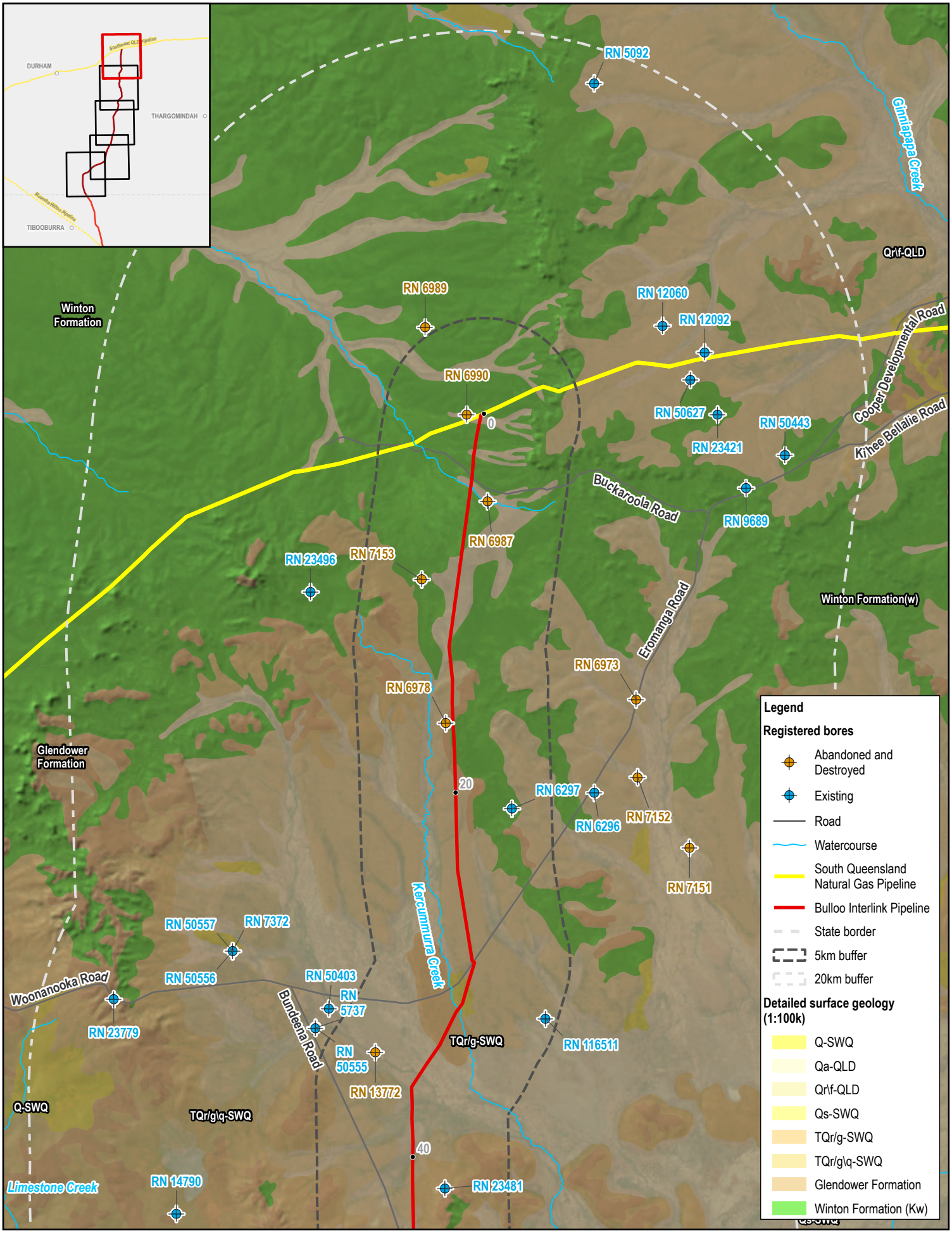
A summary of the shallow hydrogeological units along and around the pipeline alignment is provided in Table 4.10 and detailed below:

- **Unconsolidated sediments and alluvial aquifers –** The mapped surface geology indicates widespread unconsolidated sediments; however, groundwater is anticipated to be primarily associated with watercourses and form localised, unconfined, seasonally water-bearing aquifers perched on the underlying bedrock. Away from watercourses, alluvium/unconsolidated sediments are expected to be thinner and unlikely to support the permanent presence of groundwater. These strata are unlikely to yield significant quantities of water given the arid to semi-arid climate (characterised by unpredictable and highly variable rainfall, hot summers, and cool, dry winters) and is consistent with the lack of registered bores at shallow depths (refer to section 4.7.7). The permeability of unconsolidated sediments and alluvial deposits is anticipated to be highly variable with preferential flow of groundwater through higher permeability sand/gravel layers, which are interbedded with lower permeability silts and clays.
- **Sub-artesian sedimentary aquifers (Glendower Formation and Winton Formation) –** Anticipated to comprise unconfined to confined sub-artesian aquifers (sandstone lithologies) layered with low permeability units (mudstone, siltstone lithologies). Groundwater is likely to be within pore spaces of the sandstone units and within fractures and/or joints, whilst mudstone and siltstone layers are expected to have low porosity and permeability which would limit the vertical movement of groundwater between sandstone layers. The Winton Formation is generally low yielding, with recorded yields for registered bores in the order of <1 to 3.5 L/s in the study area (refer to section 4.7.7), and is part of the Winton-Mackunda partial aquifer (Geoscience Australia, 2015). Given the lithology of the Glendower Formation, this unit is also expected to be low-yielding.
- **Rolling Downs Group aquitard –** Low porosity and low permeability, fine-grained geological units, limits the movement of groundwater between the overlying aquifers (unconsolidated sediments and alluvial aquifers, Glendower Formation and Winton Formation) and the underlying aquifers of the GAB. The Rolling Downs aquitard is regionally characterised as the most effective aquitard in the GAB (Geoscience Australia, 2015).
- **Artesian aquifer of the GAB (Cadna-owie – Hooray)** – The uppermost aquifer of the GAB, predominantly comprising sandstone.

Table 4.10 Shallow hydrogeological units

Geological age	Geological unit (map symbol(s)	Lithology summary	Aquifer type
Quaternary	Alluvium (Q, Qa, Ql)	Clay, silt, sand and gravel; floodplain alluvium	Localised, seasonal and perennial (unconfined) where present Groundwater expected to be predominantly associated with alluvium beneath and near to surface water channels
	Dune sands (Qs/d)	Quartzose sand; dunes and sandplains	Seasonally water-bearing (unconfined), where present
Quaternary and Tertiary-Quaternary	Colluvium (Qr, Qr/f, TQr/g)	Gravel and sandy soils	Localised, seasonal and perennial (unconfined) where present
Tertiary (Palaeocene – Eocene epoch)	Glendower Formation (Tg)	Layered pebbly clayey sandstone, sandy siltstone, minor conglomerate and mudstone, lateritised and silicified	Localised water-bearing zones (sub-artesian) with variable hydraulic properties[1]
Late Cretaceous	Winton Formation (Kw) (uppermost unit of Rolling Downs Group)	Layered sandstone, siltstone, mudstone, minor coal	Aquifer[1] (sub-artesian) (part of the Winton Mackunda aquifer groundwater unit under the GABORA Water Plan[2])
Early Cretaceous	Rolling Downs Group (not shown on Figure 4.16)	Mudstone, siltstone, minor sandstone and limestone	Aquitard[1] Considered the most effective aquitard in the GAB[1]; expected to minimise hydraulic connectivity between the overlying Winton Mackunda aquifer and the underlying aquifer units of the GAB
Early Cretaceous to Late Jurassic	Cadna-owie Formation underlain by Hooray Sandstone (not shown on Figure 4.16), inferred presence based on registered bore records (Table 4.12)	Cadna-owie Formation: Interbedded sandstone, mudstone and siltstone Hooray Sandstone: Sandstone	Aquifer[1] generally known as Cadna-owie – Hooray aquifer (artesian)

Notes: 1. Hydrogeological Atlas of the Great Artesian Basin (Geoscience Australia, 2015)
2. Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017.



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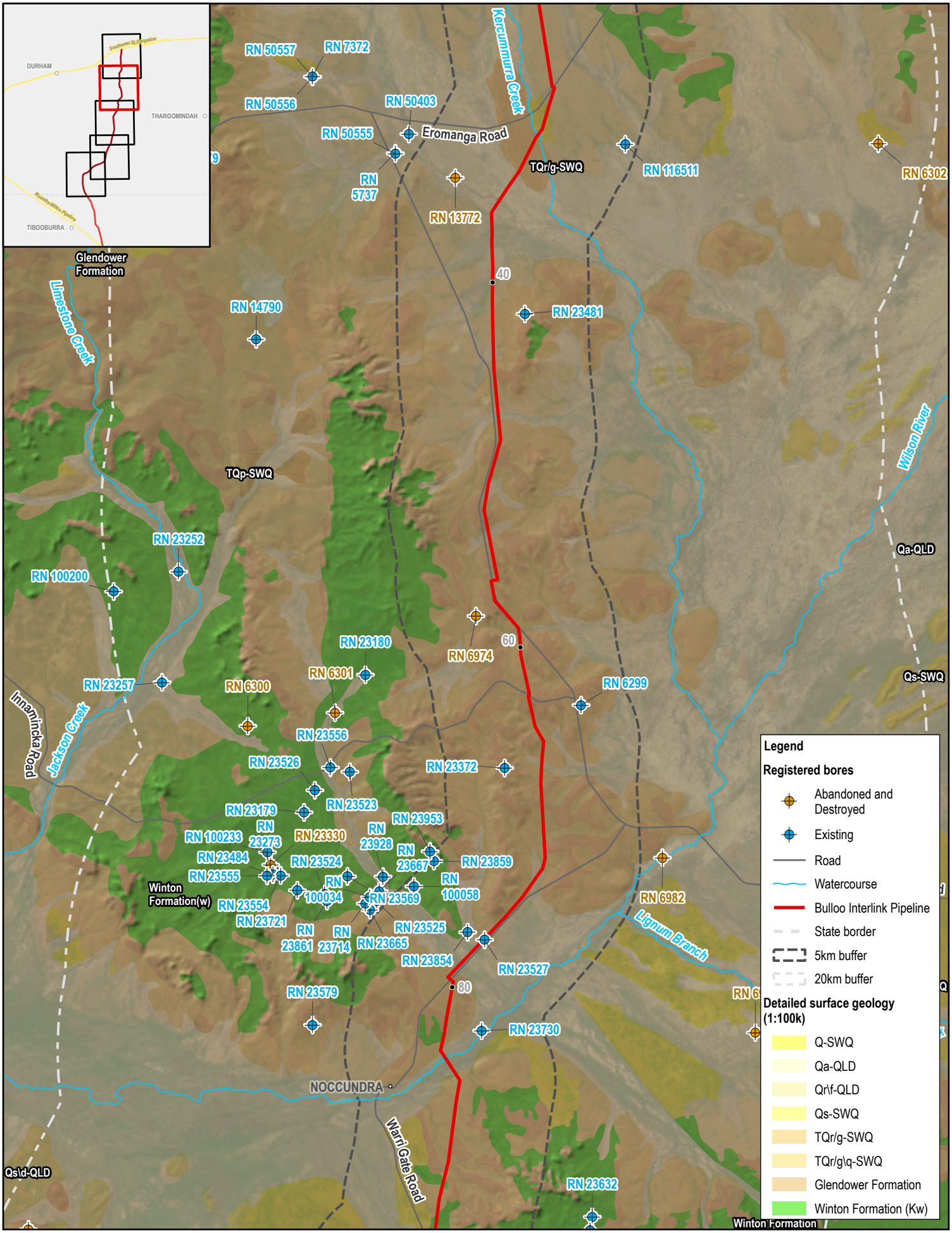
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Geology and registered bores

Figure 4.16

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Data source: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Earthstar Geographics, Esri, HERE, Garmin,DNRM/MRRD: Roads (2021), Watercourse (2023), Geology (2025); GHD: Study area (2025); APA: Project alignment, South Queensland Natural Gas Pipeline, Moomba - Wilton Natural Gas Pipeline (2025); GHD: 5km buffer, 20km buffer (2025); DLGWV: Registered groundwater bores and groundwater use (2025); GA:



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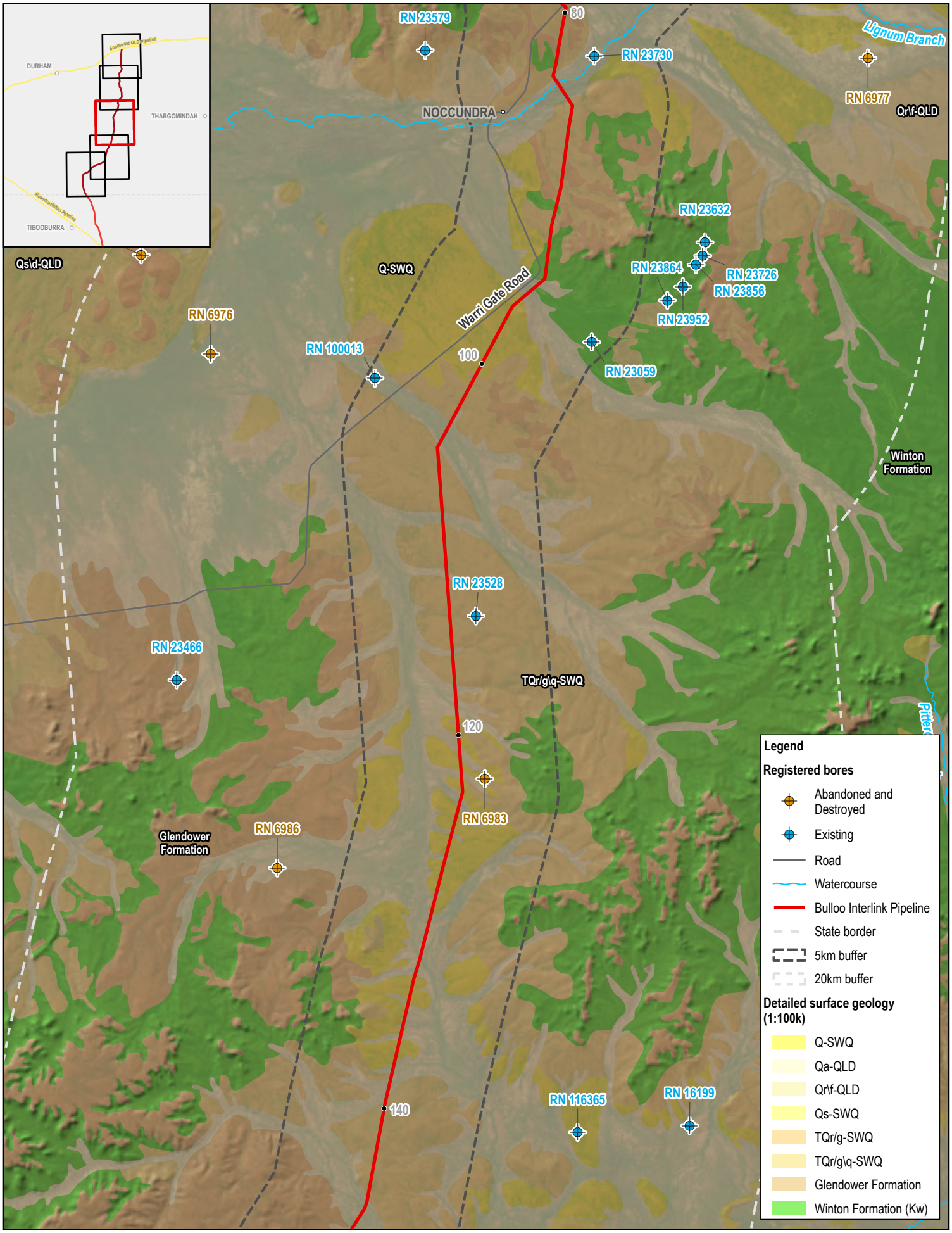
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Geology and registered bores

Figure 4.16

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Data source: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community, Earthstar Geographics, Esri, HERE, Garmin,DNRM/MRRD: Roads (2021), Watercourse (2023), Geology (2025); GHD: Study area (2025); APA: Project alignment, South Queensland Natural Gas Pipeline, Moomba - Wilton Natural Gas Pipeline (2025); GHD: 5km buffer, 20km buffer (2025); DLGWV: Registered groundwater bores and groundwater use (2025); GA:



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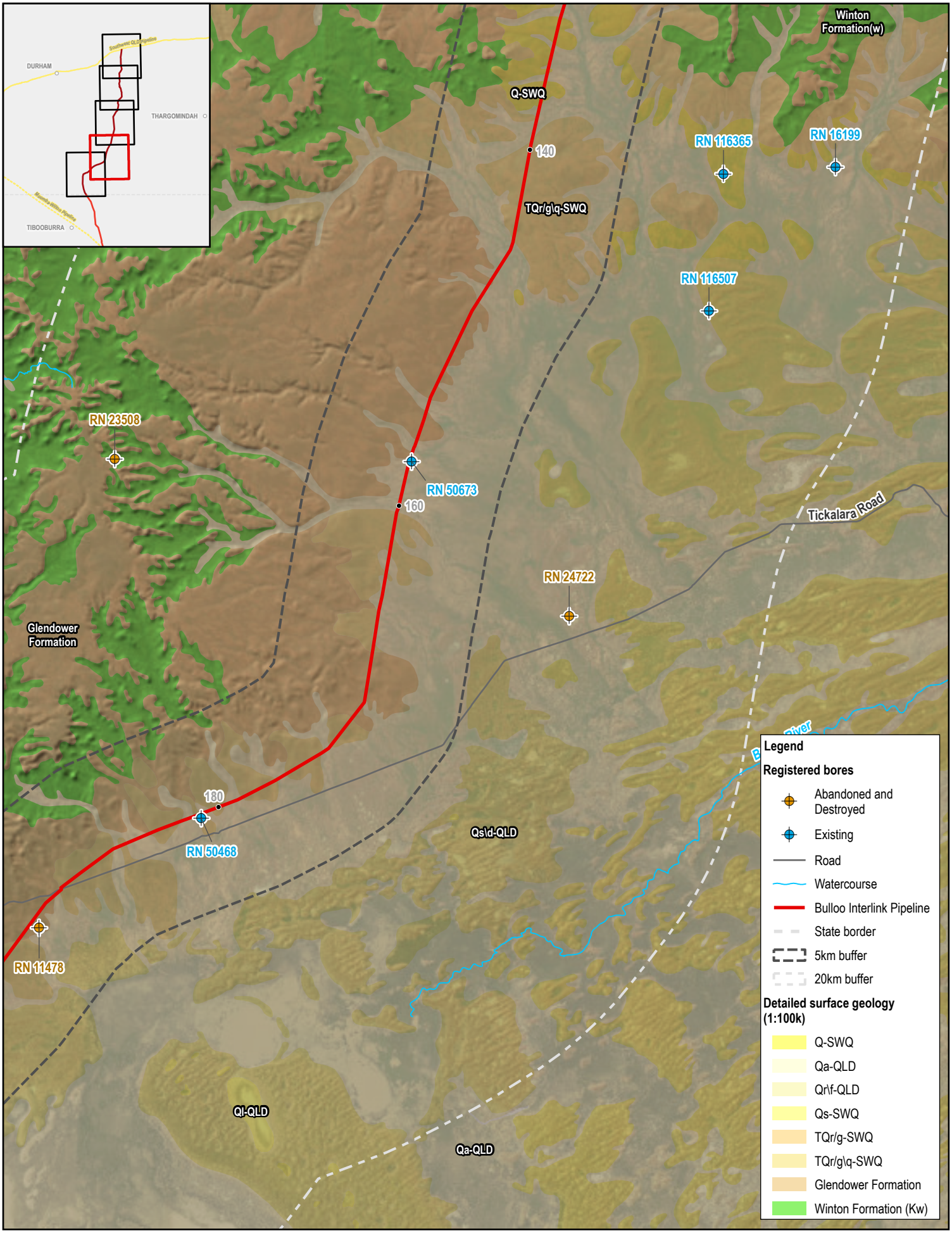
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Geology and registered bores

Figure 4.16

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Map Projection: Transverse Mercator
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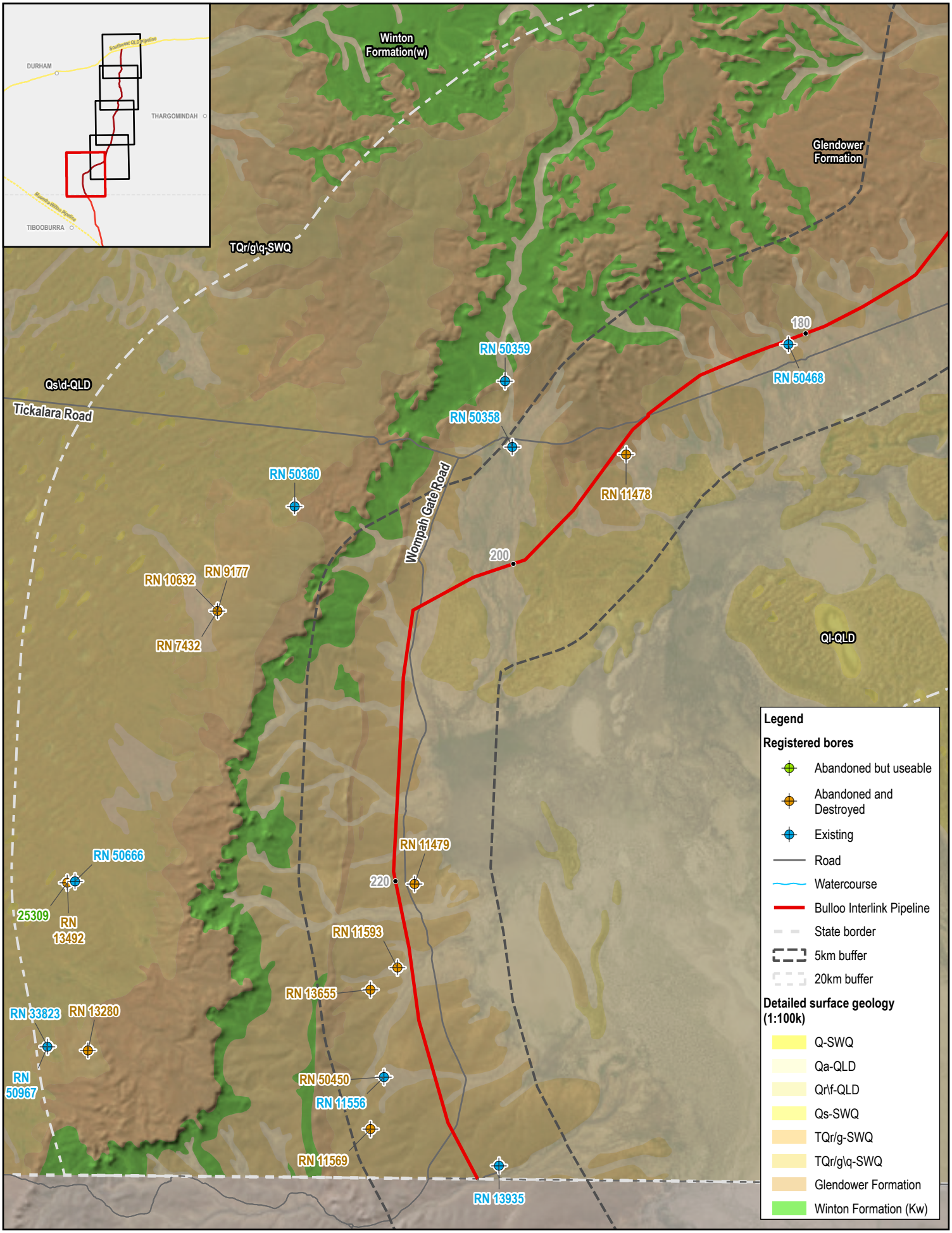
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Geology and registered bores

Figure 4.16

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Geology and registered bores

Figure 4.16

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4.7.2 Environmental values and water quality objectives

EVs reflect the qualities of a groundwater system to support human water uses and aquatic ecosystems. Human uses can be categorised as domestic (drinking water), agricultural (farm use, stock watering, and crop irrigation), and industrial (power generation and manufacturing). Aquatic ecosystem EVs include both aquatic ecosystems that solely inhabit groundwater (including bacteria and stygofauna) and GDEs. Groundwater sustains terrestrial and aquatic GDEs by supporting vegetation growth and providing discharge to channels, lacustrine and palustrine wetlands, and both the estuarine and marine environment.

As described in section 4.4.4, Schedule 1 of the EPP Water and Wetland Biodiversity defines EVs and WQOs for Queensland waters, including groundwaters.

The northern half of the project falls within the Cooper Basin, which is not listed in Schedule 1 of the EPP Water and Wetland Biodiversity and therefore does not have defined EVs nor WQOs. However, given that the geology and land use in the area around the project (predominantly grazing native vegetation) is similar for both the southern and northern portions, the groundwater EVs for the Bulloo River Basin have been adopted for the purposes of the characterisation and assessment of groundwater.

The southern half of the project is within the Bulloo River Basin and within the following Schedule 1 groundwater areas defined in the *Queensland Murray-Darling and Bulloo River Basins Groundwater Environmental Values and Water Quality Objectives* (DES, 2020d). The applicable groundwater plans to the project are:

– Alluvial Zone (GWQ4161)
– Sediments Overlying the Great Artesian Basin Zones (Sand Dunes, Tertiary Sediments, and Weathered Alluvium) (GWQ4163)
– Upper Great Artesian Basin (includes Winton Mackunda Formation) (GWQ4164)
– Main Great Artesian Basin Aquitard Zones (GWQ4165)
– Mid Great Artesian Basin Aquifer zones (GWQ4166).

Of these Schedule 1 Plan groundwater areas the ‘Alluvial Zone’, ‘Sediments Overlying the Great Artesian Basin Zones’ and ‘Upper Great Artesian Basin’ are considered relevant to this groundwater assessment as they are potentially intersected by the project (based on review of the mapped geology, refer to section 4.7.1). The relevant groundwater EVs are shown in Table 4.11.

Table 4.11 Environmental values – groundwater

Environmental value	Alluvial zones – Alluvium; Alluvium near stream; Bulloo[1]	Sediments Overlying the GAB Zones – Sand dunes[2]	Sediments Overlying the GAB Zones – Tertiary sediments[2]	Sediments Overlying the GAB Zones – Weathered alluvium[2]	Upper GAB – Winton Mackunda Western[3]
Aquatic ecosystem	✓	✓	✓	✓	✓
Irrigation	–	–	–	✓	–
Farm supply/use	✓	–	✓	✓	✓
Stock water	✓	–	✓	✓	✓
Aquaculture	–	–	–	✓	–
Drinking water	–	–	–	✓	✓
Industrial	–	–	–	✓	–
Cultural and spiritual values	✓	✓	✓	✓	✓

Notes: 1. GQW4161 – Queensland Murray-Darling and Bulloo Basins Groundwater, Alluvial Zones (DES, 2020b).
2. GWQ4163 – Queensland Murray-Darling and Bulloo Basins Groundwater, Sediments Overlying the Great Artesian Basin (DES, 2020c).
3. GWQ4164 – Queensland Murray-Darling and Bulloo Basins Groundwater, Upper Great Artesian Basin (DES, 2020d).

The WQOs for the southern half of the project are detailed in the *Murray-Darling and Bulloo River Basins Groundwater Environmental Values and Water Quality Objectives* (DES, 2020), however, WQOs have only been determined for the following groundwater zones (other zones have insufficient data):

– sediments overlying the GAB – Zone 1 – Weathered Alluvium
– upper GAB – Zone 1 – Winton Mackunda Western.

WQO zone maps for the Bulloo Basin are included in Appendix C for reference.

A summary of water quality guidelines to protect human use EVs and aquatic ecosystem EVs where there are no published WQOs are:

– *Australian and New Zealand guidelines for fresh and marine water quality* (ANZG, 2018) – for aquatic ecosystems, crop irrigation, farm supply/use, stock watering, and aquaculture
– *Australian Drinking Water Guidelines* (ADWG) (NHMRC, 2011) – for drinking water.

4.7.3 Recharge and discharge mechanisms

Anticipated groundwater recharge mechanisms are summarised below:

– **Unconsolidated sediments and alluvial deposits –** Recharge will primarily occur from downward infiltration of surface water from ephemeral watercourses during episodic flow events, across the surrounding floodplains during flood events and leakage from waterholes. Direct infiltration of rainfall at outcropping aquifers will also occur but is expected to be a minor component given the arid to semi-arid climate (refer to section 4.1).
– **Sedimentary units (Glendower Formation, Winton Formation) –** Recharge will primarily occur from downward infiltration of groundwater stored in the overlying unconsolidated sediments and alluvial deposits (along river channels and across floodplains). Direct infiltration of rainfall at outcropping aquifers will also occur but is expected to be a minor component given the arid to semi-arid climate.

Discharge mechanisms for groundwater in the study area are anticipated to be:

– evapotranspiration of riparian vegetation from shallow groundwater in alluvial deposits/unconsolidated sediments
– evaporation from permanent and semi-permanent waterholes associated with watercourses, such as permanent waterholes on Wilson River
– short duration discharge of groundwater to watercourses from alluvium if the water table is higher than the bed of the watercourse, such as after a flood or significant rain event.

4.7.4 Groundwater levels and flows

Groundwater level records from the Queensland Groundwater Database for registered bores within a 20 km search radius of the pipeline alignment are summarised in Table 4.12. Water level records are available for the Glendower Formation, Winton Formation and Hooray Sandstone. Groundwater elevations calculated from registered bore depth to water records are shown on Figure 4.17. No registered bore records for alluvium were identified.

In the absence of groundwater level data for unconsolidated sediments/alluvial deposits, potential for shallow groundwater presence has been inferred from mapped terrestrial GDE areas, surface expression GDE areas and surface expression GDE lines, and potential for shallow groundwater presence has been inferred along the main watercourses as shown in the series of figures presented in Figure 4.17.

Depth to groundwater is anticipated to be within a few metres of ground surface along and close to the watercourses (ephemeral) where denser vegetation is present, with groundwater likely to be perched on the underlying bedrock. The groundwater may be permanent or seasonal. Away from these areas, the presence of groundwater in alluvium/unconsolidated sediments is likely to be short-lived.

Based on the water level data in the Queensland Groundwater Database, depth to groundwater in the underlying sedimentary rock is highly variable and has been recorded in the range of 20 m to 100 m for the Glendower Formation and in the range of 5 m to 80 m for the Winton Formation as shown in Table 4.12 but is largely indicated to be greater than 10 m below ground level (bgl). These data are consistent with WSP (2025) results, which reports that the regional groundwater table in the Winton Formation is likely to be well below 2 mbgl along much of the proposed pipeline route.

The potential for the presence of groundwater in rock within a few meters of ground surface is however, indicated by three registered bores that recorded depths to groundwater of 5.1 m (RN13655, west of chainage 225 km and approximately 5 km west of Bulloo Lake), 6.4 m (RN50403, west of chainage 35 km) and 9.1 m (RN13772, west of chainage 35 km) all in the Winton Formation. Furthermore, WSP (2025) reports that depth to groundwater in the Winton Formation may be shallow in low-lying areas of the proposed pipeline alignment, about chainages 70–90 km, and 190–230 km, noting that this is based on extrapolation of data from very limited information.

Groundwater flow through unconsolidated sediments and alluvial deposits is anticipated to follow the overall fall in topography and direction of watercourses. The pipeline crosses a number of watercourses, and the direction of shallow groundwater flow at the crossings will vary along as shown in the series of figures presented in Figure 4.17. Inferred groundwater flow across the northern part of the proposed route is generally towards the south and the Wilson River; across the central part of the proposed route is towards the north and the Wilson River; and across the southern part of the proposed route is towards the south and Bulloo Lake.

Shallow groundwater flow directions may also be locally influenced by above-ground water storages (reservoirs/dams), providing potential for localised radial groundwater flow through unconsolidated sediments and alluvial deposits away from these structures if seepage from the storage to groundwater occurs. The mapped reservoir/dam land use features are distributed along the alignment with distances from the alignment typically ranging from approximately 0.5 to 4.6 km (refer to section 4.3.3).

Calculated groundwater elevations for the Winton Formation and Glendower Formation show overall higher groundwater elevations to the north of Wilson River as shown in Figure 4.17 and Table 4.12, and lower elevations to the south of Wilson River, and west of Bulloo Lake indicating overall groundwater flow towards the south except for the northern portion of the pipeline alignment where flow is inferred to be in a northerly direction.

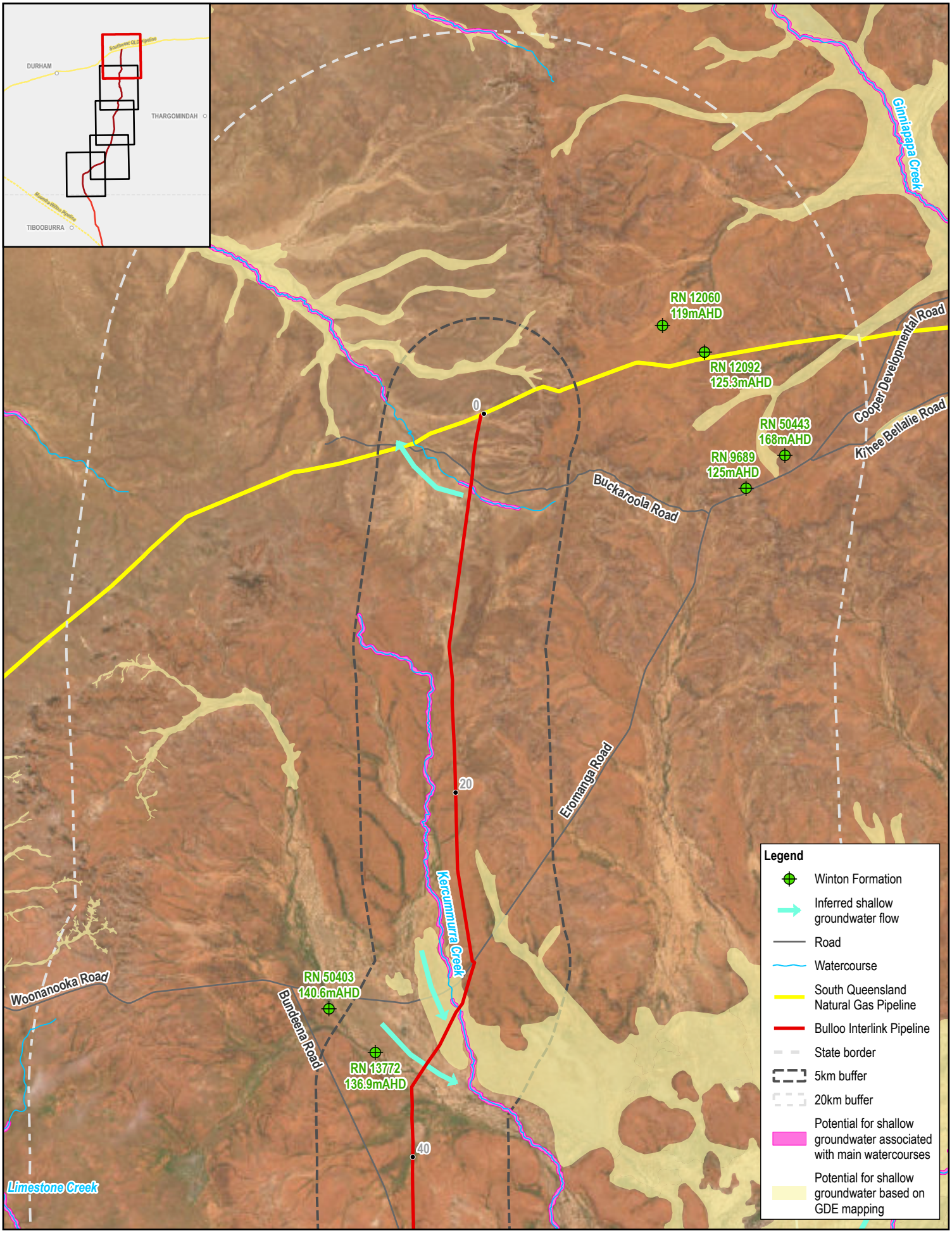
Both catchments (Bulloo River and Cooper Creek) traversed by the proposed pipeline are endorheic (i.e. are internally draining and do not discharge to the sea).

Table 4.12 Groundwater level records – registered bores (DLGWV, 2026)

Registered bore ID	Drilled date	Formation	Year of water level	Bore depth (m)[1]	Depth to water (mbgl)[2]	Surface elevation (m AHD)	Water elevation (m AHD)[3]
7432	13/10/1928	Glendower Formation	1928	110.6	81.08	128.1	47.02
10632	01/03/1944	Glendower Formation	1944	–	81.08	128.1	47.02
11479	01/01/1949	Glendower Formation	1949	–	19.8	–	–
11556	30/10/1949	Glendower Formation	1949	–	23.7	–	–
11593	01/05/1950	Glendower Formation	1950	37.2	19.3	–	–
13280	06/09/1956	Glendower Formation	1956	108.1	98.5	167.5	69.00
13492	04/05/1957	Glendower Formation	1957	102.1	79.3	150.9	71.60
13935	09/06/1958	Glendower Formation	1958	30.5	21.0	–	–
18186	16/04/1969	Glendower Formation	1969	104.2	82.3	151.2	68.90
33823	02/12/1969	Glendower Formation	1969	107.3	98.5	151.8	53.30
50673	03/04/1989	Hooray Sandstone	1989	1,069.5	-14.18	108.0	122.18
9177	01/01/1939	Winton Formation	1939	–	80.8	128.1	47.30
9689	26/10/1943	Winton Formation	1943	118.9	12.2	137.2	125.00
11478	01/01/1949	Winton Formation	1949	–	30.5	–	–
11569	09/12/1949	Winton Formation	1949	122.0	50.0	–	–

Registered bore ID	Drilled date	Formation	Year of water level	Bore depth (m)[1]	Depth to water (mbgl)[2]	Surface elevation (m AHD)	Water elevation (m AHD)[3]
12060	26/04/1952	Winton Formation	1952	170.8	27.4	146.4	119.00
12092	14/07/1952	Winton Formation	1952	136.9	12.2	137.5	125.30
13655	23/05/1958	Winton Formation	1958	86.9	5.1	–	–
13772	10/08/1946	Winton Formation	1946	–	9.1	146.0	136.90
14790	10/12/1958	Winton Formation	1959	133.2	12.2	–	–
16199	02/02/1965	Winton Formation	1965	189.0	21.3	142.7	121.40
50403	15/01/1882	Winton Formation	1982	–	6.4	147.0	140.60
50443	30/06/1988	Winton Formation	1988	28.0	12.0	180.0	168.00

Notes: 1. From casing record
2. Negative value denotes groundwater level above the measurement point (i.e. artesian)
3. Calculated value (surface elevation minus depth to water).



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Groundwater levels and inferred flows

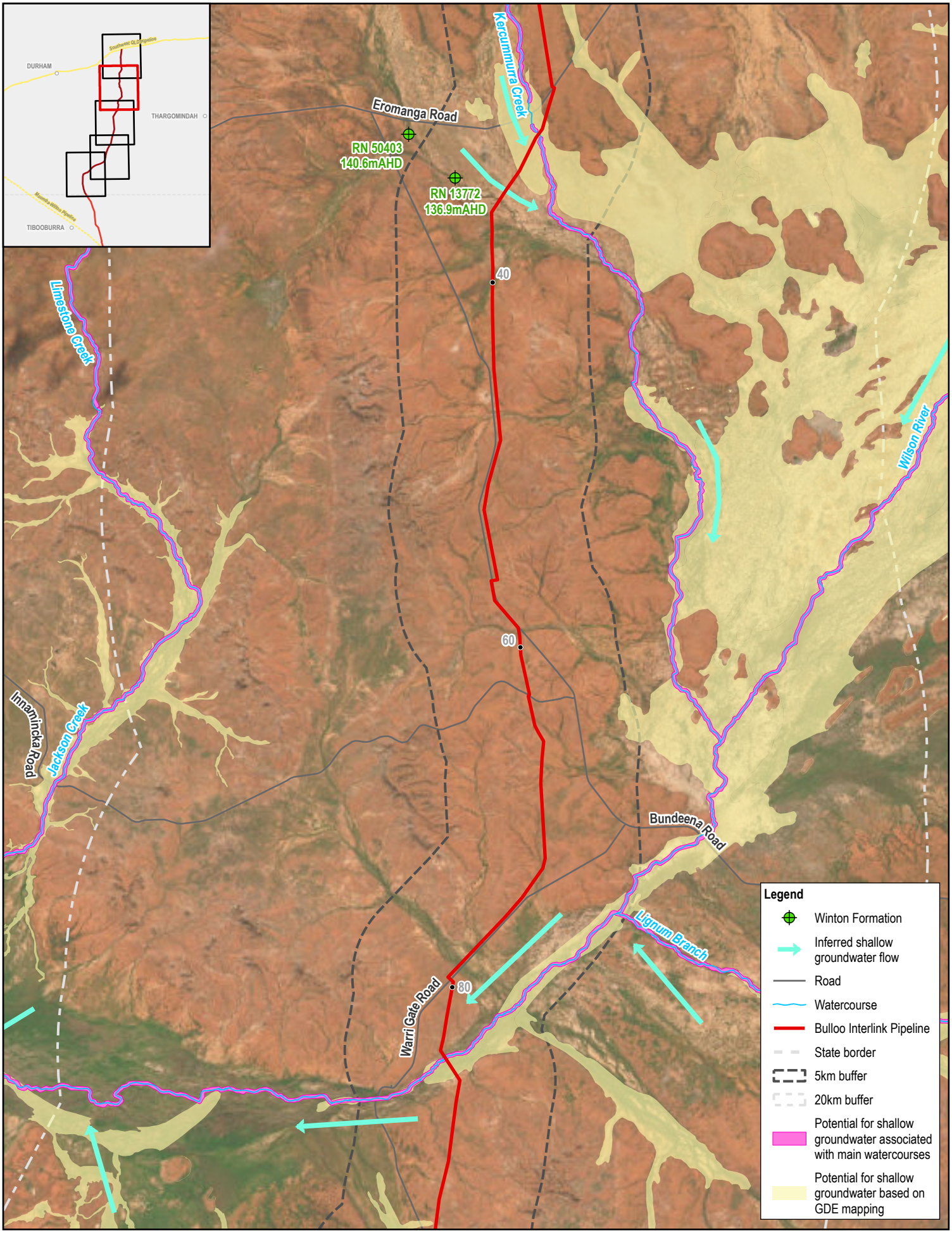
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Figure 4.17

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Groundwater levels and inferred flows

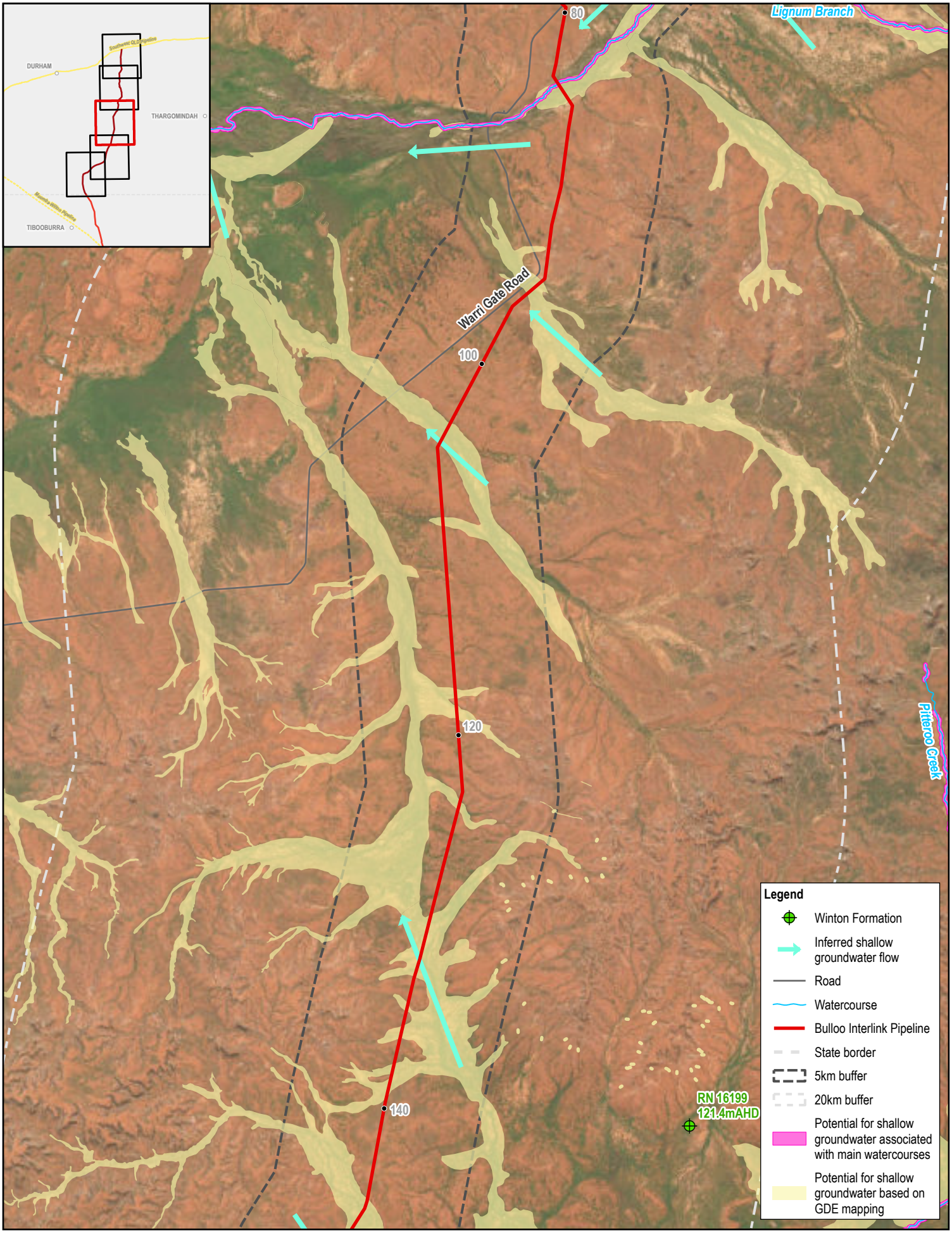
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Figure 4.17

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Groundwater levels and inferred flows

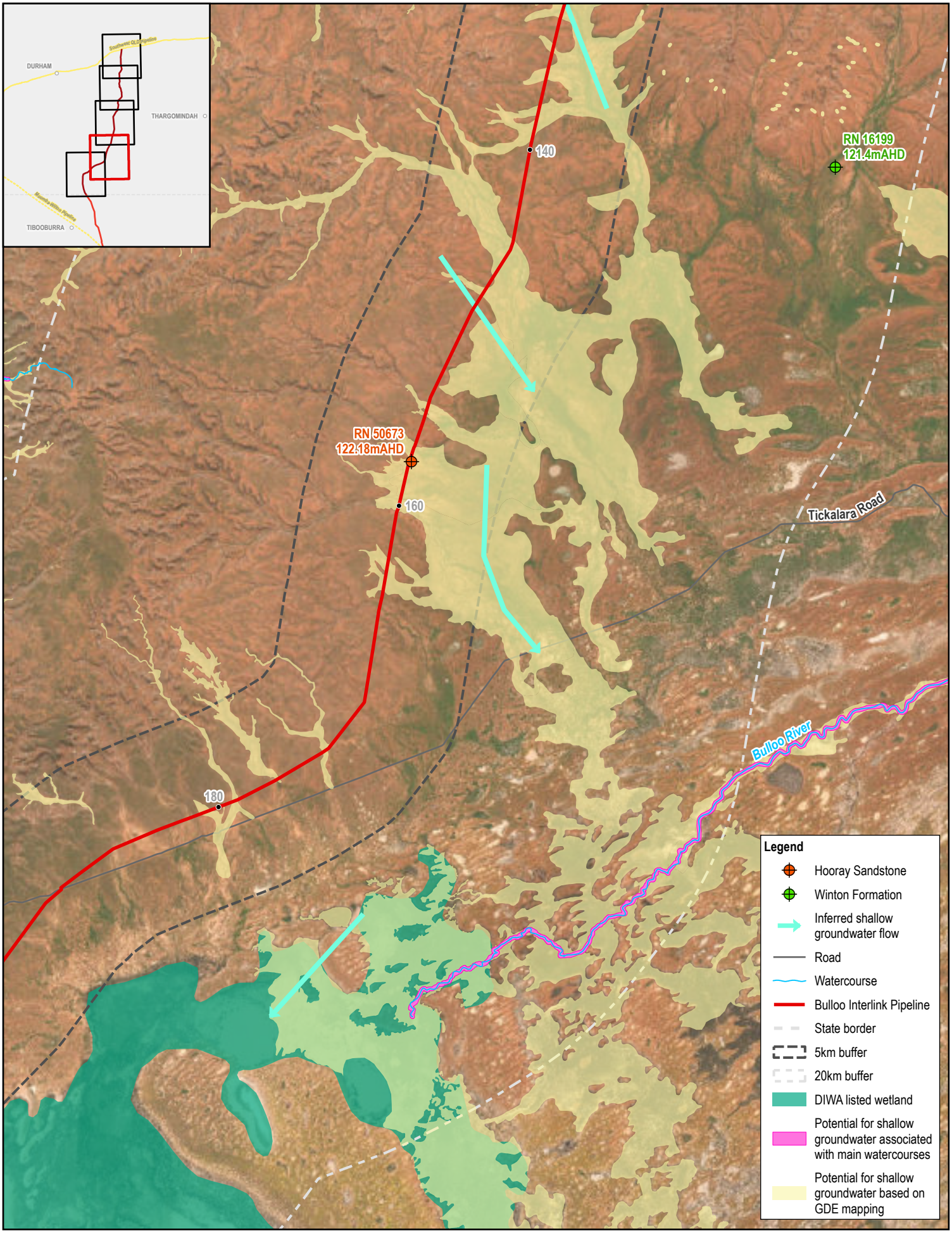
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Figure 4.17

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Groundwater levels and inferred flows

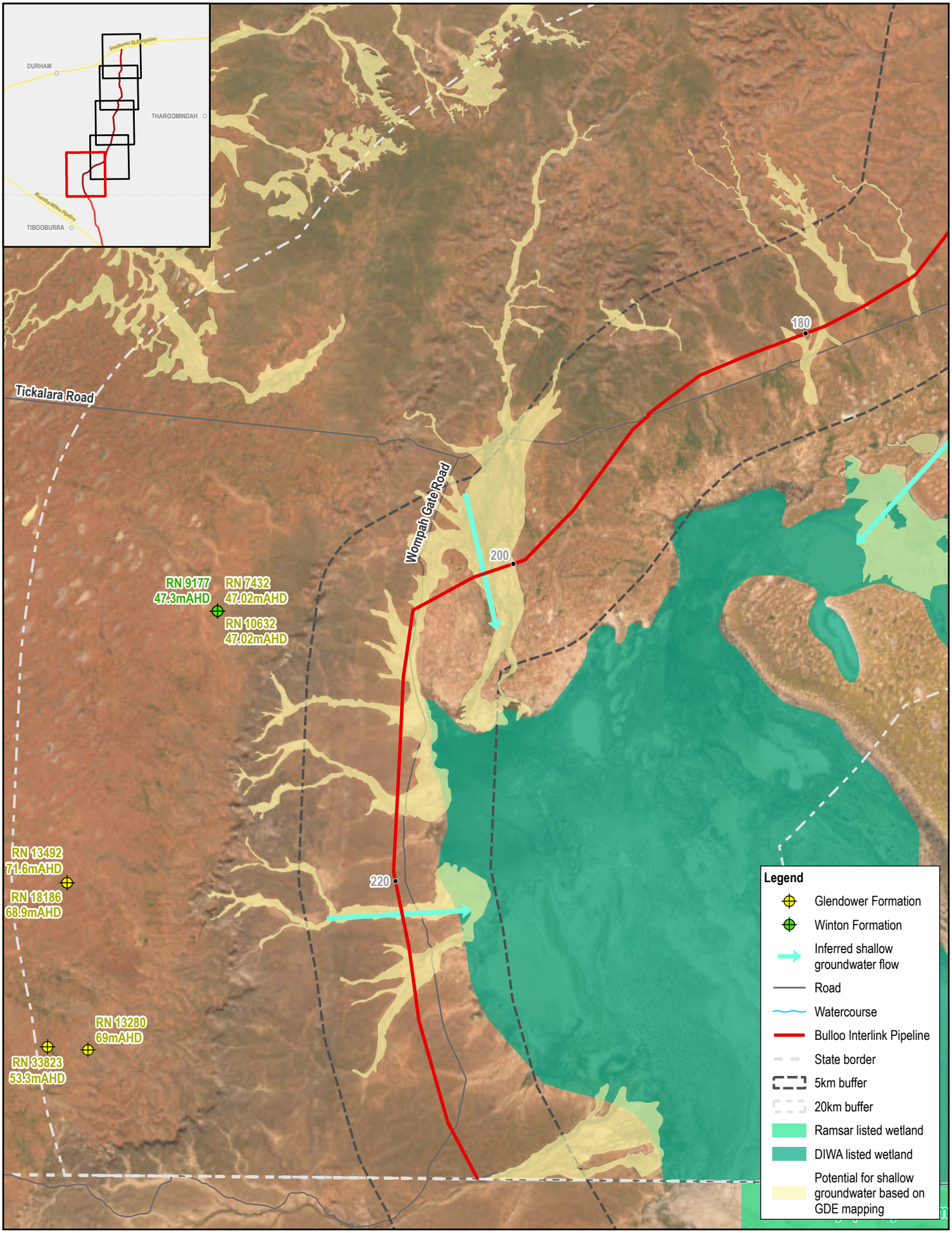
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Figure 4.17

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Groundwater levels and inferred flows

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Figure 4.17

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4.7.5 Groundwater quality

Groundwater quality is naturally variable and is influenced by many factors including source water composition, geology, soil composition and residence time. Human influence on the environment can also affect groundwater quality and the influence can be localised or extensive.

The water quality records for registered bores within the study area in the geological units above the GAB are summarised in Table 4.13. No water quality records for registered bores were identified for alluvium/ unconsolidated sediments. WQOs for Bulloo River basin (DES, 2020) also provide an indication of groundwater quality within the study area and the electrical conductivity and pH WQOs for groundwater zones within the study area are summarised in Table 4.14. Aquifer zone maps are included in Appendix C for reference.

Groundwater in alluvium and unconsolidated sediments is anticipated to be generally fresh to brackish due to seasonal/intermittent recharge of rainfall, run-off and surface water/flood water from infiltration in a low recharge/high evaporation climate. At a regional level the aquatic ecosystem WQOs for the 'Weathered Alluvium' zone within the 'Sediments Overlying the GAB' zone (DES, 2020) indicate predominantly fresh to brackish groundwater (electrical conductivity 20th percentile of 1,316 µS/cm, electrical conductivity 50th percentile of 3,650 µS/cm and 80th percentile of 24,040 µS/cm), however, there are no published WQOs for the other alluvial zones due to insufficient data.

Attributes of the terrestrial GDE mapping in the area (as shown in Figure 4.18) indicate the presence of brackish groundwater in alluvial deposits, describing the salinity of the groundwater source aquifers to the mapped terrestrial GDE as 1,500 to 3,000 mg/L TDS. The quality of shallow groundwater may also be locally influenced by above-ground water storages (reservoirs/dams) distributed along the pipeline alignment as shown in Figure 4.17. This provides potential for localised alteration to the quality of groundwater in unconsolidated sediments and alluvial deposits around these structures if seepage from the water storage to groundwater occurs.

Registered bore records indicate groundwater salinity in the Winton Formation is variable, and potable to brackish, with electrical conductivity in the range 3,900 to 10,000 µS/cm (i.e. brackish). This is within the range of a regional-scale summary of water quality within the Winton Formation, which reports groundwater as variable and ranging from fresh to saline with TDS generally in the range 1,500 to 4,000 mg/L but can be over 20,000 mg/L (DNRME, 2018).

At a regional level, aquatic ecosystem WQOs for the 'Winton Mackunda Western' zone within the 'Upper GAB' zone (DES, 2020d), where the southern part of the pipeline alignment is located, indicates groundwater quality for the Winton Formation as generally fresh to brackish groundwater (electrical conductivity 20th percentile of 1,322 µS/cm, electrical conductivity 50th percentile of 4,940 µS/cm, electrical conductivity 80th percentile of 8,880 µS/cm).

Groundwater salinity in the Glendower Formation is indicated to be brackish, with recorded electrical conductivity values of 5,700 and 6,702 µS/cm (Table 4.13).

Table 4.13 Registered bores groundwater quality (DLGWV, 2026)

Bore ID	Facility role	Formation description	Electrical conductivity	Bore search radius
5092	Not described	Hooray Sandstone	3,250 µS/cm	20 km
6987	Not described	–	480 µS/cm	5 km
13655	Not described	Winton Formation	Salty	5 km
16199	Not described	Winton Formation	10,000 µS/cm	20 km
18186	Not described	Glendower Formation	6,702 µS/cm	20 km
23059	GAB Monitoring	Hooray Sandstone	1,750 µS/cm	5 km
23372	GAB Monitoring	Hooray Sandstone	2,080 µS/cm	5 km
23466	Not described	–	2,250 µS/cm	20 km
23484	Not described	–	2,050 µS/cm	20 km
23569	GAB Monitoring	Hooray Sandstone	2,060 µS/cm	20 km
23579	Not described	–	1,880 µS/cm	20 km

Bore ID	Facility role	Formation description	Electrical conductivity	Bore search radius
33823	Not described	Glendower Formation	5,700 µS/cm	20 km
50403	Not described	Winton Formation	3,900 µS/cm	20 km
50443	Not described	Winton Formation	4,000 µS/cm	20 km
50673	Not described	Hooray Sandstone	1,960 µS/cm	5 km
116511	Water supply	Winton Formation	Potable	5 km
116507	Water supply	Winton Formation	Potable	20 km
116365	Water supply	Winton Formation	Brackish	20 km

Table 4.14 Summary of electrical conductivity and pH WQOs (DES, 2020d)

Aquifer zone	Area within aquifer zone	EC percentiles			pH percentiles		
		20th	50th	80th	20th	50th	80th
Sediments overlying the GAB	1 – Weathered Alluvium	1,316	3,650	24,040	7.2	7.6	8.06
Upper GAB	1 – Winton Mackunda Western	1,342	4,940	8,880	7.2	7.7	8.16

4.7.6 Surface water–groundwater and aquifer interaction

Interaction between surface water and groundwater is expected to occur primarily within alluvium and unconsolidated sediments along the proposed pipeline alignment. This is because groundwater beneath and near permanent or ephemeral watercourses is likely perched on the Glendower and Winton formations. Surface watercourses are ephemeral and across much of the study area where shallow groundwater (from alluvium or bedrock) does not appear to provide baseflow to surface water. However, shallow groundwater may temporarily discharge to a watercourse if the groundwater level is high enough after a significant rainfall recharge event.

Most of the waterholes in the area, mapped along Wilson River and its tributaries to the east of the pipeline alignment are classified as being regularly dry, infrequently dry or annually dry in Silcock (2009), except for two permanent waterholes on Wilson River as addressed within Appendix C (Aquatic Ecology Assessment Report) of the Environmental Authority Supporting Information Report. The waterholes receive water when watercourses flow or flood and may provide a source of recharge to the underlying alluvium/unconsolidated sediments through bed leakage, however, most of the water loss from the waterholes occurs from evaporation.

The two permanent waterholes on Wilson River closest to the proposed pipeline are close to mapped terrestrial GDE areas (moderate confidence, not field verified) indicating potential for shallow sub-surface presence of groundwater close to these waterholes, refer to Appendix C (Aquatic Ecology Assessment Report) of the Environmental Authority Supporting Information Report. These permanent waterholes may therefore be partially, or seasonally, supported by groundwater limiting the rate of bed leakage from the waterhole if the waterhole intersects the groundwater table.

Bulloo Lake (a terminal lake) receives water and is recharged from Bulloo River along with the other ephemeral watercourses that drain into it. The lake typically only fills when the adjacent Caryapundy Swamp in NSW reaches capacity as a terminal basin. However, groundwater (which is also largely considered to be ephemeral) in nearby unconsolidated sediments/alluvial deposits will also drain towards and may temporarily discharge to Bulloo Lake if, or when, the groundwater level is temporarily higher than the bed of the lake.

Depth to groundwater in the sedimentary strata (Winton Formation and Glendower Formation) underlying the alluvial and unconsolidated sediment deposits is indicated to generally be at least 10 mbgl and supports the overall low potential for hydraulic connectivity between bedrock and surface water. However, there is potential for the presence of groundwater closer to ground surface in low-lying areas along the pipeline alignment (i.e. east of Bulloo Lake and the area around Wilson River, as described in section 4.7.4).

Groundwater in the alluvium, where and when present, is likely to be perched on the underlying strata with low potential for hydraulic connectivity between the alluvium and underlying bedrock (i.e. Winton Formation and Glendower Formation). Hydraulic connectivity and interaction of the Winton Formation and Glendower Formation with the underlying aquifers of the GAB is limited by the Rolling Downs Group aquitard, which overlies the GAB aquifers in this area.

4.7.7 Groundwater use

Registered bores recorded in the Queensland Groundwater Database as ‘existing’ or ‘abandoned but useable’, with a facility role of ‘not described’, ‘water supply’ or ‘GAB monitoring’, and located within a 20 km search radius of the pipeline alignment are summarised in Table 4.12. Registered bores with a facility role of ‘petroleum/gas exploration’ are not included in the summary table. The locations of the bores in Table 4.12 are shown in Figure 4.18 and does not include bores recorded as ‘abandoned and destroyed’. Records from the Water Entitlements Database (DLGWV, 2026b) are summarised in Table 4.16 and Table 4.17.

In the study area, groundwater is anticipated to be primarily extracted from the sub-artesian rock aquifers (i.e. Glendower Formation and Winton Formation) and the artesian Cadna-owie – Hooray GAB aquifer, separated from the sub-artesian system by the Rolling Downs Group aquitard. Given the ephemeral nature of the watercourses, semi-arid to arid climate and anticipated ephemeral/seasonal presence of groundwater in the alluvial deposits, groundwater extraction from alluvium is expected to be minimal or not to occur.

The primary use of groundwater is likely to be for stock watering given the agricultural land mapping for the area is shown as native pasture/grazing (Figure 4.6, Queensland Globe, Agricultural land classes), and for stock and domestic use as indicated by water entitlement records (Table 4.16 and Table 4.17). Registered bore records indicate groundwater from the Winton Formation could be extracted for water supply (refer to Table 4.15, bores RN 116511, RN 116365 and RN 116507), however these records do not provide detail of what the water supply is used for.

Water entitlement records indicate there are active licences within the search area to take groundwater from the Cadna-owie – Hooray GAB aquifer and Wallumbilla Formation aquifer. Most of the active water licences identified the authorised purpose as ‘stock’, along with ‘domestic supply, stock’ (Lot 1673 on Plan SP289790) and ‘irrigation’ (Lot 3 on Plan M5729).

Table 4.15 Summary of existing and useable registered bores (DLGWV, 2026b)

Bore ID	Drilled date	Easting	Northing	Facility role	Formation description	Bore status*	Bore depth (m)	Yield (L/s)	Bore search radius
6297	–	667033	6982141	Not described	–	EX	–	–	5 km
6299	01/01/1927	666472	6941905	Not described	–	EX	–	–	5 km
11556	30/10/1949	612016	6796851	Not described	Glendower Formation	EX	–	–	5 km
13935	09/06/1958	618022	6792225	Not described	Glendower Formation	EX	30.5	–	5 km
23059	20/06/1982	661145	6909983	GAB monitoring	Hooray Sandstone	EX	1,243.2	–	5 km
23372	15/04/1986	662482	6938621	GAB monitoring	Hooray Sandstone	EX	1,514	–	5 km
23481	23/04/1987	663537	6962325	Not described	Hooray Sandstone	EX	1,596	–	5 km
23527	06/05/1986	661430	6929652	Not described	–	EX	–	–	5 km
23528	23/05/1986	655097	6895681	Not described	–	EX	–	–	5 km
23730	26/12/1987	661279	6924909	Not described	–	EX	–	–	5 km
23854	04/08/1989	660545	6930044	Not described	–	EX	–	–	5 km
23859	31/08/1989	658786	6933761	Not described	–	EX	–	–	5 km
50358	–	618721	6829738	Not described	–	EX	–	–	5 km
50468	–	633137	6835081	Not described	–	EX	–	–	5 km
50673	03/04/1989	644123	6853697	Not described	Hooray Sandstone	EX	1,069.5	–	5 km
116511	26/09/2017	668781	6971181	Water supply	Winton Formation	EX	84	1.8	5 km
5092	30/10/1935	671328	7020013	Not described	Hooray Sandstone	EX	1,551.8	–	20 km
5737	–	656774	6970710	Not described	–	EX	–	–	20 km
6296	–	671337	6982968	Not described	–	EX	–	–	20 km
7372	–	652446	6974707	Not described	–	EX	–	–	20 km
9689	26/10/1943	679262	6998881	Not described	Winton Formation	EX	118.9	–	20 km
12060	26/04/1952	674901	7007359	Not described	Winton Formation	EX	170.8	–	20 km
12092	14/07/1952	677098	7005967	Not described	Winton Formation	EX	136.9	–	20 km
14790	10/12/1958	649503	6960994	Not described	Winton Formation	EX	133.2	–	20 km
16199	02/02/1965	666260	6869071	Not described	Winton Formation	EX	189	–	20 km
18186	16/04/1969	595470	6806989	Not described	Glendower Formation	AU	104.2	–	20 km
23179	30/05/1982	652001	6936304	Not described	–	EX	–	–	20 km

Bore ID	Drilled date	Easting	Northing	Facility role	Formation description	Bore status*	Bore depth (m)	Yield (L/s)	Bore search radius
23180	09/07/1982	655207	6943491	Not described	–	EX	–	–	20 km
23252	24/9/1983	645442	6948868	Not described	–	EX	–	–	20 km
23257	25/11/1983	644584	6943095	Not described	–	EX	–	–	20 km
23273	06/10/1983	650376	6933059	Not described	–	EX	–	–	20 km
23421	23/10/1984	677773	7002721	Not described	–	EX	–	–	20 km
23466	15/11/1986	639477	6892343	Not described	–	EX	–	–	20 km
23484	29/11/1985	650376	6933059	Not described	–	EX	–	–	20 km
23496	05/09/1985	656512	6993458	Not described	–	EX	–	–	20 km
23523	07/09/1985	654394	6938420	Not described	–	EX	–	–	20 km
23524	19/10/1985	653080	6932032	Not described	–	EX	–	–	20 km
23525	21/03/1986	655787	6931665	Not described	–	EX	–	–	20 km
23526	04/04/1986	652567	6937457	Not described	–	EX	–	–	20 km
23554	16/08/1985	650785	6933013	Not described	–	EX	–	–	20 km
23555	04/10/1985	650075	6932989	Not described	–	EX	–	–	20 km
23556	05/11/1985	653381	6938643	Not described	–	EX	–	–	20 km
23569	16/11/1987	654269	6932959	GAB monitoring	Hooray Sandstone	EX	1,415	–	20 km
23579	01/01/1988	652445	6925211	Not described	(depth indicates Hooray Sandstone)	EX	1,400	–	20 km
23632	11/40/1987	667057	6915191	Not described	–	EX	–	–	20 km
23665	25/03/1987	655446	6931204	Not described	–	EX	–	–	20 km
23667	06/05/1987	655932	6932184	Not described	–	EX	–	–	20 km
23714	03/11/1987	655204	6931545	Not described	–	EX	–	–	20 km
23721	26/11/1987	651653	6932238	Not described	–	EX	–	–	20 km
23726	11/12/1987	666940	6914489	Not described	–	EX	–	–	20 km
23779	26/06/1988	646238	6972193	Not described	–	EX	–	–	20 km
23856	13/08/1989	666596	6914016	Not described	–	EX	–	–	20 km
23861	08/09/1989	653199	6931678	Not described	–	EX	–	–	20 km
23864	20/09/1989	665093	6912159	Not described	–	EX	–	–	20 km

Bore ID	Drilled date	Easting	Northing	Facility role	Formation description	Bore status*	Bore depth (m)	Yield (L/s)	Bore search radius
23928	23/05/1990	656125	6932949	Not described	–	EX	–	–	20 km
33823	02/12/1969	594448	6798434	Not described	Glendower Formation	EX	107.3	–	20 km
50359	–	618341	6833167	Not described	–	EX	–	–	20 km
50360	01/09/1980	607350	6826632	Not described	–	EX	–	–	20 km
50403	15/01/1882	657474	6971716	Not described	Winton Formation	EX	–	0.76	20 km
50443	30/06/1988	681292	7000596	Not described	Winton Formation	EX	28	–	20 km
50555	–	656771	6970697	Not described	Winton Formation	EX	189	–	20 km
50556	–	652446	6974707	Not described	–	EX	–	–	20 km
50557	–	652446	6974707	Not described	–	EX	–	–	20 km
50627	–	676355	7004533	Not described	–	EX	80.4	–	20 km
50666	12/02/1989	595880	6807066	Not described	Winton Formation	EX	102	–	20 km
50967	22/06/2001	594436	6798437	Water supply	–	EX	–	–	20 km
116365	29/06/2014	660407	6868725	Water supply	Winton Formation	EX	84	0.22	20 km
116507	15/10/2017	659656	6861562	Water supply	Winton Formation	EX	132	3.5	20 km

Notes: *EX = Existing, AU = Abandoned but useable.

Table 4.16 Summary of water entitlement records for registered bores within a 20 km search radius (Water entitlements, DLGWV, 2026b)

RN	Authorised purpose	Water source	Basin	Water source name and type	Nominal entitlement
5092	Stock	Hooray Sandstone	Coopers Creek Basin	Hooray Sandstone/Underground (Ground Water)	No value
23372	Stock	Hooray Sandstone	Coopers Creek Basin	Hooray Sandstone/Underground (Ground Water)	No value
23481	Stock	Hooray Sandstone	Coopers Creek Basin	Hooray Sandstone/Underground (Ground Water)	No value
23569	Stock	Hooray Sandstone	Coopers Creek Basin	Hooray Sandstone/Underground (Ground Water)	No value
23579	Stock	Hooray Sandstone	Coopers Creek Basin	Hooray Sandstone/Underground (Ground Water)	No value
116365	Stock	Hooray Sandstone	Bulloo Basin	Hooray Sandstone/Underground (Ground Water)	No value

Table 4.17 Summary of water entitlement records for lot plans intersected by a 5 km search radius (Water entitlements, DLGWV, 2026b)

Lot	Plan	Authorised purpose	Water source	Basin	Water source name and type	Nominal entitlement
3	BI22	Stock	Hooray Sandstone	Coopers Creek Basin	Hooray Sandstone/Underground (Ground Water)	No value
1	SP209773	Stock	Hooray Sandstone	Coopers Creek Basin	Hooray Sandstone/Underground (Ground Water)	No value
1	SP133822	Stock	Wallumbilla Formation	Coopers Creek Basin	Wallumbilla Formation/Underground (Ground Water)	No value
2	SP184928	Stock	Hooray Sandstone	Coopers Creek Basin	Hooray Sandstone/Underground (Ground Water)	No value
1673	SP289790	Stock	Hooray Sandstone	Bulloo Basin	Hooray Sandstone/Underground (Ground Water)	No value
1673	SP289790	Domestic supply; stock	Wallumbilla Formation	Bulloo Basin	Wallumbilla Formation/Underground (Ground Water)	No value
3	M5729	Irrigation	Hooray Sandstone	Coopers Creek Basin	Hooray Sandstone/Underground (Ground Water)	160 ML

4.7.8 Groundwater dependent ecosystems

GDEs are referenced in this report solely to identify potential groundwater–surface water interaction pathways and to inform the assessment of groundwater drawdown and groundwater quality risk. GDEs rely on either permanent, intermittent or opportunistic groundwater access to sustain themselves through the surface expression of groundwater, presence of groundwater within the capillary zone or subterranean presence of groundwater. GDEs can be categorised as aquatic, terrestrial or subterranean. Effective management of groundwater quality, levels and flows is key to maintaining the health of GDEs.

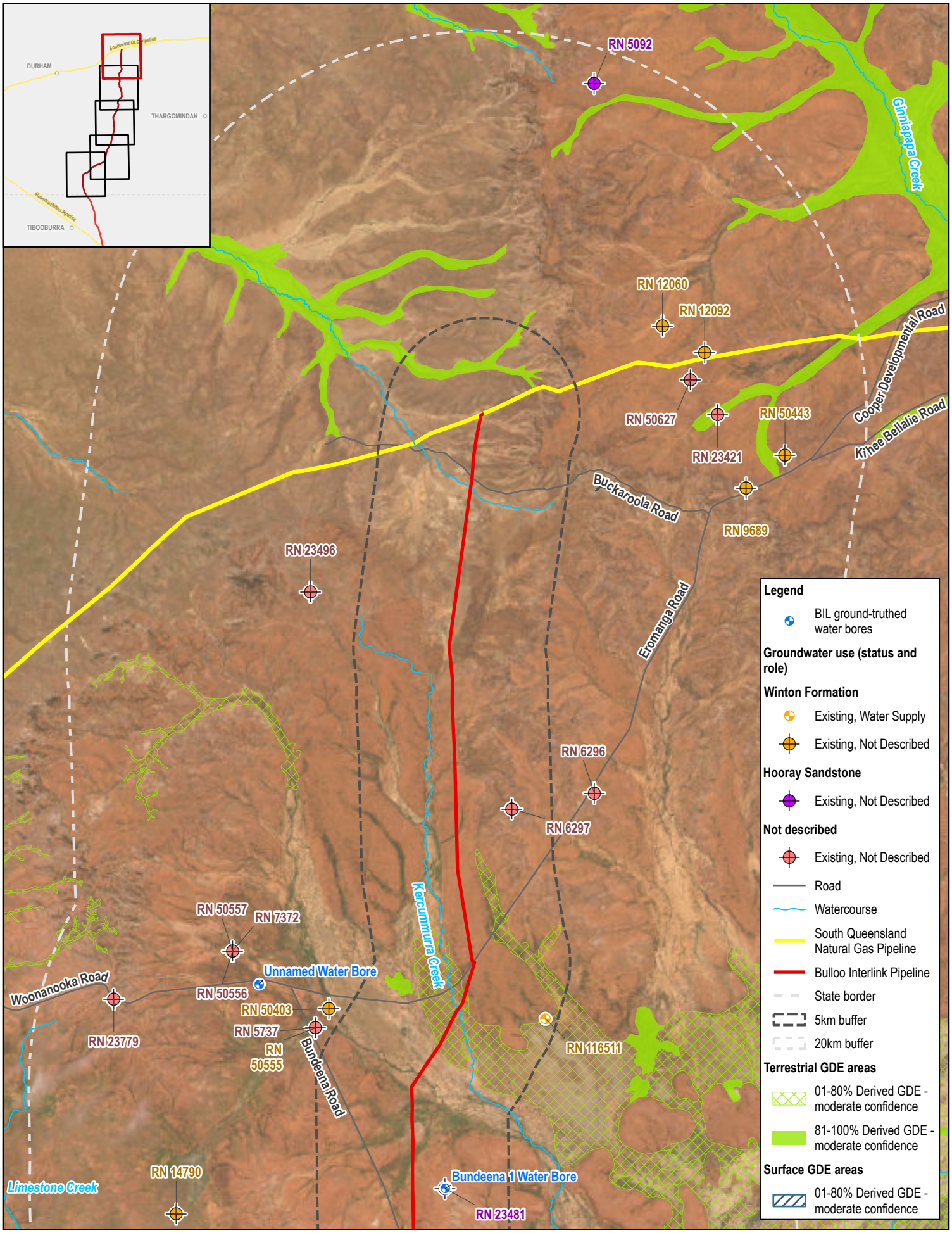
GDE mapping is shown in Figure 4.18. The mapping provides potential GDE datasets from regional and national studies (not verified by field surveys) for terrestrial GDEs and surface expression GDEs.

Surface expression GDEs rely on the surface expression of groundwater and can include rivers, wetlands, lakes and springs. The nearest potential surface expression GDE areas (moderate confidence, Figure 4.18) are more than 5 km to the west and east of the pipeline alignment, and are shown within areas of mapped alluvial/unconsolidated sediments (Figure 4.16). The nearest potential surface expression GDE lines (moderate confidence) are about 4 km east of the pipeline alignment between chainage 120 and 140 km, and appear to coincide with the boundary of the mapped Winton Formation, indicating the potential for discharge of groundwater as springs (Figure 4.18). Attributes for the surface expression GDE lines describe the temporal nature of groundwater connectivity as ephemeral and the spatial connectivity as connected, variable gaining/losing. Where surface expression of groundwater does occur, it is likely to occur after a significant rainfall recharge event and be short-lived.

Terrestrial GDEs rely on the subsurface presence of groundwater and can include vegetation ecosystems such as forests, trees and riparian vegetation. The potential for terrestrial GDE existence tends to decrease as distance from watercourses increases. The pipeline alignment intersects areas mapped as 1–80% derived terrestrial GDEs (moderate confidence) and 80–100% derived terrestrial GDEs (moderate confidence) along the pipeline alignment and appear to be associated with watercourses.

Mapping attributes of the potential GDE aquifers data set (Figure 4.19) describe the temporal nature of groundwater connectivity / presence as ephemeral and the source aquifer geology as unconsolidated sedimentary (i.e. assumed to include alluvial sediments). Field-verification surveys within the disturbance footprint for the project confirmed the presence of terrestrial GDEs represented by regional ecosystems (REs) 5.3.2, 5.3.4, 5.3.5 and 5.3.9 on main drainage lines, braided channels and major tributaries of the Wilson River and Bulloo River (refer to Appendix B (Terrestrial Ecology Assessment Report) of the Environmental Authority Supporting Information Report).

No subterranean GDE areas (i.e. caves) are mapped in the area around the proposed pipeline and the mapped bedrock geology, comprising layered sedimentary (sandstone with mudstone/siltstone) geological, does not typically support cave ecosystems. The nearest mapped springs are about 200 km to the east of the southern end of the proposed pipeline and about 200 km to the northeast of the northern end of the proposed pipeline. No GDEs as artesian mound springs were observed within the disturbance footprint of the project during field-verification surveys (refer to Appendix B (Terrestrial Ecology Assessment Report) of the Environmental Authority Supporting Information Report).



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APA Group
Bulloo Interlink Pipeline

Groundwater use and potential groundwater dependent ecosystems

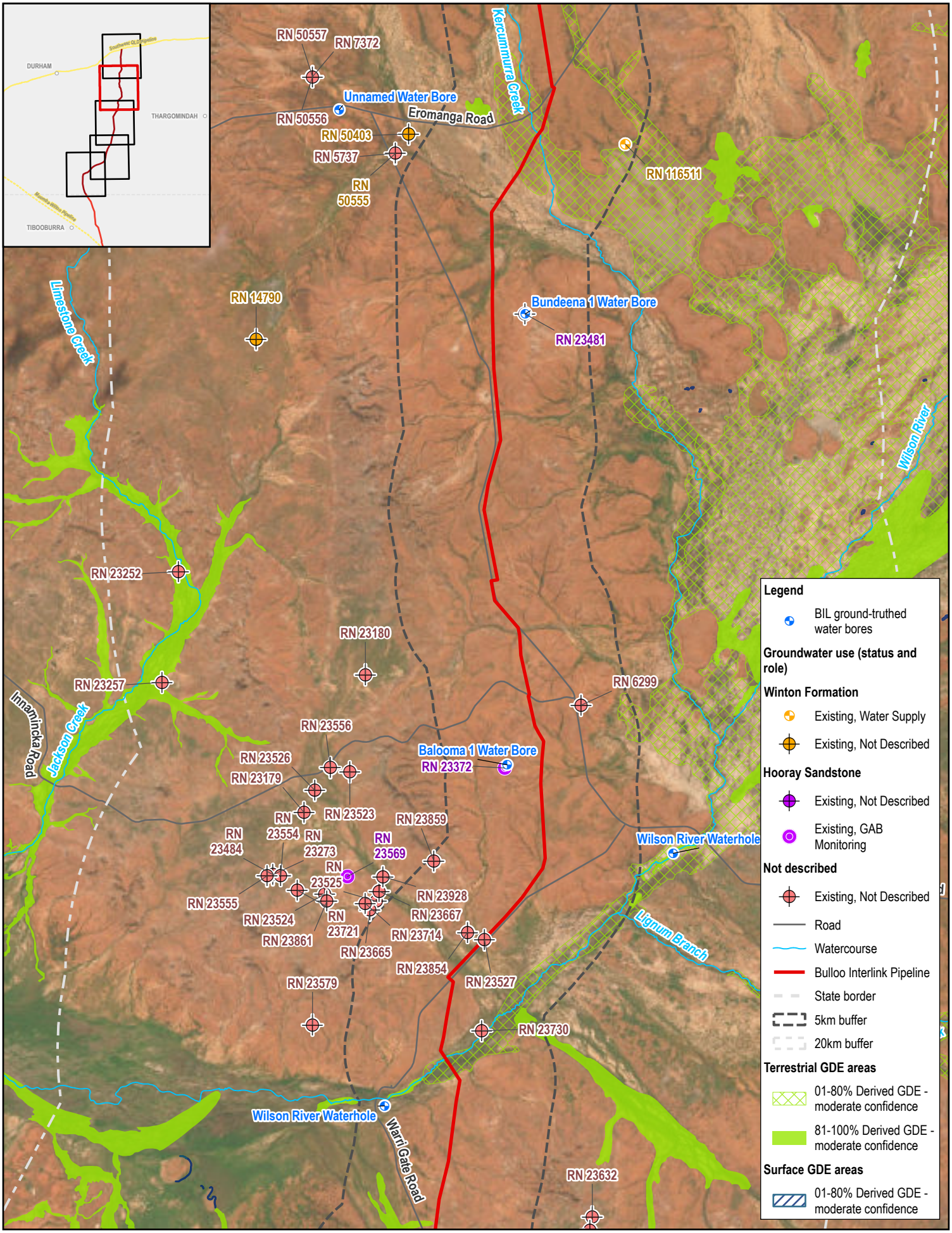
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Figure 4.18

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Groundwater use and potential groundwater dependent ecosystems

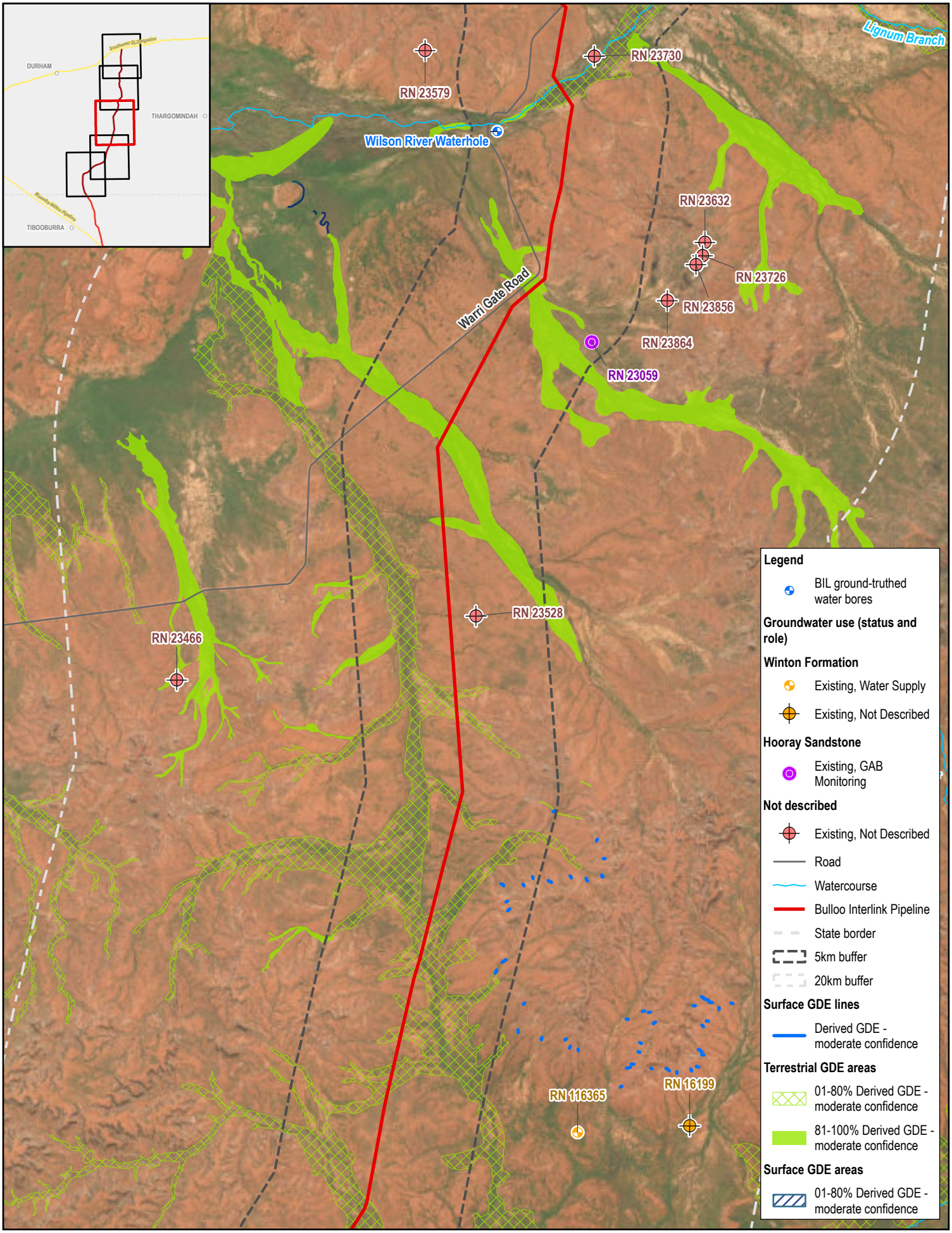
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Figure 4.18

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Groundwater use and potential groundwater dependent ecosystems

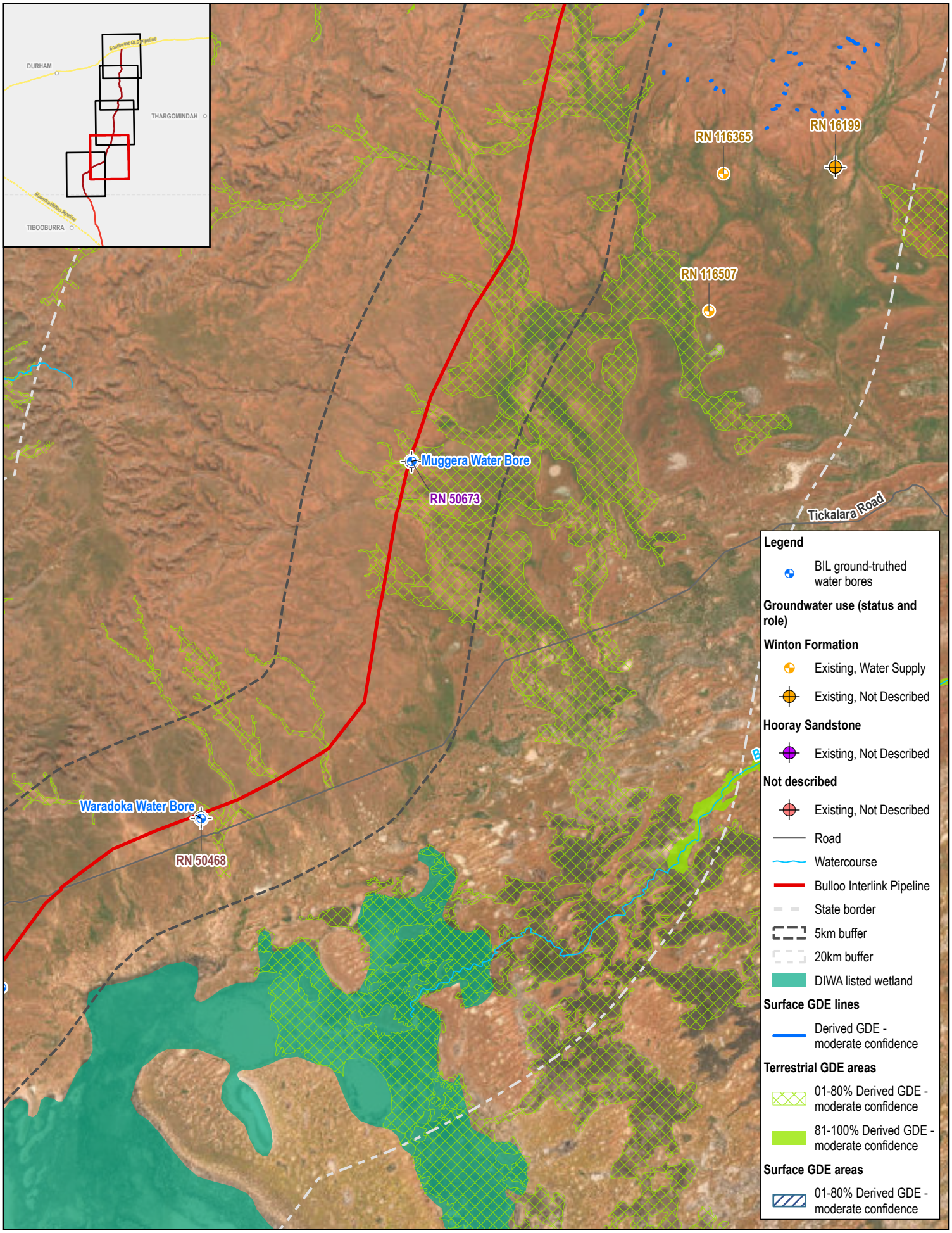
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Figure 4.18

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Groundwater use and potential groundwater dependent ecosystems

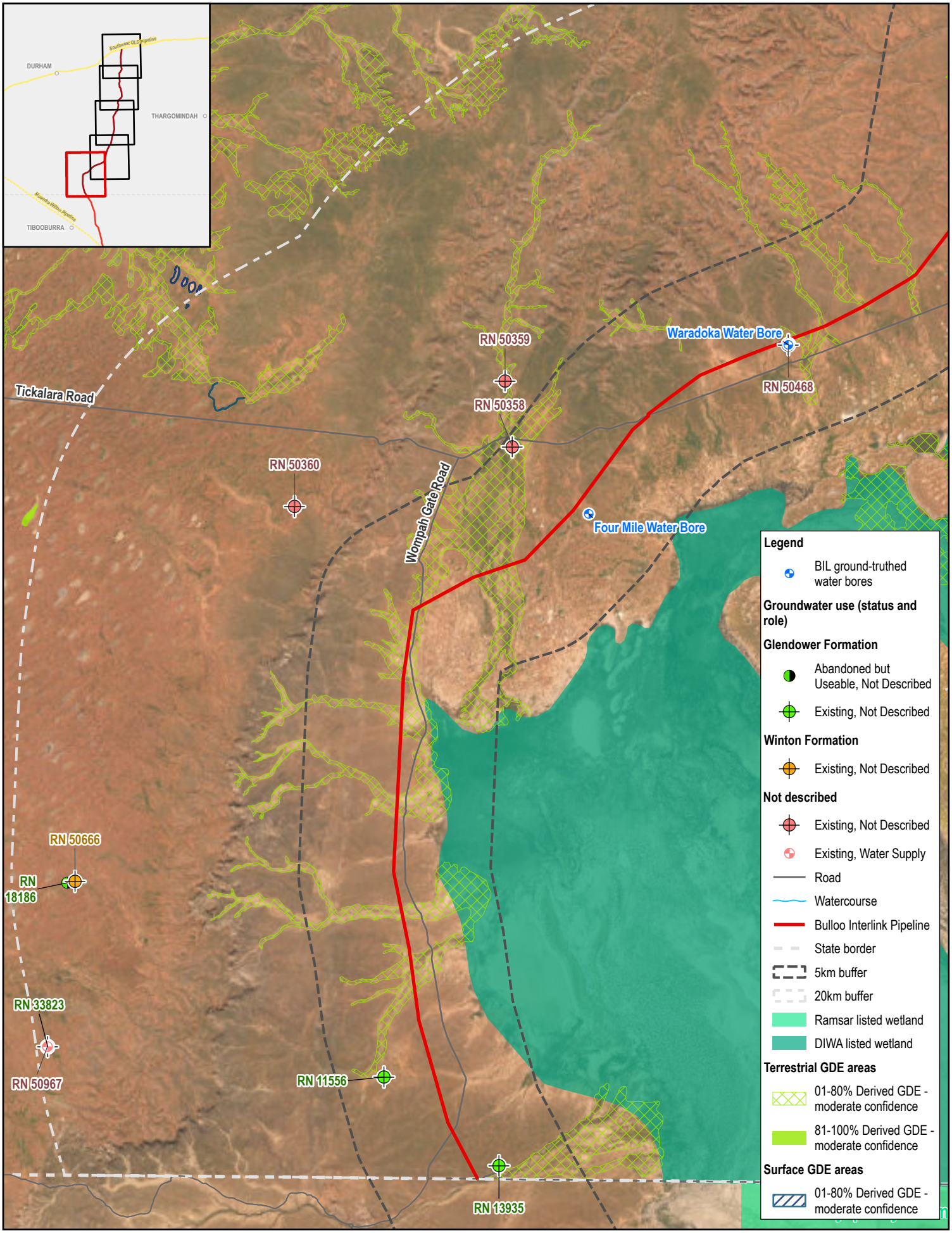
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Figure 4.18

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Groundwater use and potential groundwater dependent ecosystems

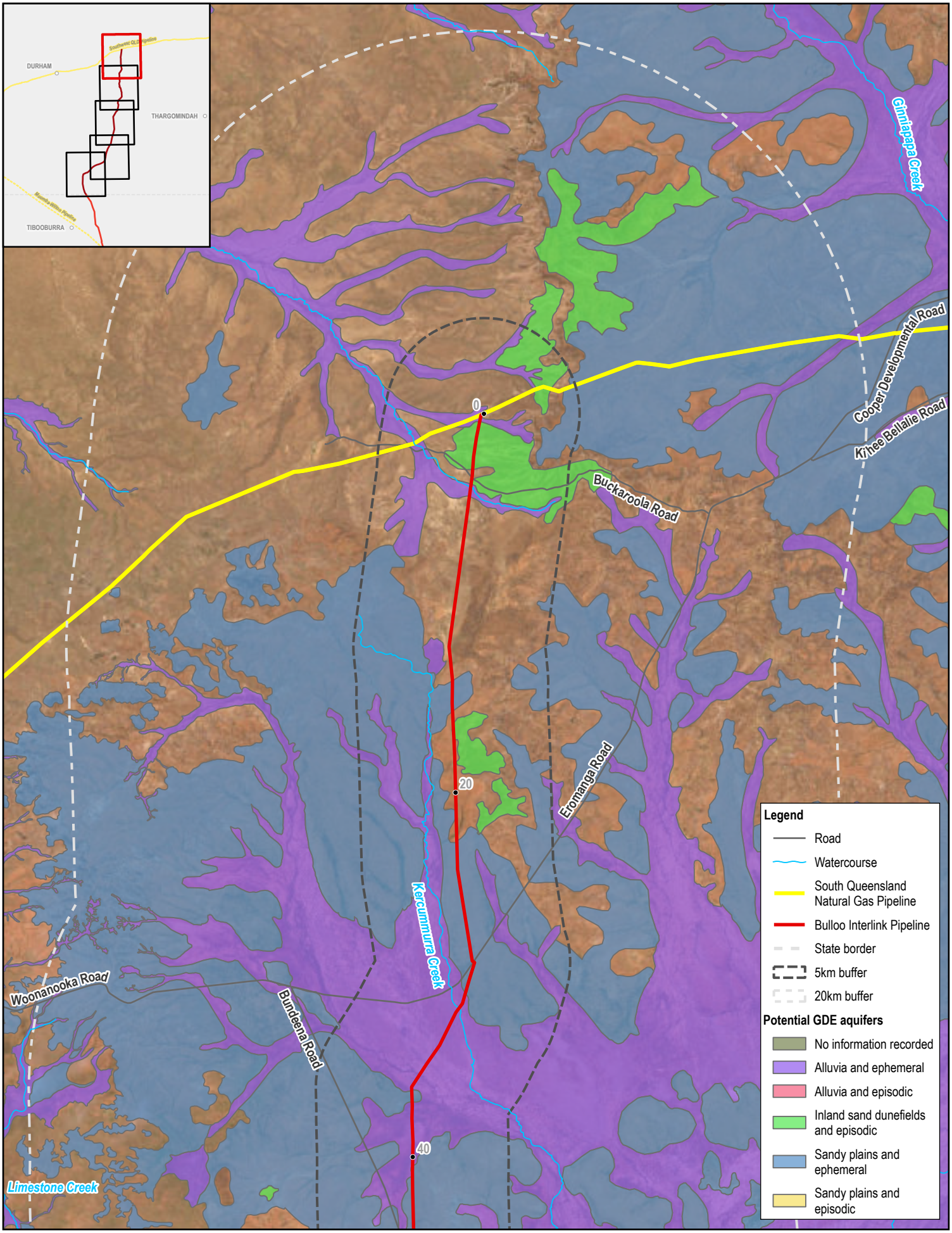
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Figure 4.18

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Bulloo Interlink Pipeline

Potential groundwater dependent ecosystem aquifers

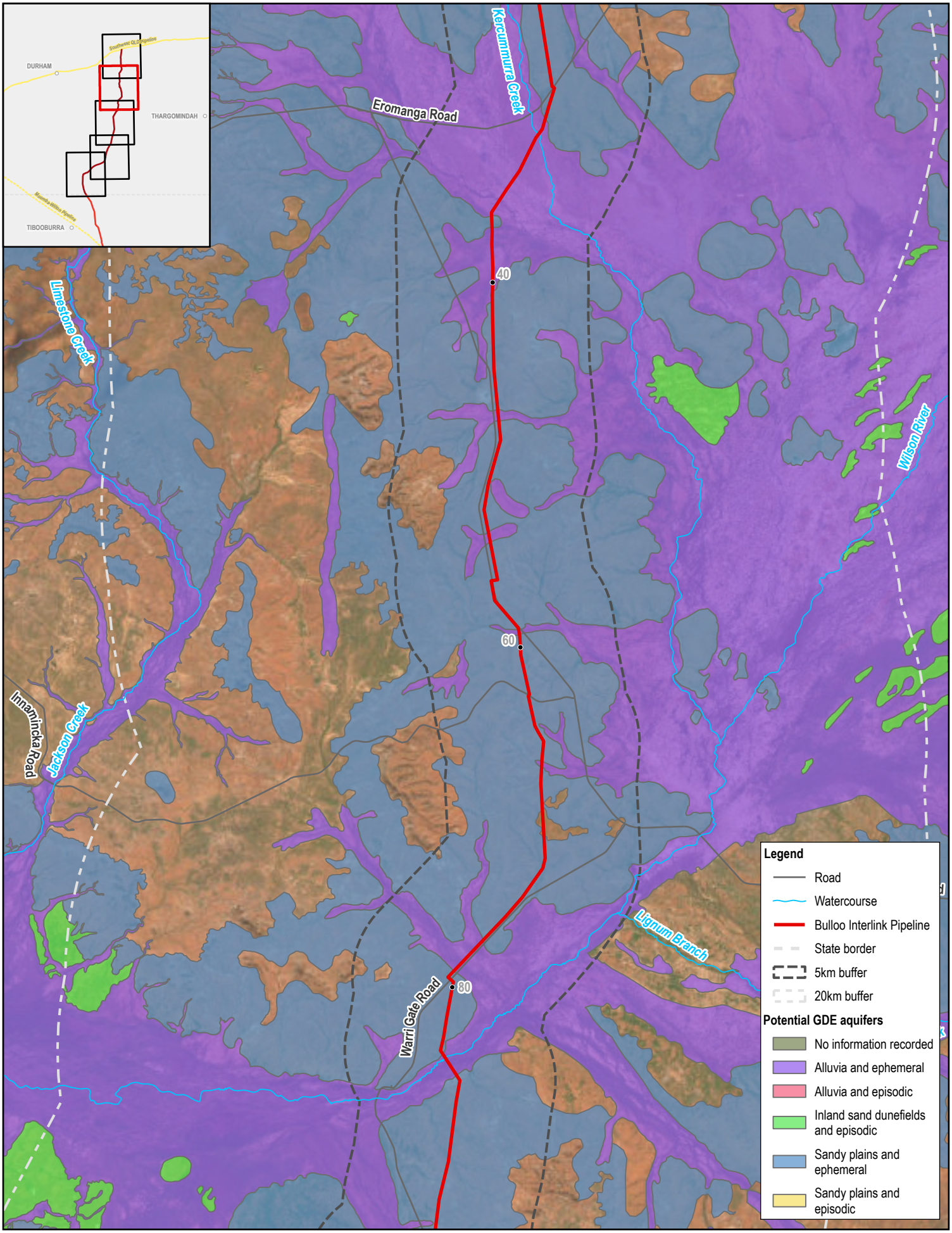
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Figure 4.19

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Bulloo Interlink Pipeline

Potential groundwater dependent ecosystem aquifers

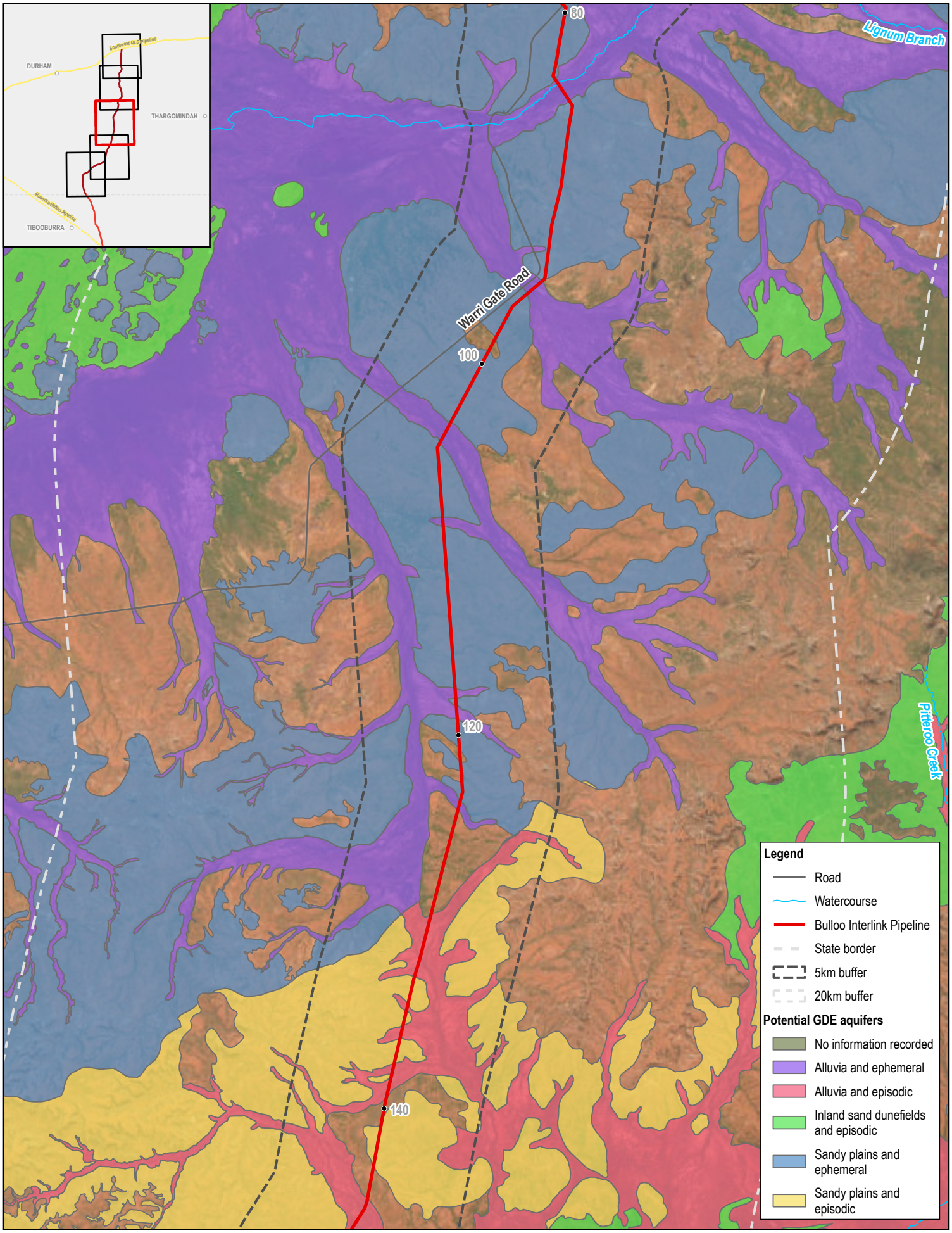
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Figure 4.19

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Data source: Earthstar Geographics, Esri, HERE, GarminDNRMMRRD: Roads (2021); Watercourse (2023); APA:Project alignment, South Queensland Natural Gas Pipeline, Moomba - Wilton Natural Gas Pipeline (2025); DETSI: Potential aquatic GDE features (2018); DEE: Caryapundy swamp/NSW Wetland (2025); DES: Bulloo lake/ QLD wetland (2025); GHD: Inferred shallow groundwater flow; High potential/potential for shallow groundwater in alluvium / unconsolidated sediments (2026);



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Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

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APA Group
Bulloo Interlink Pipeline

Potential groundwater dependent ecosystem aquifers

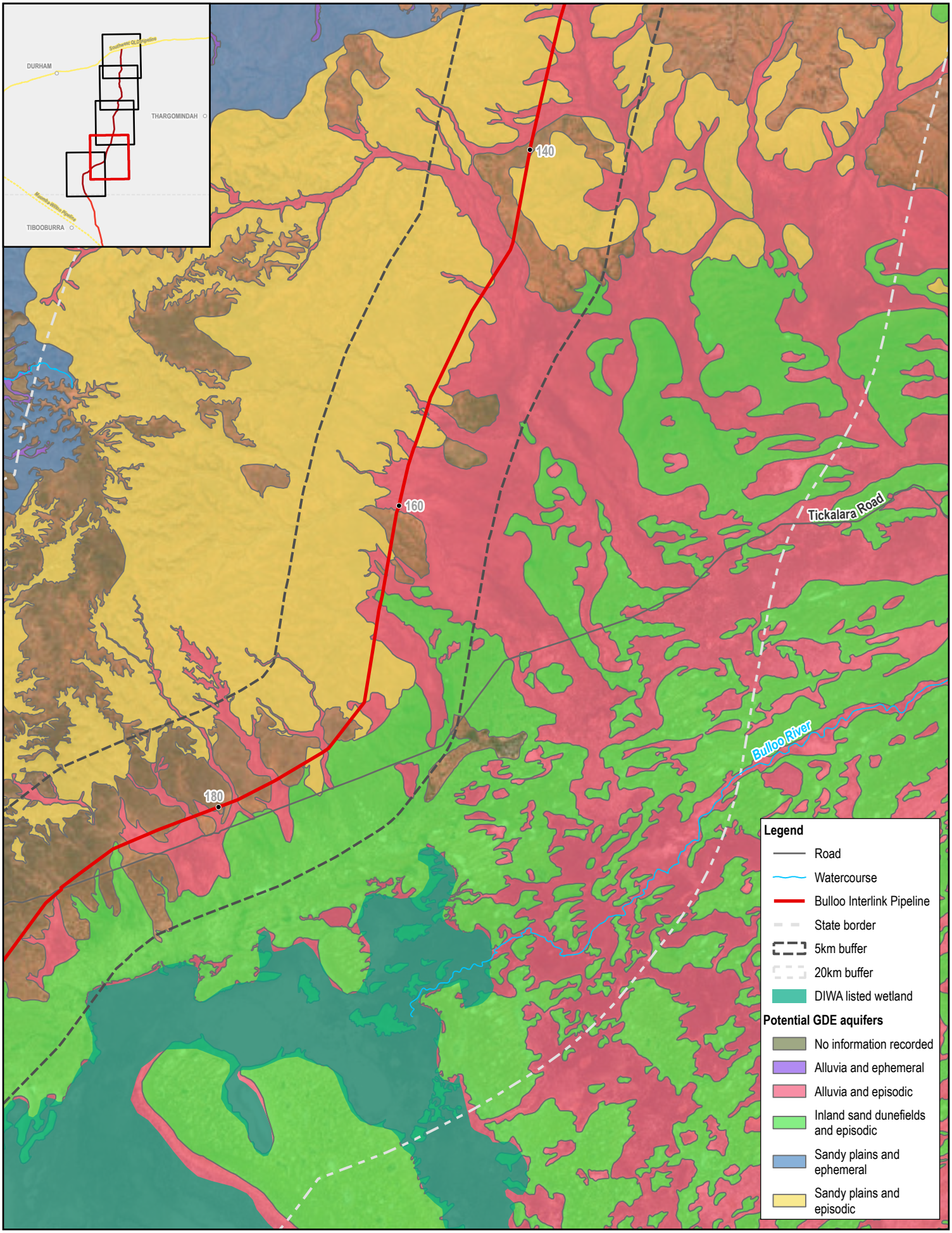
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Figure 4.19

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APA Group
Bulloo Interlink Pipeline

Potential groundwater dependent ecosystem aquifers

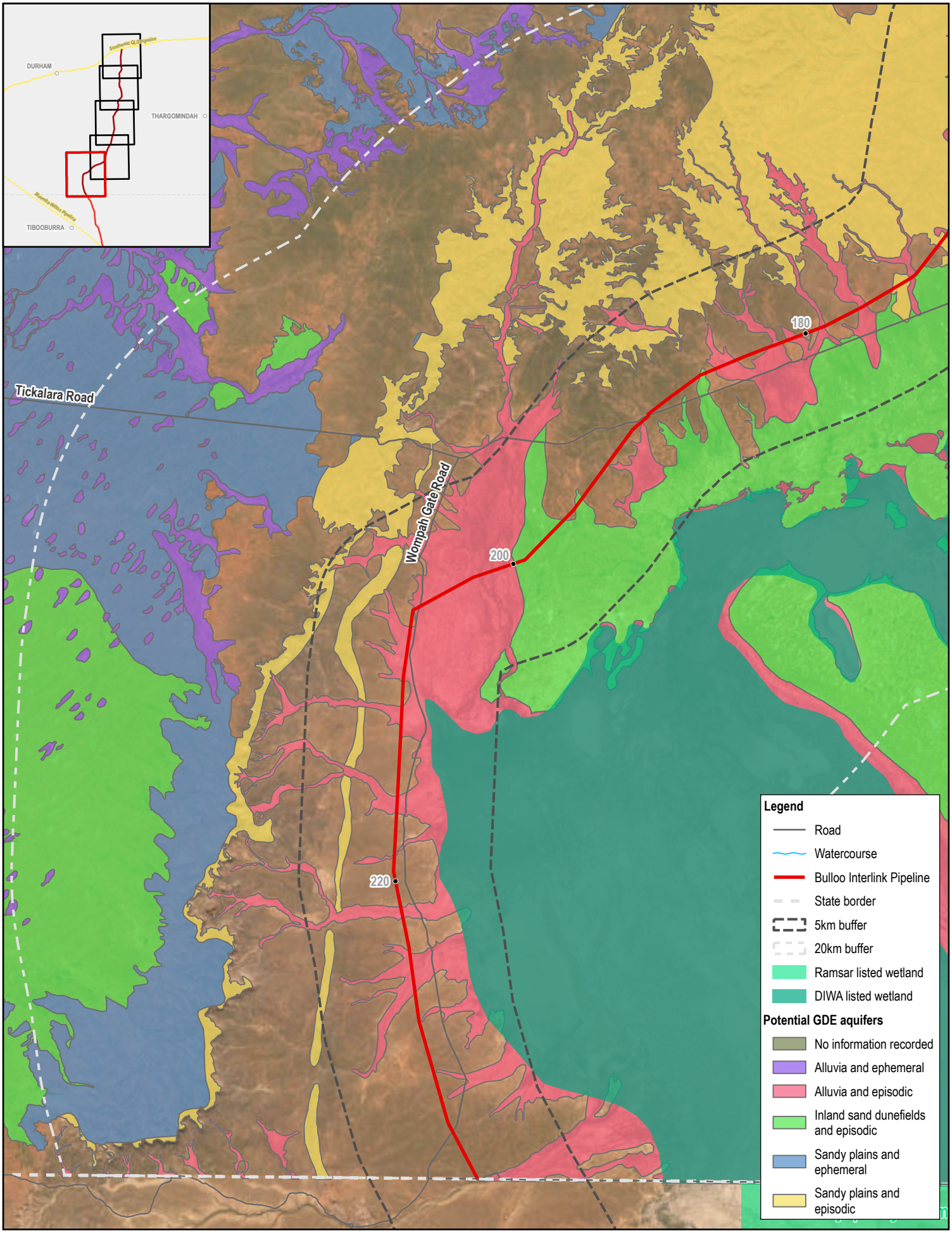
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Figure 4.19

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Bulloo Interlink Pipeline

Potential groundwater dependent ecosystem aquifers

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Figure 4.19

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4.7.9 Groundwater conceptual model summary

An illustration of the groundwater conceptual model of hydrogeological processes is provided in Figure 4.20.

Groundwater in the alluvium and unconsolidated sediments is anticipated to be largely ephemeral across much of the study area where presence of groundwater decreases with increasing distance from the watercourses. However, along the main watercourses such as Wilson River and Coopers Creek and in lower-lying areas groundwater may be present all or most of the time.

Shallow groundwater in alluvium/unconsolidated sediments, recharged by infiltration of rainfall and floodwaters at surface and downward leakage from ephemeral watercourses and waterholes (when containing water), is anticipated to be perched on the underlying Glendower Formation or on the Winton Formation where the Glendower Formation is not present.

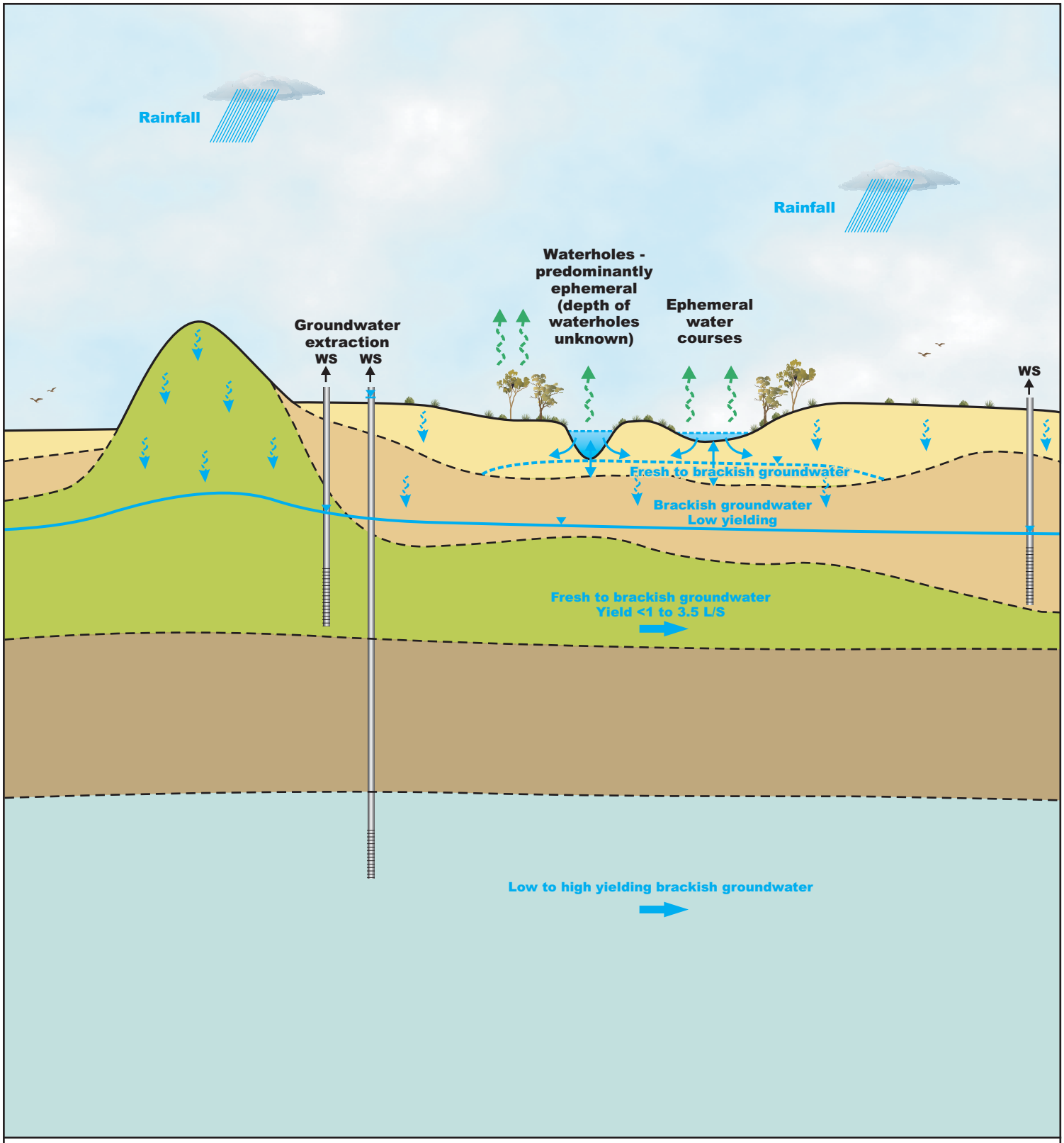
The main losses from shallow groundwater will be through evapotranspiration, with some downward leakage to the underlying strata (Glendower Formation and Winton Formation). Groundwater will preferentially move through interconnected pore spaces within higher permeability sediments (such as sand or gravel dominated layers) following the overall fall in topography of the catchments, with differing flow directions along the pipeline alignment, including towards Bulloo Lake. The lake, however, is filled by water from Bulloo River to the northeast and other ephemeral watercourses that drain into the topographic depression from the west.

Potential terrestrial GDE areas crossed by the pipeline alignment are anticipated to be supported by groundwater in the alluvium/unconsolidated sediments perched on the underlying Glendower Formation or Winton Formation. Groundwater in alluvium/unconsolidated sediments may help support the two permanent waterholes located along Wilson River up and downstream of the pipeline crossing (if the shallow groundwater level is above the base of the waterholes) however, the waterholes are filled/recharged by overflow of Wilson River during flood events.

The Glendower Formation is considered a poor sub-artesian aquifer that can provide localised sources of groundwater and the Winton Formation a sub-artesian, low-yielding aquifer. Both units are recharged by infiltration of rainfall at outcrop, downward leakage from ephemeral watercourses and from groundwater (where and when present) in overlying alluvial/unconsolidated sediments.

Groundwater losses will primarily be from groundwater extraction for water supply, anticipated to be primarily for stock watering and for stock and domestic use, with downward leakage (losses) minimised by the underlying Rolling Downs Group. Localised losses from the Winton Formation may also occur via springs if, and when, hydrogeological conditions enable this to happen, as inferred by the potential surface expression GDE lines about 4 km east of the pipeline alignment (section 4.7.8). Groundwater will move through a combination of interconnected pore spaces, joints and fractures, with an overall inferred flow direction towards the southwest.

The Rolling Downs Group regional-scale aquitard hydraulically separates sub-artesian groundwater in the overlying strata (i.e. alluvium/unconsolidated strata, Glendower Formation and Winton Formation) from the underlying Cadna-owie – Hooray GAB aquifer.



Geology

- Alluvium / unconsolidated sediments (ephemeral aquifer)
- Glendower Formation (localised aquifer)
- Winton Formation (aquifer)
- Rolling Downs Group (aquitard)
- Cadna-owie - Hooray (GAB) aquifer

Legend

- Infiltration
- Evapotranspiration
- Water table ephemeral aquifer(s)
- Water table / potentiometric surface
- Seasonal water table fluctuation
- Groundwater flow
- **WS** Water supply bore

Conceptual diagram only - not to scale

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Groundwater conceptual model illustration

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Figure 4-20

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5. Construction impacts

This section discusses the potential impacts to water (surface water, hydrology and flooding and groundwater resources) arising from the project. Refer to the Environmental Authority Supporting Information Report for details of the construction, operation, and decommissioning activities associated with the project that have been utilised for this impact assessment.

5.1 Surface water

Construction represents the project phase with the greatest potential to interact with surface water values, due to temporary disturbance of soils and vegetation, short-term modification of surface drainage patterns, and direct interaction with watercourses and floodplains. These interactions are inherently transient but may influence surface water quality, flow pathways and flood behaviour if not appropriately managed.

Pipeline construction will proceed as a linear, sequential activity within the CRoW. Works will predominantly involve open-cut trenching, with trenchless construction methods (such as horizontal directional drilling) adopted at higher-risk crossings, including the Wilson River within the Channel Country Strategic Environmental Area. Construction is expected to advance progressively along the alignment, allowing disturbance to be spatially limited and enabling progressive stabilisation and reinstatement of drainage features as works move forward.

Accordingly, this impact assessment focuses on identifying construction-related surface water, hydrological and flooding impact pathways, and evaluating the effectiveness of mitigation measures to maintain pre-construction drainage conditions, protect surface water values, and minimise the likelihood and consequence of temporary construction-phase impacts.

Construction activities with the potential to affect surface water, hydrology and flooding behaviour are summarised in Table 5.1. This impact assessment therefore focuses on identifying hydrological impact pathways and evaluating mitigation measures to maintain pre-construction drainage conditions and protect surface water values during construction.

Table 5.1 Surface water potential impacts – construction activities

Activity	Impact factors	Impact description
Clearing and grading	Vegetation clearing and habitat degradation, soil disturbance	Increased run-off velocity, and erosion and sedimentation due to vegetation clearing, topsoil stripping, and surface grading.
Stockpiling	Soil disturbance, contamination and pollution	Localised degradation of surface water quality (including hydrocarbon contamination and increased turbidity), accidental spills of contaminants (e.g. fuels, oils).
Trenching/trenched crossings	Hydrological change	Temporary alteration of existing surface drainage patterns and disruption of natural water flow paths due to open-cut trenching and excavation for pipeline installation, including minor watercourse crossings.
Trenchless crossings	Soil disturbance, contamination and pollution, noise, vibration, and hydrological change	Temporary impacts to surface waters near the drilling area due to the use of drilling fluids to remove cuttings and stabilise the borehole.
General construction activities	Habitat degradation, soil disturbance, and contamination and pollution	Accidental release of contaminants may potentially degrade water quality, habitats and flora and fauna.
Hydrostatic testing	Contamination and pollution, noise, vibration, and hydrological change	Localised degradation of surface water quality due to short-term discharges of test water.
Irrigation of treated wastewater to land	Contamination	Localised degradation of surface water quality such as increased nutrient concentrations may occur, due to runoff of treated wastewater directly or indirectly to nearby watercourses.

5.1.1 Watercourses

The pipeline alignment intersects a number of drainage features ranging from small headwater channels to larger systems (including multiple watercourses and additional un-named drainage lines) as well as large, braided channel systems where the main channel is undefined.

The project would involve construction works within and around watercourses, including riparian margins. Construction activities with the potential to directly impact watercourses include:

– clearing and grubbing
– stockpiling
– excavation (trenching) of bed and bank materials
– movement of construction vehicles, including temporary access track crossings.

If inadequately managed, such construction works have the potential to alter the flow regime, impact riparian vegetation and contribute to erosion, sedimentation and water quality impacts, and reduce the stability of watercourse bed and banks. The majority of watercourses and drainage lines are proposed to be crossed by the pipeline alignment via open trenching methods.

For watercourse and drainage line crossings by the CRoW, the banks of watercourses would be cleared and graded to enable a suitable slope and access for construction equipment and vehicles. Watercourse bed and bank material and trench spoil would be excavated and stockpiled separately outside the watercourse. Bed and bank materials would be reinstated following trench backfilling, along with any pipeline scour protection proposed. Any temporary access track crossings would follow a similar methodology.

Whilst baseflows are uncommon (i.e. watercourses are ephemeral), construction activities may coincide with, or be affected by, episodic runoff and overland flow, and therefore require robust controls for erosion, sediment and flood resilience. Construction impacts to hydrology are expected to be temporary and localised, provided that mitigation measures are implemented.

Works within and around watercourses, including riparian margins, would be undertaken with reference to regulatory requirements and guidelines (refer to Table 3.1) including the *Riverine Protection Exemption Requirements* (Department of Regional Development, Manufacturing and Water, 2023) where the requirements apply to various parties, including the holder of an EA for a resource activity and its contractors.

5.1.2 Surface water quality

From a water quality perspective, construction activities have the potential to temporarily introduce risks that may negatively impact downstream water quality of watercourse/drainage lines and wetlands. The ecological implications of these changes are assessed in Appendix C (Aquatic Ecology Assessment Report) of the Environmental Authority Supporting Information Report.

As described in section 4.4.4, surface water quality is characteristic of arid inland systems such as the Bulloo River catchment where naturally high sediment loads, episodic flooding and organic material contribute to elevated turbidity and nutrient concentrations when compared against the identified guideline values.

Additional sediment and subsequent increased turbidity may be generated during construction through:

– vegetation clearing and soil disturbance within the CRoW, access tracks and ancillary areas
– localised channel disturbance (e.g. bank slumping, bed disturbance, loss of riparian roughness)
– splash, sheet, rill and gully erosion from stockpiles and exposed surfaces.

This risk is heightened in locations where natural bare surfaces dominate land cover and where soil types (including vertosols and sodosols in proximity to the pipeline alignment) may produce high runoff or dispersive sediment when disturbed. Sediment mobilisation can occur in stages, with localised storms transporting sediment to nearby channels, and subsequent regional storms higher in the catchment transporting this sediment, even in the absence of local rainfall.

Impacts of erosion include increased turbidity (in addition to the relatively high background levels) and sediment transport during rainfall/runoff events to sensitive receptors (i.e. downstream watercourses and wetlands). Implementation of mitigation measures, including a Construction Environmental Management Plan (CEMP) and Erosion and Sediment Control Plan (ESCP) as outlined in section 9, along with progressive rehabilitation would minimise impacts associated with erosion.

During construction, a range of fuels, oils, lubricants, chemicals and drilling fluids are required to support earthworks, trenching, watercourse crossings and HDD. Potential sources of spills or leaks include:

– refuelling and maintenance of construction plant and vehicles
– storage and handling of fuels, oils and lubricants at temporary construction compounds
– hydraulic systems and hoses on mobile plant
– drilling fluid mixing, stored circulation returns, and inadvertent returns “frac-outs” (release of drilling fluids to surface through the overburden) or accidental release of drilling fluid from equipment failure, associated with HDD works.

These materials are typically handled in small to moderate quantities and are mobile by nature. While most activities occur away from permanent waterbodies, construction frequently takes place within or adjacent to drainage lines, floodplains and ephemeral channels, increasing the potential for interaction with surface water systems during rainfall events.

Spills and leaks may enter the receiving environment through several pathways, which are strongly influenced by the episodic hydrology of the study area. Spills can occur directly into waterways or occur during a runoff event, or can be indirect, occurring away from waterways during dry periods, and mobilised to surface water or groundwater at a later date.

Receptors for spills to ground (and transported through runoff to surface water) or direct to surface water include ephemeral creeks, GES/HES wetlands, and downstream waterholes. Spills can also infiltrate to the groundwater table, where present, in the alluvium (refer to section 5.3.5).

Without controls, spills and leaks have the potential to cause:

– localised degradation of surface water quality, particularly through hydrocarbon contamination or increased turbidity
– short-term toxicity impacts to aquatic organisms during flow events
– temporary contamination of shallow groundwater in the immediate vicinity of the spill.

However, the scale and persistence of these impacts to surface water would typically be limited by:

– the relatively small volumes involved
– the intermittent nature of flow in the receiving environment
– natural attenuation processes such as dilution, volatilisation and biodegradation.

Accordingly, spill-related impacts during construction are generally localised and short-term, but their likelihood and consequence increase where activities occur close to drainage lines or where spills coincide with rainfall events that provide an effective transport pathway.

5.1.3 Irrigation of treated wastewater

Irrigation of treated wastewater to land has the potential to enter nearby watercourses via runoff and cause localised degradation of surface water quality, particularly through increased nutrient loading such as nitrogen and phosphorus or change in electrical conductivity (salinity).

Assessment for the design of the wastewater irrigation system would follow the *Disposal of effluent using irrigation Technical guideline* (DES, 2020a). Wastewater to be irrigated will be treated to Class B effluent standards for disposal by effluent irrigation and non-potable reuse and operated in accordance with approval conditions.

Given the above, irrigation of treated wastewater is not expected to cause any significant change in surface water quality. Impacts to surface water are expected to be negligible.

5.1.4 Hydrotesting of the pipeline

Hydrotesting of the pipeline would be undertaken on sequential sections of the pipeline in accordance with the AS 2885 series of standards.

Biocides and corrosion inhibiting chemicals, in the form of oxygen scavengers, may be added to the hydrotest water depending upon the quality of the available water and the length of time the water is required to be held in the pipeline.

There is potential for impacts to surface waters from hydrotest water (with or without additives) as a result of:

– uncontrolled discharge or overtopping impacting downstream environments
– seepage from storage (for groundwater impacts refer to 5.3)
– erosion due to discharging of hydrotest water to the surrounding environment (if undertaken).

Hydrotest water would be subject to testing and beneficially reused following treatment (if required). If required to be discharged, discharge of hydrotest water would be to land where it meets acceptable standards and is released in a way that does not result in visible scouring or erosion or pooling or run-off or vegetation die-off..

5.1.5 Hydrology and flooding

Hydrological and hydraulic modelling undertaken for the study area indicates that flooding during a 1% AEP event is characterised by broad inundation extents and shallow, wide flow paths across low-relief floodplains, with velocities generally in the order of ~0.4–1.6 m/s across modelled locations and with flow widths that can be extensive. This style of flooding means that small changes in local topography, such as windrows, spoil placement, stockpiles, track construction or temporary bunding, can redirect sheetflow, create localised ponding or concentrate flow into erosive pathways.

Modelling indicates that pathway for these changes is the floodplain and waterways. The receptors of these impacts are downstream floodplains and wetlands.

5.1.6 Channel Country SEA

Hydrological processes within the Channel Country SEA are characterised by ephemeral and event-driven flow regimes, broad and shallow inundation during flood events, and strong connectivity between river channels, floodplains, wetlands and downstream waterholes. The Wilson River crossing will be constructed using HDD, with the pipeline installed beneath the river channel and floodplain at depth.

The HDD construction method avoids direct disturbance to the riverbed, banks and riparian corridor and does not involve in-channel works, open-cut excavation or alteration of surface drainage within the Channel Country SEA. Accordingly, the potential for impacts to hydrological processes and water quality is considered low, with any residual risks being localised, temporary and reversible.

Potential localised and temporary impacts to water quality and hydrological processes within the Channel Country SEA include:

– erosion and sedimentation impacts which would be minimised through avoidance of in-channel works and floodplain excavation due to HDD methods. Erosion and sediment control measures will be implemented at HDD management locations and other disturbed lands to minimise risk of indirect erosion and sedimentation impacts to the SEA.
– potential water quality risks, primarily associated with HDD drilling fluid management and accidental spills of fuels or lubricants from support equipment. These risks will be mitigated through closed-loop drilling fluid systems, continuous monitoring of drilling pressures and returns, implementation of spill prevention and response procedures, and appropriate storage and handling of fuels and chemicals in accordance with the project environmental management framework. No routine discharges to surface waters within the Channel Country SEA are proposed.
– alteration of surface water flows paths which would be minimised due to HDD methods at Wilson River (i.e. maintaining the existing drainage flow paths). Floodplain surfaces and drainage pathways would remain unchanged, maintaining natural geomorphic stability during and after construction.

– temporary surface disturbance which is required within a portion of the SEA (trenched pipeline, one HDD entry/exit pit and temporary access). However, surface disturbance is away from the drainage flow paths and landforms would be reestablished.

5.2 Wetlands and hydrological connectivity

Construction activities have the potential to temporarily alter surface water pathways, sediment delivery and local inundation patterns associated with mapped wetlands. The ecological significance of these changes, including implications for wetland function and values, is assessed in Appendix C (Aquatic Ecology Assessment Report) of the Environmental Authority Supporting Information Report. No permanent modification of wetland hydrology or floodplain connectivity is anticipated, provided proposed mitigation measures are implemented.

5.3 Groundwater

Impacts to groundwater during construction are expected to be local to the project, and the project is not expected to impact on the availability or quality of groundwater resources downstream or to significantly impact on groundwater resources in the surrounding area.

Groundwater has the highest potential to be impacted by the pipeline construction where the water table is within a few metres of ground surface (i.e. at and either side of watercourse crossings or other low-lying areas along the pipeline route, as illustrated on Figure 4.17). Some existing extractors (users) of groundwater also have the potential to be temporarily impacted by extraction of groundwater for construction (refer to section 5.3.7).

5.3.1 Vegetation clearing

Clearing of vegetation within the project footprint is unlikely to significantly impact on groundwater levels, flow directions or quality. Overall change to the rate of recharge of groundwater from clearing is expected to be minimal because whilst there may be a net gain from the reduction in plant uptake, the increased runoff results in less opportunity for infiltration due to the absence of vegetation. Changes to the salinity of groundwater are therefore also not expected to occur. Around watercourses where depth to groundwater may be shallow, proposed vegetation clearing (local to watercourses) is unlikely to result in groundwater level rise or change to salinity of groundwater given that clearing will be temporary and localised, with surrounding vegetation remaining undisturbed. Interaction between surface water and groundwater is therefore also unlikely to be impacted. Changes to groundwater level and flow directions from vegetation clearing, if they do occur, are expected to be minimal and highly localised.

Impacts of vegetation clearing on habitat, including potential GDE habitat, are assessed in Appendix B (Terrestrial Ecology Assessment Report).

5.3.2 Open trenching

Open trenching may intersect shallow groundwater and if dewatering is required during construction may temporarily lower the local groundwater table and alter shallow groundwater flow pathways. From a hydrogeological perspective, groundwater levels are anticipated to recover following completion of construction activities. Potential ecological responses to groundwater change are assessed separately (refer to Appendix B (Terrestrial Ecology Assessment Report) and Appendix C (Aquatic Ecology Assessment Report) of the Environmental Authority Supporting Information Report.

Trenching depth at watercourse crossings will vary depending on watercourse features (such as bed profile) and design requirements. For major watercourses a minimum cover of 2,000 mm is anticipated from the hard invert to the top of the installed pipe, assuming a 700 mm diameter pipe and 150 mm bedding. This equates to an open trench depth of about 2,850 mm to the bottom of the trench. Where necessary, alluvial material will be removed to reach a stable trench foundation. For minor watercourses a typical cover of 1,200 mm is anticipated.

These trenching depths have the potential to intersect shallow groundwater, particularly in low-lying alluvial areas. Areas at highest risk of this potential impact are within and either side of watercourse crossings where groundwater, if present, is anticipated to be close to ground surface in alluvium/unconsolidated sediments, as well as potentially in the Glendower Formation and Winton Formation in low-lying areas. A reduction in groundwater level and change to the groundwater flow regime is anticipated to be of short duration, and potential impacts are anticipated to be limited to the immediate area of the work site and to be temporary. Once works are complete, it is expected that the shallow groundwater level will recover to pre-work conditions and the groundwater flow direction will re-establish.

Trenches will be backfilled with spoil, which provides potential for the trenched spoil backfill to act as a preferential groundwater flow pathway for infiltration and for lateral movement of groundwater along the backfilled trench where the pipeline is below the water table.

Surface water flow is not expected to be impacted by dewatering because groundwater does not appear to contribute to surface water flow. Furthermore, waterholes (most of which are temporal/seasonal) are unlikely to be impacted given they are filled by surface water flows and lose water through evaporation and some leakage to groundwater. Changes to shallow groundwater levels, where they occur, are expected to be localised and temporary. The potential ecological implications of changes to groundwater availability for mapped terrestrial GDEs are assessed in the Appendix B (Terrestrial Ecology Assessment Report) of the Environmental Authority Supporting Information Report. From a hydrogeological perspective, groundwater levels are anticipated to recover following cessation of construction activities.

Pipeline installation within creeks will be completed as quickly as reasonably practicable and undertaken as a ‘special crossing’ by a suitably educated crew. This will assist in minimising the time that open trenching and any associated dewatering is required. The CRoW will be stabilised immediately following installation. While access tracks may remain in place until all pipeline construction activities are completed, they will be removed and reinstated within five days of no longer being required. Appendix C (Aquatic Ecology Assessment Report) of the Environmental Authority Supporting Information Report identifies that access track crossings of waterways designated as waterway barrier works waterways will be undertaken in accordance with the relevant requirements of the *Fisheries Act 1994*.

No impact to nearby groundwater bores is anticipated given the localised nature and short duration of potential impacts and low hydraulic connectivity between alluvium/unconsolidated sediments and bedrock.

5.3.3 Trenchless construction using HDD

HDD uses a rotating drill string, drill bit to cut through the material, and drilling fluids to cool the drill bit and to remove cuttings from the borehole, similar to the methodologies and fluids used for drilling a borehole for groundwater extraction. Trenchless construction using HDD above or below the water table has the potential to locally change the quality of shallow groundwater through the introduction of drilling fluids (primarily comprising non-potable water mixed with bentonite and other additives) used to transport the soil/cuttings from the borehole and to stabilise the hole for pipeline placement in the area close to the drilling works. Residual drilling fluids are expected to remain in the hole.

The salinity of groundwater may be locally altered and potentially increased at and down gradient of the crossing site, however changes to local groundwater quality from the use of drilling fluids are expected to be of short-duration and temporary. Changes to shallow groundwater levels, where they occur, are expected to be localised and temporary. No impact to nearby groundwater bores is anticipated given the localised nature and short duration of changes to shallow groundwater quality, and the low hydraulic connectivity between alluvium/unconsolidated sediments and bedrock.

5.3.4 Hydrotesting of the pipeline

There is potential for hydrotest water to leak to shallow groundwater during hydrotesting of the pipeline if the pipeline is not watertight. If leakage were to occur there is potential for localised short-term increase in shallow groundwater level and localised short-term change to groundwater quality. However, the groundwater regime is expected to return to pre-test conditions after the water source (test water) has been removed from the pipeline. At the time of this assessment, the quality of proposed source(s) of hydrotest water had not been determined.

5.3.5 Accidental release of contaminants

Accidental release of contaminants such as from leaks and spills from machinery, stored construction materials, chemicals and fuel during day-to-day site operations, and from inadvertent drilling fluid “frac-outs” associated with HDD works, has the potential to degrade the quality of local groundwater resources. Areas most at risk of contamination are where groundwater is close to ground surface most likely at watercourse crossings and in low-lying areas, where higher permeability strata are present at ground surface (i.e. alluvium/unconsolidated sediments) or where fractures in bedrock intersect ground surface. Contaminants introduced at the ground surface in areas like this may reach the water table relatively quickly and have the potential to migrate in the direction of groundwater flow.

Accidental release has the potential to be cumulative, for example many small spills over time, or leaks that go un-noticed and migrate through the subsurface has the potential to behave unpredictably.

5.3.6 Irrigation of treated wastewater

Irrigation of treated wastewater to land has the potential for deep drainage (i.e. water not taken up by vegetation) to occur with subsequent impact on shallow groundwater level and groundwater quality, including:

– localised changes to groundwater quality, including potential for increased nutrient concentrations and alteration of electrical conductivity (salinity) where shallow groundwater is present, or temporarily present.
– localised increase in the elevation of the shallow groundwater table (where groundwater is present), or development of perched groundwater beneath the irrigation area, from increased recharge due to irrigation.

Assessment for the design of the wastewater irrigation system would follow the *Disposal of effluent using irrigation Technical guideline* (DES, 2020a). Wastewater to be irrigated will be treated to Class B effluent standards for disposal by effluent irrigation and non-potable reuse and operated in accordance with an EA.

Given the above, and the scale of the temporary accommodation facilities and depth to groundwater away from watercourses and low-lying areas (section 4.7.4), irrigation of treated wastewater is not expected to cause any significant change in groundwater quality or groundwater levels. Impacts to groundwater based on irrigation of wastewater are expected to be negligible and not alter the EVs of groundwater (section 4.7.2). Therefore, the potential impact of the wastewater irrigation system is expected to be a minimal impact activity.

5.3.7 Groundwater extraction

Existing bores that may be used for construction water supply, subject to completion of bore assessments to confirm suitability and obtaining the necessary approvals, are shown on Figure 4.18. New extraction bores may also be drilled to supply construction water (section 3.5 and would also require completion of appropriate assessments, testing, and approvals.

Analytical solution drawdown estimation

To assess the potential impact of extraction from the Winton Formation and from the Cadna-owie – Hooray aquifer on groundwater level, the Thies (1935) analytical solution has been used to estimate drawdown (i.e. difference between the standing water level/piezometric head before pumping and groundwater level/piezometric head at the end of pumping) of the groundwater level in the aquifer. Drawdown has been calculated at nominal distance intervals from a theoretical pumped bore to illustrate the change in drawdown with increasing distance from the pumped bore. Actual locations, rates, source aquifer(s), or timeframes for extraction will be determined prior to the start of construction including testing, assessments and obtaining regulatory approvals by APA.

The Theis (1935) equation provides an estimate of non-equilibrium drawdown as a function of time and distance from the point of abstraction within a confined aquifer.

The estimate of drawdown has been carried out for a timespan of one year representing an approximation of the construction timeframe, and drawdowns have been estimated at one year after the start of pumping and assuming continuous pumping (i.e. a conservative approach).

Values used to estimate drawdown have been approximated from registered bore records within the study area and information from literature. Aquifer-specific groundwater extraction rates that have been applied are assumed values and reflect an anticipated low-yield from the Winton Formation and a reasonable yield from the Cadna-owie – Hooray aquifer. Two scenarios were run for each aquifer to generate a range of estimated drawdown:

– Cadna-owie - Hooray Scenario 1: Storativity value of 0.0001 m/m, all other inputs unchanged
– Cadna-owie - Hooray Scenario 2: Storativity value of 0.00001 m/m, all other inputs unchanged
– Winton Formation Scenario 1: Extraction rate of 0.25 L/s, all other inputs unchanged
– Winton Formation Scenario 2: Extraction rate of 0.5 L/s, all other inputs unchanged.

The aquifer property values used for the analysis, assumed bore extraction rates and justification for the selected values are summarised in Table 5.2 for extraction from the Cadna-owie – Hooray aquifer and in Table 5.3 for extraction from the Winton Formation.

Table 5.2 Assumptions for estimation of drawdown – extraction from the Cadna-owie – Hooray aquifer

	Units	Cadna-owie – Hooray Aquifer	Justification (data source)
Aquifer transmissivity, T	m^2/d	50	Recorded transmissivity for RN23372 of 34 to 58 m^2/d and RN23481 of 48 m^2/d
Hydraulic conductivity, K	m/d	0.5	Calculated value (K = T / b)
Aquifer thickness, b	m	100	Recorded test zones for RN23372 of 1,161 to 1,310 m and RN23481 of 379 to 424 m
Storage coefficient, S (Scenario 1)	m/m	0.0001	From literature: Mid-range value for a confined aquifer range of 1 x 10^{-5} to 1 x 10^{-3}, from Driscoll (2003)
Storage coefficient, S (Scenario 2)	m/m	0.00001	From literature: Lower end of range from field studies summarised in Table 5.5
Pumping duration	Days	365	Assumed duration (pumping 24 hours per day)
Pumping extraction rate	L/s	5	Assumed value, based on preliminary field assessments (excluding pumping tests) of existing landholder bores, by APA (Equivalent to around 158 ML/y)

Table 5.3 Assumptions for estimation of drawdown – extraction from the Winton Formation

	Units	Winton Formation	Justification (data source)
Aquifer transmissivity, T	m^2/d	0.5	Calculated value (T = K x b)
Hydraulic conductivity, K	m/d	0.01	Based on literature ranges: Mid-range value between sandstone (well cemented, unjointed) of 1 x 10^{-3} to 1 x 10^{-5} m/d and sandstone (friable) of 1 x 10^{-3} to 1 m/d (summarised in Driscoll, 2003) (value may be lower in reality, however, the value was used so that estimated drawdown did not exceed aquifer thickness close to pumped bore for Scenario 1)
Aquifer thickness, b	m	50	Approximated from review of strata logs of registered bores records within 20 km of the project
Storage coefficient, S (Scenario 1)	m/m	0.1	Based on literature range: Unconfined aquifer range of 0.1 to 0.3, from Lohman (1972) (value adopted so that estimated drawdown did not exceed aquifer thickness close to pumped bore)
Pumping duration	Days	365	Assumed duration (pumping 24 hours per day)
Pumping extraction rate (Scenario 1)	L/s	0.25	Registered bore records indicate <1 L/s to 3.5 L/s

	Units	Winton Formation	Justification (data source)
Pumping extraction rate (Scenario 2)	L/s	0.5	Registered bore records indicate <1 L/s to 3.5 L/s

Table 5.4 Summary of aquifer transmissivity records and test zone for registered bores within 20 km of the project (DLGWV, 2026)

RN	Test zone top (m)	Test zone bottom (m)	Transmissivity (m^2/d)			Number of records	Aquifer
			Minimum	Maximum	Average		
5092	1490.5	1533.1	0	0	-	0	Hooray Sandstone
23059	975	1050	0	6	1.3	6	Hooray Sandstone
23372	1161	1310	34	58	45	4	Hooray Sandstone
23466	1051.5	1142.94	1	1	1	1	Not recorded[1]
23481	379.76	424.26	48	48	48	1	Hooray Sandstone
23484	1099	1102	2	2	2	1	Not recorded[1]
23569	1090	1172	1	2	1.7	3	Hooray Sandstone
23579	1148.5	1219	1	1	1	2	Not recorded[1]
50673	620	1069.5	4	4	4	4	Hooray Sandstone

Note: 1. Test zone indicates Hooray Sandstone

Table 5.5 Estimated hydraulic properties of the Cadna-owie – Hooray aquifer (Commonwealth of Australia, 2014)

	Units	Minimum	Maximum
Hydraulic conductivity (horizontal), K_h	m/d	0.1	10
Transmissivity, T	m^2/d	1	2000
Storativity, S	m/m	1×10^{-5}	1×10^{-4}

Drawdown estimation results and potential impacts

Charts of estimated drawdown at the end of one year of continuous theoretical extraction at one bore from the Winton Formation and one from the Cadna-owie – Hooray aquifer are provided in Appendix D and the results are summarised in Table 5.6 and Table 5.7.

Drawdown in the order of 0.6 to 2.0 m at 15 km from a pumped bore in the Cadna-owie – Hooray aquifer is conservatively estimated for continuous extraction at 5 L/s after 365 days of continuous pumping, however in reality it is unlikely that a bore would be pumped continuously and therefore the associated drawdown relative to the water level/piezometric surface before pumping is likely to be less. Given there are existing registered bores within the vicinity of the project (Figure 4.18) there is potential for groundwater extraction from the Cadna-owie – Hooray aquifer for the project, to cause a short-term, localised reduction in groundwater level at existing registered bores extracting from the same aquifer at the same time. However, groundwater extraction for construction water supply is expected to occur only during pre-construction and construction with extraction at different times and from different locations as construction progresses, after which pumping will cease and the groundwater level will recover.

Estimated distance-drawdown results for extraction from the Winton Formation indicate impact on the groundwater level/piezometric surface in the Winton Formation is expected to be localised and extend less than 500 m from a pumped bore. However, the low extraction rate of 0.25 L/s that needed to be used to simulate drawdown without dewatering the aquifer indicates that the Winton Formation is unlikely to be a suitable source for construction water.

Extraction of groundwater for construction from the Cadna-owie – Hooray aquifer and Winton Formation is not anticipated to impact on terrestrial GDE areas (refer to section 4.7.8). This is because the Cadna-owie – Hooray aquifer is hydraulically separated from the overlying geological units and GDEs by the Rolling Downs Group aquitard, and there is considered low potential for hydraulic connectivity between the groundwater in alluvium and the underlying Winton Formation and Glendower Formation.

Table 5.6 Estimated drawdown after 365 days using Theis (1935) – theoretical extraction from Cadna-owie – Hooray aquifer

Radial distance from pumped well (m)	Estimated drawdown (m), for pumping rate of 5 L/s	
	Scenario 1 (S = 0.0001 m/m)	Scenario 2 (S = 0.00001 m/m)
1,000	4.1	5.7
2,000	3.2	4.8
3,000	2.6	4.2
4,000	2.2	3.8
5,000	1.9	3.5
6,000	1.7	3.3
7,000	1.5	3.0
8,000	1.3	2.9
9,000	1.2	2.7
10,000	1.1	2.6
15,000	0.6	2.0
20,000	0.3	1.6
25,000	0.2	1.4
30,000	0.1	1.1
40,000	0.0	0.8
50,000	0	0.6

Table 5.7 Estimated drawdown after 365 days using Theis (1935) – theoretical extraction from the Winton Formation

Radial distance from pumped well (m)	Estimated drawdown (m)	
	Scenario 1 (Pumping rate of 0.25 L/s)	Scenario 2 (Pumping rate of 0.5 L/s)
1	28.6	57.2
5	17.5	35.1
10	12.8	25.6
25	6.8	13.5
50	2.8	5.6
100	0.4	0.8
200	0.0	0.0
300	0.0	0.0
400	0.0	0.0
500	0.0	0.0

6. Operation impacts

Operational activities are generally limited to:

– routine monitoring of the pipeline
– inspections and periodic maintenance of above-ground infrastructure
– internal cleaning of the pipeline
– environmental inspections and monitoring (e.g. vegetation encroachment, erosion detection, rehabilitation monitoring, easement maintenance, etc.).

Limited excavation and rehabilitation activities around the pipeline may also be required. These activities typically involve light-vehicle and small machinery access along established tracks or permanent easement, with only minor and infrequent disturbance to the area immediately around the pipeline and surrounding land and no routine in-channel works.

Maintenance activities will occur intermittently throughout the life of the pipeline and may include vegetation management, erosion repairs, reinstatement of access tracks and maintenance of above-ground facilities. These works are generally small-scale and localised but may require temporary access by maintenance crews and machinery. If repairs to the buried pipeline are required, short-term excavation may be necessary, which may include excavation below the water table. However, such events are infrequent and typically confined to small areas.

The pipeline is buried for most of its length and operational impacts on water (including surface water, hydrology and groundwater) are expected to be minimal with risks primarily associated with legacy effects of construction, maintenance activities, and low-probability failure events. The operational phase presents a low risk to surface water, hydrology and groundwater provided that access is restricted to designated routes and that standard environmental controls are maintained. The likelihood of such impacts would be temporary and highly localised.

Operational activities considered to have the potential to impact on water (including surface water, hydrology and flooding, and groundwater resources) are:

– short-term excavation works and stockpiling of excavated materials for pipeline repairs and maintenance
– operation of the pipeline with potential for leakage of gas to the sub-surface in the event of pipeline integrity failure.

6.1 Surface water quality

During the operational phase, the gas pipeline is not expected to result in any adverse impacts on surface water quality. The pipeline would be predominantly buried, with ground surfaces reinstated to pre-construction levels to maintain existing drainage patterns and minimise long-term interaction with surface waters.

Watercourse and drainage line crossings constructed using HDD would avoid direct disturbance to channel beds and banks, thereby preserving natural flow conditions and sediment transport processes. As the pipeline conveys natural gas, there are no routine operational releases, effluent streams, or emissions to land or water.

Potential water quality impacts would be limited to highly unlikely loss-of-containment scenarios, such as a pipeline leak, which could indirectly affect surface waters through secondary mechanisms (e.g. disturbance of surrounding soils during emergency response activities). These risks are mitigated through compliance with relevant Australian Standards, APA's pipeline design and integrity management systems, routine inspection and monitoring, and established emergency response procedures, ensuring protection of downstream EVs in accordance with Queensland regulatory requirements.

As with all long-distance natural gas transmission pipelines, small volumes of water and condensate may accumulate at low points in the pipeline profile due to gas dehydration inefficiencies and condensation. Where required, low point drains would be incorporated at hydraulic low points along the pipeline long section, consistent with the requirements of AS 2885. Any liquids recovered would comprise predominantly condensed water, potentially mixed with trace quantities of hydrocarbon condensate and minor contaminants. Recovered fluids would be collected, contained and managed via licensed treatment, disposal or re-injection systems, with no uncontrolled discharge to land or surface waters.

6.2 Hydrology and flooding

Operational impacts of the pipeline on hydrology and flooding are anticipated to be minimal, primarily due to the buried nature of the infrastructure and the restriction of access to designated routes. However, where the CRoW or access tracks are not fully rehabilitated, there remains a risk of modified runoff patterns which could induce localised changes in surface hydrology. Incomplete rehabilitation or ongoing disturbance of access tracks may facilitate erosional processes, resulting in preferential flow paths that could alter natural drainage behaviour.

Minor, highly localised flood effects may occur at above-ground infrastructure, such as valves and stations, particularly during extreme rainfall events. Drainage lines, floodplains, and wetlands are the main areas likely to be affected by these operational impacts. Changes in hydrologic patterns may lead to shifts in flow speed, higher levels of sediment movement, or brief periods of flooding in these environments.

Nevertheless, operational activities are generally limited in scale and frequency. The resultant hydrologic and flooding impacts are expected to be temporary and confined to the immediate vicinity of the pipeline and associated infrastructure.

6.3 Groundwater

There is low potential for the project to impact on groundwater resources, groundwater users or terrestrial GDEs during operation. Impacts are expected to be local to the project, and the project is not expected to impact on the availability or quality of groundwater resources downstream or on groundwater resources in the surrounding area.

This section identifies hydrological and hydrogeological pathways that may influence wetlands and GDEs. The mitigation measures identified in this report are intended to maintain pre-construction hydrological processes that support water-dependent environmental values.

6.3.1 Accidental release of contaminants

Should failure of the pipeline integrity and associated gas migration into shallow groundwater occur, there is potential to impact on shallow groundwater quality, and riparian vegetation and terrestrial GDEs dependent on shallow groundwater. Once leaks have been repaired, changes to groundwater quality are anticipated to be localised and temporary and not anticipated to impact groundwater resources away from the pipeline.

The pipeline would be designed to operate with a minimum of operator intervention using a supervisory control and data acquisition (SCADA) system for system sequencing, alarm monitoring and control, enabling prompt identification of abnormal operating conditions. Control room staff would remotely monitor and control gas flows into and out of the pipeline via SCADA and coordinate field staff activities as required, while field staff would be responsible for day-to-day maintenance and patrolling of the pipeline.

6.3.2 Pipeline presence

Areas of locally depressed groundwater levels and altered groundwater quality formed around the pipeline during construction are expected to return to pre-construction conditions. The buried pipeline is 0.711 m in diameter and will have a minimum cover of 1.5 m at watercourse crossings. Therefore, it is not expected to act as a barrier to shallow groundwater flow as shallow groundwater, where present, would be able to move around (above and/or below) the pipeline. However, immediately around the pipeline there is potential for the trenched spoil backfill to act as a preferential groundwater flow pathway for infiltration and for lateral movement of groundwater along the backfilled trench where the pipeline is below the water table. There is also potential for ground disturbed by HDD to act as a preferential pathway for lateral movement of groundwater. These conditions are most likely to occur at watercourse crossings where depth to groundwater is likely to be shallow.

Except for localised preferential flow pathways associated with pipeline construction, the following are not anticipated to be impacted by the pipeline presence:

– groundwater flow regime
– groundwater levels
– surface water–groundwater interaction
– vegetation dependent on the presence of shallow groundwater
– extraction from groundwater bores.

6.3.3 Short-term excavation for pipeline repairs

Excavation for pipeline repairs or maintenance may intersect shallow groundwater, and if dewatering is required, may temporarily lower the local groundwater table and alter shallow groundwater flow pathways. High risk areas and potential impacts are considered similar to those detailed for open trenching during construction (refer to section 5.3.2). Lowering of groundwater levels or changes to the flow regime during excavation, if groundwater is intersected, are expected to be short-term, temporary, and restricted to the immediate vicinity of the works. Nearby riparian vegetation, GDEs, waterholes and groundwater extraction bores are not expected to be impacted.

7. Cumulative impacts

Cumulative impacts can be defined as the successive, incremental and combined effect of multiple impacts, which may in themselves be minor, but could become significant when considered together. The methodology and projects considered for the cumulative impact assessment are provided in section 7 of the Environmental Authority Supporting Information Report.

No relevant major future projects in the vicinity of the project site have been identified from the Queensland Department of Housing and Public Works website that would be developed concurrently with the project. Accordingly, cumulative impacts to surface and groundwater are not anticipated.

If any projects were to occur concurrently with the project, cumulative impacts are not anticipated to be significant. Based on a review of publicly available information, no other past, current or reasonably foreseeable projects have been identified within the same catchments and timeframes that will give rise to meaningful cumulative interactions with the project. In the absence of credible evidence of spatial and temporal overlap with other developments, quantitative cumulative assessment is not practicable or warranted at this stage.

8. Decommissioning impacts

At this stage, most of the underground pipeline is expected to remain in place to minimise disturbance and only limited areas would be subject to surface works. Decommissioning activities would generally involve reducing the remaining gas in the pipeline as much as possible, managing residual gas, disconnecting and removing surface facilities and, where required, cutting, capping and filling sections of the pipeline. Disturbance associated with the removal of surface infrastructure and sections where cutting, capping and filling is required, is expected to be localised. Consequently, potential impacts on hydrology, flooding and groundwater resources are expected to be localised, short-term and spatially limited, with no anticipated catchment-scale effects.

Decommissioning activities considered to have the potential to impact on water resources if inadequately managed) are:

– leaving much of the underground pipeline in place
– removal of surface infrastructure and associated ground disturbances
– excavation of ‘bell holes’ for cutting, capping and filling of pipeline segments.

Decommissioning activities are expected to have minimal potential to affect surface or groundwater quality and resources due to the comprehensive and structured process that governs pipeline retirement. This process ensures that potential risks and impacts (including risks to water quality and watercourses) are systematically identified, assessed and managed. Compared to construction, decommissioning activities would be more limited, localised and undertaken by a small work crew, typically completed within about a week at any given location. Leaving the pipeline in place would avoid widespread land disturbance, including to riparian vegetation and within watercourses.

Disturbance will be managed in accordance with controls specified in the Decommissioning Environmental Management Plan (DEMP) and measures to protect water quality and watercourses will be detailed in a soil and water management subplan to the DEMP.

9. Recommended mitigation and management measures

9.1 Approach to mitigation

This chapter consolidates all mitigation and management measures relevant to the water discipline, including surface water and hydrology, flooding, wetlands, groundwater, water sourcing and hydrostatic testing, and incidental discharges.

The chapter identifies the controls, monitoring requirements and implementation mechanisms required to avoid, minimise or manage the potential impacts identified in the preceding assessment chapters. Measures presented herein apply across all project phases, including construction, operation, maintenance and decommissioning, unless otherwise specified.

The recommendations described in this chapter are intended to:

– maintain pre-construction surface water flow paths, hydrological connectivity and flood behaviour
– protect surface water quality and EVs downstream of the project
– prevent contamination of groundwater and surface water resources
– provide sustainable and compliant sourcing, handling and disposal of water used for construction and hydrostatic testing
– provide clear, auditable commitments capable of being translated into environmental management plans, construction specifications and contractual obligations.

Mitigation and management measures for the project have been developed in accordance with the mitigation hierarchy, consistent with Queensland technical guidance and contemporary best practice for linear infrastructure projects. The hierarchy has been applied as follows:

– **Avoidance:** Avoidance of direct disturbance to watercourses, wetlands and floodplain flow paths where practicable through route selection, crossing methodology selection (e.g. trenchless construction), and siting of ancillary areas outside hydrologically sensitive zones.
– **Minimisation:** Where avoidance is not practicable, minimisation of impacts through design controls, construction methods, staging of works, and the implementation of erosion, sediment and water management measures to limit the extent, duration and magnitude of hydrological and water quality impacts.
– **Mitigation and control:** Application of procedural, physical and operational controls to manage residual risks, including erosion and sediment controls, water treatment and discharge controls, spill prevention and response measures, and monitoring programs.
– **Rehabilitation and reinstatement:** Progressive and post-construction reinstatement of disturbed areas to restore pre-existing drainage patterns, surface stability and hydrological function.
– **Monitoring and adaptive management:** Ongoing monitoring of water-related performance indicators and implementation of corrective actions where monitoring identifies non-compliance or unanticipated impacts.

The mitigation and management measures described in this chapter have been framed to meet compliance with relevant Queensland legislation, policies and guidelines, including but not limited to:

– EP Act
– EPP (Water and Wetland Biodiversity)
– Queensland Water Quality Guidelines (DEHP, 2009)
– Relevant conditions of approval, environmental authorities and water licences.

Measures are expressed as clear commitments rather than aspirational statements, enabling direct linkage to approval conditions, compliance reporting and enforcement mechanisms.

9.2 Wastewater management

9.2.1 Treatment and irrigation system

Wastewater effluent from each temporary accommodation camp would be treated by a suitably designed, manufactured, installed, commissioned and operated aerated wastewater treatment plant. Treatment will produce a Class B effluent, which is suitable for disposal by effluent irrigation and non-potable reuse. Indicative Class B wastewater effluent characteristics are outlined in Table 9.1 for information only. Specific effluent characteristics would be included within the relevant EA.

The wastewater treatment plant would use sedimentation and aerobic digestion to separate biomass from wastewater effluent. Wastewater effluent would be disinfected to remove residual pathogens prior to being pumped to the designated spray irrigation area for disposal. Effluent would be dispersed via sprinklers.

Assessment and design of the wastewater management system would be carried out in accordance with the *Disposal of effluent using irrigation Technical guideline* (DES, 2020a) which details key considerations for the evaluation, risk assessment, planning, management and monitoring of sustainable effluent irrigation systems.

Table 9.1 Indicative Class B effluent characteristics

Parameter	Unit	Guideline	Class B value
Total Nitrogen (TN)	mg/L	Maximum	20
Total Phosphorus (TP)	mg/L	Maximum	3
Electrical Conductivity (EC)	µS/cm	Maximum	2,000
pH	units	Range	6.5-8.5
Total Suspended Solids (TSS)	mg/L	Maximum	30
Biological Oxygen Demand (BOD)	mg/L	Maximum	20
E. coli	orgs/100 mL	Maximum	100

9.2.2 Design and operation safeguards

The following safeguards would be implemented during design and operation of the wastewater management system:

– the wastewater management system would:
  - be designed in accordance with best practice and all relevant guidelines and requirements, including *Eligibility criteria and standard conditions for sewage treatment works (ERA 63) – Version 2* (Department of Environment and Heritage Protection (DEHP), 2016)
  - treat wastewater, including to remove pathogens using disinfectants, to ensure that water quality meets the conditions in the EA for *ERA 63(1) - sewage treatment,* if a site-specific application is made
– the effluent irrigation areas would:
  - be a designated irrigation area (or areas)
  - be sufficiently sized for the volume of wastewater effluent
  - only used for effluent application
  - have no run-off or seepage of effluent beyond the designated irrigation area (irrigation rates controlled and irrigation areas managed to avoid surface runoff and waterlogging)
  - have control measures (e.g. fencing) and separation distances implemented in accordance with water quality guidelines
  - have no casual access by humans or animals
  - not allow spray to reach areas normally occupied by humans or animals
– wet weather storage requirements would be determined, including contingency for prolonged wet periods
– the potential impacts of stormwater and/or rainwater ingress would be considered
– the quality of wastewater would be monitored prior to application to the effluent irrigation area

– the wastewater effluent management and irrigation system would be operated in accordance with the EA
– biomass waste from the treatment plant would be trucked off site and disposed of appropriately by a licensed contractor.

9.3 Recommended mitigation measures

This section outlines recommended mitigation measures for the project, focusing on avoidance, minimisation, and management of environmental impacts and are designed to protect EVs. Mitigation measures are recommended for incorporation into the CEMP and the Operational Environmental Management Plan (OEMP) to avoid and minimise impacts to surface water and groundwater.

If any water storages (e.g. sediment basins, hydrotest tanks/ponds) could be regulated structures, it is proposed that the *Manual for assessing consequence categories and hydraulic performance of structures* (DETSI, 2025) will be applied to hazard assessment, freeboard/design storage allowance, liner selection, leak detection, and decommissioning criteria supported by a design plan by a suitably qualified environmental professional (SQEP).

9.3.1 Construction

Table 9.2 below summarises the potential impacts and proposed mitigation measures associated with the construction phase of the project, to guide CEMP requirements, and avoid and minimise impacts to surface water and groundwater.

Table 9.2 Construction mitigation measures

Potential impact	Mitigation measures	Timing
Hydrology and surface water		
Hydrology, surface water and flood behaviour	– A construction Soil and Water Management Plan (SWMP) will be prepared and implemented as part of the CEMP to manage potential impacts to surface water, watercourses, floodplains and groundwater during construction. – The SWMP will integrate erosion and sediment control, fuel and chemical management, spill response, drilling fluid management, commissioning water discharges, riparian protection, flood resilience, progressive stabilisation and rehabilitation measures, in accordance with relevant regulatory requirements. – Construction activities will be planned and sequenced to minimise disturbance to watercourses and floodplains and to avoid high-risk hydrological conditions where practicable. – Post-construction monitoring and corrective actions will be undertaken to confirm reinstatement performance and stability.	Design, pre-construction, construction
Watercourse crossings	– Watercourse crossings will be designed and constructed in accordance with *Riverine Protection Permit Exemption Requirements* (Department of Regional Development, Manufacturing and Water, 2023), *Code of Environmental Practice – Onshore Pipelines* (APGA, 2022), *Best Practice Erosion and Sediment Control* (IECA, 2025), and *Activities in a watercourse, lake or spring associated with a resource activity or mining operations* (Water Act 2000). – Crossing-specific controls will be implemented through the SWMP to maintain existing drainage lines and overland flow paths, manage temporary works, reinstate micro-topography and channel form, and monitor post-rainfall performance.	Design, construction
Groundwater		
Degradation of groundwater quality – construction and testing	– The construction SWMP will include: • controls and procedures to manage the process of HDD, including quality of introduced drilling muds and equipment lubricants (i.e. greases), response to pressure loss events or ground movement (such as stopping work, assessment of situation, additional control measures) and disposal of used drilling fluids and drilling cuttings • controls to manage the quality of hydrotest water • measures for managing fuel and chemical handling, storage, distribution and spill response during construction • procedures for regular inspections of storage areas and equipment	Pre-construction, construction

Potential impact	Mitigation measures	Timing
	• procedures/engineering solutions for potential loss of hydrotest water, to minimise losses to ground should leaks occur (e.g. prompt removal of test water should a leak occur). – The quality of proposed hydrotest water source(s) will be determined and confirm its suitability for use. – Hydrotest water will be managed in accordance with Appendix F (Waste Assessment Report) of the Environmental Authority Supporting Information Report.	
Altered hydrological function – trenching	– Installation of impermeable trench breakers will be installed in high-risk areas (e.g. watercourse crossings, wetlands, terrestrial GDEs and where pipeline trench intersects the water table) to control the movement of groundwater along the pipeline trench. – The construction SWMP, which will be prepared and implemented as part of the CEMP, will include measures to: • restrict dewatering to the immediate area of the construction works and minimise extraction volumes • minimise the duration of dewatering activities • collect extracted groundwater for treatment prior to reuse or disposal via irrigation to land.	Pre-construction, construction
Lower groundwater levels – extraction for construction water supply	– Appropriate testing and hydrogeological assessment will be carried out where necessary, and appropriate approvals obtained, to satisfy the requirements of the *Great Artesian Basin and Other Regional Aquifers water management protocol 2017* (State of Queensland, 2019).	Pre-construction, construction
Wastewater management system		
Degradation of surface water and groundwater quality – wastewater irrigation	– The wastewater treatment system and effluent irrigation area(s) will be designed in accordance with best practice and all relevant guidelines and requirements, including *Eligibility criteria and standard conditions for sewage treatment works (ERA 63) – Version 2* (DEHP, 2016)). – The water quality of wastewater effluent to be disposed of within the irrigation areas will be monitored to ensure it is within the compliance levels approval conditions.	Design, pre-construction, construction

9.3.2 Operation

Table 9.3 below summarises the potential impacts and proposed mitigation measures associated with the operation phase of the project, to guide OEMP requirements, and avoid and minimise impacts to surface water and groundwater. These are primarily associated with operational maintenance activities.

Table 9.3 Operation mitigation measures

Potential impact	Mitigation measures	Timing
Hydrology and surface water		
Degradation of surface water resources and watercourses	– Operational water use is limited to small volumes for routine maintenance, with no ongoing surface discharges. – The pipeline will remain buried, with limited surface infrastructure and no alteration to surface drainage paths. – Regular inspections of watercourse crossings will be undertaken to identify any need for localised erosion or scour protection following significant rainfall events. – Vehicle access across watercourses will be restricted to designated crossings only.	Operation (maintenance activities)
Altered surface flow paths or localised flooding	– Drainage features and overland flow paths will be inspected and maintained to remain clear during operation. – Flow paths around valve stations and surface infrastructure will be maintained to prevent localised flow obstruction.	Operation (maintenance activities)

Potential impact	Mitigation measures	Timing
Degradation of surface water quality	– Rehabilitation of trench crossings completed during construction minimises ongoing erosion and sedimentation risk. – Maintenance activities will be managed in accordance with standard operating procedures for handling fuels, chemicals and hazardous materials to prevent contamination of receiving environments. – Vehicle movements through ephemeral watercourses will generally occur under dry conditions, minimising erosion risk.	Operation (maintenance activities)
Groundwater		
Degradation of groundwater quality – pipeline leaks / failure	– Implementation of pipeline leak detection and pressure monitoring systems. – Maintain cathodic protection and corrosion control. – Monitor groundwater monitoring bores at high-risk locations for presence of pipeline gas and degradation of groundwater quality in accordance with the OEMP.	Operation (maintenance activities)
Altered hydrological function – pipeline repairs	– Conduct repair works in accordance with the OEMP. – Limit dewatering activities to the CRoW and minimise the duration of works and extraction volumes. – Manage extracted groundwater in accordance with the OEMP.	Operation (maintenance activities)

10. Conclusion

This Water Assessment Report has evaluated the potential impacts of the Bulloo Interlink Pipeline on surface water, hydrology and flooding, wetlands, and groundwater within the Queensland section of the project. The assessment has been undertaken in accordance with the *Environmental Protection Act 1994* (Qld), the Environmental Protection (Water and Wetland Biodiversity) Policy 2019, and relevant application guidance for activities with impacts to water.

The assessment considered the existing environmental values of receiving waters, the nature of the arid and semi-arid hydrological systems traversed by the pipeline, and the potential impact pathways associated with construction, operation and decommissioning of the project.

10.1 Surface water, hydrology, and flooding

A comprehensive desktop assessment was undertaken to evaluate existing environmental conditions within the study area, focusing on surface water and groundwater resources. Surface water systems within the study area are characteristic of arid inland environments, comprising predominantly ephemeral rivers, creeks, drainage lines and floodplain flow paths that remain dry for extended periods and become active only during episodic rainfall and flood events. Flooding is typically broad, shallow and laterally extensive, with flow conveyed across floodplains rather than confined to well-defined channels.

The assessment demonstrates that, provided appropriate mitigation and management measures are implemented:

– Construction-related impacts on surface water and hydrological processes will be localised, temporary and reversible.
– The dominant hydrological processes of the study area, including flood conveyance, floodplain connectivity and episodic drainage, will be maintained.
– The risk of long-term alteration to flow paths, flood levels or inundation extents is low, particularly given the buried nature of the pipeline and reinstatement of surface landforms.

At watercourse crossings, impacts are expected to be limited in duration, with bed and banks reinstated following construction. Higher-risk crossings, i.e. the Wilson River within the Channel Country Strategic Environmental Area, will be constructed using trenchless methods, avoiding direct disturbance to channel morphology and floodplain surfaces.

Operational and decommissioning phases are not expected to materially affect surface water or flooding behaviour, as ongoing activities are limited in extent and frequency and do not involve routine interaction with waterways. Any potential impacts associated with maintenance or decommissioning activities would be temporary and managed through standard controls.

10.2 Wetlands and hydrological connectivity

Wetlands within the study area derive their ecological function primarily from episodic inundation and floodplain connectivity rather than permanent surface water. The assessment confirms that:

– No Ramsar-listed wetlands occur within the project footprint.
– Mapped wetlands intersected or located near the alignment are predominantly associated with ephemeral drainage features.
– The project will not result in permanent alteration of wetland hydrology, hydroperiod or connectivity.

Temporary construction-related disturbance near wetlands may occur; however, with implementation of avoidance measures, appropriate drainage management, erosion and sediment controls, and progressive rehabilitation, wetland hydrological function is expected to be maintained. No long-term adverse impacts to wetland environmental values are anticipated.

10.3 Groundwater

Key characteristics of groundwater resources in the study area intersected by the project, and with potential to be impacted are:

– Groundwater in alluvium/unconsolidated sediments is anticipated to be primarily associated with watercourses and, where present, to form localised, unconfined, seasonally water-bearing aquifers perched on the underlying bedrock (Glendower Formation and Winton Formation). Groundwater is anticipated to be within a few metres of ground surface at watercourse crossings and in areas mapped as potential for terrestrial and surface expression GDEs, and to be fresh to brackish. These strata are unlikely to yield significant quantities of water for groundwater extraction.
– Layered siltstone, mudstone and sandstone units forming low yielding, sub-artesian aquifers of brackish quality within the Glendower Formation (localised, low yielding aquifers) and Winton Formation (low yielding aquifer), anticipated to have low hydraulic connectivity with the overlying alluvium/unconsolidated sediments.
– Groundwater in the Cadna-owie – Hooray aquifer, indicted to be of brackish quality in this area and hydraulically disconnected from overlying geological units (including alluvium/unconsolidated sediments, Glendower Formation and Winton Formation) by the Rolling Downs Group aquitard.

Potential impacts of the project on groundwater resources are expected to be primarily associated with construction of the pipeline and include:

– localised, temporary, lowering of groundwater levels around open-cut trenching during construction where the groundwater table is intersected, with highest risk areas considered to be watercourse crossings
– localised, temporary, changes to shallow groundwater quality from HDD, and to levels and quality from hydrotesting if failure points occur
– localised, temporary lowering of groundwater levels in the Cadna-owie – Hooray aquifer around groundwater extraction bores used for construction water supply, with potential to cause drawdown at existing landholder extraction bores where located within the zone of influence of the construction water extraction bores.

Leaving much of the buried pipeline in place once it is no longer in use has the potential to impact on the quality of shallow groundwater at and down gradient of the decommissioned pipeline, from corrosion of the steel pipeline over time. Pipeline corrosion could lead to localised increased concentrations of iron in groundwater.

No impact to nearby groundwater bores is anticipated from the project given the localised nature and short duration of changes to shallow groundwater, and low hydraulic connectivity between alluvium/unconsolidated sediments and bedrock. The project is not anticipated to impact on existing human users of groundwater, or on groundwater resources in the wider area around or downstream of the project site. Irrigation of treated wastewater is not expected to cause any significant change in groundwater quality or groundwater levels and impacts to groundwater are expected to be negligible.

10.4 Regional planning interests

The project avoids permanent modification of floodplain processes, does not compromise wetland hydrology or groundwater availability, and maintains surface water and groundwater connectivity characteristic of the region. Any impacts within the Channel Country SEA are temporary, localised and reversible, and will be managed through construction methodology, mitigation measures and associated management plans. On this basis, the project is consistent with the intent and outcomes of the RPI Act and supports approval under the RIDA framework.

10.5 Overall conclusion

Based on the findings of this Water Assessment Report, it is concluded that:

– The Bulloo Interlink Pipeline can be constructed, operated and decommissioned without significant adverse impacts on surface water, wetlands, hydrology or groundwater.
– Potential water-related impacts are manageable through standard mitigation measures, Environmental Management Plans and regulatory controls.
– The project will not result in long-term degradation of water quality, alteration of floodplain processes, or adverse effects on sensitive water-dependent receptors.

With the implementation of the recommended mitigation and management measures, the project is considered acceptable from a water and hydrological perspective and supports approval under the *Environmental Protection Act 1994* (Qld).

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Appendices

Appendix A

Rainfall statistics

Table A.1 Woomanooka Station rainfall statistics (BoM, 2026)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	38.6	39.6	35.4	14.2	13.9	18.3	5.3	9.6	10.2	11.5	32.4	14.7	177.3
Lowest	0	0	0	0	0	0	0	0	0	0	0	0	133.5
Median	26.8	24.6	10.3	0	0	11.3	0	0	0	4.2	23.5	3	154.8
Highest	168	193	167.6	91.2	84	79	35.8	44.3	63	79	78	86.6	266.2

Table A.2 Nockatunga Station rainfall statistics (BoM, 2026)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	40.4	32	31	14.3	17.2	17.8	14.4	10.6	9.8	14.5	18.4	19.5	233
Lowest	0	0	0	0	0	0	0	0	0	0	0	0	51.2
Median	20.4	10.9	13	1	7.1	8	2.5	3.5	2.5	5.6	5.1	8.1	205.5
Highest	449.4	374.1	209.3	135	134.1	131	92	81.3	62	115.8	141.2	154.5	729.1

Table A.3 Noccundra Hotel Station rainfall statistics (BoM, 2026)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	43.9	19.8	33.6	15.1	17.7	11.3	15.7	8.8	17.6	11.9	17.7	14.5	208.2
Lowest	0	0	0	0	0	0	0	0	0	0	0	0	73.5
Median	38.6	8.5	23.4	4.6	3	7.9	4	4.2	10	6.9	15.5	5.4	227.1
Highest	212	120.4	139.8	64	98.2	32.8	97.8	64.8	68.6	55.4	52	65	366.8

Table A.4 Thargomindah Airport Station rainfall statistics (BoM, 2026)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	31.6	42.8	44.2	12.9	16.7	17.1	15.7	10.3	13.6	17.3	30.5	26.5	273.9
Lowest	0	0	0	0	0	0	0	0	0	0	0	0	62.5
Median	26.5	19.6	25.3	6.2	5.9	7.9	7.7	2.6	2.8	9.5	22	14.4	244.2
Highest	116.8	199.4	175.7	106.7	64.6	64.4	64.7	45.1	67.4	110.8	132	144.1	796.6

Table A.5 Orientos Station rainfall statistics (BoM, 2026)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	32	24.1	23.5	8.4	15.6	14.4	14.2	7.9	11.7	11.9	16.8	16.3	202.4
Lowest	0	0	0	0	0	0	0	0	0	0	0	0	29
Median	6	5.9	10.4	0.5	7.8	7.4	1.5	2.5	3.2	5.6	5.2	7.2	172.7
Highest	306.4	231.4	183.6	60.4	107.2	161.6	91.6	43.8	110.4	91	183.5	82.7	739.2

Table A.6 Bulloo Downs Station rainfall statistics (BoM, 2026)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	32.3	27.2	24.1	11.6	17.5	11.7	14	10.5	10.7	15.5	17.8	20.9	210.3
Lowest	0	0	0	0	0	0	0	0	0	0	0	0	28
Median	10.2	13.8	5	2.5	9	6.2	3.3	3.8	2.5	7.7	5.2	8.9	183.8
Highest	196.2	186	431.5	58.9	92.2	83.9	146.5	47.8	108	108.5	135.5	269.2	723.3

Table A.7 Omicron Station rainfall statistics (BoM, 2026)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	26.8	23.4	33	5.1	9.8	12.1	7.7	7.3	19	9.5	25.1	26.7	235.9
Lowest	0	0	0	0	0	0	0	0	0	0	0	0	102
Median	12	0	30	1.9	7	0.4	2	0	1	2	13.1	14.8	187.1
Highest	122	158	171	15.4	37.4	46	49	27.6	99.5	59	98	72.7	465.5

Appendix B

Waterbodies located within the study area

Table B.1 Watercourses intersected by the pipeline alignment

Approximate chainage	Associated waterway
0.28 km	Un-named drainage feature of Windula Creek
0.41 km	Un-named drainage feature of Windula Creek
2.23 km	Un-named drainage feature of Windula Creek
3.95 km	Un-named drainage feature of Windula Creek
18.44 km	Un-named drainage feature of Kercummura Creek
31.52 km	Un-named drainage feature of Kercummura Creek
33.89 km	Un-named drainage feature of Kercummura Creek
35.13 km	Un-named drainage feature of Kercummura Creek
35.57 km	Un-named drainage feature of Kercummura Creek
37.26 km	Un-named drainage feature of Kercummura Creek
40.06 km	Un-named drainage feature of Kercummura Creek
43.67 km	Un-named drainage feature of Kercummura Creek
44.05 km	Un-named drainage feature of Kercummura Creek
46.76 km	Un-named drainage feature of Kercummura Creek
47.00 km	Un-named drainage feature of Kercummura Creek
59.22 km	Gum Creek
63.86 km	Un-named drainage feature of Gum Creek
66.39 km	Un-named drainage feature of Gum Creek
68.21 km	Un-named drainage feature of Gum Creek
71.82 km	Un-named drainage feature of Tirtywinna Creek
76.66 km	Un-named drainage feature of Tirtywinna Creek
77.00 km	Un-named drainage feature of Tirtywinna Creek
77.26 km	Un-named drainage feature of Tirtywinna Creek
78.34 km	Tirtywinna Creek
78.56 km	Tirtywinna Creek
78.59 km	Tirtywinna Creek
78.63 km	Tirtywinna Creek
83.76 km	Wilson River
83.82 km	Wilson River
84.00 km	Wilson River
84.04 km	Wilson River
84.16 km	Wilson River
84.27 km	Wilson River
84.72 km	Wilson River
89.19 km	Un-named drainage feature of Wilson River
92.76 km	Un-named drainage feature of Tippera Creek
94.61 km	Tippera Creek
95.21 km	Tippera Creek
95.30 km	Tippera Creek
95.56 km	Tippera Creek

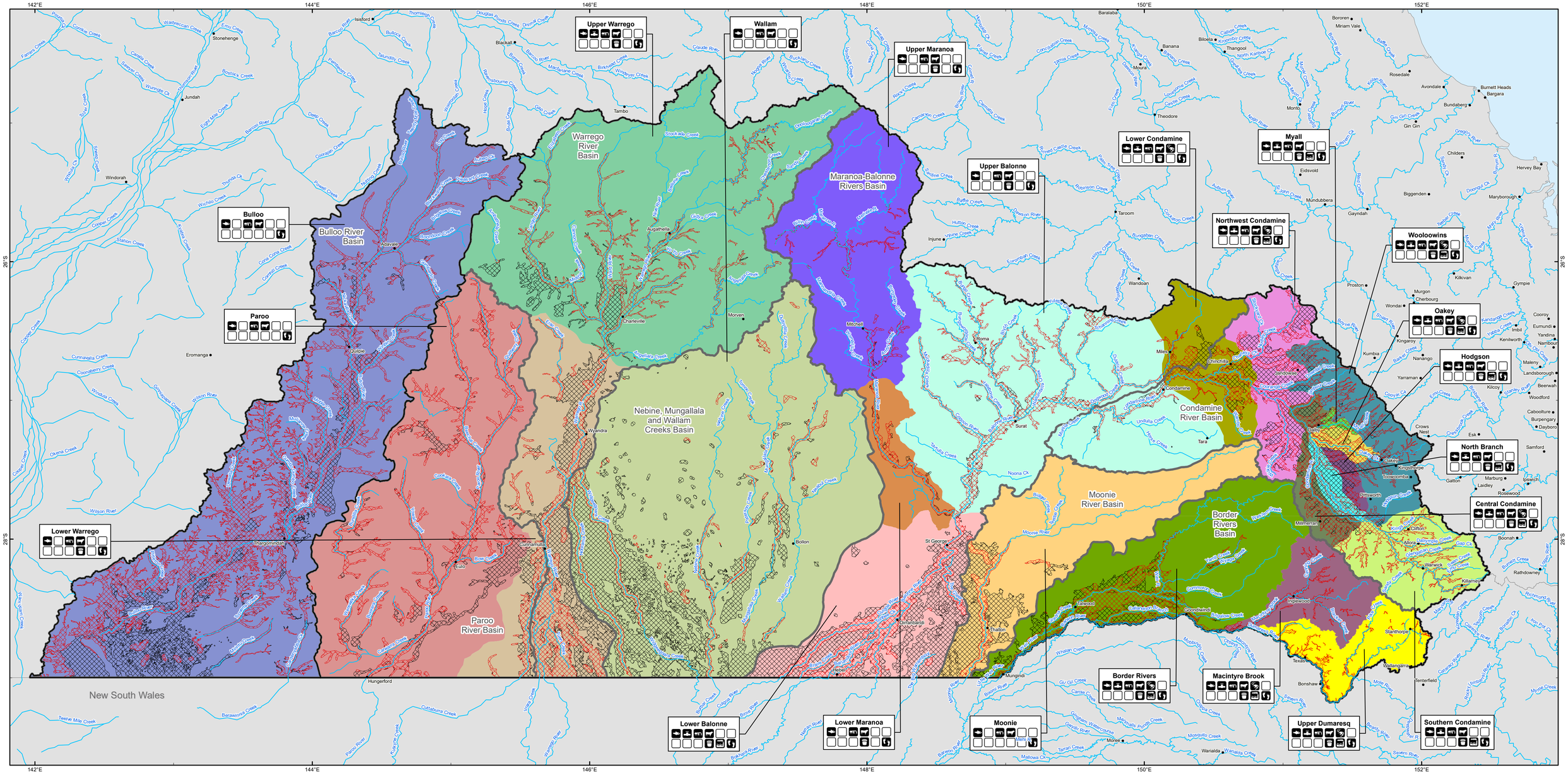
Approximate chainage	Associated waterway
103.83 km	Murrawarra Creek
104.04 km	Murrawarra Creek
104.26 km	Murrawarra Creek
104.52 km	Murrawarra Creek
111.70 km	Un-named drainage feature of Wippo Creek
115.70 km	Un-named drainage feature of Wippo Creek
117.74 km	Un-named drainage feature of Wippo Creek
118.40 km	Un-named drainage feature of Wippo Creek
118.59 km	Un-named drainage feature of Wippo Creek
131.75 km	Un-named drainage feature of Whippa Creek
132.58 km	Un-named drainage feature of Whippa Creek
136.15 km	Un-named drainage feature of Whippa Creek
137.87 km	Un-named drainage feature of Whippa Creek
139.04 km	Un-named drainage feature of Whippa Creek
145.00 km	Parrabinna Creek
146.77 km	Un-named drainage feature of Parrabinna Creek
147.91 km	Un-named drainage feature of Parrabinna Creek
148.01 km	Un-named drainage feature of Parrabinna Creek
150.24 km	Un-named drainage feature of Parrabinna Creek
150.34 km	Un-named drainage feature of Parrabinna Creek
152.29 km	Un-named drainage feature of Parrabinna Creek
152.38 km	Un-named drainage feature of Parrabinna Creek
153.34 km	Un-named drainage feature of Parrabinna Creek
154.47 km	Un-named drainage feature of Parrabinna Creek
154.68 km	Un-named drainage feature of Parrabinna Creek
154.94 km	Un-named drainage feature of Parrabinna Creek
156.74 km	Un-named drainage feature of Muggera Creek
157.69 km	Un-named drainage feature of Muggera Creek
157.81 km	Un-named drainage feature of Muggera Creek
157.98 km	Un-named drainage feature of Muggera Creek
158.57 km	Un-named drainage feature of Muggera Creek
158.65 km	Un-named drainage feature of Muggera Creek
160.24 km	Un-named drainage feature of Bulloo River
162.88 km	Un-named drainage feature
163.38 km	Un-named drainage feature
164.44 km	Un-named drainage feature
165.32 km	Un-named drainage feature
166.75 km	Un-named drainage feature
168.48 km	Un-named drainage feature
170.41 km	Un-named drainage feature
170.76 km	Un-named drainage feature

Approximate chainage	Associated waterway
173.65 km	Un-named drainage feature
175.11 km	Un-named drainage feature
176.47 km	Un-named drainage feature
176.55 km	Un-named drainage feature
178.93 km	Un-named drainage feature
179.12 km	Un-named drainage feature
181.57 km	Un-named drainage feature
181.85 km	Un-named drainage feature
184.05 km	Un-named drainage feature
184.59 km	Un-named drainage feature
185.75 km	Un-named drainage feature
187.11 km	Un-named drainage feature
188.90 km	Un-named drainage feature
189.74 km	Un-named drainage feature
192.20 km	Un-named drainage feature
195.00 km	Un-named drainage feature
200.80 km	Tickalara Creek
201.12 km	Tickalara Creek
201.38 km	Tickalara Creek
201.83 km	Tickalara Creek
202.16 km	Tickalara Creek
202.40 km	Tickalara Creek
205.43 km	Un-named drainage feature of Tickalara Creek
206.90 km	Un-named drainage feature of Tickalara Creek
207.46 km	Un-named drainage feature of Tickalara Creek
211.62 km	Un-named drainage feature
212.04 km	Un-named drainage feature
212.43 km	Un-named drainage feature
216.09 km	Morris Creek
216.14 km	Morris Creek
216.22 km	Morris Creek
221.42 km	Gidya Creek
221.57 km	Gidya Creek
221.69 km	Gidya Creek
223.83 km	Un-named drainage feature of Wanka Creek
223.87 km	Un-named drainage feature of Wanka Creek
224.71 km	Wanka Creek
224.84 km	Wanka Creek
230.14 km	Un-named drainage feature
230.24 km	Un-named drainage feature
234.24 km	Un-named drainage feature

Appendix C

Aquifer zone maps – GWQ4161, GWQ4163, GWQ4164

Source: DES (2020a, 2022b, 2020c)



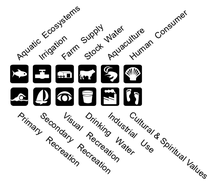
Legend

- Town
- Watercourse
- Drainage basin boundary
- Boundary of waters covered by the scheduling document

Alluvial Zones

- Alluvium
- Alluvium "near stream"
- Border Rivers
- Bulloo
- Central Condamine
- Hodgson
- Lower Balonne
- Lower Condamine
- Lower Maranoa
- Lower Warrego
- Macintyre Brook
- Moonie
- Myall
- North Branch
- North West Condamine
- Oakey
- Paroo
- Southern Condamine
- Upper Balonne
- Upper Dumaresq
- Upper Maranoa
- Upper Warrego
- Wallam
- Wooloowins

Key to Environmental Values



Notes:
1. The AWQG recommends the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value. Where groundwaters are in good condition the intent is to maintain existing water quality (20th, 50th and 80th percentiles).
2. Alluvium zone shown in cross hatching. For some Alluvium zones, water quality information is provided for 'near stream' areas (1.5km buffered area) and the overall alluvium zone - refer accompanying report.

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GWQ4161 - Queensland Murray-Darling and Bulloo Basins Groundwater Alluvial Zones

Environmental Protection (Water and Wetland Biodiversity) Policy 2019
Queensland Murray-Darling and Bulloo Basins Map Series

This plan forms part of the Queensland Murray-Darling and Bulloo Basins Groundwater Environmental Values and Water Quality Objectives scheduling document, prepared pursuant to the Environmental Protection (Water and Wetland Biodiversity) Policy 2019.

Queensland Government

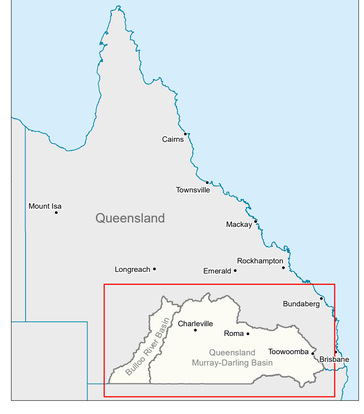
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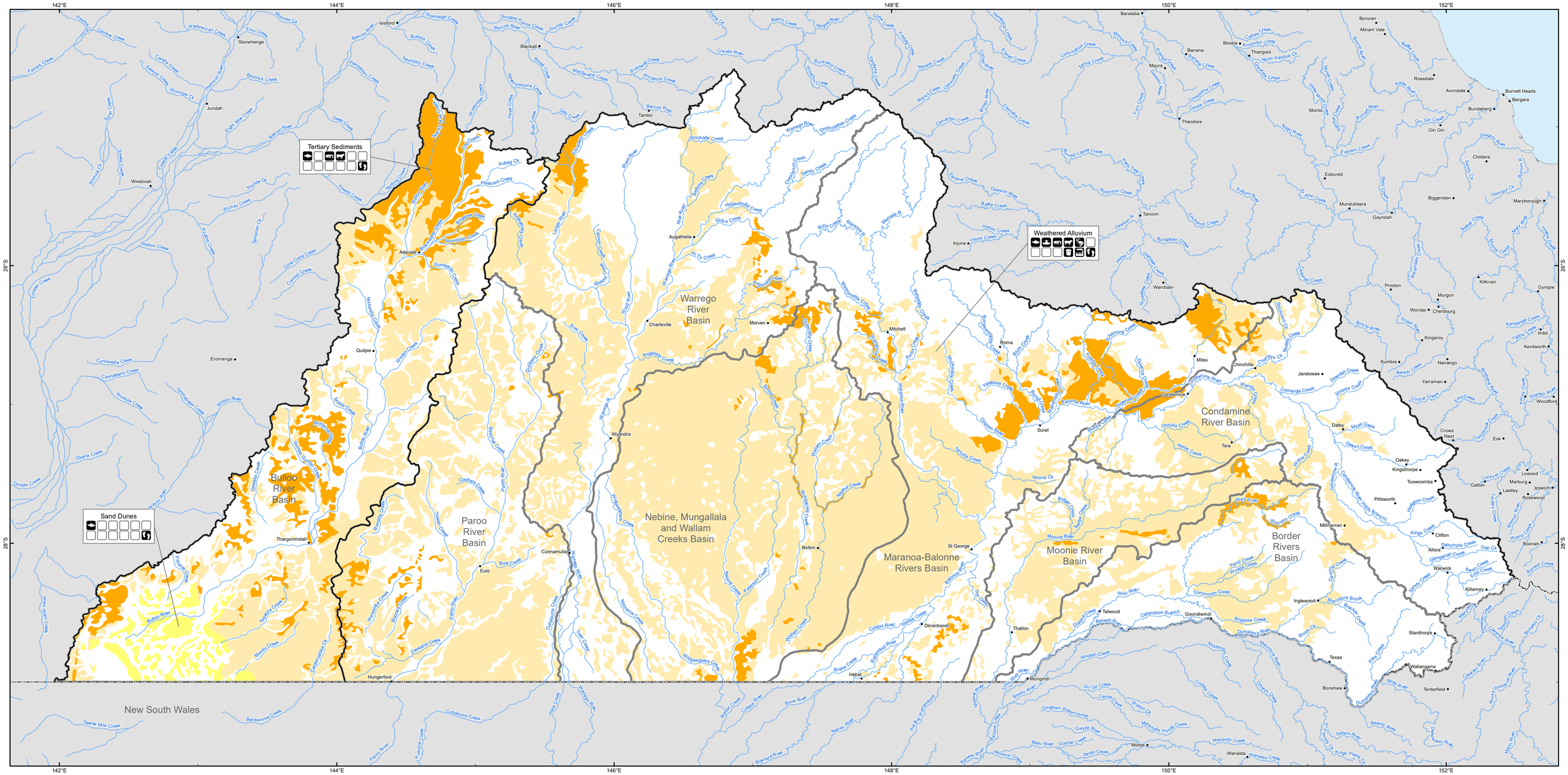
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Kilometres

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Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

Location Map





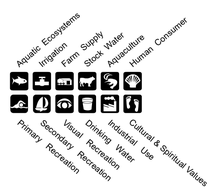
Legend

- Town
- Watercourse
- State border
- Drainage basin boundary
- Boundary of waters covered by the scheduling document

Sediments Overlying the Great Artesian Basin Zones

- No aquifers of this type
- Sand Dunes
- Tertiary Sediments
- Weathered Alluvium

Key to Environmental Values



Notes:
1. The AWQG recommends the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value. Where groundwaters are in good condition the intent is to maintain existing water quality (20th, 50th and 80th percentiles).

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GWQ4163 - Queensland Murray-Darling and Bulloo Basins Groundwater

Sediments Overlying the Great Artesian Basin Zones

Environmental Protection (Water and Wetland Biodiversity) Policy 2019

Queensland Murray-Darling and Bulloo Basins Map Series

This plan forms part of the Queensland Murray-Darling and Bulloo Basins Groundwater Environmental Values and Water Quality Objectives scheduling document, prepared pursuant to the Environmental Protection (Water and Wetland Biodiversity) Policy 2019.

Queensland Government

Prepared on: 10 August 2020

N

0 25 50 75 100 125
Kilometres

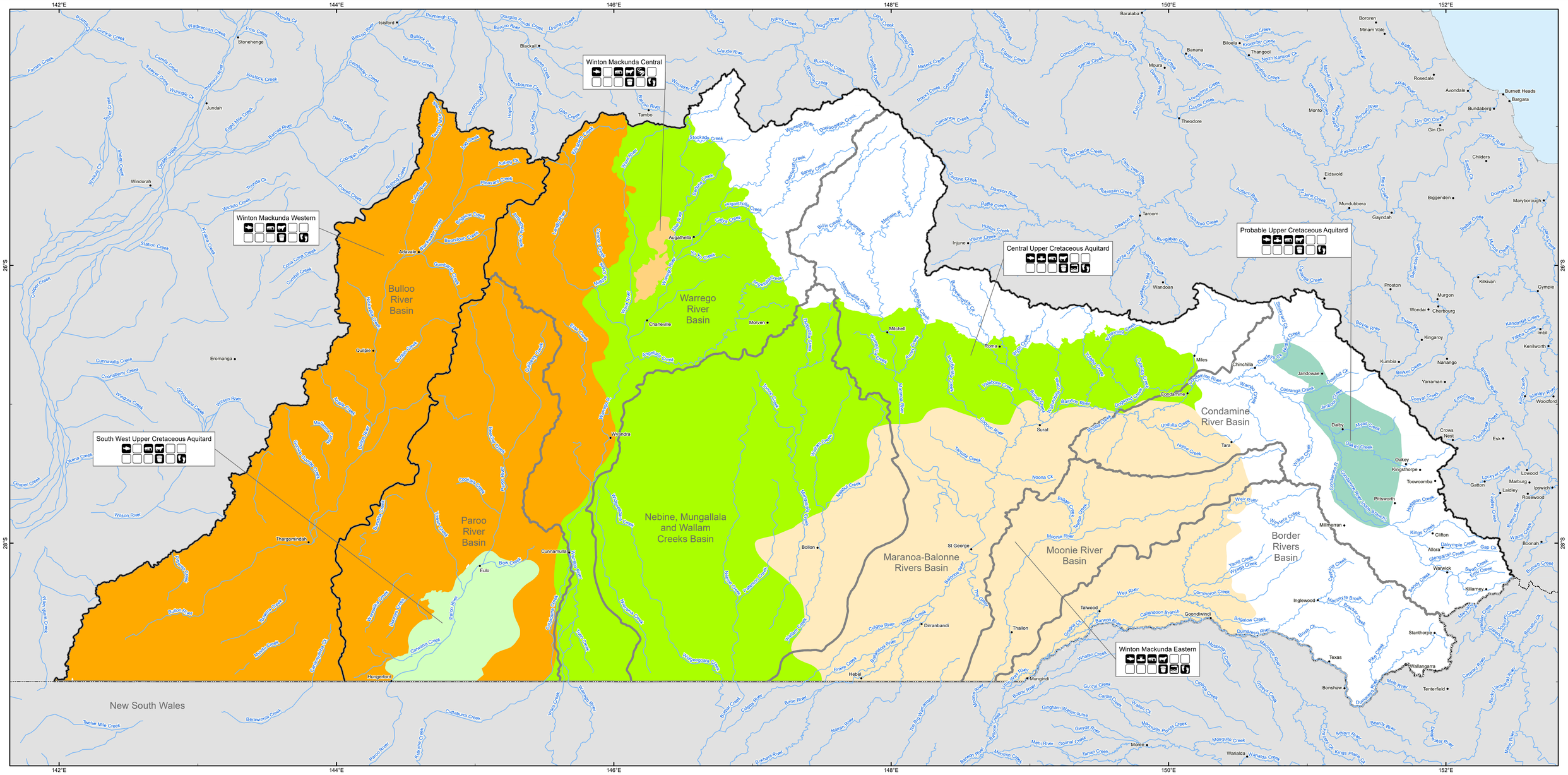
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Projection: Geocentric Datum of Australia 1994 (GDA94)

Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

Location Map





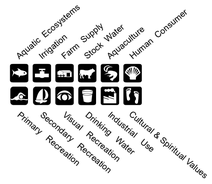
Legend

- Town
- Watercourse
- State border
- Drainage basin boundary
- Boundary of waters covered by the scheduling document

Upper Great Artesian Basin

- No aquifers of this type
- Central Upper Cretaceous Aquitard
- Probable Upper Cretaceous Aquitard
- South West Upper Cretaceous Aquitard
- Winton Mackunda Central
- Winton Mackunda Eastern
- Winton Mackunda Western

Key to Environmental Values



Notes:
1. The AWQG recommends the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value. Where groundwaters are in good condition the intent is to maintain existing water quality (20th, 50th and 80th percentiles).

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GWQ4164 - Queensland Murray-Darling and Bulloo Basins Groundwater

Upper Great Artesian Basin

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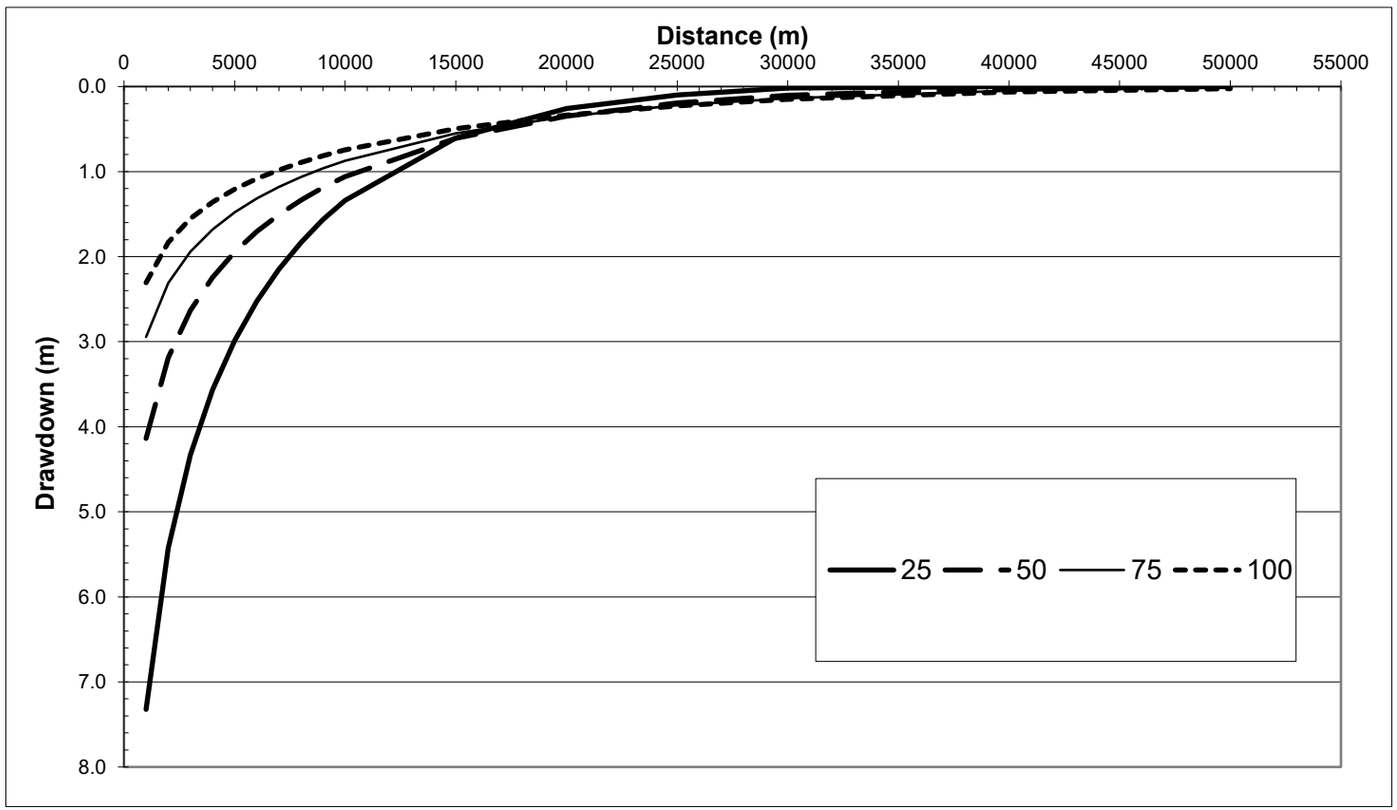
Appendix D

Estimated drawdown charts

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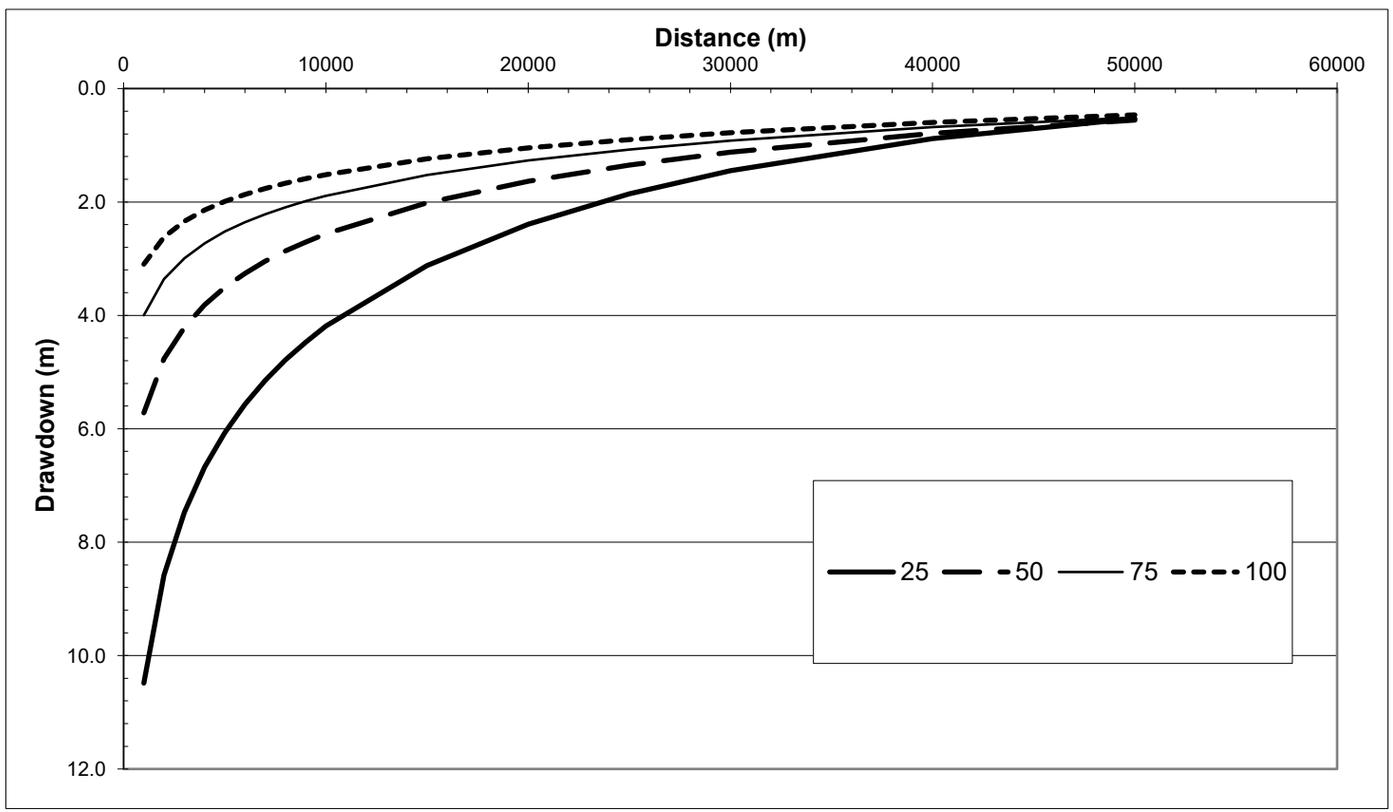
Cadna-owie - Hooray aquifer (theoretical bore, scenario 1)
Drawdown for various transmissivities



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Cadna-owie - Hooray aquifer (theoretical bore, scenario 2)
Drawdown for various transmissivities

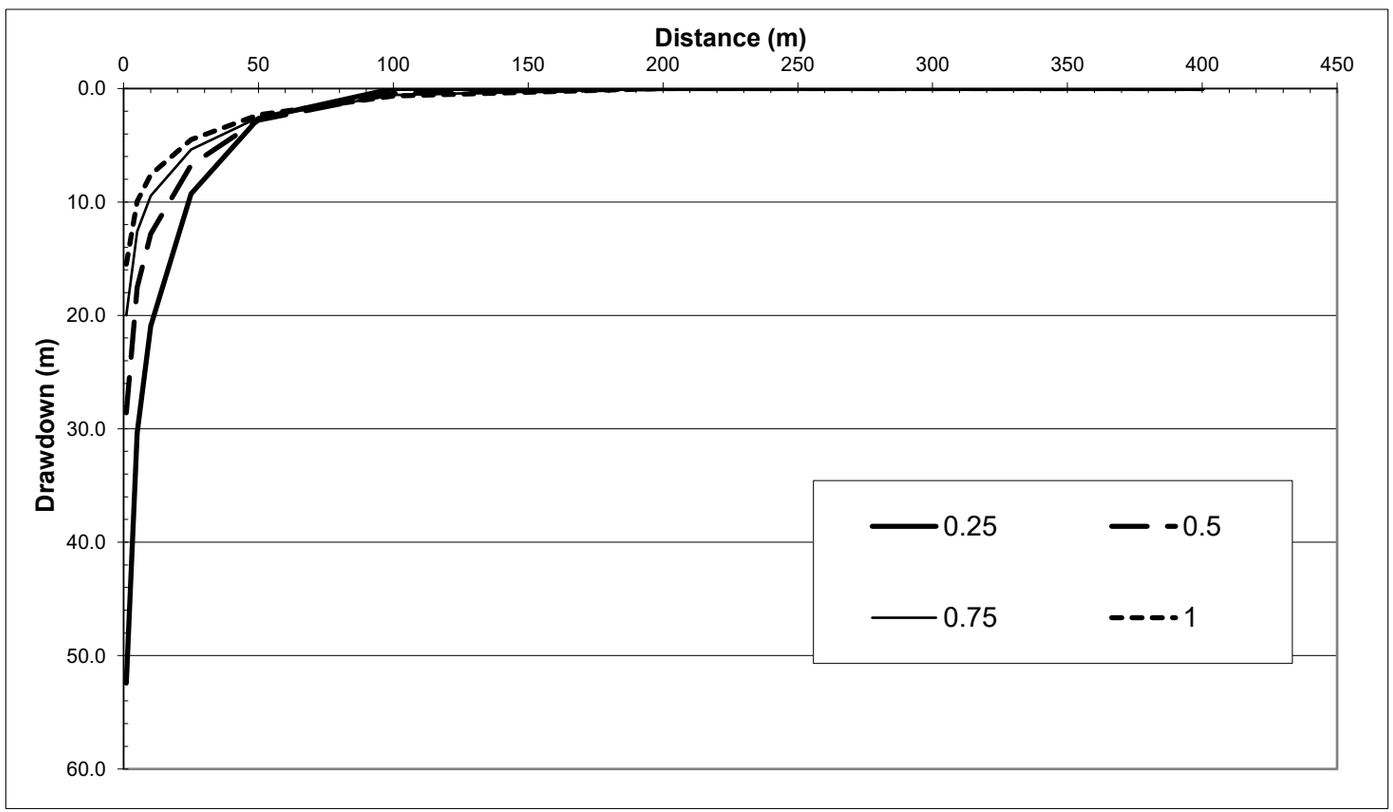


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Winton Formation (theoretical bore, scenario 1)

Drawdown for various transmissivities

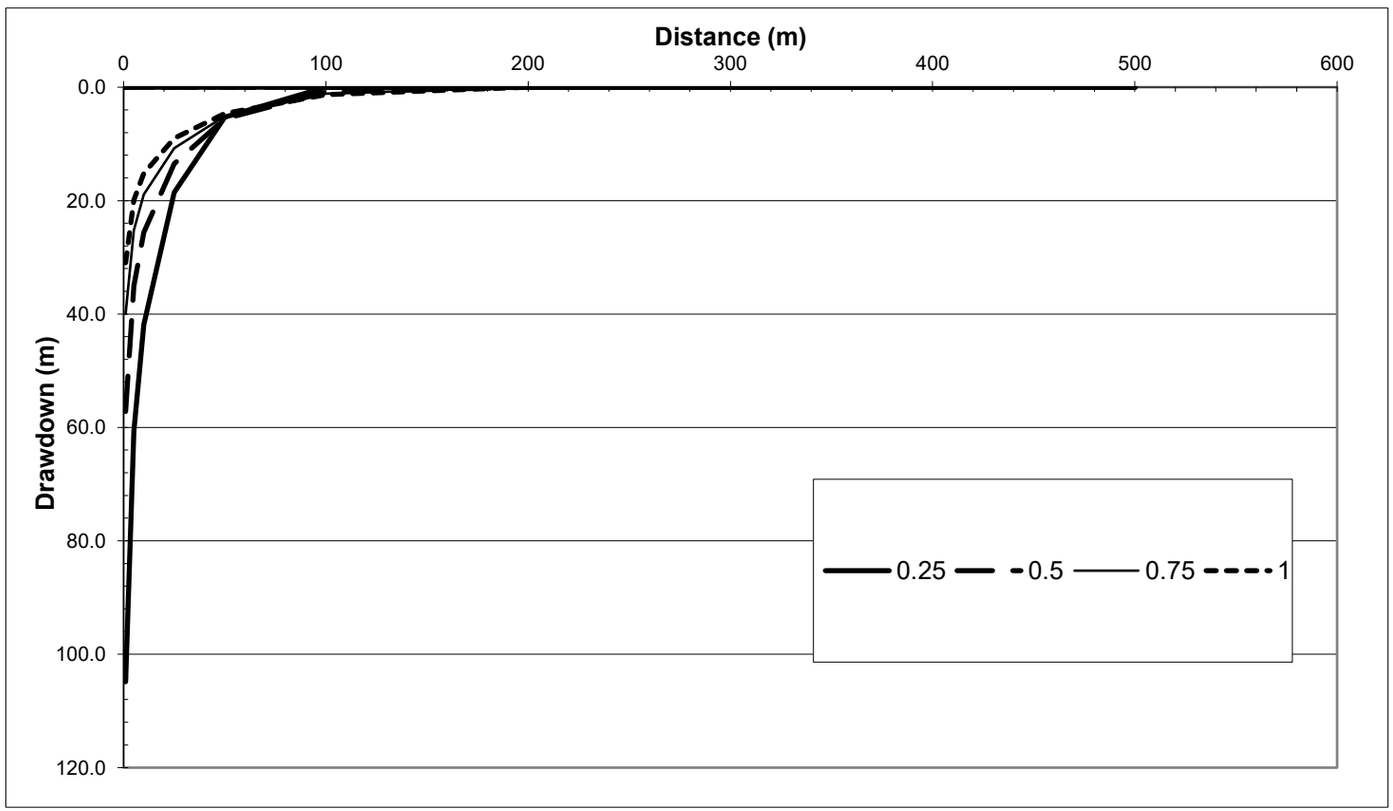


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Winton Formation (theoretical bore, scenario 2)

Drawdown for various transmissivities





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