Environmental Impact Statement/Environment Effects Statement

Appendix P

Groundwater

MARINUS LINK

Groundwater Impact Assessment - Victoria

Marinus Link

Marinus Link Pty Ltd

Reference: 754-MELEN215878ML

May 2024

GROUNDWATER IMPACT ASSESSMENT

Marinus Link

Report reference number: 754-MELEN215878ML

May 2024

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QUALITY INFORMATION

Revision history

Revision	Description	Date	Author	Reviewer	Approver
Rev0	Final	16/05/2024	J.S	K.W	J.S

EXECUTIVE SUMMARY

Marinus Link Pty Ltd (Marinus Link) contracted Tetra Tech Coffey Pty Ltd (Tetra Tech Coffey) to conduct a groundwater impact assessment as part of the Environmental Impact Statement /Environment Effects Statement (EIS/EES) for the proposed Marinus Link project (the project).

The project is a proposed 1,500 megawatt (MW) HDVC electricity interconnector between Heybridge in northwest Tasmania and the Latrobe Valley in Victoria. The portion of the project alignment covered in this assessment is defined as Waratah Bay to Hazelwood in Victoria.

The scope of the groundwater impact assessment was to characterise groundwater within the study area and identify potential impacts of the project on groundwater with reference to maintaining the identified environmental values of groundwater.

This assessment included a desktop review to support a baseline characterisation drawing on publicly available spatial information including ground surface elevation, the inferred average water table elevation, surface geological conditions and groundwater quality. The baseline characterisation draws on extensive hydrogeological, hydrological, and ecological data that is available across Victoria and particularly in the Gippsland region where the proposed project is located. Modelled groundwater levels, flow directions and aquifer hydraulic data is publicly available for the project area and is readily available in GIS formats which have been interrogated as part of the desktop baseline groundwater characterisation. The information obtained by the desktop literature and data review was considered sufficiently detailed to characterise baseline groundwater conditions to a level that is proportionate to the risk of adverse effects posed by the project.

Where potential impacts might have an impact to groundwater, the assessment aims to identify measures to avoid and minimise the impacts arising from project activities to human health and the environment, or otherwise affect recognised environmental values of groundwater so far as is reasonably practicable.

Based on the findings and results of the assessment, potential impacts were determined based on the associated environmental values of groundwater that may be threatened by project construction and operation activities. The following project activities were identified as potential hazards to groundwater, groundwater dependent ecosystems (GDEs) and groundwater users:

- Project construction and operation activities with the potential to alter groundwater levels and volume, or otherwise affect environmental values of groundwater include:
  - Temporary dewatering of onshore cable trenches, cable joint pits and direction drilling entry/exit pits.
  - Construction activities requiring impacting registered groundwater bores.
  - Project infrastructure, including haul roads and laydown areas.
  - Potential for directional drilling beneath rivers and creeks, and the Waratah Bay dune system.
  - Backfilling cable trenches with material of higher hydraulic conductivity.
  - Impermeable (or low permeability) subsurface infrastructure.
- Project construction and operation activities with the potential to cause groundwater contamination and affect environmental values of groundwater include:
  - Temporary groundwater level drawdown mobilising existing groundwater contamination.
  - Herbicide application at Driffield or Hazelwood converter station.
  - Discharge from the proposed Driffield septic tank system.
  - Accidental spills and leaks of transformer oil, lead acid batteries, and diesel fuel stored in above ground tanks at the Driffield or Hazelwood converter station.

- o Backfilled cable trench causing enhancement of recharge of stormwater runoff (including flood waters) to shallow groundwater.
- o Spills of hazardous chemicals and fuels required during constructions.
- o Construction of HDD causing groundwater contamination from drilling fluid additives.
- o Saline water intrusion from the marine environment to the aquifer induced by dewatering activities in the Waratah Bay area.

A significance assessment approach has been applied which identified mostly negligible and minor magnitude potential impacts, equating to low initial impact significance. Four potential impacts associated with planned construction activities were identified that might have higher initial impact significance. They included:

1. Construction activities destroying private (registered and unregistered) groundwater bores.
2. Impermeable (or low permeability) subsurface infrastructure creating a hydraulic barrier and causing damming affects to shallow groundwater flow.
3. Groundwater acidification due to temporary groundwater level drawdown.
4. Enhanced recharge of stormwater runoff (including flood waters) to shallow groundwater via higher-conductivity backfilled cable trench.

Management and mitigation measures have been recommended that if implemented are designed to limit the impacts of the project on groundwater through achieving the recommended Environmental Performance Requirements (EPRs). The proposed EPRs achieved a reduction of all potential impacts with an initial moderate impact significance to low residual impact significance.

It is recommended that groundwater investigations must be undertaken in areas where dewatering is likely to be required to support the project's detailed design and address recognised data gaps. This should be completed prior to construction commencing and be designed and reviewed by a suitably qualified hydrogeologist to ensure that all EPRs and minimum legislative requirements will be met. All residual impacts to groundwater were considered to be as low as reasonably practicable, following the implementation of mitigation and management measures that will achieve the recommended EPRs.

This report is presented within the limitations of the work which has been undertaken. Data gaps are summarised in Section 10. This executive summary should be read in conjunction with the body of the report and statement of limitation, which is provided in Appendix A.

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ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
AEP	Annual exceedance probability
M AHD	Australian Height Datum (in metres)
BOD	Biological oxygen demand
BoM	Bureau of Meteorology
C	Centigrade
CEMP	Construction Environment Management Plan
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEECA	The State of Victoria the Department of Energy, Environment and Climate Action
DTP	Victorian Department of Transport and Planning
DCCEEW	Australian Department of Climate Change, Energy, Environment and Water
DELWP	Department of Environment, Land, Water and Planning
EC (µS/cm)	Electrical conductivity (microsiemens per centimetre)
EES	Environment effects statement
EE Act	Environment Effects Act 1978 (Vic)
EIS	Environmental impact statement
EMF	Electromagnetic fields
EMP	Environmental Management Plan
EMPCA	Environmental Management and Pollution Control Act 1994
EPA	Environmental Protection Authority
EPR	Environmental Performance Requirement
EP Act	Environment Protection Act 2017 (Vic)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)
ERS	Environment Reference Standard
EV	Environmental Values
GDE	Groundwater dependent ecosystem
GL	Gigalitres
GIS	Geographic Information Systems
GMA	Groundwater management area
GMP	Groundwater Management Plan
HDD	Horizontal directional drilling
HVAC	High voltage alternating current
HVDC	High voltage direct current
km	Kilometres
kV	Kilovolt
L/s	Litres per second

Acronyms/Abbreviations	Definition
m	Metres
m AHD	Metres Australian Height Datum
mbgs	Metres below ground surface
mg/L	Milligrams per litre
MW	Megawatt
NEM	National Electricity Market
OEMP	Operation Environment Management Plan
PAH	Polycyclic Aromatic Hydrocarbon
PET	Potential Evapotranspiration
SEC	State Electricity Commission
SOBN	State observation bore network
TasNetworks	Tasmanian Networks Pty Ltd
TDS	Total Dissolved Solids
TRG	Technical Reference Group
TRH	Total Recoverable Hydrocarbons
UNESCO	United Nations Educational, Scientific and Cultural Organization
UTQA	Upper Tertiary Quaternary Aquifer
VAF	Victorian Aquifer Framework
VPPs	Victoria Planning Provisions
WMIS	Victorian Water Measurement Information System

1. INTRODUCTION

The proposed Marinus Link (the project) comprises a high voltage direct current (HVDC) electricity interconnector between Tasmania and Victoria, to allow for the continued trading and distribution of electricity within the National Electricity Market (NEM).

The project was referred to the Australian Minister for the Environment on 5 October 2021. On 4 November 2021, a delegate of the Minister for the Environment determined that the proposed action is a controlled action as it has the potential to have a significant impact on the environment and requires assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) before it can proceed. The delegate determined that the appropriate level of assessment under the EPBC Act is an environmental impact statement (EIS).

On 12 December 2021, the former Victorian Minister for Planning under the *Environment Effects Act 1978* (Vic) (EE Act) determined that the project requires an environment effects statement (EES) under the EE Act, to describe the project's effects on the environment to inform statutory decision making.

In July 2022 a delegate of the Director of the Environment Protection Authority Tasmania determined that the project be subject to environmental impact assessment by the Board of the Environment Protection Authority (the Board) under the *Environmental Management and Pollution Control Act 1994* (Tas) (EMPCA).

As the project is proposed to be located within three jurisdictions, the Victorian Department of Transport and Planning (DTP), Tasmanian Environment Protection Authority (Tasmanian EPA) and Australian Department of Climate Change, Energy, Environment and Water (DCCEEW) have agreed to coordinate the administration and documentation of the three assessment processes. One EIS/EES is being prepared to address the requirements of DTP and DCCEEW. Two EISs are being prepared to address the Tasmanian EPA requirements for the Heybridge converter station and shore crossing.

This report has been prepared by Tetra Tech Coffey for the Commonwealth and Victorian jurisdictions as part of the EIS/EES being prepared for the project.

1.1 PURPOSE OF THE REPORT

The purpose of the groundwater study is to characterise groundwater within the study area and identify potential impacts of the project on groundwater. Where potential impacts may affect the recognised environmental values of groundwater, the assessment aims to identify measures to avoid and minimise those impacts so far as is reasonably practicable.

The key objectives of this groundwater study are to:

- Describe applicable policy, legislation, regulations, standards, and guidelines for the minimisation of impacts to groundwater and management of impacts.
- Characterise existing groundwater conditions based on a desktop review of available information and data.
- Undertake desktop studies to obtain sufficient hydrogeological information to allow potential impacts on groundwater associated with the construction and operation of the project to be identified.
- Undertake a groundwater impact assessment that will form part of the EES for the project.
- Identify potential residual groundwater impacts and describe the proposed further investigations, inspections, and monitoring programs that will demonstrate achievement of the environmental objectives.

The outcomes of the groundwater study within Victoria are documented in this report. The Tasmanian component of the groundwater study (Heybridge) is provided within a separate report which is specific to Tasmanian assessment guidelines, 'Heybridge Groundwater Baseline and Impact Assessment'.

1.2 PROJECT OVERVIEW

The project is a proposed 1500 megawatt (MW) HVDC electricity interconnector between Heybridge in northwest Tasmania and the Latrobe Valley in Victoria (Figure 1-1). The project is proposed to provide a second link between the Tasmanian renewable energy resources and the Victorian electricity grids enabling efficient energy trade, transmission and distribution from a diverse range of generation sources to where it is most needed and will increase energy capacity and security across the National Electricity Market (NEM).

Marinus Link Pty Ltd (MLPL) is the proponent for the project and is a wholly owned subsidiary of Tasmanian Networks Pty Ltd (TasNetworks). TasNetworks is owned by the State of Tasmania and owns, operates and maintains the electricity transmission and distribution network in Tasmania.

Tasmania has significant renewable energy resource potential, particularly hydroelectric power and wind energy. The potential size of the resource exceeds both the Tasmanian demand and the capacity of the existing Basslink interconnector between Tasmania and Victoria. The growth in renewable energy generation in mainland states and territories participating in the NEM, coupled with the retiring of baseload coal-fired generators, is reducing the availability of dispatchable generation that is available on demand.

Tasmania's existing and potential renewable resources are a valuable source of dispatchable generation that could benefit electricity supply in the NEM. The project will allow for the continued trading, transmission and distribution of electricity within the NEM. It will also manage the risk to Tasmania of a single interconnector across the Bass Strait and complement existing and future interconnectors on mainland Australia. The project is expected to facilitate the reduction in greenhouse gas emissions at a state and national level.

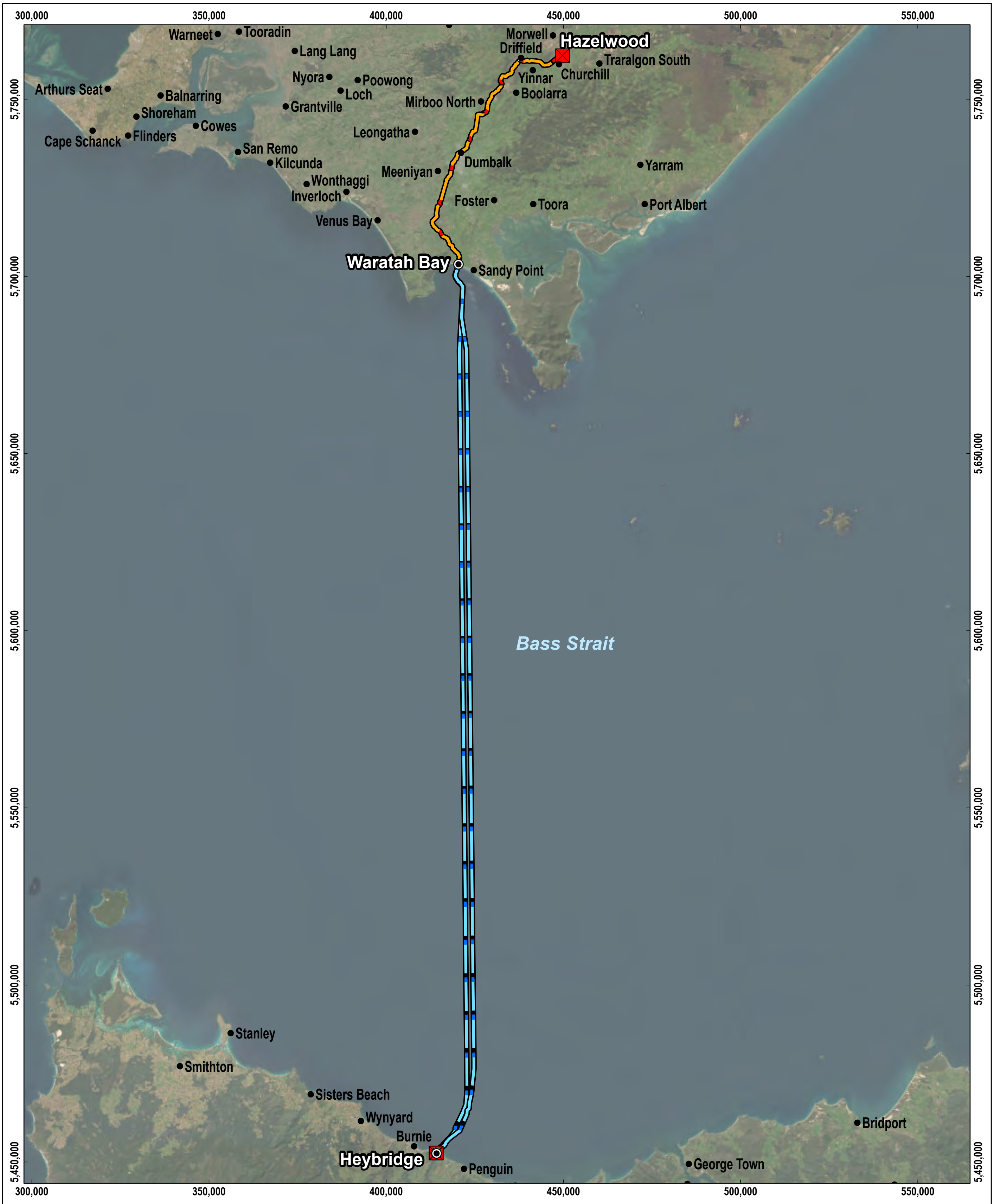
Interconnectors are a key feature of the future energy landscape. They allow power to flow between different regions to enable the efficient transfer of electricity from renewable energy zones to where the electricity is needed. Interconnectors can increase the resilience of the NEM and make energy more secure, affordable and sustainable for customers. Interconnectors are common around the world including in Australia. They play a critical role in supporting Australia's transition to a clean energy future.

1.3 ASSESSMENT CONTEXT

This groundwater study assesses the potential for groundwater impacts to result from the project during the construction, operational, and decommissioning phases. The intersection of shallow groundwater is anticipated along some sections of the project and potential changes to groundwater levels, flow, and quality could occur during the construction and operational phases.

It is important to assess whether these project activities could impact groundwater values, including groundwater users who extract groundwater from existing groundwater bores and groundwater dependent ecosystems (GDEs). GDEs are those ecosystems that require access to groundwater to meet some or all of their water requirements to maintain the terrestrial and aquatic communities and ecological processes they support, and ecosystem services they provide. These can include streams or lakes that groundwater discharges into, vegetation with roots that access groundwater, or biota living in aquifers and cave systems.

This assessment provides an understanding of the areas of potential groundwater level and groundwater quality impacts that may arise from the project, the potential risk of impacts to groundwater users and other recognised environmental values of groundwater, and informs the development of Environmental Performance Requirements (EPRs) to avoid or mitigate these impacts.



LEGEND

- Landfall
- Converter station
- HVDC subsea cable
- Underground HVDC cable
- Cable option not progressing

MARINUS LINK

0 15 30 km

SCALE 1:1,500,000

PAGE SIZE: A4

PROJECTION: GDA2020 MGA Zone 55

SOURCE
Proposed route from Tetra Tech Coffey.
Imagery from ESRI Online.

MARINUS LINK PTY LTD

MARINUS LINK
GROUNDWATER IMPACT ASSESSMENT - VICTORIA

FIGURE 1-1

Project overview

TETRA TECH COFFEY

DATE: 16.05.24 PROJECT:754-MELEN215878ML FILE: 215878ML_HYDRO_F01-1_GIS

2. ASSESSMENT GUIDELINES

This section outlines the assessment guidelines relevant to this groundwater impact assessment and the linkages to other EIS/EES technical studies. A single consolidated EIS/EES is being prepared to address all requirements of the Commonwealth and Victorian jurisdictions including the requirement for an EES. This report will use the term EIS/EES going forward.

2.1 COMMONWEALTH

DCCEEW have published the following guidelines for the EIS: *'Guidelines for the Content of a Draft Environmental Impact Statement – Environment Protection and Biodiversity Conservation Act 1999* – Marinus Link underground and subsea electricity interconnector cable (EPBC 2021/9053)'.

The sections of the EIS assessment guidelines relevant to the groundwater impact assessment include:

- Description of the environment of the proposed site and the surrounding areas that may be impacted by the action. The description should also include information on the importance and value of potentially impacted environmental features at the local and regional scale (Section 5).
- Identify the source of potential impacts (e.g., cable-installation, ship movements, noise, light) and consider potential impacts throughout the life of the project (Section 7).
- Discuss potential impacts which may arise through the transportation, storage, and use of dangerous goods (if any), fuels and chemicals, such as accidental spills (Section 7).
- Discuss potential impacts, consider how the interaction of extreme environmental events and any related safety response may impact on the environment (Sections 7 and 9).
- Consider the application of a waste management hierarchy (e.g., reduce, reuse, recycle, treat, dispose) and potential impacts caused by the need for waste disposal and management of emissions, refuse, effluent and hazardous waste (if any) (Section 9). Review and analysis of residual impacts of the proposed development and of other known proposals where there may be a spatial or temporal overlap (Sections 7.7 and 7.8).
- Consideration of the potential for cumulative impacts on the resilience of any important populations of threatened species and ecological communities and on overall habitat quality and availability (Section 7.8).
- Discussion of the potential for existing pressures to be exacerbated by the proposed development (Sections 5 and 7).
- Provide information on proposed EPRs, and any specific avoidance, management, and mitigation measures to deal with the relevant impacts of the proposed action (Section 9).

2.2 VICTORIA

The EES Scoping Requirements issued by the Minister for Planning (February 2023) outline the specific matters to be assessed across a number environmental and social disciplines relevant to the project, and to be documented in the EES for the project.

The EES Scoping Requirements inform the scope of the EES technical studies and define the EES evaluation objectives. The EES evaluation objectives identify the desired outcomes to be achieved and provide a framework for an integrated assessment of the environmental effects of a proposed project.

2.2.1 EES evaluation objective

The EES evaluation objective contained in Section 4.2 of the EES scoping requirements that is relevant to this groundwater impact assessment is:

- *Avoid and, where avoidance is not possible, minimise adverse effects on water (including groundwater, surface water, waterway, wetland, and marine) quality, movement and availability*.

2.2.2 EES scoping requirements

The sections of the EES scoping requirements relevant to this groundwater impact assessment together with the relevant sections of the report addressing the requirements are provided in Table 2-1.

Table 2-1 Final EES Scoping Requirements

Aspect	Relevant EES scoping requirements	Relevant section of the report
Key issues	The potential for adverse effects on the functions and values of groundwater due to the project's shore crossing, cable trenching or other construction activities.	Section 3 and 7.
Existing environment	Characterise the local groundwater quality and behaviour, including the environmental values and any GDEs that might be affected by the project.	Section 5
Likely effects	Identify and evaluate potential effects of the project on groundwater, including with appropriate consideration of climate change scenarios and cumulative effects.	Section 5.1 and Section 7.8
Mitigation	Identify and evaluate aspects of project works and operations, and proposed design refinement options or measures, that could avoid and minimise significant effects on groundwater. Describe further potential and proposed design options and measures that could avoid or minimise significant effects on groundwater, waterway, wetland, and marine waters during the project's construction and operation, including response measures for environmental incidents.	Section 7 and 9
Performance	Describe the framework for monitoring and evaluating the measures implemented to mitigate impacts on water, soils and landforms and contingencies.	Section 7, 8 and 9

Source: The State of Victoria the Department of Energy, Environment and Climate Action (DEECA) 2023

2.2.3 Water Act 1989 (Vic)

The *Water Act 1989* legislates for water entitlements issued and allocated in Victoria. The Act defines water entitlements and establishes the mechanisms for managing Victoria's water resources. The Act also covers the use of water through bulk entitlements and take and use licences, and licensing for mine void dewatering where the operation is below the saturated groundwater zone.

If groundwater is to be extracted by the project (such as to dewater an excavation), licensing may be required under the Water Act including:

- Section 51 – take and use license for a water supply borefield and/or mine dewatering;
- Section 67 – construction licence for dams; and
- Section 67 – works on a waterway, such as diversion drains, stream crossings, etc.

2.2.4 Safe Drinking Water Act 2003 (Vic)

The *Safe Drinking Water Act 2003* (Vic) makes provision for the supply of safe drinking water. The Act requires water suppliers and water storage managers to prepare and implement plans to manage risks in relation to drinking water in Victoria, and to ensure that the drinking water they supply meets quality standards specified by the regulations. It requires water suppliers to disclose to the public information concerning the quality of drinking water and requires the reporting of known or suspected contamination of drinking water to the Department of Human Services.

The Department of Health and Human Services is responsible for administering the Act and its framework, which comprises the both the Act and the Safe Drinking Water Regulations 2005. This framework provides a ‘Catchment to Tap’ risk management framework to ensure the safe supply of drinking water across Victoria.

2.2.5 Planning and Environment Act 1987 (Vic)

The *Planning and Environment Act 1987* (Vic) establishes a framework for planning the use, development, and protection of land in Victoria, and it enables municipal councils to introduce planning schemes to control land use. The Victoria Planning Provisions (VPPs) provide a state-wide uniform format for municipal planning schemes and contain a State Planning Policy Framework for floodplain management and a local Planning Policy Framework.

Land use planning is considered an effective means of reducing future risks and damage from flooding. The principal statutory authorities responsible for land use planning on flood prone lands in regional Victoria are Catchment Management Authorities (CMAs) and local governments.

2.2.6 Environment Protection Act 2017 (Vic)

In October 2017, the *Environment Protection Act 2017* (Vic) (the EP Act) was passed by Parliament, and the subsequent *Environment Protection Amendment Act 2018* provided the detailed environmental laws, and subordinate legislation which further informs the laws. The EP Act took effect on July 1, 2021.

The EP Act includes a ‘General Environmental Duty’, which places a duty on all Victorians and Victorian businesses who engage in an activity that may give rise to risks to harm to human health or the environment from pollution or waste to eliminate those risks, or if not possible to do so, to reduce those risks so far as reasonably practicable. The EP Act also includes a new Duty to Notify the EPA of prescribed notifiable contamination (as detailed in the Regulations), and a Duty to Manage contamination.

Subordinate legislation includes the Environment Reference Standard (ERS) and Environment Protection Regulations. The ERS is established under section 93 of the EP Act and is designed to support the protection of human health and the environment from pollution and waste by providing benchmarks to assess and report on environmental conditions. The ERS achieves this by:

- Identifying environmental values to be achieved or maintained in the whole or any part of Victoria; and
- Specifying indicators and objectives to be used to measure, determine, or assess whether those environmental values are being achieved, maintained, or threatened.

Elements of the ERS that should be considered in the whole or any part of Victoria include:

- Ambient air;
- Ambient sound;
- Land; and
- Water (groundwater and surface water).

2.3 TASMANIA

The Tasmanian component of the project is being assessed in accordance with the EIS guidelines issued by EPA Tasmania for the converter station and shore crossing at Heybridge (September 2022). This assessment is documented in a separate report (*Heybridge Groundwater Baseline and Impact Assessment* (Tetra Tech Coffey 2023).

2.4 LINKAGES TO OTHER TECHNICAL STUDIES

The groundwater impact assessment draws from the outcomes of the following studies undertaken for the project as outlined in Table 2-2.

Table 2-2 Relevant technical studies referenced

Technical study	Relevance to this assessment
Climate and Climate Change Assessment (Katestone Environmental Pty Ltd (Katestone), 2023)	Characterises the climate change predictions and risk that could affect the project. This report has been used as the basis for estimating future groundwater recharge rates and potential influences on groundwater levels and flow directions.
Aboriginal Cultural Heritage Technical Study (Ecological Australia Pty Ltd (ELA), 2023)	Details baseline condition and potential impact on Aboriginal cultural heritage. This report identifies the issues, areas or sites of relevance and concern to Traditional Owners (i.e., groundwater units being listed as a heritage site) and a process to ensure appropriate engagement is undertaken to form indicators and objectives to minimise the risks of harm with respect to this Aboriginal cultural heritage values.
Contaminated land and acid sulfate soils (Tetra Tech Coffey, 2023)	Characterises the existing contamination issues and risks associated with acid sulfate soils within the study area. The outcomes of this report have been used to identify sources of potential groundwater quality impacts that may be mobilised or encountered during construction and the risk of groundwater acidification from dewatering.
Terrestrial Geomorphology and Geology Impact Assessment (Environmental GeoSurveys Pty Ltd (Environmental GeoSurveys), 2023)	Details the baseline conditions and potential impacts associated with terrestrial geomorphology, geology and soils. Groundwater influences geomorphology and geology and vice versa.
Victorian Surface Water Impact Assessment (Alluvium Consulting Pty Ltd (Alluvium), 2023)	Characterises the hydrological setting within the study area. The outcomes of this report have supported the assessment of aquatic GDEs and their possible interaction with groundwater within the study area.
Planning and Land Use Impact Assessment (Tetra Tech Coffey, 2023)	Characterises existing land uses along the project alignment. This report has assisted with identifying of land uses which may interact with groundwater and determining potential environmental values of groundwater.
Terrestrial Ecology Impact Assessment (Ecological Australia (ELA), 2023)	Characterises the ecological setting relevant to groundwater within the study area, including terrestrial GDEs. The outcomes of this report have been used to determine the ecological value of terrestrial GDEs in the study area.

3. PROJECT DESCRIPTION

This section discusses the key component and details of the Project Description and activities that are relevant to the groundwater impact assessment.

3.1 OVERVIEW

The project is proposed to be implemented as two 750 MW circuits to meet transmission network operation requirements in Tasmania and Victoria. Each 750 MW circuit will comprise two power cables and a fibre-optic communications cable bundled together in Bass Strait and laid in a horizontal arrangement on land. The two 750 MW circuits would be installed in two stages with the western circuit being laid first as part of stage one, and the eastern cable in stage two.

The key project components for each 750 MW circuit, from south to north, are:

- HVAC switching station and HVAC-HVDC converter station at Heybridge in Tasmania. This is where the project will connect to the North West Tasmania transmission network being augmented and upgraded by the North West Transmission Developments (NWTD).
- Shore crossing in Tasmania adjacent to the converter station.
- Subsea cable across Bass Strait from Heybridge in Tasmania to Waratah Bay in Victoria.
- Shore crossing at Waratah Bay approximately 3 kilometres (km) west of Sandy Point.
- Land-sea cable joint where the subsea cables will connect to the land cables in Victoria.
- Land cables in Victoria from the land-sea joint to the converter station site in the Driffield or Hazelwood areas.
- HVAC switching station and HVAC-HVDC converter station at Driffield or at Hazelwood, where the project will connect to the existing Victorian transmission network.

A Transition Station at Waratah Bay may also be required if there are different cable manufactures or substantially different cable technologies adopted for the land and subsea cables. The location of the transition station will also house the fibre optic terminal station in Victoria. However, regardless of whether a transition station is needed, a fibre optic terminal station will still be required in the same location.

Approximately 255 km of subsea HVDC cable will be laid across Bass Strait. The preferred technology for the project is two 750 megawatt (MW) symmetrical monopoles using ±320 kV, cross-linked polyethylene insulated cables and voltage source converter technology. Each symmetrical monopole is proposed to comprise two identical size power cables and a fibre-optic communications cable bundled together. The cable bundles for each circuit will transition from approximately 300 m apart at the horizontal directional drilling (HDD) (offshore) exit to 2 km apart in offshore waters.

In Victoria, the shore crossing is proposed to be located at Waratah Bay with the route crossing at the Waratah Bay–Shallow Inlet Coastal Reserve. From the land-sea joint located behind the coastal dunes, the land cable will extend underground for approximately 90 km to the converter station. From Waratah Bay the cable will run northwest to the Tarwin River Valley and then travel to the north to the Strzelecki Ranges. The route crosses the ranges between Dumbalk and Mirboo North before descending to the Latrobe Valley where it turns northeast to Hazelwood. The Victorian converter station will be at either a site south of Driffield or Hazelwood adjacent to the existing terminal station.

The land cables will be directly laid in trenches or installed in conduits in the trenches. A construction area of 20 m to 36 m wide would be required for laying the land cables and construction of joint bays. Temporary roads for accessing the construction area and temporary laydown areas will also be required to support construction. Where possible, existing roads and tracks will be used for access, for example, farm access tracks or plantation forestry tracks.

Land cables will be installed in ducts under major roads, railways, major watercourses and substantial patches of native vegetation using trenchless construction methods (e.g., HDD), where geotechnical conditions permit. A larger area than the 36 m construction area will be required for the HDD crossing.

The assessment is focused on the Victorian section of the project. This report will inform the EIS/EES being prepared to assess the project's potential environmental effects in accordance with the legislative requirements of the Commonwealth and Victorian governments (see Figure 3-1).

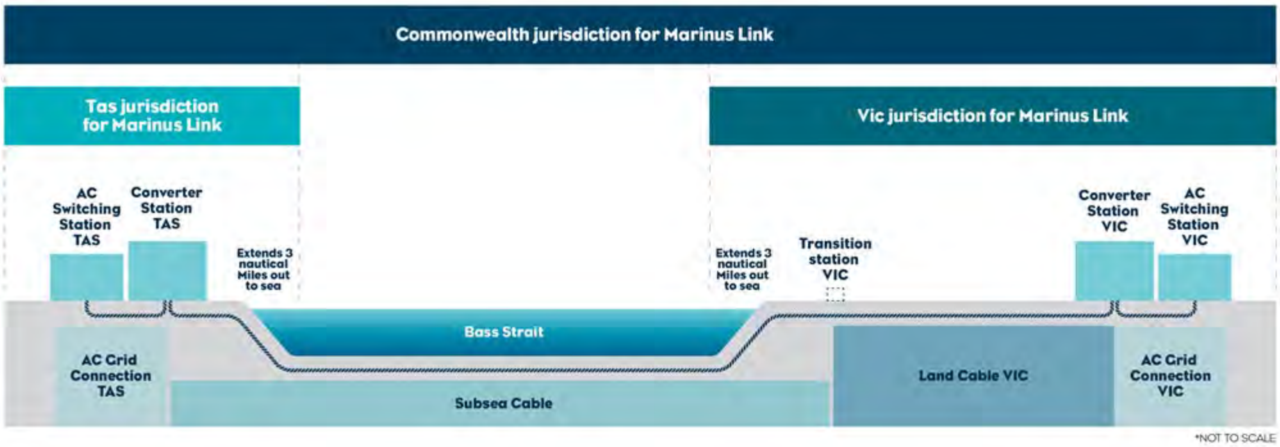


Figure 3-1 Project components considered under applicable jurisdictions (MLPL, 2022)

The project is proposed to be constructed in two stages over approximately five years following the award of works contracts to construct the project. On this basis, stage 1 of the project is expected to be operational by 2030, with Stage 2 to follow, with final timing to be determined by market demand. The project will be designed for an operational life of at least 40 years.

3.2 CONSTRUCTION

A description of elements of the project during the construction phase that have the potential to impact on environmental or social groundwater values considered within this groundwater impact assessment are summarised below.

- **Shore crossing** – HDD.
- **Transition station** – Civil works (access road, transition station bench, foundations and hardstand area).
- **Land cables** – Site establishment, topsoil stripping and stockpiling and haul road construction, construction of joint pits, HDD, excavation of trenches, installation of ducts and backfilling.
- **Converter station** – Site preparation, earthworks and civil works.

These activities can impact on groundwater quality and/or quantity through mechanisms such as:

- Converting natural surfaces to be impermeable which reduced surface infiltration of rainfall.
- Temporary dewatering of excavations reducing surrounding groundwater levels and supply to users or GDEs, potentially mobilising contamination or causing acidification of groundwater.
- Potential for groundwater daylighting/seepage where access road cuttings intercept shallow groundwater.
- Potential for wastewater discharges and improper disposal of dewatered groundwater.
- Potential for groundwater drawdown and preferential groundwater pathways (such as HDD boreholes) to induce saline water intrusion into coastal aquifers.
- Impermeable (or low permeability) subsurface infrastructure (such as thermal backfill) creating a hydraulic barrier and causing damming affects to shallow groundwater flow.

- Potential for hydraulic pathways to be created between isolated aquifers (including perched aquifers).
- Compaction of unconsolidated aquifer matrices beneath haul roads, laydown areas, or other infrastructure altering aquifer permeability and altering groundwater flow directions and levels.
- Potential for spills or leakage of chemicals, fuels and hazardous materials to entire waterways or infiltrate through soil to groundwater.
- Potential for construction materials and products (e.g., lubricants, sealants, chemical grouts) to impact groundwater quality.
- Backfilling cable trenches with material of higher hydraulic conductivity altering groundwater flow paths (e.g., causing localised groundwater recharge, dewatering, or creation of new groundwater preferential pathways).
- Backfilling of cable trenches with material of lower permeability creating hydraulic barriers and causing damming affects to shallow groundwater.
- Enhanced recharge of poor-quality stormwater runoff (including flood waters) to shallow groundwater via higher-conductivity backfilled cable trench.

3.3 OPERATION

The following operational project activities have been considered:

- Accidental spills and leaks of transformer oil, lead acid batteries, and diesel fuel stored in above ground tanks at the Driffield converter station.
- Accidental leaks from triple interceptor traps.
- Discharge from the proposed Driffield septic tank system causing groundwater contamination.
- Herbicide application at the Driffield converter station migrating to groundwater.

3.4 DECOMMISSIONING

The operational lifespan of the project is a minimum 40 years. At this time the project will be either decommissioned or upgraded to extend its operational lifespan.

Decommissioning will be planned and carried out in accordance with regulatory and landowner or land manager requirements at the time. A decommissioning plan in accordance with approvals conditions will be prepared prior to planned end of service and decommissioning of the project.

Requirements at the time will determine the scope of decommissioning activities and impacts. The key objective of decommissioning is to leave a safe, stable and non-polluting environment, and minimise impacts during the removal of infrastructure.

In the event that the project is decommissioned, all above-ground infrastructure will be removed, and associated land returned to the previous land use or as agreed with the landowner or land manager.

Decommissioning activities required to meet the objective will include, as a minimum, removal of above ground buildings and structures. Remediation of any contamination and reinstatement and rehabilitation of the site will be undertaken to provide a self-supporting landform suitable for the end land use. Decommissioning and demolition of project infrastructure will implement the waste management hierarchy principles being avoid, minimise, reuse, recycle and appropriately dispose. Waste management will accord with applicable legislation at the time.

Decommissioning activities may include recovery of land and subsea cables and removal of land cable joint pits. Recovery of land cables would involve opening the cable joint pits and pulling the land cables out of the conduits, spoiling them onto cable drums and transporting them to metal recyclers for recovery of component materials. The conduits and shore crossing ducts would be left in-situ as removal would cause significant environmental impact.

The concrete cable joint pits would be broken down to at least one metre below ground level and buried in-situ or excavated and removed. Subsea cables would be recovered by water jetting or removal of rock mattresses or armouring to free the cables from the seabed.

A decommissioning plan will be prepared to outline how activities will be undertaken and potential impacts managed.

4. ASSESSMENT METHOD

This section describes the method used to assess the potential groundwater impacts associated with project activities considering the values present in the project area. This assessment method addresses the requirements outlined in the Commonwealth and Victorian assessment guidelines for the project (Section 2).

The assessment method has three key steps.

The first step is the evaluation of the baseline conditions to identify environmental values and potential of impacts. This includes:

- Defining a study area to provide context for identifying potential issue and assessing impacts.
- Baseline characterisation of groundwater quality, uses, levels and influences from things such as climate, hydrology, existing land uses and geological conditions.
- Understanding the geology and nature of the aquifers.
- Developing a model of groundwater levels and flows.

The second step is the hydrogeological assessment which aims to predict changes to groundwater in response to the proposed construction and operation activities, such as groundwater dewatering.

The third step includes the assessment of the sensitivity of groundwater values and aquifers to change, the assessment of the magnitude of the changes, and the significance of the impact. This step also includes considering possible mitigation measures to reduce impacts and asses a residual impact.

4.1 STUDY AREA

The groundwater impact assessment considered potential impacts to the levels, flow and quality of groundwater that may, in turn, affect groundwater values.

Following an initial review of the project description the groundwater study area has been defined as a 500 m buffer zone from the centreline of the project alignment of the subsurface transmission cables and infrastructure between Hazelwood and Waratah Bay, based on professional experience of a conservatively assumed zone of potential influence. This initial assumption was subsequently verified by the drawdown analysis and modelling which confirmed higher magnitude drawdown would be limited to within 500 m of the cable trench (Section 6).

A nominal 10 m vertical study area limit was set for project alignment, based on the 1.5 m maximum trench depth and an assumed margin of safety to consider potential for vertical groundwater effects and the depths that HDD may extend to beneath river crossings and surface infrastructure.

The groundwater impact assessment also considers potential impacts associated with HDD from the Victorian transition station to a point approximately 1 km offshore in 10 m deep water where the cables will emerge and connect to the subsea cable (Figure 4-1).

The study area has been considered in four segments based on physiography:

- Coastal setting: Waratah Bay to Fishcreek
- Coastal plains and foothills: Fishcreek to Tarwin
- Highlands: Tarwin to Delburn, and
- Latrobe Valley: Delburn to Hazelwood.

Figure 4-1 Indicative shore crossing construction

The scale of the study area is such that some features of the baseline groundwater characterisation (i.e., climate, physiography and drainage, geology and hydrogeology) are described and mapped in a regional context. This is supplemented by local scale information (i.e., GDEs, registered groundwater users) and data that is publicly available to support the modelling and assessment.

4.2 BASELINE GROUNDWATER CHARACTERISATION

A baseline characterisation of the existing groundwater conditions within the study area has been based on desktop review of published literature and data for the Gippsland region. The baseline groundwater characterisation provides the necessary level of understanding of the existing groundwater environment along the project alignment.

There is extensive hydrogeological data available across Victoria, and particularly in the Gippsland region where the project is proposed. Modelled groundwater level and aquifer data is available for the project area and is readily available in geographic information system (GIS) formats which can be interrogated as part of the desktop baseline groundwater characterisation.

The scope of the desktop literature and data review included:

- Identification of the underlying mapped geology and major aquifers from various resources including published geological records and the Victorian Aquifer Framework (VAF) document (GHD, 2012).
- Review of data from the Victorian Water Measurement Information System database (WMIS) to identify registered groundwater users.
- Review of climate data from the Bureau of Meteorology (BoM) weather stations.
- Identifying areas subject to groundwater management or special conditions, such as Groundwater Management Areas and Water Supply Protection Areas.
- Identification of surface water features within the study area.
- Identification of mapped wetlands, other potential GDEs and expected groundwater-surface water interactions.
- Analysis of topography and its influence on groundwater conditions.
- Broad characterisation of the published hydraulic properties of the shallow aquifers, groundwater level and quality range, groundwater values, and identification of existing licenced extraction and monitoring bores in the study area.
- Review of known and potential groundwater contamination issues within the project study area, including the Hazelwood area converter location.

Consistent with the Ministerial guidelines for assessment of the environmental effects under the *Environment Effects Act 1978* (Vic) (EE Act), the groundwater impact assessment (including the baseline characterisation) adopts the recommended risk-based approach to ensure that the required assessment, including the extent of investigations, is proportionate to the risk of adverse effects.

The information obtained during the desktop literature and data review was considered to be sufficiently detailed across the project area to characterise baseline groundwater conditions to a level that is proportionate to the risk of adverse effects posed by the project.

In the case where the significance of a residual impact to groundwater is moderate or higher, subsequent field investigations (such as installation of groundwater wells, aquifer hydraulic testing, and level and quality monitoring) may be recommended.

4.3 HYDROGEOLOGICAL ASSESSMENT METHOD

This assessment has considered the change in hydrogeological conditions during construction where the cable trench may intersect groundwater and temporary dewatering is required. The following sections describe the approach to estimate the potential groundwater levels changes over distance. The level of predicted change is then presented in Section 6 and the associated impacts are assessed in Section 7.

4.3.1 Project dewatering requirements

The project proposes to install the HVDC transmission cables in two parallel 1.5 m deep and 1 m wide trenches along the project alignment. The potential exists for the excavations and final infrastructure to interact with groundwater where the maximum groundwater level (including seasonal fluctuations) is within 1.5 m of the ground surface.

This assessment has adopted the following preliminary assessment methodology in advance of site-specific information provided by the intrusive geotechnical investigation works that are underway to support the detailed design:

1. The depth to groundwater was calculated along the project alignment at 10 m intervals by subtracting the published average water table elevation from the ground surface elevation, each were reported in metres above the Australian Height Datum (m AHD).
2. The proposed onshore trench depth of 1.5 metres below ground surface (mbgs) was then compared with the depth to groundwater (calculated at Step 1). Where the trench depth was greater than the depth to groundwater a high dewatering likelihood rating was assigned (corresponding to red symbology on Figure 7-1 in Appendix D).
3. A second, more conservative estimate of depth to groundwater was considered by applying a further 1 m on the average groundwater elevation to account for temporal / seasonal variations that are not reflected by the published average. This 1 m buffer was based on groundwater fluctuations reported in a coastal bore (ID 100976) (discussed further in Section 5.5.3) in lieu of project specific groundwater level measurements. The depth to groundwater along the project alignment should be reviewed as project specific groundwater level data becomes available. Additional parts of the trench alignment that extend below the inferred seasonal water table range were assigned a moderate dewatering likelihood rating (corresponding to amber symbology on Figure 7-1 in Appendix D).
4. Sections of the trench alignment that did not extend below the conservative seasonal water table range were assigned low likelihood ratings (corresponding to sections of the trench alignment without any amber or red symbology on Figure 7-1 in Appendix D).

Results of the assessment of project dewatering requirements are presented in Section 6.1.

4.3.2 Groundwater drawdown assessment

Two-dimensional analytical groundwater modelling has been undertaken to simulate the possible range of groundwater level drawdown that may occur around the trench and cable joint pit excavations. The purpose of the assessment was to inform the magnitude of potential impacts to nearby groundwater users (registered bores) and GDEs.

Analytical assessment of groundwater inflow during onshore trench excavation and cable conduit construction has been carried out based on theory presented by Edelman (1972) for radial drawdown from an extensive aquifer in the case of pits and for parallel flow to a long excavation for assessment of flow towards the trench.

Conservative assumptions have been made for the aquifers that are likely to be encountered during construction (refer to Section 5.5) and which might require dewatering.

The drawdown assessment has been conducted to estimate drawdown magnitude in different aquifer settings. Where aquifers share the same hydraulic properties (such as for the Thorpdale Volcanics and the Strzelecki Group) these have been assessed together. Where an aquifer is comprised of formations with different hydraulic properties (such as the Upper Tertiary Quaternary Aquifer, comprised of the Quaternary alluvium and Haunted Hill Formation) they have been assessed separately. The assessed drawdown scenarios are based on the following lithological groupings;

- Quaternary alluvium.
- Haunted Hill Formation.
- Lower Tertiary Basalt and Wonthaggi Formation bedrock.

Results of the analytical drawdown assessment are presented in Section 6.

4.4 IMPACT ASSESSMENT

The assessment of potential groundwater impacts has been conducted by assessing the significance of an impact. This approach considers the sensitivity of the environmental segment (in this case groundwater aquifers) (Section 4.4.3) and the magnitude of the impact to relevant environmental values if it did occur (Section 4.4.2).

Impacts are assessed initially based on the implementation of standard mitigation measures that are either proposed by the proponent or are common across the industry. If needed, the development of additional mitigation or management measures (in the form of environmental performance requirements, Section 4.4.5) may be required to reduce the residual predicted impact so far as reasonably practicable.

4.4.1 Identifying potential impacts

The proposed project description (Section 3) and associated predicted effects on the groundwater environment (Section 4.3) were reviewed by the author to consider the potential adverse impacts that construction, operation and decommissioning activities that may have on the identified groundwater values.

Potential impacts from the project on the groundwater environment have been identified in the EES Scoping Requirements and are considered further by the impact assessment. Additional potential impacts were also identified based on the professional opinion and experience of Tetra Tech Coffey's technical specialist (hydrogeologists), their environmental approvals team, and the proponent's project management team gained on other linear infrastructure projects and is informed by the understanding of the existing environment presented in Section 5. Additional potential impacts identified during review by the Technical Reference Group (TRG) were also included and assessed.

As a minimum, this impact assessment considers the key issues as required in the EES Scoping Requirements.

The potential impacts identified are carried through the impact assessment in Section 7.

4.4.2 Assessing the magnitude of impacts

The magnitude of an impact on an environmental value is assessed according to the following criteria:

- *Geographical extent:* an assessment of the spatial extent of the impact where the extent is defined as site, local, regional, or widespread (meaning state-wide or national or international).
- *Duration*: the timescale of the effect (i.e., short, medium, or long term).
- *Severity:* an assessment of the scale or degree of change from the existing condition (positive or negative), as a result of the impact.

The criteria for determining the magnitude level of a potential impact, as applied in the groundwater significance impact assessment, are described in Table 4-1. The magnitude of each potential impact has been assessed in Section 7 by applying the methodology described here.

Table 4-1 Magnitude criteria for groundwater impact assessment

Magnitude level	Criteria
Severe	An impact that causes permanent changes and irreversible harm to the environmental value(s) of the groundwater system, including in its capacity to support connected features. The impact causes major public outrage and sustained widespread community complaint. Prosecution by regulatory authorities is likely. Avoidance through appropriate design responses is required to address the impact.
Major	An impact that is widespread, long lasting and results in substantial change to the environmental value(s) either temporarily or permanently to the groundwater system, including its capacity to support connected features. The impact can only be partially rehabilitated or there is some uncertainty it can successfully be rehabilitated. It causes major public outrage, receives widespread community complaint, and prosecution by regulatory authorities is possible. Appropriate design responses are required to address the impact.
Moderate	An effect that extends beyond the operational area to the environmental value(s) of the surrounding groundwater system and its connected features but is contained within the region where the project is being developed. The impacts may receive local community complaint. However, they are short term and result in changes that can be ameliorated with specific environmental management controls.
Minor	A localised impact to environmental value(s) of the groundwater system and its connected features that is short term and could be effectively mitigated through standard environmental management controls. Remediation work and follow-up required.
Negligible	A localised impact to environmental value(s) of the groundwater system and its connected features that is temporary and does not extend beyond the operational area. Either unlikely to be detectable or could be effectively mitigated through standard environmental management controls. Full recovery is expected.

4.4.3 Identification and sensitivity assessment of environmental values

For the significance impact assessment, the sensitivity of an identified environmental value of groundwater is determined with respect to the following factors as they relate to the aquifers on which they rely:

- *Protection status*: assigned to an environmental value by governments (including statutory and regulatory authorities) or recognised international organisations (e.g., United Nations Educational, Scientific and Cultural Organization (UNESCO)) through legislation, regulations and international conventions.
- *Intactness*: an assessment of how intact an environmental value is. It is a measure (with respect to its characteristics or properties) of its existing condition, particularly its representativeness.
- *Uniqueness or rarity*: an assessment of its occurrence, abundance and distribution within and beyond its reference area (e.g., bioregion/biosphere).
- *Resilience to change*: determined by the extent to which an environmental value can cope with change including that posed by threatening processes. This factor is an assessment of the ability of an environmental value to adapt to change without adversely affecting its conservation status, intactness, uniqueness, or rarity.
- *Replacement potential*: the potential for a representative or equivalent example of the environmental value to be found to replace any losses.

The criteria for the different sensitivity levels of each aquifer, as applied in the groundwater significance impact assessment, are described in Table 4-2.

The identification of environmental values, which informs aquifer sensitivity and the outcomes of the sensitivity assessment, are presented in Section 5.5.8.

Table 4-2 Definitions for the sensitivity of aquifers (based on their capacity to support groundwater values)

Sensitivity criteria	Very high sensitivity	High sensitivity	Moderate sensitivity	Low sensitivity	Not sensitive
Environmental Values of groundwater **Potential uses of groundwater related to the suitability of the water to support ecosystems, and consumptive and productive uses.**	Attributes of the groundwater system support connected features that are of high ecological importance and/or cultural or spiritual significance. Intrinsic attributes support the use of the groundwater for potable supply, agricultural use, and food production.	Attributes of the groundwater system support ecosystems that are of high importance but may be slightly modified. Intrinsic attributes support the use of the groundwater for secondary domestic supply and some agricultural uses.	Attributes of the groundwater system support ecosystems that are characterised as slightly to moderately disturbed and may have reduced biodiversity and ecological value. Groundwater quality or levels may be altered from natural conditions and partly affect some environmental values. Intrinsic attributes support the use of the groundwater for construction and irrigation purposes, and might support some short-term agricultural uses (such as during drought)	The groundwater system supports ecosystems of limited ecological importance, which are characterised as highly altered from their natural state. Groundwater quality is highly altered from natural conditions. Groundwater supports a limited range of consumptive and productive uses.	Attributes of the groundwater system (quality, occurrence, volume, extraction potential) are not suitable for environmental values. Groundwater quality may be highly altered from natural conditions and may be impacted by existing contamination sources. Groundwater supports a very limited range of consumptive and productive uses and ecosystems that have low dependence on water quality parameters.
Uniqueness and rarity **Abundance of the aquifer type and availability of equivalent or representative alternatives. Uniqueness of the aquifer or connected feature that carries conservation status.**	Attributes of the groundwater system (including connected features) are unique. There are no known available alternatives. The groundwater system, or connected feature, is listed on a recognised or statutory state, national or international register as being of conservation significance.	Attributes of the groundwater system are locally unique, and with few regionally available alternatives. The groundwater system, or connected feature, is listed on a recognised or statutory state or national register as being of conservation significance.	Attributes of the groundwater system are locally unique but have regionally available alternatives. The groundwater system, or connected feature, is recorded as being important at a regional level, and may have been nominated for listing on recognised or statutory registers.	Attributes of the groundwater system are common on a regional and national basis, and therefore, have regionally available alternatives. The groundwater system, or connected feature, is not listed on any recognised or statutory register.	Attributes of the groundwater system are common on a local and regional scale, and therefore have both local and regionally available alternatives. The abundance and widespread distribution of the groundwater system, and any connected features, ensures replacement of unavoidable losses is assured. The groundwater system, and its connected features, are not listed on any recognised or statutory register, nor are they recognised locally by relevant suitably qualified experts or organisations.
Resilience to change **Groundwater properties such as water level or pressure changes, and quality change, and the nature of the aquifer's connection to the environment.**	The groundwater system, or connected features, have a very low capacity to adjust to level or quality change or disturbance. Intrinsic properties of the groundwater system are very susceptible to change. The overall function of the groundwater system would be permanently altered.	The groundwater system, or connected features, have a low capacity to adjust to level or quality change or disturbance. Intrinsic properties of the groundwater system are susceptible to change. The overall function of the groundwater system would be temporarily altered.	The groundwater system, or connected features, have a moderate capacity to adjust to level or quality change or disturbance. Intrinsic properties of the groundwater system are moderately susceptible to change. The overall function of the groundwater system could be partly altered.	The groundwater system, or connected features, have a high capacity to adjust to level or quality change or disturbance. Intrinsic properties of the groundwater system are slightly resistant to change. The overall function of the groundwater system remains relatively unchanged.	The groundwater system may be confined and deep. The groundwater system, or connected features are not sensitive to level or quality change or disturbance and is able to fully recover. Intrinsic properties of the groundwater system are resilient to change. The overall function of the groundwater system is unchanged.
Recovery potential **Potential for groundwater systems to recover from a level or quality change naturally.**	The groundwater system has very low recharge rates and very long recovery periods are expected. Permanent quality or quantity changes may occur.	Groundwater systems with low recharge rates and slow recovery periods. Recovery potential is limited or only successful in the minority of cases. Impact may require decades to centuries to resolve.	Groundwater systems with moderate recharge rates and medium-term recovery periods. Recovery is likely to be slow or only partially successful.	Groundwater systems with relatively high recharge rates and short recovery periods. Recovery will be successfully achieved in most cases.	Groundwater systems with very high recharge rates and very short recovery periods. Recovery will be successfully achieved in all cases.
Replacement potential **Potential for temporary replacement with alternative supply where relevant.**	There are no local water features (surface water or groundwater) that could provide alternative water sources to users.	There are very limited local water features (surface water or groundwater) could provide an alternative water source to users.	There are limited local water features (surface water or groundwater) that could provide alternative water sources to users.	There are several local water features (surface water or groundwater) that could provide alternative water sources to users.	There are numerous local water features (surface water or groundwater) that could provide alternative water sources to users.

4.4.4 Significance assessment

The significance of impacts on an environmental value is determined by the sensitivity of the value itself (and considering the aquifer(s) on which it relies) and the magnitude of the change it experiences. The matrix presented in Table 4-3demonstrates how the significance of impacts is determined by considering the sensitivity of the environmental value and the magnitude of the expected change. This approach adopts a five-by-five matrix that has been established for the project and consistent across all technical studies that support the project EES/EIS.

Table 4-3 Significance assessment matrix

Magnitude of impact	Sensitivity of value				
	Very high	High	Moderate	Low	Very low
Severe	Major	Major	Major	High	Moderate
Major	Major	Major	High	Moderate	Low
Moderate	High	High	Moderate	Low	Low
Minor	Moderate	Moderate	Low	Low	Very low
Negligible	Moderate	Low	Low	Very low	Very low

The impact assessment process initially considers the impact significance based on an assessment of the impact magnitude prior to applying any additional controls (such as the avoidance and mitigation measures contained within EPRs). A description of the assessed significance rating of an impact is provided in Table 4-4.

Table 4-4 Description of significance of potential groundwater impacts

Significance of impact	Description
Major impact	Occurs when impacts will potentially cause irreversible or widespread harm to an environmental value(s) of the groundwater system, including its capacity to support connected features, that is irreplaceable because of its uniqueness or rarity. Avoidance through appropriate design responses is the only effective mitigation.
High impact	Occurs when the proposed activities are likely to exacerbate threatening processes already affecting the environmental value(s) of the groundwater system, including its capacity to support connected features. While replacement of unavoidable losses is possible, avoidance through appropriate design responses is preferred to preserve its intactness or conservation status.
Moderate impact	Occurs where, although reasonably resilient to change, the groundwater system would be further degraded, as would its capacity to support connected features, due to the scale of the impacts or its susceptibility to further change. The widespread occurrence of the groundwater system, and its connected receivers, ensures it has adequate representation in the region, and that replacement, if required, is achievable.
Low impact	Occurs where the groundwater system, and its connected features, are of local importance and temporary and transient changes will not adversely affect its viability to support environmental values provided standard environmental controls are implemented.
Very low impact	A degraded (very low sensitivity) groundwater system exposed to minor changes (negligible magnitude impact) will not result in any noticeable change in its intrinsic value and hence the proposed activities will have negligible or no effects. This typically occurs where activities occur in industrial or already highly disturbed areas.

4.4.5 Application of EPRs to determine residual impacts

Residual impacts are those remaining after the implementation of avoidance and mitigation measures contained within the EPRs. The extent to which potential impacts have been reduced is determined by undertaking an assessment of the significance of the residual impacts. This is a measure of the effectiveness of the avoidance or mitigation measures expected to be implemented to comply with EPRs in reducing the magnitude of the potential impacts.

EPRs outline the outcomes that must be achieved during design, construction, operation, and decommissioning of the project regardless of the measures adopted to comply with the EPR. Compliance with EPRs is intended to minimise impacts having regard to the local conditions and constraints, and the practical delivery of the project.

If proposed mitigation measures or design responses are ineffective in reducing the significance of the residual impacts, additional or new measures/responses would need to be developed. Where further work completed during detailed design indicated that the stated EPRs may not adequately address potential impacts and refinement or new EPRs are required, these would be proposed by the proponent's environmental team for review and verification by the appropriate regulator. In addition, contingency measures will be documented in the groundwater management plan (GMP), and implemented if proposed mitigations measures are insufficient to meet EPRs. The management plan will be developed in consultation with relevant water authorities and the EPA.

Adopting EPRs and a performance-based approach allows for flexibility in how a specified outcomes are achieved, rather than providing prescriptive measures that must be employed by contractors. Example mitigation and management measures that been discussed to illustrate how EPRs could be complied with.

4.4.6 Cumulative impact assessment

The EIS guidelines and EES scoping requirements both include requirements for the assessment of cumulative impacts. Cumulative impacts result from incremental impacts caused by multiple projects occurring at similar times and within proximity to each other.

To identify possible projects that could result in cumulative impacts, the International Finance Corporation (IFC) guidelines on cumulative impacts have been adopted. The IFC guidelines (IFC, 2013) define cumulative impacts as those that ‘result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones.

The approach for identifying projects for assessment of cumulative impacts considers:

- Temporal boundary: the timing of the relative construction, operation, and decommissioning of other existing developments and/or approved developments that coincides (partially or entirely) with the project.
- Spatial boundary: the location, scale, and nature of the other approved or committed projects are expected to occur in the same area of influence as the project. The area of influence is defined as the spatial extent of the impacts a project is expected to have.

Proposed and reasonably foreseeable projects were identified based on their potential to credibly contribute to cumulative impacts due to their temporal and spatial boundaries. Projects were identified based on publicly available information at the time of assessment. The projects considered for cumulative impact assessment in Victoria are:

- Delburn Wind farm
- Star of the South Offshore Wind farm

- Offshore wind development zone in Gippsland including Greater Gippsland Offshore Wind Project (BlueFloat Energy), Seadragon Project (Floatation Energy), Greater Eastern Offshore Wind (Corio Generation) and Great Southern Offshore Wind Farm (Macquarie).
- Hazelwood Rehabilitation Project
- Wooreen Energy Storage System

The projects relevant to this groundwater impact assessment have been determined based on the potential for cumulative impacts to groundwater values. These projects are occurring concurrently and/or are situated near the project. The assessment of the potential cumulative impacts draws on the findings from the impact assessment (see Section 7) and the identification of where effects from these credible projects and their associated activities may overlap, interact and accumulate, and therefore result in a cumulative impact on groundwater values within the study area.

The projects assessed as relevant to this groundwater impact assessment are:

- **Hazelwood Rehabilitation Project**: The project area is located near Eel Hole creek, which also a waterway that is near the Hazelwood Rehabilitation Project as well as the Hazelwood converter station. If this waterway is impacted, it would be short term and not result in long term effects as drawdown from the project is temporary as well as localised. It is also understood the Hazelwood project could result in a long term rise in groundwater levels rather than any drawdown.
- **Delburn Wind farm Project**: The Delburn Wind farm project is located along side of the project alignment, within the Driffield area. It involves excavations for turbine footings and cable trenches which may also require groundwater dewatering in locations. It is considered these impacts would be localised, short term, and ground water levels would return to pre-construction levels during the operational phase.

The assessment of cumulative impacts on groundwater values for these projects is further detailed and evaluated in Section 7.8.

4.5 ASSUMPTIONS AND LIMITATIONS

The desktop assessment has been informed by the review of available data and information. Aquifer parameters (e.g., water levels, hydraulic conductivity, specific yield, etc.) along the project alignment are based on published, regional groundwater studies and groundwater modelling. The hydrogeological data, measured and modelled groundwater levels, and aquifer hydraulic properties across the project provides a level of data considered sufficiently detailed to characterise baseline groundwater conditions to a level that is proportionate to the risk of adverse effects posed by the project.

Whilst well-established regional datasets were used in identifying baseline groundwater conditions, local variations in groundwater conditions along the project alignment may affect the assessed sensitivity of groundwater values or the magnitude of potential groundwater impacts resulting from the project. This introduces a level of uncertainty to the groundwater impact assessment. For example, potential for groundwater to be shallower than assumed or groundwater inflow rates to be higher than predicted could lead to increased potential impacts, such as more extensive areas of the cable trench requiring dewatering and higher magnitude drawdown at sensitive receivers.

The groundwater impact assessment has not undertaken site inspections and field investigations to further characterise hydrogeological features or attributes of the study area at a local scale. The assessment has incorporated site inspections from other studies where relevant to gain site-specific information. Given this; the level of detail regarding the location, nature, and significance of groundwater values within and surrounding the project alignment is limited.

Although constrained by these limitations, this groundwater impact assessment is based on information and data with a level of uncertainty that is considered sufficiently low to be suitable for the purpose of the EES, specifically the identification and assessment of project activities that may pose a risk to groundwater. This uncertainty has been addressed by adopting conservative assumptions (such as groundwater levels 1 m shallower than modelled) which minimises the effect of uncertainty. Other levels of conservatism built into the impact assessment (such as adopting long term, steady state drawdown values around areas of temporary dewatering) significantly outweigh the uncertainty and natural variability of hydrogeological conditions.

Geotechnical assessment programs are being undertaken (by Jacobs) to support the detailed design of the project and further groundwater investigations are proposed during detailed design and prior to construction commencing. These assessments will provide refined information on groundwater conditions and will provide a basis for verifying the assessments completed in the groundwater impact assessment. Various EPRs have been recommended in Section 9, which formalise this requirement prior to construction.

Heat generated by buried cables may cause locally raised groundwater temperature. The potential impacts to groundwater and associated groundwater values have not been assessed in this groundwater impact assessment as the current scope did not involve assessment of impacts associated with groundwater heating. The assessment of cable heating within the study area is presented in EIS/EES Appendix A: Electromagnetic Fields (EMF).

Community consultation has not been undertaken as part of the scope for the groundwater impact assessment. Outcomes of community consultation including their views and concerns related to groundwater issues are included in EIS/EES Technical Appendix U: Social.

No potential impacts to groundwater are considered for the decommissioning phase as the project has not identified the need for additional subsurface work or an increased environmental risk associated with future climate scenarios. However, it is acknowledged that during the decommissioning phase, some underground infrastructure may be removed, which could result in minimal impacts on groundwater (see Section 3.4). A decommissioning management plan will include mitigation measures to avoid and minimise any potential impacts to groundwater, specific to the conditions present at the time of decommissioning.

The assumptions and limitations mentioned above was informed by the data gaps described in Section 10.

5. EXISTING CONDITIONS

The baseline groundwater characterisation assessed the following existing environmental features:

- Climate and climate change (Section 5.1)
- Land use (Section 5.2)
- Geology (Section 5.3)
- Hydrology (Section 5.4)
- Hydrogeology (Section 5.5), including:
  - Regional hydrogeological setting (Section 5.5.1)
  - Groundwater management areas (Section 5.5.2)
  - Groundwater levels and flow directions (Section 5.5.3
  - Groundwater and surface water interaction (Section 5.5.4)
  - Groundwater use (Section 5.5.5)
  - Groundwater Dependent Ecosystems (GDEs) (Section 5.5.6), including:
    - Terrestrial GDEs (Section 5.5.6.1)
    - Aquatic GDEs (Section 5.5.6.2)
    - Subterranean GDEs (Section 5.5.6.3)
  - Groundwater quality (Section 5.5.7)
  - Environmental values of groundwater (Section 5.5.8)
- Groundwater contamination potential (Section 5.6).

5.1 CLIMATE

The climate and observed weather conditions are highly variable along the project alignment. The environmental setting of the project alignment transitions from a coastal setting in the south (Waratah Bay), to coastal plains and foothills (Fish Creek to Tarwin), to highlands in the north (Mirboo North), followed by the low-lying Latrobe Valley area (Hazelwood).

In order to adequately characterise the climate along the project alignment, BoM weather stations considered representative of each environmental setting have been selected and reviewed independently. The selected weather stations and their associated environmental settings are summarised below:

- Yanakie (Shallow Inlet) (Station ID: 085163) and Corner Inlet (Yanakie) (BOM station ID: 085603) – Coastal Environment
- Fish Creek (Station ID: 085028) – Coastal Plains
- East Tarwin (Mirboo Pastoral Company) (Station ID: 085227) – Foothills
- Thorpdale Peak (Station ID: 085308) – Highlands
- Latrobe Valley Airport (Station ID:085280) – Latrobe Valley.

5.1.1 Climate conditions in the study area

Table 5-1 and Figure 5-1 presented below summarise the observed weather and climate conditions along the project alignment, as reported at the nominated weather stations.

Table 5-1 Summary of Weather Observations

Representative Environment	Station ID	Elevation (m)	Average Annual Rainfall (mm)	Average Monthly Rainfall mm (min – max)	Average Monthly Temperature ºC (min – max)
Coastal Environment	085163, 085301	10 to 13	884	37 – 100 (Feb, Aug)	13.9 – 24 (Jul, Jan)
Coastal Plains	85028	70	1,116	51 – 109 (Feb, Aug)	NA
Foothills	85227	263	917	52 – 103 (Feb, Jun)	11 – 24.6 (Feb, Jul)
Highlands	85308	360	863	56 – 101 (Feb, Aug)	NA
Latrobe Valley Airport	85280	56	737	43 – 75 (Feb, Sept)	14.8 – 26.7 (Jan, Aug)

Notes: N/A = not available

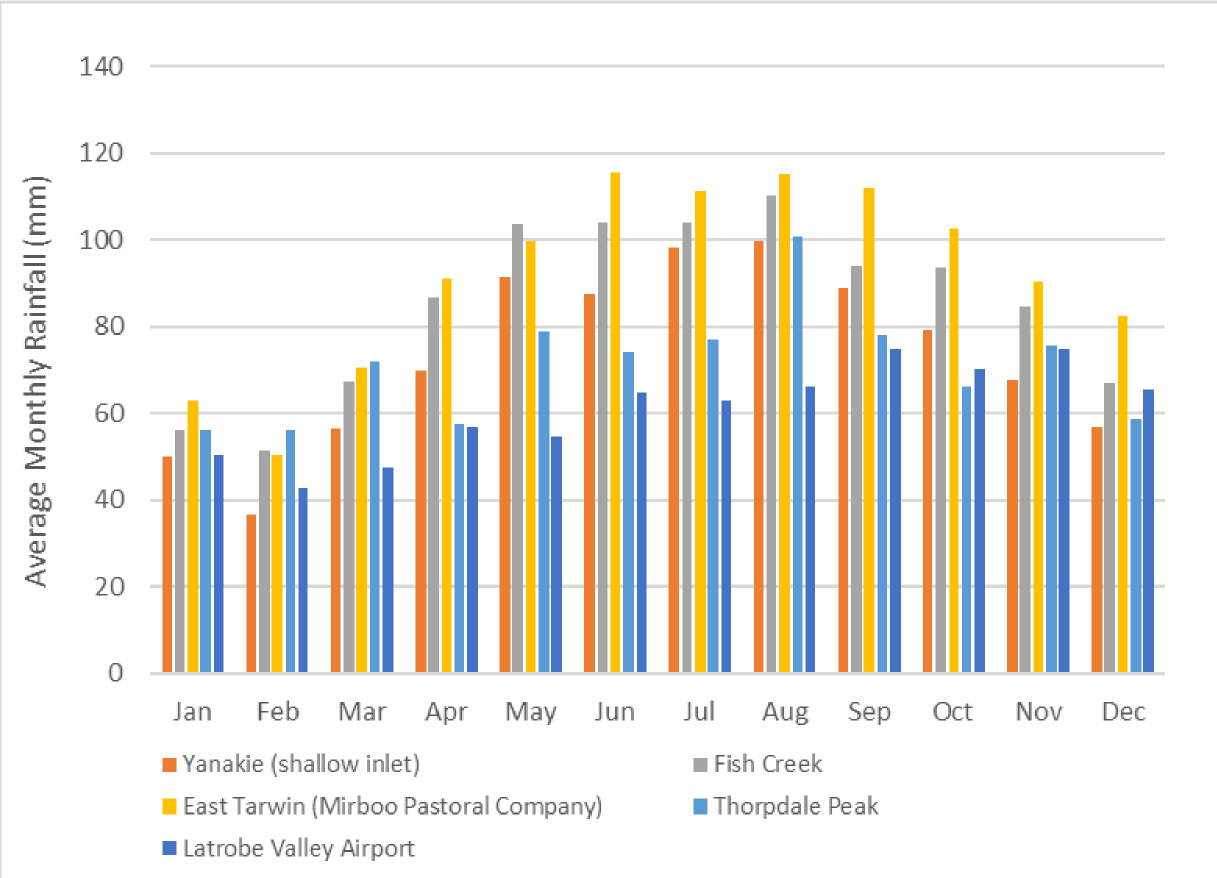


Figure 5-1 Average monthly rainfall along the project alignment

5.1.2 Climate Change

The project EES scoping requirements (refer to Section 2.2.2) specify that the groundwater impact assessment must incorporate climate risk and assess the potential impact of climate change on the project impacts to groundwater systems.

In general terms, climate change is projected to result in higher, and more extreme temperatures, more extreme weather events and sea-level rise. Some of the direct impacts of climate change in coastal zones are expected to include more hazardous storm surges, flood inundation, increased erosion and increased seasonality in groundwater recharge. This will have direct impacts on groundwater including rising groundwater levels and saline intrusion (Anderson 2017).

In Victoria, there are two key documents that relate to the assessment of future climate change scenarios and its impact on water resources:

- Department of Environment, Land Water and Planning (DELWP), 2016, *Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria* (DELWP, 2016); and
- Commonwealth Scientific and Industrial Research Organisation (CSIRO), 2015, *Southern Slopes Cluster Report, Climate Change in Australia Projections for Australia's Natural Resource Management Regions* (CSIRO, 2015).

The above documents provide a series of climate change scenarios that were considered when assessing the potential impact of climate change on water resources. DELWP (2016) provides a range of projected changes in long-term temperature, potential evapotranspiration, rainfall, runoff and recharge. Due to the spatial variability in climate and climate change impacts across Victoria, projected impacts are provided for each individual Victoria River Basin.

It should be noted that the projections provided in DELWP (2016) are based on the Intergovernmental Panel on Climate Change "climate scenario RCP8.5," which represents the highest future concentration of greenhouse gasses. Climate scenario RCP8.5 is in line with recent historical trajectory of greenhouse gas concentrations and is expected to provide both the wettest and driest projections. Similar climate projections are presented in CSIRO (2015), although unlike DELWP (2016), they cover a range of predicted future greenhouse gas concentrations (including RCP8.5).

In addition, project specific climate change assessments have been undertaken by Katestone (2022), which are discussed further below.

5.1.3 Adopted Climate Predictions

The majority of the project alignment is situated within the South Gippsland river basin, with a portion of the northern-most extent of the project alignment (Hazelwood) potentially intercepting the Mitchel-Thomson Rivers river basin. The climate change predictions associated with the South Gippsland river basin, as presented in DELWP (2016), are summarized below:

- The daily rainfall total for storm events with an annual exceedance probability (AEP) of 50% to 1% (24-168 hr storm) may increase by 5% per degree of warming (6.5%) as recommended in the DELWP (2016) guideline;
- Annual rainfall totals may reduce by 2.3%; and
- Potential evapotranspiration (PET) rates may increase by 4.2% by 2040.

The projected effects of climate change might result in long term declining groundwater levels particularly in the water table aquifers present across the project alignment. These effects are considered further in Section 7.5.

Based on the climate change assessment completed by Katestone (2023), climate change is projected to lead to reduced rainfall throughout the year in the study area. The intensity of heavy rainfall extremes is expected to increase. Based on predicted rainfall extremes it is expected that groundwater recharge may become more unpredictable but might result in long term declining groundwater levels particularly in the water table aquifers present across the project alignment. These effects are considered further in Section 7.5.

5.2 LAND USE

Land use can have a direct influence on the hydrogeological conditions within a groundwater catchment. Surface activities, the presence of vegetation, and other land management practices in developed areas can all alter groundwater recharge rates, levels, and flow directions, and affect groundwater quality.

Currently, land in the study area is primarily used for agriculture and plantation forestry in much of the area of interest. Groundwater conditions beneath agricultural land are often characterised by higher rates of recharge (particularly where irrigation practices are used), and in some cases raised groundwater levels, with the higher concentrations of nitrate contamination commonly associated with livestock wastes, septic systems, and fertiliser application. Uncontrolled stock access to waterways can also result in increased quality impacts (nutrients and suspended solids) to surface water resources and their connected groundwater environments.

Forestry resources are established over decades during which time rainfall runoff and groundwater recharge rates decrease as the trees mature. These conditions are suddenly and significantly altered when the timber resource is harvested. Areas of forestry plantations can be subject to significant changes in groundwater and surface water conditions over time.

A number of small rural communities and towns are located throughout the study area including Buffalo, Dumbalk, Baromi, and Churchill. While larger communities in the study area have reticulated sewage systems the septic systems are expected to be common along the project alignment which can be sources of nitrate, ammonia, and microbiological groundwater contaminants.

Planning zones and the portion of the preferred route associated with each is summarised in Table 5-2.

Table 5-2 Planning zones along the project alignment

Planning Zone	Description	Length along project alignment (km)	Portion of alignment (%)
Farming Zone	Includes farmland, dairy, grazing, sheep.	60.8	69.1%
Farming Zone – Schedule 1	Includes farmland around Hazelwood and some forestry plantations.	12.0	13.7%
Public Conservation and Resource Zone	Includes public reserves, Strzelecki State Forest	5.0	5.7%
Public Park and Recreation Zone	Includes bike trails, parks, playgrounds, Waratah Bay Shallow Inlet Reserve	0.2	0.2%
Public Use Zone – Service and Utility	Includes Hazelwood Cooling Pond	0.1	0.2%
Road Zone – Category 1	Roads	0.7	0.8%
Special Use Zone – Schedule 1	Forestry plantations and farmland near Driffield and Hazelwood	9.2	10.5%

5.3 GEOLOGY

The project is located within the Gippsland Basin. Geologically the Gippsland Basin is complex in its structure and depositional history. The structural geology strongly controls the thickness and elevation of geological units in the area. The study area covers the Latrobe Valley Depression, the Strzelecki Group Balook Block, and the Tarwin Sub Basin.

The northern end of the project alignment is located on the western flank of the Latrobe Valley Depression, which is a graben (i.e., a down-faulted block) bounded by the Rosedale Fault on the eastern side and the Mirboo Fault on the western edge.

The Strzelecki Group Balook Block is bounded by a number of major faults, including the Budgeree, Balook, Carrajung and Yarram faults. The Tarwin sub-basin is located west of the Balook Block. It is bounded by uplifted Strzelecki Group rocks and to the north by the Narracan Block (see Figure 5-2).

The basement rocks of the Gippsland Basin are comprised of the Strzelecki Group within the study area. The Strzelecki Group consists of non-marine Lower Cretaceous sandstone and mudstone sedimentary rocks. The Upper Strzelecki Group rocks are relatively uniform, consisting of a generally upwards-fining sequence of massive coarse- to fine-grained sandstone. These interfinger with a range of minor rock types including siltstone, fine-grained sandstone, paleosols, coal seams and lacustrine shale (Yates et al. 2015).

The Strzelecki Group basement is deep in the Latrobe Valley Depression and contains up to 900 m of Latrobe Valley Group sediments. The Latrobe Valley Group increases in thickness towards the east but pinches out against the north-east/south-west trending faults at the Driffield site and is interbedded with the Thorpdale Volcanics (Geoscience Australia 2019).

The Latrobe Valley Group are comprised of the following formations (from youngest to oldest):

- Childers Formation: Alluvial fans, braided streams and point bar sand deposits: Sandstone, conglomerate, clay, sand, gravel.
- Morwell Formation: Thick sequences of lignite (up to 160 m) and clastics accumulated in peat swamps.
- Traralgon Formation: Coarser-grained sandstones and conglomerates at the base; coals and shales in the middle; sandstones, shales and minor coals near the top.

Within the Latrobe Valley Depression, Quaternary alluvial sediments and Haunted Hill Gravels overlie the Latrobe Valley Group. The Haunted Hill Gravel is comprised of Pliocene to Pleistocene sand, silt, gravel.

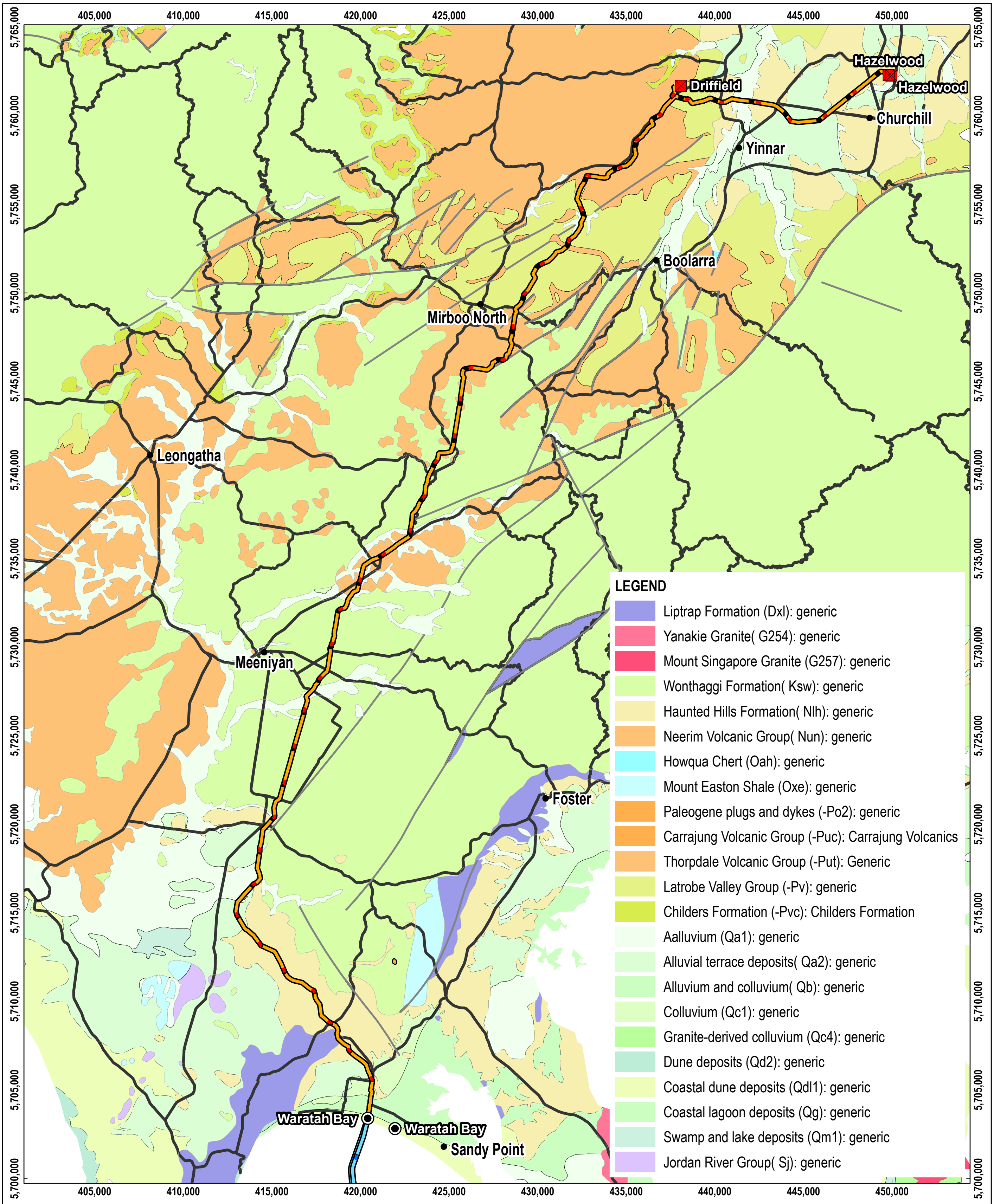
The Strzelecki Group outcrops extensively in the Strzelecki Ranges along the project alignment as the Wonthaggi Formation. Within the Tarwin Sub Basin, the Childers Formation overlies the Strzelecki Group, which in turn is overlain by Thorpdale Volcanics and Haunted Hill Gravels and Quaternary alluvium and colluvium.

The surface geology within the study area is shown on Figure 5-2. The surface geological units are summarised in Table 5-3. Geological units are ordered in prevalence along the project alignment from most prevalent to least.

Table 5-3 Summary of surface geology along project alignment

Geological Unit	Symbol	Origin	Description	Distribution	Approximate length of intersection along project alignment
Wonthaggi Formation	Ksw	Fluvial	Early Cretaceous lithic volcaniclastic sandstone, arkose, siltstone, minor conglomerate and coal.	Located throughout most of the central site route from 4 km south of Buffalo up to Dumbalk and interspersed with Put and Qa1 up to Mirboo North.	25 km
Thorpdale Volcanic Group	Put	Volcanic	Paleocene to Miocene tholeiitic and alkalic basalt; minor nephelinite, basanite, nepheline hawaiite, hawaiite, mugearite, nepheline mugearite, tuff, interbedded sandstone and silcrete.	Interspersed with Ksw, Pv, and Qa1 between Dumbalk and Driffield.	20 km
Haunted Hill Formation	Nlh	Fluvial	Pliocene to Pleistocene sand, silt, gravel: various shades of brown, yellow, red, white;	Located throughout the southernmost and northernmost sections of the	17 km

Geological Unit	Symbol	Origin	Description	Distribution	Approximate length of intersection along project alignment
			variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation.	site between Waratah Bay and Buffalo and between Driffield and Hazelwood (interspersed with Pv, Qa2 and Qa1).	
Latrobe Valley Group	Pv	Marine to deltaic	Eocene to Miocene clastic sedimentary rocks: nonmarine to paralic clastics, marine clastics.	Located between Mirboo North and 2km east of Driffield, interspersed with Put and Nlh.	11 km
Alluvial Terrace Deposits (generic)	Qa2	Alluvial floodplain	Pleistocene to Pleistocene gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1.	Located within the southern and northern sections of the site, associated with river systems, and interspersed with Ksw, Nlh and Qa1.	9 km
Alluvium (generic)	Qa1	Alluvial floodplain	Pleistocene to Holocene gravel, sand, silt: variably sorted and rounded; generally unconsolidated; includes deposits of low terraces.	Located within the southern and northern sections of the site, associated with river systems, interspersed with Ksw, Nlh and Qa1. It can also be found around Dumbalk, interspersed with Ksw and - Put.	8 km
Coastal Lagoon Deposits (generic)	Qg	Deltaic	Holocene silt, clay: dark grey to black; variably consolidated.	Located immediately within the southern sections of the site, immediately north of the coastal dune deposits (Qdl1).	2 km
Colluvium (generic)	Qc1	Base of slope, foothills	Pliocene to Holocene diamictite, gravel, sand, silt, clay, rubble: sorting variable, usually poor; generally, poorly rounded; clasts locally sourced; includes channel deposits with better rounding and sorting.	Located within the southernmost section of the site interspersed with Qg, Qa2 and Nlh.	1 km
Coastal Dune Deposits (generic)	Qdl1	Coastal dune and swamp	Holocene sand, silt, clay: well sorted, poorly consolidated; coastal dune and beach deposits, some swamp deposits	Located within the southernmost section of the site, along the beach and surrounding area at Waratah Bay	0.5 km
Liptrap Formation	Dxl	Marine	Early Devonian thin-bedded quartz-rich sandstone and siltstone with minor sandstone and gritstone, and rare diamictite which contains chert and limestone pebbles.	This unit could potentially be found for a short stretch of the site just north of Waratah Bay, interspersed with Nlh.	0.5 km



LEGEND

- Landfall
- Proposed converter station
- HVDC subsea cable
- Underground HVDC cable
- Fault
- Major road

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FIGURE 5-2

Surface geology

0 3 6 km

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PROJECTION: GDA2020 MGA Zone 55

SOURCE
Proposed route from Tetra Tech Coffey.
Geological units, contact, and share displace structure from DJPR.

TETRA TECH COFFEY

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5.4 HYDROLOGY

A brief hydrological setting in and around the study area is provided below for context in the groundwater baseline characterisation. Further detail concerning the hydrological setting and baseline characterisation for water crossings and flood modelling in the vicinity of the proposed converter stations are provided in *Marinus Link – Victorian Surface water impact assessment* (Alluvium 2023).

The project alignment intersects the Victorian coast across back beach deposits (Waratah Bay-Shallow Inlet Coastal Reserve) and low-lying pasture near Waratah Bay which forms part of the Gippsland Plain. The low-lying land near Waratah Bay is subject to tidal inundation (Alluvium 2023). The project alignment extends as a north-westerly transect crossing the southern end of the Strzelecki Range. The project alignment deviates to east-north easterly across agricultural land, passing west of Meeniyan (crossing Stony Creek) and east of Dumbalk to again cross more deeply dissected terrain (again, Strzelecki Range, and the Tarwin River East Branch), and crossing numerous minor drainages, passing east of Mirboo North. The alignment continues through forested terrain including the Thorpdale Volcanics, crossing the Little Morwell River, prior to an easterly deviation crossing the Morwell River, and passing immediately south of the Hazelwood cooling pond.

Groundwater interactions with surface water in the study area are expected to follow a pattern of surface water recharging outcropping aquifers in the highlands region (losing streams) and groundwater discharging to surface water (gaining streams) in the lowlands (Southern Rural Water, 2012).

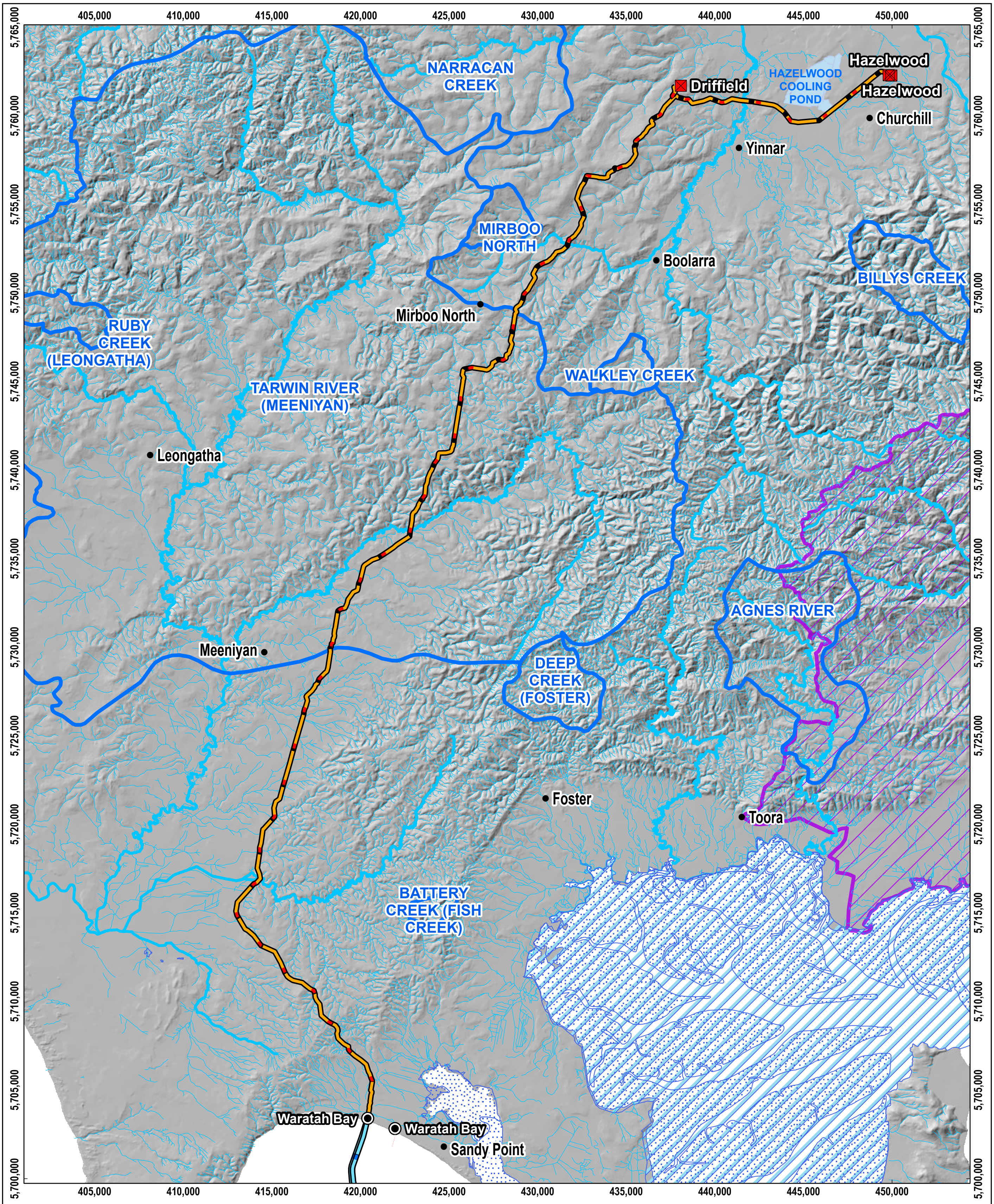
The study area traverses six surface water features (from south to north): Fish Creek, Buffalo Creek, Stony Creek, Tarwin River East Branch, Little Morwell River, and Morwell River.

The Tarwin River East Branch, Stony Creek, Buffalo Creek, and Fish Creek flow generally southwest towards the main Tarwin River which flows into Anderson Inlet near Tarwin Lower, which then enters into Bass Strait near Inverloch (Alluvium 2023). The Little Morwell River and Morwell River drain to the north into the Latrobe River system which flows into Lake Wellington in the Gippsland Lakes.

The named rivers, creeks, water bodies, and surface water catchments in and around the study area are presented on Figure 5-3. Table 5-4 lists those that overlap with the project alignment inclusive of the 500m buffer zone (excluding minor or unnamed tributaries and watercourses). These water features are considered further in relation to proposed project infrastructure in Section 7.

Table 5-4 Named rivers, creeks and waterbodies within the project alignment

River Catchment	Approximate Catchment Area (Ha)	Named Waterways
Fish Creek	170	Fish Creek
Buffalo Creek	38	Buffalo Creek
Stony Creek	72	Stony Creek (south)
		Stony Creek (north)
Tarwin River – within Tarwin River (Meeniyan) water supply area	1,500	Tarwin River East Branch, Toomey Creek, and Berrys Creek.
Morwell River	674	Morwell River, Eel Hole Creek and Hazelwood cooling pond
Little Morwell River	87	Little Morwell River



LEGEND

- Landfall
- Proposed converter station

Proposed route

- HVDC subsea cable
- Underground HVDC cable
- Designated water supply catchment
- Major watercourse
- Minor watercourse
- Directory of Important Wetlands
- Ramsar wetlands VIC
- Water supply protection areas
- Hazelwood Cooling Pond

MARINUS LINK

0 3 6 km

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PROJECTION: GDA2020 MGA Zone 55

Source:
Proposed routes from Tetra Tech Coffey.
Wetlands and water supply protection areas from DELWP.
Watercourse, pond and hillshade from VICMAP.

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FIGURE 5-3

Regional topography and drainage

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5.5 HYDROGEOLOGY

5.5.1 Regional hydrogeological setting

Groundwater in Victoria is managed under designated catchments or basins. The onshore project alignment spans the Gippsland Basin and the Highlands basin. Within these basins the project crosses the Tarwin and Central Gippsland groundwater catchments which are managed by the West Gippsland Catchment Management Authority (WGCMA).

The aquifers within the Gippsland Basin have complex relationships as a result of the dynamic depositional environment of the Gippsland Basin as well as tectonic movements experienced after deposition.

As the impact assessment considers groundwater impacts to depths within 10 m of ground surface, the relevant outcropping aquifers in the Central and Southern Gippsland groundwater basins along the project alignment can be reduced to the following three aquifers based on the division presented in the VAF (GHD 2012);

- Upper Tertiary Quaternary Aquifer (Quaternary alluvium and Haunted Hill formation),
- Lower Tertiary Basalt (Thorpdale Volcanics), and
- Cretaceous Palaeozoic Bedrock (Wonthaggi Formation of the Strzelecki Group) (see Figure 5-2 for surface geology).

The Upper Tertiary Quaternary Aquifer includes the Haunted Hill formation and Quaternary alluvial units in the floodplain and coastal sections of the Gippsland Basin (Southern Rural Water 2012). Near Hazelwood, groundwater occurs within the Haunted Hill Formation as an unconfined regional aquifer. The Haunted Hill aquifer is highly heterogeneous, comprising channel sand, clay levee and over bank deposits (Leonard 2002). Similar hydraulic properties for the two units allow them to be conceptualised as a single aquifer unit (Table 5-5).

Within the Hazelwood Power Block, a perched aquifer has developed within an overburden dump (ERM 2017), located approximately 800 m north of the Hazelwood Converter Station. This perched unit is not encountered by the project.

Thorpdale Volcanics were deposited as multiple layered lava flows that have produced vertically layered flow systems within the Lower Tertiary Basalt aquifer. Groundwater flows through fracture zones and interconnected vesicles, and is expected to have higher heterogeneity than the alluvial deposits at local scale.

The Strzelecki Group bedrock (comprised of the Wonthaggi formation in the study area) outcrops in the Strzelecki Ranges and is present as the basement rock elsewhere, below the 10 m vertical study limit. Along with the Thorpdale Volcanics, these units form fractured rock aquifers. In the Strzelecki Range the fractured rock aquifers (bedrock and basalt) and minor Quaternary alluvial valley fill are expected to have short, rapid groundwater flow paths from the upper slopes where most groundwater recharge occurs, discharging to nearby streams.

Hydraulic properties of the main aquifers encountered within the study area have been based on the aquifer parameters adopted as part of the regional Gippsland groundwater model (DEDJTR 2015), which are reproduced in Table 5-5.

Table 5-5 Adopted, representative aquifer hydraulic properties

Aquifer units	VAF grouping	K (m/d)	Sy	Ss
Upper Tertiary Quaternary Alluvium	Upper Tertiary Quaternary Aquifer	6.5	0.1	1 x 10-5
Haunted Hill Formation		3.2	0.1	1 x 10-5
Thorpdale volcanics	Lower Tertiary Basalt Aquifer	0.65	0.1	1 x 10-5
Wonthaggi Formation (Strzelecki Group)	Cretaceous Palaeozoic Bedrock	0.01	0.02	1 x 10-5

DEDJTR, 2015

5.5.2 Groundwater management areas

Victoria is divided into five groundwater basins with each comprised of one or more groundwater catchments. The onshore project alignment spans the Gippsland Basin and the Highlands basin. Within these basins the project crosses the Tarwin groundwater catchment and the Central Gippsland groundwater catchment (Figure 5-4).

These groundwater resources are managed by WGCMA. Two groundwater management areas (GMAs) exist within the study area which include restrictions on the use of groundwater where these resources are close to, or at their full sustainable allocation; the Rosedale GMA and Stratford GMA (Figure 5-4).

The Rosedale GMA applies to groundwater resources from 50 mbgs to 150 mbgs, and the Stratford GMA applies to groundwater from 150 mbgs. As a 10 m vertical limit was set for the project alignment, these management areas do not apply assuming that dewatering activities would be limited to the base of trenches or excavations at depths less than 10 mbgs.

Minor dewatering from the water table across the project alignment, if required, is not anticipated to affect aquifers subject to the limits set by the GMAs. Similarly, chemical contaminants that might potentially be released by the project at ground surface during construction or operation (such as from a spill) would not be expected to migrate vertically greater than 10 mbgs, and would not affect GMAs.

The Tarwin and Leongatha GMA are located more than 5 km from the project alignment and are well beyond the potential influence of project activities.

5.5.3 Groundwater levels and flow directions

The interpretation of levels and flow direction in the Gippsland Basin can be complex when considering the multiple aquifers present to significant depths, and the various effects of offshore oil extraction, onshore mining activities in the Hazelwood region.

For the purpose of this groundwater impact assessment, which considers only the near-surface environment, the focus is on the continuous, unconfined water table across the study area.

Groundwater levels have been assessed along the project alignment drawing on information published as part of the Secure Allocations Future Entitlements (SAFE) project (DELWP 2022). The dataset was last updated during June 2022 and draws on a range of primary data sources including measured groundwater level data from the state's groundwater observation bore network and combines a number of groundwater model outputs into the mapping process.

Indicative groundwater level contours for the continuous water table are presented on Figure 5-5 in Appendix C and are based on the 100 m grid SAFE dataset. Groundwater flow is expected to generally follow the ground surface topography, with rainfall infiltration recharging across the region and migrating from high elevation to low elevation, discharging to the network of groundwater dependent creeks and rivers.

Comparison between groundwater level contour and the ground surface elevation along the project alignment provides an indication of the depth to groundwater (Figure 5-5 and Figure 5-6).

The Victorian state observation bore network (SOBN) is monitored for groundwater level and quality to support regional groundwater resource management. Monitoring data is provided via the Victorian Water Measurement Information System (WMIS) (sourced at https://data.water.vic.gov.au/). The available SOBN locations were reviewed to identify potentially useful data to support the groundwater impact assessment. In most cases SOBN bores are installed to screen the productive aquifers at depths significantly below the water table and monitoring from these bores are not particularly useful for interpreting water table level fluctuations.

Only one SOBN bore was installed to depths of less than 30 m below ground surface (mbgs), which was nominated as a depth that would provide an indication of water table conditions along the project alignment. Bore ID 100976, located to the east of Sandy Point township, is positioned approximately 600 m from the shoreline and is screened to a depth of 5.5 mbgs. The groundwater level hydrograph for the last 10 years of level monitoring at this bore is presented in Figure 5-7 and is considered representative of the nearshore groundwater conditions that may be encountered at the shore crossing point. The depth to groundwater ranged from 1.59 mbgs to 2.57 mbgs over the most recent decade of monitoring between 2010 and 2020, indicating a seasonal fluctuation range of approximately 1 m during that period.

LEGEND

- Landfall
- Proposed converter station

Proposed route

- HVDC subsea cable
- Underground HVDC cable
- Directory of Important Wetlands
- Ramsar wetlands VIC
- Groundwater Catchment (GC)
- Water supply protection areas
- Gippsland Basin
- Port Phillip, Westernport, Tarwin (Central Basin)

0 4 8 km

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PROJECTION: GDA2020 MGA Zone 55

Source:
Proposed routes from Tetra Tech Coffey.
Wetlands from DEE.
Groundwater catchment, management areas, basin and protection areas form DEWLP.

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FIGURE 5-4

Groundwater basins and groundwater management areas

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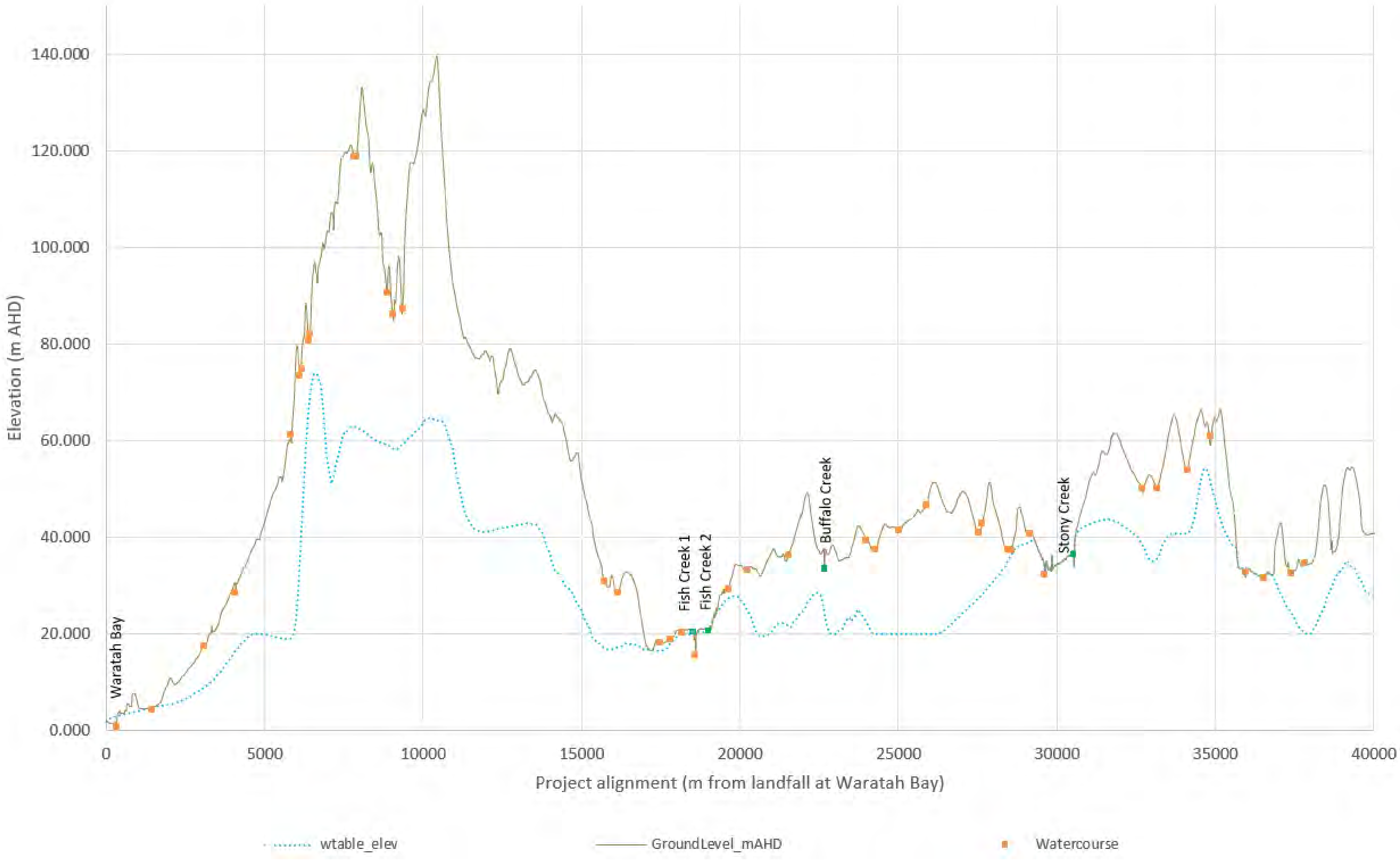


Figure 5-5 Groundwater level long section (Waratah Bay to Dumbalk)

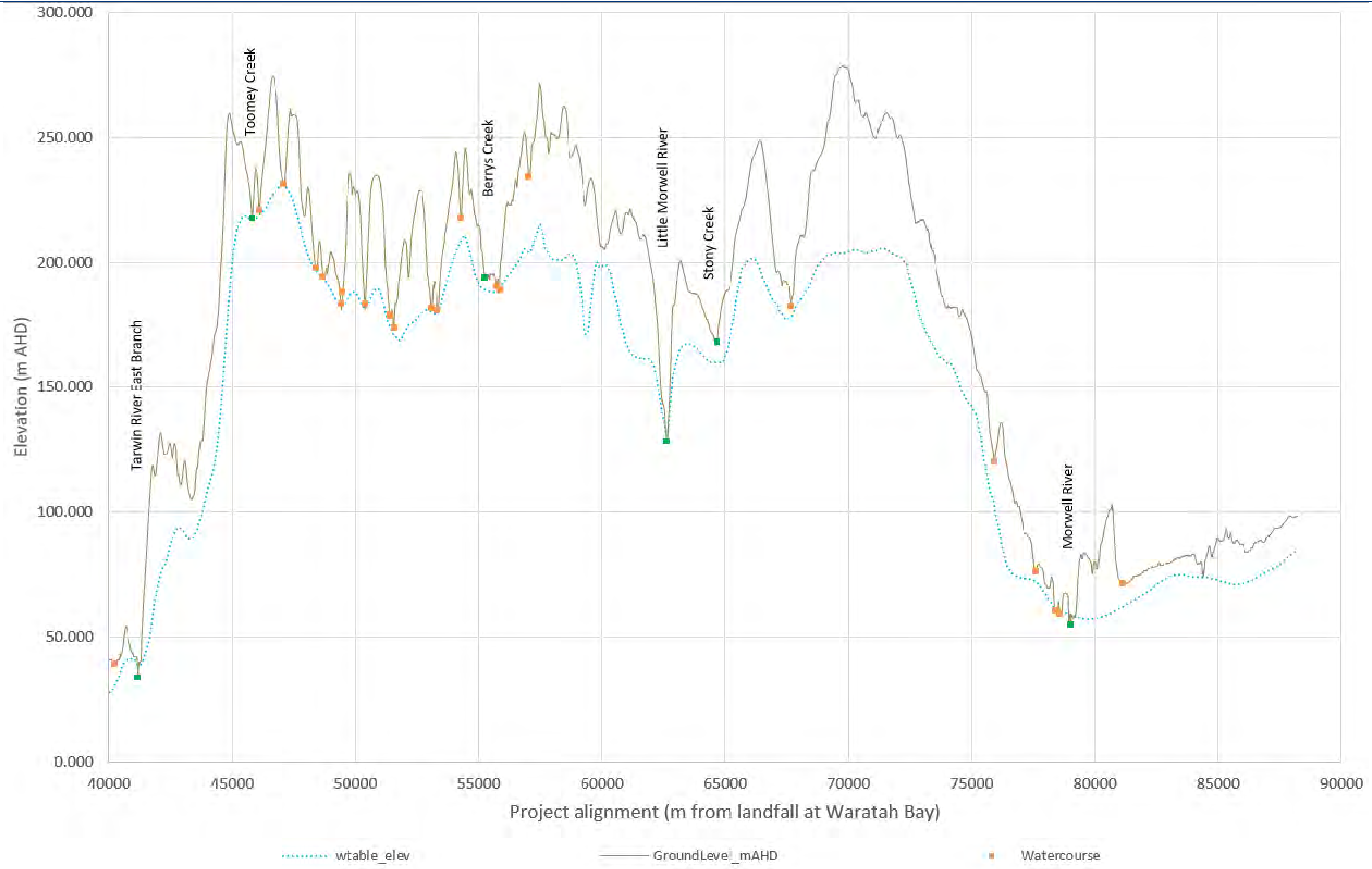


Figure 5-6 Groundwater level long section (Dumbalk to Hazelwood)

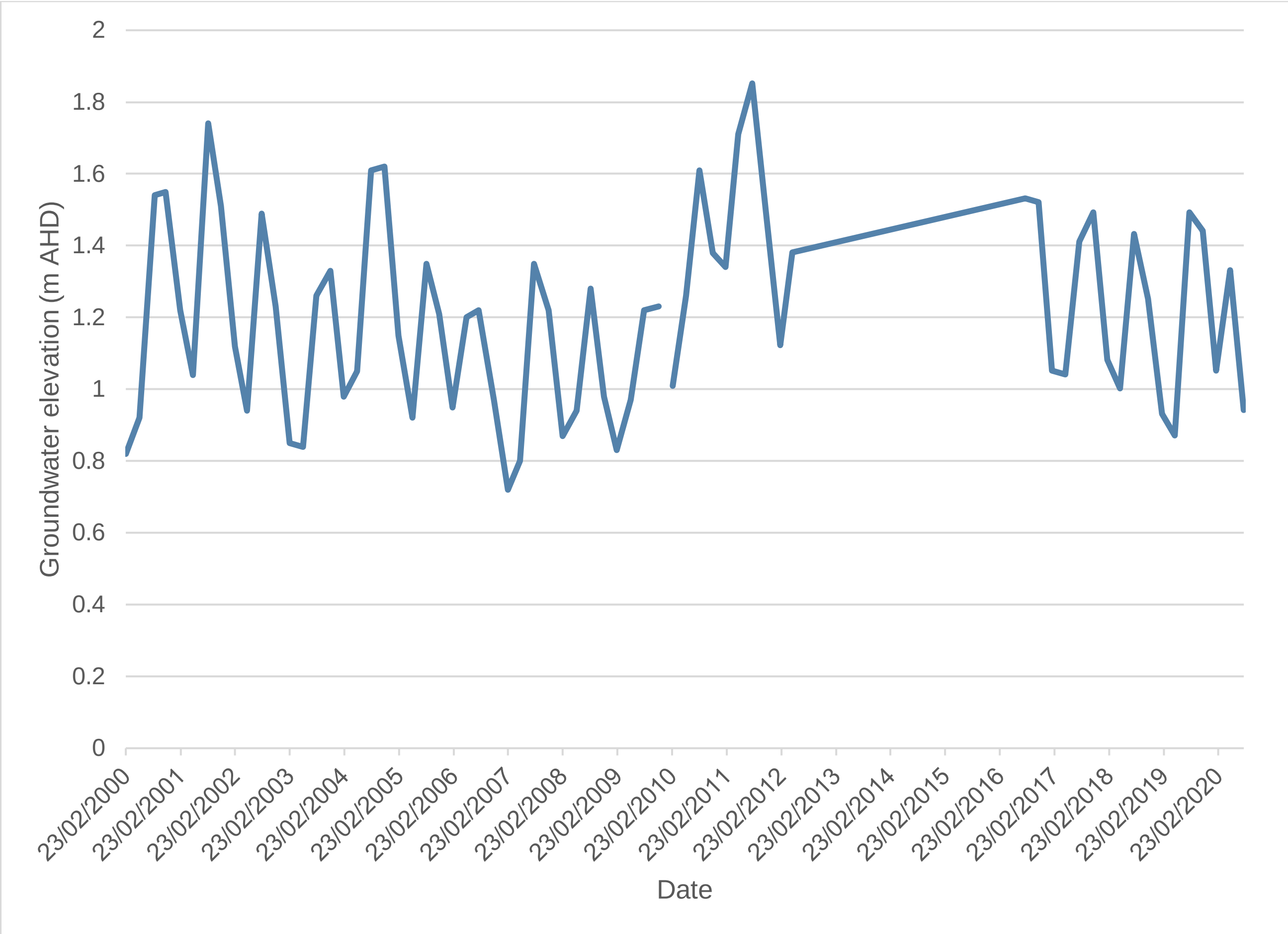


Figure 5-7 Groundwater level hydrograph for SOBN bore 100976 (Sandy Point)

5.5.4 Groundwater and surface water interaction

Groundwater – surface water interactions occur when water moves from groundwater to surface water, or vice versa. These flow dynamics can change or be absent in different sections of a catchment and can also vary in magnitude or reverse over time.

Typically, in the highlands region rainfall and surface water (as losing streams) recharges outcropping aquifers and groundwater discharges to surface water (gaining streams), wetlands, or the marine environment in the lowlands (Southern Rural Water 2012).

Groundwater-surface water interactions in the study area and the surrounding region are largely characterised by discharge from shallow groundwater systems to gaining rivers, streams, creeks, wetlands and springs (typically considered groundwater dependent – discussed in Section 5.5.6), and elsewhere as recharge from losing water bodies or water courses to groundwater.

Local, catchment scale flow systems may exist around minor creeks and wetlands where shallow perched aquifers direct local rainfall recharge laterally towards the surface water features. While these perched systems are not reported specifically within the study area, they are considered as possibly present.

Similar interactions occur between groundwater and the marine environment where aquifers are connected in the coastal zone. At low tide, the water table within the surrounding groundwater system may be higher than the coastal waters and groundwater will discharge into the marine environment of Bass Strait. At high tide, the marine water level may be higher than the onshore groundwater level, resulting in reversal of hydraulic gradients and the recharge of saline water back into the groundwater system (Anderson 2017). The magnitude of this natural tidal influence on groundwater decreases with distance from the coast, creating a naturally occurring fresh-saline transition or dispersion zone that typically extends onshore into the freshwater aquifer (see Figure 5-8). The spring tidal range at Waratah Bay is 2.5 m (DELWP 2004).

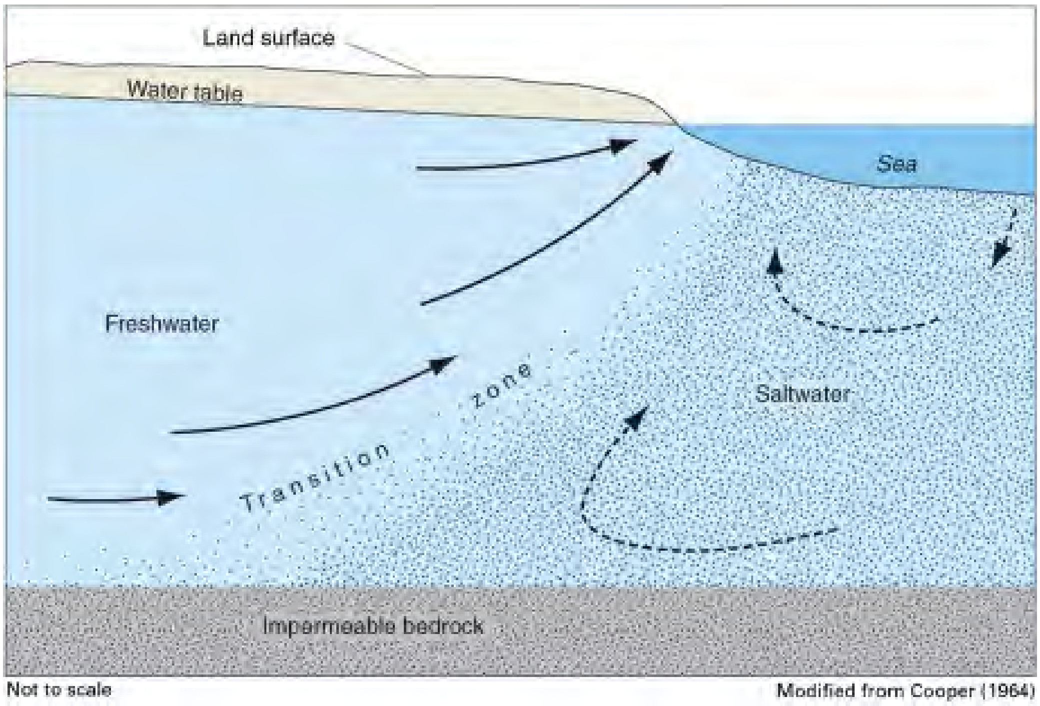
The Waratah Bay estuarine wetlands are located within the study area. The wetlands are located on anaerobic peat-rich muds on the margins of estuarine waterbodies with intermediate salinity conditions. Vegetation is determined by fluctuating salinity, which varies in time from occasionally fresh to brackish or occasionally saline according to river flows and marine tide events (DSE 2004). Groundwater conditions in this estuarine zone are likely to be brackish to saline, and flow dynamics may be complex where tidal influence on groundwater exists.

Dewatering activities of the water table aquifer within the coastal zone cause groundwater level drawdown that can induce further saltwater encroachment into the aquifer, increasing salinity within the wetlands zone. Further discussion of potential groundwater interactions with groundwater dependant surface water courses and waterbodies are provided in Section 5.5.6. Potential dewatering impacts to groundwater and migration of the saline interface are further discussed in Section 7.3.7.

5.5.5 Groundwater use

Records of registered groundwater bores were obtained from the WMIS on 15 August 2022. All registered entries with valid coordinates were incorporated into the project GIS and plotted in relation to the project alignment.

All registered bores within 500 m of the centreline of the project alignment were identified and the available registration information is presented in Appendix B, which includes 99 registered bores identified as in use, and three not in use. A further breakdown of registered use type is presented in Table 5-6 and their locations are shown in Appendix B.



Source: USGS 2017

Figure 5-8 Conceptual diagram of freshwater – saline water interface in an idealized, homogeneous coastal aquifer

Most registered bores are associated with the former State Electricity Commission (SEC) of Victoria, located between Driffield and Hazelwood (Appendix B). These bores are all expected to be groundwater observation bores forming part of a wider network of bores around the former open cut coal mine, which is undergoing a closure process. As these bores are not registered for an extractive use, potential level or quality impacts to these bores from the project are not considered further. Similarly, impacts to registered investigation and non-groundwater bores are not considered further by the impact assessment unless direct impacts might occur during construction, such as damage or the need to decommission and relocate them, which is discussed further in Section 7.

Table 5-6 Summary of registered bores within 500 m of the project alignment

Registered use	Bore status	
	Not Used	Used
Domestic	0	2
Stock and domestic	0	2
Investigation	0	1
Non-groundwater	0	4
Unknown	3	3
SEC bores	0	86
Stock	0	1
Totals	3	99

Eight active bores are registered with extractive or unknown uses are located within 500 m of the onshore project alignment (Table 5-7). Potential impact to these registered users is considered further in Section 7.

Table 5-7 Active bores with registered extractive or unknown use within 500 m of the project

Registered bore ID	Total bore depth (m)	Easting	Northing	Registered use	Distance from project alignment
84269	0	432452.3	5753830	Unknown	0.5
84270	0	432200.3	5755489	Unknown	67
N/A	83	443867	5759994	Domestic	154
85575	30.48	418111.3	5729680	Stock	178
61664	46.94	421195.3	5734918	Unknown	218
77659	12.5	414963.3	5721234	Stock and domestic	230
61662	208.48	423061.3	5736531	Stock and domestic	260
120540	6	425653.3	5742104	Domestic	303

5.5.6 Groundwater dependent ecosystems (GDEs)

GDEs are receivers that rely wholly or partially on groundwater to provide all or some of their water needs. GDEs relevant to this project can broadly be categorised as:

- Terrestrial GDEs: Ecosystems reliant on the subsurface presence of groundwater (i.e., vegetation that is accessing the water table and/or capillary fringe).

- Aquatic GDEs: Ecosystems reliant on the surface expression of groundwater (i.e., wetlands, swamps, springs, estuaries and baseflow fed watercourses).
- Subterranean GDEs: Ecosystems associated with caves and aquifers (stygofauna).

In the case of terrestrial GDEs, ecosystems may be either obligate GDEs, with a continuous or entire dependence on groundwater, or facultative GDEs, with an infrequent or partial dependence on groundwater (Zencich et al. 2002).

The BoM GDE Atlas (2012) was accessed to identify the range of landscapes within and around the study area (within 500 m of the project alignment) that may potentially contain ecosystems dependent on groundwater for some or all of their water requirements, including aquatic, terrestrial and subterranean GDEs.

The GDE mapping tool provides information concerning both known and potential GDEs. Known GDEs are those identified during previous desktop or field studies, and potential GDEs are those derived through analysis of spatial data sets. Derivation of potential GDEs relies heavily upon remote sensing data to identify vegetation growth response patterns.

The identification of terrestrial GDEs can be complex and includes inherent uncertainty. GDE impact assessments typically assign a likely GDE type based on landscape setting, remote sensing data, vegetation type and an understanding of the likely interactions with groundwater. Uncertainty is managed by adopting conservative assumptions when identifying GDEs and when developing risk mitigation measures. Where there is high potential for impact to GDEs further work may be recommended to assess the specific sources of water accessed by individual trees within an ecosystem, and the status and value of that ecosystem.

5.5.6.1 Terrestrial GDEs

The project alignment crosses large areas of predominantly cleared agricultural land between Waratah Bay and Mirboo North. There is limited native vegetation remaining in this part of the project alignment and even less which is potentially groundwater dependent.

Isolated occurrences of mapped estuarine wetland vegetation class (EVC 10) are present in the low-lying zone behind the Waratah Bay dune system, corresponding to areas of high likelihood terrestrial GDEs. This vegetation class is reported to be comprised of graminoids and halophytic herbs and is often fringed by tall scrub layer of Swamp Paperbark (*Melaleuca ericifolia*) along the landward edge (DELWP 2022a). This vegetation is noted to be adaptable to both saline and freshwater conditions (DELWP 2022a) and would draw water from both groundwater and the estuary system and is expected to be facultative. However, the shallow root zone of these species is likely to make it more sensitive to long term changes in groundwater level if this occurred.

Further inland, localised stands of native vegetation typically follow road reserves and property boundaries (Swamp Scrub, Damp Heathy Woodland, and Lowland Forest Mosaic) and along riparian zones of creeks and ephemeral drainage lines (Swampy Riparian Woodland). These vegetation classes range from vulnerable (Damp Heath Woodland and Lowland Forest Mosaic) to endangered (Swamp Scrub and Damp Forest).

The mapped occurrences of likely terrestrial GDEs and modelled average groundwater levels are presented on Figure 5-5 in Appendix C. The coincidence of likely terrestrial GDEs and areas that likely require dewatering (i.e., where depth to groundwater is potentially within 2.5 m of ground surface) is further discussed in Section 6.

From Mirboo North through to the Morwell River, the project alignment passes through extensive forestry plantations, of which very little is expected to rely on groundwater. Limited areas of native riparian vegetation along creeks (primarily Swampy Riparian Woodland and Lowland Forest) are likely to rely on groundwater during dry periods.

Most terrestrial GDEs along the project alignment are expected to be facultative GDEs, relying on groundwater for some of their water needs and drawing on rainfall infiltration and bank storage in riparian zones at other times. The impact assessment discussed in Section 7.3.2.1 considers the inherent uncertainty associated with determining the water use of terrestrial GDEs, which is common across all groundwater impact assessment projects.

5.5.6.2 Aquatic GDEs

This section identifies creeks and rivers that are reported with moderate or high likelihood for groundwater dependence based on published layers in the BoM GDE Atlas.

Most creeks and rivers have moderate to high likelihood of being dependent on groundwater for some or all of their flow during dry periods (Table 5-8). One potentially groundwater dependent swamp was identified at approximately 35,600 m along the project alignment (with 0 m starting onshore at Waratah Bay).

The low-lying land behind the Waratah Bay dune system has areas of estuarine wetlands that are intermittently identified with points of groundwater dependent terrestrial vegetation. Despite not being mapped aquatic GDEs, it is possible that this network of isolated swamps and wetlands, and connected streams may have some aquatic flora or fauna that rely on fresh groundwater input to some degree.

Table 5-8 Rivers, creeks and waterbodies with moderate or high likelihood for groundwater dependence within the project alignment

Named Water Course	Likelihood of groundwater dependence	Comment
Waratah Bay estuarine wetlands	Not mapped by GDE atlas	Shallow groundwater anticipated in an area of swamp, wetland and connected estuarine streams.
Fish Creek	High	Permanent or near-permanent flow.
Buffalo Creek	High	-
Stony Creek (south)	High	-
Freshwater swamp (35,600 m from onshore at Waratah Bay)	Unclassified potential	Palustrine, temporary freshwater swamp, approximately 80 m east of alignment.
Tarwin River East Branch	High	Permanent or near-permanent flow.
Toomey Creek	High	Toomey Creek appears ephemeral in area crossing the project alignment. There are unlikely to be aquatic ecosystems present. Not considered a GDE.
Berrys Creek	High	Highly altered stream condition through agricultural land crossed by the project alignment. Possibly of limited ecosystem value in this location.
Little Morwell River	Moderate	Limited stream flow apparent from aerial photographs. Potentially intermittent flow during dry months.
Stony Creek (north)	High	-
Morwell River	High	Permanent or near permanent
Eel Hole Creek	Moderate	May have limited flow, isolated pools crossing agricultural land. Likely highly altered aquatic ecosystem.

5.5.6.3 Subterranean GDEs

Stygofauna, a type of subterranean GDEs are small, primarily aquatic invertebrate organisms that inhabit aquifers. In Victoria, there is very limited information available on the presence of non-karstic stygofauna. Stygofauna can be found in fresh to saline water; however, they are most common in fresh to brackish water where electrical conductivity (EC) is less than 5000 µs/cm (Hancock and Boulton 2008; Hose et al. 2015). Although stygofauna have adapted to low energy and low oxygen groundwater environments, they are most abundant in shallow aquifers in areas of regular recharge where nutrients and oxygen are available (Hancock and Boulton 2008).

A regional stygofauna survey was undertaken by the Geological Survey of Victoria’s Victorian Gas Program during 2019 in the West and East Gippsland Catchment Management Authority (CMA) regions, with the nominated survey area covering the majority of the onshore project alignment (GSV 2020).

The regional stygofauna survey provides a baseline measure of stygofauna across the upper aquifers of the Gippsland Basin, albeit based on a limited number of sample locations. This survey recorded stygofauna in one of the 20 bores sampled, with one worm taxon identified in this bore. This suggests a low abundance and biodiversity of stygofauna within the unconfined aquifers of the Gippsland Basin.

5.5.7 Groundwater quality

There is limited shallow groundwater quality data available along the project alignment. Regional groundwater salinity mapping has been adopted to provide an indication of expected total dissolved solid (TDS) concentrations along the alignment.

Groundwater salinity along the onshore project alignment is expected to range from below 500 mg/L TDS up to around 3,500 mg/L TDS (Figure 5-9).

The lower TDS groundwater generally coincides with the occurrence of the Upper Tertiary/Quaternary aquifer, particularly along the alignment between Waratah Bay and joint pit JP5A. Groundwater quality in the near-shore environment as last reported during 2010 at the Sandy Point SOBN bore 100976 was relatively fresh (480 mg/L) and circum-neutral pH (6.6).

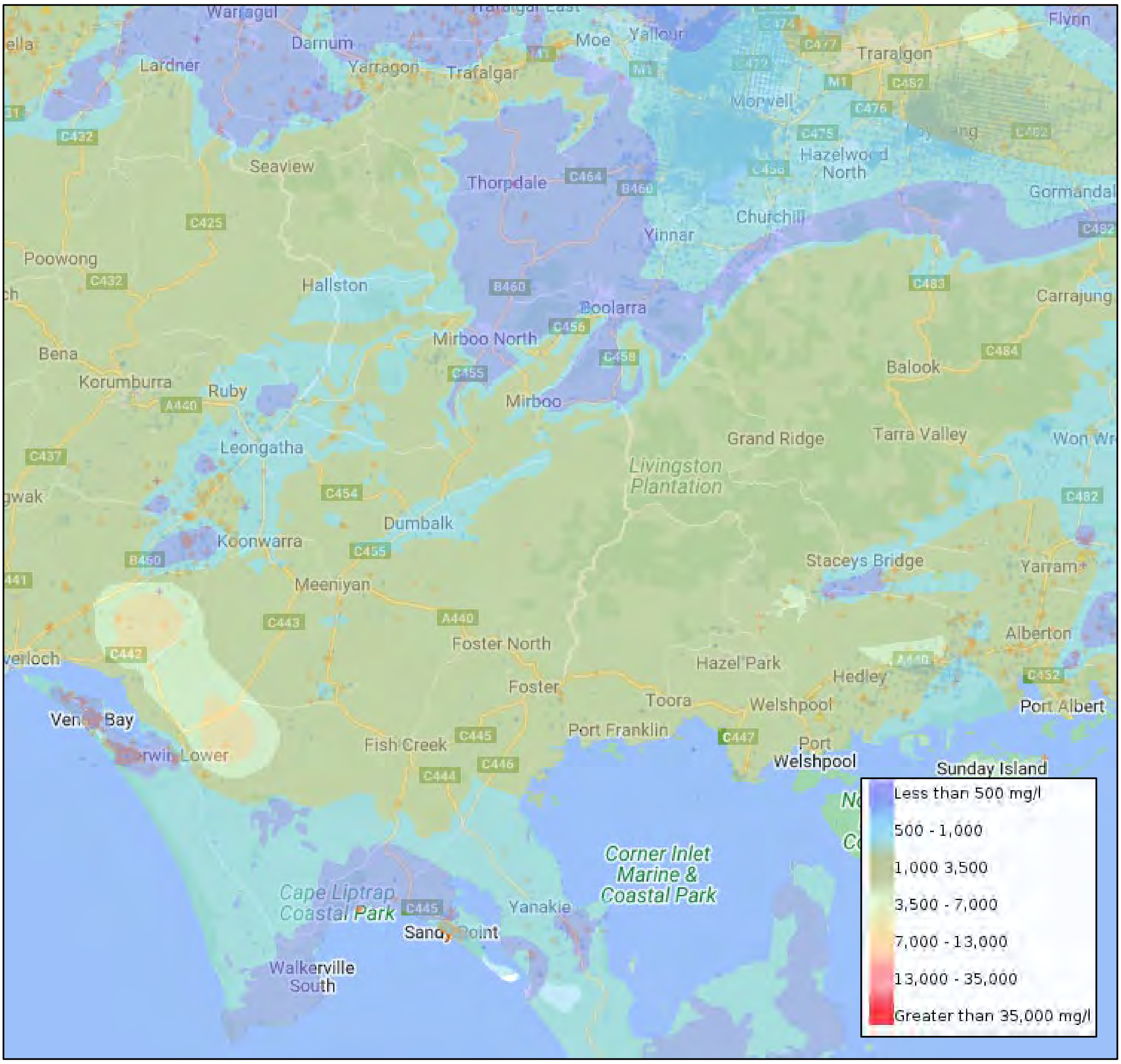


Figure 5-9 Groundwater salinity (Visualising Victoria's Groundwater)

Continuing north of joint pit JP5A, groundwater is expected to be more saline, with TDS ranging from 1,000 to 3,500 mg/L through until Mirboo North. Shallow groundwater along the remainder of the project alignment between Mirboo North and Hazelwood is expected to be relatively fresh, ranging from below 500 mg/L to approximately 1,000 mg/L TDS.

5.5.8 Environmental values of groundwater

The Environment Reference Standard (ERS 2021) defines which environmental values apply to groundwater based on groundwater salinity (i.e., the lower the salinity, the greater the range of environmental values that apply). Groundwater is divided into seven segments which are defined by the background level of salinity (i.e., TDS).

Table 5-9 provides the environmental values of groundwater in Victoria that may exist based on the background level of salinity.

Table 5-9 Environmental values that apply to the Groundwater Segments in Victoria (reproduced from Table 5.3, ERS 2021)

Environmental value	Segments (TDS mg/L)						
	A1 (0-600)	A2 (601-1,200)	B (1,201-3,100)	C (3,101-5,400)	D (5,401-7,100)	E (7,101-10,000)	F (>10,001)
Water dependent ecosystems and species	✓	✓	✓	✓	✓	✓	✓
Potable water supply (desirable)	✓						
Potable water supply (acceptable)		✓					
Potable mineral water supply	✓	✓	✓	✓			
Agriculture and irrigation (irrigation)	✓	✓	✓				
Agriculture and Irrigation (stock watering)	✓	✓	✓	✓	✓	✓	
Industrial and commercial	✓	✓	✓	✓	✓		
Water-based recreation (primary contact recreation)	✓	✓	✓	✓	✓	✓	✓
Traditional Owner cultural values	✓	✓	✓	✓	✓	✓	✓
Buildings and structures	✓	✓	✓	✓	✓	✓	✓
Geothermal properties	✓	✓	✓	✓	✓	✓	✓

Notes: grey shading – EV does not apply to Segment

Shallow groundwater in the Upper Tertiary/Quaternary aquifer along the project alignment between Waratah Bay and joint pit JP5A is likely to be categorised as Segment A1 or A2. Shallow groundwater between Mirboo North and Hazelwood is also likely to fall into one of these two categories. All identified environmental values apply to Segment A1 and A2 groundwater.

Groundwater through the central zone of the project alignment is more saline and is likely to be categorised as Segment B. The same environmental values apply to Segment B groundwater with the exception of potable water supply.

A review of Visualising Victoria's Groundwater portal (vvg.org.au) identified that there are no designated mineral springs within 2 km of the project alignment, and the alignment does not pass through a mineral spring district. The water table aquifers expected to be encountered in or around the project are unlikely to have temperatures between 30°C and 70°C, for them to be considered suitable for geothermal recreational activities. These environmental values are not considered further.

5.6 EXISTING CONTAMINATION ISSUES

Publicly available EPA Victoria records including priority sites register, environmental audits, EPA licensed areas, groundwater restricted use zones, and landfill registers were reviewed to identify existing potential sources of groundwater contamination that maybe mobilised towards the project due to temporary groundwater level drawdown. Further detail concerning potential contamination along the project alignment is provided in Contaminated Land and Acid Sulfate Soil Study (Tetra Tech Coffey 2023).

No groundwater restricted use zones were noted within the study area.

On a regional scale, diffuse sources of groundwater contamination are possibly present, associated with agricultural and forestry activities in the area. The application of agricultural or forestry chemicals including herbicides, pesticides and fertilisers are key sources of contamination in agricultural areas. Waste from livestock commonly leads to contamination of shallow groundwater resources by nutrients, biological oxygen demand (BOD), turbidity and bacteria and viruses.

Other diffuse sources of contamination include a former railway line and areas of potential acid sulfate soils. Contamination typically associated with the railway include metals, total recoverable hydrocarbons (TRHs), and asbestos (which is not mobile in the subsurface). The potential acidification of groundwater through exposure of acid sulfate soils is discussed further in Section 7.3.6.

A summary of potential point sources of contamination to groundwater and contaminants of potential concern identified are provided in Table 5-10. Potential contaminant pathways include infiltration to underlying aquifers, or by way of run-off to waterways that have a connection to shallow groundwater. The various water table aquifers in the study area are considered to have a high vulnerability to pollution, however some protection may be afforded in the presence of weathered deep clay soils.

Table 5-10 Potential Point Sources of Contamination to Groundwater

Feature	Location	Contaminants of Potential Concern
Hazelwood Cooling Pond	Hazelwood	Metals, hydrocarbons, nutrients, polycyclic aromatic hydrocarbons (PAHs), TRHs, per- and polyfluoroalkyl substances (PFAS) (ERM 2017)
Hazelwood Eastern Overburden ash dump and perched aquifer, located approximately 800 m north of the Hazelwood converter station.	Hazelwood	Metals, nutrients, PAHs, TRHs, PFAS (ERM 2017)
Agricultural land – machinery and workshops	Unknown	Metals, degreasers, solvents, TRHs
Agricultural land – sheep dips	Unknown	Metals, organochlorine/organophosphate (OC/OP) pesticides
Buried waste, informal dumps, burn piles, tyre stacks, building rubble	Unknown	Metals, TRHs, PAHS, PFAS, nutrients, OC/OP pesticides

Feature	Location	Contaminants of Potential Concern
Underground septic tanks	Unknown	nutrients, pathogens, PFAS, surfactants
Above ground fuel tanks	Unknown	TRHs

Note: 'Unknown' locations relate to commonly occurring contamination sources in agricultural use zones. Locations have not been identified but may exist within the study area.

6. MODELLING AND ASSESSMENT

This section provides a summary of modelling and further assessment undertaken to determine the magnitude of potential impacts due to groundwater dewatering and interactions with the groundwater through construction.

6.1 PROJECT DEWATERING REQUIREMENTS

The purpose of this section is to identify the potential for the project construction activities to extend below the water table and require temporary dewatering. This has been assessed for the purpose of the impact assessment by applying the assessment method outlined in Section 4.3.1.

The results of the assessment identified six main sections of the trench alignment that are likely to require dewatering (Table 6-1). These six sections include several hundred metres of the alignment that are likely to extend below the water table and require dewatering. One location is the near-shore area at Waratah Bay where groundwater levels are shallow (Figure 7-1 in Appendix D). The remaining five locations correspond with areas where the alignment crosses the alluvial aquifers that exist around surface drainage lines.

A seventh zone exists between Mardan and Darlimurla where intermittent, short sections of the alignment may require dewatering where they cross local drainage lines typically where bedrock units of the Thorpdale Volcanics or Wonthaggi Formation outcrop (Figure 7-1 in Appendix D). Further site investigations prior to construction would be required to confirm the need for dewatering in this area.

Management and disposal of extracted groundwater from dewatering activities will be required to minimise potential impacts to groundwater values. This is discussed further in Section 9.

The proposed Driffield converter station includes areas of earthworks that may also extend below the water table (Jacobs 2022). Specifically, a road cutting was identified by the geotechnical investigation that might intersect groundwater by up to 1.5 m, possibly higher if seasonal variations produce higher groundwater levels. While active dewatering is unlikely to be required, long term drainage at the road cutting is likely to occur, which would result in localised, permanent drawdown in the immediate vicinity of the cutting.

Table 6-1 Zones of moderate and high dewatering likelihood along the project alignment

Project locations	Project alignment markers (m)	Surface geology	Comments
Waratah Bay	0 to 1,820	Coastal dune and coastal lagoon	Dewatering of cable joint pit JP1A is anticipated during construction.
Fish Creek	17,000 to 19,670	Alluvium, alluvial terrace deposit	Dewatering of cable joint pit JP14A to JP19 are anticipated during construction.
Stony Creek	28,450 to 28,660 29,030 to 30,700	Alluvium, Wonthaggi Formation	N/A
Tarwin River East Branch – unnamed tributary	35,660 to 36,850	Alluvium, Wonthaggi Formation, Thorpdale Volcanics	N/A
Tarwin River East Branch	40,960 to 41,310	Alluvium, Thorpdale Volcanics	N/A
Mardan to Darlimurla	Intermittent between 45,810 and 62,690	Wonthaggi Formation and Thorpdale Volcanic Group	N/A
Morwell River	78,350 to 78,680	Alluvium	N/A

Project locations	Project alignment markers (m)	Surface geology	Comments
	78,940 to 79,240	Alluvium	Section is proposed to be directionally drilled; no dewatering required.

Note: N/A = not applicable.

6.2 GROUNDWATER DRAWDOWN ASSESSMENT

The purpose of the groundwater drawdown assessment is to estimate the extent of groundwater drawdown due to the anticipated dewatering requirements where construction is expected to extend below the water table at location identified in the previous section (Section 6.1). The impact of this interaction is discussed in Section 7.

The drawdown assessment adopts analytical methods described in Section 4.3.2. It conservatively considers the unconfined water table to be at ground surface with dewatering required to the base of the 1.5 m trench. The assessment also considers long-term, steady state conditions which would likely require several months to achieve, which is conservative and is unlikely to occur during temporary construction dewatering.

The upper 10 m of the saturated ground profile was considered. Given the limited extent of the trench excavation this is considered reasonable. Rainfall infiltration (groundwater recharge) was estimated at 5% of the average annual rainfall for Gippsland. This estimate is considered conservative, with suggestions of values ranging up to 15 % possible in some parts of the study area based on the regionally calibrated groundwater model for Gippsland (DEDJTR 2015).

Aquifer hydraulic properties applied during modelling have been based on the aquifer parameters adopted as part of the regional Gippsland groundwater model (DEDJTR 2015), presented in Section 5.5.1. These are reproduced in Table 6-2 together with results of the calculated distances to nominal groundwater drawdown intervals from the centre of the trench or joint pit excavations. Copies of the analytical spreadsheet calculations are provided in Appendix E.

Groundwater drawdown of 1 m is not predicted to propagate beyond 200 m from the edge of the onshore trench in the highest conductivity alluvial aquifers under long term, steady state conditions. Deeper joint pits, which will receive radial groundwater flow, are not predicted to produce greater drawdown magnitudes than estimated for the trench sections.

Table 6-2 Groundwater drawdown estimates

Scenario	Excavation depth (m)	Depth to groundwater (m)	Representative aquifer unit	Hydraulic conductivity (m/day)	Distance to drawdown contours (steady state) 1 m drawdown	0.5 m drawdown	0.1 m drawdown
Onshore trench	1.5	0	Upper Tertiary-Quaternary alluvium	6.5	200 m	400 m	670 m
			Haunted Hill formation	3.2	115 m	307 m	530 m
			Thorpdale Volcanic and Wonthaggi Formation	0.65	52 m	138 m	245 m
Cable joint pits	3	0	Upper Tertiary-Quaternary alluvium	6.5	54 m	140 m	400 m
			Haunted Hill formation	3.2	45 m	120 m	325 m
			Thorpdale Volcanic and Wonthaggi Formation	0.65	30 m	59 m	160 m

7. IMPACT ASSESSMENT

The following sections present the groundwater impact assessment for construction (Section 7.3) and operation (Section 7.4) of the project.

7.1 POTENTIAL IMPACTS

Each potential impact is discussed with an assessment of impact magnitude and significance provided. Summary tables of initial impact magnitude, and both initial and residual impact significance are provided in Table 7-21 and Table 7-22, respectively.

The impact assessment considers potential impacts to groundwater level and quantity, and groundwater quality from the following construction and/or operational activities:

Groundwater levels and quantity:

- Temporary dewatering of onshore cable trenches, cable joint pits, and HDD entry/exit pits during construction leading to groundwater level drawdown.
- Construction activities destroying private groundwater bores.
- HDD beneath rivers and creeks to create new hydraulic pathways if perched aquifers exist, potentially reducing groundwater availability and baseflow discharge.
- HDD through and beneath Waratah Bay dune system may alter perched groundwater systems within the dunes.
- Compaction of unconsolidated aquifer matrices beneath haul roads, laydown areas, or other infrastructure altering aquifer permeability, groundwater flow directions and levels.
- Backfilling cable trenches with material of higher hydraulic conductivity causing localised groundwater recharge and mounding.
- Construction of impermeable (or low permeability) subsurface infrastructure creating a hydraulic barrier and causing damming affects to shallow groundwater flow.

Groundwater quality:

- Mobilisation of existing groundwater contamination due to temporary dewatering and groundwater level drawdown.
- Release of contaminated groundwater generated during dewatering to the environment.
- Groundwater acidification due to temporary dewatering and groundwater level drawdown.
- Herbicide application at the Driffield and Hazelwood converter station migrating to groundwater.
- Discharge from the proposed Driffield septic tank system causing groundwater contamination.
- Accidental spills and leaks of transformer oil, lead acid batteries, and diesel fuel stored in above ground tanks at the Driffield and Hazelwood converter station.
- Enhanced recharge of stormwater runoff (including flood waters) to shallow groundwater via higher-conductivity backfilled cable trench causing changes to groundwater quality.

No potential impacts to groundwater have been identified for the decommissioning phase as the project has not advised the need for subsurface work as it is assumed the subsurface infrastructure will be left in place.

There are a range of potential impacts that are common to most construction sites, and which are routinely addressed by well-established standard operating procedures or guidelines in the construction industry, including construction and operation environmental plans. Examples of these potential impacts considered to be negligible or not feasible are summarised below:

- Contamination of groundwater from storage and handling of small volumes of cleaning chemicals, fuels and other materials.
- Contamination of groundwater from subsurface construction materials (sealing products, chemical grouts etc).
- Minor excavations for roads and drainage infrastructure intercepting groundwater and altering levels.
- Infiltration of water from temporary construction sedimentation ponds recharging groundwater and altering levels or quality.
- Temporary removal of topsoil and vegetation leading to enhanced groundwater recharge.

In summary, the Potential sources of impacts to expected groundwater values include:

- Temporary dewatering resulting in reduced groundwater levels, altered groundwater flow directions, reduced groundwater-surface water interactions, and reduced flow at any remaining groundwater springs. Groundwater level drawdown may also lead to land subsidence.
- Direct loss of aquifer resources (including baseflow discharge) due to construction and/operation of project infrastructure.
- Reduced groundwater levels and altered groundwater flow – directions, particularly around groundwater observation bores.
- Reduced groundwater quality due to contamination of aquifers during construction and operation activities.

7.2 SENSITIVITY ASSESSMENT

This section presents the sensitivity assessment of the underlying attributes of the environmental values, which may be impacted by the project.

The baseline groundwater characterisation presented in Section 5 has established the expected environmental values that apply to groundwater which include both environmental sensitive receivers and productive uses of groundwater. Collectively, the following environmental values have been considered when assessing the sensitivity of the water table aquifers across the study area:

- Registered groundwater use, including stock and domestic use. Potential for irrigation and potable water supply exists but is unlikely from shallow resources.
- Recreational use, including swimming in baseflow-fed rivers and creeks.
- GDEs, including:
  - Baseflow-fed rivers and creeks exist throughout the study area.
  - Groundwater dependent terrestrial vegetation particularly in riparian zones.
- Aboriginal cultural values of groundwater are likely to exist where they support the identified terrestrial and aquatic GDEs.

The following environmental values also apply and have been considered, but are unlikely to be realised in the study area:

- Potable groundwater supply from shallow resources is not expected. No potable water supply bores are registered within 500 m of the project, and shallow groundwater would not be a preferred potable resource.
- Potable mineral water resources are not mapped in the region. This use is unlikely to be realised.
- Incidental industrial water use is likely to be limited to the Hazelwood area where groundwater is managed as part of closure of the former coal mine and cooling ponds.

- Geothermal properties do not apply to shallow groundwater in the study area which will be at ambient temperatures.
- No groundwater springs or seeps are known to exist.

While these environmental values are recognised, they are given less weighting when comparing to the sensitivity definitions for groundwater provided in Appendix C.

Groundwater is assessed in relation to its suitability to support environmental values that are broadly categorised as:

- **Consumptive or productive uses**: including drinking water, and water for domestic use such as washing, agriculture (irrigation and stock watering), industrial and commercial use, and to support water-based recreation such as swimming.
- **Water dependent ecosystems**: as baseflow contribution to watercourses or terrestrial vegetation accessing shallow groundwater.
- **Cultural or spiritual values**: including aesthetic, historical, scientific, social or other significance to the present generation or past or future generations.

On the basis of the sensitivity criteria presented in Table 4-2, the sensitivity levels assigned to water table aquifers present across the study area are summarised in Table 7-1. Each aquifer has been assigned an overall moderate sensitivity based on the rounded mean ranking where high sensitivity = 3; moderate sensitivity = 2; low sensitivity = 1.

The above assessment relates to the process of establishing the sensitivity of aquifers which is a requisite step of the groundwater impact assessment methodology established for the project and is consistent with the EES Scoping Requirements. It is recognised that there is also a legislative requirement under the EP Act to minimise the risk of contamination to groundwater as far as reasonably practicable irrespective of an aquifer's sensitivity.

The potential impacts to environmental values as a result of the project construction and operation activities are discussed further in the following sections as they relate to either impacts to groundwater quantity and levels or groundwater quality.

Table 7-1 Sensitivity assignments for aquifers within the study area

Aquifer	Assessment	Environmental values	Uniqueness and rarity	Resilience to change	Recovery potential	Replacement potential	Overall sensitivity
Quaternary alluvial	Sensitivity assignment	High (3)	Low (1)	Moderate (2)	Low (1)	Low (1)	Moderate (Mean 1.6)
	Justification	The alluvial systems support aquatic ecosystems that are of high importance but may be slightly modified. Intrinsic attributes support the use of the groundwater for potable supply, agricultural use, and food production.	Alluvial aquifers and their connected features are common throughout the study area and on a regional and national basis.	Recharge rates and groundwater-surface water interaction likely allows moderate resilience and capacity to adjust to level or quality change.	Alluvial aquifers have relatively high recharge rates and short recovery periods.	There are several local water features (surface water or groundwater) that could provide alternative water sources to users.	
Haunted Hill Formation	Sensitivity assignment	High (3)	Low (1)	Moderate (2)	Low (1)	Low (1)	Moderate (Mean 1.6)
	Justification	Consistent with the assessment of Quaternary alluvial.	Consistent with the assessment of Quaternary alluvial.	Consistent with the assessment of Quaternary alluvial.	Consistent with the assessment of Quaternary alluvial.	Consistent with the assessment of Quaternary alluvial.	
Bedrock Units	Sensitivity assignment	Moderate (2)	Low (1)	Moderate (2)	Moderate (2)	Moderate (2)	Moderate (Mean 1.8)
	Justification	Low yields and higher salinity support secondary domestic supply and some agricultural uses. The bedrock and Tertiary Basalt are not preferred water resources but contribute some baseflow to aquatic GDEs. .	Bedrock and Tertiary Basalts are regionally extensive and do not support groundwater system, or connected feature recognised on statutory registers	Where they outcrop, the basalt and bedrock aquifers are susceptible to effects of surface activities. The low hydraulic conductivity and dominant fracture porosity will limit the radial extent of level or quality change.	Fractured rock aquifers have lower recovery potential particularly for quality changes. Remediation is more challenging and should contamination occur.	Their main occurrence in foothills and ranges, and absence of other aquifer alternatives offers reduced water supply alternatives (primarily surface water).	

7.3 CONSTRUCTION

This section identifies the potential impacts of the project on groundwater during the construction phase on identified groundwater values.

7.3.1 Impacts to groundwater users due to construction activities and dewatering

7.3.1.1 Construction activities resulting in damage to registered bores

The project proposes a 36 m disturbance zone along the onshore corridor, equivalent to 18 m either side of the project alignment's centreline. Seven registered bores are likely to be located within the clearance zone and, if they are confirmed to exist, would require decommissioning prior to construction commencing. Affected bores are summarised in Table 7-2 and discussed further below.

Of the seven bores within the clearance zone, five are registered as Victorian State Electricity Commission (SEC) bores and are likely to be associated with groundwater monitoring at former coal mining operations and the nearby power stations in the Hazelwood area.

Ongoing groundwater level monitoring, modelling, and reporting is understood to be conducted to support mine closure activities. While the five SEC bores listed in Table 7-2 are not listed as part of the regional monitoring program (GHD 2019), discussions should be held with the land owners to confirm whether these bores remain operational, and whether replacement bores may be required. In addition, discussions with land holders should include identification operational unregistered bores within areas likely to be affected by construction activities, and requirements for replacement water supply.

Registered bore 325449 is located near cable joint pit JP60 and is registered for a 'non-groundwater' use. The bore was installed in 1982 to a relatively shallow 24 m depth and is unlikely to be associated with an extractive use. It is located near the road reserve in an area now occupied by forestry plantation. Further inquiries may be necessary with the landowner to confirm whether the bore is operational and whether a replacement bore installed outside of the clearance zone may be required.

Bore 84269 has an unknown use and does not include depth or well construction information. It was installed in 1959 and, based on a review of web map, it appears to be located at the edge of a forestry plantation where an unpaved road reserve now exists. An excerpt from web map is provided in Appendix B. While it is unlikely that this bore remains operation for an extractive use, further inquiries and inspections should be made prior to construction to consider whether replacement is required.

In all cases, if bore infrastructure exists, they will require decommissioning by licenced drillers to prevent potential for contaminant ingress to aquifers during construction, and that such decommissioning will be completed in accordance with minimum bore construction requirements (EPR GW08).

Table 7-2 Registered bores within clearance corridor

Registered bore ID	Distance from centreline (m)	Easting (GDA94z55)	Northing (GDA94z55)	Bore use	Total well depth (m)	Surface geology
84269	0.5	432452.3	5753830	Unknown	0	Latrobe Valley Group
325347	2.5	438736.3	5760697	SEC bore	30	Latrobe Valley Group
325356	3.3	438324.3	5760933	SEC bore	83	Latrobe Valley Group
325348	5.2	439729.3	5760987	SEC bore	194	Haunted Hill Formation

Registered bore ID	Distance from centreline (m)	Easting (GDA94z55)	Northing (GDA94z55)	Bore use	Total well depth (m)	Surface geology
308665	6.4	446759.3	5760445	SEC bore	332.8	Haunted Hill Formation
325449	10.2	433422.3	5756518	Non-groundwater	24	Thorpdale Volcanic Group
309384	14.7	446418.3	5760186	SEC bore	395	alluvial terrace deposits

7.3.1.2 Temporary groundwater drawdown affecting groundwater users

Six bores were located within 50 m of the edge of the clearance zone (equating to 68 m from the project's centreline) are summarised in Table 7-3. These bores have highest potential to be affected by temporary groundwater drawdown of 1 m or more during construction.

Only one of the six bores (ID 84270) is registered for a potentially extractive (in this case unknown) use, with the remaining five being SEC observation bores. Bore 84270 is not located in an area where dewatering is likely to be required.

Table 7-3 Registered bores within 50 m of the onshore trench

Bore ID	Distance from centreline (m)	Easting	Northing	Bore use	Total well depth (m)	Surface geology
309389	22	446442.3	5760214	SEC bore	656	Alluvial terrace deposits (Qa2)
308889	27	443045.3	5760620	SEC bore	128.6	Haunted Hill Formation (Nlh)
308921	42	445815.3	5759689	SEC bore	146.3	Alluvial terrace deposits (Qa2)
308578	59	443454.3	5760474	SEC bore	290.5	Alluvial terrace deposits (Qa2)
308616	59	447604.3	5761034	SEC bore	149.4	Haunted Hill Formation (Nlh)
84270	68	432200.3	5755489	Unknown	0	Latrobe Valley Group (-Pv)

Further consideration was given to any bores registered for an extractive use within 500m of the sections of the onshore trench that are likely to require dewatering during construction (assessed in Section 6.1 and shown on Figure 7-1 in Appendix D).

Three registered bores were identified within the 500 m radius of sections of dewatered onshore trench, two of which were noted to have extractive uses (Table 7-4). Both extractive use bores are over 250 m from the dewatering points. Furthermore, bore ID 61662 is installed to significant depths of over 200 mbgs, screening deeper aquifers that would be unaffected by surface trenching activities.

Bore ID 120540 is shallow (6 mbgs) and may be influenced by drawdown effects if they extend over the 303 m distance. In this case, both Bore 120540 and the section of dewatered trench exist in areas where Wonthaggi Formation outcrops. The expected low hydraulic conductivity of the bedrock formation is expected to limit drawdown to <0.1 m under long term steady state conditions (refer to Section 6.2).

Geotechnical and hydrogeological investigations in the areas potentially requiring dewatering should include assessment of groundwater levels and site geological conditions. Investigation results should be reviewed and informed by experienced hydrogeologists working with the design team (GW01) to support the project's detailed design and prior to construction commencing to verify that drawdown estimates and the magnitude of impact to registered bores are not greater than assessed by the groundwater impact assessment.

EPR GW08 requires that any reduced supply to groundwater users be made good by providing an alternative water supply if required.

Table 7-4 Registered bores within 500 m dewatering zones

Bore ID	Distance from centreline (m)	Easting	Northing	Bore use	Total well depth (m)	Comment
318825	75	417032.3	5727426	Non-groundwater	297	In the vicinity of Stony Creek
61662	253 m	423061.3	5736531	Stock and domestic	208 m	In the vicinity of Tarwin River east branch
120540	303	425653.3	5742104	Domestic	6 m	In the vicinity of joint pit JP43A

Residual impacts

Five SEC monitoring bores, one 'non-groundwater' bore and one bore of unknown use are likely to require decommissioning during the construction period. This could have a moderate magnitude impact (equating to a moderate impact significance) should these bores continue to serve a use for landowners. EPR GW08 is recommended.

The recommended measures within EPR GW08 could be achieved by making inquiries with affected landowners to confirm the status of registered bores within the construction zone and, where necessary, negotiating requirements for decommissioning existing bores and replacing them with new bores or providing an alternative water supply if required.

Registered bores within the vicinity of the project are considered unlikely to be adversely affected by groundwater level drawdown. This potential impact is addressed by EPR GW08.

Therefore, the residual impact to groundwater bores due to project-related dewatering is low (with negligible magnitude of impact) with implementation of measures to comply with EPR GW08.

Environment performance requirements

The following EPRs are proposed to minimise the significance of potential impacts.

Table 7-5 Environmental performance requirements: impacts to groundwater users

EPR ID	Environmental performance requirement	Project stage
GW08	Develop and implement measures to maintain water supply to registered groundwater users	Construction

7.3.2 Impacts to GDEs due to dewatering

7.3.2.1 Temporary groundwater drawdown affecting terrestrial GDEs

Moderate and high likelihood potential terrestrial GDEs located within 500 m of areas of expected dewatering are described in Section 5.5.6.1 and are summarised below in Table 7-7.

Long term groundwater level decline can affect the health of terrestrial ecosystems with vegetation that relies on groundwater for some or all of their water needs. Typically, groundwater drawdown that occurs rapidly, is beyond the natural range of groundwater level fluctuations (in the order of 1 to 2 m) and persists for an extended period, are considered to have potential to affect terrestrial GDE health (based on professional experience in similar environments).

Residual impacts

The total period of groundwater level drawdown includes both the period of active dewatering and a period of groundwater level recovery after pumping stops. An example of the theoretical groundwater drawdown and recovery response over time is shown in Diagram 1.

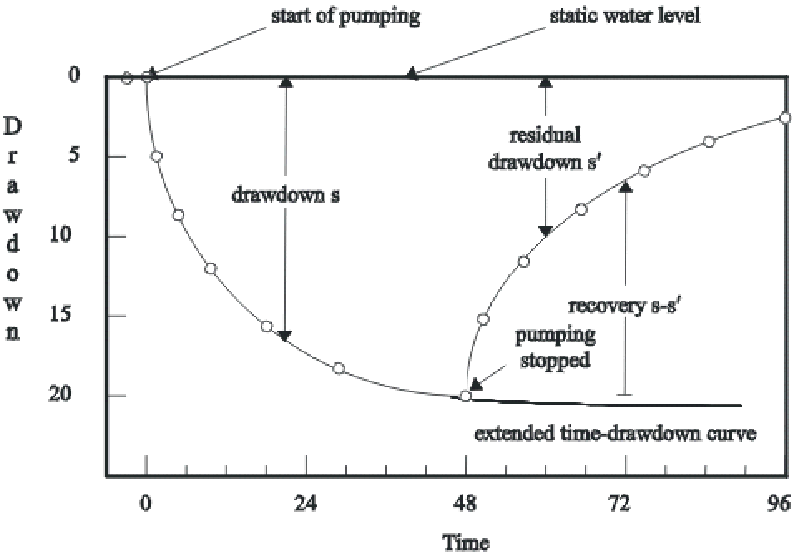


Diagram 1: Example of theoretical groundwater drawdown recovery after pumping (based on Theis [1935]) (Waterloo Hydrogeologic, 2023)

Complete recovery of groundwater to pre-construction levels may take approximately the same time that dewatering was conducted (in this case one to two months), assuming no additional sources of recharge are present, such as surface water or rainfall recharge. Therefore, the total period of level drawdown (of any magnitude) could be up to a likely maximum period of two to four months. The maximum drawdown magnitudes presented in Table 7-7 would only be experienced at terrestrial GDEs for some of this period.

Furthermore, in most cases the recovery period is likely to be substantially shorter, as most terrestrial GDEs draw groundwater from alluvial and coastal lagoon aquifers connected to surface water features which will rapidly recharge the aquifer.

The estimated magnitude and duration of groundwater level drawdown would have a negligible magnitude of impact on the terrestrial GDEs identified in the study area, corresponding to a low impact significance.

The uncertainty associated with determining the individual water sources and potential for some identified GDEs to be obligate groundwater users is minimised by the short construction period and relatively minor period of lowered groundwater levels. This is recognised as a data gap that warrants further assessment during detailed design.

EPR GW01 requires future hydrogeological assessments at points where dewatering is likely to be required. These assessments should verify the local groundwater conditions (including groundwater levels, quality and aquifer hydraulic conditions) and ensure that any revised drawdown estimates and durations are generally consistent with those assessed by the impact assessment. This could be achieved by installing groundwater monitoring wells, conducting aquifer hydraulic tests (such as rising and falling head tests), and providing updated drawdown estimates. EPR GW02 minimise the magnitude and duration of groundwater level drawdown that may affect aquatic GDEs.

Environmental performance requirements

The following EPRs are proposed to minimise the significance of potential impacts.

Table 7-6 Environmental performance requirements: impacts to GDEs due to dewatering

EPR ID	Environmental performance requirement	Project stage
GW01	Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design	Design
GW02	Develop and implement methods to minimise groundwater inflow into trenches and groundwater level drawdown	Construction

Table 7-7 Estimated groundwater drawdown at terrestrial GDEs within 500 m of dewatered zones

Project chainage point	Distance from dewatering	Outcrop geology	Predicted drawdown magnitude	Vegetation type	Likelihood of groundwater dependence	Comment
0 to 900	0 m	Coastal lagoon deposits	Up to 1.5 m	Estuarine wetland	High	Isolated areas of mapped wetland vegetation in agricultural land. Cable trench passes alongside and through the vegetation.
17,430	10 to 90 m	Alluvial terrace	1 m to 1.5 m	Damp Heathy Woodland (EVC 793), Lowland Forest Mosaic (EVC 16)	High	0.8 ha of vegetation surrounding ephemeral drainage lines on agricultural land.
28,450 to 28,660	30 m	Wonthaggi formation	1 m to 1.5 m	Swamp Scrub (EVC 53)	Moderate	260 m section of roadside native vegetation parallel to trench alignment.
29,000 to 29,880	10 to 80 m	Wonthaggi formation	1 m to 1.5 m	Swamp Scrub (EVC 53)	Moderate to high	1.5 km zone of native vegetation along unpaved road.
30,475 to 30,590	0 m	Alluvium	Up to 1.5 m	Swampy Riparian Woodland (EVC 83)	High	Stony Creek riparian vegetation.
35,700 to 36,000	0 to 60 m	Alluvium	Up to 1.5 m	Swampy Riparian Woodland (EVC 83)	High	Tarwin River East Branch – unnamed tributary riparian vegetation.
41,100 to 41,310	0 to 60 m	Alluvium	Up to 1.5 m	Swampy Riparian Woodland (EVC 83)	Moderate to High	Tarwin River East Branch, isolated stands of riparian vegetation.
62,580	20 m	Alluvium	Up to 1.5 m	Lowland Forest (EVC 16)	High	Little Morwell River riparian vegetation.

7.3.2.2 Temporary groundwater drawdown affecting aquatic GDEs

The project alignment crosses several surface water features that have been identified with moderate or high likelihood of being groundwater dependent (Section 5.5.6.2). HDD has been adopted as the construction method for river crossings which will minimise the impacts of trench drawdown in the immediate vicinity of baseflow-fed rivers and creeks. Exceptions are noted at Little Morwell River and the estuary behind the Waratah Bay dunes where trenching is currently proposed (discussed further below).

However, dewatering of trenches and HDD entry and exit excavations may cause groundwater level drawdown to propagate away from the excavations towards the surface water features. Where this occurs, hydraulic gradients between groundwater and surface water may temporarily reduce or, in some cases, reverse, locally inducing surface water to recharge groundwater. Adverse effects may be experienced where groundwater drawdown beneath aquatic GDEs results in reduced surface water levels and/or surface water flow rates. If these changes are of sufficient magnitude and duration, they could alter surface water quality and affect the dynamics of aquatic ecosystems that may rely on higher flows or levels.

These effects would be localised to the section of the stream's reach passing the zone of groundwater drawdown. Table 7-8 outlines the magnitude of potential drawdown at the points closest to the identified aquatic GDEs along the project alignment based on estimates provided for joint pits which may conservatively represent radial flow to the HDD entry and exit excavations.

Table 7-8 Estimated groundwater drawdown at aquatic GDEs

Named Water Course	Distance from dewatered trench	Predicted groundwater level drawdown at GDE	Comment
Waratah Bay estuarine wetlands	0 m	Up to 1.5 m	Cable trench crosses estuarine stream 310 m from the shore landing point. Wetland exists 320 m west of cable joint pit JP1A. Boundary effects are likely to minimise the drawdown that is realised.
Fish Creek	40 m	1.0 to 1.2 m	
Buffalo Creek	N/A	N/A	Dewatering not anticipated (refer to Section 4.3.1)
Stony Creek (south)	40 m	1.0 to 1.2 m	
Freshwater swamp (KP 34,600)	90 m	0.1 to 0.5 m	Located on low-conductivity Wonthaggi Formation outcrop. Drawdown only expected to influence western edge of the swamp and would be unlikely to have measurable effect on water balance in the short term.
Tarwin River East Branch	45 m	1.0 to 1.2 m	Joint pit at the edge of the HDD launch point, 45 m from the river.
Berrys Creek	N/A	N/A	Dewatering not anticipated
Little Morwell River	0 m	25 m zone either side of trench with 0.1 to 1.5 m groundwater drawdown	Limited flow anticipated in minor drainage line, which may increase magnitude of drawdown impact. Potential for drawdown to affect passing flow. Trenching proposed through bed which will disrupt flow more considerably than dewatering.
Stony Creek (north)	N/A	N/A	Dewatering not required.

Named Water Course	Distance from dewatered trench	Predicted groundwater level drawdown at GDE	Comment
Morwell River	260 m	<0.1 m	HDD will avoid the need for dewatering in close proximity.
Eel Hole Creek	N/A	-	Dewatering not required.

Residual impacts

The impact assessment notes that HDD is not currently proposed at river crossing for either Little Morwell River or the estuary behind the Waratah Bay dunes. In the absence of HDD construction methods at these locations, the 1.5 m deep cable trench is assumed to pass through these surface water features using temporary flow diversion or damming/retainment of the standing water during construction. Dewatering of the open cable trench would be required at these locations.

At Little Morwell River, dewatering and groundwater level drawdown within the bedrock aquifer would likely occur during construction with drawdown potentially causing temporarily reduced surface water levels or flow rates in an approximately 25 m zone either side of the trench. Impacts associated with temporary groundwater dewatering at Little Morwell River would be secondary to the direct impacts associated with trenching, which will be assessed by the surface water impact assessment report. Without mitigation, a minor impact magnitude might exist, corresponding to a low significance.

Behind the Waratah Bay dunes, the trench alignment will cross an estuarine stream that is likely to be connected to shallow groundwater. Dewatering of the open cable trench will be required through this zone during construction, including the trench section crossing the stream. Similar to Little Morwell River, temporary diversion or barriers may be required during construction in the estuarine zone. Temporary dewatering is unlikely to have significant effect on surface water levels or flow in the estuary, or estuarine water quality to the extent that it would have a measurable effect on the aquatic ecosystems or other environmental values of surface water. This requires further confirmation by local hydrogeological assessment (EPR GW01) and assumes construction methods in saturated zones will use standard excavation shoring to limit water inflow (EPR GW02).

Elsewhere, all river crossing will adopt HDD which will minimise groundwater level drawdown during construction or operation. Dewatering at the nearest point of the cable trench near Fish Creek, Stony Creek, Tarwin River East Branch has been conservatively estimated to potentially result in temporary drawdown of 1 m to 1.5 m beneath the stream bed across a short section of their total stream length. The impact magnitude as a result of localised groundwater drawdown on the aquatic ecosystem of the surface water features is likely to be negligible, as only a small component of the stream's total groundwater contribution along its length would be lost for a short period of time.

Minor groundwater drawdown of 0.1 to 0.5 m may propagate towards the freshwater swamp approximately 90 m east of project alignment maker point KP 34,600. Drawdown would only influence the western edge of the swamp and is unlikely to have a measurable effect on water levels or the ecosystem as a whole.

All other surface water features that are not listed (with the exception of Little Morwell River) would have no drawdown impact. The impact significance, based on assumed groundwater levels and aquifer properties, is therefore low.

EPR GW01 requires future hydrogeological assessments at points where dewatering is likely to be required, which should verify the aquifer hydraulic conditions and ensure that drawdown estimates are generally consistent with those assessed by the impact assessment. This could be achieved by installing groundwater monitoring wells, conducting aquifer hydraulic tests (such as rising and falling head tests), and providing updated drawdown estimates. EPR GW02 reduces uncertainty and minimises the magnitude and duration of groundwater level drawdown that may affect aquatic GDEs.

Environmental performance requirements

The following EPRs are proposed to minimise the significance of potential impacts.

Table 7-9 Environmental performance requirements: impacts to GDEs due to drawdown

EPR ID	Environmental performance requirement	Project stage
GW01	Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design	Design
GW02	Develop and implement methods to minimise groundwater inflow into trenches and groundwater level drawdown.	Construction

7.3.3 Impacts to GDEs and groundwater users due to HDD construction

Drilling can create preferential pathways for groundwater to travel along the borehole annulus if not adequately sealed. This is commonly not of concern when drilling within the same aquifer formation and can be problematic where drilling crosses confining layers and might allow interaction between previously isolated aquifers.

In alluvial settings it is not uncommon for the single alluvial sand aquifer to be interbedded with lower permeability clays. Impacts to groundwater-surface water interactions may occur if the clay layers that are present support perched local groundwater systems, and drilling through these layers could feasibly alter the flow dynamics of the system.

The borehole annulus, if not adequately sealed, can also provide a pathway for contaminants from the surface (such as runoff from agricultural areas, roads, or spills) to enter groundwater more rapidly and affect associated environmental values of groundwater.

Potential for ‘frac out’ to occur during drilling exists with all HDD activities. Frac-out is the unintentional return of drilling fluids to the surface other than via the drilling entry and exit point as a result of the pressure in the drilling hole exceeding the pressure of the surrounding ground). This could result in the loss of drilling fluids to the environment and the development of new hydraulic connections between aquifers, across confining layers or between surface water and groundwater. This occurs most frequently near the borehole entry and exit points where the drilling depth is shallowest. Frac-out occurring near the entry and exit points would have lower potential for impact to groundwater and associated environmental values due to the shallow depth, distance from surface water features, and the localised disturbance by the main borehole that would already exist around the drilling activities.

The spatial extent of changes to groundwater levels and quality if an impact did occur would be limited to the area surrounding the HDD boreholes and would have a relatively low ecosystem impact.

7.3.3.1 Residual impacts

HDD boreholes could have moderate magnitude of impact to aquatic GDEs particularly where frac out occurs, which corresponds to a moderate impact. There would be negligible magnitude of impacts to terrestrial GDEs which are less sensitive to altered hydraulic pathways and other groundwater users who would not typically achieve reliable supplies from perched systems, corresponding to a low impact.

EPR GW03 includes requirements for HDD activities to be designed based on geotechnical information and that appropriate mitigations are in place to minimise the environmental impact should unforeseen events (such as frac out) occur. Incident management, such as frac out during HDD, will be covered in EIS/EES Volume 5, Chapter 2 – Environmental Management Framework. These measures would be informed by the hydrogeological assessment completed to inform the design and construction methods (EPR GW01).

With the implementation of these measures there would be a negligible residual impact magnitude to terrestrial GDEs, and a negligible impact magnitude to aquatic GDEs. Overall, the impact on GDEs and groundwater users due to HDD construction would be low.

7.3.3.2 Environmental performance requirements

The following EPRs are proposed to minimise the significance of potential impacts.

Table 7-10 Environmental performance requirements: impacts to GDEs from HDD

EPR ID	Environmental performance requirement	Project stage
GW01	Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design	Design
GW03	Develop and implement methods for HDD and drilling to prevent groundwater movement and contamination	Construction

7.3.4 Impacts on perched systems within Waratah Bay dunes due to HDD

HDD beneath the Waratah Bay dune and beach is estimated to take up to 12 months to construct the shore crossing. Drilling will commence in the farmland behind the coastal reserve and dune system. The ground surface elevation at the drilling point is estimated to be approximately 2.5 m AHD and drilling offshore will emerge at a point with 10 m depth (approximately -10 m AHD).

Dune systems can have complex perched groundwater systems that may support terrestrial GDEs, however there are no indications or reports that such systems exist in the coastal reserve or dune system at Waratah Bay. The baseline GDE assessment did not identify any potential aquatic or terrestrial GDEs within the dunes or foreshore area. Perched systems are less likely in the estuarine setting behind the dunes where groundwater levels are near the ground surface.

7.3.4.1 Residual impacts

The potential for HDD beneath Waratah Bay dune system to alter perched groundwater systems within the dunes (if present) is considered to be very unlikely as the baseline assessment (see Section 5.5.4 and 5.5.6) did not identify any reports of perched aquifers or potential GDEs within the Waratah Bay dune system. Precautionary measures will be implemented to minimise potential for groundwater movement along the HDD borehole during crossing of the Waratah Bay dunes and in the final constructed borehole annulus (EPR GW03). Further assessment will be undertaken to confirm hydrogeological conditions at the shore crossing (EPR GW01), which will assist with refining proposed HDD and shore crossing construction methods during detailed design (EPR GW03). Therefore, the magnitude of an impact, if it did occur, would be minor. This corresponds to a low impact significance.

7.3.4.2 Environmental performance requirements

The following EPRs are proposed to minimise the significance of some potential impacts.

Table 7-11 Environmental performance requirements: HDD impacts to perched aquifers

EPR ID	Environmental performance requirement	Project stage
GW01	Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design	Design
GW03	Develop and implement methods for HDD and drilling to prevent groundwater movement and contamination.	Construction

7.3.5 Impacts on aquifers due to compaction

Proposed construction activities, such as the construction and use of haul roads, laydown areas, and construction of permanent surface infrastructure (such as the converter station) may result in the compaction of unconsolidated aquifer matrices. Compaction of the aquifer matrix can reduce pore space and locally alter the aquifer hydraulic properties, in turn locally changing groundwater levels, flow directions and flow rates. This is more feasible in areas where alluvial sediments are present and less likely in areas where bedrock units outcrop.

If compaction of the aquifer matrix did occur, it would result in greater impacts where these effects extended over larger areas. Construction and use of the central haul road along the project alignment is considered to have the highest potential for a measurable effect on groundwater.

Haul road construction and use is unlikely to cause aquifer compaction at levels greater than those experienced at higher trafficked public roads present extensively across the region.

7.3.5.1 Residual impacts

Based on the absence of observed impacts from higher trafficked public roads in the region, aquifer compaction beneath the central haul road, if it did occur, is unlikely to have a measurable effect (negligible magnitude) on the environmental values of groundwater such as GDEs and groundwater users. A low impact significance is considered to apply.

7.3.5.2 Environmental performance requirements

No EPRs are proposed or required specifically for this potential impact.

7.3.6 Impacts on groundwater due to acidification

Where potential acid sulfate soil (ASS) is present, and it is allowed to oxidise either in-situ or in temporary stockpiles, it may result in the acidification of groundwater. Acidic groundwater can have adverse ecological effects where it discharges to the surface environment.

Furthermore, as many metals have increased solubility in low pH groundwater, acidic conditions commonly results in the dissolution of metals from the aquifer matrix causing increased dissolved metals concentrations in groundwater.

The following regional mapping of potential ASS have been reviewed to identified areas where the potential presence of material with acid generating potential exists:

- Coastal acid sulfate soil published by Agriculture Victoria (Agriculture Victoria 2022).
- Atlas of Australian Acid Sulfate Soils (Australian Soil Resource Information System 2014).

A zone of mapped potential coastal ASS material is identified between the Waratah Bay landfall point and approximately the first 430 m of the onshore project alignment towards cable joint pit JP1A (Figure 7-1). This zone of coastal ASS coincides with shallow groundwater which is likely to require dewatering during construction (Section 6.2).

If groundwater levels have not fluctuated significantly over geological time, the potential exists for shallow soils to retain unoxidized sulfidic material that may pose a risk of groundwater acidification if drawdown occurs. Permanent waterlogged soils such as streams, floodplains, rivers, and wetlands have an increased potential of containing ASS. Due to the presence of estuarine wetlands and isolated swamps at Waratah Bay (see Section 5.5.6), this area has been considered as having a high probability of containing ASS, resulting in potential groundwater acidification.

Elsewhere along the project alignment, low and extremely low probability of ASS occurrence is reported. Therefore, groundwater acidification at other areas of dewatering is unlikely to occur.

7.3.6.1 Residual impacts

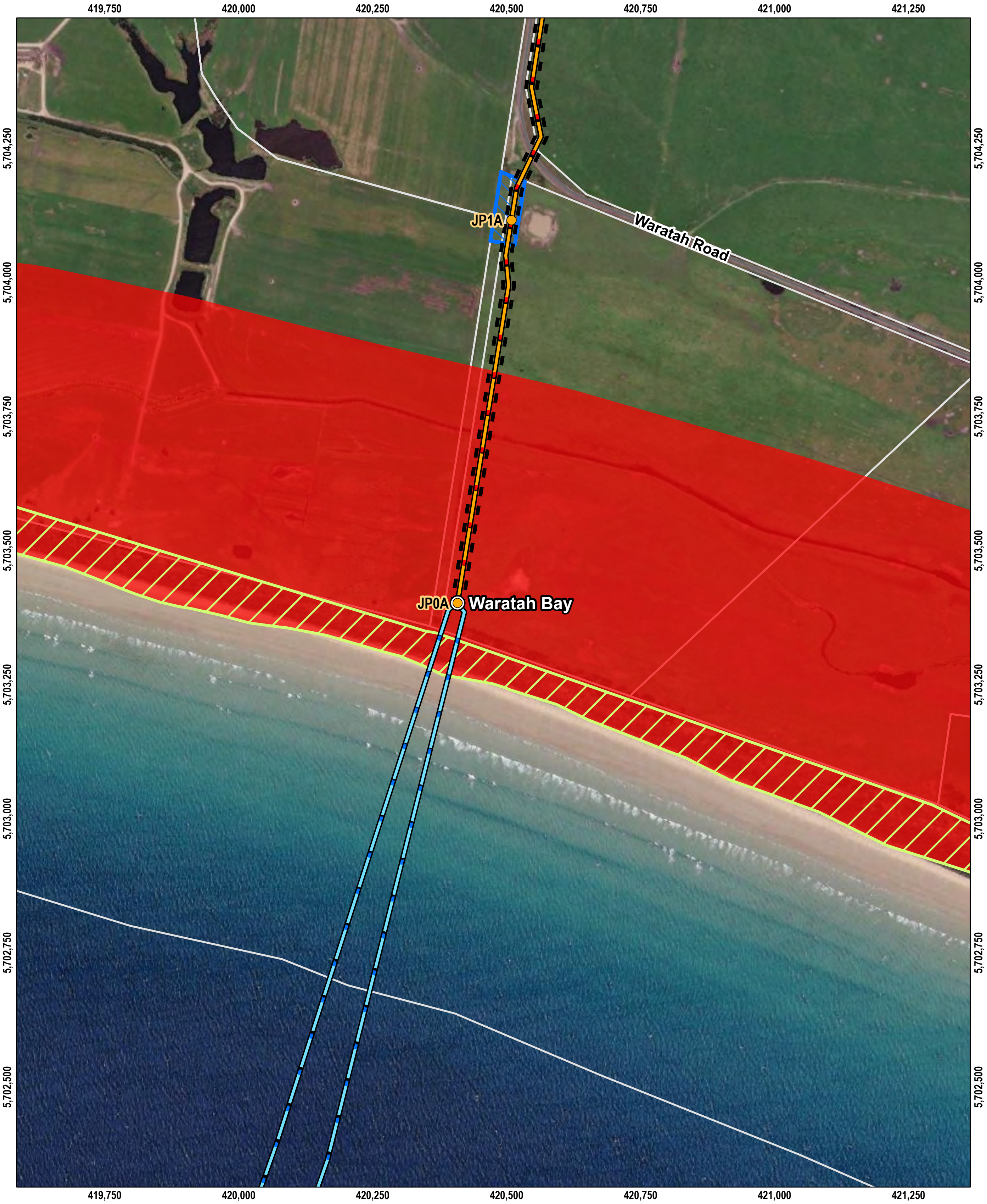
The magnitude of a groundwater quality impact from groundwater acidification (if it occurred) would be a function of the magnitude and duration of groundwater drawdown, the local aquifer hydraulic properties, the mass and form of sulfidic material present within the aquifer, and the neutralising capacity of the aquifer. Currently, the assessment relies on published regional information where present and conservative assumptions have been made where site specific information is not available.

If unmitigated, a degree of groundwater acidification may persist during operation as a result of localised groundwater drawdown. Acidic groundwater, if it were generated, would be relatively limited in extent, but would likely migrate towards the Waratah Bay coastline and the estuarine environment behind the dune system, discharging to the aquatic environment. Areas of vegetation dieback and aquatic ecosystem impact would be anticipated which would, in turn, affect other environmental values such as water-based recreation and Traditional Owner cultural values.

The extent of impact, if it occurred, would remain within the region where the project is being developed and the impacts could be rectified through remedial works. Therefore, a moderate magnitude of impact is assumed under this scenario, corresponding to a moderate impact.

EPR GW07 is proposed to further assess the presence of ASS in the coastal zone. Combined with EPR GW01 and EPR GW02, construction in the coastal zone would adopt control measures, such as installation of sheet pile walls or other barriers, or temporary groundwater injection to minimise groundwater drawdown and groundwater acidification during construction. These controls ensure that areas of potential ASS are understood prior to work commencing and engineering options are prepared in advance to minimise the potential for acidification to occur. Groundwater level and quality monitoring would likely be required to demonstrate that this EPR is being met during construction in areas where dewatering is proposed through areas of potential ASS (EPR GW06).

When meeting the EPRs, a minor residual impact magnitude is assumed.



LEGEND

- Landfall
- Joint pit
- HVDC subsea cable
- Underground HVDC cable
- Easement
- Transition station footprint
- Mapped potential coastal acid sulphate soils
- Road
- Cadastre
- Waratah Bay - Shallow Inlet Coastal Reserve

MARINUS LINK

SCALE 1:10,000

PAGE SIZE: A4

PROJECTION: GDA2020 MGA Zone 55

Source:
Proposed routes from Tetra Tech Coffey.
CASS from DEECA. Roads and cadastre from VICMAP.
Imagery from ESRI Online.

MARINUS LINK PTY LTD

MARINUS LINK
GROUNDWATER IMPACT ASSESSMENT - VICTORIA

FIGURE 7-1

Zone of mapped coast acid sulfate soil at Waratah Bay

TETRA TECH COFFEY

DATE: 16.05.24 PROJECT: 754-MELEN215878ML FILE: 215878ML_HYDRO_F07-1_GIS

7.3.6.2 Sorry, Environmental performance requirements

The following EPRs are proposed to minimise the significance of potential impacts.

Table 7-12 Environmental performance requirements: groundwater acidification

EPR ID	Environmental performance requirement	Project stage
GW01	Complete a hydrogeological assessment and dewatering drawdown assessment to inform design.	Design
GW02	Develop and implement methods to minimise groundwater inflow into trenches and groundwater level drawdown.	Construction
GW06	Undertake groundwater monitoring to establish baseline groundwater conditions prior to construction and monitor groundwater levels and quality in areas of higher potential during construction.	Construction
GW07	Develop and implement measures to prevent groundwater acidification, saline intrusion and contaminant mobilisation in areas where they are predicted to occur	Construction

7.3.7 Impacts on groundwater due to saline intrusion

Within the low-lying coastal area, temporary groundwater drawdown from trench dewatering creates the potential to alter the fresh/saline groundwater interface. This is most likely to be associated with dewatering of the cable trench between the HDD launch point and joint pit JP1A, as well as dewatering at the joint pit itself. Groundwater drawdown may result in the movement of the saline water interface inland (or upwelling of deeper saline water), disturbing fresh, shallow groundwater in the estuarine zone and increasing the salinity of the coastal aquifer.

In addition, there is also potential for preferential flow paths to be created by HDD that might allow saline water to migrate along the borehole annulus (if not adequately sealed) to the estuarine zone behind the dunes. Within the coastal zone HDD is proposed up to the landfall point and below Waratah Road.

The proposed dewatering activities in the coastal zone may result in groundwater level drawdown of up to the 1.5 m (the maximum trench depth) and drawdown of at least 1 m could extend several tens of metres, possibly up to 200 m if dewatering continued until steady state conditions were reached (which is unlikely to occur in the 3 to 5 week construction period) (Section 6.2).

Variable groundwater inflows maybe expected in the coastal zone given the presence of both high conductivity coastal dune deposits (on which drawdown estimates are based) and lower conductivity coastal lagoon deposits, which would have substantially less drawdown propagation.

7.3.7.1 Residual impacts

A groundwater assessment (EPR GW01) should be undertaken to verify the aquifer hydraulic conditions and ensure that drawdown estimates are generally consistent with those assessed by the impact assessment.

Relatively limited groundwater drawdown is expected to propagate away from the cable trench in the estuarine zone during the short construction period (subject to confirmation by EPR GW01). Under these conditions, relatively minor changes to groundwater salinity in the estuarine zone would be anticipated, however further work would be required to confirm this drawing on site-specific aquifer hydraulic properties which will support transient drawdown assessments. Furthermore, the aquatic and terrestrial ecosystems in this zone are expected to be resilient to a range of salinity conditions and are unlikely to be affected by small, localised changes to groundwater salinity. There are likely to be numerous hydraulic boundaries in the estuarine zone, such as the streams and swamps that will significantly limit the lateral propagation of groundwater drawdown away from the trench.

EPR GW01 will ensure that the existing hydrogeological conditions and dewatering requirements will be understood in the coastal zone prior to dewatering taking place. Furthermore, GW07 requires the implementation of measures to prevent saline water intrusion into freshwater aquifers where potential impacts to groundwater quality are predicted to occur (as identified in GW01) as a result of dewatering.

Dewatering activities, if they are required, may locally alter groundwater quality which is considered to have a minor magnitude impact to the estuarine wetlands, which are adapted to variable salinity. A low impact significance is assumed. This should be verified by groundwater monitoring in the coastal zone during construction to establish baseline groundwater salinity and ensure adverse impacts to environmental values of groundwater do not occur (EPR GW06).

Given the limited extent of HDD within this area, the potential for migration of seawater through preferential flow paths is considered to have minor magnitude impacts to the wetlands, which correspond to a low impact significance. Methods that seal the annulus of directionally drilled bores or otherwise prevent water movement along the borehole annulus should be adopted (EPR GW03).

7.3.7.2 Environmental performance requirements

The following measure are proposed to minimise the significance of potential impacts.

Table 7-13 Environmental performance requirements: saline water intrusion

EPR ID	Environmental performance requirement	Project stage
GW01	Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design.	Design
GW03	Develop and implement methods for HDD and drilling to prevent groundwater movement and contamination.	Construction
GW06	Undertake groundwater monitoring to establish baseline groundwater conditions prior to construction and monitor groundwater levels and quality in areas of higher potential impact during construction	Construction
GW07	Develop and implement measures to prevent groundwater acidification, saline intrusion and contaminant mobilisation in areas where they are predicted to occur	Construction

7.3.8 Mobilisation of existing groundwater contamination or release of contaminated groundwater to the environment

Historical and current land uses at sites in the vicinity of the project may have caused groundwater contamination. A comprehensive review of land and groundwater contamination along the project alignment has been reported separately in the Contaminated Land and Acid Sulphate Soil Impact Assessment (Tetra Tech Coffey 2023). A summary of potential groundwater contamination has been presented in Section 5.6.

Groundwater level drawdown associated with onshore trenching has the potential to mobilise existing groundwater contamination (where it exists) and could cause an adverse change in risk to the environmental values of groundwater.

Site features with suspected groundwater contamination identified by the Contaminated Land and Acid Sulphate Soil Impact Assessment (Tetra Tech Coffey 2023) have been compared to predicted areas of trench dewatering (Section 6.2). None were found to fall within the area of predicted groundwater level drawdown with the exception of the Hazelwood cooling water pond (Table 7-14). Dewatering may be required in the vicinity of Eel Hole Creek if excavations are required for the HDD launch and recovery sites.

Limited information is available on groundwater quality along the project alignment and the potential to encounter unexpected groundwater contamination exists. In these cases, dewatering may draw groundwater contamination from unidentified waste areas that may exist towards groundwater bores or other groundwater receivers. No extractive use bores exist within this zone of dewatering that might be affected if unexpected contamination was present and was mobilised towards areas of dewatering. Similarly, the potential to mobilise contamination towards aquatic GDEs is also considered unlikely. As such, limited impact to groundwater values are anticipated from mobilisation of existing groundwater contamination.

The main consideration is the potential to generate contaminated groundwater during dewatering that is unsuitable for discharge to the environment. Appropriate management and disposal of extracted groundwater from dewatering activities will be required to minimise potential impacts to groundwater values.

Table 7-14 Potential sources of groundwater contamination at risk of mobilisation

Groundwater contamination source	Contaminants of concern	Mobilisation pathway	Potential receptors	Significant assessment overview
Hazelwood cooling pond	Metals, hydrocarbons, nutrients, PAHs, TRHs, PFAS	Trench dewatering across Eel Hole Creek	Eel hole creek aquatic ecosystem	Dewatering may draw contaminants from the cooling water pond into the alluvial terrace deposits. This effect is likely to be localised and is unlikely to increase the impact to Eel Hole Creek which is likely to already be impacted by surface water contamination in the area.
Unidentified groundwater contamination (e.g. associated with buried waste, burn piles, etc)	Metals, hydrocarbons, nutrients, PAHs, TRHs, PFAS, nutrients or other contaminants	Trench dewatering	All groundwater values	Dewatering may draw groundwater contamination from unidentified waste areas that may exist towards groundwater bores or groundwater receivers. No extractive use bores exist within this zone of dewatering.

7.3.8.1 Residual impacts

The assessment has not identified any areas where dewatering might mobilise contaminated groundwater and result in an increased risk profile to groundwater values. Negligible to minor magnitude impacts would be anticipated if contamination was present and mobilisation did occur. EPR GW01, which includes the need for a hydrogeological investigation in areas of anticipated dewatering, will provide further information on the existing groundwater quality and verify the assessed low impact significance.

EPR GW05 is recommended to ensure that extracted groundwater is managed appropriately based on its quality and potential contamination status. This may require onsite treatment or disposal via trade waste in some situations where contaminated groundwater is encountered. EPR GW06 is recommended to establish a groundwater monitoring network if dewatering is required around the Hazelwood cooling ponds to further quantify the potential groundwater quality that may require management. GW07 requires the implementation of measures to prevent the mobilisation of existing groundwater contamination (as may be identified in EPR GW01), that might increase the risk posed to groundwater receptors or cause degraded groundwater quality.

These requirements would be formalised in a GMP, consistent with EPRs GW06 and GW07.

After application of measures to achieve these recommended EPRs, the potential to inadvertently encounter or mobilise groundwater, and unknowingly discharge it to the environment is significantly reduced. A minor impact magnitude is considered to apply resulting in a low impact significance.

7.3.8.2 Environmental performance requirements

The following measure are proposed to minimise the significance of potential impacts.

Table 7-15 Environmental performance requirements: contaminant mobilisation

EPR ID	Environmental performance requirement	Project stage
GW01	Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design.	Design
GW05	Design and implement measures to manage and dispose of extracted groundwater during construction to avoid (where possible) or minimise environmental impacts.	Construction
GW06	Develop and implement measures to prevent groundwater acidification, saline intrusion and contaminant mobilisation in areas where they are predicted to occur	Construction
GW07	Develop and implement measures to prevent groundwater acidification, saline intrusion and contaminant mobilisation in areas where they are predicted to occur	Construction

7.3.9 Groundwater contamination from construction activities

7.3.9.1 Groundwater contamination from drilling fluids

Prior to construction, geotechnical and hydrogeological investigation boreholes will be drilled at locations along the onshore cable trench alignment and at locations where construction activities are planned. Furthermore, EPR GW01 requires intrusive investigations at locations where groundwater dewatering is likely to be required and/or where construction activities may pose a high risk of impact to groundwater.

Boreholes that may be completed as groundwater monitoring wells to meet EPRs are required to be licenced by Southern Rural Water and installed by a licenced driller. Drillers are also required to install groundwater monitoring wells in generally accordance with the following guidance:

- National Uniform Drillers Licensing Committee 2020. Minimum construction requirements for water bores in Australia. Fourth Edition.

This guidance requires that, “Chemicals and other drilling fluid additives that could leave a residual toxicity should not be added to any drilling fluids or cement slurries (i.e., grouts) used to drill and complete any water bore”.

It is possible that drilling conducted for purposes other than groundwater investigation (such as HDD) could use alternative drilling fluid additives that might cause contamination by low concentrations of toxic chemicals. Considering the regional scale of the project cable trench alignment and the potential for a large number of geotechnical boreholes to be drilled along the alignment, and the proximity of HDD to sensitive groundwater receivers, the magnitude of impact might be conservatively considered to be moderate, particularly to consumptive or productive uses of groundwater and aquatic GDEs. This equates to a moderate impact significance.

Residual impacts

All activities, including construction methods using HDD, are required to meet the General Environmental Duty (GED) under the *Environment Protection Act 2017* (Vic) (the EP Act). To meet the GED, all proposed drilling activities will adopt water-based, non-toxic and biodegradable additives (such as bentonite clays). Toxic chemicals are not commonly used for these applications in Australia.

The recommended measures within EPR GW03 prevents the use of toxic drilling fluid additives for all drilling activities, removing the hazard and reducing the residual impact significance to low.

Environmental performance requirements

The following EPRs is proposed to minimise the significance of the residual impacts.

Table 7-16 Environmental performance requirements: groundwater contamination from drilling fluids

EPR ID	Environmental performance requirement	Project stage
GW01	Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design.	Design
GW03	Develop and implement methods for HDD and drilling to prevent groundwater movement and contamination.	Construction
GW06	Undertake groundwater monitoring to establish baseline groundwater conditions prior to construction and monitor groundwater levels and quality in areas of higher potential impact during construction	Construction

7.3.9.2 Groundwater contamination from construction chemicals and fuels

Construction activities will require the use of light vehicles, drill rigs, earthworks and other construction machinery for planned trenching work, construction of the cable infrastructure and associated junction points, and construction of the converter stations and ancillary infrastructure. Hydrocarbon based fuels, lubricants and degreasing agents are likely to be required on site to power and maintain machinery.

These, and other raw materials may either be hazardous or pose a contamination risk to groundwater if not adequately stored, handled and used during the construction period. Spills and leaks during storage and use may infiltrate to groundwater and cause contamination.

The following is noted in relation to the planned use of chemicals and fuel during construction activities:

- Construction activities will be managed under a Construction Environment Management Plan (CEMP) that will include the following elements:
    - A hazardous materials register.
    - Minimum requirements for the handling, use and disposal of hazardous materials consistent with EPA guidance and Australian Standards, including designated areas where hazardous materials should not be stored or used (such as near waterways and wetlands).
    - Spill response and incident management plans, including provision of spill kits, drains and booms and other equipment that may be identified as necessary by site-specific assessments.
- Light vehicles used by contractors and other project staff will be maintained and refuelled offsite at commercial service stations. Construction equipment and earthworks machinery will be refuelled onsite during the construction period by a mobile diesel fuel tanker.
- All wastes, including controlled wastes, will be transported, stored, handled and disposed. Hydrocarbon contaminated material will be removed to an appropriate disposal site or treatment facility.

The proposed construction activities and the volumes and nature of chemicals and fuels that are likely to be use are not dissimilar to most common construction activities (such as road construction and commercial building projects).

These activities are commonly managed through a project specific CEMP that aligns with the minimum standards and regulatory guidance published in relation to these commonly occurring construction activities or broader industry guidance. Notably, the CEMP will meet the requirements of the EP Act that require all businesses to take proactive steps to manage risks of harm from pollution and waste, and meet the GED.

The following guidance is noted as applicable to the planned construction activities:

- EPA Publication 1820.1: Construction – guide to preventing harm to people and the environment.
- EPA Publication 1834: Civil construction, building and demolition guide.
- EPA Publication 1698: Liquid storage and handling guidelines.
- EPA Publication 1828: Waste Disposal categories – characteristics and thresholds.
- AS/NZS ISO 14001:2016: Environmental management systems – Requirements with guidance for use.

Residual impacts

The magnitude of impact associated with groundwater contamination resulting from the use of relatively small volume chemicals and mobile refuelling during construction of the onshore cable trench and associated infrastructure would be considered minor. This is based on the assessment that where impact occurred, it would be localised, of short duration and could be effectively mitigated through standard environmental management controls.

A Construction Environment Management Plan (CEMP) will be developed and implemented by contractors to meet EPR CL04. The CEMP will include a hazardous materials register, minimum requirements for handling and disposing of hazardous materials, spill response procedures and incident management plans. The CEMP will also consider requirements for groundwater quality monitoring in areas of higher potential impact during construction (EPR GW06). Where appropriate, ongoing groundwater quality monitoring that may continue into the period of operation will be outlined in the OEMP that will include a GMP (EMP GW09)

Overall, a low residual impact significance is assumed for contamination occurring as a result of hazardous materials and chemicals used during the construction period.

Environmental performance requirements

The following EPRs will further minimise potential groundwater impacts to the extent practicable.

Table 7-17 Environmental performance requirements: groundwater contamination from chemicals and fuels

EPR ID	Environmental performance requirement	Project stage
CL02	Manage excavated soil, contaminated soils, removed wastes and potential risks to the environment due to contamination during construction	Construction
GW06	Undertake groundwater monitoring to establish baseline groundwater conditions prior to construction and monitor groundwater levels and quality in areas of higher potential impact during construction	Construction

7.3.10 Impacts to groundwater flow from cable trenches with low-permeability backfill

Aquifer damming can occur where underground infrastructure may restrict groundwater flow through an aquifer, causing changes to groundwater levels (and potentiometric pressure) upstream (mounding) and downstream (drawdown) of the structure.

This potential impact may occur in sections of the project alignment where the trench has been identified as likely to encounter groundwater (discussed in Section 6.1 and shown in Appendix D). These potential impacts are avoided by adopting EPR GW04 which preferences the backfilling of the cable trench with the same material that was excavated in approximately the same order.

Impacts may still occur in areas where thermal backfill is required and where that thermal backfill is of lower hydraulic conductivity than the original soils and where the (maximum) 1.5 m deep trench intersects the full aquifer thickness, such as shallow alluvial or perched aquifers.

Most of the locations where the cable trench is predicted to extend below the water table coincide with zones where alluvial aquifers are present around drainage lines. An example is shown in Figure 7-2 where trenching is proposed to cross the zone of alluvial outcrop in the Stony Creek floodplain between JP26 and JP27A. Similar conditions are anticipated at:

- Fish Creek;
- Unnamed tributary of Tarwin River East Branch;
- Tarwin River East Branch; and
- Morwell River.

These alluvial aquifers may be relatively thin, and the backfilled trench might penetrate the full alluvial aquifer thickness. If low permeability backfill is used in these settings the potential barrier effects may result in raised groundwater levels up gradient that may break through at ground surface creating waterlogged conditions, alter floodplain dynamics, adversely impact surface infrastructure, and cause vegetation dieback. The altered groundwater conditions around the barrier could alter surface water flow rates and reduce groundwater access to terrestrial GDEs. A moderate magnitude impact may be realised in some scenarios relating to a moderate impact significance.

7.3.10.1 Residual impacts

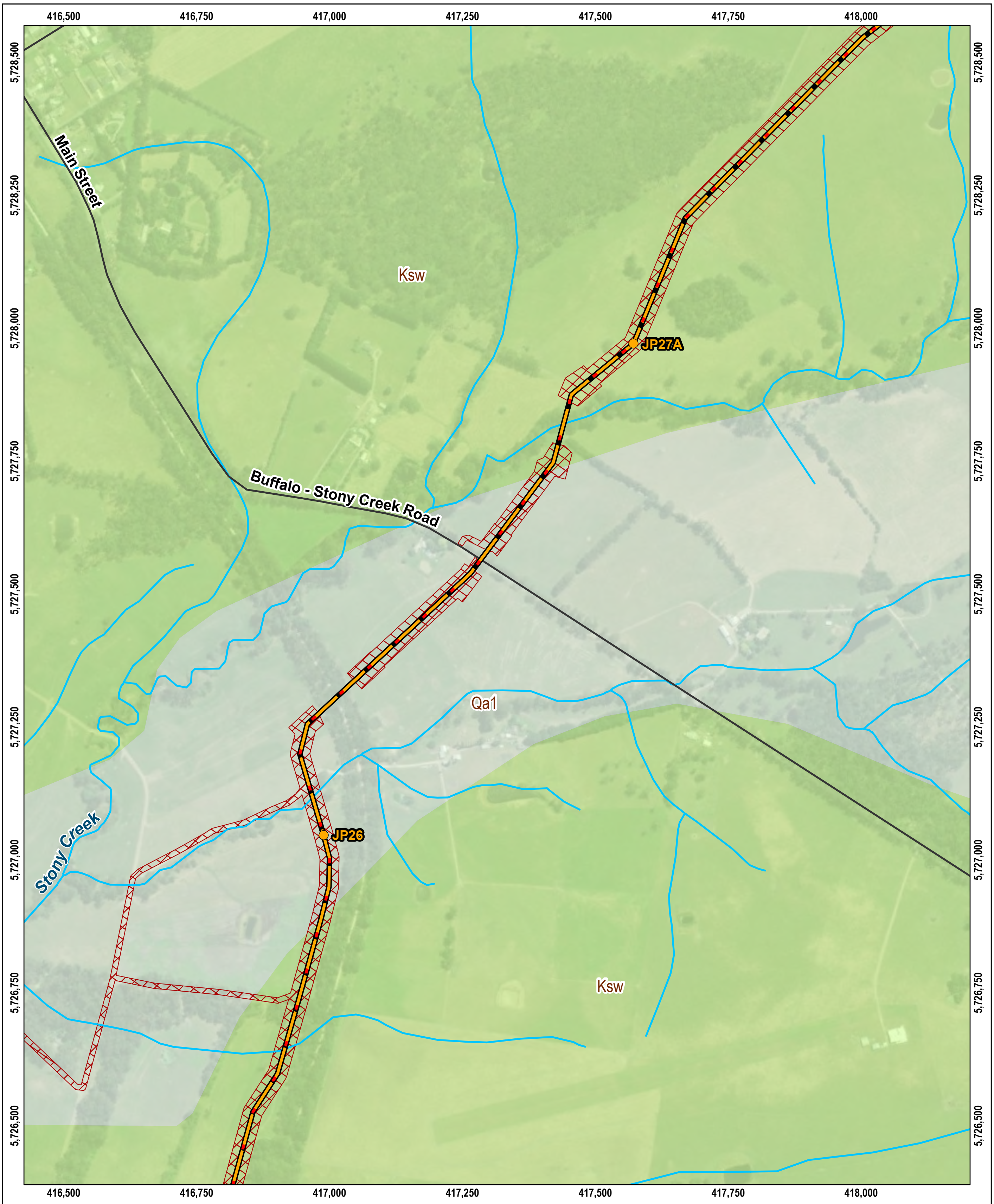
The initial impact assessment considered potential for a moderate impact significance where barrier effects cause locally raised and lowered groundwater levels, and adversely impact vegetation, productive land uses, and amenity.

EPR GW01 will provide additional groundwater information in locations where construction below the water table is anticipated. This site-specific information will allow for refined assessment for potential barrier effects to be completed during detailed design. EPR GW04 ensures that the use of low permeability thermal backfill below the water table is avoided in areas where the cable trench may penetrate the full aquifer thickness. Where this is unavoidable, engineered solutions will be adopted to prevent barrier effects.

Engineered solutions might include the design of under-drainage layers or other features that allow groundwater flow to bypass the structure. Where barrier effects are considered to potentially occur as a result of construction, and where engineering design mitigations are adopted, EPR GW06 should be implemented to monitor baseline conditions prior to construction and monitor the efficacy of the mitigations during construction and operation.

Effective application of mitigation measures that achieve the recommended EPRs will avoid barrier effects from occurring and result in a negligible residual magnitude of backfilling from cable trenches, resulting to a low impact significance.

Overall, with the implementation of measures to comply with EPRs, the residual impact would be low.



LEGEND

- Underground HVDC cable trench alignment
- Joint pit
- Surface area of disturbance
- Major road
- Minor watercourse

Geology

- Wonthaggi Formation (Ksw)
- Alluvium (Qa1)

0 100 200 m

SCALE **1:10,000**

PAGE SIZE: **A4**

PROJECTION: **GDA2020 MGA Zone 55**

Source:
Proposed routes and area of disturbancefrom Tetra Tech Coffey.
Roads and watercourses from VICMAP.
Geology from DJPR (1:250k).
Imagery from ESRI Online.

MARINUS LINK PTY LTD

MARINUS LINK
GROUNDWATER IMPACT ASSESSMENT - VICTORIA

FIGURE 7-2

Cable trench alignment through Stony Creek alluvial aquifer

DATE: **16.05.24** PROJECT: **754-MELEN215878ML** FILE: **215878ML_HYDRO_F07-2_GIS**

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7.3.10.2 Environmental performance requirements

The following EPRs are proposed during construction to minimise the significance of some potential impacts during operation.

Table 7-18 Environmental performance requirements: impacts to groundwater flow along cable trenches

EPR ID	Environmental performance requirement	Project stage
GW01	Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design.	Design
GW04	Develop and implement measures to utilise cable backfill material to minimise impact on groundwater recharge and flow.	Construction
GW06	Undertake groundwater monitoring to establish baseline groundwater conditions prior to construction and monitor groundwater levels and quality in areas of higher potential impact during construction	Construction

7.3.11 Impacts to groundwater recharge along cable trenches

The cable trench will cross multiple catchments including areas of flood inundation, ephemeral drainage lines and other areas where water may periodically flow across the trench alignment during the construction and operation period.

Backfilling cable trenches with material of higher hydraulic conductivity or material that is not adequately compacted may create pathways for surface water to preferentially recharge groundwater. Potential might also exist for runoff entering the low permeability trench to be follow the topographic gradient towards alluvial aquifers in the lower elevations, causing raised levels and potentially increase baseflow discharge and surface water flow at rivers and creeks.

The project has adopted a construction method that requires the cable trench be backfilled so that the original subsoil and topsoil is used to reinstate approximately the soil horizons and it is adequately compacted (EPR GW04).

7.3.11.1 Residual impacts

The proposed construction method including the reinstatement of the subsoil and topsoil horizons (EPR GW04) and compaction will return the overlying soil profile to approximate the original and surrounding undisturbed conditions. This will ensure that rainfall recharge is comparable to the surrounding profile and runoff does not funnel towards the cable trench.

Successful implementation of this EPR will reduce the magnitude of impacts associated with preferential recharge along the cable trench to a negligible level. This corresponds to a low impact significance.

7.3.11.2 Environmental performance requirements

The following EPRs are proposed during construction to minimise the significance of some potential impacts during construction and operation.

Table 7-19 Environmental performance requirements: impacts to groundwater recharge along cable trenches

EPR ID	Environmental performance requirement	Project stage
GW04	Develop and implement measures to utilise cable backfill material to minimise impact on groundwater recharge and flow	Construction

7.4 OPERATION

This section identifies the potential impacts of the project on groundwater during the operation phase on identified groundwater values.

7.4.1 Impacts to groundwater due to contamination from operational activities

A converter station will be required, either the construction of a new converter station at Driffield or the upgrade of the existing converter station at Hazelwood. The following features or activities that take place at either converter station during operation have potential to cause groundwater contamination:

- Accidental spills and leaks of transformer oil, the contents of lead acid batteries, and diesel fuel stored in above ground tanks.
- Discharge from the proposed Driffield septic tank system causing groundwater contamination from nutrients and pathogens.
- Herbicide application migrating to groundwater.

An OEMP will be developed to manage risks to the environment during operation and meet the requirements of the EP Act that requires all businesses to take proactive steps to manage risks of harm from pollution and waste.

The following guidance is noted as applicable to the planned construction activities:

- EPA Publication 1820.1: Construction – guide to preventing harm to people and the environment.
- EPA Publication 1698: Liquid storage and handling guidelines.
- EPA Publication 1828: Waste Disposal categories – characteristics and thresholds.
- AS/NZS ISO 14001:2016: Environmental management systems – Requirements with guidance for use.

In the case of septic tank discharge and herbicide use, contaminants may infiltrate to groundwater and affect the environmental values of groundwater. Contaminated groundwater may also migrate towards connected downstream features.

There are no registered extractive use bores in the vicinity of the proposed converter station sites at Driffield or Hazelwood. The nearest aquatic GDE to Driffield is Silver Creek located 670 m northwest of the proposed site. Aquatic GDEs of Bennetts Creek and Eel Hole Creek are approximately 350 m east and 50 m south from the Hazelwood converter station site, respectively.

7.4.1.1 Residual impacts

The design and operation of the septic tank at Driffield and the application of herbicides at either Driffield or Hazelwood site will be consistent with regulatory requirements and manufacturer’s guidance. Contaminants associated with an approved septic waste treatment system and the normal use of herbicide application in line with manufacturer guidance that might infiltrate to groundwater would be minor at the source and would attenuate over distance towards Silver Creek (Driffield) and Bennetts Creek (Hazelwood). These contamination sources would not be expected to affect groundwater values at their point of discharge. A negligible impact magnitude is considered to apply, corresponding to minor impact significance.

Larger volumes of transformer oils and fuels that may be handled at either of the converter stations may pose a risk to groundwater values if accidental release occurred. While no extractive uses of groundwater are recorded in the local area around the proposed converter stations, several environmental values of the aquifer beneath the converter station may reasonably be impacted by a spill. The spill might also migrate towards, and discharge to Silver Creek (Driffield) and Bennetts Creek (Hazelwood), affecting their environmental values.

Any hazardous chemicals stored or used during operation, including transformer oils, fuels and herbicides, will be done in accordance with the relevant regulatory requirements and manufacturer's guidance. A GMP will be developed as a sub-plan of the OEMP (EPR GW09) and will include management measures to prevent contamination of groundwater as required by EPR CL04.

Accidental spills of contaminants and their potential infiltration to groundwater would be expected to have a minor magnitude of impact when applying standard controls such as bunding (EPR GW09). The residual impact would be low with the application of EPRs.

7.4.1.2 Environmental performance requirements

The following EPRs are proposed during operation to minimise the significance of some potential impacts.

Table 7-20 Environmental performance requirements: groundwater contamination from operational activities

EPR ID	Environmental performance requirement	Project stage
GW09	Develop and implement measures to manage potential impacts to groundwater in operation.	Operation

7.5 CLIMATE CHANGE

The effect of a changing climate is most likely to result in a long-term reduction in rainfall recharge, and declining groundwater levels. DELWP (2016) predicts 11 % to 35 % reduction in groundwater recharge (50^{th} and 90^{th} percentile estimates, respectively) by 2040. These effects may be realised over the operation and decommissioning periods of the project and would result in groundwater levels that are lower than those assessed by this report.

Climate change is not considered to be relevant to most impacts associated with drawdown impacts during the construction period which will take place under the present-day climate.

Long term reduced groundwater levels would not alter the potential impacts of the project on the groundwater environment during operation and decommissioning, and the effects of climate change are not considered further.

7.6 SUMMARY OF THE POTENTIAL IMPACT MAGNITUDE ASSESSMENT

The potential impact magnitude assessment is summarised below (Table 7-21). This potential impact magnitude assessment does not account for implementation of the specified EPRs, which are considered in the residual impact summary (Section 7.7).

Table 7-21 Summary of the potential impact magnitude assessment

Project phase	Potential impact	Affected groundwater values	Assigned magnitude	Justification
Groundwater level and quantity				
Construction	Temporary dewatering of onshore cable trenches, cable joint pits, and HDD entry/exit pits during construction leading to groundwater level drawdown.	Consumptive or productive uses	Negligible	Drawdown from the trench and joint pits and is not predicted to affect registered bores for extractive uses within the vicinity of the project. Any drawdown effects at the levels presented would not alter groundwater supply.
		Terrestrial GDEs (1)	Negligible	Temporary drawdown not extending for more than 3 months is unlikely to adversely affect terrestrial GDEs which most frequently coincide with surface water drainage features. Cable trench construction periods are expected to take up to 3 to 5 weeks per section on average.
		Aquatic GDEs (1) – Little Morwell River, Waratah Bay	Minor	The 1.5 m deep cable trench is proposed to pass through the Little Morwell River, presumably with temporary flow diversion during construction. Dewatering of the bedrock aquifer would likely be required during construction with drawdown potentially causing temporary reduced levels or flow in a 25 m zone either side of the trench. Trenching through the swamp and wetland zone behind the Waratah Bay dunes will cross an estuarine stream that is likely to have some groundwater interaction. Dewatering will be required through this zone including when crossing the stream, which is assumed to include some temporary stream diversion or barriers. Temporary dewatering is unlikely to have significant effect on water levels or flow, or estuarine water quality to the extent that it would have a measurable effect on aquatic ecosystems.
		Aquatic GDEs – all other (1)	Negligible	Dewatering near Fish Creek, Stony Creek, Tarwin River East Branch may cause temporary drawdown beneath the stream bed of 1 to 1.5 m across a short section of their total stream length. The impact is likely to be negligible at these creeks and rivers. All other surface water features that are not listed (with the exception of Little Morwell River) would have no drawdown impact.
Construction	Construction activities destroying private (registered and unregistered) groundwater bores	Consumptive or productive uses	Moderate	Five SEC monitoring bores, one 'non-groundwater' bore and one bore of unknown use exist within the proposed construction corridor and are likely to require decommissioning. Potential for unregistered bores to be identified during landholder discussions.
Construction and Operation	Potential for HDD beneath rivers and creeks to create new hydraulic pathways if perched aquifers exist, potentially reducing groundwater availability and baseflow discharge.	Consumptive or productive uses	Negligible	Extractive use bores typically do not target perched systems with limited sustainable yield. No impacts anticipated.
		Terrestrial GDEs (1)	Negligible	Spatial extent of changes to groundwater levels expected to be limited to the area surrounding the HDD boreholes and have low ecosystem impact.
		Aquatic GDEs (1)	Moderate	Some creeks may rely on contributions from shallow perched groundwater. Drilling may create pathways for lateral groundwater flow typically supporting baseflow to discharge to underlying aquifers. Proposed method of backfilling borehole annulus not currently determined. The effect, if it occurred, would be to a relatively limited area around the drilling site.
Construction and Operation	Potential for HDD through and beneath Waratah Bay dune system may alter perched groundwater systems within the dunes.	Consumptive or productive uses	Negligible	Limited productive uses other than recreation. Impacts would be associated with the loss of aesthetic value of GDEs, if they exist.
		Terrestrial GDEs (1)	Minor	No mapped terrestrial GDEs within dune system.
		Aquatic GDEs (1)	Minor	Localised seeps and freshwater pools may exist within the dune system, however the baseline GDE assessment did not identify any potential aquatic GDEs. Perched systems are less likely behind the dune system.
Construction and Operation	Compaction of unconsolidated aquifer matrices beneath haul roads, laydown areas, or other infrastructure altering groundwater flow directions and levels.	All	Negligible	Construction activities, such as the construction of a central haul road, is unlikely to cause aquifer compaction at levels that would not be experienced extensively in higher trafficked roads throughout the region. Aquifer compaction is unlikely to have a measurable effect.
Construction and Operation		Consumptive or productive uses	Negligible	No impacts anticipated.
		Terrestrial GDEs (1)	Negligible	No impacts anticipated.

Project phase	Potential impact	Affected groundwater values	Assigned magnitude	Justification
	Backfilling cable trenches with material of higher hydraulic conductivity causing localised groundwater recharge and mounding.	Aquatic GDEs (1)	Negligible	Potentially for runoff directed along backfilled trench towards alluvial aquifers, causing raised levels and potentially increase baseflow discharge and surface water flow. Increased levels or flow is unlikely to have measurable or adverse effects on aquatic ecosystems.
Construction and Operation	Impermeable (or low permeability) subsurface infrastructure creating a hydraulic barrier and causing damming affects to shallow groundwater flow.	Consumptive or productive uses	Negligible	No impacts anticipated.
		Terrestrial GDEs (1)	Moderate	Barrier effects reducing groundwater levels in alluvial aquifers on down gradient side of cable trench. Potentially affecting wetland and shallow-rooted riparian vegetation.
		Aquatic GDEs (1)	Moderate	Potential barrier effects at locations where cable trench crosses alluvial aquifers leading to raised levels up gradient, lowered water levels on downgradient side resulting in altered baseflow dynamics. Changes to wetland conditions and altered flood plain dynamics.
Groundwater Quality				
Construction	Mobilisation of existing groundwater contamination towards the project due to temporary groundwater level drawdown.	Consumptive or productive uses	Negligible	The temporary and limited magnitude drawdown would have a negligible effect on existing contamination. There are no areas of likely dewatering coinciding with areas of suspected groundwater contamination that would result in mobilisation of contamination towards registered extractive use bores.
		Terrestrial GDEs (1)	Negligible	There are no areas of likely dewatering coinciding with areas of suspected groundwater contamination.
		Aquatic GDEs (1)	Minor	Dewatering in an area near a tributary draining to the Hazelwood cooling water pond could feasibly mobilise groundwater contamination sourced from the cooling water pond towards the cable trench. This would have limited effect on the aquatic ecosystem of the stream which would be experiencing any impact associated with the cooling water pond. Impacts to Eel Creek are not excepted as a result of temporary dewatering.
Construction	Release of contaminated groundwater generated during dewatering to the environment.	All	Minor	Groundwater along the cable trench alignment between Driffield and Hazelwood may be contaminated by former industrial mining and power generating activities. While only limited dewatering is expected in the Hazelwood area, groundwater generated during dewatering may be contaminated could impact the environment if not appropriately managed.
Construction	Groundwater contamination from drilling fluids.	Consumptive or productive uses	Moderate	It is possible that construction of HDD could use drilling fluid additives that might cause contamination by low concentrations of toxic chemicals. Impacts would mostly affect consumptive groundwater users and aquatic ecosystems.
		Terrestrial GDEs (1)	Minor	
		Aquatic GDEs (1)	Moderate	
Construction	Groundwater contamination from construction chemicals and fuels.	Consumptive or productive uses	Minor	Construction activities will require the use of light vehicles, drill rigs, earthworks and other construction machinery for planned trenching work, construction of the cable infrastructure and associated junction points, and construction of the converter stations and ancillary infrastructure. Low volumes of chemicals and fuels will be required, which will be stored, handled and used in line with the project CEMP, legislative requirements, and regulatory guidance. Hazardous chemicals may pose a risk to groundwater.
		Terrestrial GDEs (1)	Minor	
		Aquatic GDEs (1)	Minor	
Construction	Saline groundwater intrusion due to temporary groundwater level drawdown.	Terrestrial GDEs (1)	Minor	Relatively limited groundwater drawdown is expected to propagate away from the cable trench during the short construction period (subject to confirmation by EPR GW01). Under these conditions, relatively minor changes to groundwater salinity in the estuarine zone would be anticipated. Aquatic and terrestrial ecosystems in this zone are resilient to natural changes in salinity and are unlikely to be affected by localised saline groundwater intrusion.
		Aquatic GDEs (1)	Minor	
Construction and operation	Groundwater acidification due to temporary groundwater level drawdown.	Consumptive or productive uses	Moderate	If acidic groundwater was generated in the coastal zone, it could cause vegetation dieback and localised loss of aquatic ecosystems in the wetland and marine environment. This would impact on recreational water use and affect visual amenity.
		Terrestrial GDEs (1)	Moderate	
		Aquatic GDEs (1)	Minor	
Operation	Herbicide application at the converter station migrating to groundwater.	All	Negligible	Limited herbicide application may impact groundwater quality and migrate via groundwater towards connected features. There are no registered extractive use bores in the vicinity of the proposed converter stations. The nearest aquatic GDE to the Driffield site (Silver Creek) is 670 m

Project phase	Potential impact	Affected groundwater values	Assigned magnitude	Justification
				north-west. Bennetts Creek and Eel Hole Creek are approximately 350 m east and 50 m south from the Hazelwood converter station site. Any groundwater contamination would be minor at the source and would attenuate over distance towards Silver Creek and Bennetts Creek and would not be expected to cause measurable impacts to surface water quality. Eel Hole Creek, while in closer proximity is less likely to be groundwater dependent near the Hazelwood converter station site and is likely to have a highly altered aquatic ecosystem due to its position both within agricultural cleared land and existing impacts from the Hazelwood power infrastructure.
Operation	Discharge from the proposed Driffield septic tank system causing groundwater contamination.	All	Negligible	Any groundwater contamination caused by septic systems would be minor at the source and would attenuate over distance towards Silver Creek and would not be expected to cause measurable impacts to surface water quality. A land capability assessment would be required for approval of a septic system and would consider these risks.
Operation	Accidental spills and leaks of transformer oil, lead acid batteries, and diesel fuel stored in above ground tanks at the Driffield or Hazelwood converter station.	Consumptive or productive uses	Minor	Larger volumes of oils and fuels may pose a risk to groundwater if accidental release occurred. While no extractive uses are recorded in the local area around the proposed converter station, several Environmental Values would be impacted by a spill. The magnitude is likely to be minor when considering minimum industry requirements for storage of fuels, such as bunding and environmental reporting of incidents, and would be readily remediated via conventional methods.
		Terrestrial GDEs [1]	Negligible	No significant terrestrial GDEs present in the area.
		Aquatic GDEs [1]	Minor	As described above for 'consumptive or productive uses. Potential impacts to Silver Creek and Bennetts Creek may occur if a release is not identified and remediated. Attenuation over the >350 m would result in minor impacts when considering the minimum standards for storing and handling fuels and other chemicals. Eel Hole Creek, while in closer proximity to Hazelwood converter station site, is less likely to be groundwater dependent.
Construction and Operation	Enhanced recharge of stormwater runoff (including flood waters) to shallow groundwater via higher-conductivity backfilled cable trench.	Consumptive or productive uses	Negligible	Limited impacts would be expected to consumptive or productive uses
		Terrestrial GDEs [1]	Negligible	Limited impacts would be expected to terrestrial GDEs.
		Aquatic GDEs [1]	Moderate	Cable trenches filled with higher permeability backfill might provide a pathway for poor quality roadside runoff and floodwaters from agricultural land to migrate along the topographic gradient towards alluvial aquifers and the aquatic ecosystem of streams that they support.

(1) GDEs include both the ecological and the cultural/spiritual values of groundwater dependent environments.

7.7 RESIDUAL IMPACT SUMMARY

A summary of the outcomes of the groundwater impact assessment using the sensitivity and magnitude approach, and considering implementation of EPRs, is presented in Table 7-22.

Table 7-22 Summary of residual impact significance assessment

Project phase	Potential impact	Affected value	Sensitivity	Initial impact assessment		Recommended EPR	Residual impact assessment		
				Magnitude	Significance		Magnitude	Justification	Significance
Groundwater level and volume									
Construction	Temporary dewatering of onshore cable trenches, cable joint pits, and HDD entry/exit pits during construction leading to groundwater level drawdown.	Consumptive or productive uses	Moderate	Negligible	Low	GW08 – Develop and implement measures to maintain water supply to registered groundwater users.	Unchanged	Future hydrogeological assessments at points where dewatering is likely and proposed methods will minimise impacts on groundwater recharge, and inflow that may affect groundwater values	Low
		Terrestrial GDEs [(1)]	Moderate	Negligible	Low	GW01 – Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design in areas where groundwater may be encountered. GW02 – Develop and implement methods to minimise groundwater inflow into trenches and groundwater level drawdown. GW03 – Develop and implement methods for HDD and drilling to prevent groundwater movement and contamination.	Unchanged		Low
		Aquatic GDEs [(1)] – Little Morwell River, Waratah Bay	Moderate	Minor	Low		Unchanged		Low
		Aquatic GDEs – all other [(1)]	Moderate	Negligible	Low		Unchanged		Low
Construction	Construction activities destroying registered and unregistered groundwater bores.	Consumptive or productive uses	Moderate	Moderate	Moderate	GW08 – Develop and implement measures to maintain water supply to registered groundwater users.	Negligible	Commitment to make good with replacement bores.	Low
Construction and Operation	Potential for HDD beneath rivers and creeks to create new hydraulic pathways if perched aquifers exist, potentially reducing groundwater availability and baseflow discharge.	Consumptive or productive uses	Moderate	Negligible	Low	GW03 – Develop and implement methods for HDD and drilling to prevent groundwater movement and contamination. GW09 – Develop and implement measures to manage potential impacts to groundwater in operation	Unchanged	EPRs will further support a low unmitigated impact significance.	Low
		Terrestrial GDEs [(1)]	Moderate	Negligible	Low		Unchanged		Low
		Aquatic GDEs [(1)]	Moderate	Moderate	Moderate		Minor		Low
Construction and Operation	Potential for directional drilling through and beneath Waratah Bay dune system may alter perched groundwater systems within the dunes.	Consumptive or productive uses	Moderate	Negligible	Low	GW01 – Complete a hydrogeological assessment and dewatering drawdown assessment to inform the detailed design in areas where groundwater may be encountered. GW03 – Develop and implement methods for HDD and drilling to prevent groundwater movement and contamination. GW09 – Develop and implement measures to manage potential impacts to groundwater in operation	Unchanged		Low
		Terrestrial GDEs [(1)]	Moderate	Minor	Low		Unchanged		Low
		Aquatic GDEs [(1)]	Moderate	Minor	Low		Unchanged		Low
Construction and Operation	Compaction of unconsolidated aquifer matrices beneath haul roads, laydown areas, or other infrastructure altering groundwater flow directions and levels.	All	Moderate	Negligible	Low	Not required	Unchanged	N/A	Low
Construction and Operation	Backfilling cable trenches with material of higher hydraulic conductivity causing localised groundwater recharge and mounding.	Consumptive or productive uses	Moderate	Negligible	Low	GW04 – Develop and implement measures to utilise cable backfill material to minimise impact on groundwater recharge and flow. GW09 – Develop and implement measures to manage potential impacts to groundwater in operation	Unchanged	Proposed investigation and engineering design will minimise barrier effects and impacts on groundwater recharge and flow.	Low
		Terrestrial GDEs [(1)]	Moderate	Negligible	Low		Unchanged		Low
		Aquatic GDEs [(1)]	Moderate	Negligible	Low		Unchanged		Low

Project phase	Potential impact	Affected value	Sensitivity	Initial impact assessment		Recommended EPR	Residual impact assessment		
				Magnitude	Significance		Magnitude	Justification	Significance
Construction and Operation	Impermeable (or low permeability) subsurface infrastructure creating a hydraulic barrier and causing damming affects to shallow groundwater flow.	Consumptive or productive uses	Moderate	Negligible	Low	GW01 – Complete a hydrogeological assessment and dewatering drawdown assessment to inform the detailed design in areas where groundwater may be encountered. GW04 – Develop and implement measures to utilise cable backfill material to minimise impact on groundwater recharge and flow. GW06 – Undertake groundwater monitoring to establish baseline groundwater conditions prior to construction and monitor groundwater levels and quality in areas of higher potential impact during construction. GW09 – Develop and implement measures to manage potential impacts to groundwater in operation	Unchanged		Low
		Terrestrial GDEs (1)	Moderate	Minor	Low		Unchanged		Low
		Aquatic GDEs (1)	Moderate	Moderate	Moderate		Minor		Low
Groundwater Quality									
Construction	Mobilisation of existing groundwater contamination towards the project due to temporary groundwater level drawdown.	Consumptive or productive uses	Moderate	Negligible	Low	GW01-Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design in areas where groundwater may be encountered. GW02 – Develop and implement methods to minimise groundwater inflow into trenches and groundwater level drawdown.	Unchanged	EPRs further minimise risk to groundwater to the extent practicable.	Low
		Terrestrial GDEs (1)	Moderate	Negligible	Low		Unchanged		Low
		Aquatic GDEs (1)	Moderate	Minor	Low		Unchanged		Low
Construction	Release of contaminated groundwater generated during dewatering to the environment.	All	Moderate	Minor	Low	GW03 – Develop and implement methods for HDD and drilling to prevent groundwater movement and contamination. GW05 – Design and implement measures to manage and dispose of extracted groundwater during construction to minimise environmental impacts. GW06 – Undertake groundwater monitoring to establish baseline groundwater conditions prior to construction and monitor groundwater levels and quality in areas of higher potential impact during construction. GW07 – Develop and implement measures to prevent groundwater acidification, saline intrusion and mobilisation of contamination.	Unchanged	EPRs further minimise risk to groundwater to the extent practicable.	Low
Construction	Groundwater contamination from drilling fluids.	Consumptive or productive uses	Moderate	Moderate	Moderate	GW03 – Develop and implement methods for HDD and drilling to prevent groundwater movement and contamination.	Minor	EPR removes source of groundwater impact from all drilling activities.	Low
		Terrestrial GDEs (1)	Moderate	Minor	Low		Unchanged		Low
		Aquatic GDEs (1)	Moderate	Moderate	Moderate		Minor		Low
Construction	Groundwater contamination from construction chemicals and fuels.	All	Moderate	Minor	Low	GW01 – Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design. GW05 – Design and implement measures to manage and dispose of extracted groundwater	Unchanged	Further mitigations not required	Low

Project phase	Potential impact	Affected value	Sensitivity	Initial impact assessment		Recommended EPR	Residual impact assessment		
				Magnitude	Significance		Magnitude	Justification	Significance
						during construction to minimise environmental impacts. GW06 – Undertake groundwater monitoring to establish baseline groundwater conditions prior to construction and monitor groundwater levels and quality in areas of higher potential impact during construction. GW07 – Develop and implement measures to prevent groundwater acidification, saline intrusion and mobilisation of contamination.			
Construction	Saline groundwater intrusion due to temporary groundwater level drawdown.	Terrestrial GDEs (1)	Moderate	Minor	Low	GW01 –Complete a hydrogeological assessment and dewatering drawdown assessment to inform the detailed design in areas where groundwater may be encountered. GW03 – Develop and implement methods for HDD and drilling to prevent groundwater movement and contamination. GW06 – Undertake groundwater monitoring to establish baseline groundwater conditions prior to construction and monitor groundwater levels and quality in areas of higher potential impact during construction. GW07 – Develop and implement measures to prevent groundwater acidification, saline intrusion and mobilisation of contamination.	Unchanged	Further mitigation not required	Low
		Aquatic GDEs (1)	Moderate	Minor	Low		Unchanged		Low
Construction and operation	Groundwater acidification due to temporary groundwater level drawdown.	Consumptive or productive uses	Moderate	Moderate	Moderate	GW01- Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design in areas where groundwater may be encountered. GW02 – Develop and implement methods to minimise groundwater inflow into trenches and groundwater level drawdown. GW06 – Undertake groundwater monitoring to establish baseline groundwater conditions prior to construction and monitor groundwater levels and quality in areas of higher potential impact during construction. GW07 – Develop and implement measures to prevent groundwater acidification, saline intrusion and mobilisation of contamination. GW09 – Develop and implement measures to manage potential impacts to groundwater in operation	Minor	Recommended controls will avoid dewatering acid sulfate soils and minimises potential for groundwater acidification to the extent practicable.	Low
		Terrestrial GDEs (1)	Moderate	Moderate	Moderate		Minor		Low
		Aquatic GDEs (1)	Moderate	Minor	Low		Unchanged		Low
Operation	Herbicide application at the converter station migrating to groundwater.	All	Moderate	Negligible	Low	GW09 – Develop and implement measures to manage potential impacts to groundwater in operation.	Unchanged	Consider minimum industry requirements for storage of fuels, such as bunding and environmental reporting of incidents, and would be readily	Low
Operation	Discharge from the proposed Driffield septic tank system causing groundwater contamination.	All	Moderate	Negligible	Low		Unchanged		Low

Project phase	Potential impact	Affected value	Sensitivity	Initial impact assessment		Recommended EPR	Residual impact assessment		
				Magnitude	Significance		Magnitude	Justification	Significance
Operation	Accidental spills and leaks of transformer oil, lead acid batteries, and diesel fuel stored in above ground tanks at the Driffield or Hazelwood converter station.	Consumptive or productive uses	Moderate	Minor	Low		Unchanged	remediated via conventional remediation methods.	Low
		Terrestrial GDEs [(1)]	Moderate	Negligible	Low		Unchanged		Low
		Aquatic GDEs [(1)]	Moderate	Minor	Low		Unchanged		Low
Construction and Operation	Enhanced recharge of stormwater runoff (including flood waters) to shallow groundwater via higher-conductivity backfilled cable trench.	Consumptive or productive uses	Moderate	Negligible	Low	GW01- Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design in areas where groundwater may be encountered GW04 – Develop and implement measures to utilise cable backfill material to minimise impact on groundwater recharge and flow. GW06 – Undertake groundwater monitoring to establish baseline groundwater conditions prior to construction and monitor groundwater levels and quality in areas of higher potential impact during construction. GW09 – Develop and implement measures to manage potential impacts to groundwater in operation.	Unchanged	Adopted mitigations will minimise movement of water along cable trench towards aquatic ecosystems	Low
		Terrestrial GDEs [(1)]	Moderate	Negligible	Low		Unchanged		Low
		Aquatic GDEs [(1)]	Moderate	Moderate	Moderate		Low		Low

(1) GDEs are receivers that rely wholly or partially on groundwater to provide all or some of their water needs (-) given no EPRs, there was no justification provided.

7.8 CUMULATIVE IMPACTS

A cumulative impact assessment has been completed for the project in line with the assessment methodology outlined in Section 4.4.6. Two projects were identified that each might have potential to affect groundwater in close proximity to the project alignment. They were;

- Hazelwood Rehabilitation Project
- Delburn Wind Farm Project

Details of these nearby projects are provided in Table 7-23, together with a high-level assessment of their potential individual effects on groundwater values and an assessment of the possible cumulative effects that might result.

As the predicted effects of the project on groundwater values are assessed to be temporary (i.e. there are no long-term changes to groundwater levels or quality as a result of project construction or operation) and short lived (i.e., over a maximum period of 2 to 4 months during construction), the potential for cumulative effects to be experienced by groundwater values are very low.

The potential for an increase impact magnitude in addition to those already assessed (such as mobilisation of existing contamination – Section 7.3.8) would be negligible. This would not increase the impact significance to levels greater than already assessed by this report.

Table 7-23 Cumulative impacts assessment summary

Project	Project description	Potential effects on groundwater values	Cumulative effects assessment
Hazelwood Rehabilitation Project (EPBC Referral 2022)	Closure and rehabilitation of the former mine and cooling water ponds is planned from 2024, continuing for a 10 to 20 year period. Items of relevance to groundwater include: • Cessation of pit dewatering and establishment of a pit lake. • Groundwater extraction of 17-19 GL/yr to support pit filling over 10 to 20 years. • Draining and rehabilitation of the cooling water pond and reinstatement of Eel Hole Creek • Diversion of Morwell River from current alignment to its original path through the site.	• Complex changes to groundwater levels and flow directions that may result in lower or higher levels during different periods of operation. • Draining of the cooling pond is expected to have the most significant effect on groundwater levels along the project alignment resulting in lower groundwater levels than current assessed. • There may be a long-term regional groundwater level rise as the pit lake is established and groundwater extraction is discontinued. • Altered levels and flow direction may mobilise groundwater contamination, potentially in the direction of the project.	Temporary construction dewatering near Eel Hole Creek and Morwell River will be short-lived and would not result in long term effects that would exacerbate level changes associated with the Hazelwood Rehabilitation Project. Interim groundwater level drawdown and/or long-term groundwater level rise during the operational period of the project would not result in adverse potential impacts not already considered.
Delburn wind farm project (Golder 2020)	Proposed development of 33 wind turbines and associated infrastructure. Details of relevance to the groundwater impact assessment include: • Proposed 2 to 5 m deep foundations, with footings up to 25 m diameter. • Trenched cables to connect turbines.	• The desktop geotechnical excavations for wind turbine foundations concluded that they will generally be less than 5 m in depth and were not expected to encounter groundwater, which is estimated at 10 mbgs. • No discussion was provided on the need to dewater cable trenches. It is assumed this is also not anticipated.	There is potential that in the unlikely case where temporary cable trench dewatering coincided with nearby temporary wind turbine foundation dewatering, the temporary groundwater drawdown effects at GDEs or groundwater users might be greater than currently assessed by this project. The cumulative effect of groundwater drawdown follows the principal of superposition (USGS, 1984) which will result in the predicted drawdown from both projects being added together. The magnitude of potential drawdown from the project is typically very minor and localised and would not result in a cumulative impact that would be significantly greater than that assessed by this report.

8. INSPECTION AND MONITORING

A range of inspection and compliance monitoring activities are proposed to meet the recommended EPRs.

The planned geotechnical investigations will include a hydrogeological assessment at locations where dewatering may be required during construction (EPR GW01). Investigation results shall be reviewed by experienced hydrogeologists supporting the project's detailed design, and prior to construction commencing to verify that drawdown estimates, and the magnitude of impacts are not greater than assessed by the groundwater impact assessment. These investigations will support the project's detailed design including the methods of dewatering adopted, suitable measures to minimised groundwater inflow and drawdown, and groundwater disposal options that may be required.

The groundwater assessments should include installation of a suitable number and arrangement of groundwater observations bores (as directed by a suitably experienced hydrogeologist) at each point of predicted dewatering to measure baseline groundwater levels and quality prior to construction commencing (EPRs GW01 and GW06). Aquifer hydraulic tests may also be required to meet EPR GW01, which includes the requirement to verify the assumptions and subsequent drawdown estimates made by the groundwater impact assessment.

The groundwater assessments will be designed, implemented, and used by a suitably qualified hydrogeologist that forms part of the detailed design construction team, to ensure that relevant EPRs will be achieved, should the project proceed.

EPR GW06 requires groundwater monitoring to further assess baseline groundwater conditions prior to construction and to monitor potential impacts during construction in areas where higher significance impacts may occur. These are currently identified in the vicinity of the Hazelwood Cooling Pond and the coastal zone at Waratah Bay. They may be expanded further to include areas where barrier effects may result from construction activities to monitor the efficacy of the engineered mitigation solutions. Groundwater monitoring may also be required during operation in areas where hazardous chemicals are stored and used during operation, such as the new converter station at Driffield or the upgraded existing converter station at Hazelwood.

Details of the groundwater monitoring activities will be formalised in GMPs that will be developed for the project during construction (EPR GW06) and operation (EPR GW09). The construction GMP will be developed by suitably qualified hydrogeologists and environmental scientists/engineers engaged during the detailed design and construction phase after completion of the subsequent groundwater investigations that are recommended as part of EPR GW01. The operation phase GMP will be developed by similarly qualified environmental scientists and engineers during construction phase.

The GMPs will ensure that the necessary environmental outcomes are achieved and the environmental values of groundwater are maintained. This includes the legislative requirements under the General Environmental Duty to minimise environmental impacts so far as reasonably practicable. The following aspects will be included in the GMP as a minimum:

- Organisational responsibilities and accountabilities for environmental management.
- A register of environmental risks and impacts to be maintained during project implementation.
- A proposed groundwater monitoring program including monitoring objectives, indicators and requirements.
- Summary of relevant EPRs.
- Contingency measures, if EPRs are not met.
- Emergency response plans if unexpected groundwater contamination is encountered (see EPR GW05).

- Reporting requirements to regulators, key stakeholders and the public.

Examples of measures that may be implemented in the GMP are discussed in Table 9-1, EPR GW06.

EIS/EES Volume 5, Chapter 2 – Environmental management framework (refer to section 2.5) outlines the requirements of the CEMP, OEMP and sub plans. The groundwater management plan will be a sub plan to the CEMP and OEMP, and will include contingency measures, where required. Contingency measures will be defined in the GMP, where required, and implemented if existing measures are not adequate to mitigate groundwater impacts.

9. ENVIRONMENTAL PERFORMANCE REQUIREMENTS

EPRs set out the environmental outcomes that must be achieved during the design, construction, operation and decommissioning phases of the project.

The following EPRs have been informed by the example mitigation measures discussed in the impact assessment (Section 7). These mitigation measures are discussed to provide an example of how the EPRs could be implemented. The EPRs have also been developed with consideration of industry standards, relevant legislations, guidelines and policies.

The recommended groundwater EPRs to reduce the significance of all potential impacts to low, are summarised in Table 9-1**.**

In addition to the groundwater EPRs outlined in Table 9-1, EPRs recommended in the following technical studies will also reduce the potential for impacts to groundwater resulting from the project:

- Contaminated land
- Surface water
- Marine ecology

A decommissioning plan will be prepared to outline how potential groundwater impacts associated with decommissioning activities will be avoided, reduced or mitigated. The groundwater EPRs for the decommissioning management plan is provided in EIS/EES Volume 5, Chapter 2 – Environmental Management Framework.

Table 9-1 Environmental Performance Requirements

EPR ID	Environmental Performance Requirement	Project Stage
GW01	**Complete a hydrogeological assessment and dewatering drawdown assessment to inform the design** Prior to commencement of project works, complete a hydrogeological assessment at locations identified along the final project alignment as likely to encounter groundwater during construction to refine the predicted groundwater drawdown levels identified and assessed in EIS/EES Technical Appendix P: Groundwater Assessment. The assessment must: • Be completed by a suitably qualified hydrogeologist. • Consider the assumptions and approach outlined in the EIS/EES Technical Appendix P. • Be informed by hydrogeological investigations including groundwater level and quality monitoring, and aquifer hydraulic testing. • Be informed by geotechnical investigations where available. • Be informed by representative aquifer hydraulic conditions (such as from aquifer hydraulic tests completed on-site) in areas of shallow groundwater and use relevant, available monitoring data. • Include a groundwater drawdown assessment for areas where dewatering of construction trenches will be required based on the detailed design. • Incorporate groundwater quality analysis undertaken to assess for the presence of unexpected, existing groundwater contamination. The assessment must be documented as part of the groundwater management plan as a sub plan to the CEMP and implemented during construction.	Design
GW02	**Develop and implement methods to minimise groundwater inflow into trenches and groundwater level drawdown** Prior to commencement of project works, develop methods that identify and either avoid (where possible) or minimise groundwater inflow into cable trenches and joint pits. The construction method should: • Be informed by the hydrogeological assessment completed for EPR GW01. • Include measures to minimise groundwater drawdown where impacts may occur to groundwater quality, productive uses or the function of GDEs. • Consider scheduling construction works to minimise the total time that dewatering is required. • Adopt engineering controls during construction such as sheet pile walls or other temporary structures to avoid (where possible) or minimise groundwater ingress to construction trenches at locations where: o High groundwater inflows are predicted to be encountered. o The hydrogeological assessment (EPR GW01) identifies potential impacts to groundwater that may be more significant than assessed the EIS/EES Technical Appendix P. These measures must be documented in a groundwater management plan as a sub plan to the CEMP and implemented during construction.	Construction

EPR ID	Environmental Performance Requirement	Project Stage
GW03	**Develop and implement methods for HDD and drilling to prevent groundwater movement and contamination** Prior to commencement of project works, develop methods to identify and avoid or minimise impacts to groundwater that: • Seal the annulus of directionally drilled bores or otherwise prevent water movement along the borehole annulus. • Adopt relevant guidance from *Minimum construction requirements for water bores in Australia* (2020) to minimise potential for impacts to groundwater. • Utilise non-toxic and/or biodegradable drilling additives, such as bentonite clay and xanthan gum for HDD and other drilling activities during construction. • Are informed by investigations as required by EPR GW01. • Are informed by geotechnical investigations or advice prior to commencing HDD activities. • Include methods for HDD monitoring and mitigation measures to minimise potential for frac-outs to occur and limit the scale of impact in sensitive areas. These include minimum observations during drilling to detect frac-outs (such as loss of fluid circulation) and pressure relief methods. Emergency response measures for frac out during HDD are covered by EPR SW01. These measures must be documented in a groundwater management plan as a sub plan to the CEMP and implemented during construction.	Construction
GW04	**Develop and implement measures to utilise cable backfill material to minimise impact on groundwater recharge and flow** Prior to commencement of project works, develop measures to backfill excavations with the same material that was excavated in approximately the same order so far as reasonably practicable, and having regard to EPR A03. • The backfill should reinstate the soil profile with adequate compaction to avoid (where possible) or minimise surface water ingress to the trench, flow along the trench, and preferential recharge to groundwater, and allow for existing groundwater movement. • Backfill below the water table should be informed by a hydrogeological assessment (EPR GW01). • Where the existing material is not suitable for backfill and thermal backfill is required, the placement of thermal backfill and the construction design should be informed by the hydrogeological assessment (EPR GW01) to prevent barrier effects and allow groundwater pressure to equilibrate across the structure. Engineered solutions might include the design of under-drainage layers or other features that allow groundwater pressure to equilibrate across the structure. These measures must be documented in a groundwater management plan as a sub plan to the CEMP and implemented during construction.	Construction, Operation
GW05	**Design and implement measures to manage and dispose of extracted groundwater during construction to avoid (where possible) or minimise environmental impacts** Prior to commencement of project works, develop measures to manage, monitor, reuse where possible, treat where necessary, and dispose of groundwater inflows during construction dewatering that identify and avoid or minimise potential impacts to groundwater values and conditions.	Construction

<table>
<tr><th>EPR ID</th><th>Environmental Performance Requirement</th><th>Project Stage</th></tr>
<tr><td></td><td>The measures must be developed in consultation with relevant water authorities and EPA Victoria, and comply with relevant legislation and guidelines, including but not limited to:
• EP Act and Environment Protection Regulations 2021.
• Environment Reference Standard.
• Water Industry Regulations 2006.
• Occupational Health and Safety Act 2004 (Vic) and Occupational Health and Safety Regulations 2017.
• The waste management hierarchy.
The measures must be documented in a plan that also outlines the approach to:
• Avoiding or minimising wastewater production from dewatering groundwater, consistent with EPR GW02.
• Monitoring of groundwater levels and quality where dewatering may occur.
• Management of extracted groundwater including collection methods, quality monitoring methods during disposal, discharge criteria and trigger levels developed in consultation with relevant regulators, proposed treatment methods, and disposal processes.
• Groundwater disposal options and individual discharge locations including estimated discharge volumes and flow rates, discharge limits for water quality and flow rates, anticipated potential water treatment requirements and any required approvals, monitoring and reporting.
These measures must be documented in a groundwater management plan as a sub plan to the CEMP and implemented during construction.</td><td></td></tr>
<tr><td>GW06</td><td>Undertake groundwater monitoring to establish baseline groundwater conditions prior to construction and monitor groundwater levels and quality in areas of higher potential impact during construction
Prior to commencement of project works, develop a groundwater monitoring program to establish background and baseline groundwater conditions to the extent reasonably practicable. The baseline and background level and quality data will be used to identify if there are any changes in groundwater during construction. The program must focus on areas where higher impacts to environmental values may occur and include, but not be limited to, the project alignment area adjacent to Hazelwood cooling pond, Waratah Bay, groundwater dependent ecosystems and areas of potential ASS.
The monitoring program must:
• Be developed in consultation with EPA Victoria to confirm the extent and duration of monitoring required prior to, during and post construction.
• Establish seasonal variability and other long-term trends of groundwater conditions.
• Establish baseline groundwater levels and quality conditions in areas where shallow groundwater is expected to be encountered and is susceptible to groundwater quality, flow and drawdown impacts, as identified in EPR GW01.
• Calibrate the groundwater drawdown assessment prior to commencement of project works and during construction activities to verify predictions.</td><td>Construction</td></tr>
</table>

EPR ID	Environmental Performance Requirement	Project Stage
	• Verify the adequacy of the proposed design and construction methods, and where required, identify and implement any additional measures required to mitigate impacts from changes in groundwater levels, flow and quality. • Be informed by the outcomes of the hydrogeological assessment (EPR GW01) and acid sulfate soil assessment (EPR GW07). • Outline the approach to review of monitoring results and define acceptability criteria for groundwater recovery at completion of construction for water quality, flows and level recovery as predicted by the groundwater drawdown assessment required in EPR GW01 and considering the impacted groundwater values. Where recovery may extend into operation, relevant groundwater monitoring activities should be incorporated into the OEMP (EPR GW09) The monitoring program, where required, must be consistent with the obligations of the EP Act, EPA Victoria Publication 668 *Hydrogeological assessment groundwater quality guidelines*, EPA Victoria Publication 669 *Groundwater Sampling Guidelines*, EPA Victoria Publication 2033 *Background levels methodology guidance* and the Environment Reference Standard. This program must be documented in a groundwater management plan as a sub plan to the CEMP and implemented during construction.	
GW07	**Develop and implement measures to prevent groundwater acidification, saline intrusion and contaminant mobilisation in areas where they are predicted to occur** Prior to commencement of project works, develop measures to prevent groundwater acidification within the zone of groundwater drawdown and in the coastal area. The measures must: • Be informed by the ASS management plan (EPR CL03) that will identify locations where ASS could occur. • Be based on the findings of the hydrogeological assessment EPR GW01 and groundwater monitoring EPR GW06. • Adopt appropriate engineering controls, such as sheet pile walls or other barriers, to prevent groundwater level drawdown, so far as reasonably practicable or adopt other mitigations or management measures to prevent groundwater acidification impacts. Develop and implement measures to: • Prevent saline water intrusion into freshwater aquifers where potential impacts to groundwater quality are predicted to occur as a result of dewatering in the coastal zone. Measures should be developed based on the outcome of the hydrogeological assessment (EPR GW01) and prior to the commencement of works. • Prevent the mobilisation of known, existing groundwater contamination, as identified in EPR GW01, that would increase the risk posed to groundwater receptors or cause degraded groundwater quality. Groundwater monitoring must be carried out during construction to verify groundwater acidification, saline intrusion and mobilisation of contamination is not occurring and responses are implemented if quality impacts are detected. The measures must be documented in a sub plan endorsed by a person(s) appointed by EPA Victoria as an environmental auditor. These measures must be documented in a groundwater management plan as a sub plan to the CEMP and implemented during construction.	Construction
GW08	**Develop and implement measures to maintain water supply to registered groundwater users**	Construction

EPR ID	Environmental Performance Requirement	Project Stage
	• Confirm the status and use of registered and unregistered bores within the immediate construction zone by making inquiries with affected landholders and estimate the drawdown area due to construction. • Where necessary, negotiate requirements to decommission existing bores where they may be destroyed during construction, and/or negotiate the need for replacement with new bores or the provision of an alternative water supply. • Where dewatering reduces access to groundwater for landholders, negotiate arrangements to provide alternative water supplies until groundwater levels return to enable supply of water. • Bore decommissioning must be completed in accordance with the *Minimum Construction Requirements for Water Bores in Australia*. These measures must be documented in a groundwater management plan as a sub plan to the CEMP and implemented during construction.	
GW09	**Develop and implement measures to manage potential impacts to groundwater in operation** As part of the OEMP, develop and implement measures to identify and avoid (where possible), or minimise potential impacts to groundwater during the operation of the project as identified by the EIS/EES Technical Appendix P or by assessment of impacts from the proposed operation and maintenance activities. The OEMP must also include measures to manage any residual impacts to groundwater from construction that need to be managed in operation. The measures must address: • Ongoing monitoring requirements as determined through the monitoring program developed in accordance with EPR GW06, including monitoring to confirm recovery of groundwater levels and quality, where required. • Management of materials to prevent contamination of groundwater, as required by EPR CL04. The groundwater management plan must be a sub plan to the OEMP and implemented during operation.	Operation

10. DATA GAPS

All major construction projects progress through increasing levels of design certainty prior to construction commencing. It is common for data gaps or some uncertainty to exist at the time when an EES/EIS is prepared so long as those gaps would not materially affect the conclusions of the assessment.

In many cases, EPRs are proposed to ensure that the detailed design process resolves critical data gaps and continues to minimise uncertainty.

The following data gaps are recognised. They are not considered to be uncommon for a project of this type, they are commensurate with the level of risk posed by the project to the groundwater environment, and they are consistent with the level of information required to provide a robust EES/EIS:

- Site specific groundwater investigations have not been completed. The assessment has relied on published regional geology, groundwater levels, quality, and aquifer hydraulic properties.
    - Site specific data is required in areas where dewatering is anticipated (EPR GW01).
- Limited information is available on groundwater quality along the project alignment and the potential to encounter unexpected groundwater contamination exists.
    - EPR GW01 includes the requirement to complete groundwater quality assessments to reduce uncertainty in areas where dewatering is anticipated.
- The identification and assessment of GDEs can be complex and includes inherent uncertainty. Terrestrial GDE impact assessments typically assign a likely terrestrial GDE type based on landscape setting, remote sensing data, vegetation type and an understanding of the likely interactions with groundwater. Ten GDEs were classified using the BOM GDE Atlas, whilst an additional two GDEs were identified by the desktop assessment as likely to be groundwater dependent. Uncertainty is managed by adopting conservative assumptions when identifying GDEs, predicting impacts, and developing risk mitigation measures. These assumptions have been carried through the impact assessment process to be conservative and the identified ecosystems are assumed to be GDEs until proven otherwise by further investigation.
- There is limited information on the presence and nature of stygofauna in shallow aquifers across the project alignment.
    - This data gap is common across Victoria. As the proposed construction activities would not have a long-term impact to stygofauna communities (if present) this data gap is considered to be of low importance to the assessment.
- The ERS (2021) does not set specific groundwater quality or quantity criteria for the protection of Traditional Owner and Cultural Values. Direct consultation with local traditional owner groups is recommended to establish suitable criteria, often which can relate back to other environmental values (such as aquatic ecosystems, recreational water use etc). Traditional Owner and cultural values of groundwater have not been specifically determined through consultation with Traditional Owners at the time of writing.
    - Formal advice on tangible and intangible cultural heritage values (including that of surface water and groundwater) has not yet been provided by the First Peoples groups, represented by the Gunaikurnai Land and Waters Aboriginal Corporation (GLaWAC), the Bunurong Land Council Aboriginal Corporation (BLCAC) and the Boonwurrung Land and Sea Council (Aboriginal Corporation) (BLSC). Relevant information will be sought during preparation of a series of Aboriginal cultural values assessment (CVAs) proposed by the Cultural Heritage Technical Study (EcoLogical Australia 2024).
    - In the absence of this information, and until advice is received from First Peoples groups, this environmental value of groundwater has adopted water quality criteria for all other relevant

groundwater values (such as recreational water use, water dependent ecosystem, agriculture and irrigation) with the assumption that these will also be protective of Traditional owner and cultural values.

- The status, condition and use of registered groundwater bores is unknown.
  - All bores are conservatively considered to remain active regardless of age or land use.
  - EPR GW08 requires the status and use of registered bores at risk of impact to be confirmed through consultation with landowners.
- Groundwater drawdown estimates have adopted long term, steady state conditions. The time to achieve and recover from these steady state conditions is currently unknown.
  - Impacts have been conservatively based on steady state drawdown being achieved, and maximum drawdowns have been adopted. The duration of any degree of drawdown is assumed to be between two to four months, with maximum drawdown conservatively experienced for half of this time. It is likely that lower magnitude drawdown will eventuate in most locations.

Uncertainty has been addressed by adopting conservative assumptions (such as groundwater levels 1 m shallower than modelled) which minimises the effect of uncertainty. Other levels of conservatism built into the impact assessment, such as adopting long term, steady state drawdown values around areas of temporary dewatering, significantly outweigh the uncertainty and natural variability of hydrogeological conditions.

11. CONCLUSION

This document presents the results of groundwater impact assessment for the Victorian onshore section of the project.

The project proposes to lay two 750 MW HVDC cable circuits in two individual 1.5 m deep trenches excavated along the proposed project alignment between the landfall point at Waratah Bay, converter stations at either Driffield or Hazelwood and a possible transition station at Waratah Bay. The project will also include cable joint pits at nominal intervals of between 800 to 1,200 m along the project alignment, which will include buried infrastructure to 3 mbgs.

A desktop hydrogeological assessment has been completed drawing on publicly available spatial information on ground surface elevation, the inferred average water table elevation, surface geological conditions and groundwater quality. These inputs, together with information on groundwater quality, GDEs and groundwater users has supported an assessment of the potential impacts of the project's construction, operation and decommissioning on groundwater receivers. No potential impacts to groundwater have been identified for the decommissioning phase at this stage of the project as the project has not identified the need for subsurface work with the decommissioning approach assumed to be to leave subsurface infrastructure in place.

A significance assessment approach has been applied which identified mostly negligible and minor magnitude potential impacts, equating to low initial impact significance.

The following potential activities were considered to have moderate initial impact significance which were considered further:

1. Construction activities destroying private (registered and unregistered) groundwater bores.
2. Impermeable (or low permeability) subsurface infrastructure creating a hydraulic barrier and causing damming affects to shallow groundwater flow.
3. Groundwater acidification due to temporary groundwater level drawdown
4. Enhanced recharge of stormwater runoff (including flood waters) to shallow groundwater via higher-conductivity backfilled cable trench.

EPRs were developed to reduce the significance of all potential impacts so far as reasonably practicable. The proposed EPRs achieved a reduction of all potential impacts with a moderate initial impact significance to low.

Groundwater investigations are recommended prior to construction commencing to support design (EPR GW01). These investigation and assessments have been proposed to verify the assumptions made in the impact assessment, further refine the level of certainty as the project progresses towards construction, and develop specific, suitable mitigation measures that may be required to achieve the EPRs.

All residual impacts to groundwater are considered to be low after implementing mitigation and management measures that will achieve the recommended EPRs.

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APPENDIX A - STATEMENT OF LIMITATIONS

IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY ENVIRONMENTAL REPORT

Introduction

This report has been prepared by Tetra Tech Coffey for you, as Tetra Tech Coffey's client, in accordance with our agreed purpose, scope, schedule and budget.

The report has been prepared using accepted procedures and practices of the consulting profession at the time it was prepared, and the opinions, recommendations and conclusions set out in the report are made in accordance with generally accepted principles and practices of that profession.

The report is based on information gained from environmental conditions (including assessment of some or all of soil, groundwater, vapour and surface water) and supplemented by reported data of the local area and professional experience. Assessment has been scoped with consideration to industry standards, regulations, guidelines and your specific requirements, including budget and timing. The characterisation of site conditions is an interpretation of information collected during assessment, in accordance with industry practice.

This interpretation is not a complete description of all material on or in the vicinity of the site, due to the inherent variation in spatial and temporal patterns of contaminant presence and impact in the natural environment. Tetra Tech Coffey may have also relied on data and other information provided by you and other qualified individuals in preparing this report. Tetra Tech Coffey has not verified the accuracy or completeness of such data or information except as otherwise stated in the report. For these reasons the report must be regarded as interpretative, in accordance with industry standards and practice, rather than being a definitive record.

Your report has been written for a specific purpose

Your report has been developed for a specific purpose as agreed by us and applies only to the site or area investigated. Unless otherwise stated in the report, this report cannot be applied to an adjacent site or area, nor can it be used when the nature of the specific purpose changes from that which we agreed.

For each purpose, a tailored approach to the assessment of potential soil and groundwater contamination is required. In most cases, a key objective is to identify, and if possible quantify, risks that both recognised and potential contamination pose in the context of the agreed purpose. Such risks may be financial (for example, clean up costs or constraints on site use) and/or physical (for example, potential health risks to users of the site or the general public).

Limitations of the Report

The work was conducted, and the report has been prepared, in response to an agreed purpose and scope, within time and budgetary constraints, and in reliance on certain data and information made available to Tetra Tech Coffey.

The analyses, evaluations, opinions and conclusions presented in this report are based on that purpose and scope, requirements, data or information, and they could change if such requirements or data are inaccurate or incomplete.

This report is valid as of the date of preparation. The condition of the site (including subsurface conditions) and extent or nature of contamination or other environmental hazards can change over time, as a result of either natural processes or human influence. Tetra Tech Coffey should be kept appraised of any such events and should be consulted for further investigations if any changes are noted, particularly during construction activities where excavations often reveal subsurface conditions.

In addition, advancements in professional practice regarding contaminated land and changes in applicable statues and/or guidelines may affect the validity of this report. Consequently, the currency of conclusions and recommendations in this report should be verified if you propose to use this report more than 6 months after its date of issue.

The report does not include the evaluation or assessment of potential geotechnical engineering constraints of the site.

Interpretation of factual data

Environmental site assessments identify actual conditions only at those points where samples are taken and on the date collected. Data derived from indirect field measurements, and sometimes other reports on the site, are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact with respect to the report purpose and recommended actions.

Variations in soil and groundwater conditions may occur between test or sample locations and actual conditions may differ from those inferred to exist. No environmental assessment program, no matter how comprehensive, can reveal all subsurface details and anomalies. Similarly, no professional, no matter how well qualified, can reveal what is hidden by earth, rock or changed through time.

The actual interface between different materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

For this reason, parties involved with land acquisition, management and/or redevelopment should retain the services of a suitably qualified and experienced environmental consultant through the development and use of the site to identify variances, conduct additional tests if required, and recommend solutions to unexpected conditions or other unrecognised features encountered on site. Tetra Tech Coffey would be pleased to assist with any investigation or advice in such circumstances.

Recommendations in this report

This report assumes, in accordance with industry practice, that the site conditions recognised through discrete sampling are representative of actual conditions throughout the investigation area. Recommendations are based on the resulting interpretation.

Should further data be obtained that differs from the data on which the report recommendations are based (such as through excavation or other additional assessment), then the recommendations would need to be reviewed and may need to be revised.

Report for benefit of client

Unless otherwise agreed between us, the report has been prepared for your benefit and no other party. Other parties should not rely upon the report or the accuracy or completeness of any recommendation and should make their own enquiries and obtain independent advice in relation to such matters.

Tetra Tech Coffey assumes no responsibility and will not be liable to any other person or organisation for, or in relation to, any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report.

This report should not be applied for any purpose other than that stated in the report.

Interpretation by other professionals

Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, a suitably qualified and experienced environmental consultant should be retained to explain the implications of the report to other professionals referring to the report and then review plans and specifications produced to see how other professionals have incorporated the report findings.

Given Tetra Tech Coffey prepared the report and has familiarity with the site, Tetra Tech Coffey is well placed to provide such assistance. If another party is engaged to interpret the recommendations of the report, there is a risk that the contents of the report may be misinterpreted and Tetra Tech Coffey disowns any responsibility for such misinterpretation.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, laboratory data, drawings, etc. are customarily included in our reports and are developed by scientists or engineers based on their interpretation of field logs, field testing and laboratory evaluation of samples. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

This report should be reproduced in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

Responsibility

Environmental reporting relies on interpretation of factual information using professional judgement and opinion and has a level of uncertainty attached to it, which is much less exact than other design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. As noted earlier, the recommendations and findings set out in this report should only be regarded as interpretive and should not be taken as accurate and complete information about all environmental media at all depths and locations across the site.

APPENDIX B - REGISTERED GROUNDWATER BORES

STATION	TOTAL_DEPTH (m)	EASTING (GDA94z55)	NORTHING (GDA94z55)	USETYPE	STATUS	Formation	Log Description	Distance from Alignment (RevJ)	wtable_elev (Source SAFE)
84269	0	432452.3	5753830	NKN,	Used	Latrobe Valley Group (-Pv): generic	Clastic sedimentary rocks: nonmarine to paralic clastics, marine clastics.	1	163.4
325347	30	438736.3	5760697	SEC,	Used	Latrobe Valley Group (-Pv): generic	Clastic sedimentary rocks: nonmarine to paralic clastics, marine clastics.	3	102.7
325356	83	438324.3	5760933	SEC,	Used	Latrobe Valley Group (-Pv): generic	Clastic sedimentary rocks: nonmarine to paralic clastics, marine clastics.	3	128.7
325348	194	439729.3	5760987	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	5	73.7
308665	332.8	446759.3	5760445	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	6	73.3
325449	24	433422.3	5756518	NG,	Used	Thorpdale Volcanic Group (-Put): Generic	Tholeiitic and alkalic basalt; minor nephelinite, basanite, nepheline hawaiite, hawaiite, mugearite, nepheline mugearite, tuff, interbedded sandstone and silcrete.	10	178.6
309384	395	446418.3	5760186	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	15	73.9
309389	656	446442.3	5760214	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	22	73.8
308889	128.6	443045.3	5760620	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	27	58.3
308921	146.3	445815.3	5759689	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	42	75.1
308578	290.5	443454.3	5760474	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	59	60.4
308616	149.4	447604.3	5761034	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	59	71.3
84270	0	432200.3	5755489	NKN,	Used	Latrobe Valley Group (-Pv): generic	Clastic sedimentary rocks: nonmarine to paralic clastics, marine clastics.	68	200.9
308008	160.3	445366.3	5759760	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	69	73.8
325335	59	437775.3	5761700	SEC,	Used	Thorpdale Volcanic Group (-Put): Generic	Tholeiitic and alkalic basalt; minor nephelinite, basanite, nepheline hawaiite, hawaiite, mugearite, nepheline mugearite, tuff, interbedded sandstone and silcrete.	71	127.8
318825	297.78	417032.3	5727426	NG,	Used	alluvium(Qa1): generic	Gravel, sand, silt: variably sorted and rounded; generally unconsolidated; includes deposits of low terraces; alluvial floodplain deposits	76	38.3
308271	16.8	442878.3	5760767	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	92	57.5
308272	19.8	442680.3	5760799	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	92	57.1
<Null>	25	415519	5721390	NULL	Not Used	Wonthaggi Formation(Ksw): generic	Lithic volcaniclastic sandstone, arkose, siltstone, minor conglomerate and coal; fluvial	95	30.4
308270	24.4	443076.3	5760739	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	95	58.1
308269	21.3	443268.3	5760709	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	96	59.0
309148	80	446778.3	5760585	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	103	72.6
309315	324	443909.3	5760017	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	107	63.9
308242	83.8	443047.3	5760539	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	107	58.5
309336	346.5	443908.3	5760017	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	107	63.9
308236	76.2	442646.3	5760602	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	108	57.5
308234	53.3	442250.3	5760665	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	109	57.4
308274	22.6	442845.3	5760569	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	109	57.9
308618	172.2	448525.3	5761703	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	110	76.2
308692	264	446784.3	5760600	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	111	72.5
308583	224	443252.3	5760501	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	111	59.4
308588	161.8	446640.3	5760192	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	119	74.3
308995	10.4	445841.3	5759864	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	121	74.1
309305	344.7	443889.3	5760019	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	122	63.9
<Null>	25	415571	5721467	NULL	Not Used	Wonthaggi Formation(Ksw): generic	Lithic volcaniclastic sandstone, arkose, siltstone, minor conglomerate and coal; fluvial	122	31.5
307995	152.4	449051.3	5762429	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	128	80.2
308330	61.9	449051.3	5762429	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	128	80.2
308584	245.7	443468.3	5760681	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	135	60.0
325345	67	437898.3	5761329	SEC,	Used	Latrobe Valley Group (-Pv): generic	Clastic sedimentary rocks: nonmarine to paralic clastics, marine clastics.	142	138.8
<Null>	25	415620	5721554	NULL	Not Used	Wonthaggi Formation(Ksw): generic	Lithic volcaniclastic sandstone, arkose, siltstone, minor conglomerate and coal; fluvial	145	32.0
<Null>	83	443867	5759994	DS,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	154	63.8
85575	30.48	418111.3	5729680	ST,	Used	Wonthaggi Formation(Ksw): generic	Lithic volcaniclastic sandstone, arkose, siltstone, minor conglomerate and coal; fluvial	178	38.1
308996	9.4	445952.3	5759565	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	188	75.9
309003	9.1	443939.3	5760427	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	200	62.9
308007	129.5	443775.3	5760018	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	213	63.3
61664	46.94	421195.3	5734918	NKN,	Used	Thorpdale Volcanic Group (-Put): Generic	Tholeiitic and alkalic basalt; minor nephelinite, basanite, nepheline hawaiite, hawaiite, mugearite, nepheline mugearite, tuff, interbedded sandstone and silcrete.	218	29.2
77659	12.5	414963.3	5721234	DM, ST,	Used	Wonthaggi Formation(Ksw): generic	Lithic volcaniclastic sandstone, arkose, siltstone, minor conglomerate and coal; fluvial	231	24.6
308002	146.6	447214.3	5761098	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	233	69.9
308706	3	443490.3	5760786	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	240	59.7
325225	59.1	440597.3	5760524	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	248	71.2
61662	208.48	423061.3	5736531	DM, ST,	Used	alluvium(Qa1): generic	Gravel, sand, silt: variably sorted and rounded; generally unconsolidated; includes deposits of low terraces; alluvial floodplain deposits	260	38.4
308598	230.1	446746.3	5760764	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	263	71.6
325397	59.8	439227.3	5761081	SEC,	Used	Latrobe Valley Group (-Pv): generic	Clastic sedimentary rocks: nonmarine to paralic clastics, marine clastics.	266	78.3
325342	30.5	437808.3	5761898	SEC,	Used	Thorpdale Volcanic Group (-Put): Generic	Tholeiitic and alkalic basalt; minor nephelinite, basanite, nepheline hawaiite, hawaiite, mugearite, nepheline mugearite, tuff, interbedded sandstone and silcrete.	269	121.3
325221	28	440346.3	5761064	NG,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	281	69.3
325350	31	438066.3	5760708	SEC,	Used	Latrobe Valley Group (-Pv): generic	Clastic sedimentary rocks: nonmarine to paralic clastics, marine clastics.	286	135.1
308908	64.6	442121.3	5761089	SEC,	Used	alluvium(Qa1): generic	Gravel, sand, silt: variably sorted and rounded; generally unconsolidated; includes deposits of low terraces; alluvial floodplain deposits	290	57.2
308911	103.9	442519.3	5761027	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	291	56.6
308264	34.7	442910.3	5760965	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	292	57.1
308232	89.6	443106.3	5760936	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	295	57.8
308263	21.3	443305.3	5760905	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	296	58.6
308289	25.9	442328.3	5761064	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	298	56.7
308231	61	442709.3	5761005	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	300	56.7
308905	68.3	441922.3	5761121	SEC,	Used	alluvium(Qa1): generic	Gravel, sand, silt: variably sorted and rounded; generally unconsolidated; includes deposits of low terraces; alluvial floodplain deposits	302	57.8

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STATION	TOTAL_DEPTH (m)	EASTING (GDA94z55)	NORTHING (GDA94z55)	USETYPE	STATUS	Formation	Log Description	Distance from Alignment (RevJ)	wtable_elev (Source SAFE)
120540	6	425653.3	5742104	DM,	Used	Wonthaggi Formation(Ksw): generic	Lithic volcaniclastic sandstone, arkose, siltstone, minor conglomerate and coal; fluvial	304	202.3
41629	0	425653.3	5742104	IV,	Used	Wonthaggi Formation(Ksw): generic	Lithic volcaniclastic sandstone, arkose, siltstone, minor conglomerate and coal; fluvial	304	202.3
325321	129	439802.3	5761285	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	308	71.7
308278	20.7	442613.3	5760403	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	310	57.9
308233	143.3	443504.3	5760873	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	325	59.6
308565	267.3	443879.3	5760642	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	334	62.2
325337	30	437735.3	5761985	SEC,	Used	Thorpdale Volcanic Group (-Put): Generic	Tholeiitic and alkalic basalt; minor nephelinite, basanite, nepheline hawaiite, hawaiite, mugearite, nepheline mugearite, tuff, interbedded sandstone and silcrete.	349	120.1
308637	190.5	449841.3	5762312	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	351	88.3
325248	9.1	440905.3	5761306	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	358	62.5
308994	9.1	445753.3	5760101	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	361	72.8
325249	9.8	441176.3	5761288	SEC,	Used	alluvium(Qa1): generic	Gravel, sand, silt: variably sorted and rounded; generally unconsolidated; includes deposits of low terraces; alluvial floodplain deposits	362	60.5
309094	18.3	443927.3	5760644	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	365	62.4
325369	73.9	439608.3	5761329	SEC,	Used	Latrobe Valley Group (-Pv): generic	Clastic sedimentary rocks: nonmarine to paralic clastics, marine clastics.	366	73.0
325358	67	438360.3	5760544	SEC,	Used	Latrobe Valley Group (-Pv): generic	Clastic sedimentary rocks: nonmarine to paralic clastics, marine clastics.	369	121.0
309032	3	443047.3	5760271	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	371	59.2
309101	9.1	443929.3	5760674	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	390	62.3
325250	16.2	441440.3	5761270	SEC,	Used	alluvium(Qa1): generic	Gravel, sand, silt: variably sorted and rounded; generally unconsolidated; includes deposits of low terraces; alluvial floodplain deposits	396	59.5
309278	8	447032.3	5760147	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	397	75.6
325251	13.7	441702.3	5761253	SEC,	Used	alluvium(Qa1): generic	Gravel, sand, silt: variably sorted and rounded; generally unconsolidated; includes deposits of low terraces; alluvial floodplain deposits	412	58.1
325437	20	440928.3	5761364	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	413	62.2
308629	301.4	448925.3	5761637	SEC,	Used	alluvium(Qa1): generic	Gravel, sand, silt: variably sorted and rounded; generally unconsolidated; includes deposits of low terraces; alluvial floodplain deposits	414	79.0
308712	351.4	446585.3	5759768	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	417	75.7
309085	15.2	444077.3	5760595	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	417	63.3
308975	9.1	441930.3	5761238	SEC,	Used	alluvium(Qa1): generic	Gravel, sand, silt: variably sorted and rounded; generally unconsolidated; includes deposits of low terraces; alluvial floodplain deposits	420	57.7
308580	141.7	443378.3	5760077	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	420	61.1
308976	14.3	442203.3	5761211	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	423	56.7
308617	212.1	448650.3	5762493	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	427	76.0
309004	9.1	444315.3	5760370	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	430	65.2
318828	144.17	414683.3	5720718	NG,	Used	alluvium(Qa1): generic	Gravel, sand, silt: variably sorted and rounded; generally unconsolidated; includes deposits of low terraces; alluvial floodplain deposits	447	19.8
325315	193	440400.3	5761229	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	455	67.5
309093	18.3	444114.3	5760614	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	455	63.4
308579	187.8	442956.3	5760184	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	472	59.0
325247	9.1	440641.3	5761323	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	472	64.7
308587	220.1	445857.3	5760330	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	476	72.1
309084	15.5	444121.3	5760644	SEC,	Used	alluvial terrace deposits(Qa2): generic	Gravel, sand, silt: variably sorted and rounded, generally unconsolidated; dissected to form terraces higher than Qa1, alluvial floodplain deposits	483	63.4
308615	262.1	447730.3	5761829	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	485	70.5
308259	29	442942.3	5761157	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	487	56.9
308258	30.5	442771.3	5761186	SEC,	Used	Haunted Hills Formation(Nlh): generic	Sand, silt, gravel: various shades of brown, yellow, red, white; variably sorted; variably rounded; crudely to well-bedded; commonly strongly oxidised with ironstone near the top and also within the formation	488	56.5

APPENDIX C - GROUNDWATER LEVELS AND SENSITIVE RECEIVERS MAPBOOK

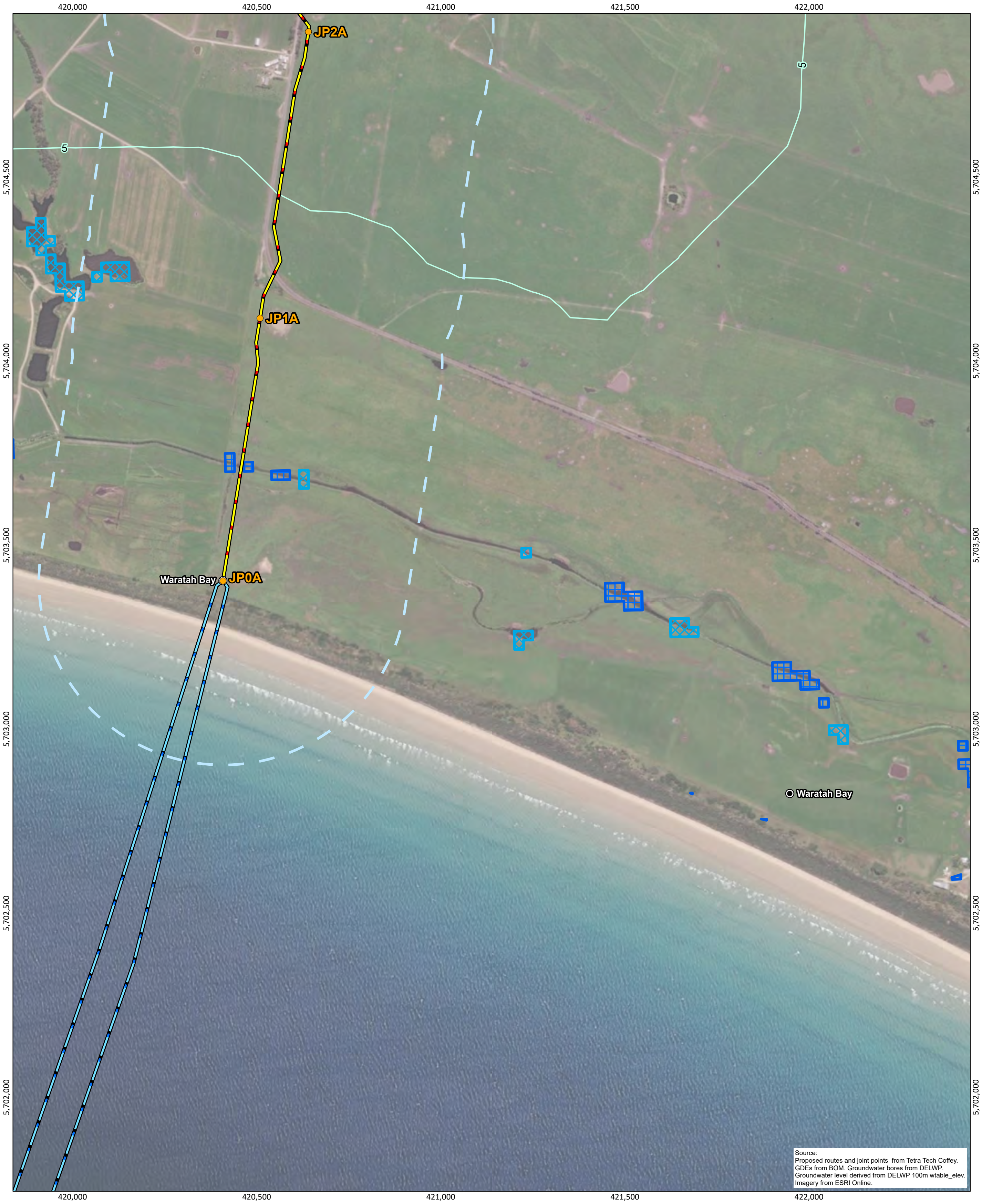

Figure 5.4 - Groundwater levels and sensitive receptors (map 1 of 29)

Legend

- Landfall
- Proposed joint points

Proposed route

- HVDC subsea cable
- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

Coordinate System: GDA2020 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA2020

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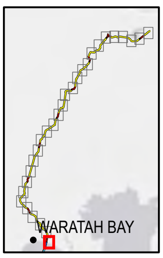

Date: 29/06/2023 10:40 AM

Prepared by: George Young

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MARINUS LINK

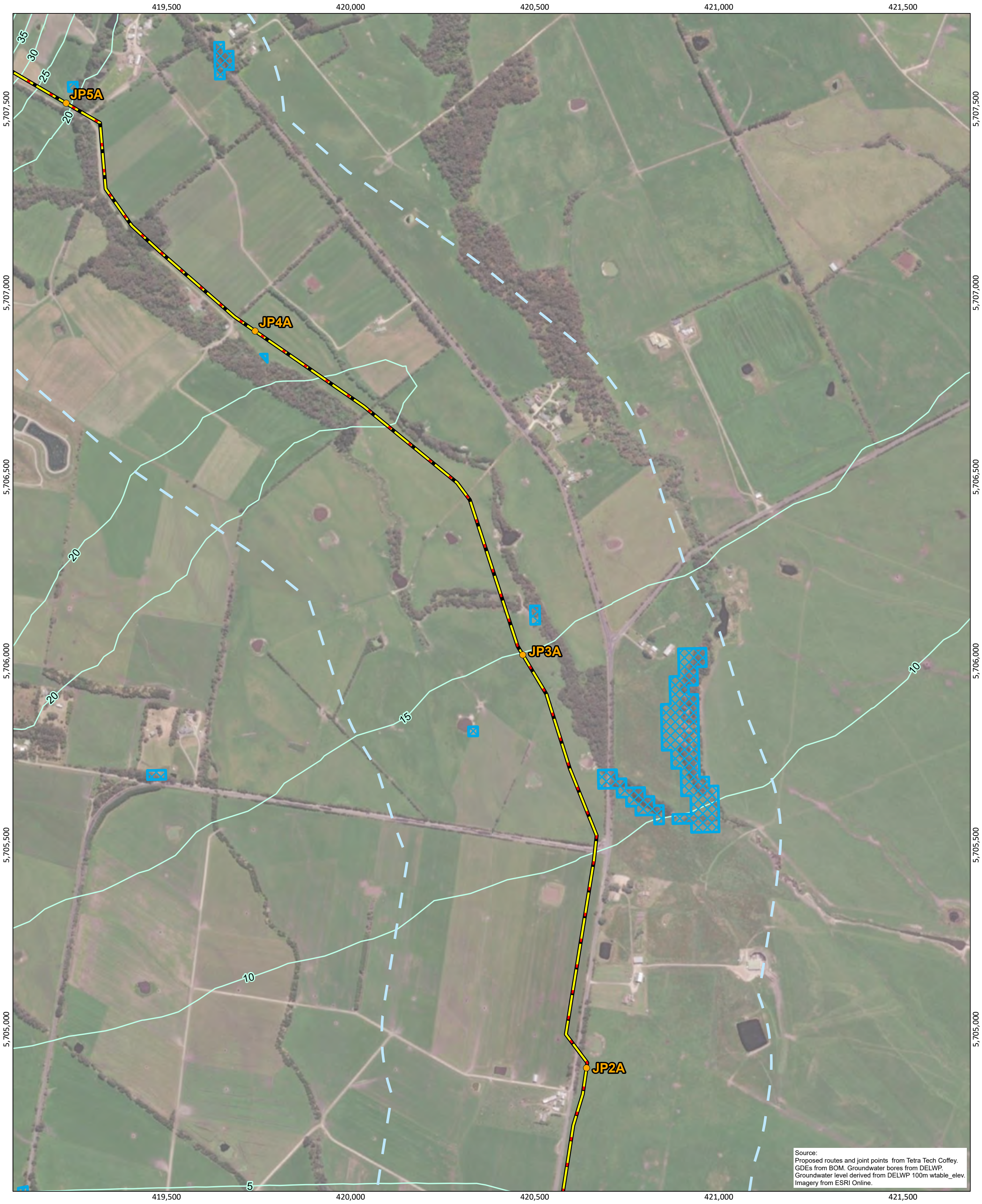


Figure 5.4 - Groundwater levels and sensitive receptors (map 2 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)

Terrestrial GDEs

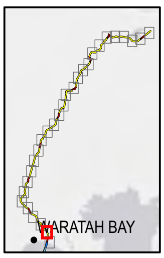
- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

Coordinate System: GDA2020 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA2020



Date: 29/06/2023 10:40 AM

Prepared by: George Young

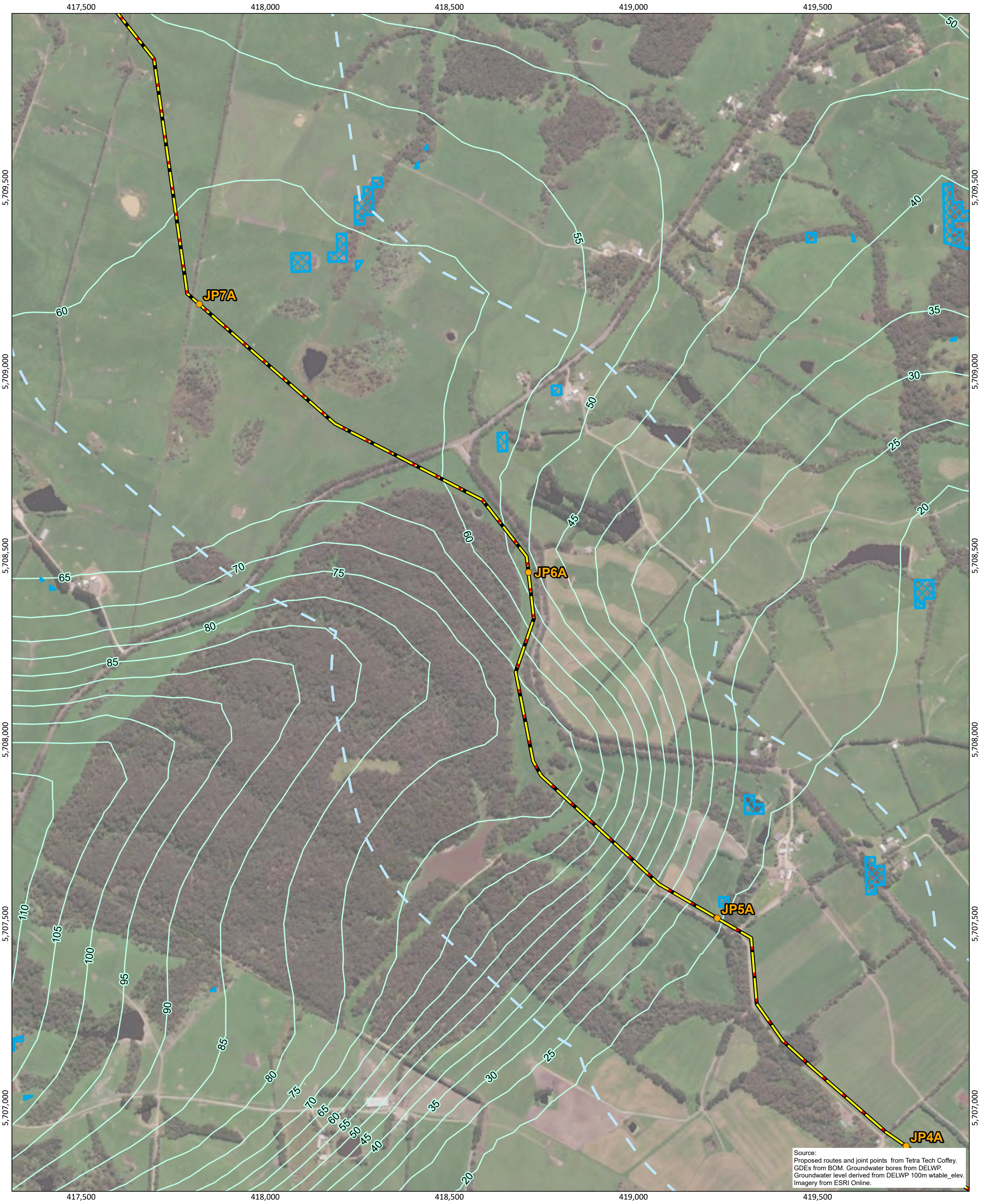


Figure 5.4 - Groundwater levels and sensitive receptors (map 3 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Scale: 1:10,000

Coordinate System: GDA2020 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA2020

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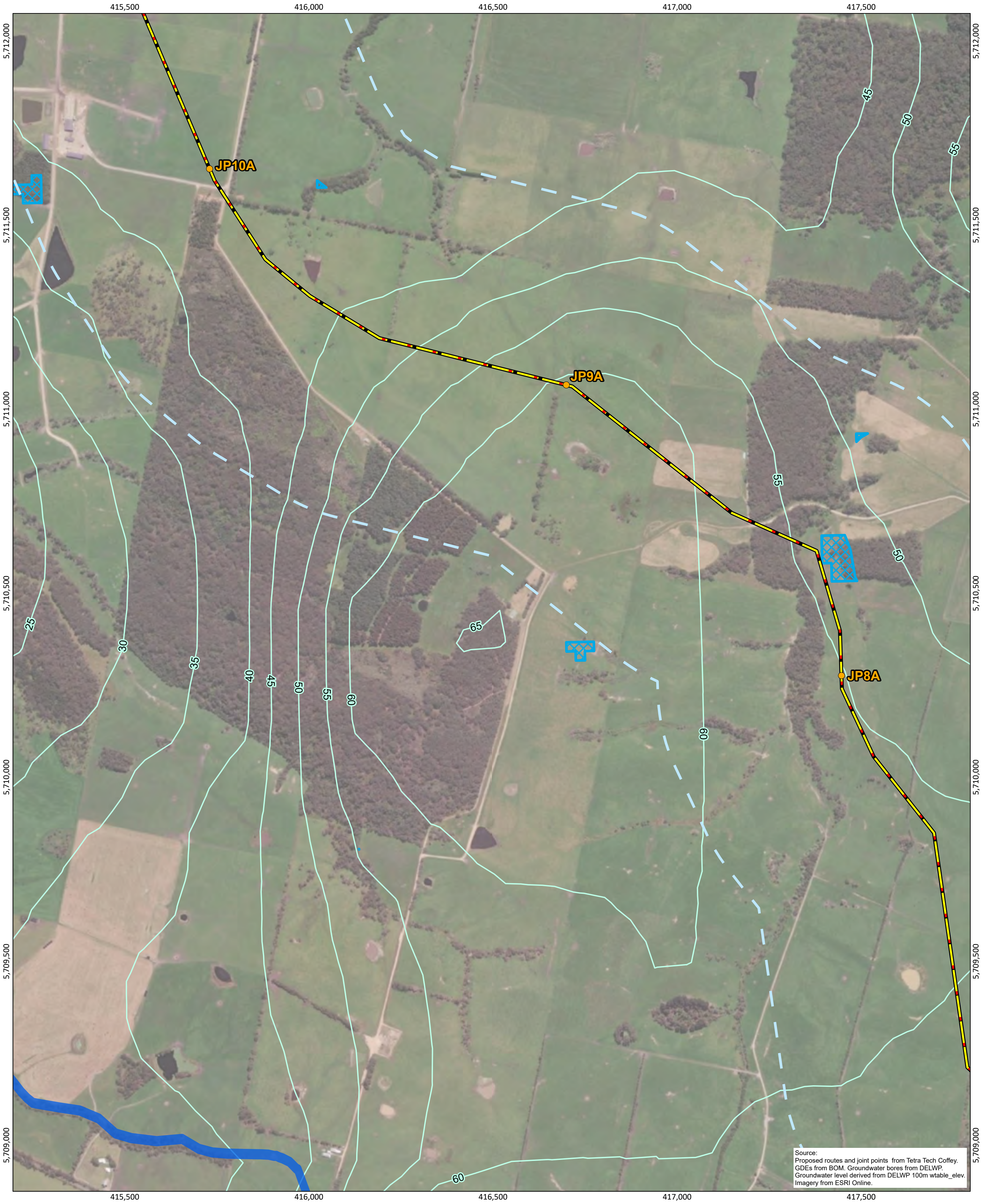

Figure 5.4 - Groundwater levels and sensitive receptors (map 4 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

Coordinate System: GDA2020 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA2020

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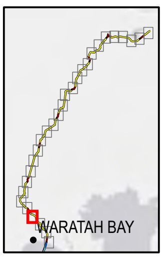

Date: 29/06/2023 10:40 AM

Prepared by: George Young

TETRA TECH COFFEY

MARINUS LINK

Figure 5.4 - Groundwater levels and sensitive receptors (map 5 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

Coordinate System: GDA2020 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA2020

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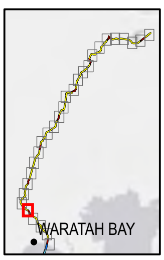

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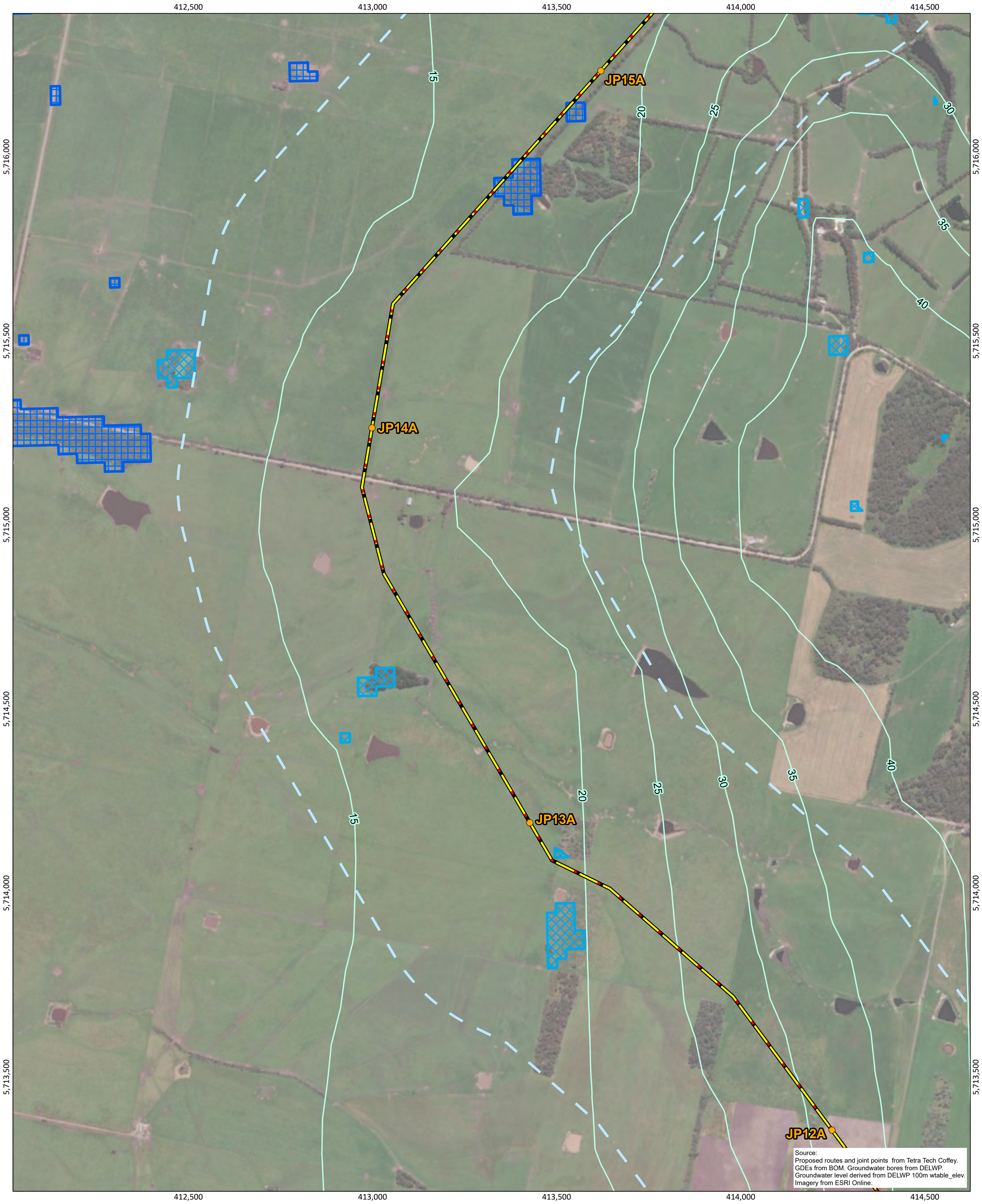

Figure 5.4 - Groundwater levels and sensitive receptors (map 6 of 29)

Legend

Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

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Projection: Transverse Mercator
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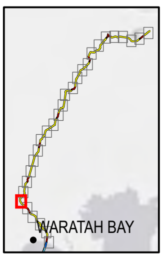

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Figure 5.4 - Groundwater levels and sensitive receptors (map 7 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)
- Major watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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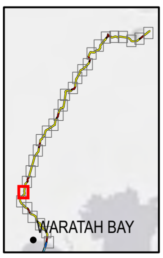

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Figure 5.4 - Groundwater levels and sensitive receptors (map 8 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route

Registered bore

- Domestic & stock
- Non-groundwater
- Unknown or other

- Indicative groundwater level (mAHD)

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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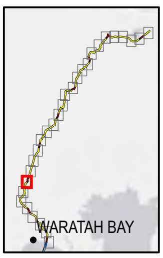

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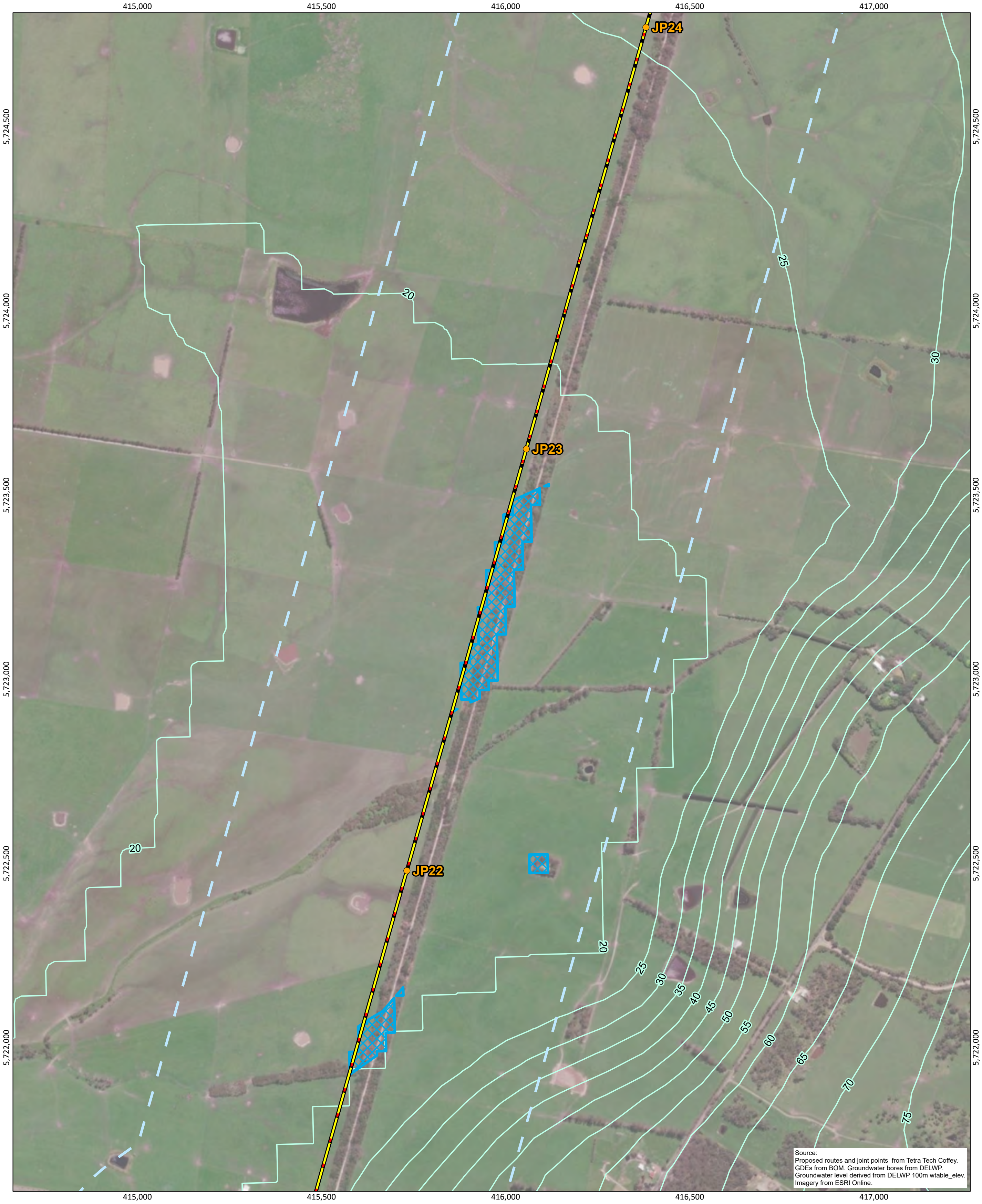

Figure 5.4 - Groundwater levels and sensitive receptors (map 9 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

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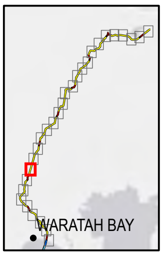

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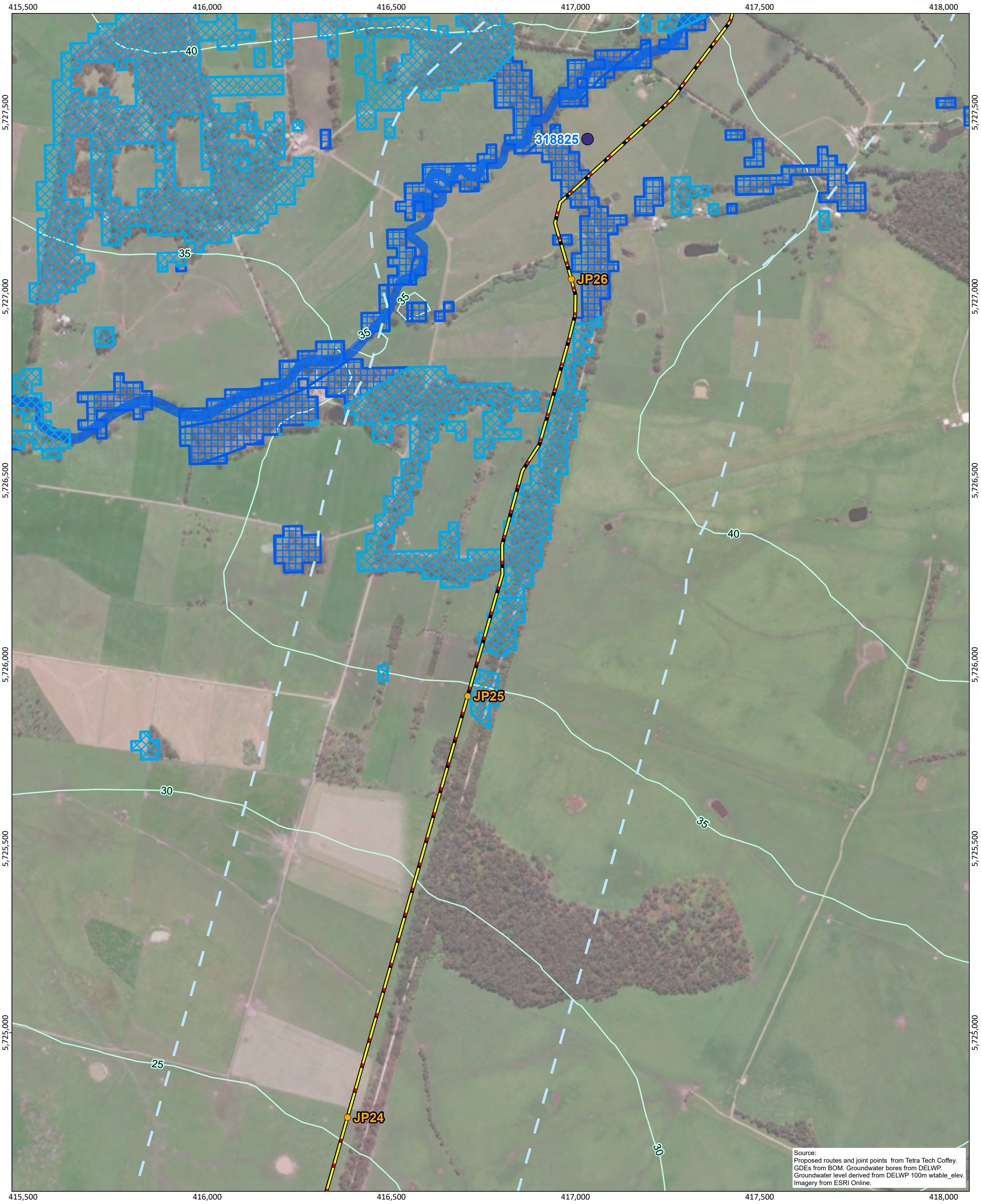

Figure 5.4 - Groundwater levels and sensitive receptors (map 10 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route

Registered bore

- Non-groundwater
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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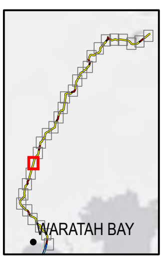

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Figure 5.4 - Groundwater levels and sensitive receptors (map 11 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route

Registered bore

- Stock
- Non-groundwater
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

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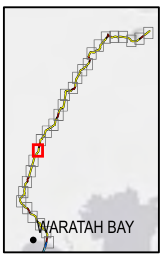

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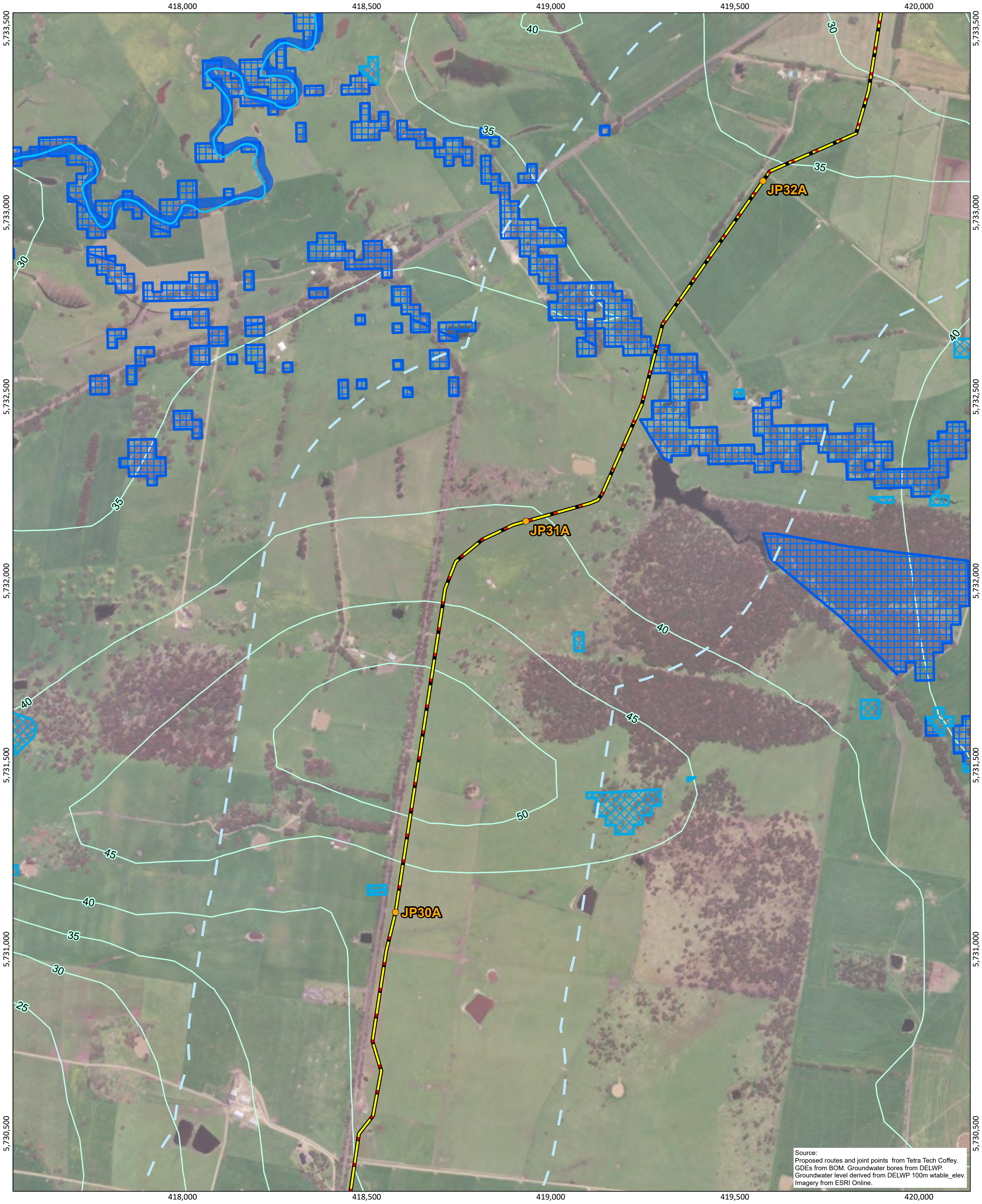

Figure 5.4 - Groundwater levels and sensitive receptors (map 12 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)
- Major watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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Figure 5.4 - Groundwater levels and sensitive receptors (map 13 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route

Registered bore

- Unknown or other
- Indicative groundwater level (mAHD)
- Major watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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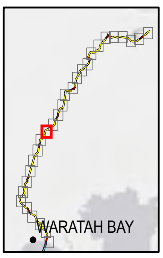

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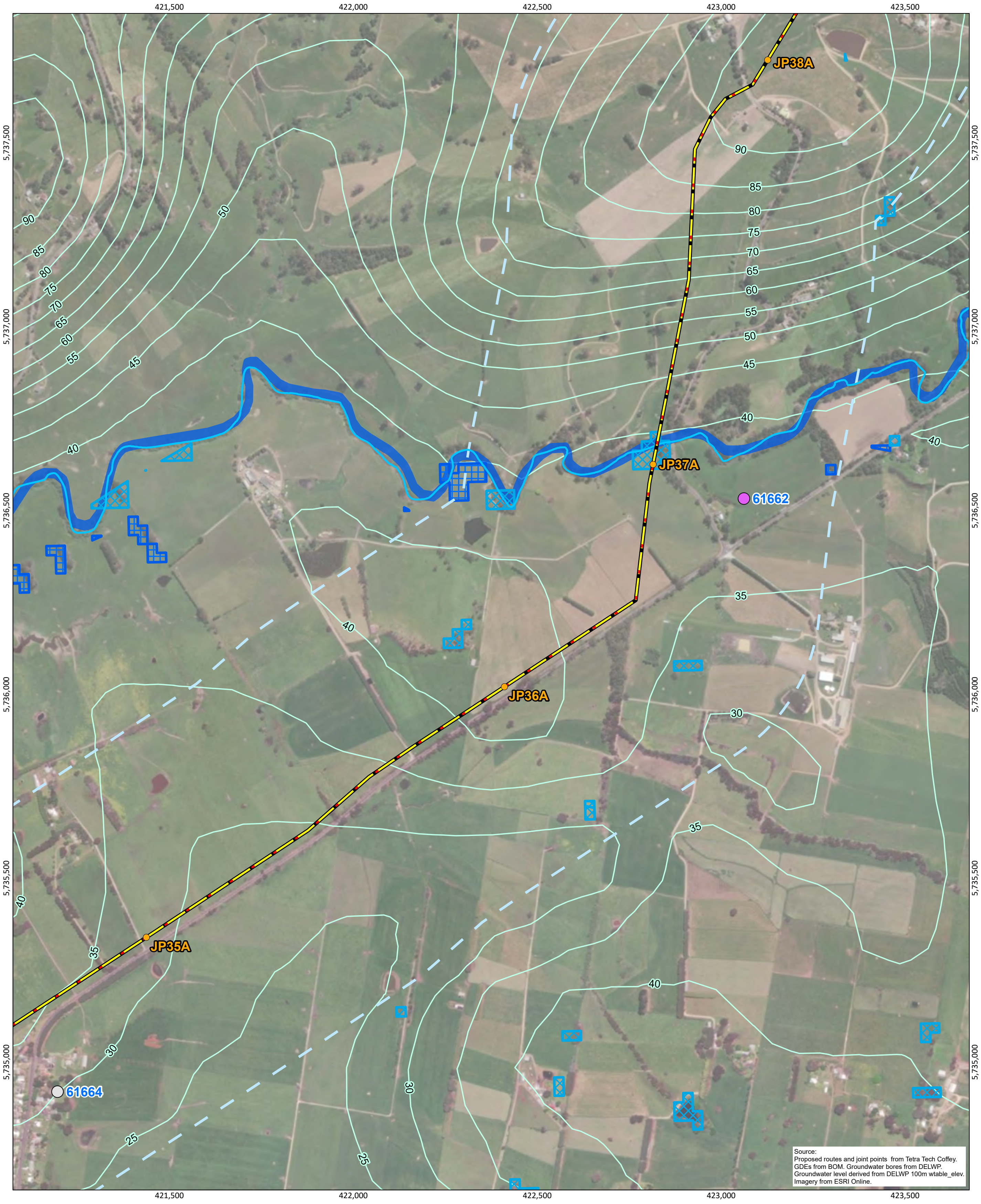

Figure 5.4 - Groundwater levels and sensitive receptors (map 14 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route

Registered bore

- Domestic & stock
- Unknown or other
- Indicative groundwater level (mAHD)
- Major watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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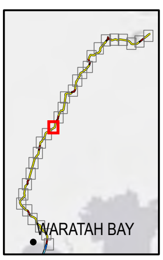

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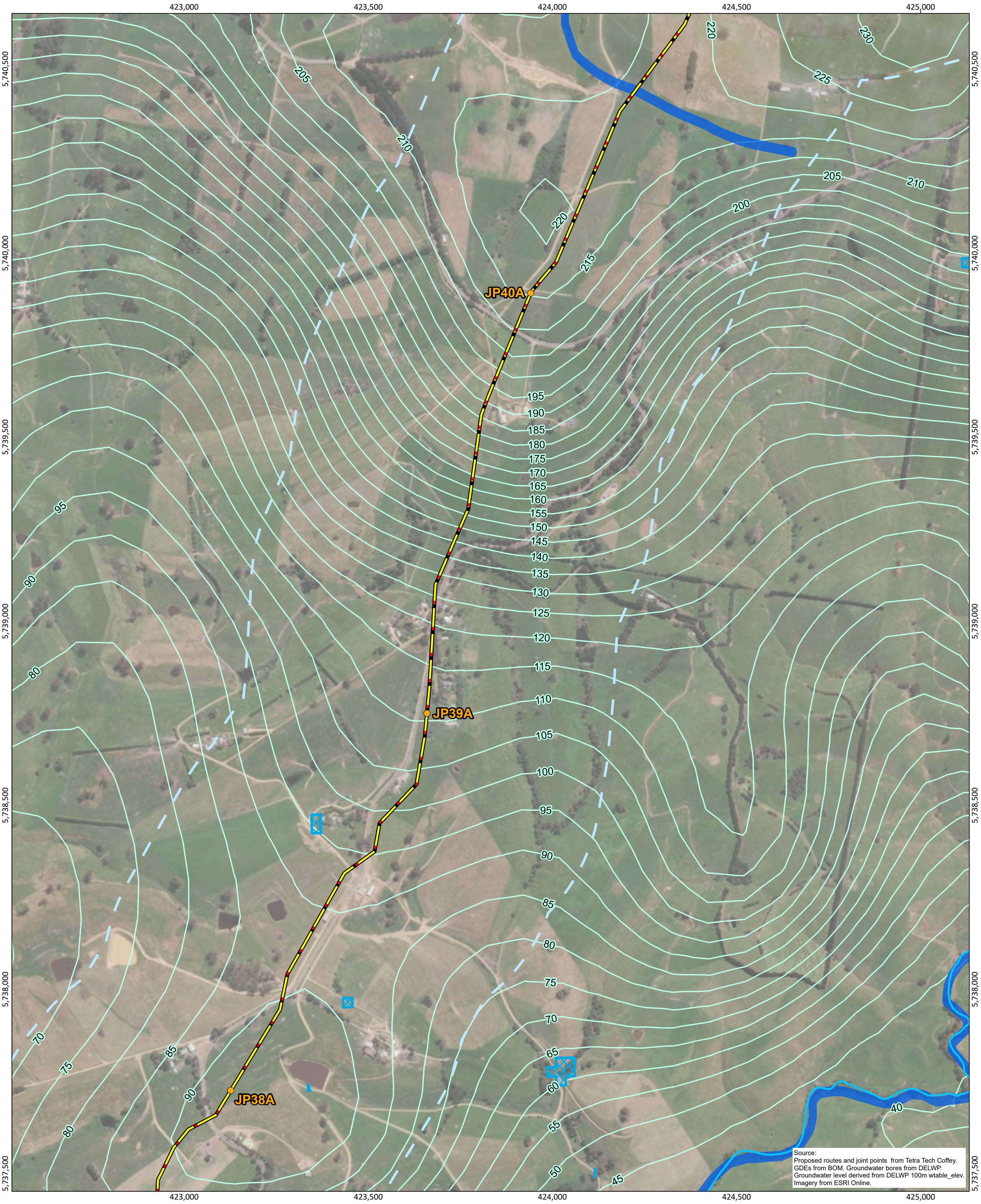

Figure 5.4 - Groundwater levels and sensitive receptors (map 15 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)
- Major watercourse

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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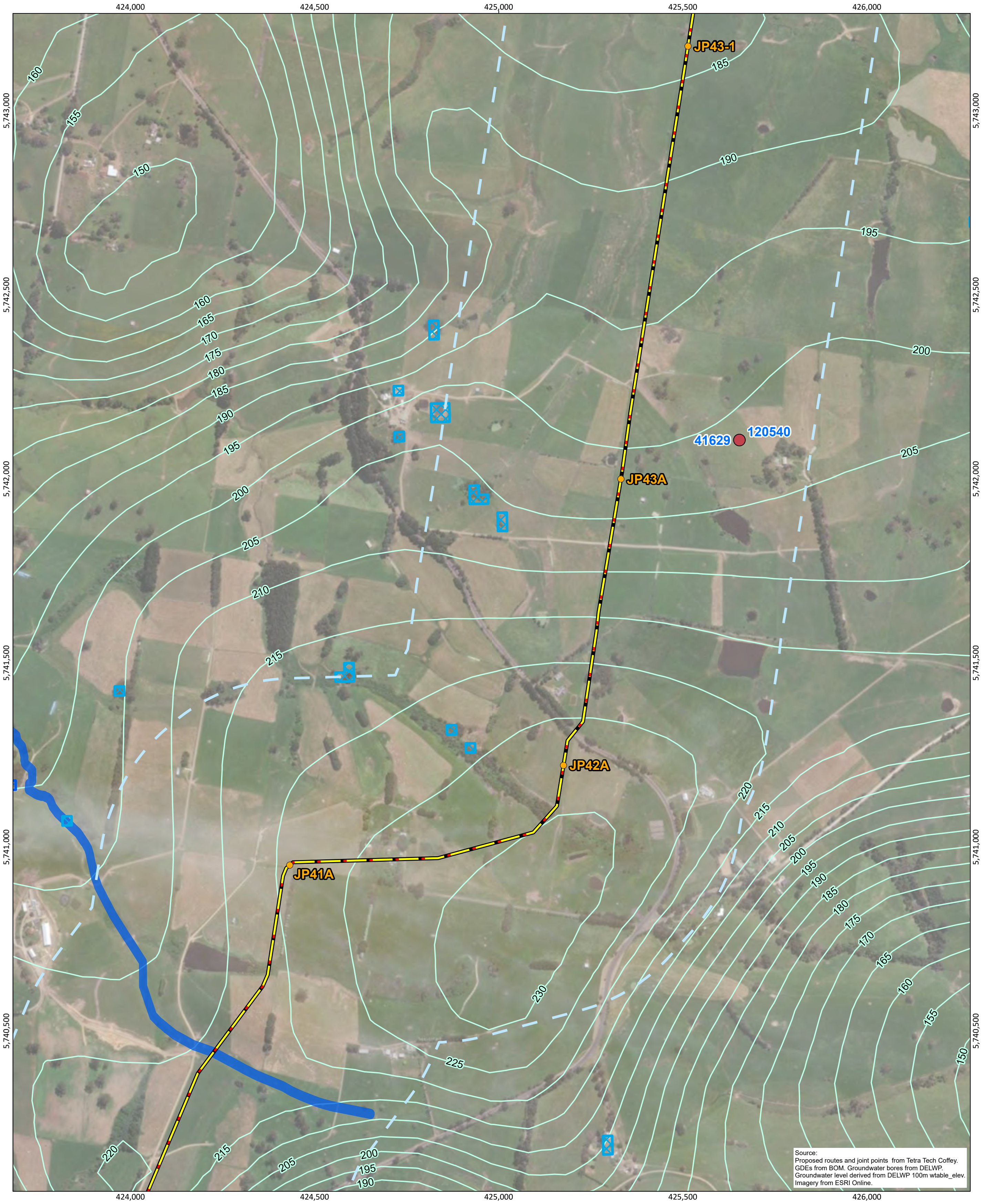

Figure 5.4 - Groundwater levels and sensitive receptors (map 16 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route

Registered bore

- Domestic
- Investigation
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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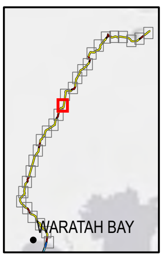

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Figure 5.4 - Groundwater levels and sensitive receptors (map 17 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

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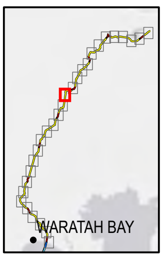

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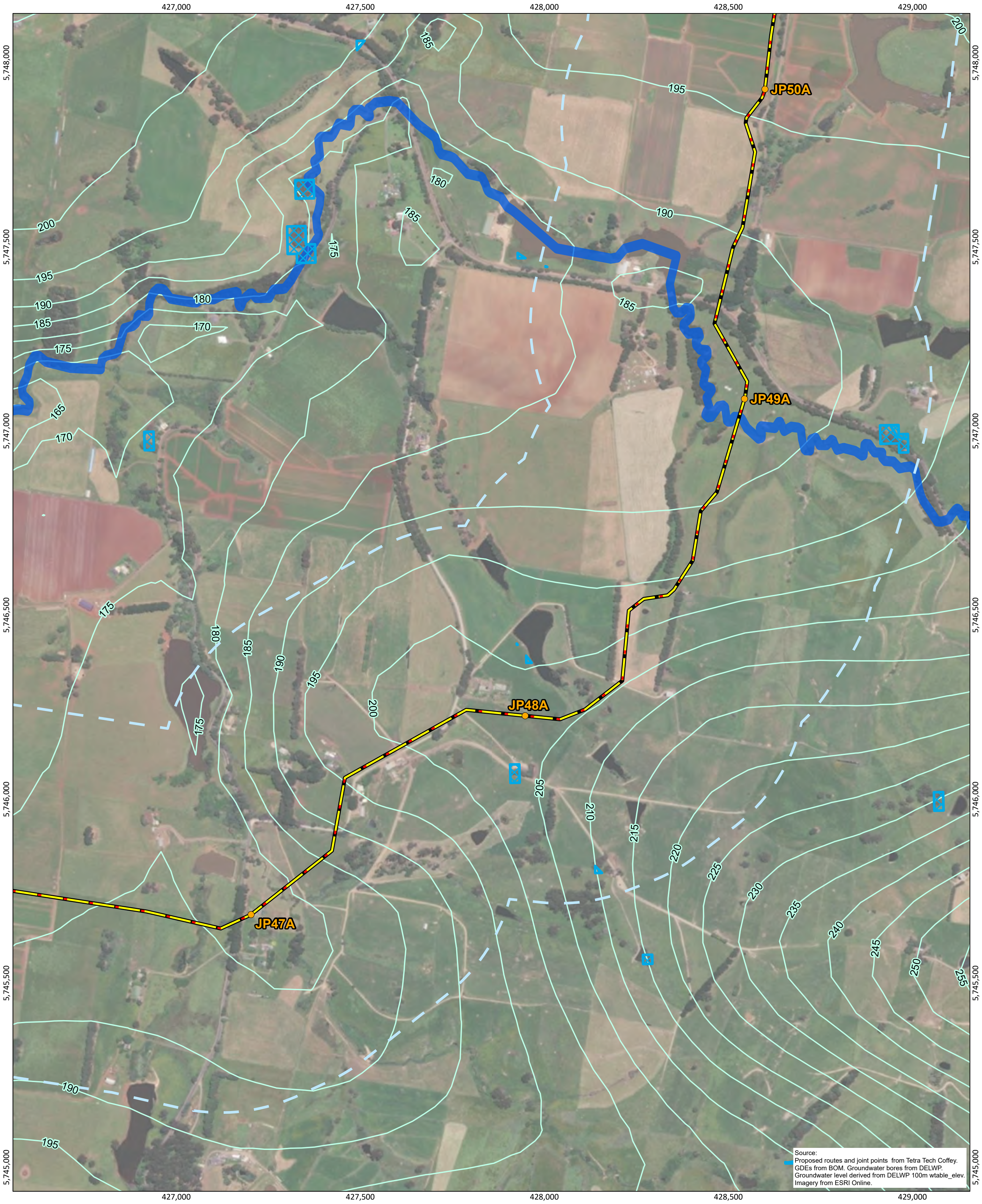

Figure 5.4 - Groundwater levels and sensitive receptors (map 18 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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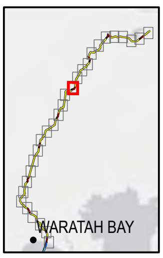

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Figure 5.4 - Groundwater levels and sensitive receptors (map 19 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

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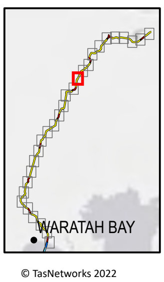

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Figure 5.4 - Groundwater levels and sensitive receptors (map 20 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)
- Major watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

N

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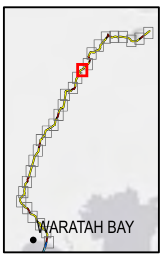

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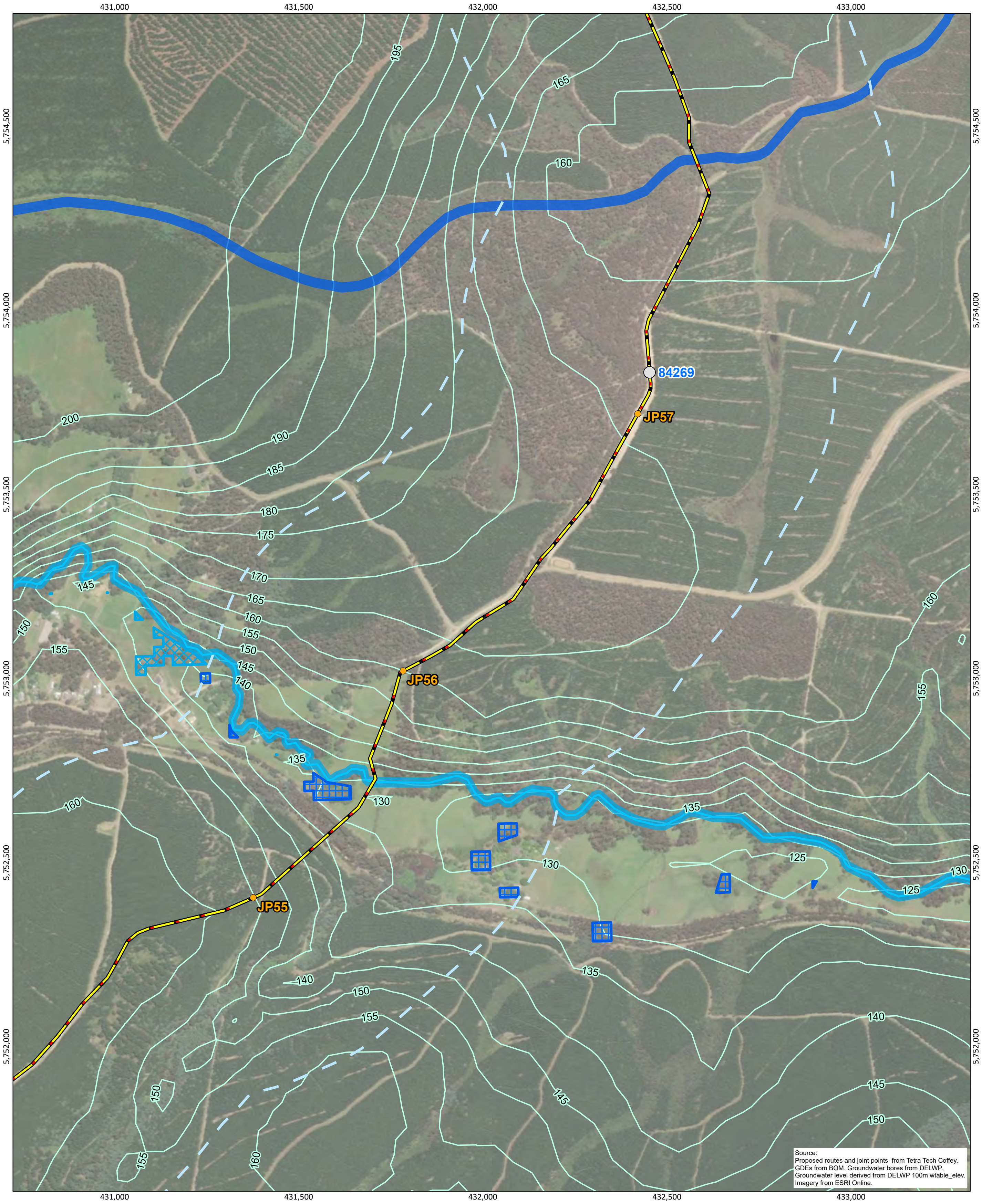

Figure 5.4 - Groundwater levels and sensitive receptors (map 21 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route

Registered bore

- Unknown or other
- Indicative groundwater level (mAHD)
- Major watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

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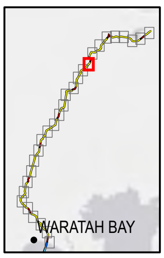

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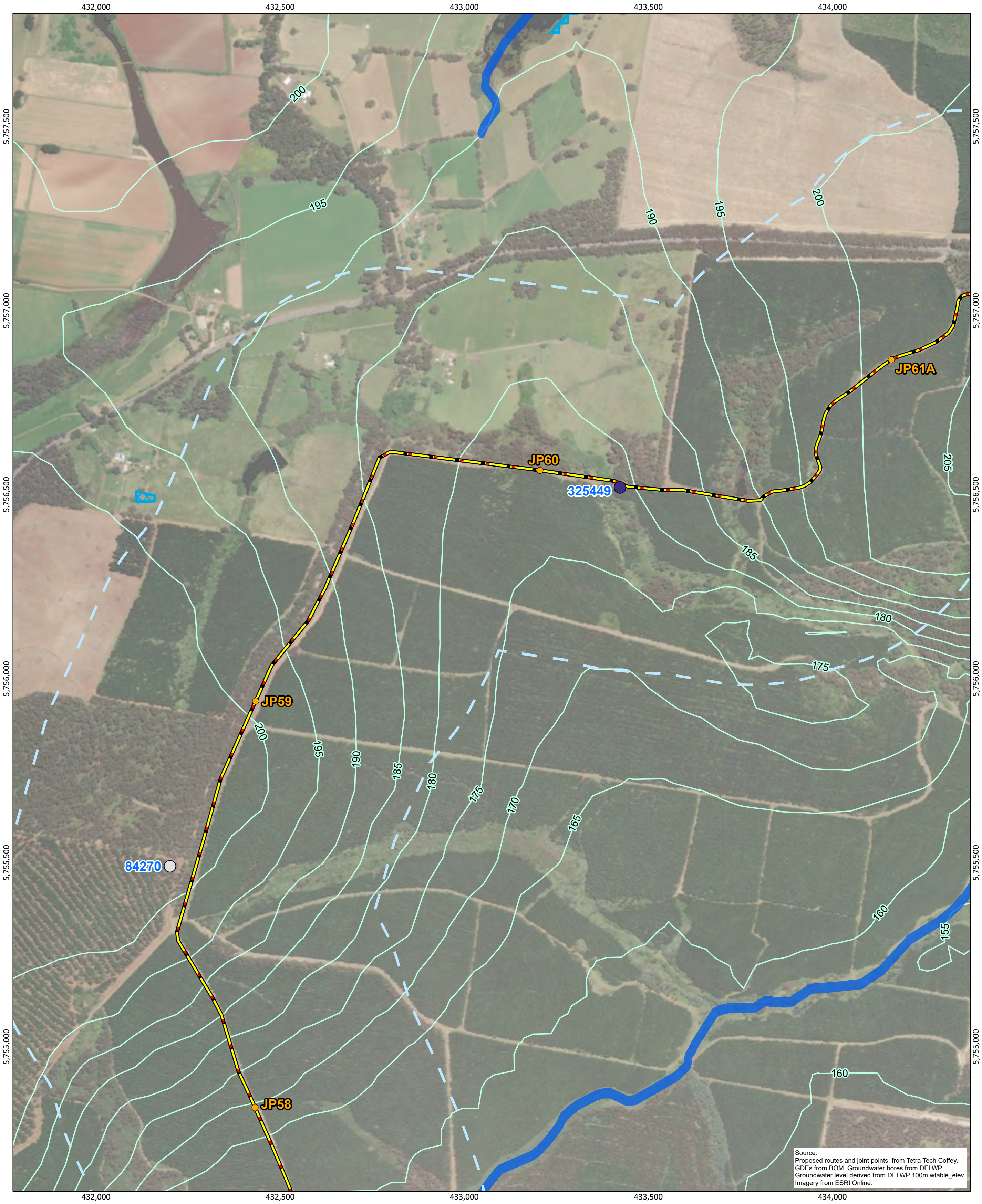

Figure 5.4 - Groundwater levels and sensitive receptors (map 22 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route

Registered bore

- Non-groundwater
- Unknown or other

- Indicative groundwater level (mAHD)

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

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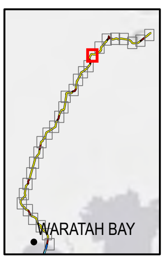

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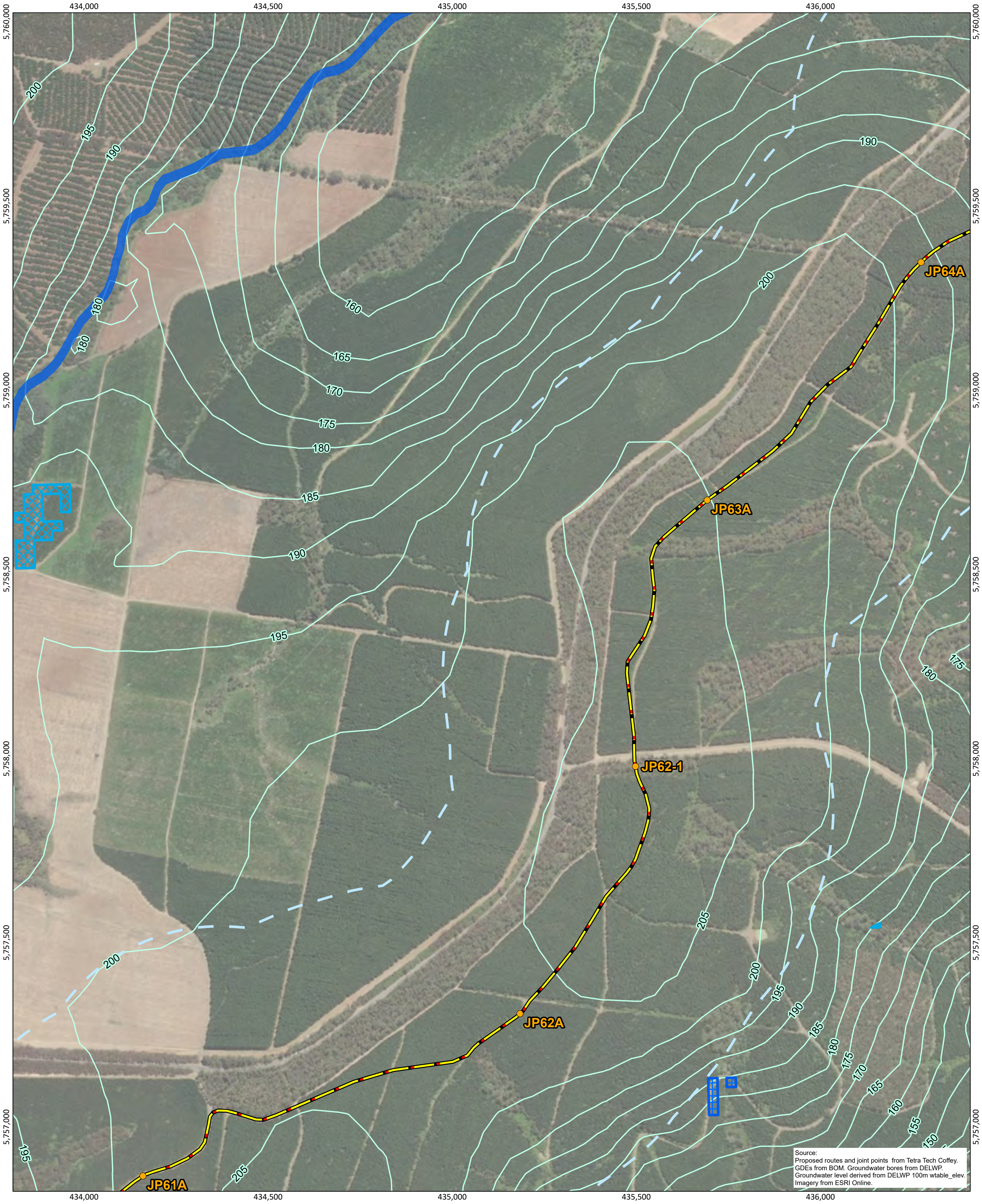

Figure 5.4 - Groundwater levels and sensitive receptors (map 23 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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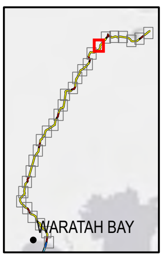

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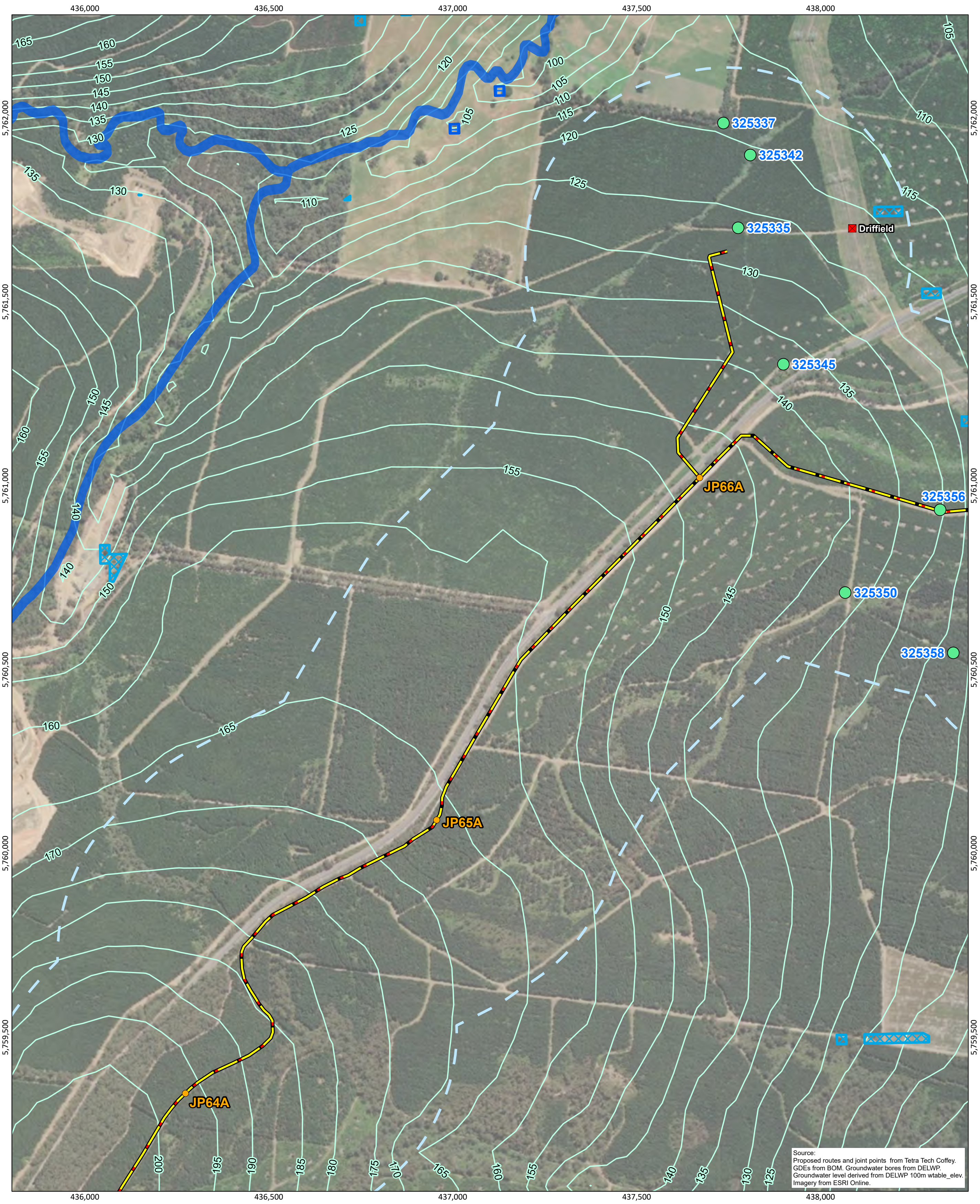

Figure 5.4 - Groundwater levels and sensitive receptors (map 24 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Proposed converter station

Registered bore

- SEC monitoring bore
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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Coordinate System: GDA2020 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA2020

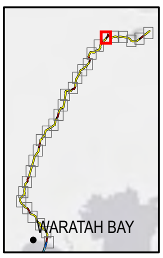

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Figure 5.4 - Groundwater levels and sensitive receptors (map 25 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route

Registered bore

- Non-groundwater
- SEC monitoring bore
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

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Figure 5.4 - Groundwater levels and sensitive receptors (map 26 of 29)

Legend

- Proposed joint points

Proposed route
- Underground HVDC cable
- 500 m buffer of route

Registered bore
- SEC monitoring bore
- Indicative groundwater level (mAHD)

- Major watercourse

Terrestrial GDEs
- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs
- High potential GDE (national assessment)

N

Scale: 1:10,000

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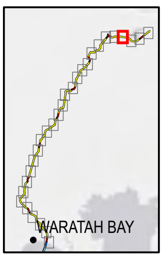

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Figure 5.4 - Groundwater levels and sensitive receptors (map 27 of 29)

Legend

Proposed joint points

Proposed route

Underground HVDC cable

500 m buffer of route

Registered bore

SEC monitoring bore

Unknown or other

Indicative groundwater level (mAHD)

Terrestrial GDEs

High potential GDE (national assessment)

Moderate potential GDE (national assessment)

Aquatic GDEs

High potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

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Figure 5.4 - Groundwater levels and sensitive receptors (map 28 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route

Registered bore

- SEC monitoring bore
- Indicative groundwater level (mAHD)

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

Coordinate System: GDA2020 MGA Zone 55
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Figure 5.4 - Groundwater levels and sensitive receptors (map 29 of 29)

Legend

- Proposed joint points

Proposed route

- Underground HVDC cable
- 500 m buffer of route
- Proposed converter station

Registered bore

- SEC monitoring bore

- Indicative groundwater level (mAHD)

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

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APPENDIX D - AREAS POTENTIALLY REQUIRING DEWATERING MAPBOOK

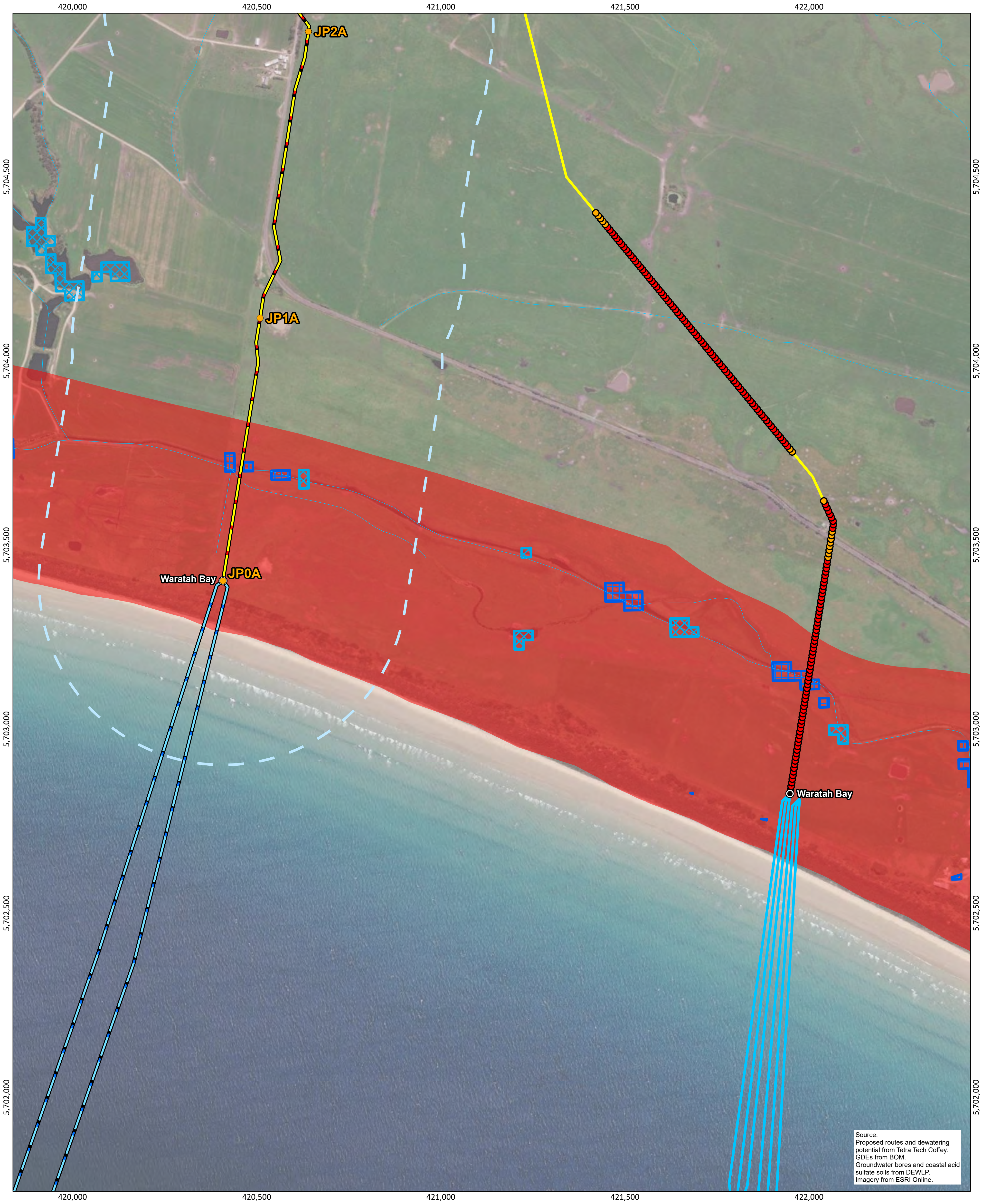

Figure 7.1 - Onshore area likely requiring dewatering (map 1 of 29)

Legend

- Landfall
- HVDC subsea cable
- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- HVDC subsea cable
- Underground HVDC cable

Dewatering potential

- Amber = moderate likelihood
- Red = high likelihood
- Minor watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Coastal acid sulfate soils

- Prospective

N

Scale: 1:10,000

200 100 0 200 m

Coordinate System: GDA2020 MGA Zone 55
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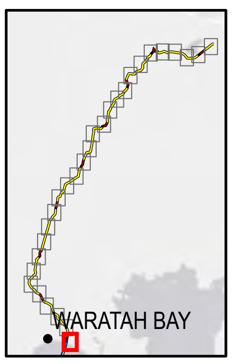

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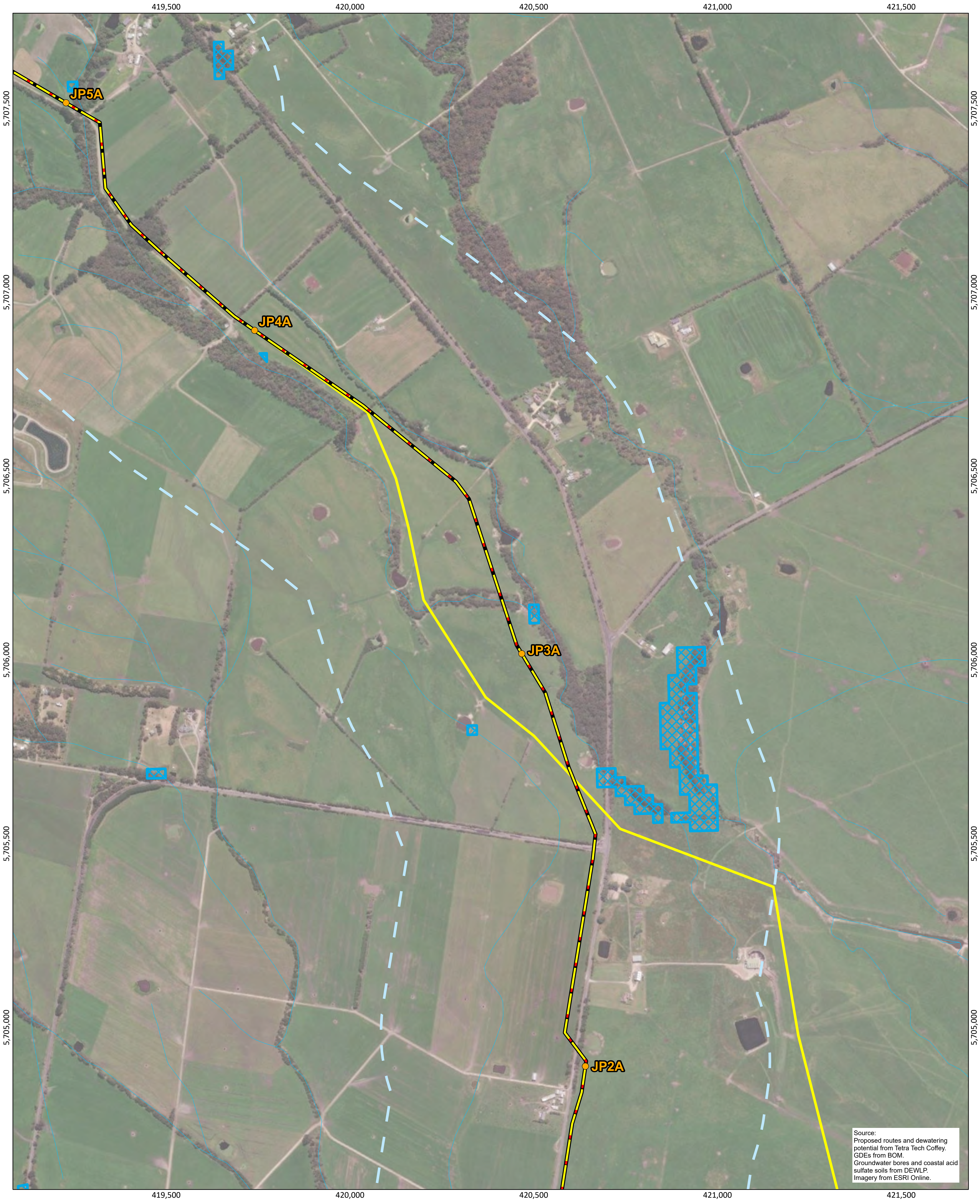

Figure 7.1 - Onshore area likely requiring dewatering (map 2 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable
- Minor watercourse

Terrestrial GDEs

- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

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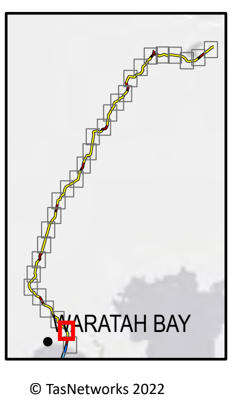

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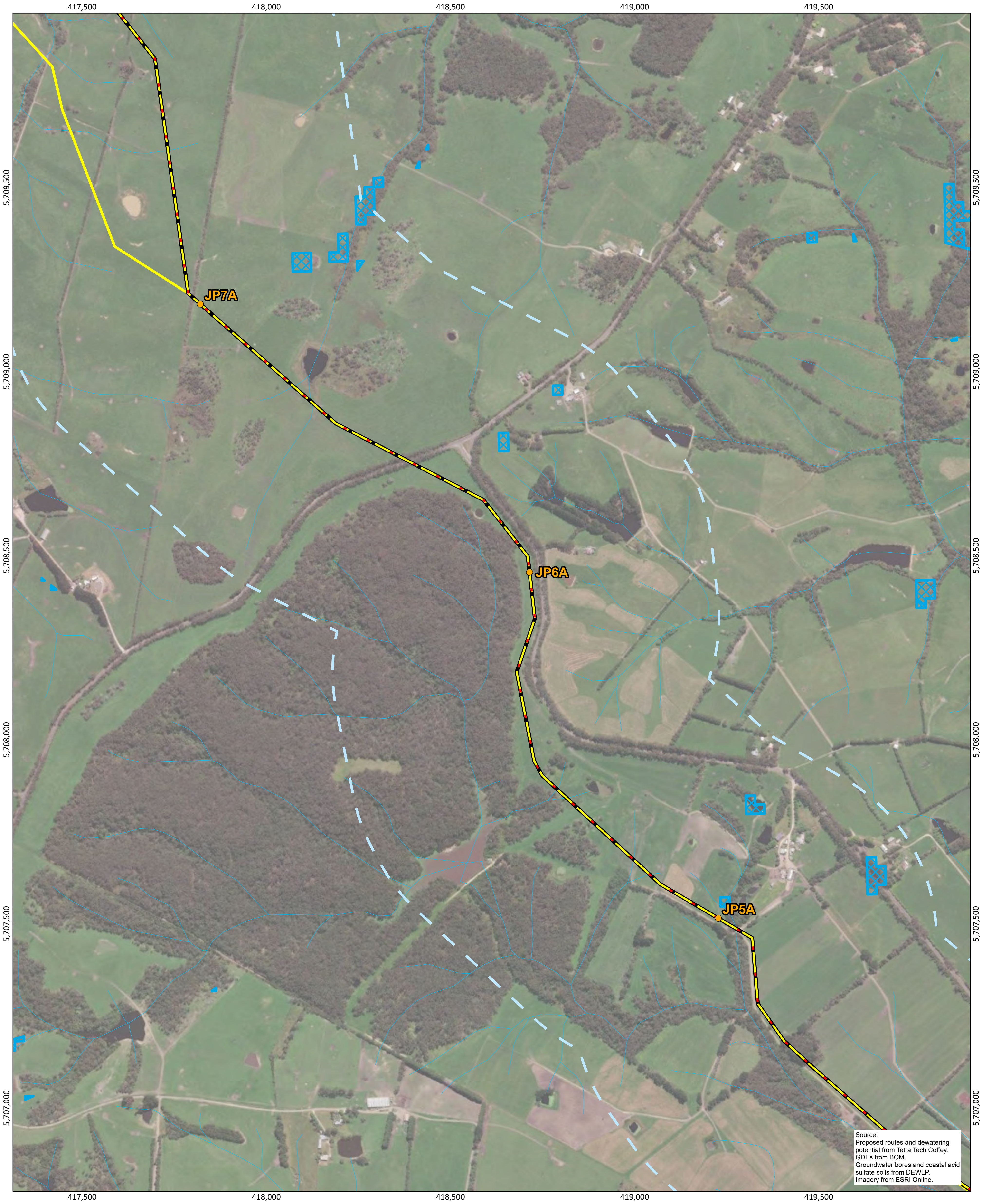

Figure 7.1 - Onshore area likely requiring dewatering (map 3 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable
- Minor watercourse

Terrestrial GDEs

- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

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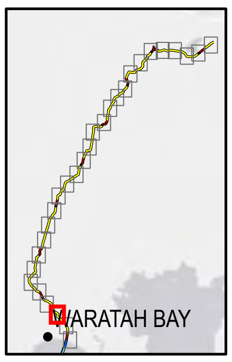

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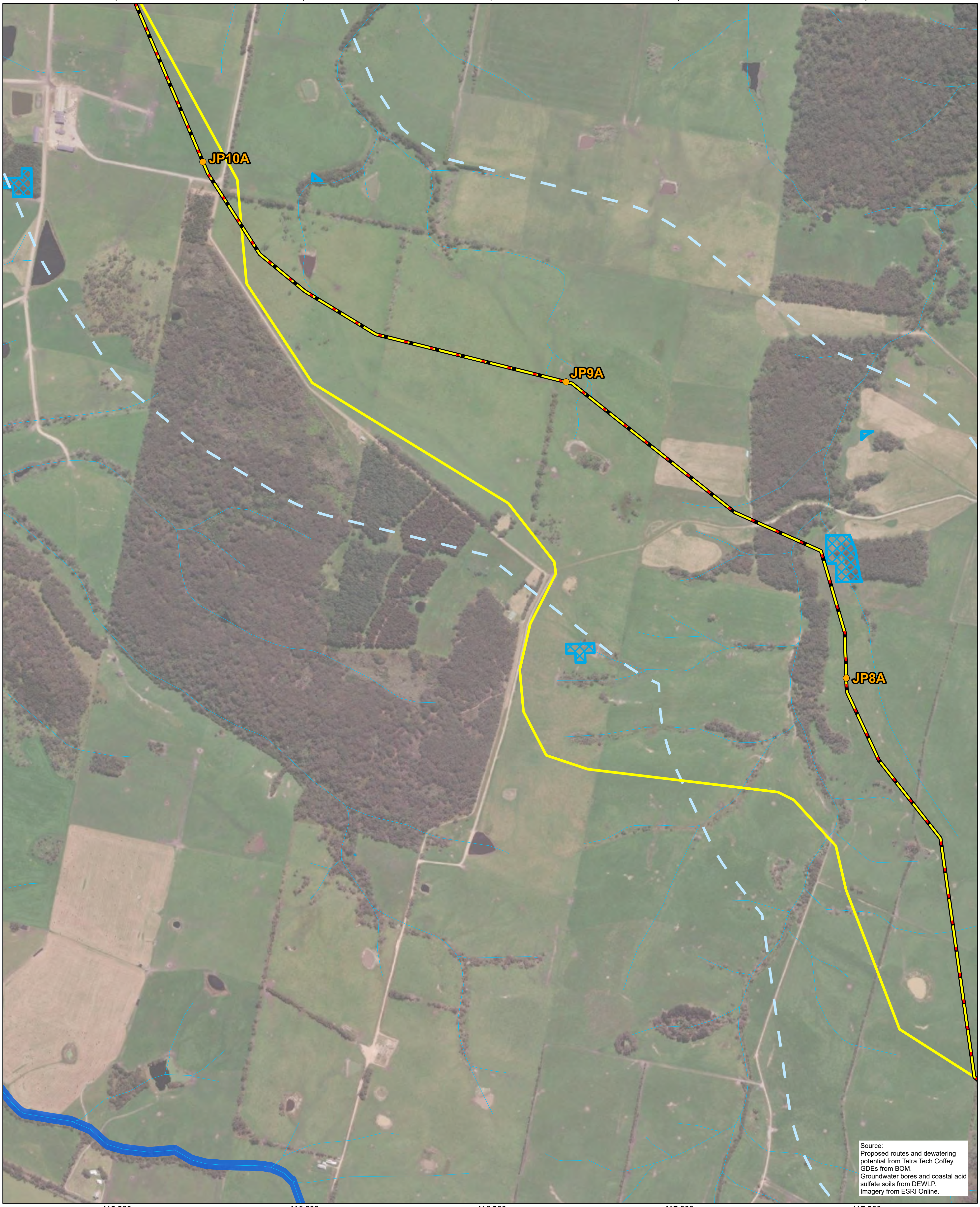

Figure 7.1 - Onshore area likely requiring dewatering (map 4 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable
- Minor watercourse

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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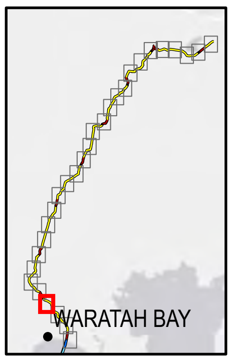

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Figure 7.1 - Onshore area likely requiring dewatering (map 5 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable
- Minor watercourse

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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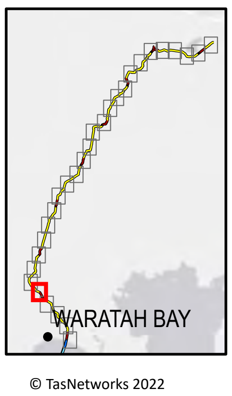

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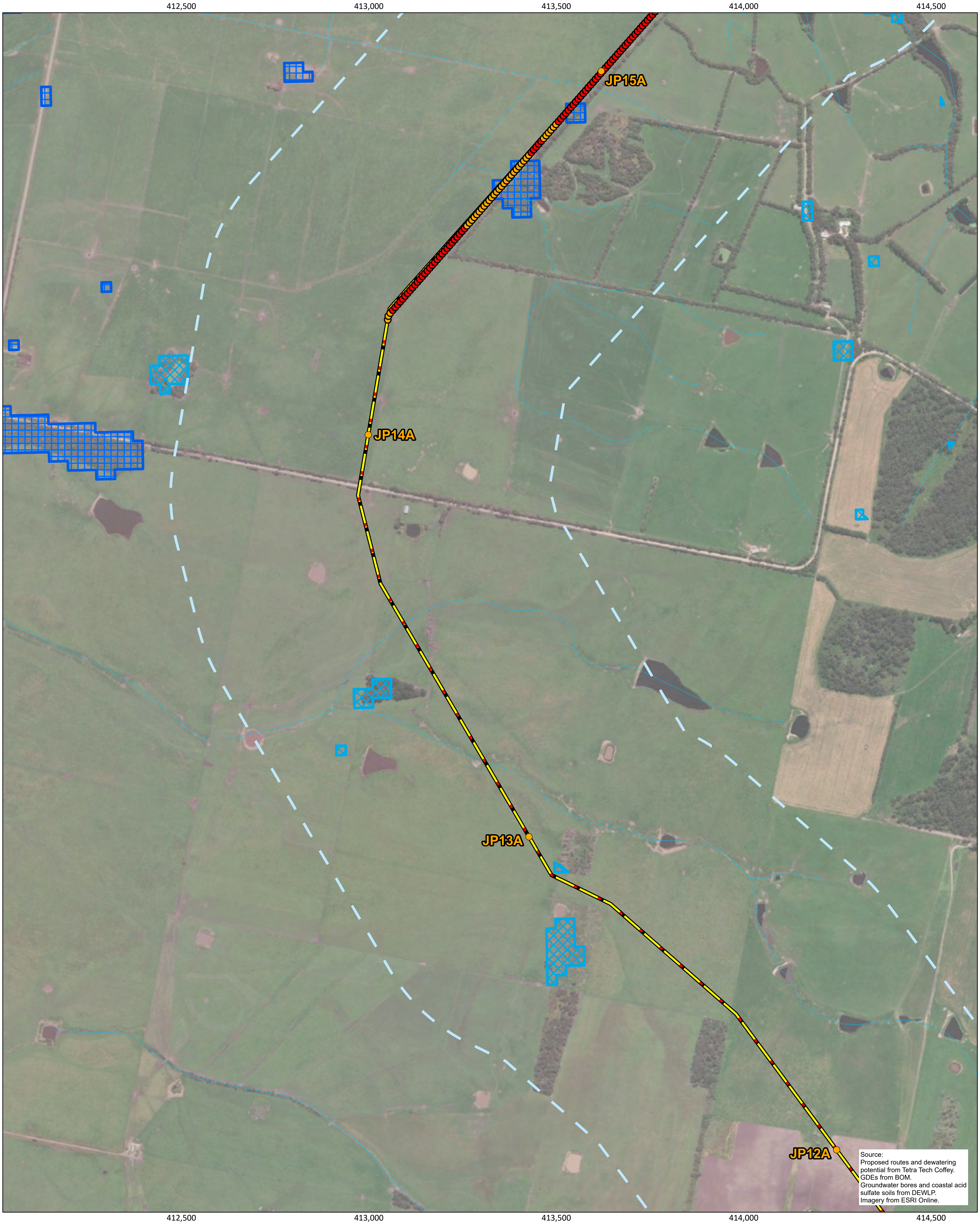

Figure 7.1 - Onshore area likely requiring dewatering (map 6 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable

Dewatering potential

- Amber = moderate likelihood
- Red = high likelihood
- Minor watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

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Coordinate System: GDA2020 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA2020

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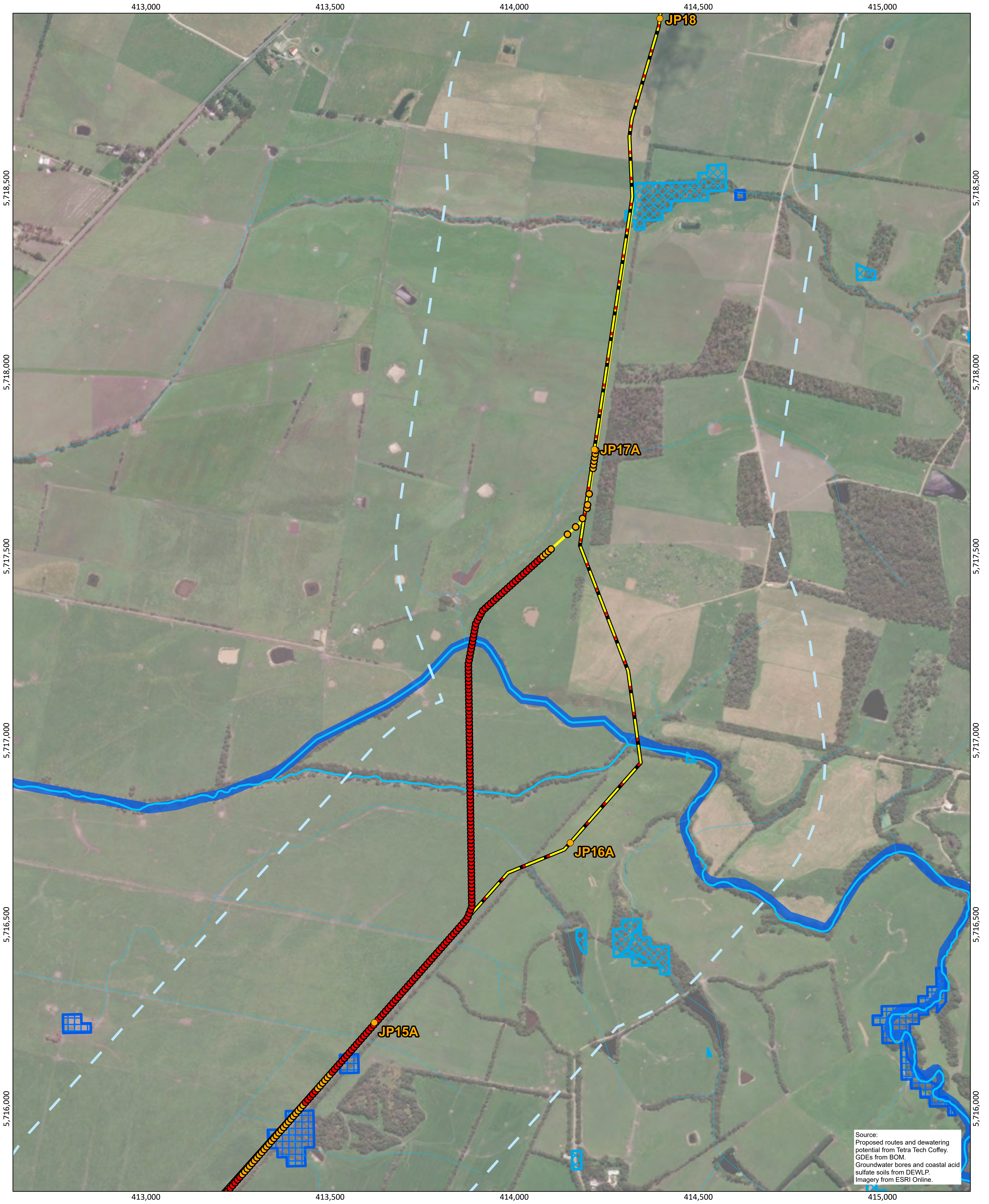

Figure 7.1 - Onshore area likely requiring dewatering (map 7 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable

Dewatering potential

- Amber = moderate likelihood
- Red = high likelihood
- Major watercourse
- Minor watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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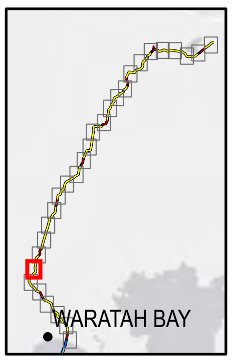

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Figure 7.1 - Onshore area likely requiring dewatering (map 8 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable
- Minor watercourse

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)
- Groundwater bores (within 500m, DELWP 16/08/2022)

N

Scale: 1:10,000

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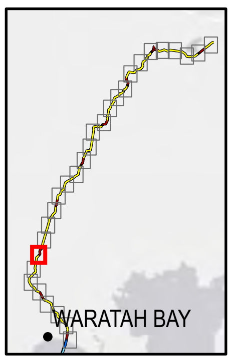

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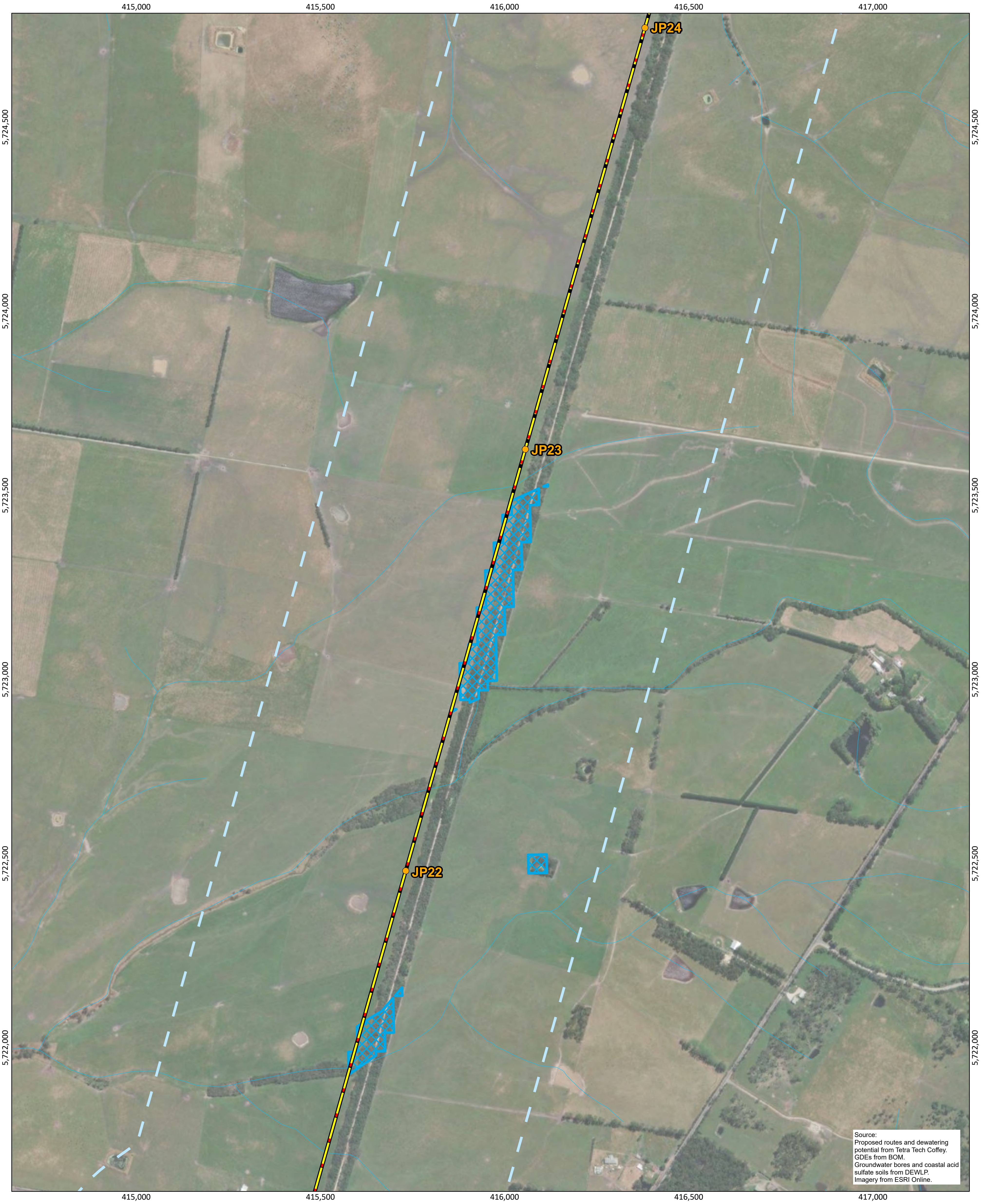

Figure 7.1 - Onshore area likely requiring dewatering (map 9 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable
- Minor watercourse

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Scale: 1:10,000

200 100 0 200 m

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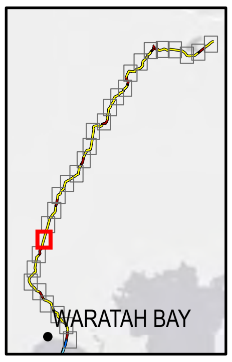

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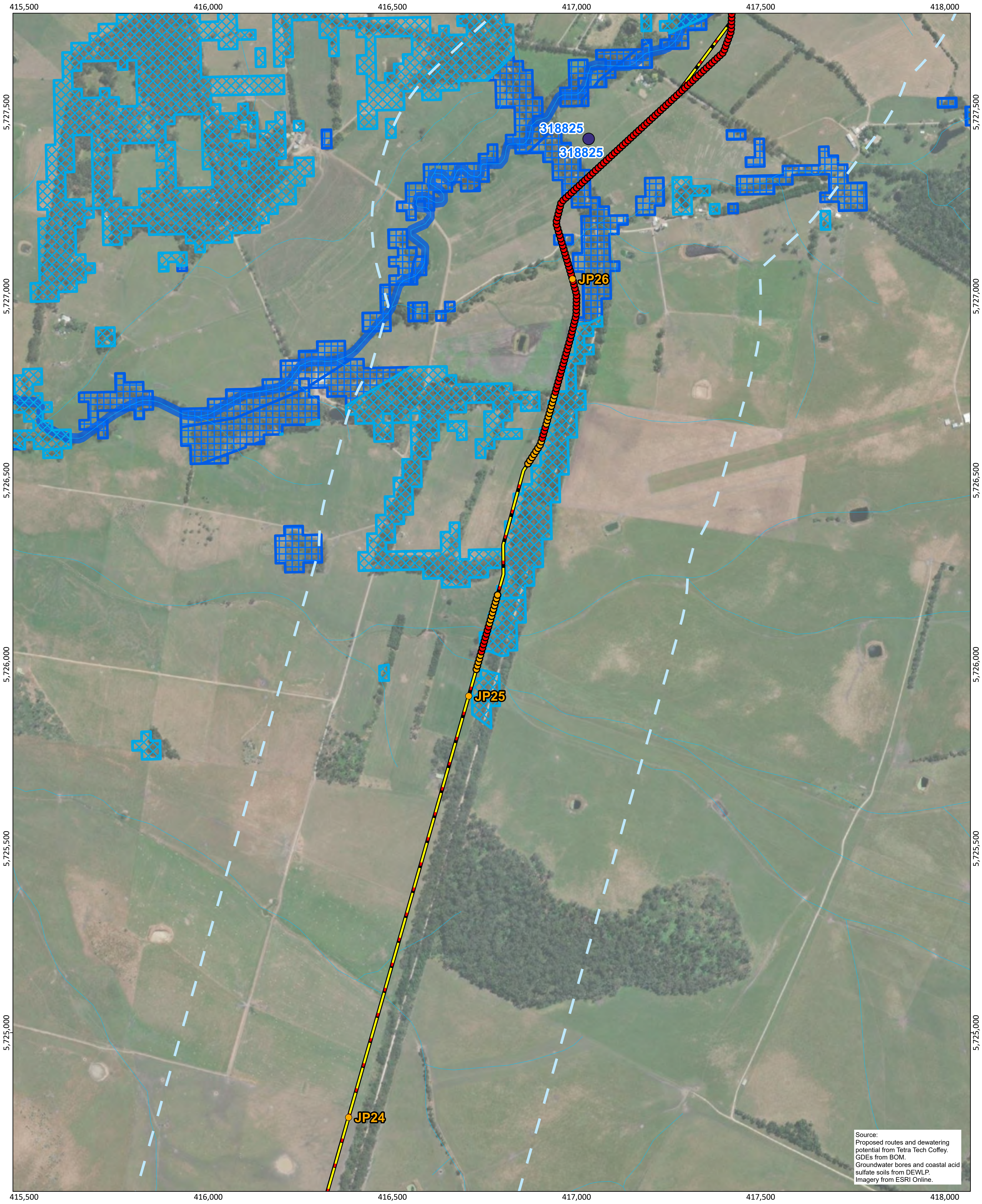

Figure 7.1 - Onshore area likely requiring dewatering (map 10 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable

Dewatering potential

- Amber = moderate likelihood
- Red = high likelihood
- Minor watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)
- Groundwater bores (within 500m, DELWP 16/08/2022)

N

Scale: 1:10,000

200 100 0 200 m

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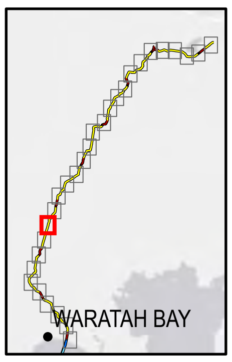

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Figure 7.1 - Onshore area likely requiring dewatering (map 11 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable

Dewatering potential

- Amber = moderate likelihood
- Red = high likelihood
- Minor watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)
- Groundwater bores (within 500m, DELWP 16/08/2022)

N

Scale: 1:10,000

200 100 0 200 m

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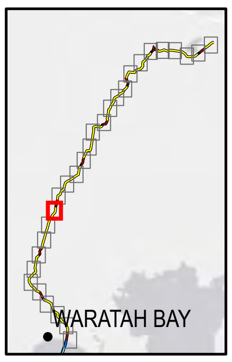

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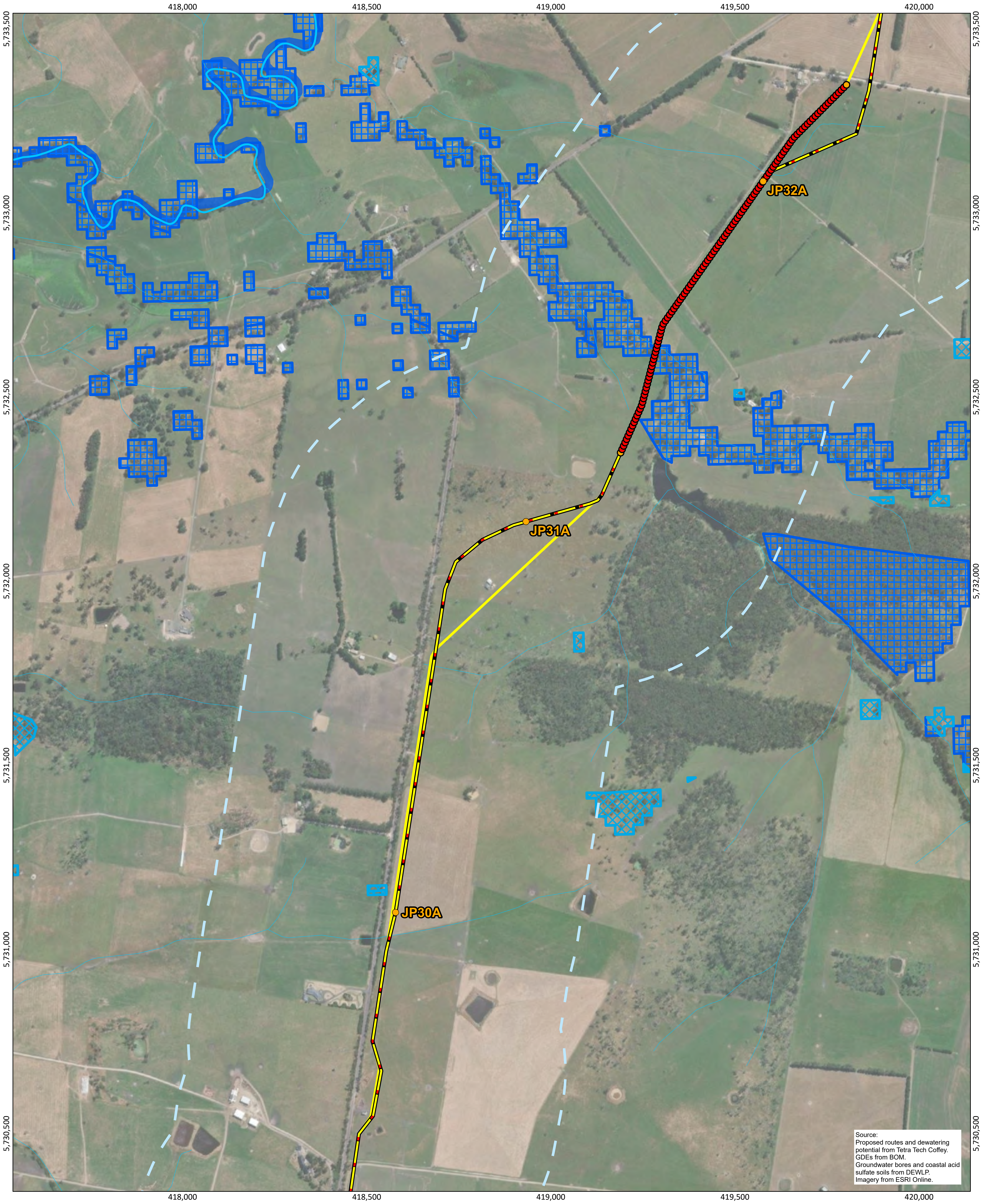

Figure 7.1 - Onshore area likely requiring dewatering (map 12 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable

Dewatering potential

- Amber = moderate likelihood
- Red = high likelihood
- Major watercourse
- Minor watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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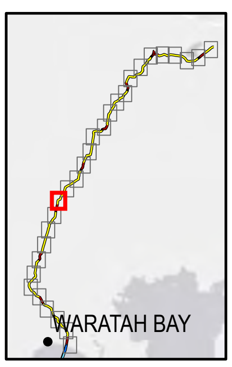

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Figure 7.1 - Onshore area likely requiring dewatering (map 13 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable

Dewatering potential

- Amber = moderate likelihood
- Red = high likelihood
- Major watercourse
- Minor watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)
- Groundwater bores (within 500m, DELWP 16/08/2022)

N

Scale: 1:10,000

200 100 0 200 m

Coordinate System: GDA2020 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA2020

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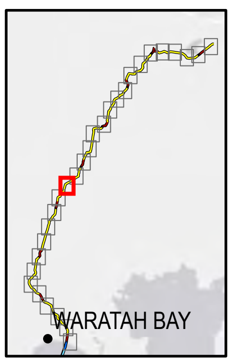

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Figure 7.1 - Onshore area likely requiring dewatering (map 14 of 29)

Legend

Underground HVDC cable
500 m buffer of route
Proposed route (2021)
Underground HVDC cable
Dewatering potential
Amber = moderate likelihood
Red = high likelihood
Major watercourse
Minor watercourse

Terrestrial GDEs
High potential GDE (national assessment)
Moderate potential GDE (national assessment)
Aquatic GDEs
High potential GDE (national assessment)
Groundwater bores (within 500m, DELWP 16/08/2022)

N

Scale: 1:10,000

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Coordinate System: GDA2020 MGA Zone 55
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Figure 7.1 - Onshore area likely requiring dewatering (map 15 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable

Dewatering potential

- Amber = moderate likelihood
- Red = high likelihood

- Major watercourse
- Minor watercourse

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

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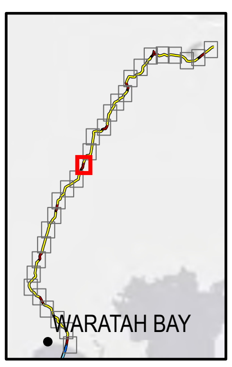

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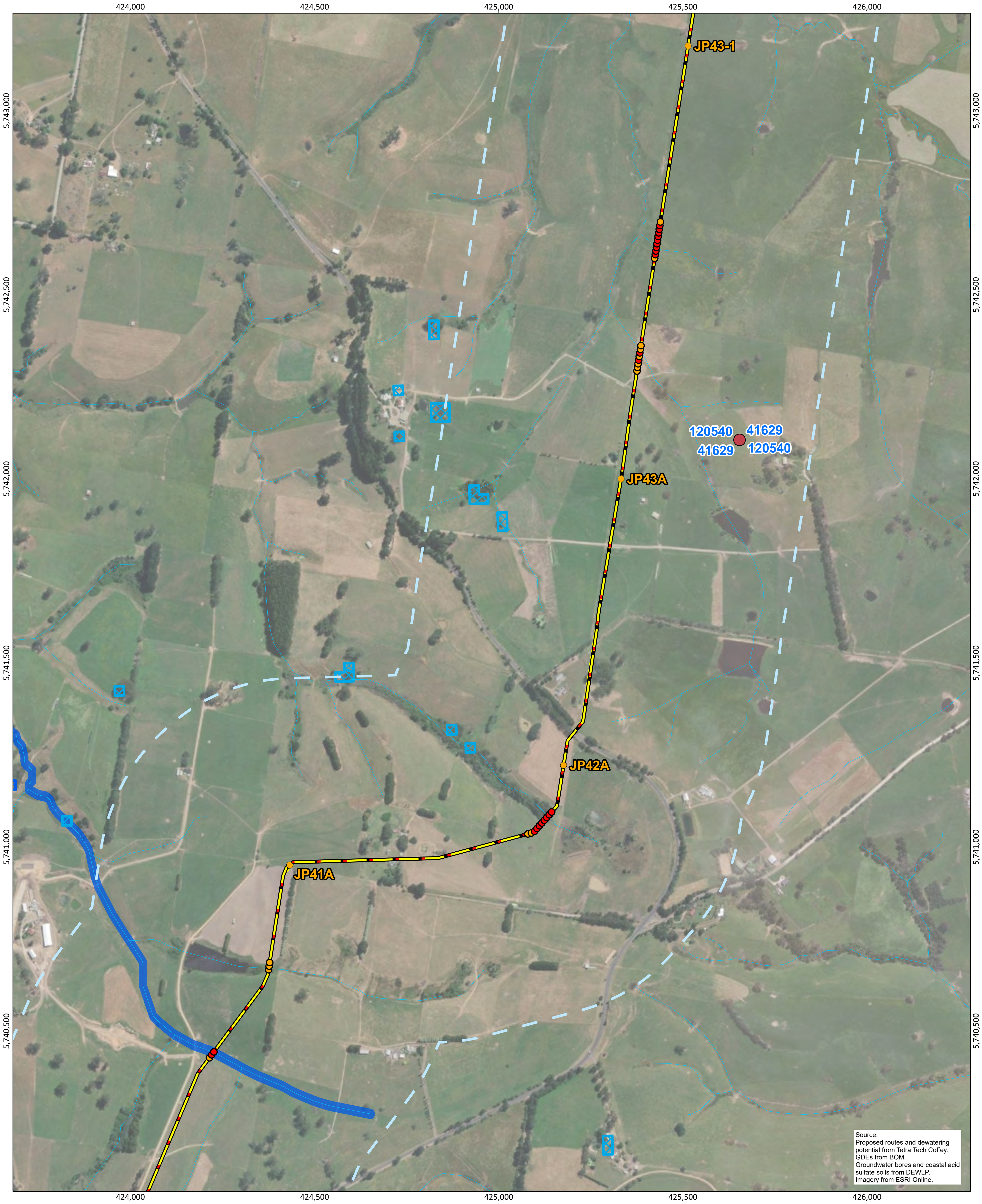

Figure 7.1 - Onshore area likely requiring dewatering (map 16 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable

Dewatering potential

- Amber = moderate likelihood
- Red = high likelihood
- Minor watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)
- Groundwater bores (within 500m, DELWP 16/08/2022)

N

Scale: 1:10,000

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Datum: GDA2020

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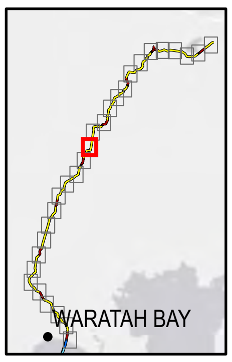

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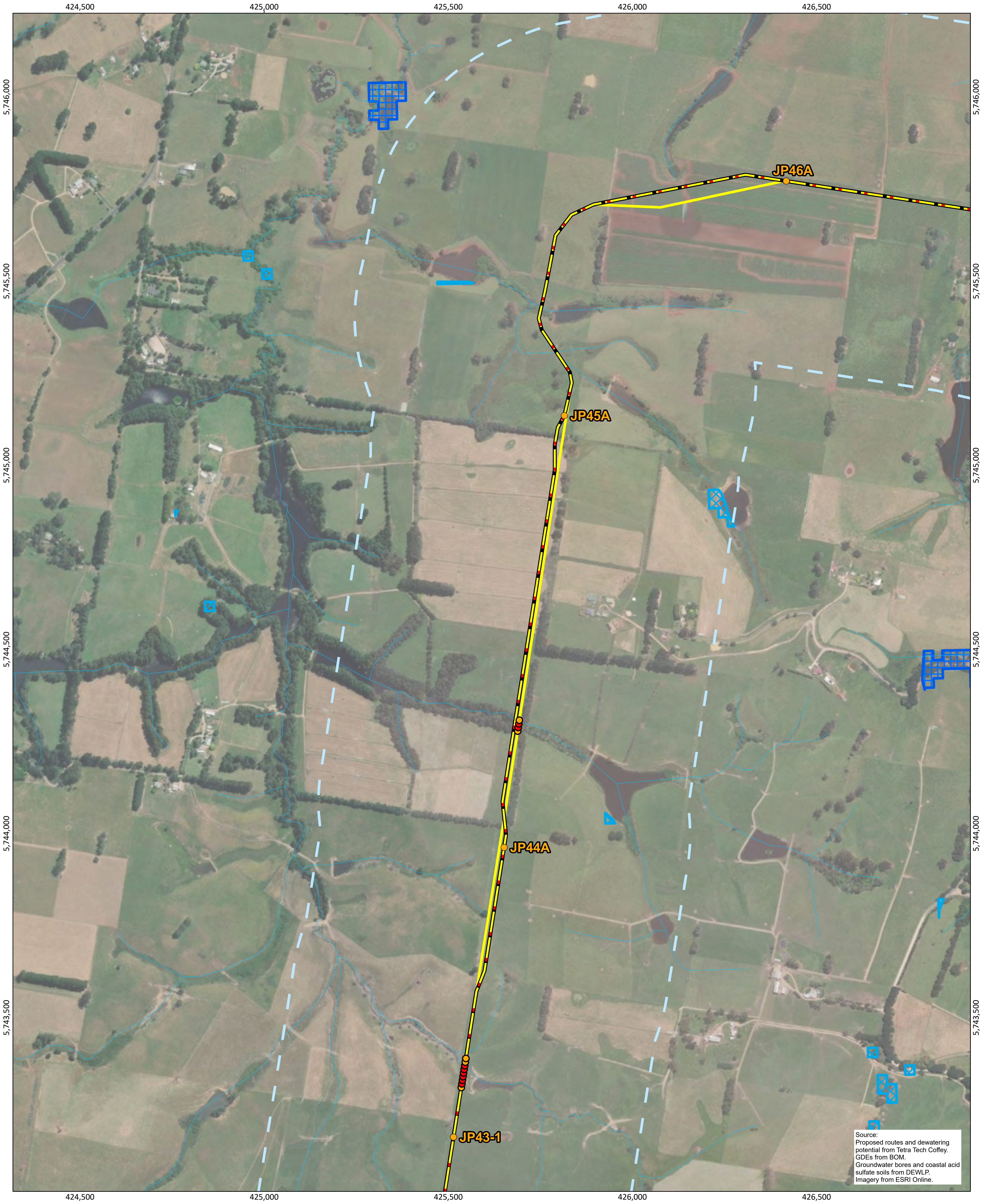

Figure 7.1 - Onshore area likely requiring dewatering (map 17 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable

Dewatering potential

- Amber = moderate likelihood
- Red = high likelihood
- Minor watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

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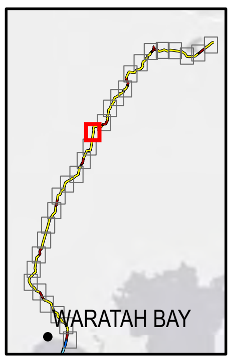

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Figure 7.1 - Onshore area likely requiring dewatering (map 18 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable

Dewatering potential

- Amber = moderate likelihood
- Red = high likelihood

- Minor watercourse

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

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Projection: Transverse Mercator
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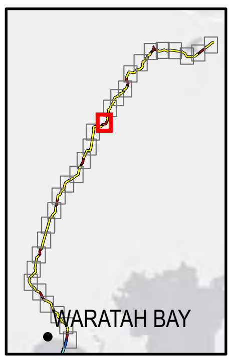

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Figure 7.1 - Onshore area likely requiring dewatering (map 19 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable
- Minor watercourse

Terrestrial GDEs

- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

Coordinate System: GDA2020 MGA Zone 55
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Datum: GDA2020

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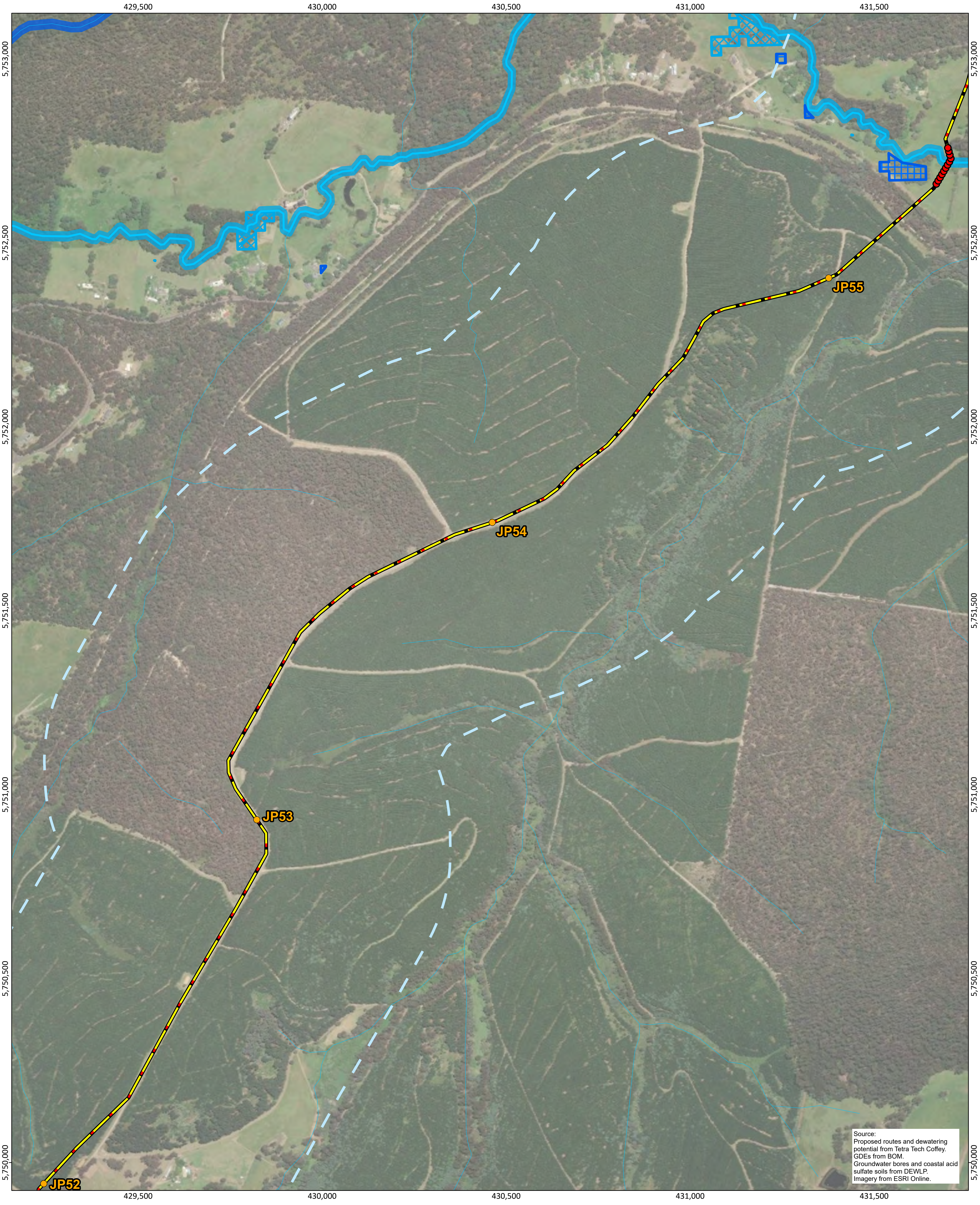

Figure 7.1 - Onshore area likely requiring dewatering (map 20 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable

Dewatering potential

- Red = high likelihood
- Major watercourse
- Minor watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

Coordinate System: GDA2020 MGA Zone 55
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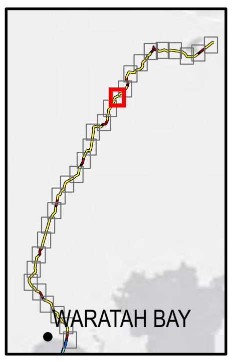

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Figure 7.1 - Onshore area likely requiring dewatering (map 21 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)
- Underground HVDC cable

Dewatering potential
- Red = high likelihood
- Major watercourse
- Minor watercourse

Terrestrial GDEs
- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs
- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)
- Groundwater bores (within 500m, DELWP 16/08/2022)

N

Scale: 1:10,000

200 100 0 200 m

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Figure 7.1 - Onshore area likely requiring dewatering (map 22 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable
- Minor watercourse

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)
- Groundwater bores (within 500m, DELWP 16/08/2022)

N

Scale: 1:10,000

200 100 0 200 m

Coordinate System: GDA2020 MGA Zone 55
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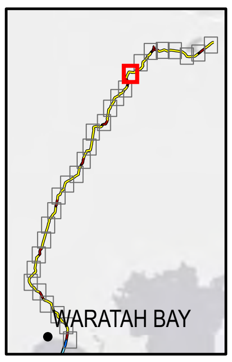

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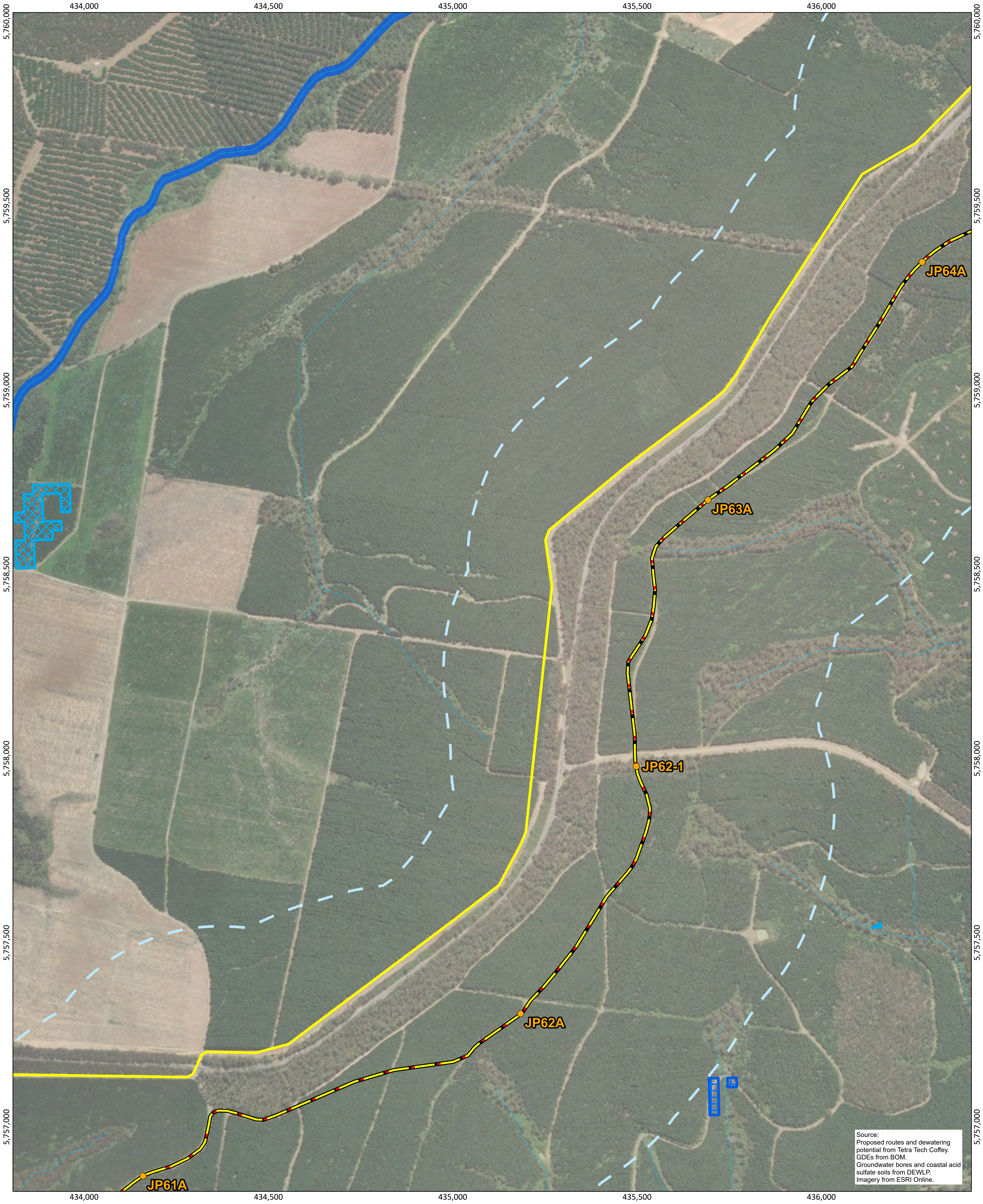

Figure 7.1 - Onshore area likely requiring dewatering (map 23 of 29)

Legend

Underground HVDC cable

500 m buffer of route

Proposed route (2021)

Underground HVDC cable

Minor watercourse

Terrestrial GDEs

High potential GDE (national assessment)

Moderate potential GDE (national assessment)

Aquatic GDEs

High potential GDE (national assessment)

N

Scale: 1:10,000

200 100 0 200 m

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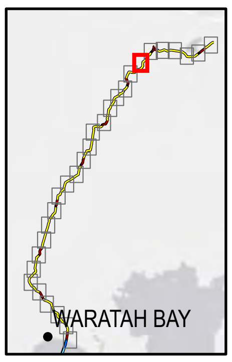

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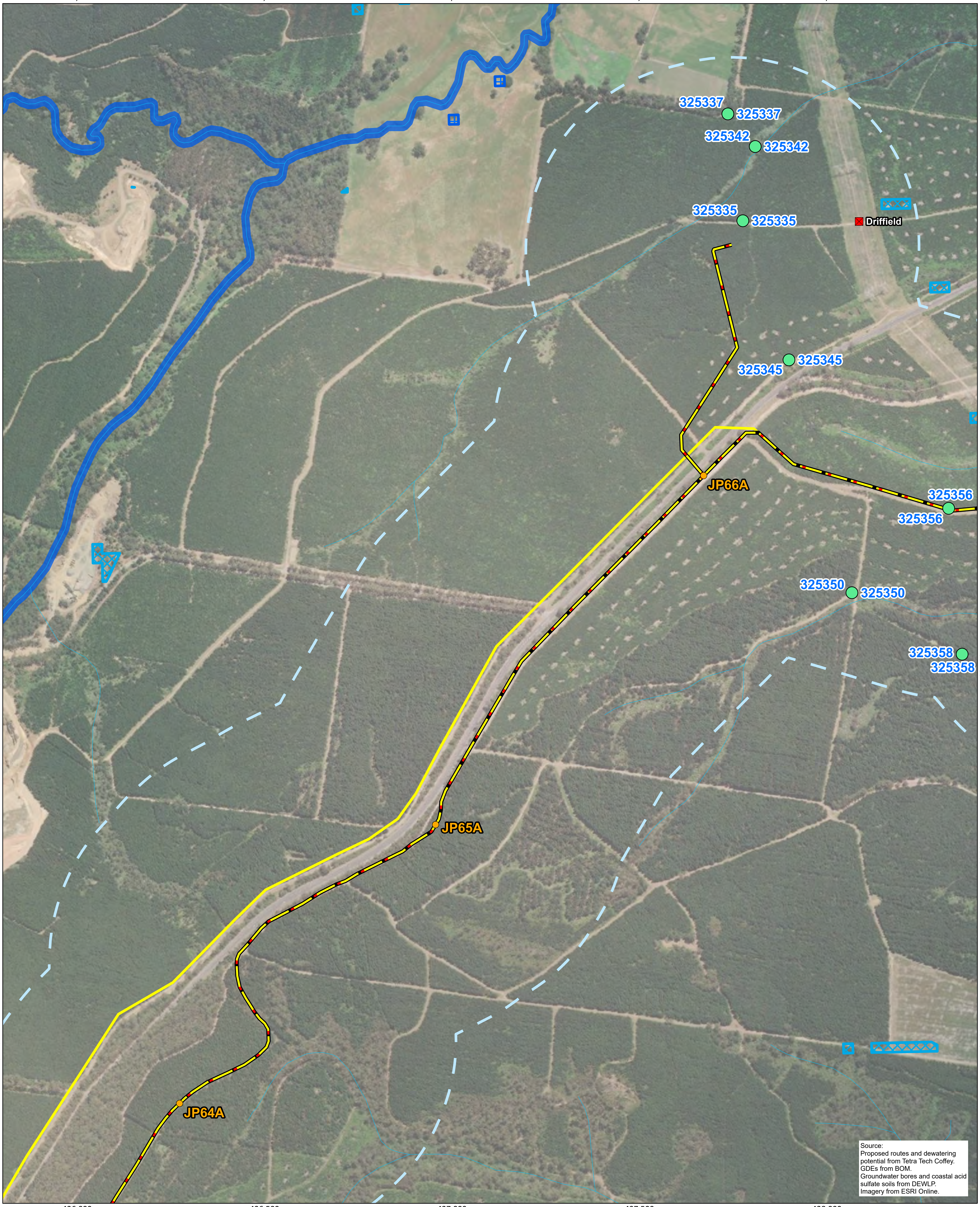

Figure 7.1 - Onshore area likely requiring dewatering (map 24 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable
- Proposed converter station
- Minor watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)
- Groundwater bores (within 500m, DELWP 16/08/2022)

N

Scale: 1:10,000

200 100 0 200 m

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Projection: Transverse Mercator
Datum: GDA2020

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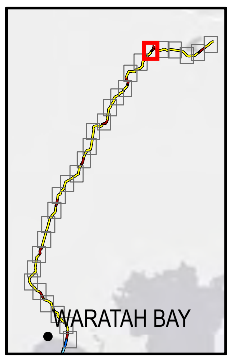

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Figure 7.1 - Onshore area likely requiring dewatering (map 25 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable
- Minor watercourse

Terrestrial GDEs

- Moderate potential GDE (national assessment)
- Groundwater bores (within 500m, DELWP 16/08/2022)

N

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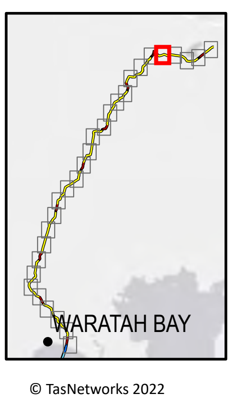

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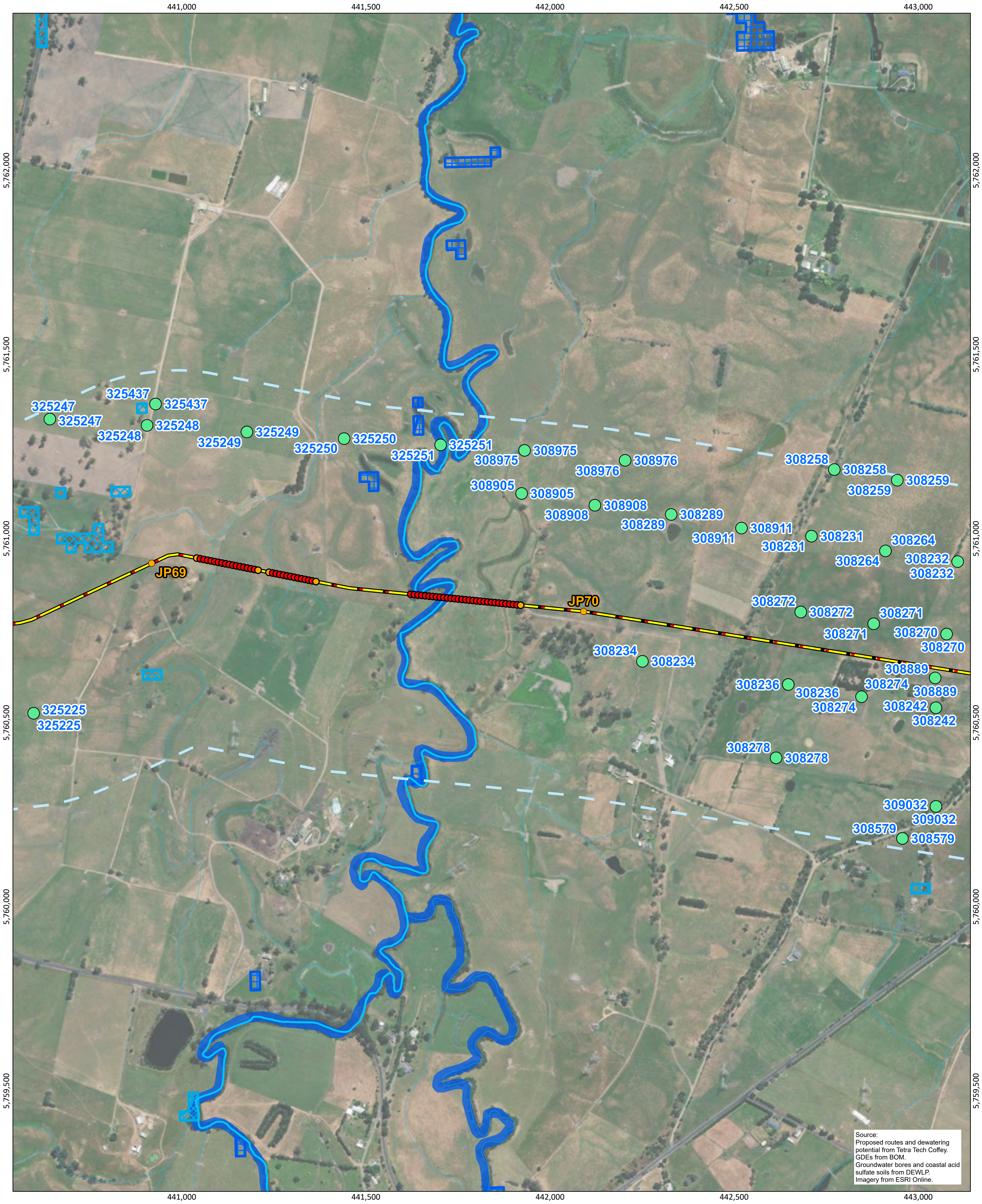

Figure 7.1 - Onshore area likely requiring dewatering (map 26 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)
- Underground HVDC cable

Dewatering potential
- Amber = moderate likelihood
- Red = high likelihood
- Major watercourse
- Minor watercourse

Terrestrial GDEs
- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs
- High potential GDE (national assessment)
- Groundwater bores (within 500m, DELWP 16/08/2022)

N

Scale: 1:10,000

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Coordinate System: GDA2020 MGA Zone 55
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Figure 7.1 - Onshore area likely requiring dewatering (map 27 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable
- Minor watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- High potential GDE (national assessment)
- Groundwater bores (within 500m, DELWP 16/08/2022)

N

Scale: 1:10,000

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Coordinate System: GDA2020 MGA Zone 55
Projection: Transverse Mercator
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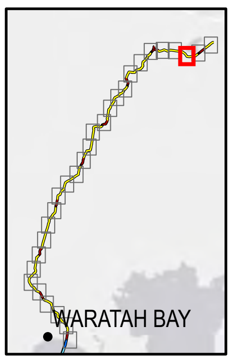

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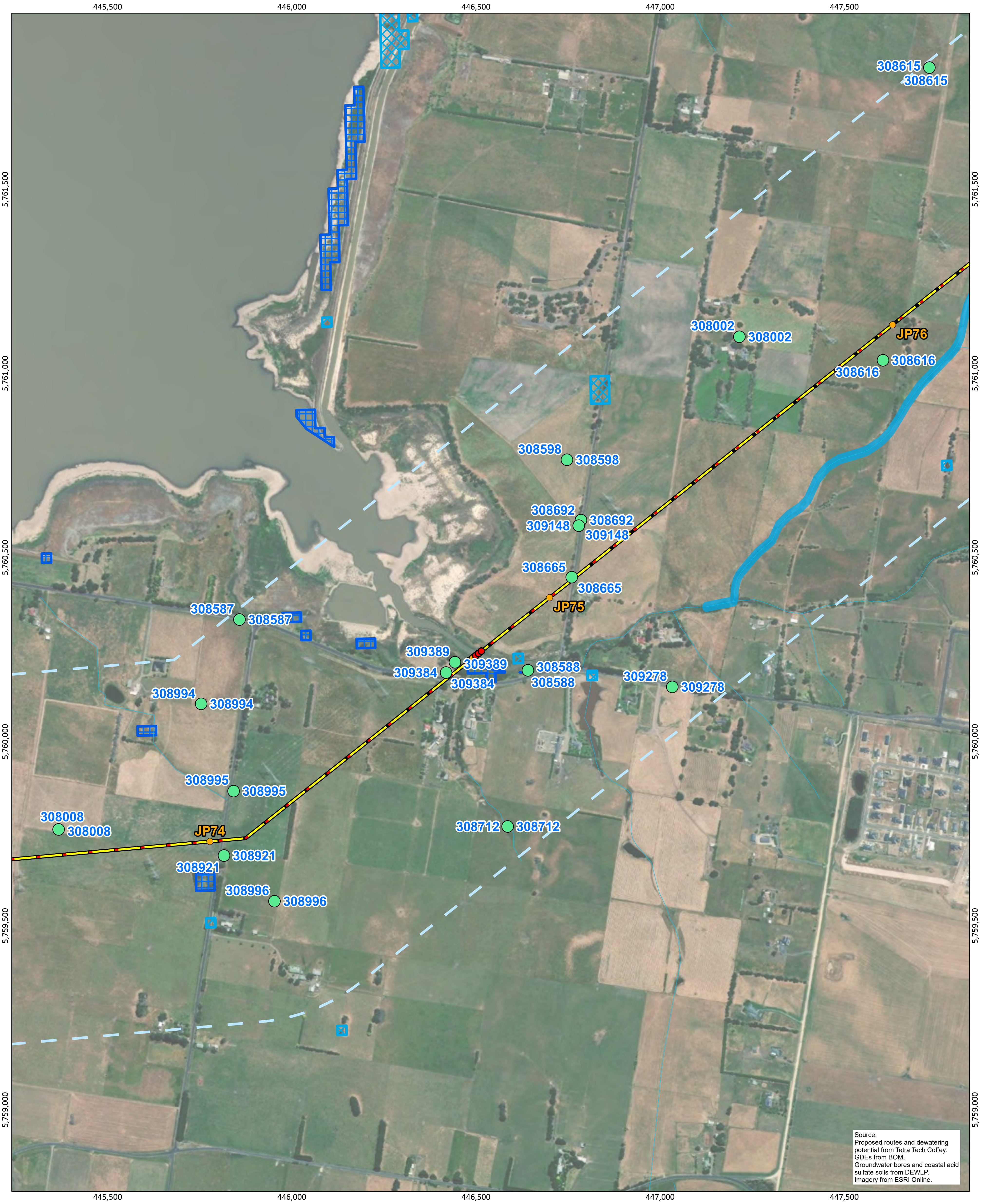

Figure 7.1 - Onshore area likely requiring dewatering (map 28 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable

Dewatering potential

- Amber = moderate likelihood
- Red = high likelihood
- Minor watercourse

Terrestrial GDEs

- High potential GDE (national assessment)
- Moderate potential GDE (national assessment)

Aquatic GDEs

- Moderate potential GDE (national assessment)
- Groundwater bores (within 500m, DELWP 16/08/2022)

N

Scale: 1:10,000

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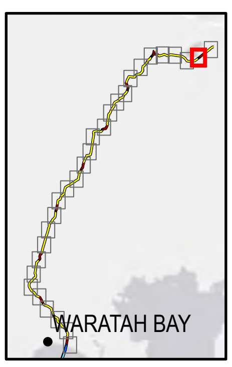

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Figure 7.1 - Onshore area likely requiring dewatering (map 29 of 29)

Legend

- Underground HVDC cable
- 500 m buffer of route

Proposed route (2021)

- Underground HVDC cable
- Proposed converter station
- Minor watercourse

Terrestrial GDEs

- Moderate potential GDE (national assessment)

Aquatic GDEs

- Moderate potential GDE (national assessment)
- Groundwater bores (within 500m, DELWP 16/08/2022)

N

Scale: 1:10,000

200 100 0 200 m

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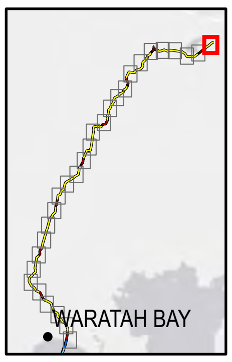

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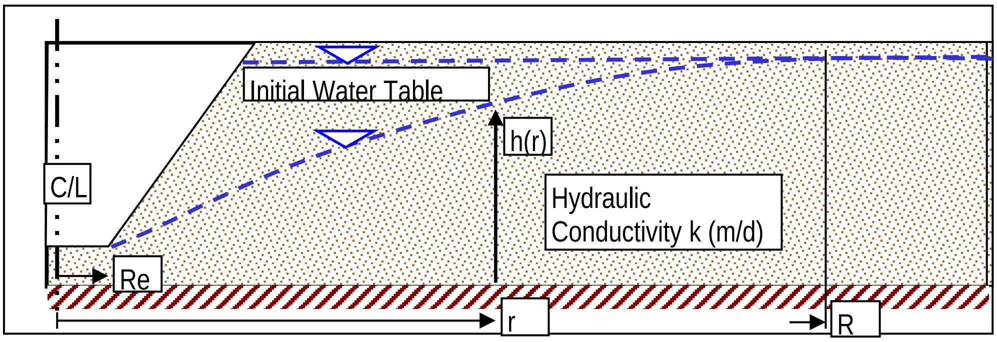
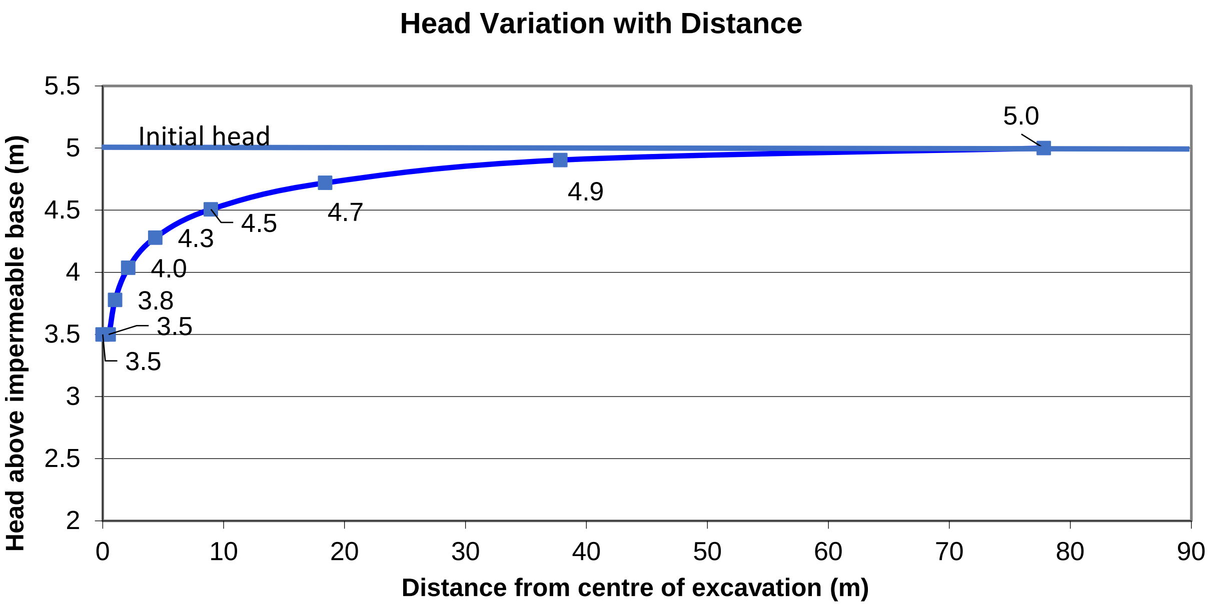
APPENDIX E - GROUNDWATER DRAWDOWN ANALYTICAL ESTIMATE



Input Parameters	
Radius of Excavation (m)	0.5
Hydraulic Conductivity (m/d)	6.5
Initial Saturated Thickness h(R) (m)	5
Sat Thickness in Excavation h(Re) (m	3.5
Infiltration Rate (m/d)	0.00301

Calculated Parameters	
Radius of Influence (m)	78
Long term Inflow (m3/d)	57.252
Long term Inflow (L/s)	0.663



Assessment of inflow rate and drawdwon profile for long term inflow to an excavation within an extensive unsaturated aquifer under uniform infiltration

Reference: JH Edelman 'Groundwater Hydraulics of Extensive Aquifers', International Institute for Land Reclaimation and Improvement, Wageningen, 1972

drawn	JHS	TETRA TECH COFFEY	client:	
approved	-		project:	**Marinus Link Project**
date	19/08/2022			
scale	N/A		title:	Onshore cable trench drawdown estimate - alluvium
original	A4		project no: **754-MELEN215878ML**	figure no:

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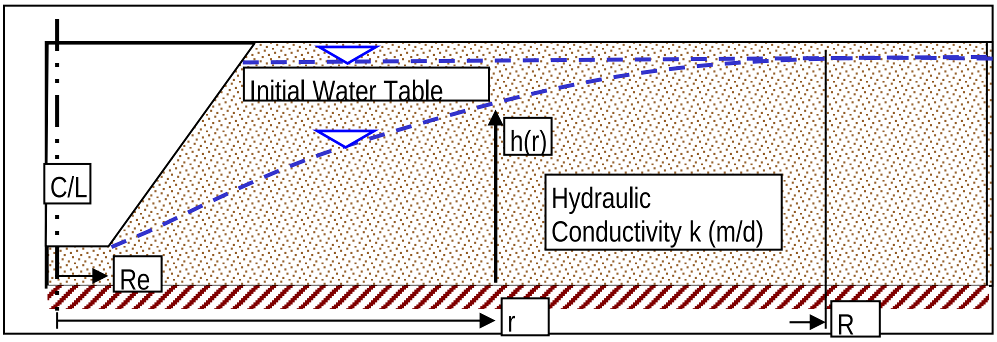
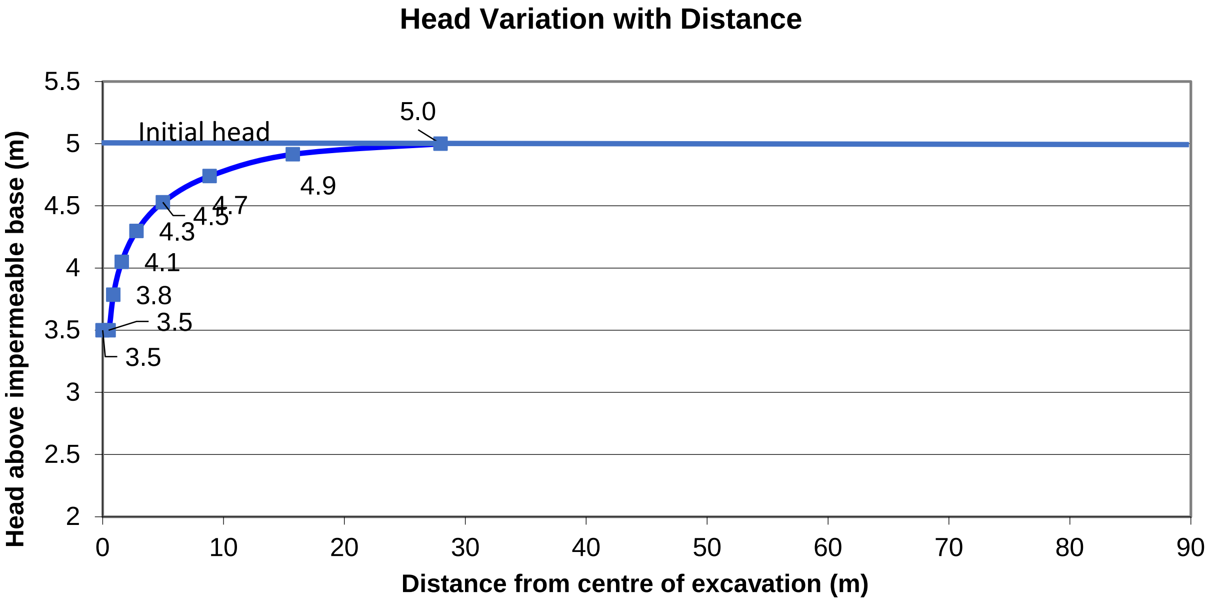


Input Parameters	
Radius of Excavation (m)	0.5
Hydraulic Conductivity (m/d)	0.65
Initial Saturated Thickness h(R) (m)	5
Sat Thickness in Excavation h(Re) (m	3.5
Infiltration Rate (m/d)	0.00301

Calculated Parameters	
Radius of Influence (m)	28
Long term Inflow (m3/d)	7.386
Long term Inflow (L/s)	0.085



Assessment of inflow rate and drawdwon profile for long term inflow to an excavation within an extensive unsaturated aquifer under uniform infiltration

Reference: JH Edelman 'Groundwater Hydraulics of Extensive Aquifers', International Institute for Land Reclaimation and Improvement, Wageningen, 1972

drawn	JHS	client:
approved	-	project: **Marinus Link Project**
date	19/08/2022	
scale	N/A	title: Onshore cable trench drawdown estimate - Bedrock
original	A4	project no: **754-MELEN215878ML** figure no:

TETRA TECH COFFEY

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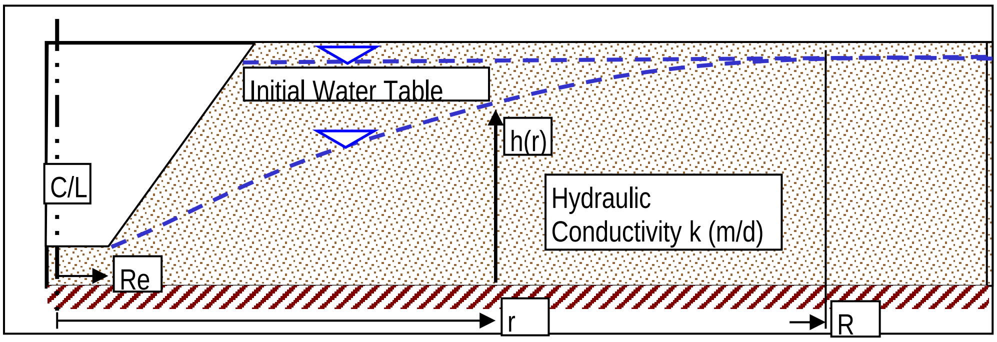
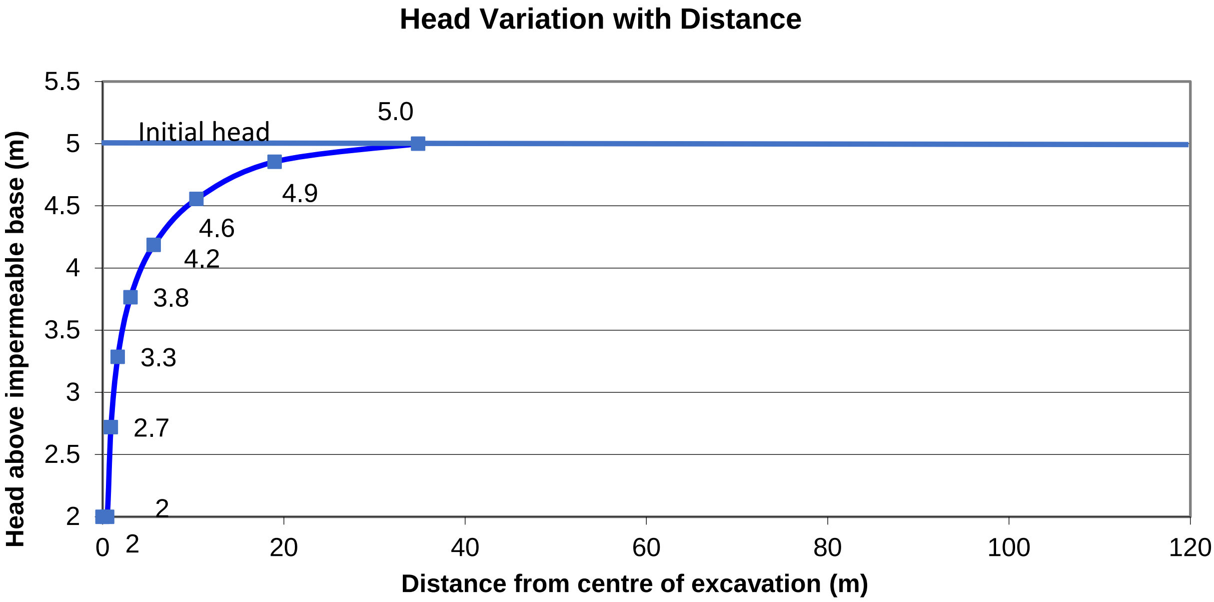


Input Parameters	
Radius of Excavation (m)	0.5
Hydraulic Conductivity (m/d)	0.65
Initial Saturated Thickness h(R) (m)	5
Sat Thickness in Excavation h(Re) (m	2
Infiltration Rate (m/d)	0.00301

Calculated Parameters	
Radius of Influence (m)	35
Long term Inflow (m3/d)	11.454
Long term Inflow (L/s)	0.133



Assessment of inflow rate and drawdwon profile for long term inflow to an excavation within an extensive unsaturated aquifer under uniform infiltration

Reference: JH Edelman 'Groundwater Hydraulics of Extensive Aquifers', International Institute for Land Reclaimation and Improvement, Wageningen, 1972

drawn	JHS	TETRA TECH COFFEY	client:
approved	-		project: **Marinus Link Project**
date	19/08/2022		
scale	N/A		title: Onshore cable junction pit drawdown estimate - Bedrock
original	A4		project no: **754-MELEN215878ML** figure no:

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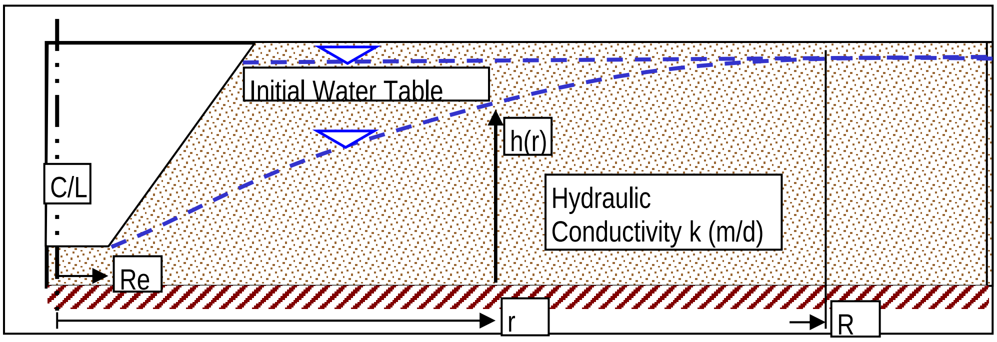
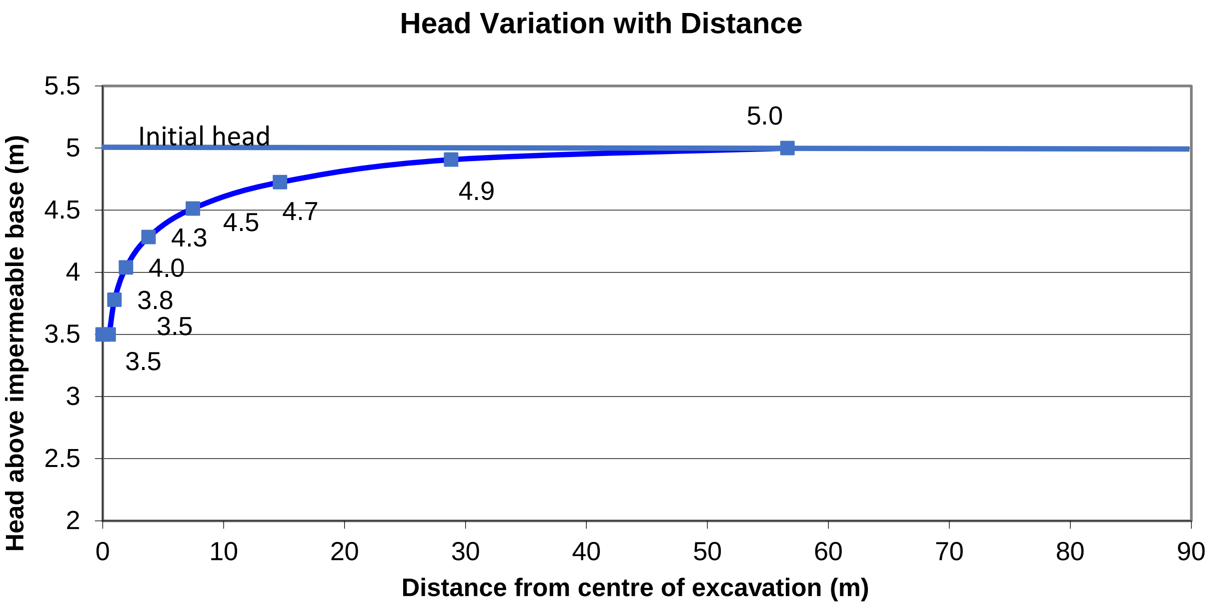


Input Parameters	
Radius of Excavation (m)	0.5
Hydraulic Conductivity (m/d)	3.2
Initial Saturated Thickness h(R) (m)	5
Sat Thickness in Excavation h(Re) (m	3.5
Infiltration Rate (m/d)	0.00301

Calculated Parameters	
Radius of Influence (m)	57
Long term Inflow (m3/d)	30.304
Long term Inflow (L/s)	0.351



Assessment of inflow rate and drawdwon profile for long term inflow to an excavation within an extensive unsaturated aquifer under uniform infiltration

Reference: JH Edelman 'Groundwater Hydraulics of Extensive Aquifers', International Institute for Land Reclaimation and Improvement, Wageningen, 1972

drawn	JHS	client:	
approved	-	project:	**Marinus Link Project**
date	19/08/2022		
scale	N/A	title:	Onshore cable trench drawdown estimate - Haunted Hill
original	A4	project no: **754-MELEN215878ML**	figure no:

TETRA TECH COFFEY

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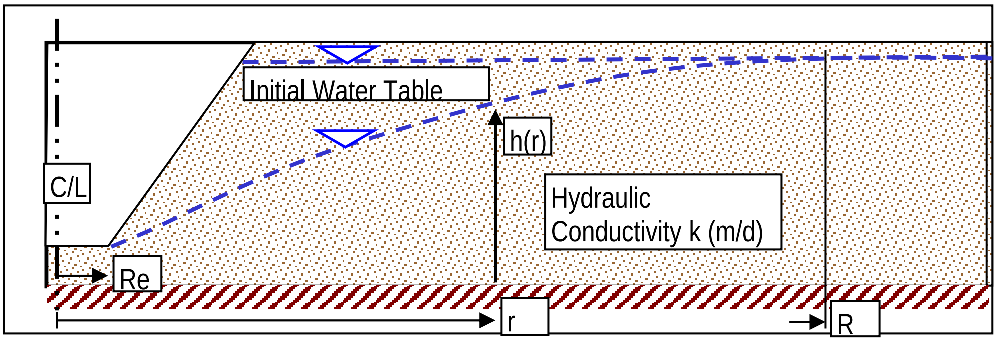
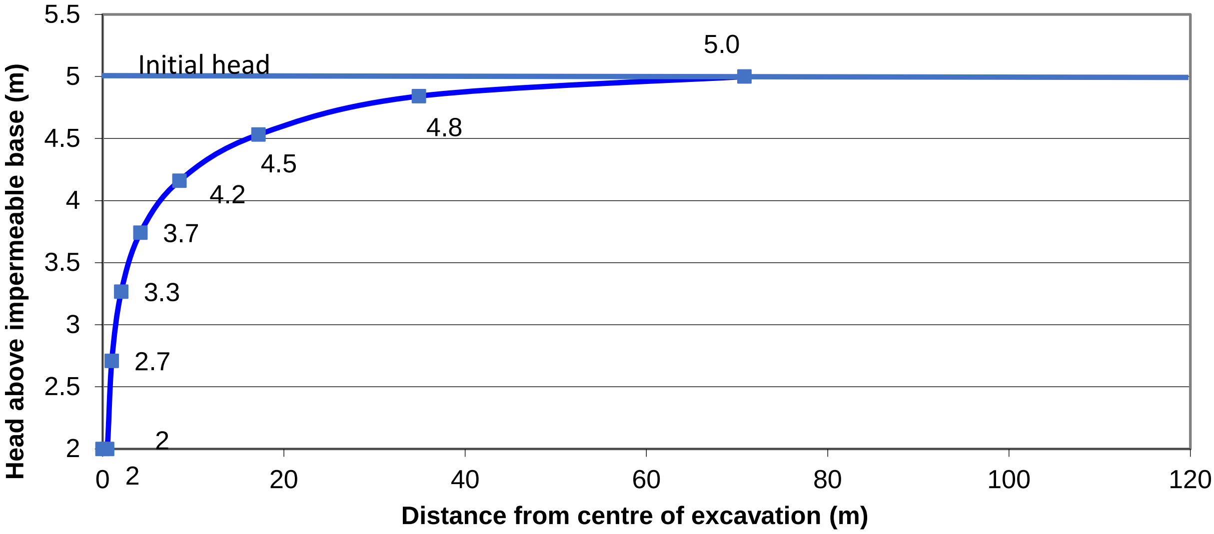


Input Parameters	
Radius of Excavation (m)	0.5
Hydraulic Conductivity (m/d)	3.2
Initial Saturated Thickness h(R) (m)	5
Sat Thickness in Excavation h(Re) (m	2
Infiltration Rate (m/d)	0.00301

Calculated Parameters	
Radius of Influence (m)	71
Long term Inflow (m3/d)	47.406
Long term Inflow (L/s)	0.549



Assessment of inflow rate and drawdwon profile for long term inflow to an excavation within an extensive unsaturated aquifer under uniform infiltration

Reference: JH Edelman 'Groundwater Hydraulics of Extensive Aquifers', International Institute for Land Reclaimation and Improvement, Wageningen, 1972

drawn	JHS	TETRA TECH COFFEY	client:	
approved	-		project:	**Marinus Link Project**
date	19/08/2022			
scale	N/A		title:	Onshore cable junction pit drawdown estimate - Haunted Hill
original	A4		project no: **754-MELEN215878ML**	figure no:

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