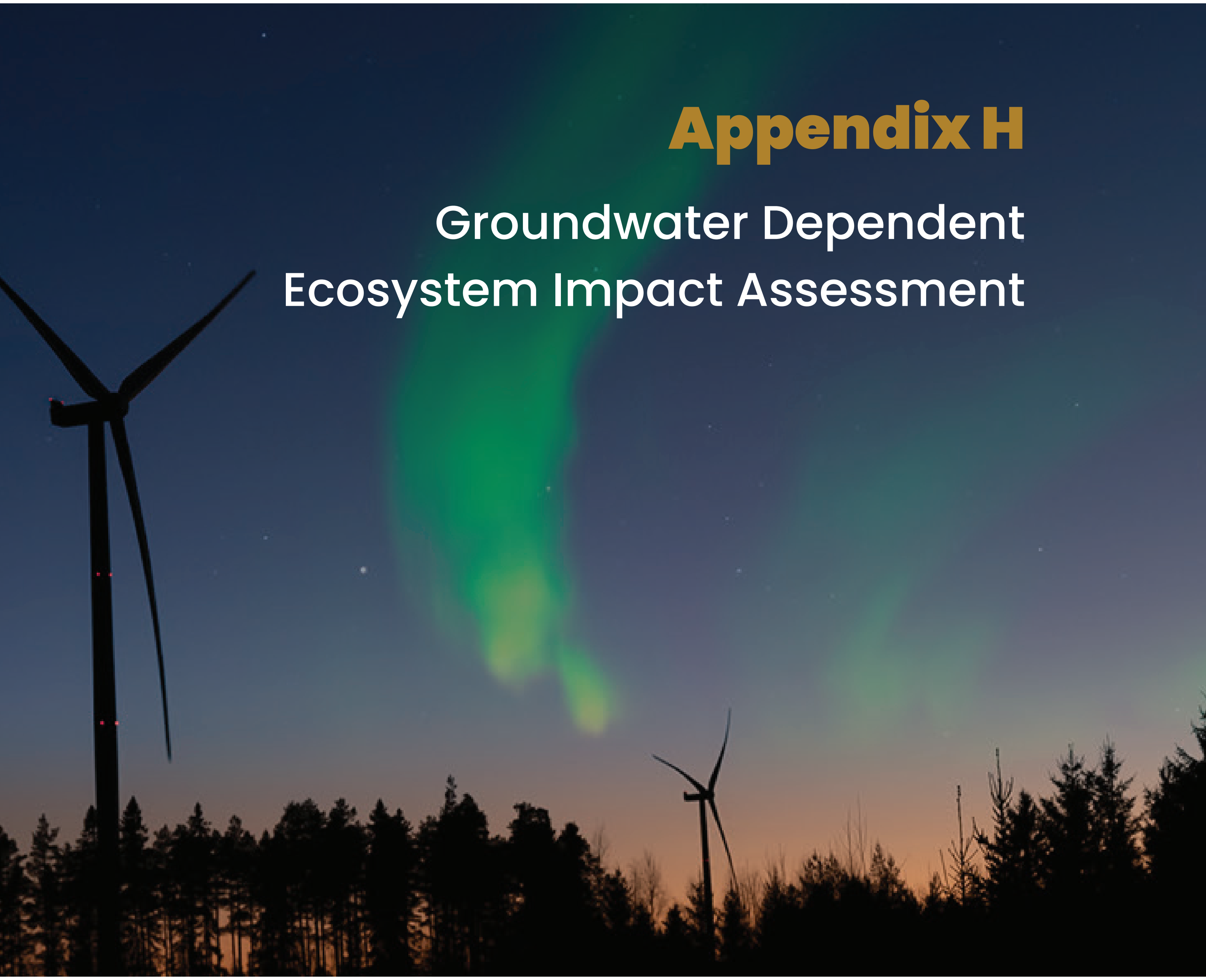

Appendix H

Groundwater Dependent Ecosystem Impact Assessment

KENTBRUCK GREEN POWER HUB

Neoen Australia Pty Ltd

Kentbruck Green Power Hub EES Technical Report Groundwater Dependent Ecosystem Impact Assessment

8 October 2024

Rev 5

Executive Summary

Overview

The Kentbruck Green Power Hub ('the Project') is a proposed renewable energy development comprised of wind turbines, associated infrastructure, transmission lines, quarry and groundwater supply. The Project is situated in southwest Victoria, approximately 25 kilometres (km) northwest of Portland and 3 km east of Nelson.

On 25 August 2019, the Minister for Planning determined that an EES is required for the Project pursuant to the EE Act due to the potential for significant environmental effects. The EES enables decision makers to understand the likely environmental impacts of the project and how they are proposed to be managed. The project is being assessed under the bilateral agreement between the Commonwealth and Victorian Governments, which allows the project and potential impacts on MNES to be assessed under the Victorian EES process.

The purpose of this Groundwater Dependent Ecosystem (GDE) Impact Assessment is to assess the potential impact the Project could have on GDEs to inform the preparation of an Environment Effects Statement (EES) required for the Project. This report documents the potential effects of the project that have the potential to impacts GDEs during construction and operation of the Project.

This report has been compiled using existing information and data, including the results of the Groundwater Impacts Assessment (AECOM, 2024a), Environmental Site Investigation (AECOM, 2023), Surface Water Impact Assessment (AECOM, 2024b), and Flora and Fauna Existing Conditions and Impact Assessment (Biosis, 2023).

Existing Environment

Groundwater dependent ecosystems (GDEs) are ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services (Richardson et al., 2011). GDEs can be impacted via physical disruption and changes to the surface water regime, but the primary impact mechanism is via changes to the groundwater regime, both quantity and quality, and this is the primary focus of this assessment.

Terrestrial and Aquatic GDEs exist across the Project Area. The GDEs assessed in this report include:

- Subterranean GDEs and Stygofauna – Geological studies in the area suggest karstic conditions (that could support subterranean GDEs) are not widespread. Based on the limited information, it has been assumed that conditions that could support subterranean GDEs exist in the Port Campbell Limestone. Although no stygofauna have been identified in the Project Area, the geological setting of limestone and sand aquifers suggests conditions in which stygofauna could exist and therefore it is assumed that stygofauna could be present in the Project Area.
- Terrestrial GDEs – The GDE Atlas (BOM, 2022) has identified low to high potential terrestrial GDEs exist across the Project Area associated with:
  - In the plantation sub area terrestrial GDEs are primarily associated with Coastal Alkaline Scrub (Long Swamp Complex and Beach/Dune System, part of the Glenelg Estuary and Discovery Bay Ramsar site along the southwestern boundary), Damp Sands Herb-rich Woodland (Plantations and Farmland) and Damp Sands Herb-rich Woodland/Damp Heathland/Damp Heathy Woodland Mosaic (Lower Glenelg National Park) on parallel dune limestone ridges with intervening swamps and closed karst depressions and young volcanoes in the southeast.
  - In the northeastern sub area terrestrial GDEs are primarily associated with Wet Heathland/Heathy Woodland Mosaic, mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks.

  - In the transmission line sub area terrestrial GDEs are primarily associated with Lowland Forest, mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks.

- Aquatic GDEs – The GDE Atlas (BOM, 2022) has identified low to high potential terrestrial GDEs exist across the Project Area associated with:
  - In the plantation sub area aquatic GDEs are primarily associated with palustrine and lacustrine wetlands, temporary freshwater swamps, marshes and meadows on parallel dune limestone ridges with intervening swamps and closed karst depressions and young volcanoes in southeast. Aquatic GDEs are mostly confined to the Long Swamp Complex and Beach/Dune System (part of the Glenelg Estuary and Discovery Bay Ramsar site) along the southwestern boundary, however small portions are mapped within the plantations.
  - In the northeastern sub area aquatic GDEs are primarily associated with palustrine or lacustrine wetlands, mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks.
  - In the transmission line sub area aquatic GDEs are primarily associated with palustrine wetlands and temporary freshwater marshes and meadows, mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks. The Surrey River is also identified as a high potential GDE.
  - The Karst Springs and Associated Alkaline Fens of the Naracoorte Coastal Plain Bioregion TEC was listed as Endangered under the EPBC Act on 15 December 2020. Within the Investigation Area, known occurrences include Lake Mombeong, which also forms part of the Glenelg Estuary and Discovery Bay Ramsar site.

Potential Impacts

A source pathway receptor model has identified the following potentially complete pathway linkages. Each identified linkage has been assessed to have a low risk to GDEs:

- Groundwater supply extraction causing drawdown of the watertable which could reduce the groundwater available for aquatic ecosystems (WAA2-DE07-GDE3). The conceptualisation based on current data is that the aquifer is leaky confined at the point of extraction and extraction volumes are not large enough over a long enough timeframe to cause a change in groundwater conditions in the watertable at the wetlands.
- Transmission line cabling trenchless crossings causing sediment/ drilling mud release to creeks / wetlands and a reduction in water quality that could impact aquatic ecosystems (WAA4-DE11-GDE3). The volume, frequency and duration of release is unlikely to be such that aquatic GDEs could be impacted given the dilution likely in a perennial creek.

Mitigation and Contingency Measures

The outcomes of this assessment indicate that no permanent or measurable impacts to GDEs will occur as a result of the project (based on the available information) and therefore further risk assessment is not required as there is low to no risk to GDEs. The mitigation and management measures outlined in other water impact assessments (groundwater, surface water and environmental site assessment) will protect water resources which in turn will protect GDEs from potential impacts. A proposed mitigation measure for continued monitoring and adaptive management is outlined in Table E-1.

Table E-1 Proposed mitigation measures and references relevant to the identified impact pathways for GDEs.

<table>
<tr><th>Mitigation measure ID</th><th>Recommended mitigation measure</th><th>Stage</th></tr>
<tr><td>MM-GD01</td><td>GDE Monitoring and Management Plan
A GDE Monitoring and Management Plan will be developed prior to construction commencing in collaboration with the CMA, SRW and DEECA and to the satisfaction of the responsible authority. The GDE Monitoring and Management Plan will include:
At least daily groundwater level data collection (via data loggers) in pairs of target bores along the swamp edge and inland to measure changes to hydraulic gradient. Key bores include pairs MW05 and MW06, and MW07 and MW08.
At least daily groundwater levels data collection (via data loggers) in two “background” bores to measure natural variations so that any deviations from natural variations in the target bores can be identified. Key background bores would be MW01 and MW09.
Monitoring of these bores will begin at least 12 months before pumping commences so that baseline conditions (and natural variations in hydraulic gradient) can be determined.
Before pumping commences, target trigger levels will be developed (based on the seasonal baseline condition monitoring) so that changes to the hydraulic gradient outside of natural variations triggers contingency measures, such as temporary cessation of pumping, reduction in pumping volumes or introduction of an intermittent pumping schedule, to be determined prior to pumping commencing.
Measures to ensure the hydraulic gradient to the Ramsar wetland is maintained throughout the life of the groundwater extraction (construction – 2 years) and during system recovery (additional 2 years) via a monitoring plan with triggers and a set of contingencies. Ensure that assumptions underpinning the GDE Monitoring and Management Plan are updated as pumping progresses if drawdown varies from predictions.
Assessment against trigger levels and comparison of drawdown vs predicted drawdown will happen at a minimum biannual frequency.
At least daily groundwater level data collection (via data loggers) in MB01 to compare actual drawdown values to predicted drawdown. In the first 6 months of pumping the actual compared to predicted will be assessed at a minimum monthly basis so that the predictions can be validated and updated. After this period, biannual assessment in line with the target and background bore assessments.
Data loggers will be downloaded at a minimum of quarterly frequency and validation manual water level readings taken so that dataloggers errors can be noticed and corrected in a timely manner.</td><td>Construction – for the duration of groundwater pumping and for recovery period equal to the duration of pumping</td></tr>
</table>

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Document history & status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
Rev A	20 Jan 2023	J. Fawcett	J. Fawcett	20 Jan 2023	Draft for comment
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Section 1 Introduction

1.1 Project overview

The Kentbruck Green Power Hub ('the Project') is a proposed renewable energy development comprised of wind turbines, associated infrastructure, transmission lines, quarry and groundwater supply. The Project is situated in southwest Victoria, spanning an area that is approximately 25 kilometres (km) northwest of Portland and 3 km east of Nelson. The Project is primarily located in an actively managed and harvested pine plantation.

On 25 August 2019, the Minister issued a decision confirming that an EES is required for the Project due to the potential for significant environmental effects. The Project was also referred to the Commonwealth Government, on 7 November 2019, and declared a 'controlled action', requiring assessment and approval under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

1.2 Purpose of this report

The purpose of this Groundwater Dependent Ecosystem (GDE) Impact Assessment is to assess the potential impact the Project could have on GDEs to inform the preparation of an Environment Effects Statement (EES) required for the Project. This report documents the potential effects of the project that have the potential to impacts GDEs during construction and operation of the Project.

This report, along with the other environmental impact assessments, will inform the development of an Environmental Management Framework (EMF) for the Project. The mitigation measures listed in the EMF will be implemented in the approvals and management plans for the Project.

1.3 GDEs

Groundwater dependent ecosystems (GDEs) are ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services (Richardson et al., 2011). The dependence of an ecosystem on groundwater can vary depending on the ecosystem's location in the landscape and temporally depending on seasonal and long term climatic conditions.

GDEs can be impacted via physical disruption and changes to the surface water regime, but the primary impact mechanism is via changes to the groundwater regime, both quantity and quality.

- Physical disruption of a GDE can occur through excavation, building or any other site activity that has the potential to directly (physically) impact the ecosystem. This impact pathway does not relate to the ecosystem's reliance on groundwater. Physical disruption of wetlands and native vegetation is assessed in the Flora and Fauna Existing Conditions and Impact Assessment (Biosis, 2023).
- Impacts via surface water pathways can include changes in surface water quality as well as changes to the flow regime for GDEs that are connected to surface water systems (i.e. on-stream wetlands). This impact pathway does not directly relate to the ecosystem's reliance on groundwater, although a reduction in surface water flow could increase or induce a reliance on groundwater.
- Impacts from groundwater can include reducing a GDEs access to groundwater (via drawdown of the watertable or a reduction of groundwater flow) and changes to the quality of groundwater GDEs have access to. This impact pathway directly relates to the ecosystem's reliance on groundwater.

1.4 Report interconnections

This report relies on the work included in other impact assessment reports prepared for the EES. The primary sources are listed below:

- Groundwater Impact Assessment, Kentbruck Green Power Hub Project EES Technical Report (AECOM, 2024a) EES Appendix G

  Issued June 2024 following multiple rounds of Technical Reference Group (TRG) comments and including the updated project layout and description including a reduction in the number of turbines from 116 to 105 and an assessment of transmission line options and a change of preferred transmission line option. This version also incorporates results and interpretation of 7-day pumping test (described below) and groundwater level monitoring data collected at monitoring wells MW4 to MW8 between July 2022 and April 2023.

- Environmental Site Investigation, Kentbruck Green Power Hub Project EES Technical Report (AECOM, 2023) EES Appendix I

  Issued October 2023 following multiple rounds of TRG comments and including the updated project layout and description described above.

- Surface Water Impact Assessment, Kentbruck Green Power Hub Project EES Technical Report (AECOM, 2024b) EES Appendix F

  Issued January 2024 following multiple rounds of TRG comments and including the updated project layout described above.

- Flora and Fauna Existing Conditions and Impact Assessment, Kentbruck Green Power Hub EES Technical Report (Biosis, 2023) EES Appendix C

  Issued May 2023 and including the amended project footprint described above. Physical disruption of wetlands and native vegetation (unrelated to changes in groundwater condition) is assessed in this report.

- Factual Report – 7-day groundwater pumping test (CDM Smith, 2023)

  Issued 17th May 2023 and detailing the method and results, including analysis, of a 7-day groundwater pumping test completed in TB01 at Kentbruck Plantation and included as Appendix D of this report.

The above reports have been used in the following ways:

- Context setting – the physical setting of the Project Area as it relates to GDEs (i.e. climate, hydrology, hydrogeology) has been described based on the AECOM groundwater and surface water reports (AECOM, 2024a and 2024b) as well as other publicly available information. The 7-day pumping test reduced the uncertainty of the hydrogeological conceptualisation of the deeper aquifer.
- Direct and indirect effects – the effects of the project on the groundwater and surface water regimes have been assessed in the AECOM surface water, groundwater, and environmental site assessments (AECOM 2024a, 2024b and 2023, respectively). These effects have been used to assess potential impacts to GDEs.

1.5 Investigation area

The investigation includes the outline of the project as well as the physical extent of the potential effects identified in the groundwater, surface water and environmental site assessment reports (AECOM 2024a, 2024b and 2023, respectively). The outline of the project includes the wind farm site boundary plus the transmission line corridor, which has been defined as follows in the Groundwater Impact Assessment (AECOM, 2024a):

- Wind farm site boundary (known as the wind farm 'plantation sub-area') plus 500 metre buffer zone.
- The 'northeastern sub-area' plus 500 metre buffer zone.
- Underground transmission line corridor towards Heywood plus 200 metre buffer zone.

Note, buffer zones are defined for describing the project context and to define the investigation area. For consistency with the groundwater report, these sub zones have been adopted in this GDE Impact Assessment and are described in more detail in Section 5.5.

AECOM considered impacts beyond the defined 500 m buffer for the groundwater supply assessment. The effects described relevant to the groundwater supply have been included in this GDE assessment.

The Flora and Fauna Existing Conditions and Impact Assessment (Biosis, 2023) defines the Investigation Area as the area in which field studies have been undertaken, to include the project area plus areas surrounding the site where additional data collection was undertaken.

Section 2 Project Description

Neoen is proposing a renewable energy development, known as the Kentbruck Green Power Hub, comprising a wind energy facility (wind farm) with associated infrastructure. The Project would be mostly located in an actively managed and harvested pine plantation in southwest Victoria, between Portland and Nelson, in the Glenelg LGA.

The Project would involve two main components:

- A wind farm of up to 600 MW comprising up to 105 wind turbines and associated permanent and temporary infrastructure.
- A new 275 kV underground transmission line, which would connect the Project to the existing AusNet electricity transmission network. The transmission line would extend from the eastern boundary of the wind farm site underground to the existing 275/500 kV Heywood Terminal Station and would be approximately 26.6 km in length.

2.1 Wind Farm

As shown in Figure 2-1, permanent infrastructure to be constructed as part of the Project would include:

- Up to 105 wind turbines
- Access roads, including:
  - Public roads for site access. Existing site access routes into the commercial forestry operation would be utilised to minimise the need for new site entrances. Some public roads and intersections would need to be upgraded to facilitate delivery of Project components, particularly wind turbine blades.
  - Internal access roads. Existing access tracks within the commercial forestry operation and on land currently used for agricultural purposes would be used where possible. Some of these roads and intersections may need to be upgraded.
- Up to eight meteorological monitoring masts within the wind farm site.
- Permanent hardstand areas at each turbine location, with a footprint of approximately 0.4 ha, subject to refinement based on the dimensions of the final wind turbine model selected.
- Three collector substations.
- Underground powerlines connecting the wind turbines to the collector substations.
- A main wind farm substation to which all the collector substations would be connected. The main substation would connect the wind farm to the existing electricity transmission network via a new underground transmission line.
- A high voltage powerline connecting the collector substations to the main substation, which would be a combination of overhead and underground cabling.
- Transition stations at which the high voltage powerline would transition from overhead to underground or vice versa (if needed; see below).
- Up to two permanent site compounds, including 30 carparking spaces at each location.

Temporary infrastructure associated with construction of the wind farm would include:

- Up to three concrete batching plants.
- Laydown areas with a footprint of approximately 0.6 ha located at each turbine.
- Up to six construction compounds, each containing a site office, carparking, storage, amenities, and a workshop.

2.2 Onsite Quarry

A new limestone quarry is also proposed to be established in the wind farm site adjacent to the existing quarry operated by Green Triangle Forest Products (GTFP), on North Livingston Road (see Figure 2-1). The cemented "cap rock" quarry would operate during both construction and operation, with the extracted material to be used for hardstands and for upgrades to existing access roads or construction of new access roads.

The quarry would have an extraction area of approximately of 9 ha and be approximately 14 m deep, with actual dimensions to be determined following a comprehensive drilling, sampling and testing program during detailed design of the Project. The total extracted volume is estimated to be up to 300,000 cubic metres (m3), with material to be extracted progressively during construction. The quarry would also be used throughout the Project's lifetime for road maintenance and would be made safe and rehabilitated at the end of its use for the Project to a suitable landform.

2.3 Electrical Reticulation

The Project would require new electrical reticulation that involves the construction of underground and overhead cabling throughout the wind farm site and electrical substations. A new underground transmission line to connect the Project to the existing transmission network is also proposed.

2.3.1 Main substation

A main electrical substation would be constructed in the wind farm site to facilitate connection of the Project to the existing electricity network. This substation would be located near the eastern boundary of the wind farm site to minimise the distance between the substation and the connection point to the transmission network (at the Heywood Terminal Station) (see Figure 2-1).

The main substation would have a footprint of up to 3.3 ha with a maximum height of approximately 40 m. It would contain protection equipment and a control room with communications equipment, with tanks for storing water and oil for maintenance of the collector and main substation equipment. The substation would be constructed on a hardstand, with appropriate contamination/stormwater controls used around the oil tanks such as bunding and concrete slabs. The substation would be fully enclosed in security fencing with sufficient space for a fire break and screening around the perimeter.

2.3.2 Collector substations

Up to three collector substations would be constructed within the wind farm site to facilitate collection and distribution of electricity generated from the wind turbines into the existing electricity network. Indicative locations of the collector substations are shown on Figure 2-1.

The collector substations would have a footprint of up to 1 ha with a maximum height of approximately 35 m. Each substation would contain a range of electrical equipment including step-up transformers, protection equipment (including lightning protection), and a high voltage bus bar connecting to the high voltage overhead powerline. The collector substations would be constructed on hardstands, with the transformers mounted on concrete slabs. The collector substations would be fully enclosed in security fencing.

2.3.3 Onsite wind farm powerlines

The Project would involve the installation of up to 190 km of underground powerlines (33 kV or 66 kV) connecting the wind turbines to the collector substations, and up to 27.8 km of high voltage powerline connecting the collector substations to the main wind farm substation.

The high voltage powerline would likely be 275 kV (subject to detailed design) and would run overhead along Portland-Nelson Road from the western collector substation to the eastern collector substation.

From the Portland-Nelson Road / Sandy Hill Road intersection it would pass beneath Portland-Nelson Road then continue underground to the main substation. The proposed alignment of the powerline is shown in Figure 2-1.

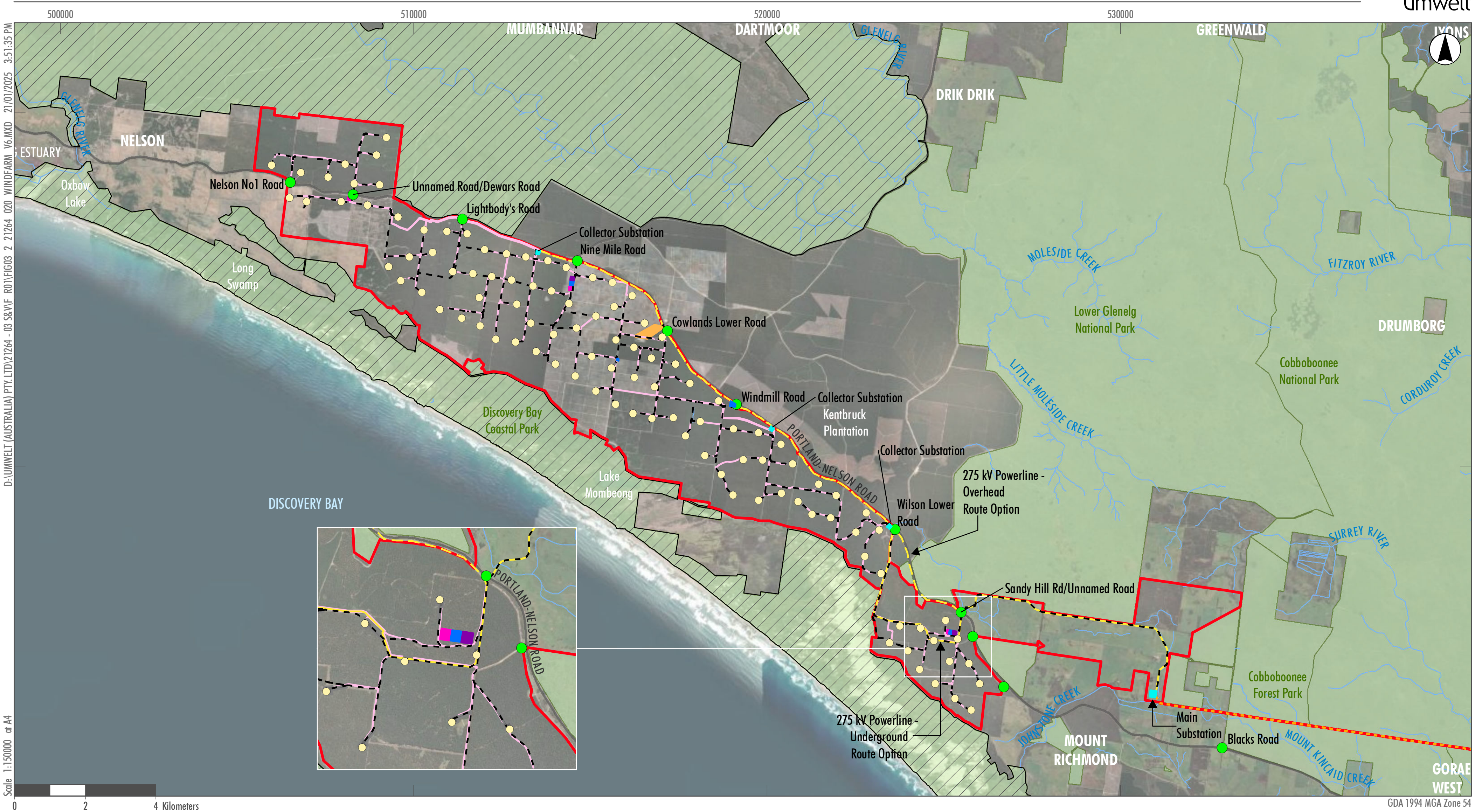
2.3.4 Transmission line

The Project would require a new 275 kV transmission line to connect the Project to the existing transmission network. The proposed transmission line route measures approximately 26.6 km in length and would extend underground from the main wind farm substation near the eastern boundary of the wind farm site to the existing Heywood Terminal Station (see Figure 2-2). The transmission line would bisect Cobboboonee National Park and Cobboboonee Forest Park for approximately 17.6 km, where it would be buried beneath an existing road (Boiler Swamp Road).

After exiting Cobboboonee Forest Park the underground line would continue for 1.2 km through freehold agricultural land. As shown on Figure 2-2, two options have been identified for this section of the transmission line. The slightly shorter southern route is the preferred option, but due to its proximity to a swampy area adjacent to the Surrey River it may not be feasible for underground construction. The viability of this option will be determined in response to geotechnical investigations undertaken during detailed design and only one option would ultimately be constructed. After crossing the Surrey River, the transmission line would continue underground until its connection point into the Heywood Terminal Station.

The underground route through Cobboboonee National Park / Forest Park has been delineated into a 6.5 m-wide construction footprint to minimise impacts on native vegetation within the Boiler Swamp Road corridor. The cabling would be buried using a specialised machine that excavates, lays the cable and backfills the trench in a single pass, minimising the associated construction footprint through small trench widths and minimal spoil generation. Once the transmission line exits Cobboboonee Forest Park, the construction footprint would be approximately 9 m wide as it continues through freehold land until it reaches Heywood Terminal Station. Traditional open-cut trenching methods would be used for this section of the underground transmission line.

All transmission line options that have been considered for the Project, including those which are no longer being pursued by Neoen, are discussed in Chapter 4 of the EES and detailed in the options assessment report prepared by Umwelt (2023). Appendix B of this report provides a summary of the impacts associated with three alternative transmission line options considered by Neoen to date, including a combined overhead-underground option to the Heywood Terminal Station, and overhead and underground options through freehold land southeast of the wind farm site. These options are referred to as Options 1A, 2A and 2B, respectively.



Legend
- Project Area
- Glenelg Estuary and Discovery Bay Ramsar Wetland
- Roads
- Watercourses
- Site Access Points

Permanent Wind Farm Infrastructure
- Onsite Quarry
- Collector Substation
- Crane Hardstand
- Proposed Turbine Location
- Underground Transmission Line
- 275 kV Powerline - Overhead
- 275 kV Powerline - Underground
- Internal Access Roads
- Underground Powerlines

Temporary Wind Farm Infrastructure
- Concrete Batch Plant
- Laydown Areas
- Site Compounds

FIGURE 2.1 **Wind Farm Details**

Image Source: ESRI Basemap (2021) Data source: DELWP (2021); Geoscience Australia (2021); Aurecon (2021)

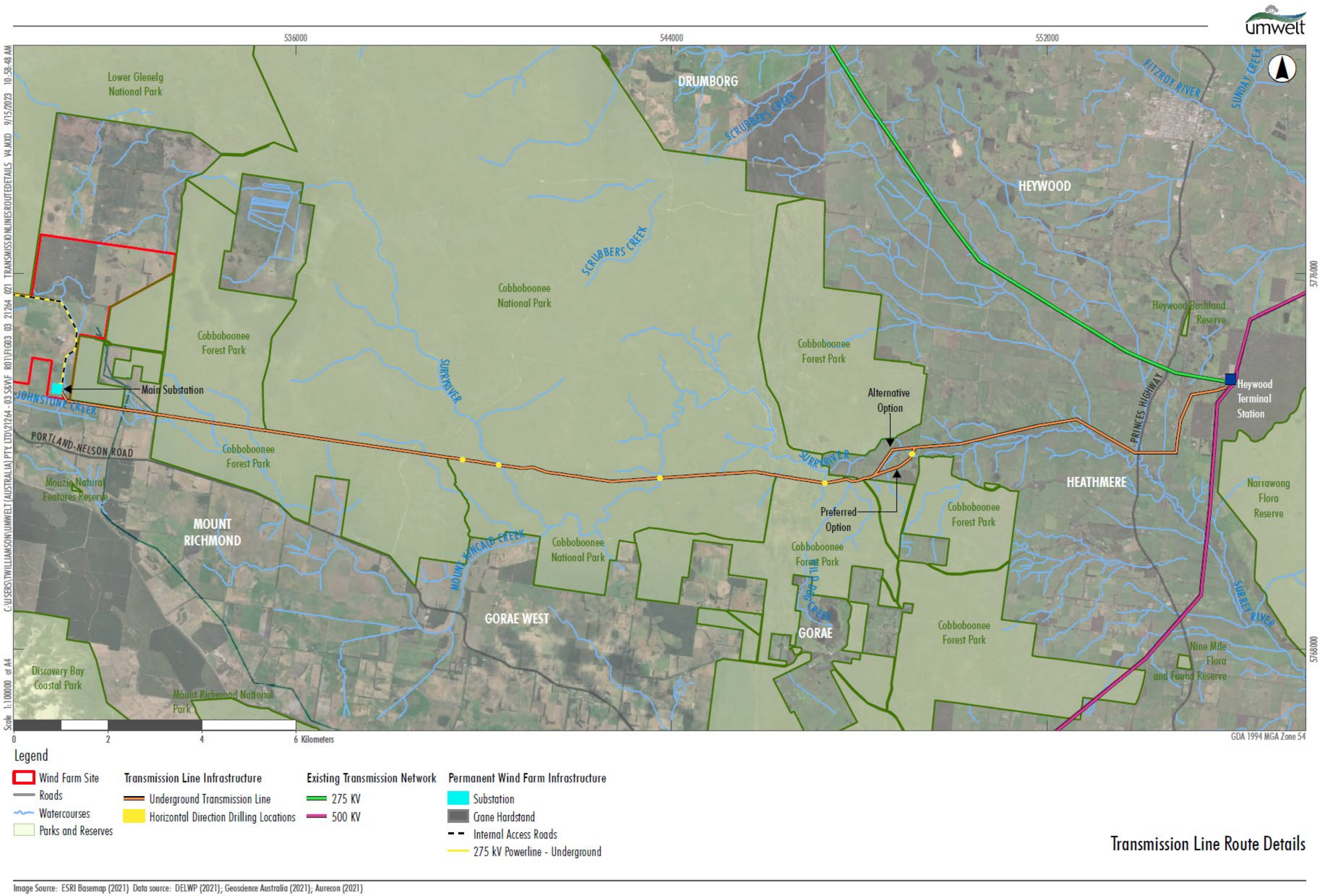


Figure 2-2 Transmission Line route details (provided by Umwelt)

Section 3 EES Scoping Requirements

3.1 EES evaluation objectives

The scoping requirements for the EES by the Minister for Planning set out the specific environmental matters to be investigated and documented in the Project's EES, which informs the scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the Project.

The following evaluation objective is relevant to the GDE assessment:

> ***Biodiversity and habitat:*** *To avoid or minimise potential adverse effects on biodiversity values within the project site and its environs, including native vegetation, listed species and ecological communities other protected species and habitat for these species.*
>
> ***Catchment values and hydrology:*** *To maintain the functions and values of aquatic environments, surface water and groundwater quality and stream flows and prevent adverse effects on protected beneficial uses.*

3.2 EES scoping requirements

The Scoping Requirements for the Project identify the following key issues relevant to this assessment:

- Potential for adverse effects on the ecological character and biodiversity values of the Glenelg Estuary and Discovery Bay Ramsar site
- Potential for the Project to have a significant impact on wetland systems, including, but not limited to, Glenelg Estuary and Discovery Bay Ramsar site and its associated aquatic environments, and the ability for wetland systems to support habitat for protected flora and fauna species.
- Potential for adverse effects on nearby and downstream water environments (including Glenelg Estuary and Discovery Bay Ramsar site and listed Nationally Important Wetlands) due to changed water quality, flow regimes, impacts on groundwater or waterway conditions during construction.

Several scoping requirements are relevant to GDEs. Table 3-1 identifies these requirements and indicates how each has been addressed in this assessment.

It should be noted (and is referenced in Table 3-1) that there is a large degree of interconnection between reports. This GDE Impact Assessment is focussed solely on GDEs, and therefore where a scoping requirement references native vegetation or wetlands, only those that are identified as being potentially dependent on groundwater have been assessed as part of this report. Other effects on native vegetation or wetlands that are not dependant on groundwater (such as physical disruption) are assessed in the Biosis Flora and Fauna Existing Conditions and Impact Assessment report (Biosis, 2023) and the AECOM Surface water Impact Assessment report (AECOM, 2024b).

Table 3-1 EES Scoping Requirements relevant to GDEs

Scoping requirement	How this report satisfies the requirement	Outcome of GDE impact assessment relevant to this requirement	Report linkages
Key Issues			
Potential for adverse effects on the ecological character and biodiversity values of the Glenelg Estuary and Discovery Bay Ramsar site	This report follows a robust assessment framework using a source-pathway-receptor model to identify whether GDEs (including the Glenelg Estuary and Discovery Bay Ramsar site) will suffer adverse effects from the construction and operation of the Project. The framework is described in Section 4 and the assessment completed in the following sections.	The GDE Impact Assessment shows a low risk of impact to the ecological character and biodiversity values of the Glenelg Estuary and Discovery Bay Ramsar from changes to the groundwater regime and associated connected surface water.	This scoping requirement is also addressed in the Flora and Fauna Existing Conditions and Impact Assessment (Biosis, 2023) – Appendix C of the EES
Potential for the Project to have a significant impact on wetland systems, including, but not limited to, Glenelg Estuary and Discovery Bay Ramsar site and its associated aquatic environments, and the ability for wetland systems to support habitat for protected flora and fauna species	Risk pathways associated with GDEs, including the Glenelg Estuary and Discovery Bay Ramsar site (direct effects, groundwater and surface water) have been identified and assessed in Section 6.3 and Section 8 and a threat assessment has been undertaken in Section 9.	The GDE Impact Assessment shows a low risk of impact to wetland systems and associated aquatic environments, and the ability for wetland systems to support habitat for protected flora and fauna species from changes to the groundwater regime and associated connected surface water.	This scoping requirement is also addressed in Section 6.0 of the Groundwater Impact Assessment (AECOM, 2024a) (Appendix G of the EES) and Section 8.0 of the Surface water Impact Assessment (AECOM, 2024b) (Appendix F of the EES)
Potential for adverse effects on nearby and downstream water environments (including Glenelg Estuary and Discovery Bay Ramsar site and listed Nationally Important Wetlands) due to changed water quality, flow regimes, impacts on groundwater or waterway conditions during construction.	The potential effects from the project related to GDEs, including the Glenelg Estuary and Discovery Bay Ramsar site, have been collated from other report (i.e. groundwater, surface water, environmental assessment) and assessed for potential impact on identified GDEs. Risk pathways have been identified and assessed in 6.3 and Section 8 and a threat assessment has been undertaken in Section 9.	The GDE Impact Assessment shows a low risk of impact to nearby and downstream water environments from changes to the groundwater regime and associated connected surface water.	This scoping requirement is also addressed in Section 8.1 of the Groundwater Impact Assessment (AECOM, 2024a) (Appendix G of the EES) and Section 8.0 of the Surface water Impact Assessment (AECOM, 2024b).(Appendix F of the EES)

Scoping requirement	How this report satisfies the requirement	Outcome of GDE impact assessment relevant to this requirement	Comment
Existing Environment			
Identify and characterise any areas of native vegetation and groundwater dependant ecosystems (GDEs) that may be affected by groundwater drawdown or surface hydrological changes	The GDE Atlas has been used as a broad identification tool for aquatic GDEs and terrestrial GDEs (including native vegetation). Areas of Native Vegetation in the Project Area have been described in more detail in the Flora and Fauna Impact Assessment (Biosis, 2023). A site visit was completed to confirm the presence of GDEs in potential impact areas using the GDE Atlas as the base map. The results of the Groundwater Impact Assessment and the Surface Water Impact Assessment have been used to identify which GDEs may be affected by groundwater drawdown or surface hydrological changes using a source pathway receptor model.	The GDE Impact Assessment identifies GDEs (terrestrial and aquatic) within potential groundwater and surface water impact zones. The risk of impact to these GDEs has been assessed as low.	This scoping requirement is also addressed in the Flora and Fauna Existing Conditions and Impact Assessment (Biosis, 2023) – Appendix C of the EES
Characterise the wetland systems in the Project Area and its environs including the extent, types and condition of wetlands that could be impacted by the Project, having regard to terrestrial and aquatic habitat, including as habitat corridors or linkages	As above. Only wetlands that can be affected by changes to the groundwater system have been included in this Groundwater Dependent Ecosystem Impact Assessment.	The GDE Impact Assessment identifies wetland (groundwater dependent) within potential groundwater and surface water impact zones, including aquatic and terrestrial GDEs. The risk of impact to these GDEs has been assessed as low.	This scoping requirement is also addressed in Section 6.0 of the Surface water Impact Assessment (AECOM, 2024b) (Appendix F of the EES)
Likely Effects			
Assess the direct and indirect effects of the project and feasible alternatives, on the ecological character of the Glenelg Estuary and Discovery Bay declared Ramsar site	The potential effects from the project related to GDEs, including the Glenelg Estuary and Discovery Bay Ramsar site, have been collated from other report (i.e. groundwater, surface water, environmental assessment) and assessed for potential impact on identified GDEs. Risk pathways have been identified and assessed in 6.3 and Section 8 and a threat assessment has been undertaken in Section 9.	The potential direct and indirect effects of the project on the ecological character of the Glenelg Estuary and Discovery Bay declared Ramsar site, with regards to changes to the groundwater regime and associated connected surface water, have been assessed as a low risk of impact.	This scoping requirement is also addressed in the Flora and Fauna Existing Conditions and Impact Assessment (Biosis, 2023) – Appendix C of the EES

Scoping requirement	How this report satisfies the requirement	Outcome of GDE impact assessment relevant to this requirement	Comment
Assess the potential effects of the project on surface water and groundwater environments and associated environmental values, including on permanent and ephemeral wetland systems in the Project Area and its environs and downstream, considering appropriate climate change scenarios.	The potential effects from the project related to GDEs, including permanent and ephemeral wetland GDEs, have been collated from other report (i.e. groundwater, surface water, environmental assessment) and assessed for potential impact on identified GDEs. Risk pathways have been identified and assessed in 6.3 and Section 8 and a threat assessment has been undertaken in Section 9.	The potential direct and indirect effects of the project on permanent and ephemeral wetland systems in the Project Area and its environs and downstream, with regards to changes to the groundwater regime and associated connected surface water, have been assessed as a low risk of impact.	This scoping requirement is also addressed in Section 8.1 and 8.2 of the Groundwater Impact Assessment (AECOM, 2024a) (Appendix G of the EES) and Section 8.0 of the Surface water Impact Assessment (AECOM, 2024b) (Appendix F of the EES)
Assess the potential effects on Glenelg Estuary and Discovery Bay Ramsar site, due for example to changed water quality, flow regimes, impacts on groundwater or waterway conditions during construction considering appropriate climate change scenarios	The potential effects from the project related to GDEs, including the Glenelg Estuary and Discovery Bay Ramsar site, have been collated from other report (i.e. groundwater, surface water, environmental assessment) and assessed for potential impact on identified GDEs. Risk pathways have been identified and assessed in 6.3 and Section 8 and a threat assessment has been undertaken in Section 9. Climate change has been taken into account in the effects as per the Groundwater and Surface Water Impacts Assessments (AECOM, 2024a and 2024b). CDM Smith considers this approach appropriate, given the short duration potential impacts predicted.	The potential effects of the project on Glenelg Estuary and Discovery Bay Ramsar site, with regards to changes to the groundwater regime and associated connected surface water, have been assessed as a low risk of impact.	This scoping requirement is also addressed in Section 8.0 of the Surface water Impact Assessment (AECOM, 2024b) (Appendix F of the EES)
Mitigation Measures			
Identify proposed measures to mitigate any potential effects, including any relevant design features or preventative techniques to be employed during construction and operation.	Mitigation measures proposed in other impact assessment report (groundwater and surface water) are relevant to the protection of GDEs. No further mitigation measures have been proposed based on the GDE Impact Assessment (Section 10).	The outcomes of this assessment indicate that no permanent or measurable impacts to GDEs will occur as a result of the project and therefore there is low to no risk to GDEs. The mitigation and management measures outlined in other water impact assessments (groundwater, surface water and environmental site assessment) will protect water resources which in turn will protect GDEs from potential impacts.	The mitigation measures relevant to the GDE impact pathways are detailed in the Groundwater Impact Assessment (Appendix G of the EES) (AECOM, 2024a) and the Surface water Impact Assessment (AECOM, 2024b) (Appendix F of the EES)

3.3 Relevant Legislation

Legislation relevant to this assessment of the Project is summarised in Table 3-2.

Table 3-2 Legislation relevant to the Project

Legislation	Governing Agency	Summary
Federal		
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Department of Climate Change, Energy, the Environment and Water (DCCEEW)	The EPBC Act and supporting regulations provide for the protection of the environment and conservation of biodiversity in Australia, specifically for Matters of National Environmental Significance (MNES). Three MNES are relevant to the Project: • Ramsar wetlands of international importance. • Threatened species and ecological communities. • Migratory species.
State		
Environment Effects Act 1978	Department Transport and Planning (DTP)	The Act provides for assessment of proposed projects (works) that are capable of having a significant effect on the environment. The Act enables the administering Minister to decide that an Environment Effects Statement (EES) should be prepared for the project. The EES process provides for the analysis of potential effects on environmental assets and the means of avoiding, minimising and managing adverse effects.
Environment Protection Act 2017	EPA	The Act provides a framework for the protection of human health and the environment (including land and groundwater) from pollution and waste. The Environment Protection Authority Victoria (EPA) is an independent statutory authority which administers the Act as well as *the Pollution of Waters by Oils and Noxious Substances Act 1986 and the National Environment Protection Council (Victoria) Act 1995.* Potential groundwater pollution is identified through a range of activities and programs that EPA regulates, including Victoria's environmental audit system. The EP Act also provides the basis for the Environmental Reference Standard (ERS). The ERS define the uses and environmental values to be protected in Victoria and the environmental quality objectives needed to protect these environmental values
Flora and Fauna Guarantee Act 1988	DEECA	The Act is the main piece of Victorian legislation for the conservation and protection of threatened species and ecological communities and for the management of potentially threatening processes.
Planning and Environment Act 1987	DTP	The purpose of the Act is to establish a framework for planning the use, development and protection of land in Victoria. It also sets out the process for obtaining permits under schemes, settling disputes, enforcing compliance with planning schemes and permits, and other administrative procedures. Under the Act, Development of Wind Energy Facilities in Victoria Policy and Planning Guidelines (November 2021) have been developed to inform planning decisions about wind farms.

Legislation	Governing Agency	Summary
Water Act 1989	DEECA	Groundwater is allocated for consumptive use under the Act. In considering an application to take and use groundwater, the Act requires the Rural Water Corporations to consider any adverse effects that the extraction is likely to have on the environment. Under the Act, Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems have been developed. The guidelines: • establish a clear framework for considering groundwater dependent ecosystems when making groundwater licensing decisions. • clarify how high value groundwater dependent ecosystems are to be protected. • provide guidance on how to make an assessment about groundwater dependent ecosystems in consideration of sections 40 and 53 of the Act.
International Agreements		
Convention on Wetlands of International Importance (Ramsar Convention) 1971	International Union for Conservation of Nature (IUCN)	The Ramsar Convention is an International Convention on Wetlands that was signed in Ramsar, Iran in 1971 and is administered by the IUCN. The convention aims to end the worldwide loss of wetlands and establishes a framework to do this with the cooperation of participating countries. Under the Ramsar Convention, Australia is obliged to maintain the ecological character of its designated Ramsar sites through the conservation and wise use of wetlands. Victoria has eleven sites currently listed as Wetlands of International Importance under the Convention, including one relevant to the Project: • Glenelg Estuary and Discovery Bay Ramsar site.

Section 4 Assessment Framework

4.1 The Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems

GDE risk and impact assessments in Victoria often refer to the Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems (the Guidelines) as a framework for assessing the risk of impact to GDEs. However, these guidelines are limited in their applicability by the following:

- The Guidelines only apply to licencing of groundwater extraction and not to other water affecting activities that can impact GDEs such as dewatering for construction, changes to surface water regime, impacts to stygofauna, changes to surface water or groundwater quality, etc., or other direct GDE impacts such as physical disruption, grazing regimens, tree spraying activities, etc.
- The Guidelines only apply to high value ecosystems defined as ecosystems recognised by State or National Governments as being significant for their environmental values, including:
  - Ramsar listed wetlands as identified in the Australian Wetlands database of the Commonwealth Government wetlands listed in the Directory of Important Wetlands in Australia of the Commonwealth Government
  - Heritage river areas under Schedule 1 of the Heritage Rivers Act 1992
  - Species and communities listed under the Flora and Fauna Guarantee Act 1998 of the Victorian Government or the Environmental Protection and Biodiversity Act 1999 of the Commonwealth Government
  - Priority environmental values set by waterway managers, including those identified in Regional Waterway Strategies or their relevant sub strategies.

  Many of the potential GDEs within the Project Area are not identified by any State or National significance and would therefore not be assessed within this framework.
- The Guidelines only apply within the "licence application area" which is defined as the area within which measurable groundwater drawdown (>0.1 m) occurs. Impacts to GDEs can occur outside of a cone of drawdown, such as changes to water quality, changes to groundwater throughflow (groundwater damming), etc.
- The Guidelines do not take into account:
  - The hydrogeological conceptual model and the existence of source pathway receptor linkages
  - The GDEs resilience/sensitivity, or other environmental stressors on the GDE
  - The timeframe for the impacts, especially duration of impact

In order to assess the potential impacts the project may have on GDEs, a more holistic approach is required. The National Water Commission (NWC) framework for assessing potential local and cumulative effects of mining on groundwater (Howe, 2011) has been adopted to provide structure for the assessment of impacts to GDEs. This framework is described in more detail in Section 4.2. The purpose of using this framework is to provide a structured approach for assessing the impact to GDEs based on all water effecting activities and a source-pathway-receptor approach, which is a common framework for impact assessments. The NWC framework allows for:

- Inclusion of all water affecting activities,
- Inclusion of all GDEs, including those not identified as high value,
- Inclusion of potential impacts outside of the "licence application area"

- Provide a conceptualisation and a source pathway receptor model to identify whether impacts may be realised based on the groundwater and surface water conditions as well as the sensitivity/resilience of the GDEs and the nature (extent, magnitude and duration) of the impact.

4.2 The NWC groundwater impact assessment framework

The National Water Commission (NWC) framework for assessing potential local and cumulative effects of mining on groundwater (Howe, 2011) has been adopted to provide structure for the assessment of impacts to GDEs. Although this framework was initially developed to assess mining activities, it provides a robust framework for the assessment of any potentially groundwater impacting activity. It should be noted that the framework adopts the terminology of "effects" rather than "impacts", as impacts are generally perceived to be negative whereas effects can be either negative or positive. In this report the NWC terminology is used throughout the assessment, except the final section where effects are discussed as impacts to be consistent with the EES process.

The framework incorporates seven steps, the first five of which are addressed by this report:

- Step 1 involves setting the context for assessing potential water-related effects arising from the proposed operation. The Project context is described in more detail in the groundwater, surface water, flora and fauna and environmental site assessments and summarised in Section 5 of this report.
- Step 2 involves the setting of management objectives. Preliminary management objectives based on the project scoping requirements are presented in Section 6 along with the potential ecological groundwater users identified for the Project.
- Steps 3 to 4 provide the source-pathway-receptor analysis for the effects assessment.
  - Step 3 considers the direct groundwater effects (impacts) linked to water affecting activities (WAAs), with the WAAs forming the 'source' component and the direct effects (altered water resource condition) forming the 'pathways' component. The direct effects assessment is presented in Section 7 and based on the impacts described in the Groundwater and Surface Water Impact Assessments (AECOM, 2024a and 2024b).
  - Step 4 considers the potential exposure of groundwater users to direct effects, essentially forming the 'receptor' component of the analysis. This assessment is presented in Section 8.
- Step 5 brings together the outcomes of Steps 3 and 4 to complete the effects assessment (impact assessment) and involves identifying threats posed to groundwater users identified as being at risk from WAAs. This assessment is presented in Section 9.
  - Threat assessment is central to the typical environmental approvals process, serving to assess the actual consequences arising from WAAs - not just in terms of direct effects (altered water resource condition) but more importantly, in terms of possible receptor response (such as loss of biodiversity or reduced water access for other users).
- Step 6 involves making an informed decision as to the potential for adverse effects to arise to groundwater users.
  - The identified potentially complete impact pathways are summarised and mitigation measures proposed to inform the residual risk of the effect (impact).
  - The nature of water resources does not always lend complete certainty to risk characterisation in regard to understanding the way the system works and how it will respond to WAAs.
- Step 7 involves establishing monitoring infrastructure, where deemed necessary, and implementing an appropriate program of data collection, evaluation and analysis, which is a fundamental component of any effects assessment process.

Figure 4-1 provides an illustration of the framework.

This framework effectively works as an identification of source-pathway-receptor linkages. After setting the context (description of the existing environment in which the effects could occur to impact GDEs, Section 5), the "receptors"

(GDEs) are broadly identified (Section 6). The GDE Atlas and existing information has been used to identify all potential GDEs in the Project Area. The next step is a direct effects assessment (6.3) to identify potential "sources" (in this context the Groundwater Affecting Activity, Section 7.2) that could impact GDEs directly or through groundwater or surface water "pathways" (Section 7.3).

Only the GDEs with complete source-pathway-receptor linkages (Section 8) are assessed in more detail in the threat (impact) assessment (Section 9).

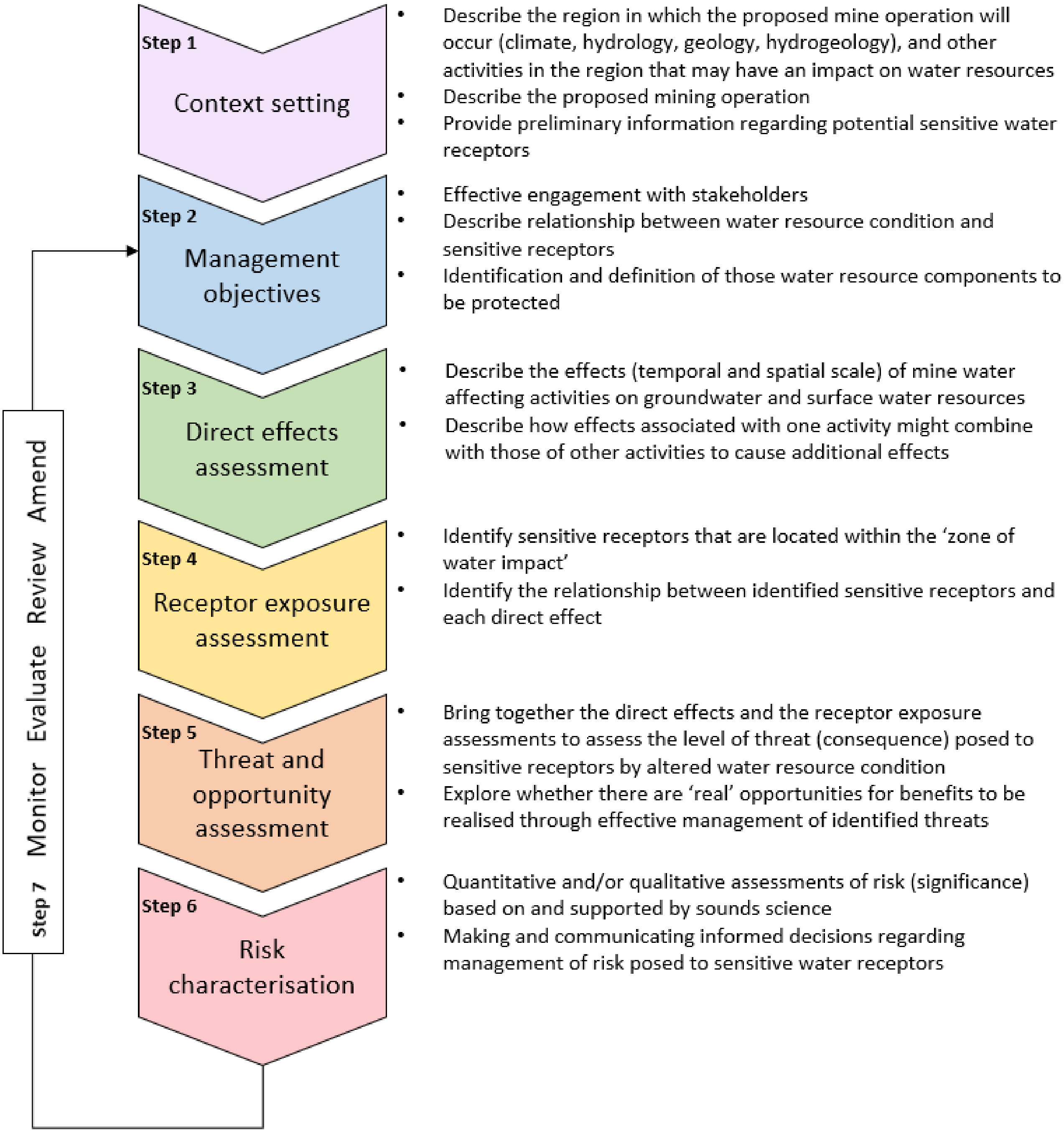


Figure 4-1 Flowchart for assessing the effects of mining on water resources (Fuentes et al. 2014)

4.3 Assumptions, limitations and uncertainty

A number of limitations apply to a hydrogeological assessment based on the inherent uncertainty of predicting groundwater flow in an aquifer. Assumptions have been made throughout this assessment and are described throughout, including:

- Use of the GDE Atlas to identify potential GDEs (see Section 6.2). The GDE Atlas comprises maps that show the location of both known and potential GDEs across Australia based on previous studies as well as spatial analysis using existing feature layers and products developed from analysis of remotely sensed data. The Atlas is considered a good starting point for identifying potential terrestrial and aquatic GDEs in this part of Victoria but is limited in its mapping of subterranean GDEs. The Biosis (2023) brolga wetland mapping has also been used to identify potential aquatic GDEs. To account for the uncertainty of the potential groundwater dependence of the GDE features, all GDEs have assumed to be high potential and high value in this assessment. To account for the uncertainty of the sub terranean mapping, it is assumed that all carbonate rocks (the Port Campbell Limestone) could host subterranean GDEs.
- Work completed by other parties has been used in this assessment and therefore the assumptions and limitations for those works apply here. This includes the Groundwater Impact Assessment Section 5.3 (AECOM, 2023), Environmental Site Investigation Section 2.4 (AECOM, 2023), Surface Water Impact Assessment Section 5.4 (AECOM, 2023) and Flora and Fauna Existing Condition and Impact Assessment Section 3.10 (Biosis, 2023). Some of the key assumptions from these assessments include:
  - Desktop assessments are limited to readily available public information, site observations and information obtained from current landowners / managers where available to be contacted; and is based on conditions that existed at the time the assessment was completed.
  - Field work investigations are limited to the conditions encountered at the locations investigated and the time over which the assessment was conducted.
- Site specific hydrogeological data (outside of publicly available geological and hydrogeological data and mapping) is restricted to 12 shallow monitoring wells, one deeper limestone monitoring bore, one deeper limestone test bore, aquifer testing, groundwater sampling and water level gauging. The results have been interpolated across the study area but there is inherent uncertainty in assessing hydrogeological impacts using a small number of bores. To manage this uncertainty, conservative assumptions have been used when assessing potential impact pathways. These are described in more detail in the impact assessment.

Section 5 Context Setting

The hydrogeological and ecological setting is described below based on Groundwater Impact Assessment (AECOM, 2024a), the Environmental Site Assessment (AECOM, 2023), the Surface Water Impact Assessment (AECOM, 2024b) and the Flora and Fauna Existing Conditions and Impact Assessment (Biosis, 2023) as well as existing publicly available data and information.

5.1 Climate

The Investigation Area has a temperate climate of warm, dry summers and cool, wet winters. The average annual rainfall is in the order of 800 millimetres (mm) but ranges from approximately 750 - 970 mm annually, calculated from the annual rainfall statistics recorded at the Nelson (BoM ID 90059), Mount Richmond (BoM ID 90050) and Cape Bridgewater (BoM ID 90013) weather stations.

Evaporation statistics from Mount Gambier in South Australia (BoM Station ID 026021), located approximately 35 km northwest of the Investigation Area, were compared to the rainfall at Nelson (Department of Environment Land Water and Planning 2017a) and results suggest that the groundwater recharge in the Investigation Area will be winter dominated, with monthly rainfall likely to exceed evaporation during winter months (May to August). However, for the remaining months evaporation exceeds rainfall.

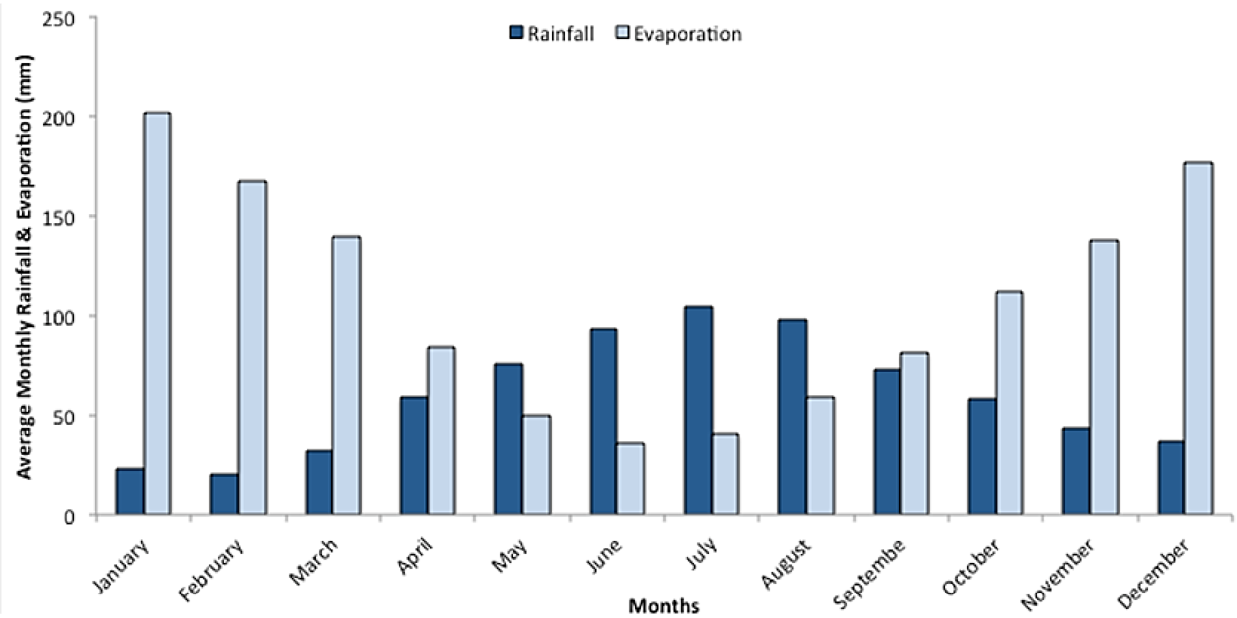


Figure 5-1 Mean Monthly Rainfall (Nelson) and Evaporation (Mt Gambier) (1940 - 2014 BoM Data) Source: Umwelt, 2022 (Figure 21 of DELWP (2017))

The AECOM (2024a) groundwater impact assessment states that *“Climate change is predicted to reduce rainfall in the Glenelg River catchment by between five and 17 per cent assuming two degrees of warming and predicted runoff to reduce by between 18 and 48 per cent (Post et al., 2012). Decreased recharge of the unconfined aquifer may lead to lowered groundwater levels, and reduced discharge to springs and seeps (DAWE, 2020)”.*

AECOM (2024a) state that, *“for the groundwater assessment, climate change is not considered an issue during construction given the proposed construction timeline of two years. During operation, the potential reduction in recharge and lowering of groundwater levels would reduce the potential for, and depth of, groundwater intersection by Project infrastructure (such as turbines and trenches).”*

5.2 Topology and Hydrology

The Project occurs within the Glenelg River Basin and Portland Coast Basin catchments. The wind farm site is positioned predominately within the Glenelg River Basin, whilst the transmission line route is positioned within the Portland Coast Basin.

The general topography of the wind farm site is sloping towards the Glenelg Estuary and Discovery Bay Ramsar site with highpoints across Portland-Nelson Road in the north of the Project Area. The topography on the south side of Portland-Nelson Road follows a local ridgeline that connects a local highpoint to the mountain range running north south, beginning at Mount Richmond, through the Lower Glenelg and Cobboboonee National Parks (AECOM 2024b).

Within and adjacent to the Project, the Glenelg River estuary and Discovery Bay wetland complex comprise a network of freshwater permanent wetlands, intermittently inundated marshes, estuarine waters and intertidal sandy beaches (AECOM 2024b). The wetland system exhibits a complex interaction of surface and groundwater flows and local rainfall runoff (AECOM 2024b).

There are a few ephemeral watercourses with minor hierarchy crossing the area of agricultural land between Portland-Nelson Road and the eastern boundary of the wind farm site (AECOM 2024b). These waterways merge to Johnstone Creek and Mcphails Creek outside of the wind farm site boundary and eventually drain to the Glenelg Estuary and Discovery Bay Ramsar site (AECOM 2024b). The Johnstone Creek catchment intersects with the wind farm site and transmission line route, before draining into the Glenelg Estuary and Discovery Bay Ramsar site (AECOM 2024b). The surface hydrology systems, in combination with the geohydrology systems, are crucial to the estuary functioning, and the freshwater wetlands (DELWP 2017b).

The transmission line route intersects tributaries of Mount Kincaid Creek and Wattle Hill Creek. The land use of the transmission line route is mostly modified agricultural land with some man-made drainage channels connecting to tributaries of Mount Kincaid Creek and Wattle Hill Creek (AECOM 2024b). Mount Kincaid Creek merges with the Surrey River at the south side of Cobboboonee National Park near the junction of Fish Hole Road and Boiler Swamp Road (AECOM 2024b). The assessed condition of Wattle Hill Creek and Surrey River varies from very poor condition to moderate condition (AECOM 2024b).

5.3 Geology

The Project occurs within the Otway Basin, a geological basin of mostly Cretaceous and Cainozoic sedimentary and volcanic rocks, which is around 3,000 m thick at the Project Area.

The surface geology varies across the Project Area. In the windfarm area the surface geology is predominantly aeolian, calcareous dunes and dune limestone (Bridgewater Formation) overlying upper mid-Tertiary limestone (AECOM 2024a). Coastal dunes and minor swamp deposits are present directly to the south of the wind farm site, which form the beach and dune system and the Long Swamp wetlands. East of the of the wind farm site (in the vicinity of the transmission line alignment), the surface geology consists mostly of extrusive basalts of the Quaternary (Holocene) Newer Volcanics, and some inland dunal sands and swamp deposit further east. South-east of the wind farm site the Bridgewater Formation continues parallel with the coast, while inland dunal sands and minor swamp deposits are present further inland and to the east (AECOM 2024a).

The surface Quaternary formations are underlain by the Port Campbell Limestone (PCL), which is greater than 200 m thickness in the Project Area. The PCL comprises a stack of thinly deposited repetitive cycles dipping to the south. It typically consists of grey unconsolidated to semi-consolidated, and rarely lithified, muddy carbonate sands and lesser sandy muds with minor quartz and clay (Radke et al, 2022). Although fractures and joints in the PCL can be widened over time by carbonate dissolution and form secondary porosity, karstification is not pervasively developed as in the Gambier Limestone to the west (Bush, 2009). Further, karst areas were not identified as being present within the study area based on work carried out as part upper Tertiary limestone aquifer groundwater resource appraisal (Jacob, 2016). This is consistent with drilling and testing carried out at the Project Area (AECOM, 2024a).

The Port Campbell Limestone is underlain by the Gellibrand Marl and Lower Tertiary Formations. However, given the thickness of the Port Campbell Limestone, only this formation and overlying Quaternary geology is considered in this assessment.

5.4 Hydrostratigraphy

The aquifers (from the Victorian Aquifer Framework (VAF)) across the Project Area relevant to the hydrogeological conceptualisation are the Quaternary Aquifer (QA) (consisting of the Bridgewater Formation and various aeolian deposits, fluvial, lacustrine, alluvial and colluvial sediments) and the underlying Upper-Mid Tertiary Aquifer (UMTA) (Port Campbell Limestone). At the western end of the transmission line, the Upper Tertiary/Quaternary Basalt Aquifer (UTB) exists above the UMTA. There is no mapped aquitard between the QA/UTB and the UMTA formations, and these two units are considered to be in hydraulic connection at a regional scale (AECOM 2024a). On a local scale, based on the results of the drilling and testing as part of the water resource investigation (AECOM, 2024a), the deeper PCL appears to behave as a confined aquifer.

Table 5-1 Hydrostratigraphy of the study area (AECOM, 2024a)

Sub area	Aquifer (VAF)	Hydrogeological Groundwater Unit	Depth (m below surface) (approximate/typical)
Wind farm site	QA	Various aeolian deposits, fluvial, lacustrine, alluvial and colluvial sediments	0 to 30 (Bridgewater Formation reduces in thickness to around 10 m at lower elevations)
	UMTA	Port Campbell Limestone	30 to 250
Heywood Transmission line (underground cable – west)	UTB	Newer Volcanics Basalt	0 to 50
Heywood transmission line (underground cable – east)	QA	Various aeolian deposits, fluvial, lacustrine, alluvial and colluvial sediments	0 to 5
	UMTA	Port Campbell Limestone	5 to 200

5.5 Hydrogeological conceptual models

AECOM (2024a) have developed three hydrogeological conceptual models based on three sub areas of the project:

1. Wind farm plantation sub-area
2. Wind farm Northeastern sub-area
3. Heywood transmission line sub-area

The conceptual models have been summarised in Table 5-2 and key figures from the AECOM, (2024a) groundwater impact assessment are shown in Figure 5-2 and Figure 5-5.

Table 5-2 Hydrogeological conceptual models for the three sub areas (summarised from AECOM, 2024a)

Conceptual model component	Wind farm plantation sub-area	Wind farm Northeastern sub-area	Heywood transmission line sub-area
General setting	Located on an area of high ground between the coastline and Ramsar wetlands to the south and the Glenelg River to the north. Variable topography characterised by calcareous sand ridges parallel to the coast separated by inter dune swales and closed limestone depressions. Ground surface elevation typically ranges from around 20 to 60 mAHD for much of the plantation sub-area, with some lower lying areas between 10 and 20 mAHD at the southern boundary of the site adjacent to the Ramsar site, swamps and wetlands. At the eastern extent of the plantation sub-area the ground elevation rises to around 120 mAHD. There are no watercourses within the plantation sub-area due to the highly porous and transmissive soils and geology underlying the site	Located at a topographical high point, with lower lying areas towards the Glenelg River to the northwest (approximately 11 km distant), Fitzroy River to the northeast (approximately 7 km distant), and the coastline to the south (approximately 4 km distant). The topography is relatively flat through the central portions of the site (around 145 mAHD) with the ground falling away to the west (approximately 130 mAHD) and east (approximately 135 mAHD). In the northeast portion of the site the land falls away to the north from around 155 mAHD (Piccaninny Mountain) to 120 mAHD at the northeastern sub-area site boundary. Several unnamed drains and waterbodies (classified as flat areas subject to inundation) are located within this sub-area and likely to drain south via the Johnstones Creek catchment. Numerous dams and waterbodies are also mapped as being present within this sub-area.	The proposed 26.6 km long underground transmission line traverses the southern part of the Cobboboonee National Park and Forest Park beneath an existing road (Boiler Swamp Road), then continues beneath farmland to the Heywood Terminal Station. The ground elevation through Cobboboonee National Park and Forest Park falls from a high of around 140 mAHD in the west, to around 40 mAHD in the east. Further east, the topography initially falls gently from around 40 mAHD to 20 mAHD as the route follows west to east alongside the Surrey River. From a low point at approximately 6 km from the edge of the Cobboboonee National Park the ground rises more steeply over the final 2 km to an elevation of approximately 45 mAHD at Heywood Terminal Station the Surrey River, Mount Kincaid Creek and Wild Dog Creek intersect the transmission line corridor, and several waterbodies/wetland areas are also mapped as being within the sub-area.
Relevant geology	Predominantly aeolian, calcareous dunes and dune limestone (Bridgewater Formation) overlying upper mid-Tertiary limestone (Port Campbell Limestone). Some coastal dunes and minor swamp deposits are present directly to the south forming the beach and dune systems and the Long Swamp wetlands. Drilling indicates loose to moderately cemented, fine to coarse grained sand, with occasional interbedded minor limestone layers and occasional shells interpreted as the Bridgewater Formation (bores up to 10 m deep). The Bridgewater Formation increases in thickness from less than 5 m at the southern boundary to more than 30 m in the north. The Port Campbell Limestone is present beneath the Quaternary sediments at shallow depths at the southern boundary of the windfarm area and at greater depths further inland.	Quaternary age aeolian (windblown) coastal and inland dunes (Qdl1), and swamp deposits across the centre of the site (Qm1). Extrusive basalts of the Quaternary (Holocene) Newer Volcanics (Qn) in the eastern portion of the site, and a small eruption site known as Picaninny Mountain present in the northeast part of the site. Drilling in this sub area indicates silty, clayey sand and sand to 6 m. The Newer Volcanics were not encountered during drilling, however, due to the variable thickness of the overlying QA it is possible that the depth to Upper Tertiary Basalt Aquifer (UTBA) could be less than 6 metres in places, particularly close to eruption points such as Piccaninny Mountain.	Regional geological mapping indicates basalts of the Quaternary age Newer Volcanics to be at surface between the windfarm northeastern sub-area and the eastern boundary of the Cobboboonee National Park, with some minor swamp deposits along a small reach of the transmission line corridor. Further east, the surface geology is mapped as being Quaternary age swamp and lake deposits consisting of silt, clay and peat. No project specific bores have been drilled along the transmission line but bores within the state database indicate that shallow geology is predominantly clay formed from weathered basalt. .
Groundwater occurrence	The water table is hosted by the QA or the upper UMTA, dependent on the groundwater elevation compared to the top of the UMTA elevation. There is no mapped aquitard between the QA and UMTA, which are considered to be in direct hydraulic connection and to essentially act as one hydrogeological unit regionally (SRW, 2016). The cross sections provided in AECOM (2024a) suggest that the watertable is predominately in the upper UMTA, however this contact has been marked on the cross section based on the regional mapping (Victorian Aquifer Framework). Drilling for the project indicates the shallow wells (MW* series, <10 m deep) are all installed within the Bridgewater Formation and therefore the water levels measured in these wells represents the watertable elevation. Significant discrete fractures were only encountered at depths of greater than 90 mbgs in the lower UMTA and were overlain by a lower permeability limestone matrix. Based on the drilling and testing for TB01, the deeper UMTA appears to behave as a confined or leaky confined aquifer, separate from the watertable.	The watertable table is hosted by the QA or the upper UTBA, dependent on the groundwater elevation compared to the top of the UTBA elevation. It is unclear whether the QA forms a shallow perched groundwater system and/or to what extent it is interconnected with the underlying Upper Tertiary Basalt Aquifer (UTBA). Given the shallow nature of likely impacts, this data gap is not considered to be material.	The watertable table is hosted by the QA or the upper UTBA, dependent on the groundwater elevation compared to the top of the UTBA elevation.
Hydraulic conductivity	The range of hydraulic conductivities at the shallow monitoring wells varied by an order of magnitude and were estimated at around 4 to 65 m/day, consistent with the lithology encountered by the monitoring bores tested (Bridgewater Formation). Aquifer parameters were also estimated for the deeper test bore TB01 (open hole completion from 54 to 144 metres in the lower Port Campbell Limestone). The test bore targets the deeper portion of the UMTA and encountered discrete fractures at depths of greater than 80 mbgs within the lower permeability limestone matrix. A bulk hydraulic conductivity in the order of 0.11 and 0.17 m/day was estimated from the transmissivity determined by analysis of the 24-hour CRT. The 7-day pumping test supports these hydraulic parameters (Appendix D).	The range of hydraulic conductivities measured in the shallow monitoring wells in this area was between 3.5 and 23 m/day, consistent with the lithology encountered by the monitoring bores tested. It is noted that geology in some areas of the site could be more silty or clayey (such as in the centre of the site where regional mapping indicates swamp deposits). Literature values for lower hydraulic conductivity lithologies such as clays and silts are in the order of less than 0.0001 m/day to 2 m/day (Domenico and Schwartz, 1990).	There is no site-specific data to inform hydraulic conductivity in this sub area. Given the geology, hydraulic conductivity values from the northeastern sub area can be assumed.

Conceptual model component	Wind farm plantation sub-area	Wind farm Northeastern sub-area	Heywood transmission line sub-area
Depth to groundwater	Regional scale mapping indicates that the depth to water table is greater than 10 mbgs across much of the plantation sub-area but reduces to less than 10 mbgs in some areas, including immediately north of the Ramsar site and associated swamps and wetlands. Depth to water varies greatly across the site and increases quickly to the north away from the southern site boundary due the relatively flat water table compared to the undulating ground surface. Variations in groundwater levels general correlate with rainfall trends and seasonal variations are generally less than 0.5 m.	Regional mapping indicates that the water table varies between less than 10 mbgs across much of the northeastern sub-area, to greater than 10 mbgs in localised areas beneath higher topography such as Piccaninny Mountain. Groundwater levels are typically between 1 to 3 mbgs in the summer, and near surface in winter (pers. comm. with landowner); dependent on the local variation in ground surface elevations. This is consistent with the limited monitoring for this sub area.	Much of the transmission line corridor is mapped as having groundwater at less than ten metres below ground surface; based on regional scale interpretation and interpolation. There is no site-specific data to inform groundwater levels in this sub area.
Groundwater flow direction	Inferred groundwater elevation contours for the shallow local groundwater flow system are oriented approximately parallel to the coast, and groundwater flow beneath the site is towards the Ramsar wetlands and the coast. In the QA and shallow portions of the UMTA local groundwater flow systems dominate, with relatively short flow paths between recharge at topographically elevated areas and discharge at topographically depressed lakes, streambeds and springs (Jacobs, 2015). The hydraulic gradient is relatively flat beneath the wind farm plantation sub-area, particular within a kilometre of the southern boundary where the hydraulic gradient is in the order of 0.003 metres change in elevation per horizontal metre (m/m). The hydraulic gradient is inferred to increase to around 0.007 m/m further north. It is inferred that there is a groundwater divide in the shallow groundwater system beneath the higher topography; between the lower lying groundwater discharge areas to the south (i.e. the coast and Ramsar wetland complex), and the north (i.e. the Glenelg River). Groundwater movement within the deeper portions of the UMTA occurs as intermediate to regional scale flow paths. These longer flow paths are less influenced by local scale topographical highs and lows.	Groundwater flow in the QA appears to be radial and away from the central portion of the northeastern sub-area towards the southwest and southeast based on the topography, groundwater elevations and surface water elevations. In the northern section of the site it is anticipated that there will be a component of radial flow away from Piccaninny Mountain (a potentially higher recharge zone) and is seen to be northwards at the northern portion of the northeastern sub-area site. Shallow groundwater levels and flow direction will also be locally influenced by the various table drains constructed across the site.	The regional groundwater flow direction is unclear but likely to follow topography (i.e. west to east and southeast towards the coast at Portland). Local shallow groundwater flow paths are likely to be influenced by local watercourses or groundwater extraction, where present.
Groundwater recharge	Recharge to the QA is via direct rainfall infiltration, which is reduced due to uptake by trees across the plantation area. Under establishing plantation conditions, the recharge rates could be as low as 1% of rainfall and as high as 20% where land is used for crops or pastures (SKM, 2007). Recharge to the upper portions of the UMTA is via rainfall infiltration through the overlying unsaturated QA or leakage from the overlying QA where saturated and hydraulic gradients allow. Recharge to lower portions of the UMTA (targeted by TB01) will occur via leakage from overlying portions of the UMTA or up-dip to the north where it outcrops or sub-crops towards the margins of the Basin.	Recharge to the QA is via direct rainfall infiltration. Piccaninny Mountain is an area of potentially higher recharge. Groundwater may be locally recharged by waterbodies (such as dams, watercourses, or drains) following rainfall events.	Recharge to the QA and UTB is via direct rainfall infiltration. Groundwater may be locally recharged by waterbodies (such as dams, watercourses, or drains) following rainfall events.
Groundwater discharge	Groundwater in the QA and upper portions of the UMTA (the shallow groundwater system) is discharged to the Ramsar wetland complex via relatively high transmissivity sediments; as indicated by on site hydraulic conductivity and shallow hydraulic gradient. Groundwater discharge from the study area in the lower UMTA occurs as throughflow beneath the site as part of intermediate and regional flow systems. These flow paths are generally from regional scale recharge areas at the margins of the basin (north), to regional discharge areas beyond the coast (south).	Discharge from the groundwater is likely to be to the local waterbodies or via evapotranspiration where the watertable is shallow. Throughflow out of the study area in the QA or to underlying geological units is also possible.	Discharge from the groundwater is likely to be to the local waterbodies or via evapotranspiration where the watertable is shallow. Throughflow out of the study area in the QA or to underlying geological units is also possible.
Groundwater surface water interaction	Groundwater elevations close to the southern boundary are at or higher than surface water elevations at various swamps and wetlands (such as Ewings Long Swamp, Small Patch Long Swamp, Lake Mombeong and the Sheepwash). Therefore, shallow groundwater discharge to these features is likely to be occurring. It is possible that localised and temporary reversal of shallow groundwater flow may occur at times (that is, from wetlands to the aquifer). This may occur in response to specific rainfall runoff events and/or tidal events. The groundwater contribution from the underlying UMTA is not known but is anticipated to occur from the upper portions of the UMTA via the Bridgewater Formation and/or alluvial deposits underlying the swamps and wetlands. Some wetlands may receive groundwater flow directly from upper portions of the UMTA where it is intersected by deeper lake systems such as Lake Mombeong, Malseed Lake and Swan Lake.	Spot height survey data collected for several dams and water bodies within the northeastern sub-area, indicate that they are likely to be formed by depressions that intersect the water table when compared to groundwater elevation data from nearby monitoring bores. It is anticipated that these dams would be reliant on groundwater during summer months but, may discharge into the shallow groundwater system locally following rainfall events when surface water elevations are higher relative to groundwater. Based on the information available it is assumed that there is direct connection and interaction between groundwater and surface water.	Groundwater surface water interaction is likely to be limited to local interaction between shallow groundwater in alluvial sediments of associated creeks (such as the Surrey River) and GDEs (such as wetlands). Waterbodies mapped as potential aquatic GDEs in or close to Heywood transmission line sub-area suggest the possibility of local surface water-groundwater interaction at these locations.

Conceptual model component	Wind farm plantation sub-area	Wind farm Northeastern sub-area	Heywood transmission line sub-area
GDEs	The GDE Atlas identifies terrestrial GDEs scattered in small areas across the plantation sub area as well as along the southwestern boundary associated with the Long Swamp Complex and Beach/Dune System (part of the Glenelg Estuary and Discovery Bay Ramsar site). Aquatic GDEs in this area are primarily associated with the mostly confined to the Long Swamp Complex and Beach/Dune System, however small portions are mapped within the plantations. GDE occurrence is described in more detail in Section 6.2.	The GDE Atlas identifies terrestrial GDEs scattered in small areas across the northeastern sub area. Aquatic GDEs in this area are primarily associated palustrine or lacustrine, mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks. GDE occurrence is described in more detail in Section 6.2.	The GDE Atlas identifies terrestrial GDEs scattered in small areas across the transmission line sub area and a large part of the Cobboboonee Forest. Aquatic GDEs in this area are primarily associated palustrine wetlands and temporary freshwater marshes and meadows, as well as the Surrey River. GDE occurrence is described in more detail in Section 6.2.

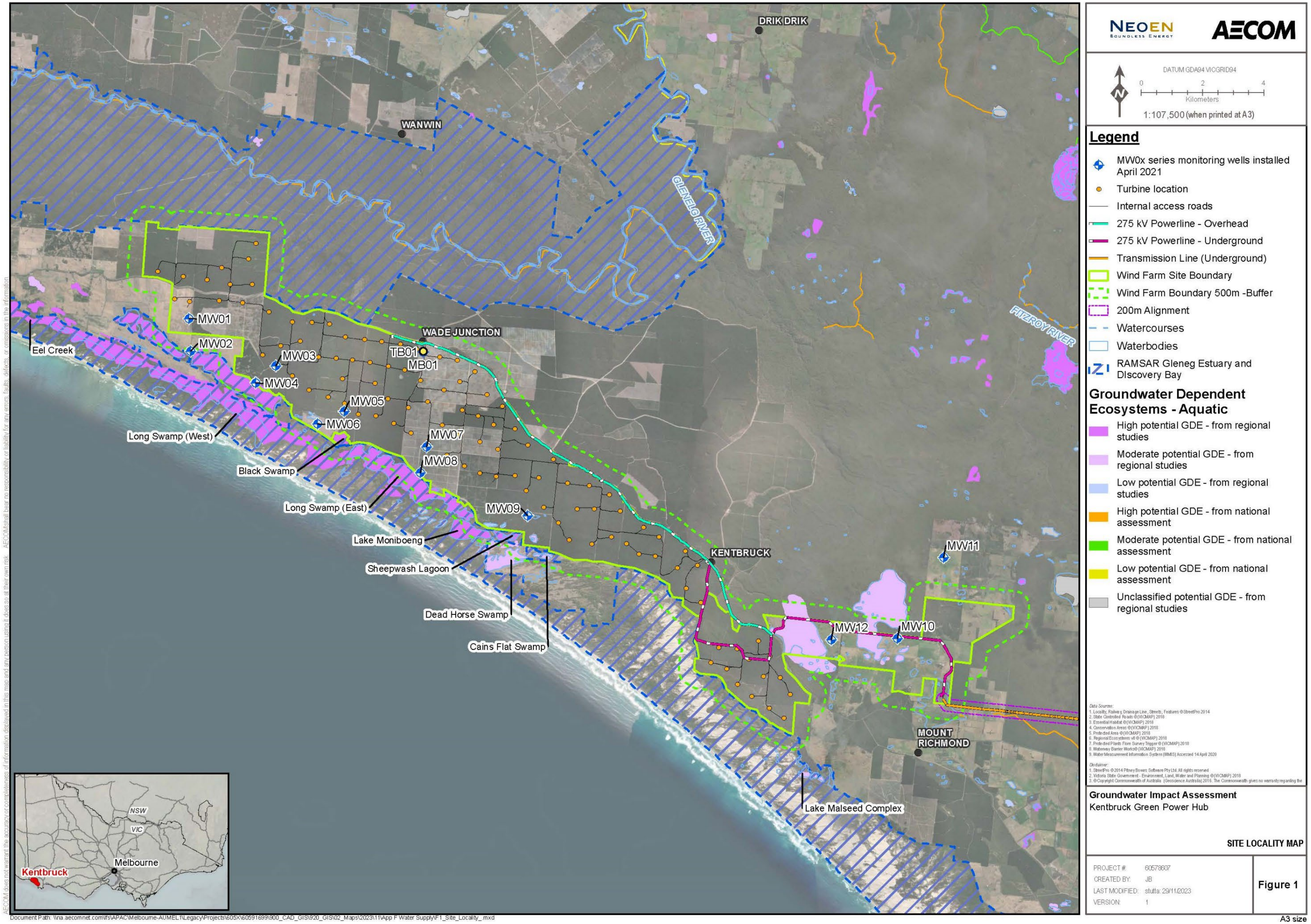


Figure 5-2 Location of onsite monitoring wells, site infrastructure and aquatic GDEs – windfarm planation and windfarm northeast sub areas (from AECOM, 2024a)

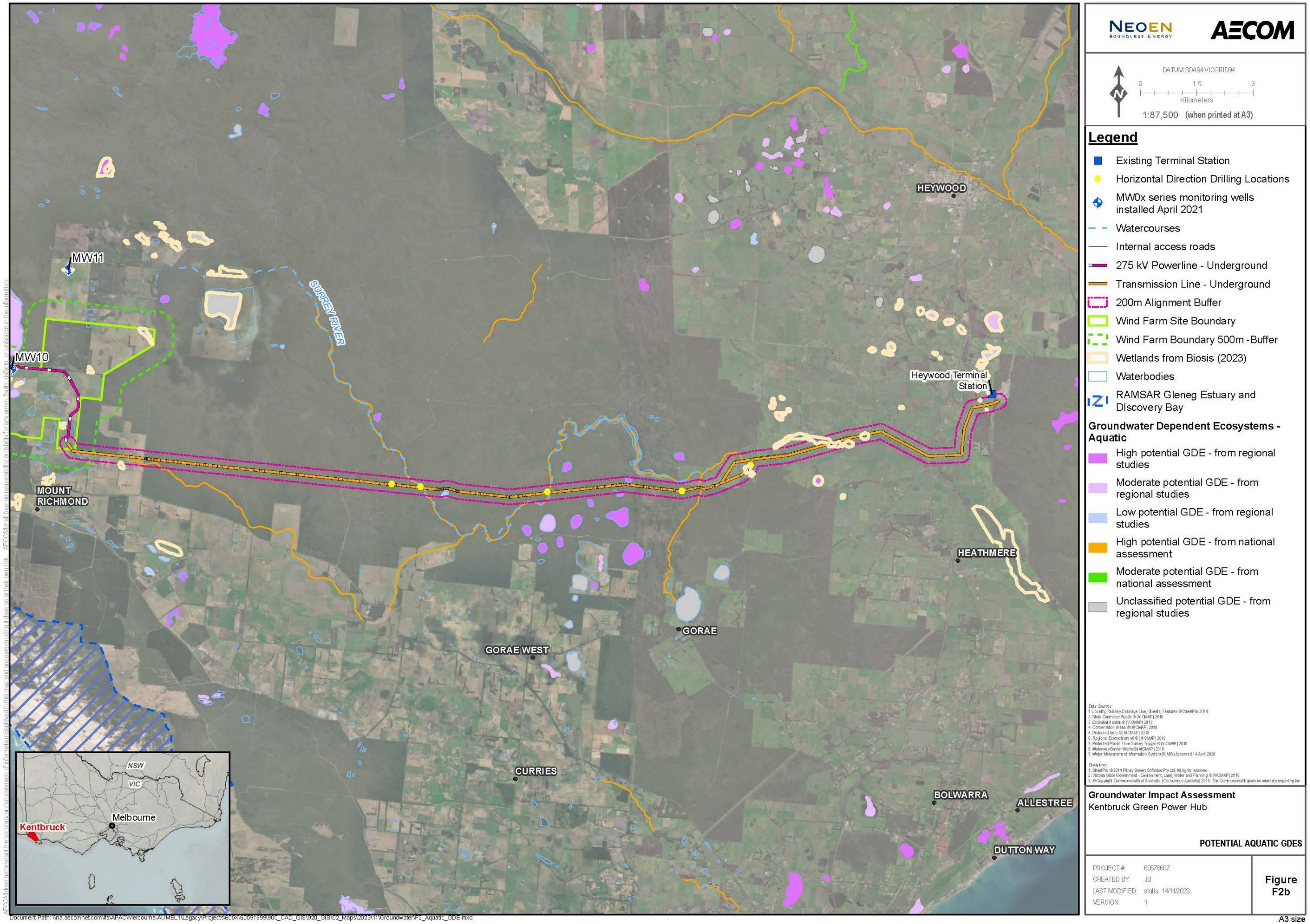


Figure 5-3 **Location of onsite monitoring wells, site infrastructure and aquatic GDEs – transmission line sub area (from AECOM, 2024a)**

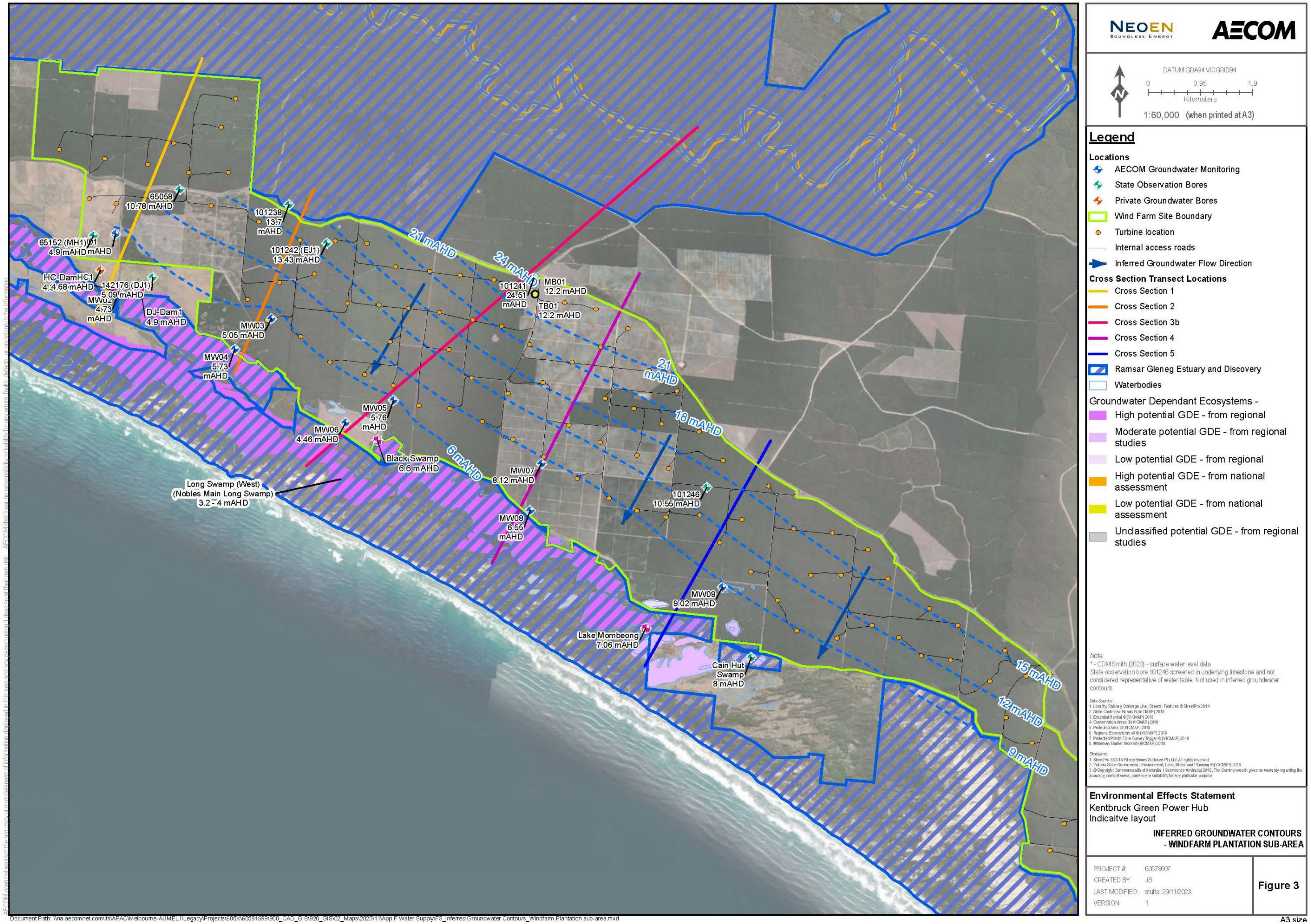


Figure 5-4 Groundwater flow direction for windfarm plantation sub area (from AECOM, 2024a)

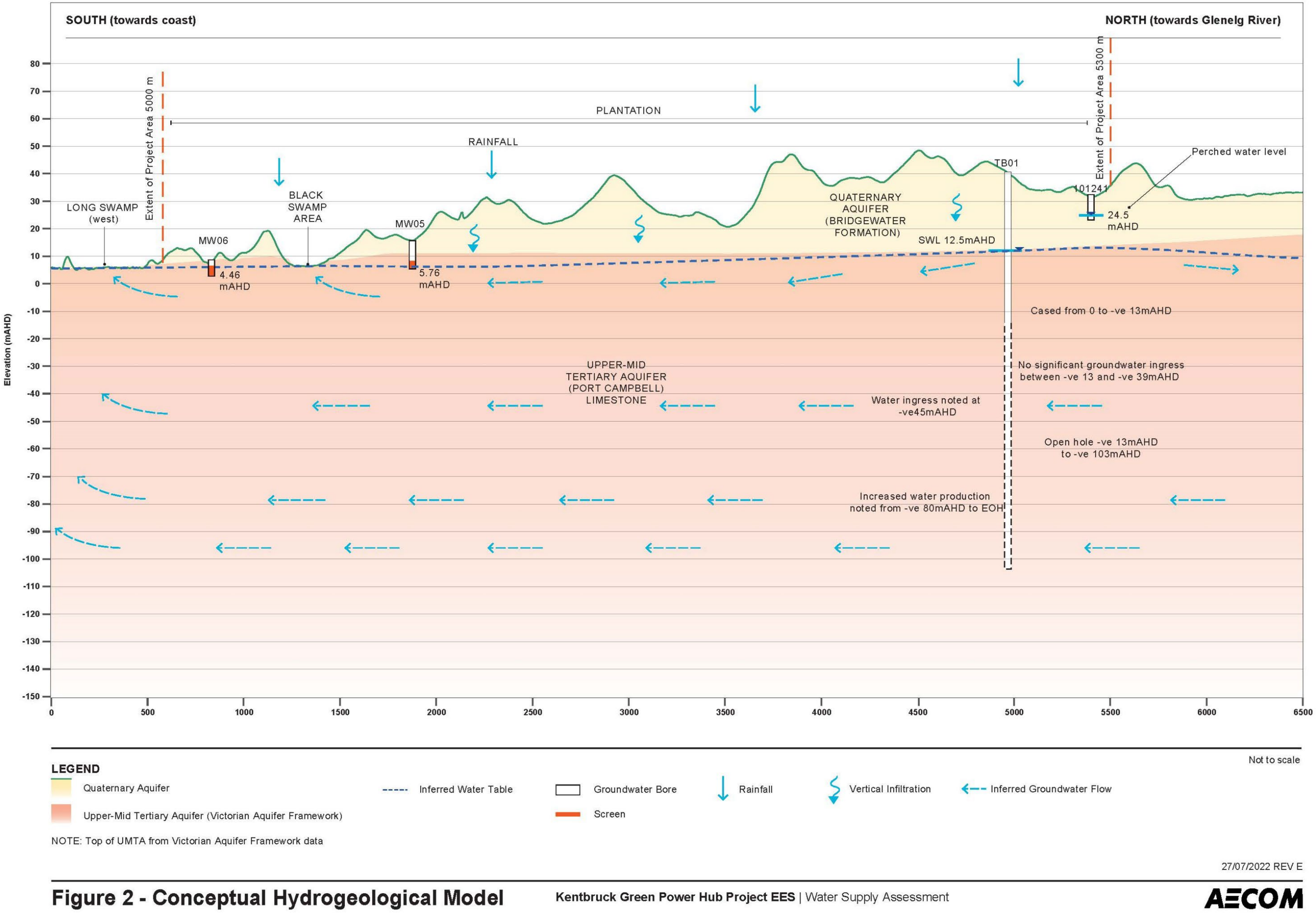


Figure 5-5 Cross section 3b (from AECOM, 2024a)

Section 6 Management Objectives

6.1 Management objectives

One of the key environmental risks identified in the Environment Effects Statement (EES) Scoping Requirements for the Project relate to effects on groundwater that may result in adverse changes to GDEs or affect the ecological character of the Glenelg Estuary and Discovery Bay Ramsar site.

The Scoping Requirements for the Project identify the following key issues relevant to this assessment:

- Potential for adverse effects on the ecological character and biodiversity values of the Glenelg Estuary and Discovery Bay Ramsar site.
- Potential for the Project to have a significant impact on wetland systems, including, but not limited to, Glenelg Estuary and Discovery Bay Ramsar site and its associated aquatic environments, and the ability for wetland systems to support habitat for protected flora and fauna species.
- Potential for adverse effects on nearby and downstream water environments (including Glenelg Estuary and Discovery Bay Ramsar site and listed Nationally Important Wetlands) due to changed water quality, flow regimes, impacts on groundwater or waterway conditions during construction.

It should be noted that this report is focussed solely on GDEs, and therefore where a scoping requirement references native vegetation or wetlands, only those that are identified as being potentially dependent on groundwater have been assessed as part of this report. Other effects on native vegetation or wetlands that are not dependant on groundwater (such as physical disruption) are assessed in the Biosis Flora and Fauna Existing Conditions and Impact Assessment report (Biosis, 2023) and the AECOM Surface water Impact Assessment report (AECOM, 2024b).

6.2 Identification of GDEs(receptor)

For the purpose of this assessment, only groundwater dependent ecosystems (GDE) re considered. Other groundwater values, such as consumptive use, are addressed in the Groundwater Impact Assessment (AECOM, 2024a). Table 6-1 presents the identified GDEs and their likely occurrence within the Project Area, while Figure 6-1 presents these graphically. The GDEs have primarily been identified using the Groundwater Dependant Ecosystem Atlas (GDE Atlas, BoM) which is considered to be a robust assessment of potential aquatic and terrestrial GDEs in this part of Australia. CDM Smith completed a 1-day site walkover on 3rd October 2022 to confirm the locations of the high potential aquatic GDEs such as the Surrey River and Discovery Bay Wetlands in relation to proposed turbine locations near the Ramsar site (since removed) and along the transmission line. The site visit supported that the GDE Atlas adequately identifies the presence of likely high value GDEs in this region and therefore the distribution of GDEs represented in the Atlas has been used to identify GDE locations for this assessment. In addition, wetland mapping provided by Biosis has been used to identify wetlands not included in the GDE Atlas (described in Table 6-1 below) which may or may not be groundwater dependent.

At this stage in the assessment all GDEs regardless of potential groundwater dependence or value are considered as equally likely to exist and of equal value/importance.

Table 6-1 Identified GDE types in the project area.

GDEs	Description	Considered herein?
GDE1 – sub terranean GDEs	Subterranean GDEs refer to aquifer and cave ecosystems generally associated with carbonate rocks and are not well represented in the GDE Atlas in this part of Victoria. AECOM (2024a) state the following in describing the Port Campbell Limestone (PCL): - The PCL consists of grey unconsolidated to semi-consolidated, and rarely lithified, muddy carbonate sands and lesser sandy muds with minor quartz and clay (Radke et al, 2022) - Although fractures and joints in the PCL can be widened over time by carbonate dissolution and form secondary porosity, karstification is not pervasively developed as in the Gambier Limestone to the west (Bush, 2009). - Karst areas were not identified as being present within the study area based on work carried out as part upper Tertiary limestone aquifer groundwater resource appraisal (Jacob, 2016). - The above descriptions are consistent with drilling and testing carried out at MW01 – MW09, TB01 and MB01. Although the presence of cave ecosystems is not likely given the above, a conservative assumption is made that they could exist. Aquifer ecosystems include habitat that supports stygofauna. Stygofauna are animals that live permanently underground in water. In this region, stygofauna may live between grains of sand in the Quaternary aquifer or in fractures and fissures in the limestone aquifer. Sampling for stygofauna in the Project Area was undertaken as part of the Victorian Gas Project (Bold et al., 2020) which sampled bores screened in unconfined aquifers across the Otway Basin to test for stygofauna presence. Two bores were located within the wind farm area screened in the Bridgewater Formation and the Port Campbell Limestone. No stygofauna were identified in these bores during this sampling. The nearest bore with identified stygofauna is 20 km to the north screened in the QA. Although no stygofauna have been identified in the Project Area, the geological setting of limestone and sand aquifers suggests conditions in which stygofauna could exist and therefore, for the purpose of this assessment, it is assumed that stygofauna are present in the Project Area. For the purposes of the assessment, the risk of impacts to stygofauna are used to assess other subterranean GDEs (i.e. changes to water levels, quality and flow will likely effect both in similar pathways). Stygofauna habitat can include all geologies, whereas subterranean caves are only likely in the PCL.	☑
GDE2 – Terrestrial GDEs	The GDE Atlas (BOM, 2022) has identified low to high potential terrestrial GDEs exist across the Project Area. Appendix C.2 provides detail on the terrestrial GDE types. In summary: • In the plantation sub area terrestrial GDEs are primarily associated with Coastal Alkaline Scrub (Long Swamp Complex and Beach/Dune System, part of the Glenelg Estuary and Discovery Bay Ramsar site along the southwestern boundary), Damp Sands Herb-rich Woodland (Plantations and Farmland) and Damp Sands Herb-rich Woodland/Damp Heathland/Damp Heathy Woodland Mosaic (Lower Glenelg National Park) on parallel dune limestone ridges with intervening swamps and closed karst depressions and young volcanoes in the southeast. A total of 185 mapped features with total area of 1,383.8 Ha. • In the northeastern sub area terrestrial GDEs are primarily associated with Wet Heathland/Heathy Woodland Mosaic, mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks. A total of 121 mapped features with total area of 90.9 Ha. • In the transmission line sub area terrestrial GDEs are primarily associated with Lowland Forest, mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks. A total of 213 mapped features with total area of 1,990 Ha. For the purpose of this assessment, all terrestrial GDEs regardless of potential groundwater dependence or value are considered as equally likely to exist and of equal value/importance.	☑

GDEs	Description	Considered herein?
GDE3 – Aquatic GDEs	The GDE Atlas (BOM, 2022) has identified low to high potential aquatic GDEs exist across the Project Area. Appendix C.2 provides detail on the aquatic GDE types. In summary: • In the plantation sub area aquatic GDEs are primarily associated with palustrine and lacustrine wetlands, temporary freshwater swamps, marshes and meadows on parallel dune limestone ridges with intervening swamps and closed karst depressions and young volcanoes in southeast. Aquatic GDEs are mostly confined to the Long Swamp Complex and Beach/Dune System (part of the Glenelg Estuary and Discovery Bay Ramsar site) along the southwestern boundary, however small portions are mapped within the plantations. A total of 20 mapped features with total area of 909.6 Ha. • In the northeastern sub area aquatic GDEs are primarily associated with palustrine or lacustrine wetlands, mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks. A total of 11 mapped features with total area of 462.6 Ha. • In the transmission line sub area aquatic GDEs are primarily associated with palustrine wetlands and temporary freshwater marshes and meadows, mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks. The Surrey River is also identified as a high potential GDE. A total of 18 mapped features with total area of 114 Ha. In addition to the potential GDEs described above, Biosis wetland mapping has been used to identify unmapped wetlands in the northeastern and transmission line areas where shallow groundwater is known to be present. This wetland mapping focuses on wetlands determined as known, likely or suitable habitat for the Brolga (breeding or foraging/roosting that may be used as part of breeding home ranges). These wetlands were mapped using a combination of desktop assessment (including review of aerial imagery) and field assessment (see Biosis, 2023). For the purpose of this assessment, all aquatic GDEs regardless of potential groundwater dependence or value are considered as equally likely to exist and of equal value/importance.	☑

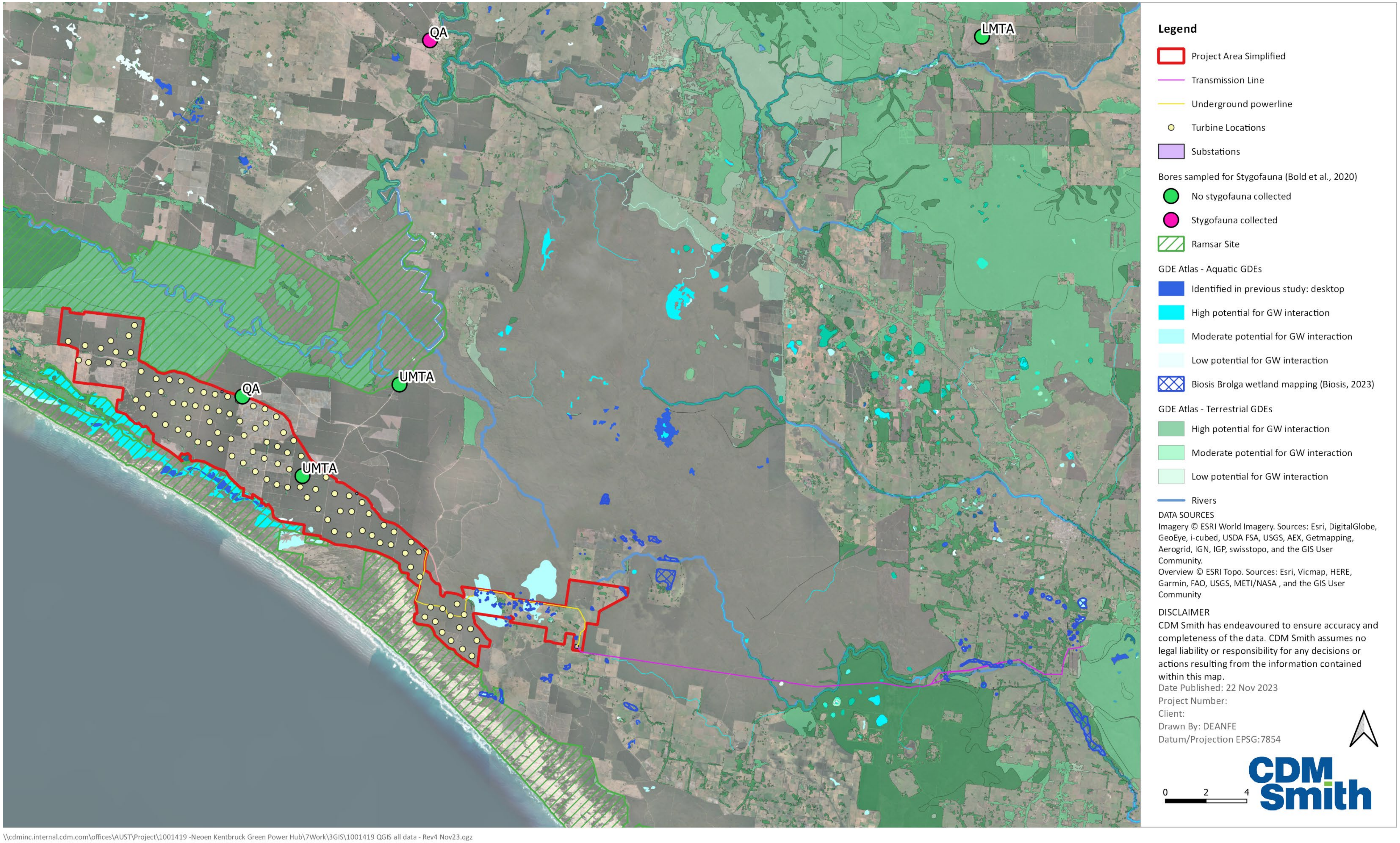


Figure 6-1 Location of mapped GDEs and stygofauna sampling bores from the Victorian Gas Project (Bold et al., 2020)

6.3 Important GDEs in the investigation area

There are some GDEs identified in the Investigation Area and surrounds that are of national importance. These are described in more detail below. These GDEs are included in the GDE Atlas mapping and therefore are included in description of aquatic and terrestrial GDEs in Table 6-1.

6.3.1 Glenelg Estuary and Discovery Bay Ramsar site

The Glenelg Estuary and Discovery Bay Ramsar site (the Ramsar site) is a Wetland of International Importance under the Ramsar Convention and is situated within the Glenelg Hopkins Catchment Management Area. The Ramsar site comprises the western part of Lower Glenelg National Park from the South Australian border to the Nelson - Winnap Road, most of the Discovery Bay Coastal Park and the Nelson Streamside Reserve (DELWP, 2017b). Both the National Park and Coastal Park are managed by Parks Victoria in partnership with Glenelg Hopkins Catchment Management Authority and local stakeholders (DELWP, 2017b).

The Ramsar Site borders the wind farm site along the southern and north-western boundaries and contains numerous mapped aquatic and terrestrial GDEs (Figure 6-1). The Ramsar site protects the Glenelg River estuary and wetlands along the coastal dunes between Nelson and Cape Bridgewater and includes the western part of the Lower Glenelg National Park between the South Australian border and Nelson-Winapp Road.

The Ramsar site covers an area of approximately 22,289 hectares (ha) and supports three broad land systems, which comprise different wetland types (DELWP 2017a), including:

- Freshwater wetlands of several types that lie in a chain behind the dune system. The system that lies to the south of the wind farm site is the Long Swamp complex, which includes Sheepwash Lagoon, Cains Hut Swamp, Lake Mombeong (also known as Lake Bung Bung), Black Swamp, McFarlanes Swamp, and Eel Creek. The Long Swamp Complex is connected to the Glenelg Estuary at Oxbow Lake via Eel Creek.
- The Glenelg River estuary is a seasonally closed salt wedge estuary, which extends from the river mouth upstream for approximately 75 km to near Dartmoor. A portion of this estuary (67.9 km) is also included within the EPBC Act listed endangered threatened ecological community (TEC): *Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community*.
- The beach and dune systems within Discovery Bay Coastal Park, which is a long sandy intertidal beach, outcrops with the underlying limestone in places. A large part of the dune system can be classified as humid dune slacks, a rare and poorly documented wetland type, that comprise depressions in the dune system that hold water (still, groundwater or tidal).

A hydrogeological conceptualisation of the Ramsar site was undertaken in 2020 (CDM Smith, 2020) and the relationships between groundwater and surface water features of the Ramsar sites have been represented in three distinct conceptual models:

- Glenelg Estuary and Oxbow Lake – driven by tidal exchange and river inflows, supported by local and regional groundwater flow to maintain damp conditions and moderate water quality (i.e. freshening) (Figure 6-2)
- Ephemeral shallow wetlands – driven by local rainfall-runoff in combination with groundwater inflows that maintain damp conditions and support both the permanently inundated areas and the hydraulic connectivity between sites defined by diverse ecotones (Figure 6-3)
- Permanent lakes – primarily sourced from groundwater inflows while bathymetry shows deep intersection of the limestone aquifer with fresh groundwater supporting the diversity of ecotones found in and adjacent to these features (Figure 6-4).

The Ramsar site is included in the assessment of potential impacts to GDEs as it is represented in the GDE Atlas as both aquatic and terrestrial GDEs. The Salt Wedge Estuary Community TEC is assessed in the Flora and Fauna Impact Assessment (Biosis, 2023). Conservation advice for this TEC (DoEE, 2018) defines the extent of the community and specifies buffer zone to be considered when determining likely significant impacts on the community, including a groundwater buffer zone of at least 200 m from the edge of the estuary. All groundwater affecting activities are outside this buffer and the proposed groundwater extraction (TB01) is 3 km from the TEC.

The Ramsar site meets five of the nine Ramsar listing criteria, as detailed in Appendix C.1. A Significant Impact Assessment, in accordance with Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (Department of the Environment 2013), is included in Section 9.3.

6.3.2 The Karst Springs and Associated Alkaline Fens of the Naracoorte Coastal Plain Bioregion

The Karst Springs and Associated Alkaline Fens of the Naracoorte Coastal Plain Bioregion TEC was listed as Endangered under the EPBC Act on 15 December 2020. The TEC is a type of permanent groundwater dependent wetland occurring on low lying areas in the near-coastal zone between Millicent in South Australia and Portland in Victoria (TSSC 2020). The TEC is part of a once extensive system of wetlands that occurred on low lying areas over Gambier limestone bedrock near the coastal zone of the Otway Basin (Geoscience Australia 2021) in South Australia and western Victoria (Grimes, Mott & White 1999).

The primary defining features of this community are the underlying limestone geology, karst fed (alkaline) freshwater springs, soaks, pools or streams and fringing fens which include herblands, peatlands, sedgelands and/or shrubland vegetation (TSSC 2020). Wetland dependent plants within the ecological community range from aquatic, emergent to fringing terrestrial species. Only fringing native vegetation that is hydrologically connected (at least intermittently) or dependent on the Tertiary limestone aquifer is part of the TEC.

Occurrences are limited to near coastal areas with limestone substrates, mostly at elevations of less than 2 metres above sea level, with some occurrences potentially up to 25 metres above sea level (Biosis, 2023). Within the Investigation Area, known occurrences include Lake Mombeong, which also forms part of the Glenelg Estuary and Discovery Bay Ramsar site. With regards to the Project and as noted by Biosis (2021, pers. comm., 20 October to Umwelt):

- Wetlands within the Plantation and Northeastern sub-areas are not expected to be permanent or semi-permanent and therefore are unlikely to satisfy the hydrological diagnostic criteria to qualify for listing as the TEC. Native species present in these wetlands include *Juncus* spp., *Gahnia* spp., common tussock grass (*Poa labillardieri*) and tall sedge (*Carex appressa*), which are typical of seasonally inundated wetlands where some soil moisture is present for most of the year, but periods of drying can be tolerated.
- There are some low-lying areas within the Transmission Line sub-area dominated by exotic grasses and some rushes, however these areas do not meet the diagnostic characteristics or condition thresholds to qualify for listing as the TEC.

A key diagnostic feature for the listed community is a hydrological regime that is predominantly groundwater fed, from the tertiary limestone aquifer (DAWE 2020). Notably, the wetlands described above are not in areas of outcropping Tertiary Limestone.

Biosis (2023) completed an impact assessment for this TEC and included the following:

Note that the approved conservation advice for this community recommends a buffer zone of 1220 m from the area of open water to protect occurrences of this community from adverse hydrological impacts or pollution. The open water area of Lake Mombeong is located more than 1,500 m from the nearest wind farm infrastructure. The small wetlands within the Project Area to the north of Lake Mombeong, which are potential examples of this community, do not support areas of open water, and are more than 1,000 m from the nearest wind farm infrastructure. Wetlands on farmland in the eastern section of the wind farm do not represent examples of this community (DAWE 2020).

The TEC is included in the assessment of potential impacts to GDEs as are represented in the GDE Atlas as both aquatic and terrestrial GDEs. All GDEs identified by the GDE Atlas have been assumed to have high value in this assessment. A Significant Impact Assessment, in accordance with Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (Department of the Environment 2013), is included in Section 9.3.

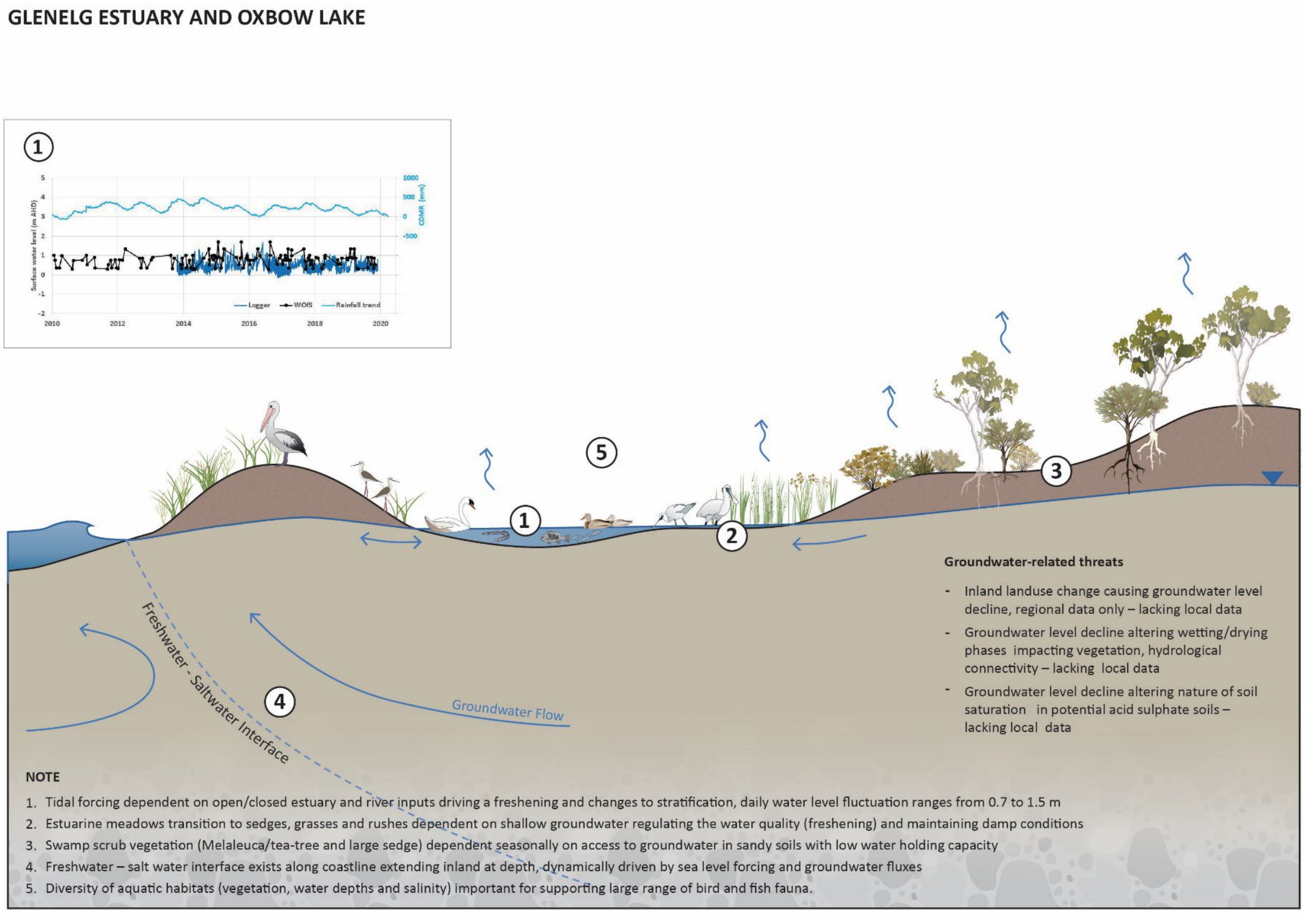


Figure 6-2 Hydrogeological conceptualisation of Glenelg Estuary and Oxbow Lake within the Ramsar site (CDM Smith, 2020)

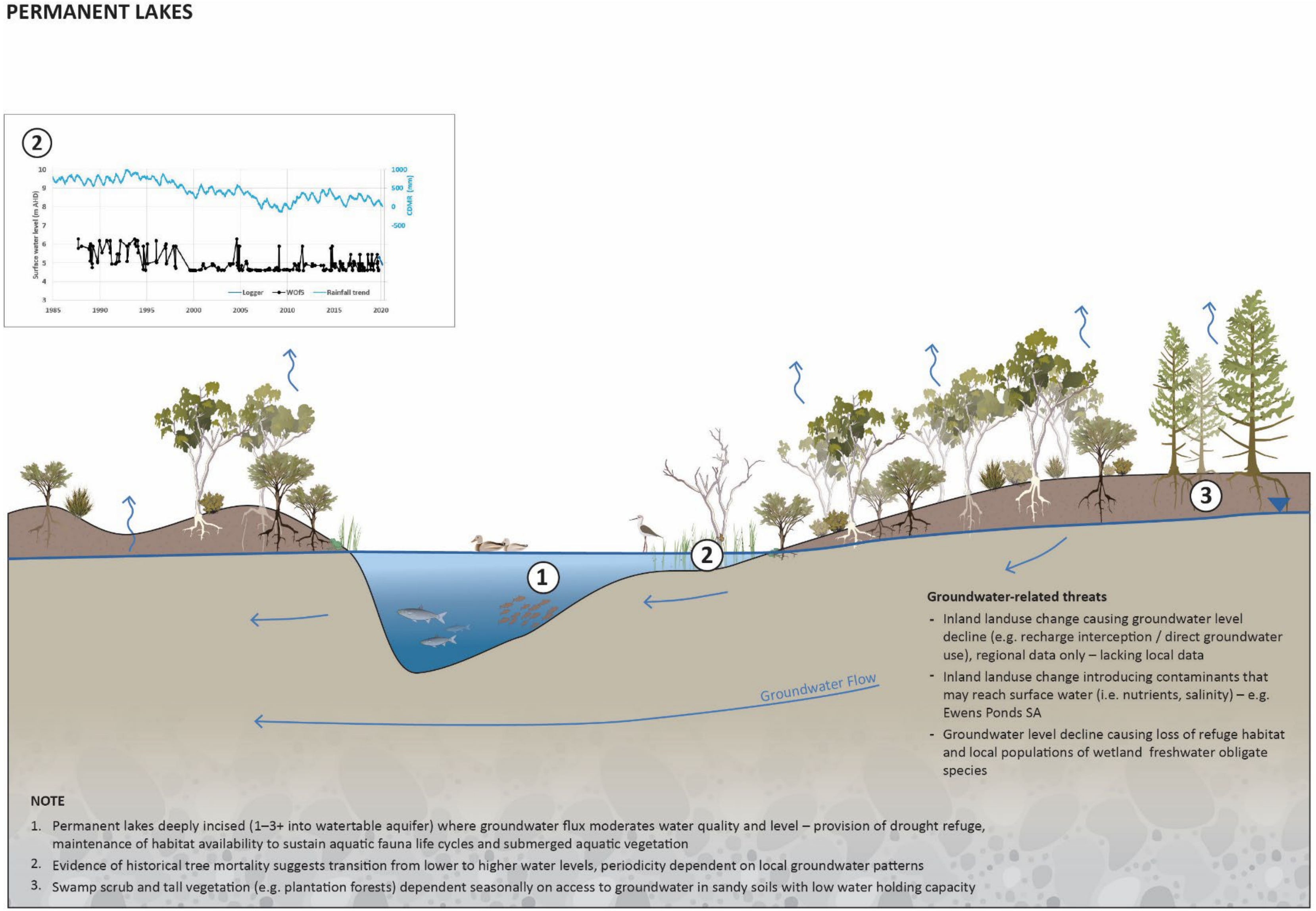


Figure 6-3 Hydrogeological conceptualisation of ephemeral shallow wetlands within the Ramsar site (CDM Smith, 2020)

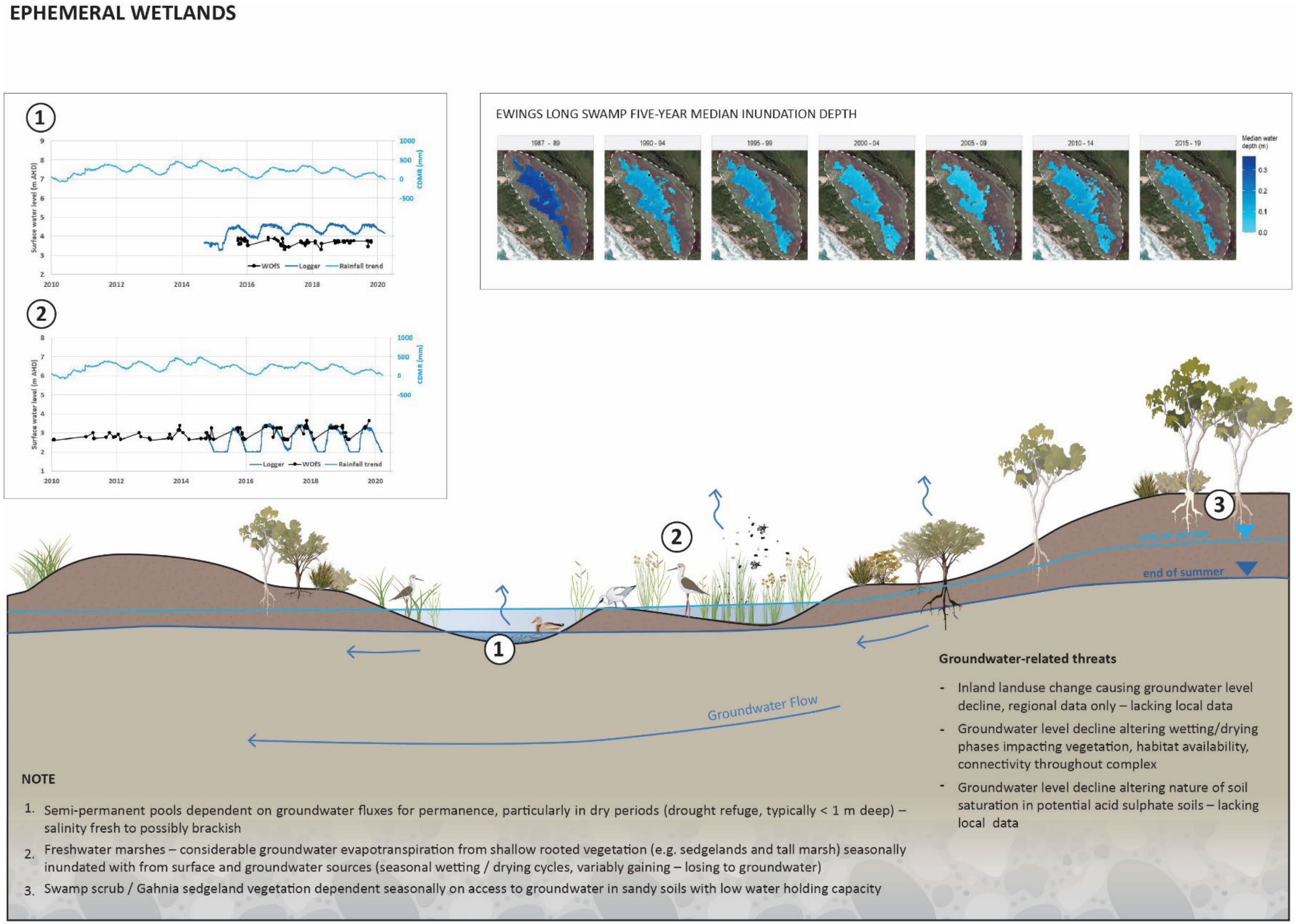


Figure 6-4 Hydrogeological conceptualisation of permanent lakes within the Ramsar site (CDM Smith, 2020)

Section 7 Direct Effects Assessment

7.1 Overview

According to the NWC framework (Howe, 2011), *direct effects* are changes to physical and/or quality aspects of water, resources or the changes to the physical characteristics of groundwater and/or surface water systems, as a consequence of water affecting activities (WAAs). A direct effects assessment seeks to describe the linkage(s) between each of the potential WAAs (i.e. sources) and the applicable potential direct effect(s) (i.e. pathways) for groundwater and surface water. A schematic of this framework is illustrated earlier in this report as Step 3 in Figure 4-1.

This study focuses on WAAs that could impact GDEs via groundwater and surface water impacts associated with the construction and operation of the Project. As discussed previously, other effects on native vegetation or wetlands that are not dependant on groundwater (such as physical disruption) are assessed in the Biosis Flora and Fauna Existing Conditions and Impact Assessment report (Biosis, 2023) and the AECOM Surface water Impact Assessment report (AECOM, 2024b).

7.2 Groundwater Affecting Activities (Source)

WAAs are any activity that have the potential to alter water resources from baseline conditions, for example, the abstraction of groundwater for water supply. In a source-pathway-receptor analysis, WAAs can otherwise be thought of as sources. The AECOM (2024a) Groundwater Impact Study details all potential WAAs relating to groundwater. Additional information has been used from AECOM's (2023) Site Investigation Report in relation to potentially acid sulfate soils impacts and Surface Water Impact Assessment (2024b). These reports identify mitigation measures to avoid or minimise impacts to receptors (see Table 10-3). The WAAs identified in these reports and relevant mitigation measures have been summarised in Table 7-1.

Table 7-1 Identified WAAs (Sources)

WAA (source) ID	Description (AECOM, 2024a; 2024b and 2023)	Considered herein?
WAA1 – turbine foundation dewatering (construction)	Slab (gravity) foundations would involve the excavation of approximately 1600 cubic metres (m^3) of ground material to a depth of approximately 4 m (based on a 25 m diameter foundation). Dry conditions are required to construct turbine foundations and therefore any groundwater encountered during construction would need to be dewatered. Turbine foundations would require dewatering for up to one month while open during construction if groundwater was encountered. Dewatering of an excavation would cause a temporary area of reduced water levels. The magnitude of groundwater level reduction from dewatering will be influenced by the permeability of the saturated material, duration of dewatering, and the depth of groundwater intersected (and thus the rate of dewatering required) (AECOM, 2024a). The Groundwater Impact Assessment (AECOM, 2024a) includes mitigation measures to avoid, minimise and actively manage dewatering. These measures include MM-GW01 (turbine location) and MM-GW02 (dewatering management) (see Table 10-3).	☑

WAA (source) ID	Description (AECOM, 2024a; 2024b and 2023)	Considered herein?
WAA2 – groundwater supply extraction (construction)	A source of water will be required during construction, which will primarily be used for road construction, dust suppression and turbine foundations. The preferred source of water supply for the Project is groundwater from a bore (or bores) within the wind farm site. The current conservative estimate is that up to 250 ML of groundwater would be required over the 24-month construction period. This would likely be extracted from several production wells across the plantation sub-area to ensure adequate firefighting capabilities and to meet dust suppression needs across the Project Area. A water supply assessment undertaken by AECOM (2024a) identified the deep (>80 m) Port Campbell Limestone as a potential water supply target. The Groundwater Impact Assessment (AECOM, 2024a) includes a mitigation measure to manage water supply investigations (MM-GW03, see Table 10-3).	☑
WAA3 – onsite cable trenching dewatering (construction)	The Project would involve the installation of up to 190 km of underground powerlines (33 kV or 66 kV) connecting the wind turbines to the collector substations, and up to 27.8 km of a high voltage powerline connecting the collector substations to the main substation. The high voltage line would be overhead until reaching the eastern collector substation. From there it would either continue overhead along Portland-Nelson Road to a transition station at the Portland-Nelson Road / Sandy Hill Road intersection or would transition to underground at the collector substation and run beneath existing roads in the GTFP pine plantation to the Sandy Hill Road intersection. From there it would pass beneath Portland-Nelson Road then continue underground to the main substation through agricultural land, buried at a depth of 0.8-1.2 metres unless other construction methods such as horizontal directional drilling (HDD) are required. The underground route through the GTFP plantation is the preferred option. If groundwater is encountered during any underground cabling works, dewatering may be required, depending on the construction method. The Surface Water Impact Assessment (AECOM, 2024b) includes a mitigation measures to manage dewatering from trenches (MM-SW01, see Table 10-3).	☑
WAA4 – transmission line cabling dewatering and trenched and trenchless creek and wetland crossings (construction)	The Project would require a new 275 kV transmission line to connect the Project to the existing transmission network. The proposed transmission line comprises 26.6 km length of underground cabling as follows: • 17.6 km within the Cobboboonee National Park and Cobboboonee Forest Park (buried beneath Boiler Swamp Road to minimise environmental impacts) • 1.2 km through freehold agricultural land and crossing the Surrey River (two options have been identified for this section of the transmission line, with the slightly shorter southern route the preferred option) • 7.8 km through freehold land until it reaches Heywood Terminal Station The underground route through Cobboboonee National Park / Forest Park has been delineated into a 6.5 m-wide construction footprint to minimise impacts on native vegetation within the Boiler Swamp Road corridor. Once the transmission line exits Cobboboonee Forest Park, the construction footprint would be approximately 9 m wide. The majority of the transmission line would be constructed using traditional open-cut trenching methods to a depth of approximately 1.25 m. The cabling would be buried beneath an existing road (Boiler Swamp Road) using a specialised machine that uses integrated excavation, cable laying and backfilling equipment. HDD would be used at several crossings of the Surrey River to avoid interaction with the waterway and riparian zone, thereby reducing the risk of transporting sediment into nearby waterways. Trenched crossings are proposed for all ephemeral creeks and wetlands. If groundwater is encountered during any underground cabling works, dewatering may be required, depending on the construction method. The Surface Water Impact Assessment (AECOM, 2024b) includes mitigation measures to manage dewatering from trenches (MM-SW01), management for trenching across waterways (MM-SW03) and HDD drilling (MM-SW04) (see Table 10-3).	☑

WAA (source) ID	Description (AECOM, 2024a; 2024b and 2023)	Considered herein?
WAA5 – quarry dewatering (construction)	A new limestone quarry is proposed to be established in the wind farm site adjacent to the existing quarry owned by Green Triangle Forest Products (GTFP), on North Livingston Road. The quarry material would be used for hardstands and for upgrades to existing access roads or construction of new access roads. The quarry footprint would have an extraction area of approximately 9 ha and be approximately 14 m deep, with actual dimensions to be determined during detailed design. The total extracted volume is estimated to be up to 300,000 m^3, with material to be extracted progressively during construction. Dewatering will be required at the quarry when groundwater is intersected.	☑
WAA6 – turbine foundations impede groundwater flow (operation)	There is a conceivable risk that groundwater flow could be impeded to some extent by the presence of turbine foundations, leading to changes in groundwater levels and groundwater flow direction. ***During the groundwater impact assessment AECOM (***2024a***) state that "Measurable changes in groundwater levels or flow (if any) will be localised and small in magnitude, with groundwater readily flowing around and/or beneath the Project structures. This is based on the relatively shallow foundations and limited depth of groundwater intersected, the width of foundations relative to the regional flow systems, and the fact they are not being keyed into underlying lower permeability materials (i.e. aquitard)."*** ***And following analytical assessment of this potential impact "Impeded groundwater would readily flow around and beneath these foundations, and effects on groundwater levels would be negligible in magnitude and extent away from the foundations."***	☒ No measurable groundwater impact has been identified and therefore no impact to GDEs to assess
WAA7 – cable trenches impeded groundwater flow (operation)	There is the potential for shallow groundwater flow to be impeded by cable trenches following completion with thermally stable backfill if required (typically in the form of flowable concrete) followed by excavated backfill or crushed rock to surface. ***During the groundwater impact assessment AECOM (***2024a***) state that "Any such impacts on shallow groundwater levels due to the trench acting as a barrier (or partial barrier) to groundwater flow are not expected to be material given the size and scale of the trench relative to the aquifers and regional context of groundwater flow, and ability of groundwater to flow beneath the trench."*** ***And following analytical assessment of this potential impact "Potential impacts to groundwater users would therefore be negligible due to changes in groundwater levels up- and down hydraulic gradient of the trench"***	☒ No measurable groundwater impact has been identified and therefore no impact to GDEs to assess
WAA8 – contaminated soil interacting with groundwater	The presence and extent of contaminated soils and groundwater was assessed in the AECOM (2023) Site Investigation (Section 8.1). ***AECOM (***2023***) state that "due to existing and historical land uses within the Project Area, there is a low potential for contaminated soil to be encountered during the construction works. The field investigation, concluded that, based on broadly spaced intrusive investigations, soil contaminants were not found above laboratory limits of reporting or relevant guidelines." And "Based on the site history and field investigation results, it is considered unlikely that the Project construction would encounter unknown contamination that will result in a long-term and irreversible impacts to human health and the environment."*** AECOM (2023) provide contingency measures to be followed in the unlikely event that unknown contamination is encountered to be included in the construction environmental management plan (CEMP) for the Project (relevant mitigation measures are described in Table 10-3, including MM-GW05, MM-CA02, MM-SW01).	☒ Unlikely that soil and groundwater contamination (outside natural conditions) exists and therefore unlikely that groundwater will encounter contaminated soil.

WAA (source) ID	Description (AECOM, 2024a; 2024b and 2023)	Considered herein?
WAA9 – contaminated water or excess sediment entering surface water	Risks to surface water quality were assessed in the AECOM (2024b) Surface Water Impact Assessment (Section 8.1 and Section 8.2). Risks to surface water quality include the mobilisation and discharge of sediment, dewatering of excavations and trenches, contaminated runoff from disturbed ground and pollution from spills. ***AECOM (2024b) assessed all risks to surface water quality from the project as low providing standard environmental management practices are followed during construction and operation of the project. This includes development of a CEMP to include a site-specific surface water management plan (SWMP) that provides details on the recommended mitigation measures and contingency measures aligned with industry best practice guidelines.*** Relevant mitigation measures are described in Table 10 3, including MM-GW05, MM-CA02, MM-SW01.	☒ Unlikely that contaminated water or sediment will migrate to GDEs if standard environmental management practices are followed.
WAA10 – pine clearing for turbine construction	Pine trees will be cleared for construction of turbines. Clearing of pine trees would increase groundwater recharge, as the pine trees are likely to intersect a large portion of infiltrating water through evapotranspiration. It should be noted the area of clearing is minimal in comparison to the overall size of the pine plantation. Cleared areas will be replaced with concrete and therefore infiltration of rainwater will be minimal, and the net effect on groundwater recharge rates will be negligible.	☒ Change to net recharge rates will be negligible

7.3 Direct Effects (Pathway)

The NWC framework defines four (4) categories of direct effects to groundwater arising from WAAs:

1. Altered groundwater quantity.
2. Altered groundwater quality.
3. Altered surface water – groundwater interactions.
4. Physical disruption of aquifers (this effect has not been considered further as potential aquifer disruption impacts have already been considered in the identification of WAAs)

Table 7-2 describes the linkage(s) between the identified WAAs and the applicable potential direct effect(s) for groundwater. Note, only the direct effects with a relevant WAA have been considered further in this assessment. Figure 7-2, Figure 7-1 and Figure 7-3 illustrate the maximum potential impact footprints for each of the WAAs that include drawdown of the watertable.

Table 7-2 Identified Direct Effects (Pathways)

WAA (source)	Direct effects (pathway)		Details from relevant assessment (AECOM, 2024a)	Relevant for further assessment?
	Category	ID		
WAA1 – turbine foundation dewatering (construction)	Quantity	DE01 – drawdown of watertable	**Plantation sub area:** Groundwater monitoring and mapping by AECOM (2023) indicates the watertable in the location of the turbines is likely to be deeper than the proposed turbine footings (>4 m). Due to the depth to groundwater, it is not expected that any dewatering will be required for the construction of turbine foundations. The Groundwater Impact Assessment (AECOM, 2024a) outlines contingency measures if groundwater were to be intersected at a turbine foundation location based on a hierarchy to include changes the location of the turbine to higher ground and development of a dewatering and monitoring plan specific to each location where groundwater is intersected (see Table 10-3 MM-GW01 and MM-GW02). *Turbines previously proposed in areas with a watertable less than 6 m below ground level (e.g. in the lower elevated areas near the Ramsar wetlands or in the northeastern sub area) have been removed during project design updates.*	☒
	Quality	DE02 – exposure of PASS	**Plantation sub area:** No drawdown predicted so no exposure of PASS, not relevant. Mitigation measure MM-CA03 (AECOM, 2023) includes development of a detailed Acid Sulfate Soil Management Plan (ASSMP) to manage ASS and any associated waters – see Table 10-3.. *Turbines previously proposed in areas with a watertable less than 6 m below ground level (e.g. in the lower elevated areas near the Ramsar wetlands or in the northeastern sub area) have been removed during project design updates.*	☒
	Altered GW/SW interactions	DE03 – change in groundwater levels/flow	**Plantation sub area:** No drawdown predicted so no change to gw-sw interaction, not relevant. *Turbines previously proposed in areas with a watertable less than 6 m below ground level (e.g. in the lower elevated areas near the Ramsar wetlands or in the northeastern sub area) have been removed during project design updates.*	☒

WAA (source)	Direct effects (pathway)		Details from relevant assessment (AECOM, 2024a)	Relevant for further assessment?
	Category	ID		
WAA2 – groundwater supply extraction (construction)	Quantity	DE04 – drawdown of watertable	Extraction of groundwater for supply purposes will induce reduction of pressures in the pumped aquifer. An impact assessment was carried out as part of the groundwater supply and hydrogeological Assessment (AECOM, 2024a) and a 7-day constant rate test was completed in 2023 by CDM Smith. During the 24-hour testing, the aquifer (discrete fracture zones in the UMTA at depths <80 m) behaved as a confined system meaning that impacts to the watertable and any connected water features would be unlikely. The 7-day test supported the outcomes of the 24 hour test and identified a potential leaky aquitard behaviour with very low vertical hydraulic conductivity values for the aquitard, meaning very slow leakage rates. Forward modelling of the leaky confined aquifer scenario using the timeframe and rates for the potentiation water supply indicates a large cone of depressurisation in the pumped aquifer, some depressurisation in the aquitard (assuming conservative assumption of a fully penetrating observation well) and no "measurable drawdown" (i.e. >0.1 m as defined in the Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems) in the overlying watertable aquifer (see DE07 below). As there is no predicted measurable drawdown in the overlying watertable aquifer predicted, this direct effect is not assessed further. Mitigation measure MM-GW03 (AECOM (2024a) includes additional water supply investigations as part of groundwater take and use application to be undertaken in consultation with SRW – see Table 10-3.	☒
	Quality	DE05 – exposure of PASS	The proposed water supply location is in an area of the site where no ASS has been identified and ASS is not expected based on the surface geology. Further, no measurable drawdown in the watertable aquifer is expected based on the results of the pumping tests and forward modelling. No management for ASS is required. Mitigation measure MM-CA03 (AECOM, 2023) includes development of a detailed Acid Sulfate Soil Management Plan (ASSMP) to manage ASS and any associated waters – see Table 10-3.	☒
		DE06 – extraction induces saline intrusion	Pumping significant volumes of groundwater in coastal areas can induce reductions in groundwater levels in the fresher water, such that upward or lateral flow occurs from the salt wedge. This can then increase salinity within the freshwater lens. Groundwater extraction for construction supply will be from deeper portions of the UMTA and will occur from around 5 to 6 km from the coast. Lateral flow or upward leakage from the 'salt wedge' is not anticipated based on the depth of extraction, distance from the coast, the sea water and groundwater interaction model, and short-term, temporary extraction (AECOM, 2024a). Mitigation measure MM-GW03 (AECOM (2024a) includes additional water supply investigations as part of groundwater take and use application to be undertaken in consultation with SRW – see Table 10-3.	☒

WAA (source)	Direct effects (pathway)		Details from relevant assessment (AECOM, 2024a)	Relevant for further assessment?
	Category	ID		
	Altered GW/SW interactions	DE07 – change in groundwater levels/flow	Pumping from a confined aquifer can result in changes to groundwater-surface water interaction. The current conceptualisation suggests the deeper pumped aquifer is leaky confined and therefore there is a possible connection between the pumping and overlying surface water features (although very limited). Maximum depressurisation in the pumped aquifer and aquitard and drawdown in the watertable aquifer have been predicted using an analytical model forward prediction software (Aqtesolv) using the leaky confined solutions Moench (1985) and Neuman-Witherspoon (1969). In order to achieve the required volume of 250 ML over two years, a rate of 4 L/sec has been modelled at TB01. The drawdown and depressurisation limit of 0.1 m is applied in these scenarios based on the Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems definition of "measurable drawdown". • Average pumping rate of 4 L/s, 24 hours a day, 365 days a year for 2 years continuous pumping (252 ML in total). Maximum depressurisation extent in the pumped aquifer at 730 days is 60 km. Maximum depressurisation extent in the aquitard is 12 km. No drawdown above 0.1 m in the overlying aquifer. Drawdown in the pumping well may exceed available drawdown and therefore more than one supply bore would be required pumping at lower rates. Although the watertable aquifer (overlying aquifer) is not predicted to be impacted by drawdown, leakage from the aquitard could impact the water balance in the watertable aquifer over the longer term. One well pumping at 4 L/sec has been used in the impact assessment as this is the currently proposed scheme, to be confirmed during the take and use licence application process. Mitigation measure MM-GW03 (AECOM (2024a) includes additional water supply investigations as part of groundwater take and use application to be undertaken in consultation with SRW – see Table 10-3.	☑
WAA3 – onsite cable trenching dewatering (construction)	Quantity	DE08 – drawdown of watertable	**Plantation sub area:** It is not anticipated that groundwater will be intersected by the shallow cable trenches (up to 1.2 m deep) within the plantation sub-area based on the measured depth to watertable, and therefore no dewatering will be required and no drawdown of the watertable.	☒
			Windfarm northeastern sub area: A limited depth of groundwater intersection may occur at the northeastern sub-area where groundwater was measured to be between one and three mbgs (in April 2021) and anticipated to be near surface during winter months. The depth of any groundwater intersection during trenching would be limited (i.e. less than one metre) and along localised sections in lower lying areas. Also, dewatering durations would be in the order of hours (rather than days). Modelling by AECOM (2024a) indicates drawdown away from the trench section being dewatered would be negligible at distances beyond 10 to 20 metres and occur for less than a week. Note, dewatering is not likely to be required along the entire length of trenching.	☑
	Quality	DE09 – exposure of PASS	**Plantation sub area:** No drawdown predicted so no exposure of PASS, not relevant. Mitigation measure MM-CA03 (AECOM, 2023) includes development of a detailed Acid Sulfate Soil Management Plan (ASSMP) to manage ASS and any associated waters – see Table 10-3.	☒

WAA (source)	Direct effects (pathway)		Details from relevant assessment (AECOM, 2024a)	Relevant for further assessment?
	Category	ID		
			Windfarm northeastern sub area: This area of the site (called the Central Wind Farm in the AECOM assessment (2023)) is identified as an area requiring management for ASS if soils are disturbed. The predicted potential drawdown is of limited duration and extent – the trench depth is to 1.2 m depth so even assuming groundwater is at the surface during excavation, a maximum of 1.2 m drawdown would occur at the trench. Groundwater levels measured in bores in this area in April and October 2021 indicate seasonal variations of 0.87 m (MW10), 1.65 m (MW11) and 1.27 m (MW12). These seasonal variations indicate the watertable will not be lowered below typical seasonal fluctuations, and therefore exposure of PASS beyond what is typically experienced is unlikely. A detailed ASS Management Plan will be developed for this area, as per recommendations in the AECOM assessment (2023). Mitigation measure MM-CA03 (AECOM, 2023) includes development of a detailed Acid Sulfate Soil Management Plan (ASSMP) to manage ASS and any associated waters – see Table 10-3.	☒
	Altered GW/SW interactions	DE10 – change in groundwater levels/flow	**Plantation sub area:** No drawdown predicted so no change to gw-sw interaction, not relevant	☒
			Windfarm northeastern sub area: Drawdown of the watertable can result in changes to groundwater-surface water interaction. However, given the limited extent and very short duration (less than one week), it is unlikely that drawdown in the watertable would induce changes to the groundwater-surface water regime.	☒
WAA4 – transmission line cabling dewatering and trenched and trenchless creek and wetland crossings (construction)	Quantity	DE11 – drawdown of watertable	The shallow depth of trenching will limit the potential to penetrate a significant depth below the water table, and dewatering (if required) would be carried out for a short duration only (hours rather than days) immediately prior to installation of the cable and backfill. Given the low hydraulic conductivity of shallow soils likely to be encountered (clay or silty/clay), the limited depth of in-trench groundwater (less than 1.25 metres) and short duration of dewatering (in the order of hours rather than days), drawdown away from the trench would be very limited. Modelling by AECOM (2024a) indicates drawdown away from the trench section being dewatered would be negligible at distances beyond around 5 metres and occur for less than a week. Note, dewatering is not likely to be required along the entire length of trenching. AECOM (2024b) has conducted a waterway crossing assessment to identify which creeks/wetlands are perennial and therefore require trenchless crossings. Trenchless crossings are achieved using horizontal directional drilling (HDD), so the creek/wetland is not disturbed at the surface. This method should also prevent drawdown. Mitigation measures MM-SW01 (Dewatering Plan), MM-SW03 (Trenching Across Waterways) and MM-SW04 (HDD Water Crossings) (AECOM, 2024b) provide details on how these activities will be managed – see Table 10-3.	☑

WAA (source)	Direct effects (pathway)		Details from relevant assessment (AECOM, 2024a)	Relevant for further assessment?
	Category	ID		
	Quality	DE12 – exposure of PASS	A search of the Australian Soil Resource Information System (ASRIS) was undertaken and shows the alignment is in an area of 'extremely low probability' and 'low probability' of acid sulphate soils (very low confidence). Most of the transmission line cable is located in an area of the site where no ASS has been identified and ASS is not expected based on the surface geology (Newer Volcanics Basalt). However, in the eastern end of the transmission line swamp and lake deposits may occur. Although no testing of these sediments has been undertaken, dewatering of these types of sediments may cause the exposure of ASS to occur and acidity to be mobilised. This area of the site (the eastern end of the Heywood Transmission Line) is identified in the AECOM assessment (2023) as an area requiring management for ASS if soils are disturbed. Mitigation measure MM-CA03 (AECOM, 2023) includes development of a detailed Acid Sulfate Soil Management Plan (ASSMP) to manage ASS and any associated waters – see Table 10-3.	☑
		DE13 – sediment/ drilling mud release to creeks / wetlands	The transmission line route includes direct interface between construction and waterways/creeks and therefore there is a risk of quality impacts to waterways from the proximity of the works. Trenched crossings are planned for ephemeral creeks and wetlands. Even if works are planned around flows, there is still a risk of rainfall events causing direct runoff from construction activities to the ephemeral watercourses. Trenchless crossings involve the HDD method which should prevent impacts to groundwater and surface water flows in the perennial streams. Risks from this method include release of drilling muds into the waterway or the method failing due to ground conditions. Mitigation measures MM-SW01 (Dewatering Plan), MM-SW03 (Trenching Across Waterways) and MM-SW04 (HDD Water Crossings) (AECOM, 2024b) provide details on how these activities will be managed – see Table 10-3.	☑
	Altered GW/SW interactions	DE14 – change in groundwater levels/flow	Drawdown of the watertable can result in changes to groundwater-surface water interaction. However, given the very short timeframes for dewatering to occur during laying of the transmission line, changes to the interaction of groundwater and surface water are unlikely.	☒
WAA5 – quarry dewatering (construction)	Quantity	DE15 – drawdown of watertable	A new limestone quarry is proposed to be established in the northern central part of the wind farm plantation sub area, adjacent to the existing quarry owned by Green Triangle Forest Products (GTFP), on North Livingston Road. The adjacent existing quarry is at a depth of approximately 18 mbgs (current base of quarry surveyed to be 35.97 mAHD) and groundwater has not been intersected. This is consistent with the inferred groundwater elevation of approximately 18 mAHD (i.e. 36 m below the rim of the quarry). Based on conditions at the existing quarry and maximum depth of the 15 mbgs at the proposed new quarry, groundwater will not be intersected, and a dewatering impact pathway has not been identified.	☒
	Quality	DE16 – exposure of PASS	No drawdown predicted so no exposure of PASS, not relevant. Mitigation measure MM-CA03 (AECOM, 2023) includes development of a detailed Acid Sulfate Soil Management Plan (ASSMP) to manage ASS and any associated waters – see Table 10-3.	☒

WAA (source)	Direct effects (pathway)		Details from relevant assessment (AECOM, 2024a)	Relevant for further assessment?
	Category	ID		
	Altered GW/SW interactions	DE17 – change in groundwater levels/flow	No drawdown predicted so no change to gw-sw interaction, not relevant	☒

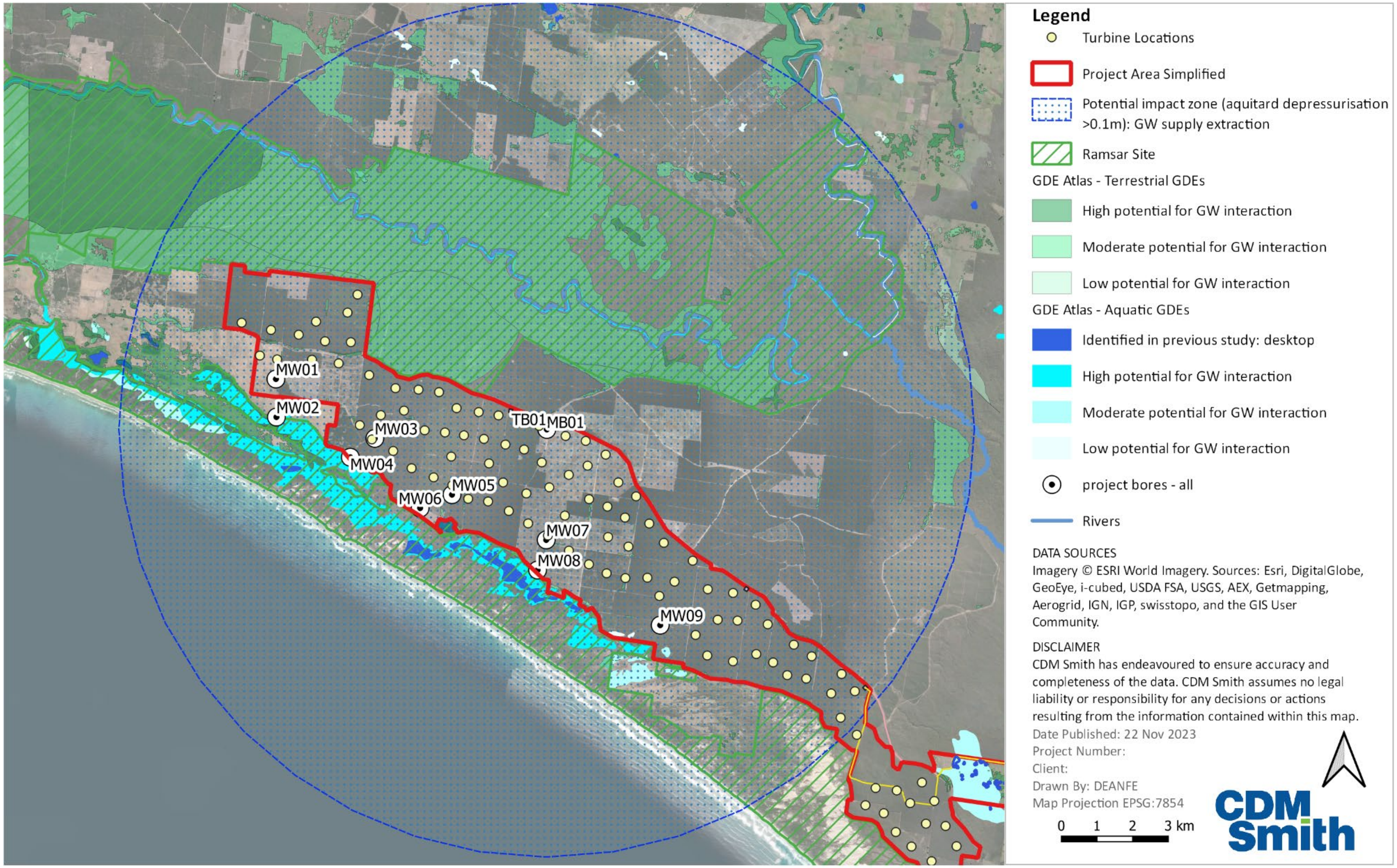


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Figure 7-1 Potential impact zone (depressurisation within aquitard >0.1m – no predicted drawdown in the watertable) for WAA2– shown as 12 km from current extraction bore

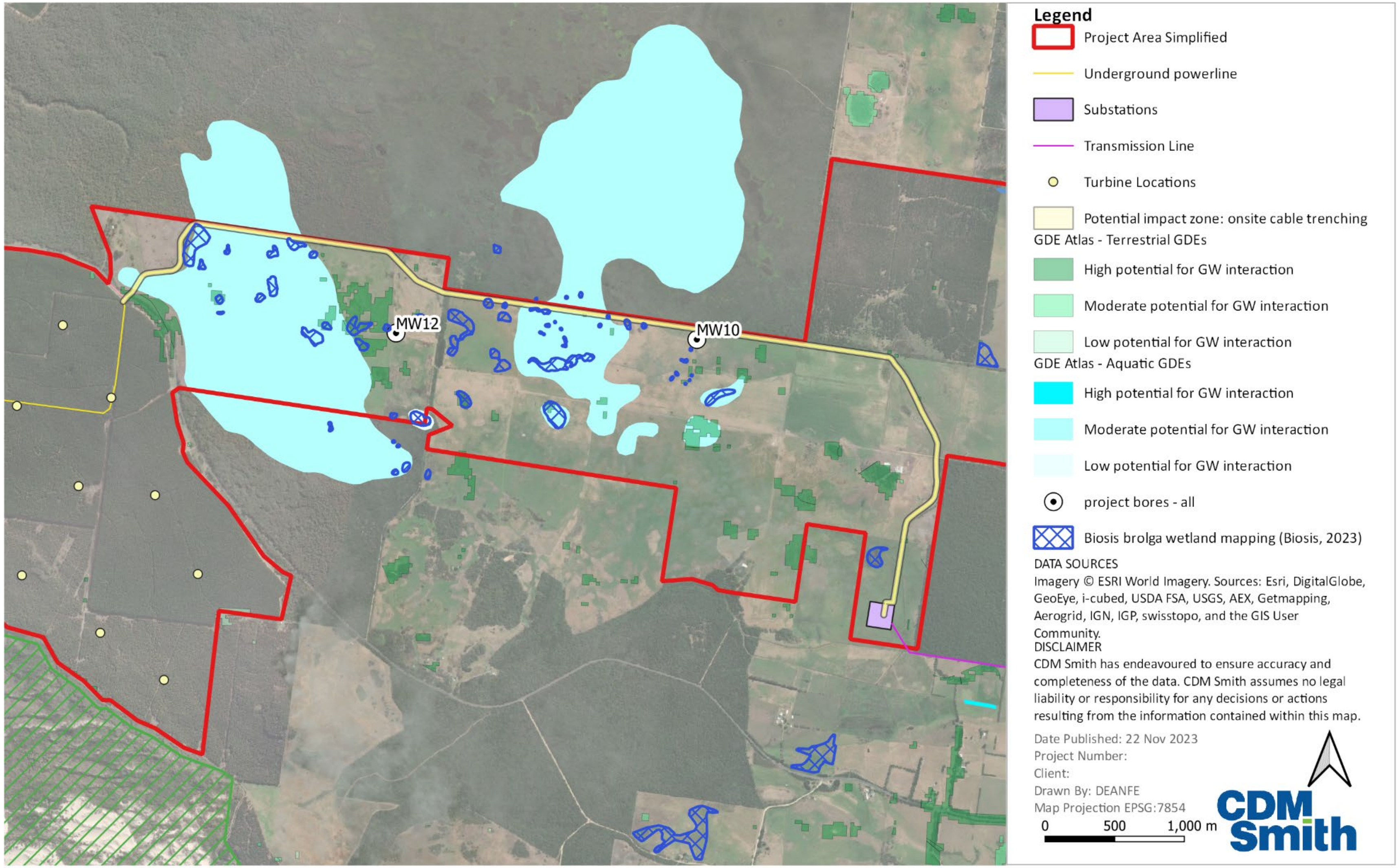

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Figure 7-2 Potential impact zones (drawdown of watertable) for WAA3 – shown as 20 m either side of proposed trench location

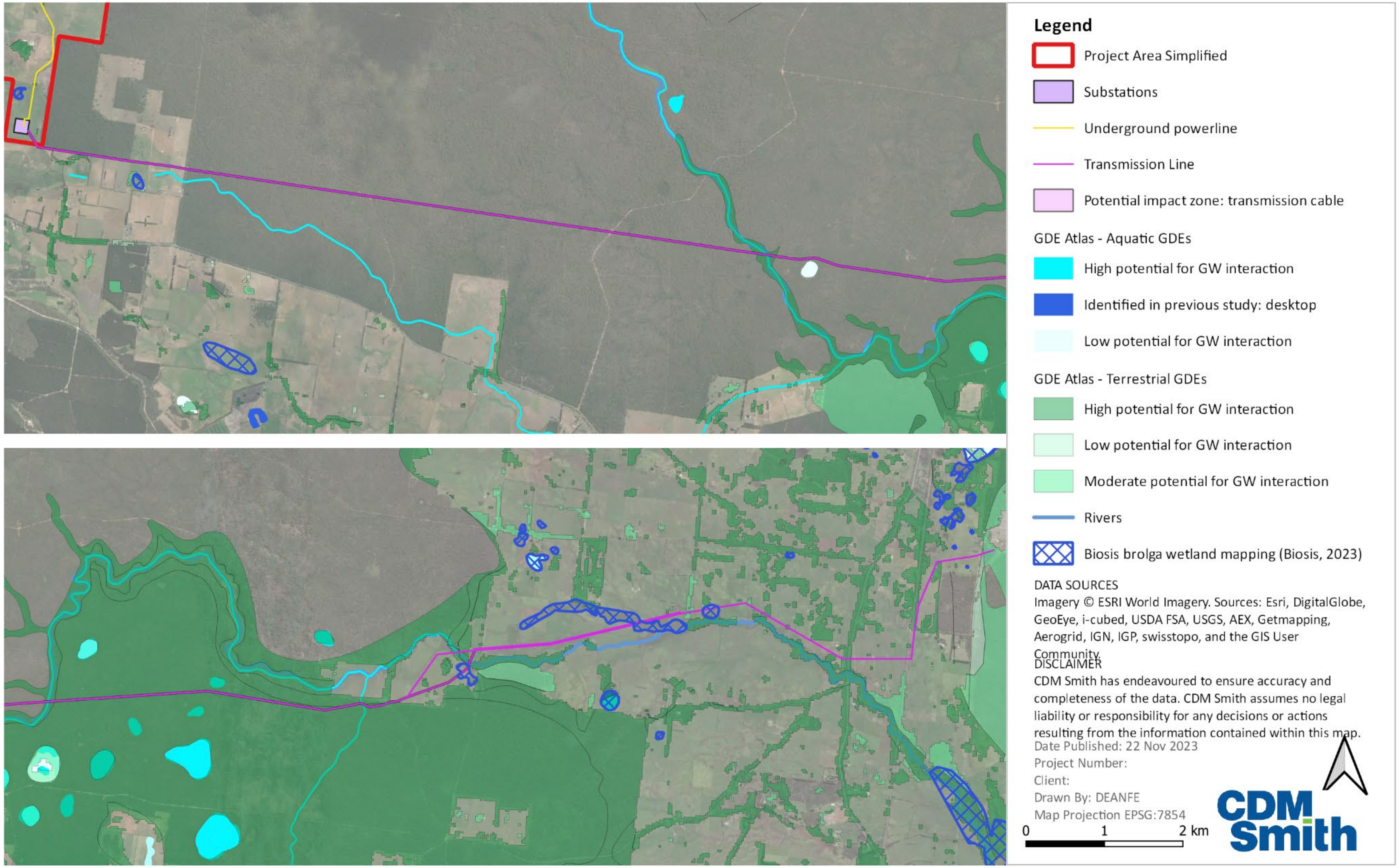

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Figure 7-3 Potential impact zone (drawdown of watertable) for WAA4– shown as 5 m either side of proposed trench location

Section 8 GDE Exposure Assessment

8.1 Exposure Pathway and Linkages

An exposure pathway describes the process by which a direct effect can alter baseline water conditions such that an GDEs environmental water requirement[1] (EWR) are impacted. For example, if dewatering for turbine bases (a source) causes drawdown of the water table (direct effect), an exposure pathway exists if drawdown increases the depth to the water table beyond the root zone of groundwater reliant vegetation(receptor).

Table 8-1 presents a summary of possible exposure pathways between direct effects (source) and potentially sensitive GDEs (receptors) that have been identified in the Project Area. The active exposure pathways are discussed further as part of the threat (impact) assessment in Section 9.

[1] The amount of water required to sustain a GDE, with a minimum risk of degradation.

Table 8-1 Possible exposure pathway for potential GDEs

GDE (receptor)	WAA (source)	Direct effect (pathway)		Indirect (GDE) effect	Active pathway (linkage)?	Carried forward to threat assessment?
GDE1 – Subterranean GDEs (Stygofauna)	WAA2 – groundwater supply extraction (construction)	Altered GW/SW interactions	DE07 – change in groundwater levels/flow	Changed gw-sw interactions could impact stygofauna habitat or other subterranean habitat	**No**. The presence or absence of stygofauna in the Project Area has not been identified but suitable stygofauna habitat in the Project Area is assumed to be present, as well as other potential subterranean habitat. The proposed pumping is predicted to depressurise the pumped aquifer and some of the overlying aquitard, which does not result in a reduction in saturated aquifer volume, and therefore no impact to the available stygofauna and sub terranean habitat.	☒
	WAA3 – onsite cable trenching dewatering (construction)	Quantity	DE08 – drawdown of watertable (windfarm northeastern sub area)	Decrease in groundwater levels could impact stygofauna habitat	**No**. The presence or absence of stygofauna in the Project Area has not been identified but suitable stygofauna habitat in the Project Area is assumed to be present. The groundwater at the site seasonally rises and falls following rainfall patterns. Any stygofauna present at the site will be able to move vertically within the aquifer to account for this seasonal change. The short term and temporary changes in watertable elevation that may occur if trench dewatering is required is unlikely to compromise the habitat of stygofauna in the aquifer. The stygofauna habitat at the site is non-unique and therefore any temporary change in habitat is unlikely to result in a loss of species. Therefore, although stygofauna may occur along the cable route, the duration and limited extent (less than 1 m of drawdown up to 20 m from cable trench for less than one week) would be very unlikely to impact these communities. No drawdown is predicted in the PCL and therefore other subterranean GDEs unlikely to be affected.	☒
	WAA4 – transmission line cabling dewatering and trenched and trenchless creek and wetland crossings (construction)	Quantity	DE11 – drawdown of watertable	Decrease in groundwater levels could impact stygofauna habitat	**No**. The presence or absence of stygofauna in the Project Area has not been identified but suitable stygofauna habitat in the Project Area is assumed to be present. The groundwater at the site seasonally rises and falls following rainfall patterns. Any stygofauna present at the site will be able to move vertically within the aquifer to account for this seasonal change. The short term and temporary changes in watertable elevation that may occur if trench dewatering is required is unlikely to compromise the habitat of stygofauna in the aquifer. The stygofauna habitat at the site is non-unique and therefore any temporary change in habitat is unlikely to result in a loss of species. Therefore, although stygofauna may occur along the transmission line cable route, the duration and limited extent (less than 1.25 m of drawdown up to 5 m from cable trench for less than one week) would be very unlikely to impact these communities. No drawdown is predicted in the PCL and therefore other subterranean GDEs unlikely to be affected.	☒
		Quality	DE12 – exposure of PASS	Change in groundwater quality from PASS exposure could impact stygofauna habitat	**No**. The presence or absence of stygofauna in the Project Area has not been identified but suitable stygofauna habitat in the Project Area is assumed. Given the very short duration of exposure, and limited magnitude and extent (likely within seasonal variations), the mobilisation of acidity such that it would cause damage to stygofauna habitat is unlikely.	☒
		Quality	DE13 – sediment/ drilling mud release to creeks / wetlands	Change in wetland water quality could impact stygofauna habitat	**No**. The presence or absence of stygofauna in the Project Area has not been identified but suitable stygofauna habitat in the Project Area is assumed. Any environmental incident involving release of sediment or drilling muds into the creeks would be of short duration and unlikely to impact the groundwater environment.	☒
GDE2 – Terrestrial GDEs	WAA2 – groundwater supply extraction (construction)	Altered GW/SW interactions	DE07 – change in groundwater levels/flow	Change in groundwater level / flow could alter the availability of water being sourced by terrestrial vegetation	**No.** The area of impact represents potential depressurisation in the aquitard, which would not impact vegetation accessing groundwater in the watertable aquifer. No change to groundwater levels in the watertable aquifer are predicted and therefore there is no impact pathway for a reduction of availability of groundwater to terrestrial vegetation.	☒
	WAA3 – onsite cable trenching dewatering (construction)	Quantity	DE08 – drawdown of watertable (windfarm northeastern sub area)	Decrease in groundwater levels could reduce the groundwater available to terrestrial vegetation	**No**. Although high potential terrestrial GDEs occur along the cable route, the duration and limited extent (less than 1 m of drawdown up to 20 m from cable trench for less than one week) would be very unlikely to impact vegetation which would be accustomed to seasonal variations within this range.	☒
	WAA4 – transmission line cabling dewatering and trenched and trenchless creek and wetland crossings (construction)	Quantity	DE11 – drawdown of watertable	Decrease in groundwater levels could reduce the groundwater available to terrestrial vegetation	**No**. Although high potential terrestrial GDEs occur along the transmission cable route, the duration and limited extent (less than 1.25 m of drawdown up to 5 m from cable trench for less than one week) would be very unlikely to impact vegetation which would be accustomed to seasonal variations within this range.	☒
		Quality	DE12 – exposure of PASS	ASS impacted groundwater could impact terrestrial vegetation using groundwater as a source of water	**No**. High potential terrestrial GDEs occur along the transmission cable route. Given the very short duration of exposure, and limited magnitude and extent (likely within seasonal variations), the mobilisation of acidity such that it would affect vegetation using groundwater is unlikely.	☒
		Quality	DE13 – sediment/ drilling mud release to creeks / wetlands	Decrease in water quality could impact terrestrial vegetation relying on this water source	**No.** The short-term release of sediments or muds into a waterway is unlikely to impact terrestrial vegetation using groundwater	☒

GDE (receptor)	WAA (source)	Direct effect (pathway)		Indirect (GDE) effect	Active pathway (linkage)?	Carried forward to threat assessment?
GDE3 – Aquatic GDEs	WAA2 – groundwater supply extraction (construction)	Altered GW/SW interactions	DE07 – change in groundwater levels/flow	Decrease in groundwater availability for aquatic ecosystems	**Yes.** It is possible that the extraction of groundwater for use could result in less groundwater being available for aquatic GDEs via depressurisation of the aquitard separating the pumped aquifer and the watertable aquifer. The volume of water that could leak from the overlying aquifer is dependent on pumping rates and duration.	☑
	WAA3 – onsite cable trenching dewatering (construction)	Quantity	DE08 – drawdown of watertable (windfarm northeastern sub area)	Decrease in groundwater levels could reduce the groundwater available for aquatic ecosystems	**No.** Although moderate potential aquatic GDEs and mapped brolga wetlands (Biosis, 2023) occur along the cable route, the duration and limited extent (less than 1 m of drawdown up to 20 m from cable trench for less than one week) would be very unlikely to impact these ecosystems.	☒
	WAA4 – transmission line cabling dewatering and trenched and trenchless creek and wetland crossings (construction)	Quantity	DE11 – drawdown of watertable	Decrease in groundwater levels could reduce the groundwater available for aquatic ecosystems	**No**. Although high potential aquatic GDEs occur along the transmission cable route (Surrey River) and brolga wetlands (Biosis, 2023), the duration and limited extent (less than 1.25 m of drawdown up to 5 m from cable trench for less than one week) would be very unlikely to impact these ecosystems. Trenchless crossings have been proposed (AECOM, 2024b) for the crossings of the Surrey River and therefore drawdown in the areas of the aquatic GDEs is not likely to occur.	☒
		Quality	DE12 – exposure of PASS	ASS impacted groundwater could impact aquatic ecosystems if ASS migrates to wetland/creek	**No. P**otential aquatic GDEs along the transmission line route are associated with the Surrey River and mapped potential brolga wetlands (Biosis, 2023). River crossings will not be trenched and therefore dewatering, and drawdown (to expose PASS) will not occur in the vicinity of this aquatic GDE. For other GDEs the duration and limited extent (less than 1.25 m of drawdown up to 5 m from cable trench for less than one week) would be very unlikely to impact these ecosystems.	☒
		Quality	DE13 – sediment/ drilling mud release to creeks / wetlands	Reduction in water quality could impact aquatic ecosystems	**Yes.** The release of sediments or drilling mud to waterways could impact aquatic ecosystems that rely on clear water. The Surrey River is identified as an aquatic GDE.	☑

Section 9 Threat Assessment

9.1 Overview

The threat assessment brings together the direct effects (impacts) and GDE exposure assessments to provide the basis from which to assess consequences arising from development activities (Project WAAs). This assessment involves consideration of direct effects (altered groundwater resource condition, such as water table decline and groundwater quality) and, importantly, GDE (or indirect) effects, such as loss of biodiversity or reduced water access by GDEs (Howe, 2011). This forms the impact assessment for GDEs.

The Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems have been applied where they are applicable to complete impact pathways, i.e. in circumstances where groundwater extraction causes watertable drawdown and GDEs are within the drawdown cone (>0.1 m).

9.2 Potentially Threatened GDEs

9.2.1 Overview

Table 9-1 provides a summary of the active exposure pathways and potentially threated GDEs. Only two active exposure pathways have been identified, and any impact from these pathways is expected to be spatially limited and of short duration (up to 3 years during construction). The results suggest aquatic GDEs may be impacted by direct effects relating to (i) changes in groundwater flow to surface waters, and (ii) sediment or drilling mud entering surface waterways, potentially causing indirect effects (impacts) to receptors. These impacts will require management to decrease the likelihood of the indirect effects occurring. Discussion regarding the threat to each GDE is presented in the below subsections, including discussion of the extent, magnitude and duration of potential impacts.

Table 9-1 Summary of the identified potentially threatened GDEs and direct and indirect effects (impact)

GDE (receptor)	WAAs (source)	Direct effect (pathway)	Indirect (GDE) effect
GDE3 – Aquatic GDEs	WAA2 – groundwater supply extraction (construction)	DE07 – change in groundwater levels/flow	Decrease in groundwater availability for aquatic ecosystems
	WAA4 – transmission line cabling dewatering and trenched and trenchless creek and wetland crossings (construction)	DE13 – sediment/ drilling mud release to creeks / wetlands	Reduction in water quality could impact aquatic ecosystems

9.2.2 GDE3 – Aquatic ecosystems

9.2.2.1 Groundwater supply extraction

The proposed groundwater supply will likely target the deeper (more than 80 m deep) Port Campbell Limestone aquifer. The test pumping of TB01 indicates a sustainable yield to meet supply demands can be met with one well (TB01), however, it is likely that multiple wells pumping lower volumes will be installed, so that firefighting capacity can be met. It should be noted, final locations of, and extraction rates at proposed wells have not been determined and this assessment is based on the currently available information. Mitigation measure MM-GW03 (Table 10-3) includes further water supply investigation as part of the groundwater take and use application that will be undertaken with Southern Rural Water (AECOM, 2024a).

The current estimate of water supply demands during construction (2 years) includes dust suppression (73 ML), concreate foundation construction (35.4 ML) and soil moisture conditioning (146 ML) for a total of 254.4 ML over 2 years (127.2 ML/y). This is an average daily rate of 0.35 ML and a maximum daily rate (based on all three activities occurring at once) of 0.45 ML (4 to 5 L/sec).

The AECOM groundwater pumping test (AECOM, 2024a) consisted of a 24-hour pumping test of TB01 (at a rate of 2 L/sec), a 120 m deep test bore cased to 54 m and open hole to 144 m depth (i.e. into the lower UMTA). AECOM (2024a) conclude from the drilling and testing program and analysis of the test data that the deeper Port Campbell Limestone is a confined aquifer and is not connected to the watertable and shallow groundwater users. This conclusion is drawn from the following evidence:

- The drilling results: between 25 m and 54 m depth mud rotary technique was used to drill the borehole and "no drilling mud losses were reported that would have indicated significant permeability through this section of the profile" (AECOM, 2024a). The borehole was cased from surface to 54 m and drilling commenced to 144 m depth using tricone bit and air. Between 54 and 80 m "water and drilling fluids were periodically injected to aid cuttings removal, with no significant water strikes or groundwater ingress observed" and "water ingress was noted at approximately 90 mbgs and an increase in water production noted from around 120 mbgs" (AECOM, 2024a).
- The pumping test: analysis of drawdown and recovery over time in both TB01 and monitoring well MB01 (constructed to the same depth of TB01) indicate a response consistent with a confined aquifer (compared to the Theis aquifer type curve). Drawdown over distance estimates were made based on the aquifer parameters obtained from the pumping test to predict drawdown at MW05 and MW07 (located 3 km away) to be 0.3 m at the end of the test. No drawdown was observed at these bores, which are screened in the shallower watertable. This indicates there is limited connection between the deeper extraction zone and the shallow watertable.

A further 7-day pumping test was completed by CDM Smith in 2023 (Appendix D). This test supports the conceptualisation of a confined aquifer although analysis also fits a leaky confined aquifer with a very low hydraulic conductivity aquitard.

Forward predictions using the leaky aquitard solution by Moench (1985) have been completed using the Aqtesolv analytical software. Both 2 L/sec and 4 L/sec were tested to estimate the potential drawdown at the edge of the Ramsar wetland (3.8 km from the pumping bore) and to estimate the radial extent of the cone of depression in the pumped aquifer (lower UMTA). The Moench solution does not allow for an estimation of depressurisation in the aquitard or drawdown in the overlying watertable aquifer. To make these predictions another leaky aquifer solution (Neuman-Witherspoon, 1969) was used, using the aquitard parameters estimated from the Moench solution. The results are shown in Table 9-2.

Table 9-2 Predicted depressurisation and extent of depressurisation in the pumped aquifer after 730 days of continuous pumping

Pumping scenario	Moench predictions		Neuman-Witherspoon predictions	
	Depressurisation in the pumped aquifer at wetland edge (m)	Extent of cone of depression (to 0.1 m) in pumped aquifer (km)	Depressurisation in aquitard at wetland edge (m)	Drawdown in overlying aquifer at wetland edge (m)
2 L/sec	3	45	0.15	<0.01
4 L/sec	7	60	0.30	<0.01

No drawdown is predicted to occur in the shallow aquifer and therefore the hydraulic gradient to the wetlands in the shallow UMTA and QA is predicted to be maintained throughout the pumping period. Although no drawdown can be observed in the overlying aquifer, the depressurisation in the aquitard indicates some degree of recharge from the aquitard to the pumped aquifer could occur (this is based on modelling a fully penetrating aquitard well which will overestimate depressurisation at the top of the aquitard where it is in contact with the overlying watertable aquifer). In reality, it is more likely that recharge would occur primarily from upgradient throughflow within the pumped aquifer, however, to account for the inherent uncertainty in predicting aquifer behaviour, a conservative assessment has been undertaken to estimate the maximum magnitude of a potential impact. This assessment consists of a simple water balance which assumes the entire pumped volume (250 ML over 2 years) is sourced from the aquitard (calculations shown in Appendix D):

- The cone of depressurisation in the pumped aquifer is predicted to be up to 60 km in radius at the end of 2 years continuously pumping at 4 L/sec (252 ML in total compared to predicted requirement of 250 ML). This is based on the edge of the cone of depressurisation at 0.1 m in line with the Ministerial Guidelines.
- The leakage from the aquitard would be expected to occur across the entire cone of depressurisation. Conservatively assuming leakage only occurs where depressurisation in the pumped aquifer is greater than 1 m, the cone of leakage would be 15 km in radius.
- The proportion of this cone of leakage that is overlain by the Ramsar wetlands is around 2%, but to take into account areas of the shallow aquifer that may be contributing groundwater to the wetlands, a value of 20% (10 times) has been assumed.
- The total volume of water that will be extracted (and could therefore be sourced from the aquitard) is 252 ML over 2 years.
- Assuming this volume was all sourced from the aquitard in the 2-year pumping period, the volume leaking from the aquitard underlying the wetland and contributing areas would be 26 L/year ($2x10^{-2}$ L/year/Ha).
- In reality, the leakage would take much longer due to the low hydraulic conductivity of the aquitard. The Aqtesolv forward modelling indicates it would take at least 35 years for the system to fully recover, which would mean 1.5 L/year ($1x10^{-4}$ L/year/Ha) would leak from under the wetlands and contributing areas of the shallow aquifer.

The water balance shows that leakage from the aquitard and overlying shallow aquifer would have a negligible effect on the overlying aquifer groundwater water balance and GDEs.

Using conservatism to manage uncertainty

The above assessment uses conservative assumptions to account for the inherent uncertainty in predicting aquifer behaviour. All models are simplified representations of reality and therefore any model prediction contains uncertainties. A conservative approach does not aim to make exact and/or reliable predictions but aims at making overestimated predictions. The conservatism is a buffer between the model predictions and the reality of the natural system, which is always to some extent unknown by definition. The magnitude of the buffer cannot be known but the conservative approach offers confidence that reality will be within the envelope provided by the conservative prediction. If a highly conservative approach does not result in an estimated impact to the receptor, there can be confidence that no impact will occur, regardless of the uncertainty.

Assumptions for the type of analytical modelling used in this assessment include assuming a homogeneous, isotropic aquifer of infinite aerial extent and uniform thickness. These assumptions are not satisfied for a fractured rock aquifer where groundwater flow is through secondary porosity. However, given the information from the desktop assessment and drilling, sufficient fracturing exists in the limestone that it will likely act as a porous flow media on the regional scale. Some anisotropy is likely to exists (evidence in the discrete fracture zones encountered during drilling) and therefore the cone of depression is likely to be ellipsoidal rather than circular. Given the conservative water balance calculations, this is not considered to be a material limitation.

The conservative assumptions in this assessment include:

- It is unlikely that all water sourced for the water supply would come from the aquitard. It is more likely that the aquifer would be replenished from upgradient recharge and throughflow.
- Leakage from the aquitard would occur across the cone of depressurisation, not just within the 1 m depressurisation contour. If the entire cone of depressurisation is taken into account (60 km to 0.1 m), less than 0.1 L/year over 35 years ($6x10^{-6}$ L/year/Ha) would occur from the wetland area and contributing shallow aquifer.

Table 9-3 GDE3-WAA2-DE04 Ministerial Guidelines Assessment

<table>
<tr><th>Step</th><th>Assessment</th><th>Comments</th></tr>
<tr><td>Step 1</td><td>Screening questions:
Is the aquifer unconfined?
No
Are there high value GDEs within the licence application area?
Yes</td><td>The aquifer is conceptualised as confined (or leaky confined) and therefore this WAA is screened out at this step of the assessment. However, to account for inherent uncertainty in predicting aquifer behaviour, the next steps have been completed.

If the pumped aquifer was unconfined (the results of the pumping test do not support an unconfined aquifer conceptualisation), the cone of drawdown would be much smaller as unconfined aquifers have much greater volumes of accessible stored water. In this case, assuming a specific yield of 0.1 and transmissivity of 17 m^2/day, the cone of drawdown would be <1 km and there would be no GDEs within the “licence application area”. The Ministerial Guidelines assign a consequence of “none” where no high value ecosystems are within the application area.</td></tr>
<tr><td>Step 2</td><td>Likelihood for aquifer/wetlands<table><tr><td>Unlikely</td><td>The groundwater is “confined”
Perched watertable in all conditions</td></tr><tr><td>Possible</td><td>Perched watertable in summer/dry conditions</td></tr><tr><td>Certain</td><td>Watertable at or above base of wetland in summer/dry conditions</td></tr></table></td><td>The proposed extraction is from a confined aquifer and therefore likelihood is unlikely.</td></tr>
<tr><td>Step 3</td><td>Consequence for aquifer/rivers/wetlands<table><tr><td>Minor</td><td>Watertable decline of <0.1 m
Hydraulic gradient at wetland boundary remains positive</td></tr><tr><td>Moderate</td><td>Water table decline 0.1 to 0.2 m
Hydraulic gradient at wetland may fall to zero at boundary in dry conditions</td></tr><tr><td>Significant</td><td>Watertable decline >2m at boundary
Hydraulic gradient at wetland reverses direction at boundary</td></tr></table></td><td>No watertable decline is predicted and the hydraulic gradient in the watertable aquifer will remain positive at the wetland boundary, based on the predictions using the leaky confined model. Consequence is minor.</td></tr>
<tr><td>Step 4</td><td>Risk evaluation<table><tr><td></td><td></td><td colspan="3">Consequence</td></tr><tr><td></td><td></td><td>Min</td><td>Mod</td><td>Sig</td></tr><tr><td rowspan="3">Likelihood</td><td>Unl</td><td>L</td><td>L</td><td>H</td></tr><tr><td>Pos</td><td>L</td><td>M</td><td>H</td></tr><tr><td>Cer</td><td>M</td><td>H</td><td>H</td></tr></table></td><td>Using the risk evaluation framework in the Ministerial Guidelines the risk to aquatic GDEs is low.</td></tr>
</table>

9.2.2.2 Transmission line trenching and trenchless creek crossings

The Surrey River is identified as a high potential aquatic GDE in the Atlas and the vegetation observed in the river at the time of the CDM Smith site walkover (October 2022) is typical of groundwater fed perennial systems (as shown in Figure 9-1). Where the transmission line crosses the Surrey River, trenchless crossing technique (HDD) has been proposed (AECOM, 2024b). This technique involves drilling a horizontal bore under the waterway and pulling the piping and cabling through. While this technique protects the ecosystems associated with the river from direct disruption, there is a potential for temporary release of drilling fluids or sediment during this process if ground conditions are difficult.

Figure 9-1 Ribbon grass in the Surrey River indicative of perennial flow

The release of drilling fluids or sediment during construction of the creek crossings may alter the condition of GDEs or negatively influence changes to their ecological character. Sedimentation may limit aquatic plant growth through loss of light and adversely affect aquatic fauna that rely on GDEs for habitat through loss or reduction of resources, reduction of visibility, and in more extreme cases, physical damage (e.g., clogged gills) or suffocation (EPA Victoria 2020).

Any release during construction is likely to be of very short duration (days). The Surrey River is perennial with flow all year and therefore any sediment released to the creek will be quickly diluted with very limited and short-lived impact to aquatic vegetation and ecosystems. Mitigation measures MM-SW03 and MM-SW04 (Table 10-3) include management guidelines for the trenched and trenchless waterway crossings to prevent impacts, including sediment control measures.

9.3 EPBC Act Significant Impact Assessment

The Glenelg Estuary and Discovery Bay Ramsar Site was gazetted as a Wetland of International Significance in August 2018. The Karst Springs and Associated Alkaline Fens of the Naracoorte Coastal Plain Bioregion TEC was listed as Endangered under the EPBC Act on 15 December 2020. A significant impact assessment was undertaken in accordance with the EPBC Act Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (Department of the Environment 2013) for each of these ecosystems based on the impact assessment detailed above (i.e. groundwater and surface water impacts). The Flora and Fauna Impact Assessment (Biosis, 2023) includes an assessment from the point of view of physical disturbance.

Table 9-4 Significant impact assessments

Significant Impact Criteria (is there a real chance or possibility that the Project will result in these outcomes?)	Response
Significant Impact Assessment: Glenelg Estuary and Discovery Bay Ramsar Site	
Areas of the wetland being destroyed or substantially modified	☒ No project activities to be undertaken within the Ramsar site. Low risk of impact via surface water and groundwater pathways.
A substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland	☒ Low risk of impact via surface water and groundwater pathways.
The habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected	☒ Low risk of impact via surface water and groundwater pathways.
A substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health	☒ Low risk of impact via surface water and groundwater pathways. The Project will employ best practice construction methodologies and environmental controls to minimise the potential for the mobilisation of contaminants downstream to the Ramsar wetland off-site.
An invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.	☒ Low risk of impact via surface water and groundwater pathways. The Project will employ best practice construction methodologies and environmental controls to minimise the potential for the mobilisation of invasive species downstream to the Ramsar wetland off-site.
Significant Impact Assessment: Karst Springs and Associated Alkaline Fens of the Naracoorte Coastal Plain Bioregion	
Reduce the extent of an ecological community	☒ No direct impact to known extents of the TEC (Lake Mombeong). Low risk of impact via surface water and groundwater pathways to potential areas of groundwater dependent TEC (any GDE identified in the Atlas).
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	☒ No direct impact to known extents of the TEC (Lake Mombeong).
Adversely affect habitat critical to the survival of an ecological community	☒ There is no definition for habitat critical to the survival of the TEC. Low risk of impact via surface water and groundwater pathways to potential areas of groundwater dependent TEC.

Significant Impact Criteria (is there a real chance or possibility that the Project will result in these outcomes?)	Response
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	☒ No direct impact to known extents of the TEC (Lake Mombeong). Low risk of impact via surface water and groundwater pathways to potential areas of groundwater dependent TEC.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	☒ No direct impact to known extents of the TEC (Lake Mombeong). Low risk of impact via surface water and groundwater pathways to potential areas of groundwater dependent TEC.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: • assisting invasive species, that are harmful to the listed ecological community, to become established, or • causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	☒ No direct impact to known extents of the TEC (Lake Mombeong). Low risk of impact via surface water and groundwater pathways to potential areas of groundwater dependent TEC. The Project will employ best practice construction methodologies and environmental controls to minimise the potential for the mobilisation of contaminants or invasive species downstream.
Interfere with the recovery of an ecological community	☒ No direct impact to known extents of the TEC (Lake Mombeong). Low risk of impact via surface water and groundwater pathways to potential areas of groundwater dependent TEC.

9.4 Cumulative impacts

Cumulative impacts to GDEs may occur when drawdown overlaps during dewatering or when groundwater impacts occur at the same time and place as other impacts, such as a reduction in surface water flows or a contamination event. The Surface Water Impact Assessment (AECOM, 2024b) and Environmental Site Investigation (AECOM, 2023) outline mitigation and management measures designed to reduce the likelihood of impacts to surface water flows and contamination events, and therefore, with these management and mitigation measures in place it is not expected that cumulative impacts will eventuate of this sort.

Cumulative drawdown is not expected to occur from project related dewatering. Drawdown in the watertable is only predicted from trenching for onsite cabling and the transmission line. Dewatering and drawdown will only occur where the water table is encountered during construction and the drawdown is estimated to be of small magnitude and short duration. The conservative assessment assumes the entire length of these cable lines will be dewatered at the same time, which is not going to be the case. Therefore the conservative assessment takes into account potential cumulative impacts from this source.

The deep aquifer depressurisation from groundwater extraction from the site may coincide with other groundwater extraction in the area, causing cumulative depressurisation in excess of that predicted in this assessment. The Groundwater Impact Assessment (AECOM, 2024a) conducted a search of nearby groundwater users and found that the majority of registered bores are installed at depths of 50 m or less within the upper UMTA. Given the conceptualisation of the groundwater supply at TB01 coming from a deeper confined section of the Port Campbell Limestone, the likelihood of cumulative impacts is low.

Section 10 Summary of Impacts and Mitigations

This assessment has identified potential GDEs in the Project Area and within possible impact zones. All potential GDEs have been treated as equally high value and equally likely to be groundwater dependent as part of this assessment. The source pathway receptor model of this impact assessment has evaluated the potential extent, magnitude and duration of impacts from the project and the degree of change to GDEs based on the available knowledge of the project, environment and potential groundwater impacts at the time of assessment.

This assessment has been undertaken using data and information available at the time of reporting, including the outcomes of other studies, most importantly the Groundwater Impact Assessment (AECOM, 2024a). In order to account for the inherent uncertainty associated with predicting groundwater impacts, a conservative approach to the assessment has been taken. This includes assuming all GDEs identified in the GDE Atlas are present, accessing groundwater and of high value and condition. The GDE assessment has also used the most conservative outcomes of the groundwater impacts presented by AECOM (2024a) and from the 7-day groundwater pumping test (Appendix D).

Potential impacts to GDEs have been assessed based on the groundwater affecting activities and the likelihood of GDEs being connected to and reliant on groundwater. Based on the short term, temporal nature of any groundwater impacts (<5 years), any change in climate over the construction period is not likely to change the outcome of the impact assessment (refer Section 5.1). Ongoing climate change has not been considered as no long-term operational impacts to the groundwater system or GDEs have been identified (i.e. climate change is not likely to change the outcomes of the impact assessment).

The outcomes of this assessment indicate that no permanent or measurable impacts to GDEs will occur as a result of the project (based on the available information) and therefore further risk assessment is not required as there is low to no risk to GDEs. The mitigation and management measures outlined in other water impact assessments (groundwater, surface water and environmental site assessment) will protect water resources which in turn will protect GDEs from potential impacts. Specific mitigation measures are shown in Table 10-3. Measures include:

- Development of a Construction Environmental Management Plan (CEMP) that includes the management measures outlined in the Environmental Site Investigation (AECOM, 2023) and the Surface Water Impact Assessment (AECOM, 2024b) regarding management of spoil, dewatering water and erosion and sediment control.
- Development of detailed ASS Management Plan (ASSMP) in line with the guidance provided in the CASS BPMG (2010) as outlined in the Environmental Site Investigation (AECOM, 2023).
- Development of a contingency dewatering and monitoring plan for turbine foundations in line with the recommendations in the Groundwater Impact Assessment (AECOM, 2024a).

The Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems have been applied to the groundwater extraction impact in this assessment. As part of the groundwater licence application, in consultation with Southern Rural Water and in line with the Ministerial Guidelines, further testing and analysis may be required and will be guided by Southern Rural Water requirements. The licence application will be progressed once the projects water requirements and the location of bores have been finalised.

The results of the GDE impact assessment (sources, pathways and receptors) are summarised below in Table 10-1. All impacts have been assessed as low. However, given the inherent uncertainty associated with groundwater assessments, a mitigation measure relating to the maintenance and monitoring of the hydraulic gradient towards the Ramsar site is proposed in Table 10-2. This is included in the draft Groundwater Monitoring Plan which is presented in Section 10.2 of the Groundwater Impact Assessment (AECOM, 2024a). The mitigation and management measures outlined in the Groundwater, and Surface Water Impacts Assessments and the Environmental Site Assessment (AECOM, 2024a, 2024b and 2023, respectively) as described above and presented in Table 10-3 will protect water resources, and therefore protect GDEs.

Table 10-1 Summary of GDE impact assessment

WAA (source)	Direct effect (pathway)	Active pathway to GDE (receptor)	Summary of impact assessment
WAA1 – turbine foundation dewatering (construction) ☑	DE01 – drawdown of watertable ☒	-	-
		-	-
		-	-
	DE02 – exposure of PASS ☒	GDE1 – Stygofauna ☒	-
		GDE2 – Terrestrial GDEs ☒	-
		GDE3 – Aquatic GDEs ☒	-
	DE03 – change in groundwater levels/flow ☒	-	-
WAA2 – groundwater supply extraction (construction) ☑	DE04 – drawdown of watertable ☒	-	-
	DE05 – exposure of PASS ☒	-	-
	DE06 – extraction induces saline intrusion ☒	-	-
	DE07 – change in groundwater levels/flow ☑	GDE1 – Stygofauna ☒	-
		GDE2 – Terrestrial GDEs ☒	-
		GDE3 – Aquatic GDEs☑	Low – conceptualisation based on current data is that the aquifer is leaky confined at the point of extraction and extraction volumes are not large enough over a long enough timeframe to cause a change in groundwater conditions in the watertable at the wetlands.
WAA3 – onsite cable trenching dewatering (construction) ☑	DE08 – drawdown of watertable ☑	GDE1 – Stygofauna ☒	-
		GDE2 – Terrestrial GDEs ☒	-

WAA (source)	Direct effect (pathway)	Active pathway to GDE (receptor)	Summary of impact assessment
		GDE3 – Aquatic GDEs ☒	-
	DE09 – exposure of PASS ☒	-	-
	DE10 – change in groundwater levels/flow ☒	-	-
WAA4 – transmission line cabling dewatering and trenched and trenchless creek and wetland crossings (construction) ☑	DE11 – drawdown of watertable ☑	GDE1 – Stygofauna ☒	-
		GDE2 – Terrestrial GDEs ☒	-
		GDE3 – Aquatic GDEs ☒	-
	DE12 – exposure of PASS ☑	GDE1 – Stygofauna ☒	-
		GDE2 – Terrestrial GDEs ☒	-
		GDE3 – Aquatic GDEs ☒	-
	DE13 – sediment/ drilling mud release to creeks / wetlands ☑	GDE1 – Stygofauna ☒	-
		GDE2 – Terrestrial GDEs ☒	-
		GDE3 – Aquatic GDEs ☑	Low – volume, frequency and duration of release unlikely to be such that aquatic GDEs could be impacted given the dilution likely in a perennial creek
	DE14 – change in groundwater levels/flow ☒	-	-
WAA5 – quarry dewatering (construction) ☑	DE15 – drawdown of watertable ☒	-	-
	DE16 – exposure of PASS ☒	-	-
	DE17 – change in groundwater levels/flow ☒	-	-

WAA (source)	Direct effect (pathway)	Active pathway to GDE (receptor)	Summary of impact assessment
WAA6 – turbine foundations impede groundwater flow (operation) ☒	-	-	-
WAA7 – cable trenches impeded groundwater flow (operation) ☒	-	-	-
WAA8 – contaminated soil interacting with groundwater ☒	-	-	-
WAA9 – contaminated water or excess sediment entering surface water ☒	-	-	-
WAA10 – pine clearing for turbine construction ☒	-	-	-

Table 10-2 Proposed mitigation measure for protection of GDEs

Mitigation measure ID	Recommended mitigation measure	Stage

MM-GD01	**GDE Monitoring and Management Plan**
	A GDE Monitoring and Management Plan will be developed prior to construction commencing in collaboration with the CMA, SRW and DEECA and to the satisfaction of the responsible authority. The GDE Monitoring and Management Plan will include:
	• At least daily groundwater level data collection (via data loggers) in pairs of target bores along the swamp edge and inland to measure changes to hydraulic gradient. Key bores include pairs MW05 and MW06, and MW07 and MW08.
	• At least daily groundwater levels data collection (via data loggers) in two "background" bores to measure natural variations so that any deviations from natural variations in the target bores can be identified. Key background bores would be MW01 and MW09.
	• Monitoring of these bores will begin at least 12 months before pumping commences so that baseline conditions (and natural variations in hydraulic gradient) can be determined.
	• Before pumping commences, target trigger levels will be developed (based on the seasonal baseline condition monitoring) so that changes to the hydraulic gradient outside of natural variations triggers contingency measures, such as temporary cessation of pumping, reduction in pumping volumes or introduction of an intermittent pumping schedule, to be determined prior to pumping commencing.
	• Measures to ensure the hydraulic gradient to the Ramsar wetland is maintained throughout the life of the groundwater extraction (construction – 2 years) and during system recovery (additional 2 years) via a monitoring plan with triggers and a set of contingencies. Ensure that assumptions underpinning the GDE Monitoring and Management Plan are updated as pumping progresses if drawdown varies from predictions.
	• Assessment against trigger levels and comparison of drawdown vs predicted drawdown will happen at a minimum biannual frequency.
	  – At least daily groundwater level data collection (via data loggers) in MB01 to compare actual drawdown values to predicted drawdown. In the first 6 months of pumping the actual compared to predicted will be assessed at a minimum monthly basis so that the predictions can be validated and updated. After this period, biannual assessment in line with the target and background bore assessments.
	  – Data loggers will be downloaded at a minimum of quarterly frequency and validation manual water level readings taken so that dataloggers errors can be noticed and corrected in a timely manner.
		Construction

Table 10-3 Mitigation measures recommended in other studies that are relevant to the protection of GDEs

Mitigation measure ID	Recommended mitigation measure	Stage
MM-GW01	**Turbine Location** To minimise the risk of final foundation locations intersecting groundwater, turbine locations will avoid areas with an inferred depth to groundwater of less than 6mbgs ***Groundwater Impact Assessment – AECOM, 2024a***	Design/ construction
MM-GW02	**Dewatering** If groundwater is going to be intersected at a turbine foundation location, the turbine should be moved to higher ground, or a dewatering management plan should be developed specific to each turbine location. ***Groundwater Impact Assessment – AECOM, 2024a***	Construction

<table>
<tr><th>Mitigation measure ID</th><th>Recommended mitigation measure</th><th>Stage</th></tr>
<tr><td>MM-GW03</td><td>Water supply investigation
Additional water supply investigations as part of groundwater take and use application to be undertaken in consultation with SRW.
Water supply extraction bores to be located along Nelson-Portland Road and within the deeper UMTA to reduce potential impacts to groundwater users; in consultation with SRW.
Groundwater allocation to be short-term and temporary transfer only (in the order of 2–3 years during construction)
Groundwater Impact Assessment – AECOM, 2024a</td><td>Construction</td></tr>
<tr><td>MM-GW05</td><td>Groundwater contamination management
The following measures will be implemented if contaminated groundwater is encountered:
If groundwater is extracted from the area near TP05 during construction activities, it will be tested prior to discharge to determine whether it must be remediated or sent offsite for disposal or can be discharged to land. Assessment must be completed in accordance with the Duty to Manage (EP Act 2017), the ASC NEPM (amended 2013) and associated guidance documents.
If groundwater is encountered in current or former pine plantations, groundwater must be sampled and characterised prior to disposal in accordance with the GED and regulatory approvals. Processes for managing groundwater extraction, including sampling and characterisation prior to disposal, will be set out in the Dewatering Plan (MM-GW02).
If there any are observations of odour, discolouration, sheen, or other signs of potential contamination in extracted groundwater, the abstraction of groundwater will cease. Groundwater will then be sampled and tested to confirm whether additional management measures and remediation are required, and whether abstraction can re-commence.
Groundwater that is contaminated by acid sulfate soils will be tested and discharged or disposed in accordance with protocols outlined in the Acid Sulfate Soil Management Plan (MM-CA03).
Specific measures to manage contaminated groundwater (if intersected) will be included in the Dewatering Plan. Groundwater will be disposed in accordance with the obligations under the general environmental duty and in accordance with relevant regulatory approvals.
Environmental Site Investigation – AECOM, 2023</td><td>Construction / Decommissioning</td></tr>
<tr><td>MM-GW06</td><td>Groundwater level monitoring program
A groundwater level monitoring program should be developed and included in the CEMP to assess for effects on groundwater levels from groundwater supply extraction.
Groundwater Impact Assessment – AECOM, 2024a</td><td>Pre-Construction, Construction</td></tr>
</table>

Mitigation measure ID	Recommended mitigation measure	Stage
MM-CA02	**Management of unknown contamination** In the event that unknown contamination is uncovered during Project construction, the following measures should be undertaken in accordance with the construction environmental management plan (CEMP) for the Project: - Cessation of ground disturbance at the unknown contamination location and within the immediate vicinity, and isolation of the area (if required). - Assessment of the unknown material by an experienced environmental or health and safety practitioner (depending on the nature of the material) and appropriate disposal or treatment of the material - Assessment of the site contamination in accordance with EPA guidelines and determination and implementation of appropriate remedial action (if required). - Where potentially impacted waste soils are encountered, they must be sampled and categorised in accordance with EPA Publications IWRG702 and 1828.2 and managed in accordance with regulations. These measures will be outlined in the Project's CEMP ***Environmental Site Investigation – AECOM, 2023***	Construction / Decommissioning

<table>
<tr><th>Mitigation measure ID</th><th>Recommended mitigation measure</th><th>Stage</th></tr>
<tr><td>MM-CA03</td><td>Acid Sulfate Soil Management Plan
A detailed Acid Sulfate Soil Management Plan (ASSMP) will be developed in conjunction with the CEMP and implemented to manage ASS and any associated waters. Development of the ASSMP will be guided by the Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soils (DSE, 2010) and the National Acid Sulfate soils guidance (https://www.waterquality.gov.au/issues/acid-sulfate-soils). The ASSMP will include (but not be limited to) the following:
• Project overview, including overview of proposed disturbance works.
• Description of the site and environmental setting, including topography, hydrology and geology, groundwater characteristics, land use and presence of sensitive receptors.
• Summary of the ASS investigations and assessment undertaken in the Project Area, including spatial distribution and expected occurrence of ASS associated with the Project, and potential impacts.
• Timing of planned Project works and environmental management activities.
• Description of the ASS management strategies that will be used to minimise impacts from the Project works, including strategies for:
– Avoiding or minimising disturbance of ASS and preventing oxidation of metal sulfides.
– Planned treatment or neutralisation of ASS and any run-off or acidic leachate that might be generated, and potential reuse of treated ASS or disposal of ASS.
– Water management, including onsite and offsite water table management before, during and after disturbance, and containment of run-off or acidic leachates.
– Treatment for reduction or neutralisation of acidity, spoil management including offsite reuse or disposal, water management, monitoring, record keeping, reporting and EPA consultations and approvals.
• Soil and water monitoring requirements, and treatment validation.
• Reporting requirements and record keeping relating to excavation/backfill locations and volumes, treatment methods and volumes, monitoring, laboratory analysis monitoring and incidents.
• Contingency procedures to manage potential impacts/incidents, including trigger levels, and remedial and restorative actions.
• Consultation with relevant stakeholders and authorities and approval process associated with the ASSMP.
If removing and disposing of ASS offsite, ASS will be disposed of at a lawful place that is permitted/licenced to accept N123 WASS/PASS.
Environmental Site Investigation – AECOM, 2023</td><td>Construction / Decommissioning</td></tr>
</table>

<table>
<tr><th>Mitigation measure ID</th><th>Recommended mitigation measure</th><th>Stage</th></tr>
<tr><td>MM-SW01</td><td>Dewatering
• Dewatering activities would be managed in accordance with the Dewatering Plan in the CEMP. The plan would adopt a management hierarchy that prioritises the prevention of discharges into surface waters as far as is reasonably practicable. The relevant suggested measures outlined in EPA Victoria Publication: 1834: Civil Construction, Building and Demolition Guide (2020) should also be incorporated into the CEMP.
• Water resulting from dewatering activities should be tested for potential contaminants.
• Groundwater that is contaminated by acid sulfate soils should be tested and discharged or disposed in accordance with protocols outlined in the Environmental Site Investigation EES Technical Report.
• Ponded stormwater and rainwater collected in excavations may be suitable for onsite treatment, reuse or discharge, subject to water quality testing results.
• Water recycled for reuse onsite will be used for construction activities such as dust suppression.
• Where deemed suitable, discharge of collected water to land should be to areas of low gradient to avoid soil erosion or sedimentation of land or water. Discharges to land should also avoid areas that are saturated or at risk of becoming inundated.
• Water from excavated areas should not be discharged into or within 50 m of a watercourse, drainage pathway or wetland without prior treatment.
• Sediment control devices should be used where required, to remove suspended soils and dissipate flow. These devices include sediment fences or basins.
Surface Water Impact Assessment – AECOM, 2024b</td><td>Construction</td></tr>
<tr><td>MM-SW02</td><td>Surface water run-off
• All construction works will be carried out in accordance with industry best practice guidelines including the IECA Best Practice Erosion, Sediment Control Guidelines and EPA Publication 1834 Civil Construction, Building and Demolition Guide, EPA Publication 1894: Managing Soil Disturbance, and EPA Publication 1895: Managing stockpiles.
• A Project-wide CEMP will be developed and implemented, incorporating a Sediment, Erosion and Water Quality Management Plan (SEWQMP) for all work areas. The SEWQMP will outline the erosion and sediment mitigation measures to be implemented for each work area. Erosion and sediment control measures will include:
– Sediment control devices such as bunding or silt fences around stockpiled material, earthworks and disturbed areas.
– Clean water diversion around disturbed or unvegetated areas.
Surface Water Impact Assessment – AECOM, 2024b</td><td>Construction</td></tr>
</table>

Mitigation measure ID	Recommended mitigation measure	Stage
MM-SW03	**Trenching Across Waterways** • All trenched waterway crossings will be carried out in accordance with industry best practice guidelines including the IECA Best Practice Erosion and Sediment Control Guidelines and EPA Publications 1834 Civil Construction, Building and Demolition Guide and 1896 Working within or adjacent to waterways. • Waterway crossing works and reinstatement will be carried out in consultation with the GHCMA. • Trench crossing works will be programmed for dry or low flow conditions, such that works are preferentially scheduled for drier months of the year and lowest flow of the waterway and works are avoided when high rainfall events are expected. • Cabling will be assembled and prepared so that it can be installed as quickly as practicable once trenching over a watercourse has been completed. • The exposed trench within a watercourse and riparian zones will be reinstated immediately following the installation of the cable, including providing suitable compaction and revegetation. • Waterway reinstatement will be designed to avoid future erosion. This may include the use of riprap made of stones to stabilise the waterway. If necessary, a geofabric will be provided to prevent erosion and scour until the vegetation has established. • Visual monitoring for changes in turbidity will be undertaken downstream of the trench during flow events, if the trench has not been reinstated. • For 12 months after completion of trenching works, trenched waterways will be visually inspected following significant rainfall/flow events. If during these visual inspections waterway reinstatement works are observed to be not performing appropriately (ie erosion is occurring), rectification measures will be developed and implemented in a timely manner. • Temporary diversions will be provided if there is permanent or tidal flow in the waterway in accordance with the IECA Best Practice Erosion and Sediment Control Guidelines. • Sediment control devices such as silt fences will be used to remove suspended solids and dissipate flow where required. ***Surface Water Impact Assessment – AECOM, 2024b***	Construction

Mitigation measure ID	Recommended mitigation measure	Stage
MM-SW04	**HDD waterway crossings** • The proposed HDD profile design and the work method statement shall be submitted to the GHCMA and approved prior to the commencement of works at the Surrey River crossings. • Risk of frac-out should be assessed in accordance with industry best practice guidelines to determine likelihood of occurrence (e.g. modelling). • Drilling profiles should be adjusted where the risk of frac-out is considered likely. • Drilling fluid properties should be monitored during HDD operations to reduce the risk of frac-outs (e.g. mud weight, viscosity, pressure). • Drilling equipment and configuration should be appropriate for the proposed HDD operation to prevent frac-out. • Pollution prevention strategies should be in accordance with EPA Publication 1834; Civil Construction, Building and Demolition Guide, IECA Best Practice Erosion and Sediment Control Appendix P; Land Based Pipeline Construction Guidelines and EPA Publication 1896: Working within or adjacent to waterways. • Sediment control devices such as silt fences should be put used to remove suspended solids and dissipate flow where required. • Earth bunds/or and drainage channels should be placed around the upper edges of drill sites and work areas to divert natural runoff around and away from the site and prevent mixing with drilling compound runoff. • Sump pits should be constructed at the bottom of the drill site. The sump pit would be positioned to capture runoff from the drilling compound. Materials collected in the sump pit will be assessed and managed in accordance with industry best practice guidelines for HDD operations. • An earth bund or silt fence would be placed around the sump pit to contain any spillage. • All facilities utilised in the surface mud handling (mixing, cleaning and pumping) during the HDD activities should be bunded. ***Surface Water Impact Assessment – AECOM, 2024b***	Construction
MM-SW06	**Changes to flow regime during construction** • A project wide CEMP would be developed and implemented, incorporating a SWMP for all sites. The SWMP will outline the flood risk management measures for each site. • Construction compounds, drilling compounds, laydown areas and material storage areas should be located outside of the floodplain or areas that are subject to inundation. Where this is not considered feasible, site design optimisation would minimise the extent of works and storage in the floodplain. • Stockpiling of excavation material, topsoil and trench spoil in areas that are flood prone should be avoided. • Site activities, facilities, infrastructure and materials should be set back from drainage pathways and waterways to the satisfaction of the GHCMA and, in the absence of regulatory requirements, in accordance with IECA Best Practice Erosion and Sediment Control guidelines. ***Surface Water Impact Assessment – AECOM, 2024b***	Construction

Mitigation measure ID	Recommended mitigation measure	Stage
MM-SW07	**Changes to flow regime during operation** • Proposed infrastructure should be designed to maintain existing levels of flood protection associated with overland flow paths (considering flood levels, flows and velocities) through compliance with GHCMA requirements for flooding and overland flows. • Permanent surface structures should be designed to allow a set back from waterways and drainage pathways and maintain existing flow regime. • Modifications to existing flow pathways (e.g. drainage diversion) would be carried out to the satisfaction of the GHCMA and Glenelg Shire Council. ***Surface Water Impact Assessment – AECOM, 2024b***	Operation
MM-BD01	**Native Vegetation** A Native Vegetation Plan (NVP) will be prepared in consultation with DEECA Environment Branch and to the satisfaction of the responsible authority prior to the commencement of construction. The NVP will identify areas permitted for removal or required for retention, and detail procedures for protection of no-go areas. This NVP is to be of suitable detail to be used during construction works by all contractors involved in the works. The following specific measures will be incorporated into the NVP to minimise potential impacts on native vegetation: • Where possible, wind turbines and associated infrastructure including electricity poles associated with the reticulation and transmission network will be located away from native vegetation, including temporary stockpiles and storage of equipment during construction. • Areas of retained native vegetation within the wind farm site and overhead transmission line corridor, including scattered trees, will be protected by temporary fencing if construction activities are to be conducted within 15 m of native vegetation. Fencing will be installed before construction work commences. • Retained native vegetation within Cobboboonee National Park and Forest Park will be no-go areas identified during inductions for construction staff and daily toolbox talks. These areas will not be fenced during Project construction due to the continuous nature of native vegetation within the parks. • Where threatened flora species are recorded in previously unsurveyed areas during pre-clearance surveys, these areas are to be avoided or otherwise managed through measures to be described in the Construction Environmental Management Plan (CEMP). • Existing gates and access tracks will be used where possible. Where there is a requirement to widen existing or create new access tracks, this will be undertaken outside areas of native vegetation where feasible. If native vegetation cannot be avoided, appropriate consents will be obtained prior to vegetation removal and any conditions complied with . • Any locations used for storage of materials or equipment, or turning of vehicles, will be identified, prior to construction, with the advice of a qualified ecologist to ensure no additional native vegetation or habitat areas are impacted. If native vegetation cannot be avoided, appropriate consents will be obtained prior to vegetation removal and any conditions complied with . • Construction works will be limited to the construction footprint, particularly along Boiler Swamp Road. ***Fauna and Flora Existing Conditions and Impact Assessment – Biosis, 2023***	Construction

Section 11 References

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AECOM (2024b) Surface Water Impact Assessment, Kentbruck Green Power Hub Project EES Technical Report. Rev2 Issued January 2024

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Appendix A Disclaimer and Limitations

Appendix A Disclaimer and Limitations

This report has been prepared by CDM Smith Australia Pty Ltd (CDM Smith) for the sole benefit of Neoen Australia Pty Ltd for the sole purpose of providing an assessment of the potential for impact to GDEs from the Kentbruck Green Power Hub Project to support the EES process and to provide an assessment for the Inquiry and Advisory Committee.

This report should not be used or relied upon for any other purpose without CDM Smith's prior written consent. Neither CDM Smith, nor any officer or employee of CDM Smith, accepts responsibility or liability in any way whatsoever for the use of or reliance on this report for any purpose other than that for which it has been prepared.

Except with CDM Smith's prior written consent, this report may not be:

a. released to any other party, whether in whole or in part (other than to officers, employees and advisers of Neoen Australia Pty Ltd and as part of the EES process and the Inquiry and Advisory Committee);

b. used or relied upon by any other party; or

c. filed with any Governmental agency or other person or quoted or referred to in any public document (except as part of the EES process and the Inquiry and Advisory Committee).

Neither CDM Smith, nor any officer or employee of CDM Smith, accepts responsibility or liability for or in respect of any use or reliance upon this report by any third party.

The information on which this report is based has been provided by Neoen Australia Pty Ltd and third parties (as stated within this report). CDM Smith (including its officers and employees):

a. has relied upon and presumed the accuracy of this information;

b. has not verified the accuracy or reliability of this information (other than as expressly stated in this report);

c. has not made any independent investigations or enquiries in respect of those matters of which it has no actual knowledge at the time of giving this report to Neoen Australia Pty Ltd; and

d. makes no warranty or guarantee, expressed or implied, as to the accuracy or reliability of this information.

In recognition of all of the above, this report is based on the data and information provided to CDM Smith at the time of reporting and CDM Smith's interpretation through professional judgment and experience. CDM Smith makes no guarantee or warranty related to and shall not be liable for the outcome of the EES review or any other review or approval process.

If further information becomes available, or additional assumptions need to be made, CDM Smith reserves its right to amend this report.

Appendix B Alternative Transmission Line Options Impact Assessment

B.1 Background

Section 3.4 of the Scoping Requirements for Kentbruck Green Power Hub Environment Effects Statement requires that the Project's EES document the likely environmental effects of the Project's feasible alternatives, including routes and configurations for the transmission line. The depth of investigation should be proportionate to the potential of the alternatives to minimise potentially significant adverse effects and to meet the Project objectives.

This appendix describes the feasible transmission line alternatives that have been considered by Neoen for this Project, and the potential effects to GDEs of each alternative. The preferred option for the Project, referred to as "Option 1B", has been assessed in detail in this report, so is not subject to any further assessment in this appendix. Instead, this appendix considers the potential environmental effects of the following transmission line alternatives (see Figure B-1):

- Option 1A ("Heywood Underground-Overhead Combined"): Follows the same route as Option 1B (the preferred option) underground through Cobboboonee National Park / Forest Park, however it then transitions to an overhead transmission line for the remainder of the alignment to the Heywood Terminal Station.
- Option 2A ("Portland Overhead"): A wholly overhead option that connects to the existing Heywood Portland 500 kV line north of Portland. Runs southeast from the wind farm site through rural landholdings. No final route was determined for this option as landowner agreements were unable to be secured for the entire length of transmission line. This option therefor includes several route options.
- Option 2B ("Portland Underground"): Follows the same route as Option 2A but is wholly underground.

B.2 Transmission Line Project Objectives

The fundamental objective of the Project is to provide a source of clean, renewable energy to help power homes and businesses in Victoria and throughout eastern Australia which are connected to the National Electricity Market (NEM). Neoen's environmental and social objectives for the Project, as described in Section 2.2 of the EES, stem from the need to develop the Project in accordance with the principles of ecologically sustainable development. Neoen's objectives relating specifically to the transmission line component of the Project are to:

- Deliver renewable electricity from the Project to the NEM
- Seek opportunities to co-locate infrastructure with existing compatible land uses such as existing easements and transport routes
- Avoid or minimise potential adverse impacts on the natural environment
- Avoid or minimise potential adverse impacts on Aboriginal and historical heritage
- Avoid or minimise potential adverse impacts on nearby residents associated with visual amenity, noise, traffic, and air quality
- Avoid impacts to business and commercial operations
- Avoid or minimise potential impacts on productive agricultural land
- Avoid or minimise the risk of bushfire
- Ensure an appropriate land use outcome by avoiding areas of sensitivity and potential land use conflicts
- Be able to obtain necessary agreements with landowners and land managers to install and operate infrastructure
- Be able to obtain planning and environmental approvals from all necessary authorities
- Provide a constructable and cost-effective grid connection.

Umwelt (2023) has prepared a Transmission Line Options Assessment which describes all the transmission line options considered by Neoen to date, including those which were not found to be viable and were removed from the Project before the EES process commenced or very early in the EES process. The Options Assessment uses an objective, criteria-based approach to assessing each option. The assessment criteria and scoring metrics were developed in accordance with the transmission line objectives provided above.

This appendix describes the potential impacts of the feasible transmission line options identified in the options assessment report on GDEs, providing information for use by Umwelt in the options assessment in relation to the GDE related criteria.

B.3 Alternative Transmission Line Options

The Project being pursued by Neoen, and subject to full impact assessment in this report, comprises a preferred transmission line route as described in Section 2 of this report (underground through Cobboboonee National Park and Forest Park, and farmland to the Heywood Terminal Station – Option 1B). An alternative configuration to this option has also been considered by Neoen, which follows the same route as Option 1B however it involves an overhead section between Cobboboonee Forest Park and the Heywood Terminal Station (Option 1A).

Two other options which were identified as feasible in the Transmission Line Options Assessment but are no longer being pursued by the Project due to a lack of landowner and community support, are Options 2A and 2B which run southeast from the wind farm site and connect to the Heywood-Portland 500 kV line north of Portland. Option 2A is wholly overhead, while Option 2B is wholly underground.

The three alternative transmission line options are described as follows:

- Option 1A: The underground transmission line would extend east from the main wind farm substation and traverse Cobboboonee National Park and Forest Park beneath an existing road. From there, the transmission line would transition to an overhead line as it travels through freehold land to reach Heywood Terminal Station.
- Option 2A: The overhead transmission line would extend southeast from the main wind farm substation and traverse several freehold rural landholdings used primarily for grazing. This option would require development and construction of a new terminal station adjacent to the existing Heywood-Portland 500 kV line north of Portland.
- Option 2B: The underground transmission line would extend southeast from the main wind farm substation and traverse several freehold rural landholdings used primarily for grazing. This option would require development and construction of a new terminal station adjacent to the existing Heywood- Portland 500 kV line north of Portland.

The three options are shown in Figure B-1.

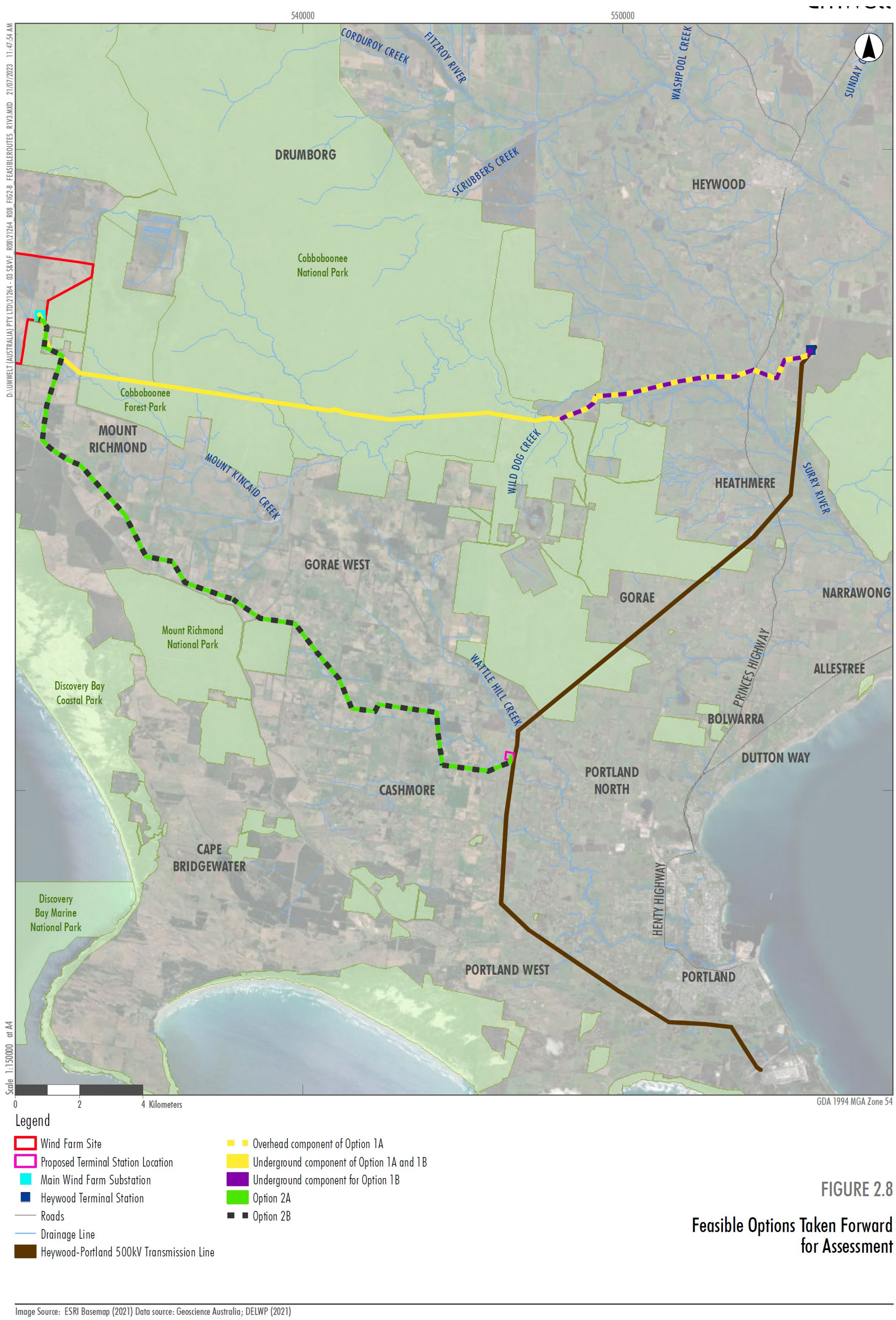

Figure B-1 Transmission line options (figure provided by Umwelt)

B.4 Assessment Methodology

This assessment follows the framework set out in the main report. Although a groundwater extraction licence will not be required for any trench dewatering, the Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems are used an as assessment framework, supported by the National Water Commission (NWC) framework for assessing potential local and cumulative effects of mining on groundwater (Howe, 2011). For the purpose of this assessment, all GDEs mapped in the GDE Atlas are considered to be High Value.

The western portion of Option 1A is the same as Option 1B – both being a proposed 17 km of underground transmission line traversing the southern part of the Cobboboonee National Park. Therefore, the underground section of Option 1A is already addressed in the main section of this report and only the overhead section has not been assessed.

It should be noted that only water affecting activities are considered in this assessment. Physical disturbance is a key non-water use related impact to aquatic and terrestrial ecosystems regardless of their groundwater dependence and is assessed elsewhere (i.e. impacts to vegetation are assessed in the Flora and Fauna Assessment (Biosis, 2023)). Overhead cabling (Option 2A and the eastern end of Option 1A) is not considered in this assessment, as no water effecting activities have been identified associated with this type of infrastructure.

Given the above, only Option 2B ("Portland Underground") is considered in this Appendix.

B.5 Existing Conditions

The groundwater conditions along the proposed transmission line alignments are described in more detail in the Groundwater Impact Assessment (AECOM, 2023a). In summary:

- For the transmission line options only the surface geology is relevant (<1.5 m excavation). Option 2B runs primarily through Molineaux Sands consisting of sand and fine sand deposited in an aeolian environment with small sections running through Quaternary swamp and lake deposits (<1 km) or Newer Volcanic basalts (<3.5 km).
- Regional mapping indicates depth to groundwater being less than 5 mbgs along much of the transmission line route options.
- Regional mapping indicates watertable groundwater salinity between 500 and 3,500 mg/L.

Potential GDEs have been identified using the Groundwater Dependant Ecosystem Atlas (GDE Atlas, BoM) which is considered to be a robust assessment of potential GDEs in this part of Australia. The number, type and area of the GDEs along the Option 2B alignment (with a 50 m buffer either side of the alignment) are shown Table B-1. The Ecological Vegetation Classes (EVCs) are shown in Table B-2.

Table B-1 Mapped GDEs intersecting with transmission line Option 2B including 50 m buffer

GDE Type	Mapped features (Area (ha))				Total mapped features	Total Area (ha)
	High Potential	Moderate Potential	Low Potential	Unclassified Potential		
Aquatic	0	0	1 (3.65)	0	1	3.65
Terrestrial	36 (207)	2 (14)	1 (0.19)	0	39	221

Table B-2 Terrestrial GDE types (Option 2B)

EVC	High Potential	Moderate Potential	Low Potential	Total
EVC 23 – Herb-rich Foothill Forest (Vulnerable)	1	2	1	4
EVC 650 – Heathy Woodland/Damp Heathy Woodland/Damp Heathland Mosaic (Vulnerable)	28	-	-	28
EVC 200 – Shallow Freshwater Marsh (Endangered)	1	-	-	1
EVC 746 – Damp Heathland/Damp Heathy Woodland Mosaic (Depleted)	4	-	-	4
EVC 48 – Heathy Woodland (Least Concern)	2	-	-	2

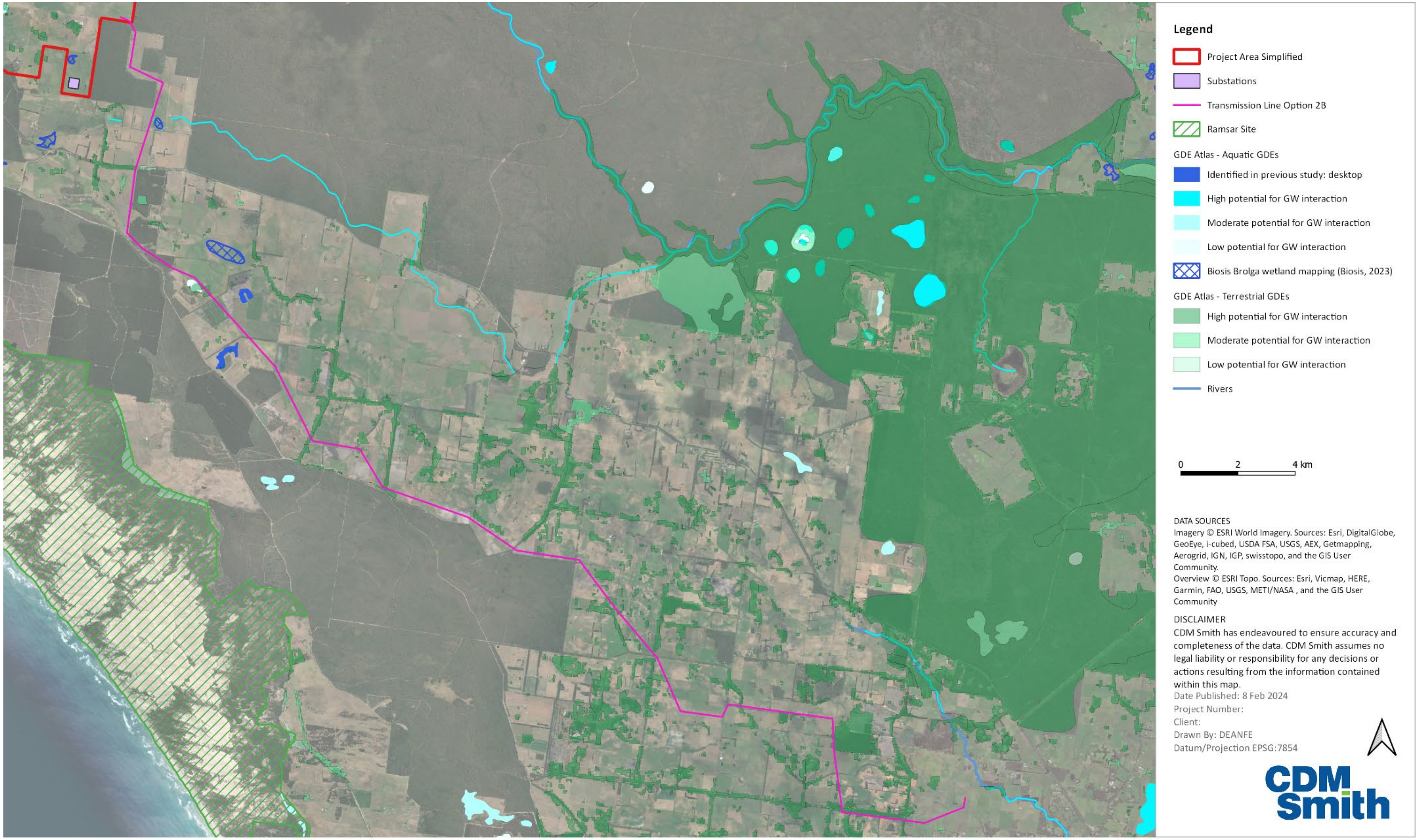

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Figure B-2 Location of mapped GDEs in the vicinity of alignment Option 2B

B.6 Identification of impact pathways

B.6.1 GDEs (receptors)

For the purpose of this assessment, only groundwater dependent ecosystems (GDE) are considered. Other groundwater values, such as consumptive use, are addressed in the Groundwater Impact Assessment (AECOM, 2023a).

Table B-3 presents the identified GDEs and their likely occurrence within the Project Area, while Figure B-2 present these graphically. At this stage in the assessment all GDEs regardless of potential groundwater dependence or value are considered as equally likely to exist and of equal value/importance.

Table B-3 Identified GDEs

–GDE types	Description	Considered herein?
GDE1 - sub terranean GDEs	As described in the main body of the report, for the purpose of this assessment, it is assumed that sub terranean ecosystems and stygofauna could be present in the Project Area, although limited investigations have been conducted into their presence.	☑
EV2 – Terrestrial GDEs	The GDE Atlas (BOM, 2022) has identified low to high potential terrestrial GDEs exist along the alignment options. In summary the Option 2B alignment (and 50 m buffer) intersect with 221 mapped terrestrial GDEs consisting of 5 EVC types including foothill forest, heathland, woodland and freshwater marsh	☑
EV3 – Aquatic GDEs	The GDE Atlas (BOM, 2022) has identified one low potential aquatic GDEs associated with the Option 2B alignment. The mapped aquatic GDE is a shallow marsh wetland.	☑

B.6.2 Groundwater affecting Activities (source)

WAAs are any activity that have the potential to alter water resources from baseline conditions, for example, the abstraction of groundwater for water supply. In a source-pathway-receptor analysis, WAAs can otherwise be thought of as sources. The AECOM (2023a) Groundwater Impact Study details all potential WAAs relating to groundwater. Additional information has been used from AECOM's (2023) Site Investigation Report in relation to potentially acid sulfate soils impacts and Surface Water Impact Assessment (2024b). The WAAs identified in these reports have been summarised in Table B-4. WAA numbers have been maintained from the main report body for clarity.

It should be noted that only water affecting activities are considered in this assessment. Physical disturbance is a key non-groundwater related impact to aquatic and terrestrial ecosystems regardless of their groundwater dependence and is assessed elsewhere (i.e. impacts to vegetation are assessed in the Flora and Fauna Assessment (Biosis, 2023)). Overhead cabling (Option 2A and the overhead portion of Option 1A) is not considered in this assessment, as no water effecting activities have been identified associated with this type of infrastructure.

Table B-4 Identified WAAs (Sources)

WAA (source) ID	Description (AECOM, 2024a; 2024b and 2023)	Considered herein?
WAA4 – transmission line cabling dewatering and trenched and trenchless creek and wetland crossings (construction)	Option 2B: The underground transmission line would extend southeast from the main wind farm substation and traverse several freehold rural landholdings used primarily for grazing. This option would require development and construction of a new terminal station adjacent to the existing Heywood- Portland 500 kV line north of Portland The underground cabling of the transmission line would primarily be constructed using trenching. The cabling would be buried at a depth of approximately 1.25 m using a specialised machine that uses integrated excavation, cable laying and backfilling equipment. Trenched crossings are proposed for all ephemeral creeks and wetlands. If groundwater is encountered during any underground cabling works, dewatering may be required, depending on the construction method. The Surface Water Impact Assessment (AECOM, 2024b) includes mitigation measures to manage dewatering from trenches (MM-SW01), management for trenching across waterways (MM-SW03) and HDD drilling (MM-SW04) (see Table 10-3).	☑
WAA7 – cable trenches impeded groundwater flow (operation)	There is the potential for shallow groundwater flow to be impeded by cable trenches following completion with thermally stable backfill if required (typically in the form of flowable concrete) followed by excavated backfill or crushed rock to surface. ***During the groundwater impact assessment AECOM (2023a) state that "Any such impacts on shallow groundwater levels due to the trench acting as a barrier (or partial barrier) to groundwater flow are not expected to be material given the size and scale of the trench relative to the aquifers and regional context of groundwater flow, and ability of groundwater to flow beneath the trench."*** ***And following analytical assessment of this potential impact "Potential impacts to groundwater users would therefore be negligible due to changes in groundwater levels up- and down hydraulic gradient of the trench"*** Given the similar geology and construction methods for the transmission option alignments, it is considered that this statement is valid for assessment of these impacts.	☒ No measurable groundwater impact has been identified and therefore no impact to GDEs to assess
WAA8 – contaminated soil interacting with groundwater	The presence and extent of contaminated soils and groundwater was assessed in the AECOM (2023b) Site Investigation. ***AECOM (2023b) state that "due to existing and historical land uses within the Project Area, there is a low potential for contaminated soil to be encountered during the construction works. The field investigation, concluded that, based on broadly spaced intrusive investigations, soil contaminants were not found above laboratory limits of reporting or relevant guidelines. Based on the site history and field investigation results, it is considered unlikely that the Project construction would encounter unknown contamination that will result in a long-term and irreversible impacts to human health and the environment."*** Given the land use for the transmission option alignments, it is considered that this statement is valid for assessment of these impacts. AECOM (2023) provide contingency measures to be followed in the unlikely event that unknown contamination is encountered to be included in the construction environmental management plan (CEMP) for the Project (relevant mitigation measures are described in Table 10-3, including MM-GW05, MM-CA02, MM-SW01).	☒ Unlikely that soil and groundwater contamination (outside natural conditions) exists and therefore unlikely that groundwater will encounter contaminated soil.

WAA (source) ID	Description (AECOM, 2024a; 2024b and 2023)	Considered herein?
WAA9 – contaminated water or excess sediment entering surface water	Risks to surface water quality were assessed in the AECOM (2024b) Surface Water Impact Assessment. Risks to surface water quality include the mobilisation and discharge of sediment, dewatering of excavations and trenches, contaminated runoff from disturbed ground and pollution from spills. ***AECOM (2024b) assessed all risks to surface water quality from the project as low providing standard environmental management practices are followed during construction and operation of the project.*** Given the same construction methods for the transmission option alignments, it is considered that this statement is valid for assessment of these impacts. Relevant mitigation measures are described in Table 10 3, including MM-GW05, MM-CA02, MM-SW01.	☒ Unlikely that contaminated water or sediment will migrate to GDEs if standard environmental management practices are followed.

B.6.3 Direct Effects (pathways)

The NWC framework defines four (4) categories of direct effects to groundwater arising from WAAs:

1. Altered groundwater quantity.
2. Altered groundwater quality.
3. Altered surface water – groundwater interactions.
4. Physical disruption of aquifers (this effect has not been considered further as potential aquifer disruption impacts have already been considered in the identification of WAAs)

Table B-5 describes the linkage(s) between the identified WAA and the applicable potential direct effect(s) for groundwater. Note, only the direct effects with a relevant WAA have been considered further in this assessment.

Table B-5 Identified Direct Effects (Pathways)

WAA (source)	Direct effects (pathway)		Details from relevant assessment (AECOM, 2024b)	Relevant for further assessment?
	Category	ID		
WAA4 – transmission line cabling dewatering and trenched and trenchless creek and wetland crossings (construction) **OPTION 2B**	Quantity	DE11 – drawdown of watertable	If groundwater were to be intersected by the cable trench it would need to be dewatered prior to the installation of underground cabling and placement of backfill. However, the shallow depth will limit the potential to penetrate a significant depth below the water table, and dewatering (if required) would be carried out for a short duration only (hours rather than days) immediately prior to installation of the cable and backfill. The alignments follow areas of swamp deposits and Molineaux Sands. Analytical drawdown modelling using literature values for the encountered geology (there is no site-specific data) that given the limited depth of in-trench groundwater (less than 1.25 metres) and short duration of dewatering (in the order of hours rather than days), drawdown away from the trench would be very limited. • Along sections of the higher hydraulic conductivity fine to medium sands of the Molineaux Sand deposits (most of Option 2), the reduction in groundwater levels (drawdowns) away from the trench would be negligible (<0.1 m) at distances beyond 20 metres and occur for less than a week (AECOM, 2024a) • Where low hydraulic conductivity materials are intersected (that is, the swamp and lake deposits, and the weathered basalt sections – small sections of Option 2) the drawdowns away from the trench section would be negligible (<0.1 m) at distances beyond around 5 metres and would occur for less than a week (AECOM, 2024a) It is assumed that trenchless crossings using horizontal directional drilling (HDD) will be used where the alignment crosses creeks/wetlands, so they are not disturbed at the surface. This method should also prevent drawdown. Mitigation measures MM-SW01 (Dewatering Plan), MM-SW03 (Trenching Across Waterways) and MM-SW04 (HDD Water Crossings) (AECOM, 2024b) provide details on how these activities will be managed – see Table 10-3.	☑
	Quality	DE12 – exposure of PASS	A search of the Australian Soil Resource Information System (ASRIS) was undertaken and shows the alignment is in an area of 'extremely low probability' of acid sulphate soils (very low confidence). Given the majority of the alignment is underlain by Molineaux Sand (aeolian sand), PASS is unlikely to be present. Mitigation measure MM-CA03 (AECOM, 2023) includes development of a detailed Acid Sulfate Soil Management Plan (ASSMP) to manage ASS and any associated waters – see Table 10-3.	☒

WAA (source)	Direct effects (pathway)		Details from relevant assessment (AECOM, 2024b)	Relevant for further assessment?
	Category	ID		
		DE13 – sediment release to creeks / wetlands	All transmission line route options include direct interface between construction and waterways/creeks and therefore there is a risk of quality impacts to waterways from the proximity of the works. Trenched crossings are planned for ephemeral creeks and wetlands. Even if works are planned around flows, there is still a risk of rainfall events causing direct runoff from construction activities to the ephemeral watercourses. Trenchless crossings involve the HDD method which should prevent impacts to groundwater and surface water flows in the perennial streams. Risks from this method include release of drilling muds into the waterway or the method failing due to ground conditions. Mitigation measures MM-SW01 (Dewatering Plan), MM-SW03 (Trenching Across Waterways) and MM-SW04 (HDD Water Crossings) (AECOM, 2024b) provide details on how these activities will be managed – see Table 10-3.	☑
	Altered GW/SW interactions	DE14 – change in groundwater levels/flow	Drawdown of the watertable can result in changes to groundwater-surface water interaction. However, given the very short timeframes for dewatering to occur during laying of the transmission line, changes to the interaction of groundwater and surface water are unlikely.	☒

B.7 Impact assessment

An exposure pathway describes the process by which a direct effect can alter baseline water conditions such that an GDE's environmental water requirement (the amount of water required to sustain an GDE with a minimum risk of degradation) are impacted. For example, if dewatering for trenching causes drawdown of the water table (direct effect), an exposure pathway exists if drawdown increases the depth to the water table beyond the root zone of groundwater reliant vegetation (GDE).

Table B-6 presents a summary of possible exposure pathways between direct effects (source) and potentially sensitive groundwater and surface water related GDEs (receptors) that have been identified in the transmission line options. No active pathway linkages are identified for either route option.

Table B-6 Possible exposure pathway for potential groundwater related GDEs

WAA (source)	GDE (receptor)	Direct effect (pathway)		Indirect (GDE) effect	Active pathway (linkage)?	Carried forward to threat assessment?
WAA4 – transmission line cabling dewatering and trenched and trenchless creek and wetland crossings (construction) **Option 2B**	GDE1 – Stygofauna	Quantity	DE11 – drawdown of watertable	Decrease in groundwater levels could impact stygofauna habitat	**No**. Suitable stygofauna habitat in the Project Area is assumed. Although stygofauna may occur along the transmission cable route, the duration and limited extent (less than 1.25 m of drawdown up to 20 m from cable trench for less than one week) would be very unlikely to impact these communities.	☒
		Quality	DE13 – sediment release to creeks / wetlands	Change in wetland water quality could impact stygofauna habitat	**No**. Suitable stygofauna habitat in the Project Area is assumed. Any environmental incident involving release of sediment or drilling muds into the creeks would be of short duration and unlikely to impact the groundwater environment.	☒
	GDE2 – Terrestrial GDEs	Quantity	DE11 – drawdown of watertable	Decrease in groundwater levels could reduce the groundwater available to terrestrial vegetation	**No**. Although high potential terrestrial GDEs occur along the transmission cable route, the duration and limited extent (less than 1.25 m of drawdown up to 20 m from cable trench for less than one week) would be very unlikely to impact vegetation.	☒
		Quality	DE13 – sediment release to creeks / wetlands	Decrease in water quality could impact terrestrial vegetation relying on this water source	**No.** The short-term release of sediments or muds into a waterway is unlikely to impact terrestrial vegetation using groundwater	☒
	GDE3 – Aquatic GDEs	Quantity	DE11 – drawdown of watertable	Decrease in groundwater levels could reduce the groundwater available for aquatic ecosystems	**No**. One low potential aquatic GDEs occurs along the transmission cable route (shallow marsh), however this feature is outside the predicted zone of impact (35 m from the cable). The mapped aquatic GDE is listed in the Wetland map as a "temporary freshwater marsh and meadow". Aerial imagery confirms this feature does not hold permanent water and is therefore unlikely to be dependent on groundwater as the primary water source.	☒
		Quality	DE13 – sediment release to creeks / wetlands	Reduction in water quality could impact aquatic ecosystems	**No.** The mapped aquatic GDE is ephemeral and does not hold permanent water. The trench is more than 30 m from the mapped edge of the wetland and therefore overland flow of sediments in quantities sufficient to cause damage to aquatic ecosystems is unlikely if standard construction site practices are followed.	☒

Appendix C Desktop GDE Characterisation

Additional Information for GDE Characterisation

This information was compiled by Umwelt in 2021.

C.1 Listing Criteria for the Glenelg Estuary and Discovery Bay Ramsar Site

The Glenelg Estuary and Discovery Bay Ramsar site meets five of the nine Ramsar listing criteria for identifying Wetlands of International Importance as detailed below.

Table C-7 Listing Criteria for the Glenelg Estuary and Discovery Bay Ramsar Site (https://www.dcceew.gov.au/water/wetlands/ramsar/criteria-identifying-wetlands)

Criterion	Values in the Ramsar Site
Criterion 1 – A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.	The Ramsar site meets this criterion through its unique combination of geomorphological features and wetland types (peat and dune slack wetlands and the Glenelg Estuary), including GDEs which include several of the most globally threatened wetland types: fens, wet grasslands, and temporary pools.
Criterion 2 – Species and ecological communities – A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities	The Ramsar site meets this criterion, regularly supporting one TEC, two threatened plant species and six threated animal species under the EPBC Act. These are: • subtropical and temperate coastal saltmarsh TEC • maroon leek-orchid (Prasophyllum frenchii) • swamp greenhood (Pterostylis tenuissima) • Australasian bittern (Botaurus poiciloptilus) • fairy tern (Sterna nereis nereis) • hooded plover (Thinornis rubricollis) • Yarra pygmy perch (Nannoperca obscura) • growling grass frog (Litoria reniformis), and • ancient greenling (Hemiphlebia mirabilis).
Criterion 4 – Species and ecological communities – A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.	The Ramsar site meets this criterion for supporting migratory species of waterbirds and fish as well as beach-nesting birds and providing freshwater habitat when the surrounding region is dry. The Ramsar site provides habitat for 95 waterbirds, including 24 species listed under international agreements. Beach-nesting birds such as hooded plover (Thinornis rubricollis) and red-capped plover (Charadrius ruficapillus) are regularly recorded nesting on the dunes of the Discovery Bay Coastal Park. The Ramsar site supports 14 species of native fish which are diadromous, migrating between habitats for part of their lifecycle. Additionally, the permanent wetlands of Long Swamp provide habitat for obligate aquatic species when the surrounding landscape is dry and during drought.
Criteria 8 – Fish – A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.	The Ramsar site provides a range of fish species with sources of food, spawning grounds and nurseries, and acts as a migration path on which diadromous fishes of the region depend, as such it is deemed to meet this criterion. The Glenelg Estuary provides nursery habitat for several species of recreationally important fish including black bream (Acanthopagrus butcheri) and estuary perch (Macquaria colonorum). The Ramsar site supports at least 14 species of fish that migrate between habitats for parts of their lifecycle including: short-finned eel (Anguilla australis), tupong (Pseudaphritis urvillii), estuary perch (Macquaria colonorum) and common galaxias (Galaxias maculatus).

Criterion	Values in the Ramsar Site
Criterion 9 – Other taxa – A wetland should be considered internationally important if it regularly supports one percent of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.	This criterion is met on the basis of the Ramsar site supporting more than 1% of the population of ancient greenling (Hemiphlebia mirabilis). The species is the only extant representative of this superfamily of damselfly globally.

C.2 GDE Characterisation – Features

A total of 568 GDE features (≥ 0.1 ha in size) covering 4,959.9 ha are mapped within the Project Area, the majority being terrestrial GDE types, as shown below.

Table C-8 Potential Groundwater Dependent Ecosystem Features Mapped in the Project Area (from the BoM Atlas)

GDE Type	Mapped Features (Area (ha))				Total Mapped Features	Total Area (ha)
	High Potential	Moderate Potential	Low Potential	Unclassified Potential		
Aquatic	23 (891.4)	13 (545.2)	5 (21.1)	8 (28.5)	49	1,486.2
Terrestrial	365 (1,912.4)	142 (1,533.7)	12 (27.6)	0 (0)	519	3,473.7

C.2.1 Plantation Sub-area

The Plantation sub-area comprises three distinct 'zones' for which GDEs are characterised:

- Plantations and Farmland
- Lower Glenelg National Park (situated in the northern portion of the Ramsar site)
- Long Swamp Complex and Beach/Dune System (situated in the southern portion of the Ramsar site).

A total of 205 GDE features (> 0.1 ha in size) covering 2,293.4 ha are mapped within the Plantation sub-area, dominated by terrestrial GDE types. A breakdown of these GDEs is provided in Table C-9.

Aquatic GDEs are primarily associated with palustrine and lacustrine wetlands, temporary freshwater swamps, marshes and meadows on parallel dune limestone ridges with intervening swamps and closed karst depressions and young volcanoes in southeast. Aquatic GDEs are mostly confined to the Long Swamp Complex and Beach/Dune System, however small portions are mapped within the plantations. Terrestrial GDEs are primarily associated with Coastal Alkaline Scrub (Long Swamp Complex and Beach/Dune System), Damp Sands Herb-rich Woodland (Plantations and Farmland) and Damp Sands Herb-rich Woodland/Damp Heathland/Damp Heathy Woodland Mosaic (Lower Glenelg National Park) on parallel dune limestone ridges with intervening swamps and closed karst depressions and young volcanoes in the southeast.

Table C-9 Potential Groundwater Dependent Ecosystem Features Mapped in the Plantation Sub Area (from the BoM Atlas)

GDE Type	Mapped Features (Area (ha))				Total Mapped Features	Total Area (ha)
	High Potential	Moderate Potential	Low Potential	Unclassified Potential		
Aquatic	6 (798.1)	5 (76.2)	2 (7.3)	7 (28.0)	20	909.6

GDE Type	Mapped Features (Area (ha))				Total Mapped Features	Total Area (ha)
	High Potential	Moderate Potential	Low Potential	Unclassified Potential		
Terrestrial	88 (279.3)	3 (1.8)	94 (1,102.7)	0 (0)	185	1,383.8

Plantations and Farmland

The majority of the Plantation sub-area comprises plantations of radiata pine (Pinus radiata) of varying stand age, as well as areas of farmland to the southwest. Mature pine plantations within the site provide limited fauna habitat value due to the monoculture, high level of shading and dense little layer of pine needles which suppresses growth of understorey plants (Biosis 2021). However, some areas were noted to contain an understorey of recolonising native species, particularly near the edge of the plantation and in younger stands (Biosis 2021). There is a small section of blue-gum (Eucalyptus globulus) plantation in the easternmost extent of Zone 1 between the pine plantation and Ramsar site which generally supports a higher cover and diversity of native understorey species (Biosis 2021). The plantations and farmland occur within the Glenelg Plain Bioregion (DELWP 2020).

Review of 2005 EVC mapping (DELWP 2021) indicates that vegetation communities associated with GDEs intersecting the pine plantation in the Plantation sub-area comprise:

- EVC 3 – Damp Sands Herb-rich Woodland (Vulnerable)
- EVC 23 – Herb-rich Foothill Forest (Vulnerable)
- EVC 179 – Heathy Herb-rich Woodland (Depleted)
- EVC 645 – Wet Heathland/Heathy Woodland Mosaic (Least Concern)
- EVC 681 – Deep Freshwater Marsh (Vulnerable)
- EVC 858 – Coastal Alkaline Scrub (Least Concern).

Vegetation mapping undertaken by Biosis (2021) confirmed the presence of EVC 3 – Damp Sands Herb-rich Woodland (Vulnerable) and EVC 858 – Coastal Alkaline Scrub (Least Concern) along road reserves within the pine plantation.

Groundwater studies conducted by (AECOM 2021a) indicate that the depth to water varies greatly within the plantations (1.8 - 40.9 mbgs), due to the relatively flat water table compared to the undulating ground surface. The depth to groundwater is shallowest in lower lying areas adjacent to the Ramsar wetlands (AECOM 2021a). Shallow groundwater flow is anticipated to flow south, providing a component of flow to the wetland complexes that form part of the Ramsar site (AECOM 2021a). The permanent or intermittent dependency of terrestrial or aquatic systems on groundwater within the plantations is considered likely where groundwater is shallow. The dependency on groundwater for terrestrial ecosystems becomes less likely as the depth to groundwater increases.

Threatened flora and fauna species identified by Biosis (2021), either through VBA records or field survey observations, that are likely to be reliant on GDEs in this locality are provided in Table C-10. The DELWP Advisory list is superseded by the FFG Act DELWP list of threatened species. However, the DELWP Advisory List is still included in this table for species that are not listed on the FFG Act list (noting that the FFG act takes precedence).

Table C-10 Threatened Species Known to Occur in the Groundwater Dependent Ecosystems of the Plantations and Farmland in the Plantation Sub-area

Common Name	Species Name	EPBC Act[1]	FFG Act[1]	DELWP Advisory List[1]	Source
Birds					
brolga	*Grus rubicunda*		En	Vu	VBA records and Biosis (2021) observations

Common Name	Species Name	EPBC Act[1]	FFG Act[1]	DELWP Advisory List[1]	Source
eastern ground parrot	*Pezoporus wallicus*		En	En	VBA records
pied cormorant	*Phalacrocorax varius*			Nt	VBA records
rufous bristlebird	*Dasyornis broadbenti*		En	Nt	Biosis (2021) observations
sanderling	*Calidris alba*	Mi		Nt	VBA records
south-eastern red-tailed black-cockatoo	*Calyptorhynchus banksii graptogyne*	En	En	En	VBA records
white-throated needletail	*Hirundapus caudacutus*	Vu, Mi	Vu	Vu	VBA records and Biosis (2021) observations
Mammals					
long-nosed potoroo	*Potorous tridactylus tridactylus*	Vu	Vu	Nt	VBA records
swamp antechinus	*Antechinus minimus maritimus*	Vu	Vu	Nt	VBA records
Amphibians					
growling grass frog	*Litoria raniformis*	Vu	Vu	En	VBA records
Reptiles					
eastern bearded dragon	*Pogona barbata*		Vu	Vu	Biosis (2021) observations
four-toed skink	*Hemiergis peronii*			Nt	Biosis (2021) observations
striped worm-lizard	*Aprasia striolata*		En	Nt	Biosis (2021) observations

Notes: [1] Cr = Critically endangered, En = Endangered, Vu = Vulnerable, Nt = Near threatened, Mi = Migratory

Figure C-3 Aerial view of plantations and The Sheepwash lake, situated adjacent to the Long Swamp Complex and Beach/Dune System (Biosis 2021)

Lower Glenelg National Park

Lower Glenelg National Park is situated adjacent to the northern boundary of the Plantation sub-area and forms part of the Ramsar site. The National Park protects a diverse suite of values including the Glenelg River estuary and riverine corridor. Terrestrial GDEs are mapped across the National Park and include the heathlands and woodlands that support the ecology of the Glenelg Estuary (DELWP 2017a). The National Park occurs within the Glenelg Plain Bioregion (DELWP 2020).

Review of 2005 EVC mapping (DELWP 2021) indicates that vegetation communities associated with GDEs intersecting the Lower Glenelg National Park in the Plantation sub-area comprise:

- EVC 3 – Damp Sands Herb-rich Woodland (Vulnerable)
- EVC 740 – Damp Sands Herb-rich Woodland/Heathy Woodland/Sand Heathland Mosaic (Vulnerable)
- EVC 881 – Damp Sands Herb-rich Woodland/Heathy Woodland Mosaic (Vulnerable).

Vegetation mapping undertaken by Biosis (2021) identifies the following vegetation communities associated with GDEs within the Plantation sub-area where it borders the Lower Glenelg National Park:

- EVC 3 – Damp Sands Herb-rich Woodland (Vulnerable)
- EVC 858 – Coastal Alkaline Scrub (Least Concern).

Monitoring at groundwater bore 101238 indicates a groundwater depth of between 18 - 21 mbgs in the north-western portion of the wind farm site (AECOM 2021a). At this depth terrestrial vegetation is less likely to access groundwater on a permanent or intermittent basis. It is also noted that cave systems are known to be present surrounding and underneath the Glenelg Estuary and thus may be present within the Investigation Area.

Threatened flora and fauna species identified by Biosis (2021), either through VBA records or field survey observations, that are likely to be reliant on GDEs in this locality are provided in Table C-11.

Table C-11 Threatened Species Known to Occur in the Groundwater Dependent Ecosystems of the Lower Glenelg National Park in the Plantation Sub-area

Common Name	Species Name	EPBC Act[1]	FFG Act[1]	DELWP Advisory List[1]	Source
Plants					
coast ixodia	*Ixodia achillaeoides* subsp. *arenicola*	Vu		Vu	Biosis (2021) observations
Birds					
Australasian bittern	*Botaurus poiciloptilus*	En	Cr	En	VBA records
rufous bristlebird	*Dasyornis broadbenti*		En	Nt	VBA records and Biosis (2021) observations
south-eastern red-tailed black-cockatoo	*Calyptorhynchus banksii graptogyne*	En	En	En	VBA records
white-throated needletail	*Hirundapus caudacutus*	Vu, Mi	Vu	Vu	VBA records and Biosis (2021) observations
Mammals					
heath mouse	*Pseudomys shortridgei*	En	En	Nt	VBA records
long-nosed potoroo	*Potorous tridactylus tridactylus*	Vu	Vu	Nt	VBA records
southern brown bandicoot	*Isoodon obesulus obesulus*	En	En	Nt	VBA records

Notes: [1] Cr = Critically endangered, En = Endangered, Vu = Vulnerable, Nt = Near threatened, Mi = Migratory, L = Listed

Long Swamp Complex and Beach/Dune System

The southern boundary of the Plantation sub-area borders the Ramsar site. A prominent feature of the Ramsar site is the Long Swamp Complex, a series of freshwater wetlands situated in a chain behind the beach and dune system. Both aquatic and terrestrial GDEs are mapped within the Long Swamp Complex and Beach/Dune System. The Long Swamp Complex occurs within the Bridgewater Bioregion (DELWP 2020).

A review of 2005 EVC mapping (DELWP 2021) indicates that vegetation communities associated with GDEs intersecting the Long Swamp Complex and Beach/Dune System in the Plantation sub-area comprise:

- EVC 3 – Damp Sands Herb-rich Woodland (Vulnerable)
- EVC 160 – Coastal Dune Scrub (Least Concern)
- EVC 680 – Freshwater Meadow (Endangered)
- EVC 681 – Deep Freshwater Marsh (Vulnerable)
- EVC 682 – Permanent Open Freshwater (Not Applicable)
- EVC 858 – Coastal Alkaline Scrub (Least Concern).

Vegetation mapping undertaken for the Long Swamp Complex by the Nature Glenelg Trust (Bachmann et al. 2018) has identified a pattern of mostly shrub-dominated vegetation types, interspersed by sedgeland and, to a lesser extent, aquatic communities. These communities are illustrated on Figure C-4, while a representative photo is provided as Figure C-5.

Vegetation mapping undertaken by Biosis (2021) identified the following vegetation communities associated with GDEs within the Plantation sub-area where it borders the Long Swamp Complex and Beach/Dune System:

- EVC 3 – Damp Sands Herb-rich Woodland (Vulnerable)

- EVC 858 – Coastal Alkaline Scrub (Least Concern).

These vegetation communities are regarded as GDEs at this location as groundwater is close to the surface (<4 mbgs) in this area (AECOM 2021a), and groundwater is fed into the wetlands behind the dunes.

The ecology of the Long Swamp Complex and Beach/Dune System is closely linked to the surface and groundwater flows through this area, as illustrated by the Long Swamp Restoration Trial Evaluation Report undertaken by the Glenelg Trust (Bachmann et al. 2018). These terrestrial and aquatic GDEs support a diversity of species (including waterbird species) and associated habitats.

In addition, and as recognised by the Ramsar site's Ecological Character Description (DELWP 2017a), the Long Swamp Complex and Beach/Dune System is known to regularly support several threatened flora and fauna species. Threatened flora and fauna species identified by Biosis (2021), either through VBA records or field survey observations, that are likely to be reliant on GDEs in this locality are provided in Table C-12.

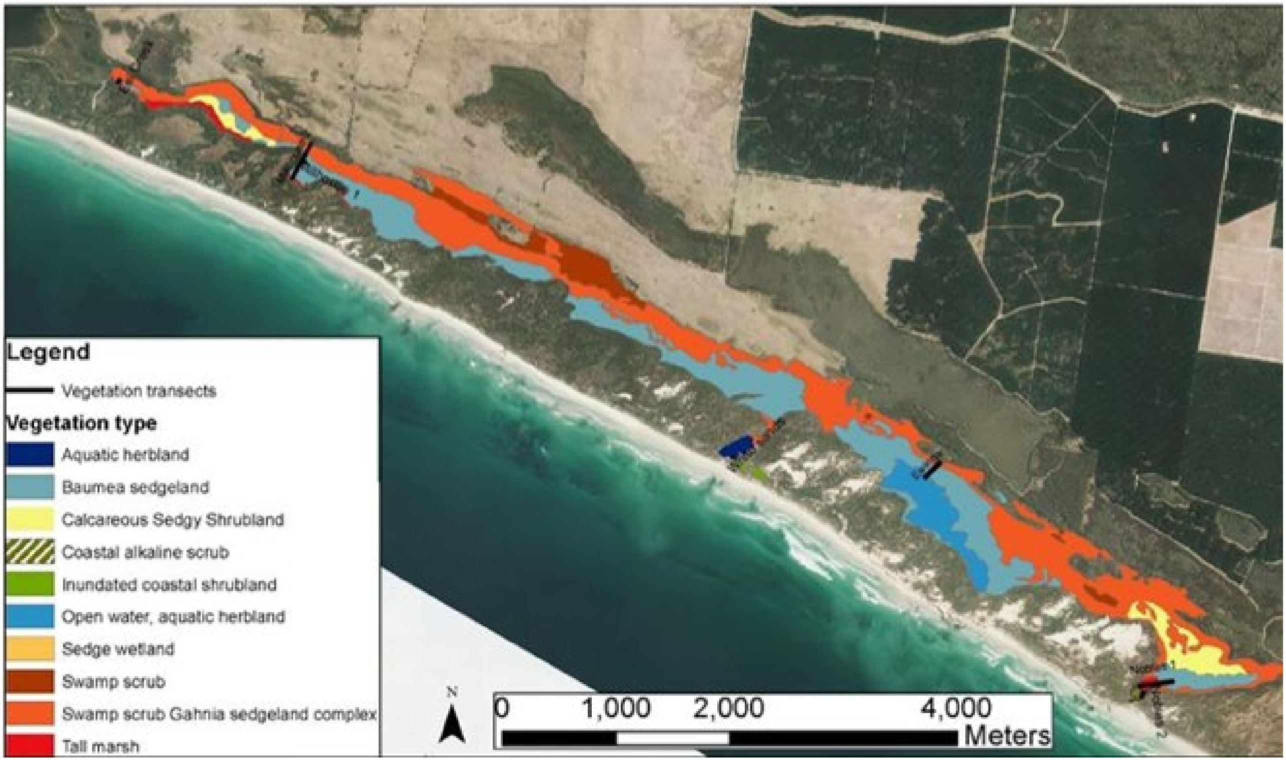

Figure C-4 Vegetation Mapping Completed for the Long Swamp Complex (Bachmann et al. 2018)

Figure C-5 Aerial view of the Long Swamp Complex and Beach/Dune System (Biosis 2021)

Table C-12 Threatened Species Known to Occur in the Groundwater Dependent Ecosystems of the Long Swamp Complex and Beach/Dune System in the Plantation Sub-area

Common Name	Species Name	EPBC Act[1]	FFG Act[1]	DELWP Advisory List[1]	Source
Plants					
coastal leek orchid	*Prasophyllum litorale*		Cr	Vu	Biosis (2021) observations
maroon leek-orchid	*Prasophyllum frenchii*	En	En	En	Ramsar ECD
scented spider-orchid	*Caladenia fragrantissima*		Cr	En	Biosis (2021) observations
swamp greenhood	*Pterostylis tenuissima*	Vu		Vu	Ramsar ECD
Birds					
Australasian bittern	*Botaurus poiciloptilus*	En	Cr	En	Ramsar ECD, VBA records and Biosis (2021) observations
bar-tailed godwit	*Limosa lapponica*	Vu, Mi	Vu		Biosis (2021) observations
brolga	*Grus rubicunda*		En	Vu	VBA records and Biosis (2021) observations
common greenshank	*Tringa nebularia*	Mi	En	Vu	Biosis (2021) observations
crested tern	*Thalasseus bergii*	Mi			Biosis (2021) observations

Common Name	Species Name	EPBC Act[1]	FFG Act[1]	DELWP Advisory List[1]	Source
curlew sandpiper	*Calidris ferruginea*	Cr, Mi	Cr	En	Ramsar ECD and Biosis (2021) observations
double banded plover	*Charadrius bicinctus*	Mi			Biosis (2021) observations
eastern ground parrot	*Pezoporus wallicus*		En	En	VBA records
fairy tern	*Sterna nereis nereis*	Vu	Cr	En	Ramsar ECD
hooded plover	*Thinornis rubricollis*	Vu	Vu	Vu	Ramsar ECD and Biosis (2021) observations
orange bellied parrot	*Neophema chrysogaster*	Cr	Cr	Cr	VBA records and Biosis (2021) observations
red knot	*Calidris canutus*	En, Mi	En	En	Biosis (2021) observations
red-necked stint	*Calidris ruficollis*	Mi			Biosis (2021) observations
rufous bristlebird	*Dasyornis broadbenti*		En	Nt	VBA records and Biosis (2021) observations
sanderling	*Calidris alba*	Mi		Nt	Ramsar ECD, VBA records and Biosis (2021) observations
sharp-tailed sandpiper	*Calidris acuminata*	Mi			Biosis (2021) observations
south-eastern red-tailed black-cockatoo	*Calyptorhynchus banksii graptogyne*	En	En	En	VBA records
white-throated needletail	*Hirundapus caudacutus*	Vu, Mi	Vu	Vu	VBA records and Biosis (2021) observations
Mammals					
swamp antechinus	*Antechinus minimus maritimus*	Vu	Vu	Nt	VBA records
Fishes					
Yarra pygmy perch	*Nannoperca obscura*	Vu	Vu	Vu	Ramsar ECD
Amphibians					
growling grass frog	*Litoria raniformis*	Vu	Vu	En	Ramsar ECD, VBA records
Reptiles					
swamp skink	*Lissolepis coventryi*		En	Vu	VBA records
four-toed skink	*Hemiergis peronii*			Nt	VBA records and Biosis (2021) observations
striped worm-lizard	*Aprasia striolata*		En	Nt	Biosis (2021) observations
Invertebrates					
ancient greenling	*Hemiphlebia mirabilis*	-	En	En	Ramsar ECD and VBA records

Notes: [1] Cr = Critically endangered, En = Endangered, Vu = Vulnerable, Nt = Near threatened, Mi = Migratory

C.2.2 Northeastern Sub-area

The Northeastern sub-area occurs within areas of active farmland that have mostly been cleared of vegetation and are currently being used for dryland grazing by sheep and cattle. The cleared paddocks are dominated by introduced grasses, but many have scattered native species present, including grasses, rushes, Austral bracken (Pteridium esculentum) and shrub species close to adjacent public land (Biosis 2021). There is an extensive area of blue-gum plantations in the north-east of the Northeastern sub-area, surrounded by Cobboboonee National Park (Biosis 2021).

The Northeastern sub-area intersects three bioregions: the Glenelg Plain Bioregion in the west, Victorian Volcanic Plain Bioregion in the east and Bridgewater Bioregion in the south (DELWP 2020).

A total of 132 GDE features (> 0.1 ha in size) covering 553.5 ha are mapped within the Northeastern sub-area. A breakdown of these GDEs and their associated EVCs is provided in Table C-13. Aquatic GDEs are primarily associated with palustrine or lacustrine wetlands, mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks. Terrestrial GDEs are primarily associated with Wet Heathland/Heathy Woodland Mosaic, mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks.

Table C-13 Potential Groundwater Dependent Ecosystem Features Mapped in the Northeastern Sub-area (from the BoM Atlas)

GDE Type	Mapped Features (Area (ha))				Total Mapped Features	Total Area (ha)
	High Potential	Moderate Potential	Low Potential	Unclassified Potential		
Aquatic	3 (5.8)	6 (454.3)	1 (2.0)	1 (0.5)	11	462.6
Terrestrial	106 (77.1)	10 (11.8)	5 (2.0)	0 (0)	121	90.9

The mapped aquatic and terrestrial GDEs within the Northeastern sub-area are not directly associated with the Ramsar site but do form part of the Lower Glenelg National Park, which further west is associated with the Ramsar site.

A review of 2005 EVC mapping (DELWP 2021) indicates that vegetation communities associated with GDEs intersecting the Northeastern sub-area comprise:

- EVC 3 – Damp Sands Herb-rich Woodland (Vulnerable)
- EVC 6 – Sand Heathland (Rare)
- EVC 8 – Wet Heathland (Least Concern)
- EVC 16 – Lowland Forest (Least Concern)
- EVC 23 – Herb-rich Foothill Forest (Vulnerable)
- EVC 48 – Heathy Woodland (Least Concern)
- EVC 179 – Heathy Herb-rich Woodland (Depleted)
- EVC 645 – Wet Heathland/Heathy Woodland Mosaic (Least Concern)
- EVC 681 – Deep Freshwater Marsh (Vulnerable)
- EVC 858 – Coastal Alkaline Scrub (Least Concern).

Vegetation mapping undertaken by Biosis (2021) identifies the following vegetation communities associated with GDEs within the Northeastern sub-area:

- EVC 3 – Damp Sands Herb-rich Woodland (Vulnerable)
- EVC 8 – Wet Heathland (Least Concern)

- EVC 16 – Lowland Forest (Least Concern)
- EVC 23 – Herb-rich Foothill Forest (Vulnerable)
- EVC 48 – Heathy Woodland (Least Concern)
- EVC 53 – Swamp Scrub
- EVC 858 – Coastal Alkaline Scrub (Least Concern).

Groundwater levels are close to the surface in this locality, generally between 1 - 3 mbgs (AECOM 2021a). Waterbodies (mapped aquatic GDEs) in this locality are anticipated to be reliant on groundwater, particularly during summer months (AECOM 2021a). Given the shallow water table, terrestrial vegetation is considered likely to access groundwater on a permanent or intermittent basis. This is supported by terrestrial GDE mapping surrounding and in the immediate vicinity of mapped aquatic GDEs.

Threatened flora and fauna species identified by Biosis (2021), either through VBA records or field survey observations, that are likely to be reliant on GDEs in this locality are provided in Table C-14.

Table C-14 Threatened Species Known to Occur in the Groundwater Dependent Ecosystems of the Northeastern Sub-area

Common Name	Species Name	EPBC Act[1]	FFG Act[1]	DELWP Advisory List[1]	Source
Birds					
Australasian bittern	*Botaurus poiciloptilus*	En	Cr	En	VBA records and Biosis (2021) observations
brolga	*Grus rubicunda*		En	Vu	VBA records and Biosis (2021) observations
eastern great egret	*Ardea alba modesta*		Vu	Vu	VBA records
rufous bristlebird	*Dasyornis broadbenti*		En	Nt	Biosis (2021) observations
Mammals					
heath mouse	*Pseudomys shortridgei*	En	En	Nt	VBA records
southern brown bandicoot	*Isoodon obesulus obesulus*	En	En	Nt	VBA records
Amphibians					
growling grass frog	*Litoria raniformis*	Vu	Vu	En	VBA records

Notes: [1] Cr = Critically endangered, En = Endangered, Vu = Vulnerable, Nt = Near threatened, Mi = Migratory, L = Listed

C.2.3 Transmission Line Sub-area

The Transmission Line sub-area includes a section of underground powerline running east-west through Cobboboonee National Park and State Forest, beneath or adjacent to Boiler Swamp Road. Between Cobboboonee State Forest and the Heywood Terminal Station, the transmission line is overhead through private property. The sub-area is situated within the Victorian Volcanic Plain Bioregion (DELWP 2020).

A total of 231 GDE features (> 0.1 ha in size) covering 2,113 ha are mapped within the Transmission Line sub-area. A breakdown of these GDEs is provided in Table 4.8. Aquatic GDEs are primarily associated with palustrine wetlands and temporary freshwater marshes and meadows, mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks. Terrestrial GDEs are primarily associated with Lowland Forest, mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks.

Table C-15 Potential Groundwater Dependent Ecosystem Features Mapped in the Transmission Line Sub-area (from the BoM Atlas)

GDE Type	Mapped Features (Area (ha))				Total Mapped Features	Total Area (ha)
	High Potential	Moderate Potential	Low Potential	Unclassified Potential		
Aquatic	14 (87.5)	2 (14.7)	2 (11.8)	0 (0)	18	114.0
Terrestrial	171 (1,556.0)	38 (419.2)	4 (23.8)	0 (0)	213	1,999.0

High potential terrestrial and aquatic GDEs are mapped in large parts of the transmission line route. This mapping is supported by predicted groundwater depth levels, regarded as being <10 mbgs (AECOM 2021a). This suggests that there is at least some degree of reliance on groundwater, being either on a permanent or intermittent basis.

Review of 2005 EVC mapping (DELWP 2021) indicates that vegetation communities associated with GDEs intersecting the transmission line route comprise:

- EVC 16 – Lowland Forest (Least Concern)
- EVC 23 – Herb-rich Foothill Forest (Vulnerable)
- EVC 53 – Swamp Scrub (Vulnerable)
- EVC 198 – Sedgy Riparian Woodland (Vulnerable)
- EVC 200 – Shallow Freshwater Marsh (Endangered)
- EVC 650 – Heathy Woodland/Damp Heathy Woodland/Damp Heathland Mosaic (Vulnerable)
- EVC 681 – Deep Freshwater Marsh (Vulnerable)
- EVC 713 – Damp Sands Herb-rich Woodland/Damp Heathland/Damp Heathy Woodland Mosaic (Vulnerable).

The Cobboboonee National Park supports extensive areas of EVC 8 – Wet Heathland (Least Concern), EVC 16 – Lowland Forest (Least Concern), EVC 23 – Herb-rich Foothill Forest (Vulnerable) and EVC 48 – Heathy Woodland (Least Concern).

Vegetation mapping undertaken by Biosis (2021) identified the following vegetation communities associated with GDEs within the Transmission Line sub-area:

- EVC 3 – Damp Sands Herb-rich Woodland (Vulnerable)
- EVC 16 – Lowland Forest (Least Concern)
- EVC 23 – Herb-rich Foothill Forest (Vulnerable)
- EVC 48 – Heathy Woodland (Least Concern)
- EVC 198 – Sedgy Riparian Woodland (Vulnerable) (Figure C-6).

Threatened flora and fauna species identified by Biosis (2021), either through VBA records or field survey observations, that are likely to be reliant on GDEs in this locality are provided in Table C-16.

Figure C-6 EVC 198 – Sedgy Riparian Woodland along Boiler Swamp Road in the Transmission Line Sub-area (Biosis 2021)

Table C-16 Threatened Species Known to Occur in the Groundwater Dependent Ecosystems of the Transmission Line Sub-area

Common Name	Species Name	EPBC Act[1]	FFG Act[1]	DELWP Advisory List[1]	Source
Plants					
small sickle greenhood	*Pterostylis lustra*		En	En	Biosis (2021) observations
Birds					
brolga	*Grus rubicunda*		En	Vu	VBA records and Biosis (2021) observations
masked owl	*Tyto novaehollandiae*		Cr	En	VBA records
musk duck	*Biziura lobata*		Vu	Vu	VBA records
powerful owl	*Ninox strenua*		Vu	Vu	VBA records
white-throated needletail	*Hirundapus caudacutus*	Vu, Mi	Vu	Vu	VBA records
Mammals					
heath mouse	*Pseudomys shortridgei*	En	En	Nt	VBA records
long-nosed potoroo	*Potorous tridactylus trisulcatus*	Vu	Vu	Nt	VBA records
southern brown bandicoot	*Isoodon obesulus obesulus*	En	En	Nt	VBA records
spot-tailed quoll	*Dasyurus maculatus maculatus*	En	En	En	VBA records

Common Name	**Species Name**	**EPBC Act[1]**	**FFG Act[1]**	**DELWP Advisory List[1]**	**Source**
swamp antechinus	*Antechinus minimus maritimus*	Vu	Vu	Nt	VBA records
white-footed dunnart	*Sminthopsis leucopus*		Vu	Nt	VBA records
Fishes					
Yarra pygmy perch	*Nannoperca obscura*	Vu	Vu	Vu	VBA Records
Reptiles					
four-toed skink	*Hemiergis peronii*			Nt	VBA records

Notes: [1] Cr = Critically endangered, En = Endangered, Vu = Vulnerable, Nt = Near threatened, Mi = Migratory, L = Listed

Appendix D 7-day pumping test factual report

Neoen Australia Pty Ltd

Factual Report – 7-day groundwater pumping test

17 May 2023

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Document history & status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
Rev0	17 May 2023	M Dudding	F Dean	17 May 2023	Draft for client comments
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Section 1 Introduction

CDM Smith was engaged by Neoen to complete a 7-day groundwater pumping test of an existing groundwater extraction bore at the Kentbruck Plantation. The objectives of the pumping test were to build on the data and analysis collected during a 24-hour pumping test completed at the same bore in March 2022. The results of the 7-day test intend to increase confidence in the hydrogeological conceptual model developed as part of the groundwater impact assessment and inform future groundwater assessments.

1.1 Site location and bores

Kentbruck Plantation is located in southwest Victoria, 17 km east of the border with South Australia. The pumping well (TB01) is located on Nine Mile Road, near the junction with Portland-Nelson Road in an area of recently harvested commercial forestry. The primary monitoring well (MB01) is located 14 m to the south of TB01 and the other monitoring wells (MW05 to MW08) are located between 3,100 and 4,200 m away.

The pumping well and monitoring well details are shown in Table 1-1 and a bore location map is shown on Figure 1.

Table 1-1 Groundwater well details

Well ID	Distance from TB01 (m)	Ground elevation (m AHD)	Total depth	Screened interval	Screened geology	Standing water level (m AHD)
TB01	0	41.11	144 m bgs [-102.89 m AHD]	54 to 144 m bgs [-12.89 to -102.89 m AHD]	Port Campbell Limestone	12.69
MB01	14	41.07	132 m bgs [-90.93 m AHD]	100 to 130 m bgs [-58.93 to -88.93 m AHD]	Port Campbell Limestone	12.53
MW05	3,240	13.24	10 m bgs [3.24 m AHD]	7 to 10 m bgs [6.24 to 3.24 m AHD]	Bridgewater Formation	5.71
MW06	4,200	7.48	5 m bgs [2.48 m AHD]	2 to 5 m bgs [5.48 to 2.48 m AHD]	Bridgewater Formation	4.48
MW07	3,100	14.55	10 m bgs [4.55 m AHD]	5.5 to 8.5 m bgs [9.05 to 6.05 m AHD]	Bridgewater Formation	8.52
MW08	3,950	8.33	4 m bgs [4.33 m AHD]	1 to 4 m bgs [7.33 to 4.33 m AHD]	Bridgewater Formation	6.63

Notes: m bgs = metres below ground surface, m AHD = metres Australian Height Datum, standing water level measured 17/04/2023

The hydrogeological model for the site has been developed as part of the Groundwater Impact Assessment (AECOM, 2022) based on a regional desktop assessment and local site investigation including drilling of monitoring wells and a 24 hour pumping test at TB01. The hydrogeological conceptual model is presented in Table 1-2 and Figure 2. Further details can be found in the Groundwater Impact Assessment, specifically Appendix F (AECOM, 2022).

Table 1-2 Hydrogeological conceptual model

Aspect of conceptualisation	Description (from AECOM, 2022)
Geology and hydrostratigraphy	Calcareous dunes and dune limestone of the Bridgewater Formation (BF) overlie the Port Campbell Limestone (PCL) to varying thicknesses. The BF is generally thicker to the north and becomes thinner southwards towards the coast where it forms a thin covering. The BF forms the Quaternary Aquifer (QA) in the region and the PCL is part of the Upper-Mid Tertiary Aquifer (UMTA). There is no significant aquitard between the QA and UMTA, and they are considered to act as one unit on a regional scale; but connection between the two formations will vary at the local scale. Significant discrete fractures were only encountered at depths of greater than 90 mbgs in the lower UMTA, and were overlain by lower permeability limestone matrix. The lower UMTA targeted by the test bore TB01 behaved as a confined system during pumping tests, and is consistent with the lithology encountered during drilling.
Groundwater levels and flow	The water table is hosted either by the QA or the underlying UMTA depending on water table elevation relative to the base of the QA. A groundwater divide is inferred to be present in the shallow groundwater system beneath a topographic high (generally coincident with the Portland-Nelson Road). Shallow groundwater flow (in the QA and upper UMTA) in towards the Glenelg River north of the divide, and south of the divide flow towards the Ramsar wetland complexes along the coast. Flow in the lower UMTA occurs as throughflow beneath the site as part of intermediate and regional flow systems. These flowpaths are generally from regional scale recharge areas at the margins of the basin (north), to regional discharge areas beyond the coast (south).
Recharge	Recharge to the QA is via direct rainfall infiltration, which is reduced due to uptake by trees across the plantation area. Recharge to the upper UMTA is via rainfall infiltration through the overlying unsaturated QA or leakage from the overlying QA (where saturated) and vertical hydraulic gradients allow. Recharge to lower portions of the UMTA (targeted by TB01) will occur via leakage from overlying portions of the UMTA or up-dip to the north where it outcrops or sub-crops towards the margins of the Basin
Discharge	Groundwater in the QA and upper UMTA (the shallow groundwater system) is discharged to the Ramsar wetland complex via relatively high transmissivity sediments; as indicated by on site hydraulic conductivity and shallow hydraulic gradient. Groundwater in the lower UMTA flows to regional discharge areas beyond the coast.
Potential impact of pumping on receptors	The lower UMTA appears to be poorly connected from the shallow groundwater system and therefore the existing consumptive use bores, with limited potential for vertical leakage between the lower UMTA and QA/upper UMTA. If the lower UMTA were to act as an unconfined or leaky confined (semi-confined) system during longer term pumping then the extent of drawdown would be much reduced (due to increased available storage), and the magnitude of water table drawdown would not be significant. It should be noted that in a leaky aquifer impact would be related to timeframe and over a long enough pumping period, impact would likely occur in a leaky system. Timing of impact would be dependent on how the pumping would alter the overall water balance between aquifers and aquitards.

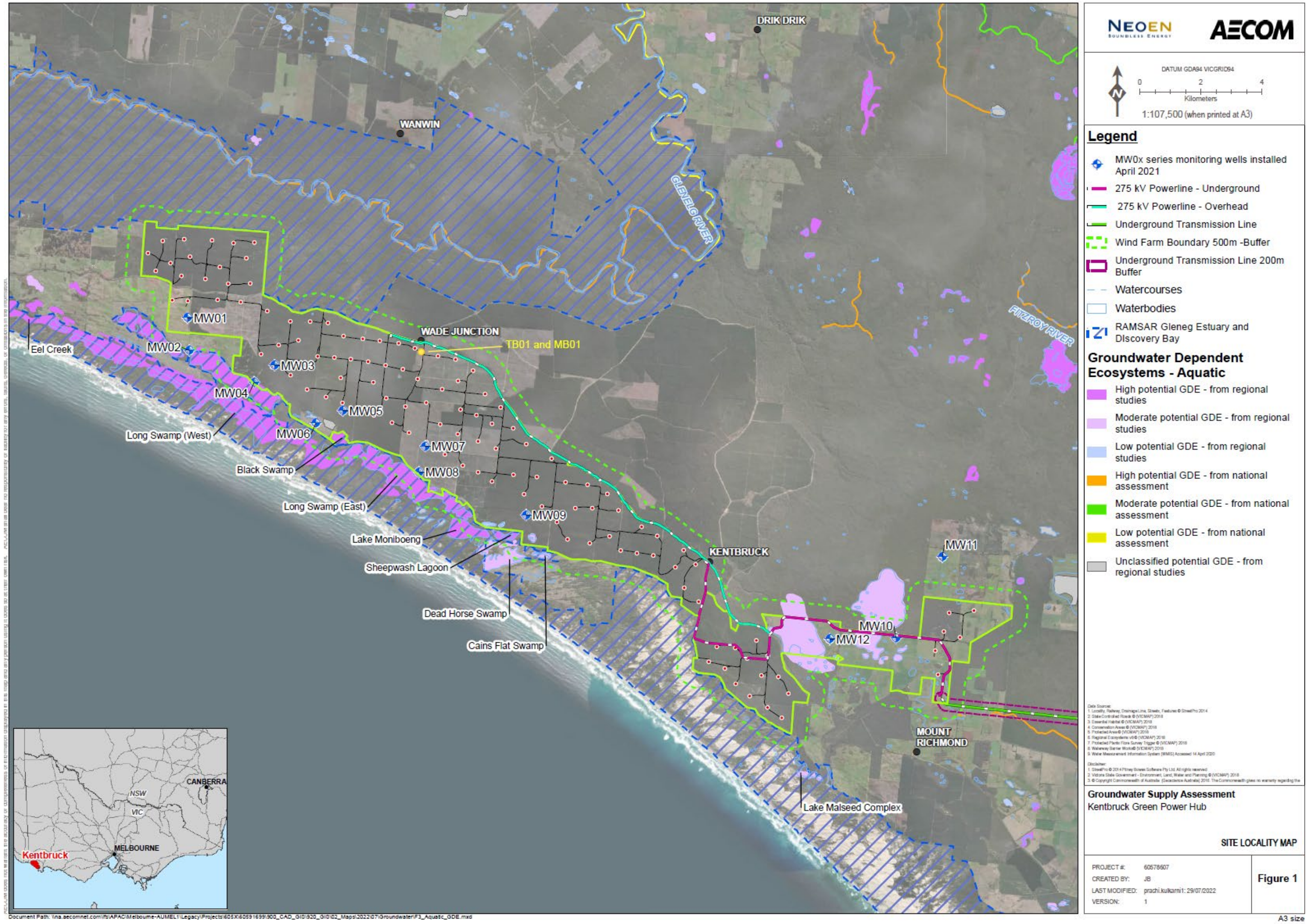


Figure 1 Groundwater bore location map

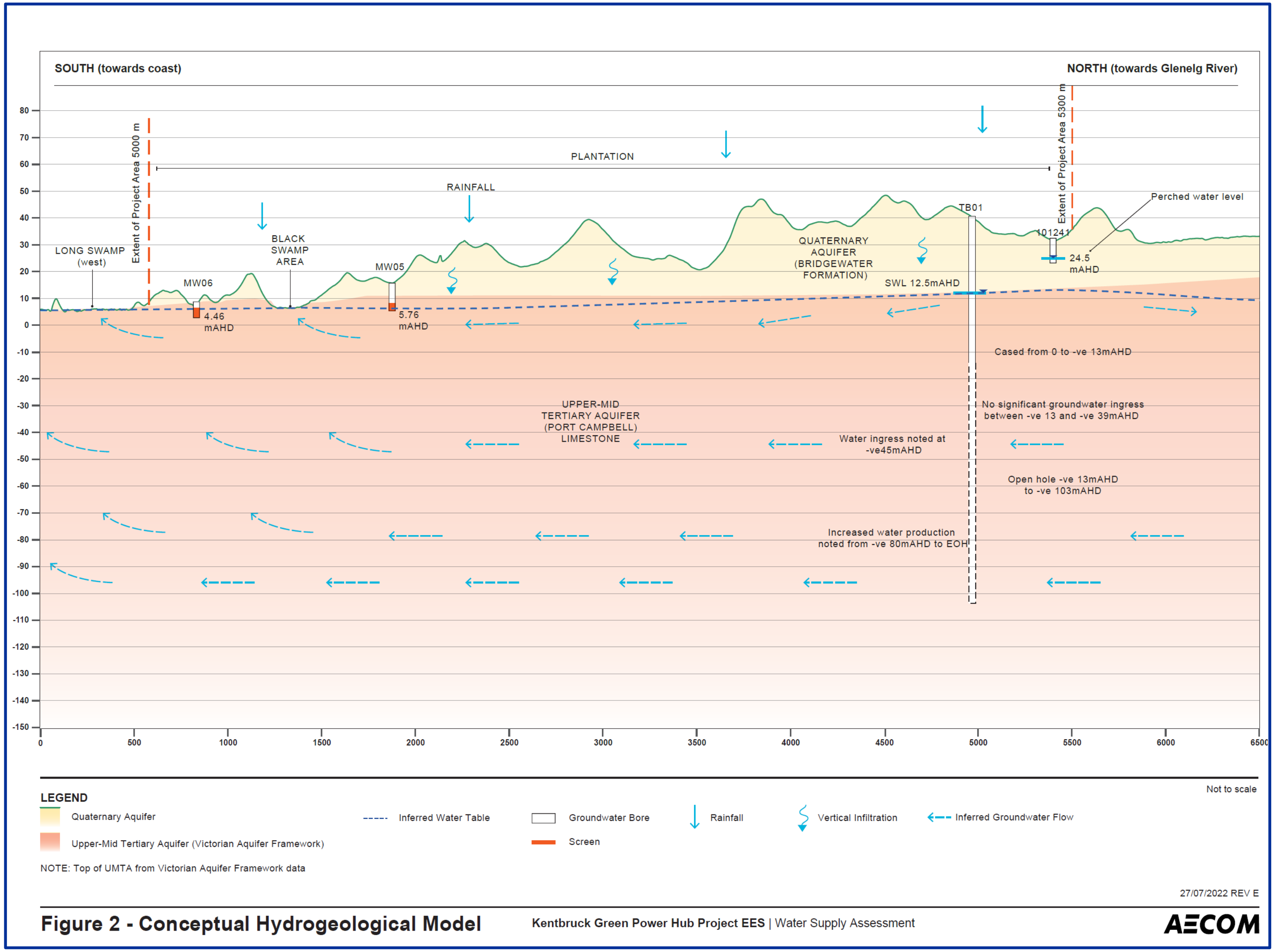


Figure 2 Hydrogeological conceptual model (from AECOM, 2022)

Section 2 Methodology and Results

2.1 Methodology

Agmek Ballarat Pty Ltd mobilised to site on 17 April 2023 to undertake a 7 day constant rate pumping test at TB01. The test was completed using an electric submersible pump installed in the 100 mm TB01 at a depth of 51 m (within the cased section of the well). Solinst leveloggers were used to collect water level readings in TB01 and nearby MB01. Level loggers were also installed in the shallow observation wells MW05, MW06, MW07 and MW08. A barometric logger was installed at MB01 so that the logger readings could be corrected for barometric pressure. A flow meter fitted with a logger recorded readings for flow. Groundwater was discharged via lay flat hose nearby into the plantation area.

The pumping test commenced at 16:40 on 17th April 2023 at 2 L/sec (to emulate the 24 hour test) and was switched off 7 days later at 16:40 on 24th April. The pump was left in the bore (with a no return valve) for a further 7 days to record groundwater levels as they recovered. Water levels in TB01 recovered 100 % over this period and water levels in MB01 recovered to 95% of the original standing water level (within 0.5 m).

During the pumping phase, the test was supervised by Agmek staff and readings of level and flow were recorded to ensure a steady flow rate and that water levels remained within the available drawdown. The rate of 2 L/sec was maintained throughout the test although a number of pump surges occurred which caused temporary increased drawdown.

Plate 1 Site layout showing TB01 and MB01 with pump and generator

2.2 Water level results

The observed water levels (as m AHD) for TB01 and MB01 are shown on Figure 3 and MW05 to MW08 on Figure 4.

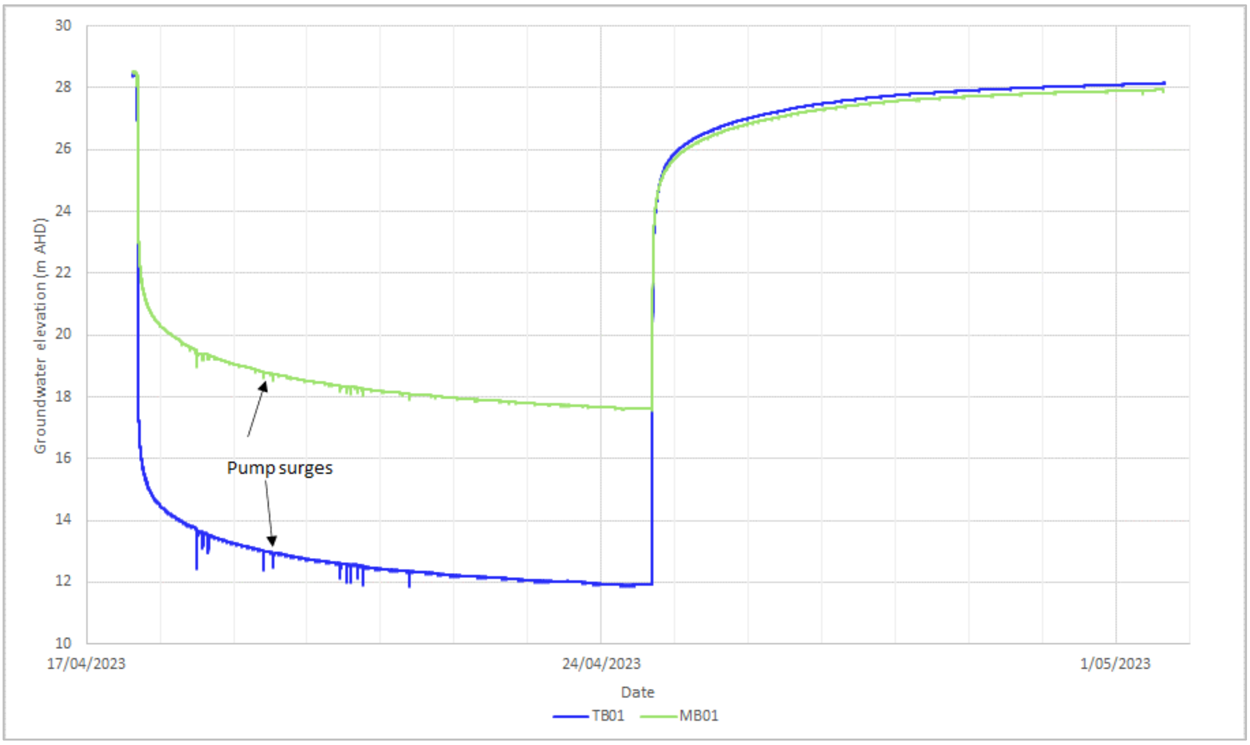


Figure 3 **Groundwater levels for TB01 and MB01 during pumping and recovery phases**

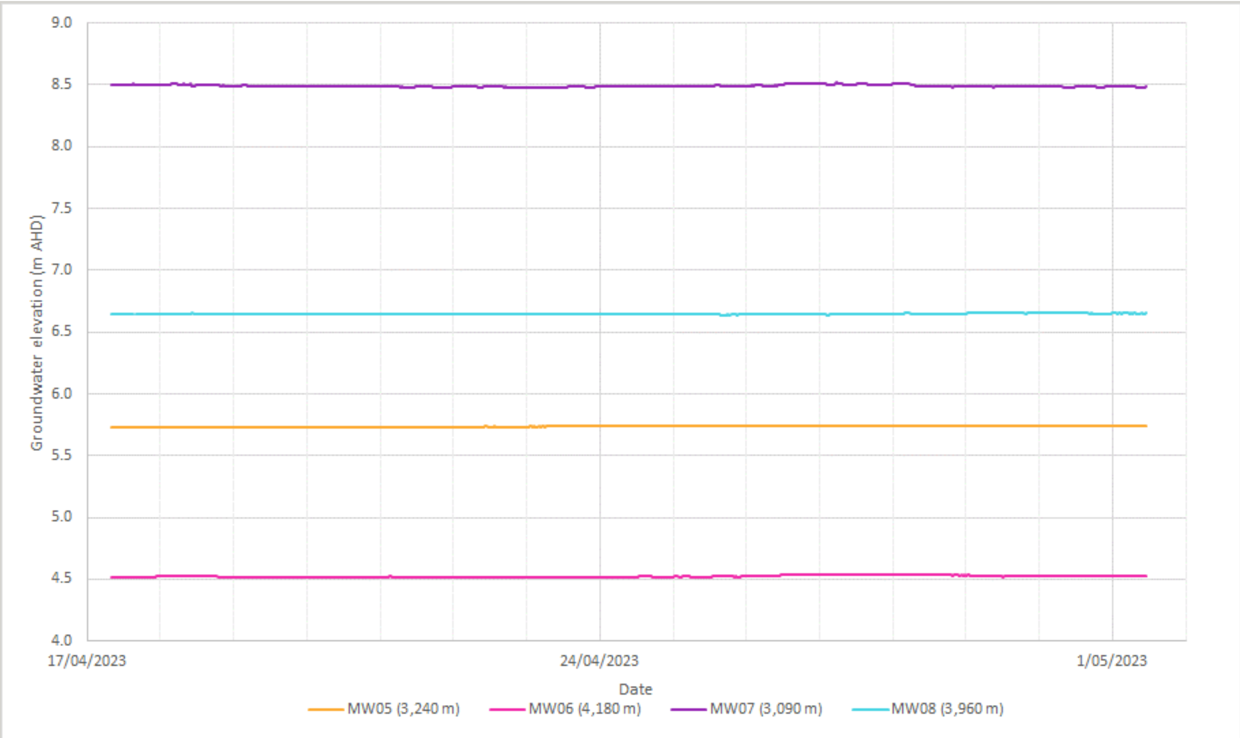


Figure 4 **Groundwater levels for MW05, MW06, MW07 and MW08 during pumping and recovery phases**

The drawdown (change in water level) in TB01 and MB01 is shown in Figure 5 and MW05 to MW08 on Figure 6 as semi log plots. A negative value on a drawdown plot indicates the water level has risen above the starting water level. The drawdown for MW05 to MW08 is both positive and negative during the pumping period and shows a rise in water levels before the pumping stopped. Given the magnitude of barometric change compared to the magnitude of water level change and the correlation between the two, the changes in water level in these wells is most likely due to barometric changes (an increase in barometric pressure induces a lowering of water in the well which is open to the atmosphere) and have therefore not been included in the analysis.

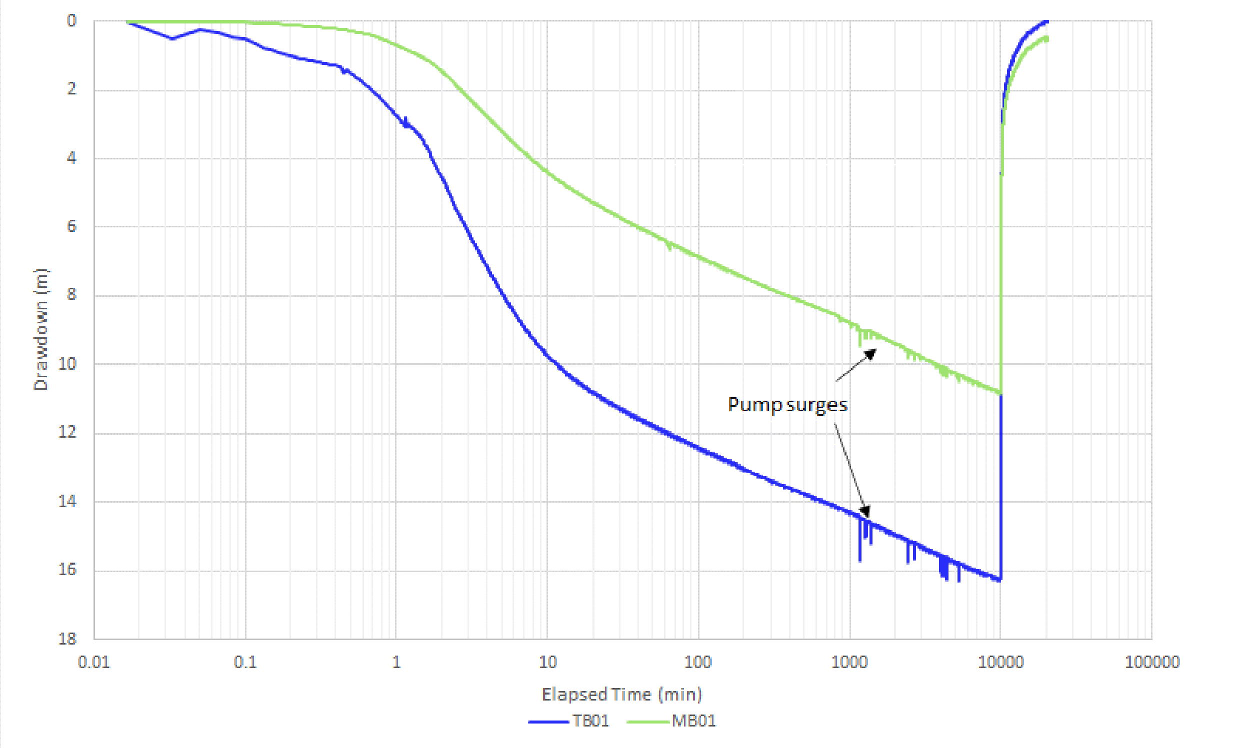


Figure 5 **Drawdown in TB01 and MB01**

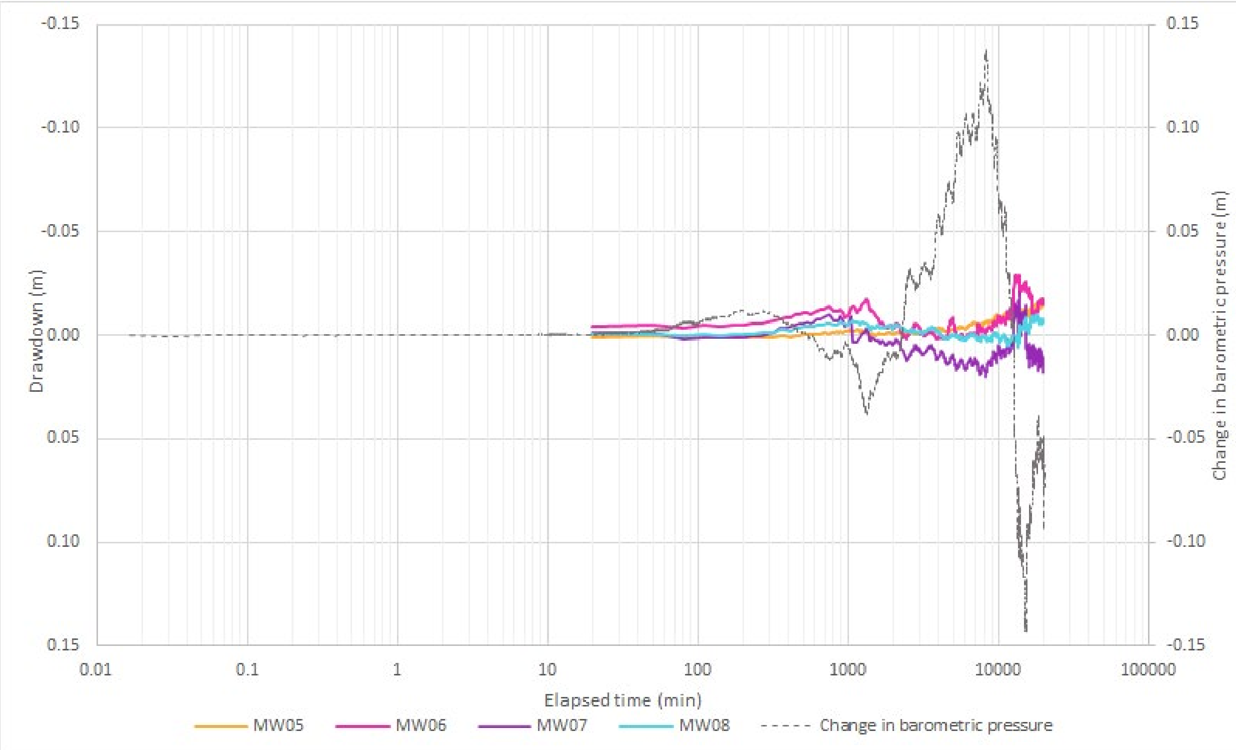


Figure 6 **Drawdown at MW05, MW06, MW07 and MW08 (negative value indicates water level is above the initial standing water level) and change in barometric pressure in m head (positive value indicates an increase in pressure)**

Section 3 Analysis

Pumping test analysis was completed using Aqtesolv Pro 4.0 software to fit theoretical type curves to observed data in order to understand aquifer properties. The initial aquifer and bore set up data are provided in Table 3-1. Although the open hole is from 54 m to 144 m below ground surface, the drilling indicates limited water ingress until 80 m and therefore the top of the aquifer is conceptualised to be at 80 m below ground surface. Drawdown data from both TB01 and MB01 was input into the model, along with the averaged flowrate data. For the initial analysis, aquifer thickness was set to 129 m (the Victorian Aquifer Framework indicates a depth to base of UMTA of 209m) and the anisotropy ratio to 0.1 in line with the analysis from the 24 hour pumping test.

Table 3-1 Pumping test model input data

Well ID	[d] top of aquifer to top of screen (m)	[L] length of screen (m)	[r(c)] casing radius (m)	[r(w)] radius of drilled bore (m)	[Kv/Kh] anisotropy ratio	[B] saturated aquifer thickness (m)
TB01	0	64	0.1	0.1	0.1	129
MB01	20	30	0.025	0.05	0.1	129

The following solution fits are shown in Appendix A.

Cooper Jacob (1946)

The straight line Cooper Jacob (1946) solution was applied to both wells separately. Observed water level response has been plotted alongside the derivative data which indicates well bore storage effects in the early time data. Therefore the straight line was fitted to the mid and late time data. Well bore storage effects are observed in both the pumping bore and the observation bore. To check whether wellbore storage is the likely influence on the early time data, the radial flow diagnostic plot was checked. This shows the early time drawdown on a unit slope, which indicates wellbore storage influence.

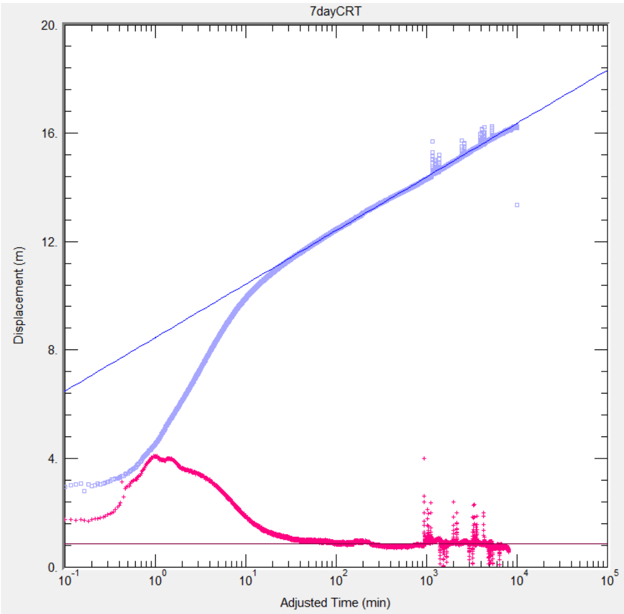


Figure 7 TB01 Cooper Jacob solution fit

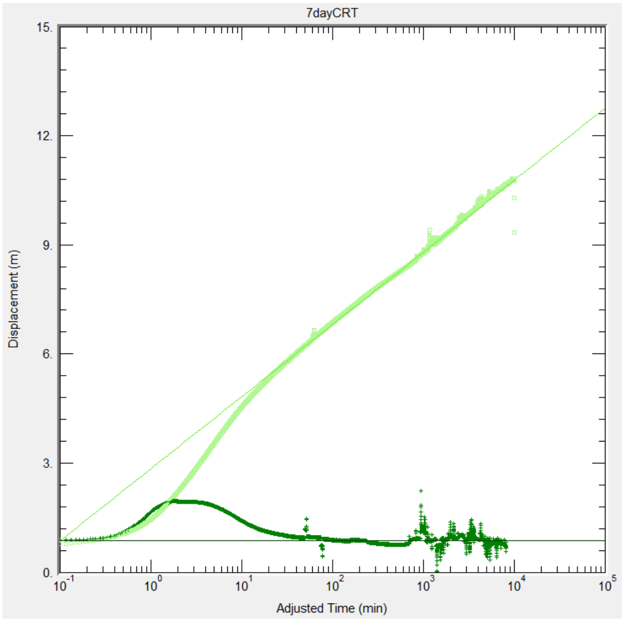


Figure 8 MB01 Cooper Jacob solution fit

Theis (1935)

The Theis (1935) solution was applied to both wells separately and provides a good fit for the mid and late time data for both TB01 and MB01. The early fit for TB01 is poor with a corresponding poor derivative fit which fits with the concept of wellbore storage discussed above. The recovery fit for TB01 is good until recovery comes within 1 m and then the fit diverges. The early time fit for MB01 is reasonable and the very good fit to mid and late time data supports the conceptualisation of a confined aquifer.

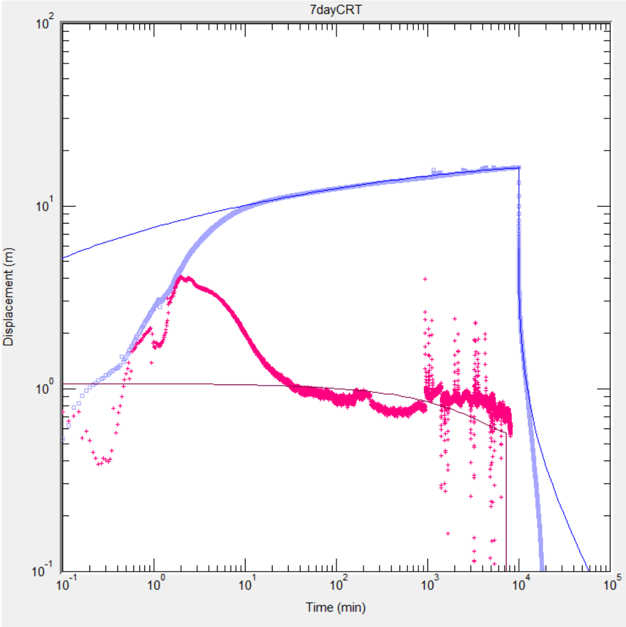


Figure 9 **TB01 Theis solution fit**

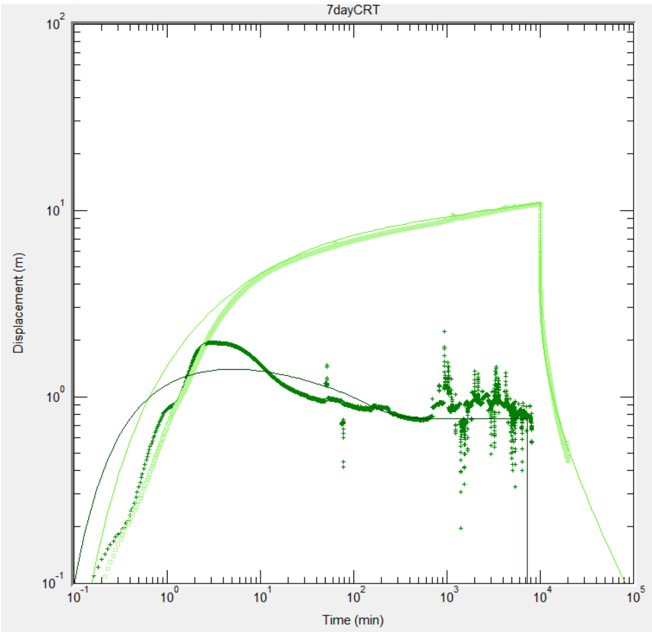


Figure 10 **MB01 Theis solution fit**

Other Solutions

Two wellbore storage solutions have been tested: The Papadopulos-Cooper (1967) solution and the Dougherty-Babu (1984) solution. While both solutions account for wellbore storage, only the Dougherty-Babu solution can account for the effects of partial penetration. Partial penetration is likely to impact on a pumping test if the observation bore screen is shorter than the pumping bore screen (as is the case here) and/or the observation bore is located within 1.5 to 2 times the aquifer thickness (also the case in this test).

A much better fit for MB01 was achievable with the Papadopulos-Cooper solution (Figure 11) compared to the Dougherty-Babu (Figure 12), although TB01 and the recovery for MB01 has a poor match. The Papadopulos-Cooper does not consider partial penetration and therefore it would not be expected to give a better fit given the pumping well and observation well set up. There are various reasons this could be the case:

- The aquifer has a higher vertical hydraulic conductivity than 0.1 ratio to horizontal hydraulic conductivity. Increasing the ratio to 1 does not result in a better fit in this case (Figure 13).
- The bore has developed a negative skin. To test this the skin factor was decreased to a negative value and a good fit was achieved at around -2.5 m (Figure 14). It is possible the drilled diameter was bigger than 200 mm (dues to hole collapse or increased rock fracturing during drilling), or the open hole diameter has increased over time and with pumping, or that the aquifer around the well has become overdeveloped from pumping (i.e. the aquifer material around the well has increased in transmissivity).
- There is leakage occurring from the aquitard. To test this theory a leaky aquifer solution (Moench, 1985, Case 1) was employed that can also account for wellbore storage (but not partial penetration). A reasonable fit to the entire MB01 dataset (including recovery) is achieved with this solution. When a negative skin is also applied the

fit to both curves is very good. The vertical hydraulic conductivity of the aquitard is estimated by this solution to be between 5x10^{-7} and 7x10^{-6} m/day and the developed area of the aquifer around the open hole to be more than 1 m.

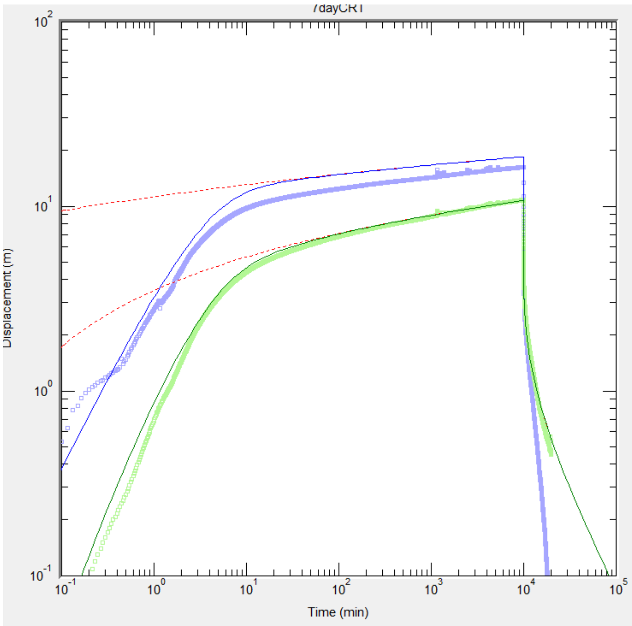


Figure 11 **TB01 and MB01 Papadopulos-Cooper solution fit (red line indicates equivalent Theis curve)**

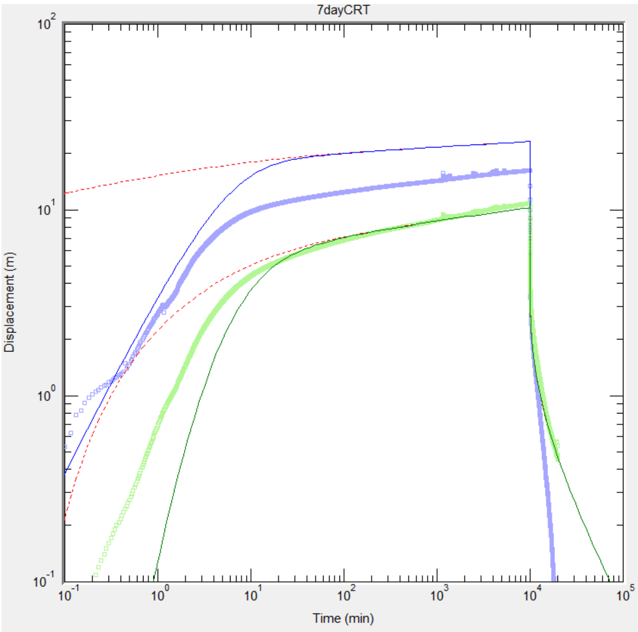


Figure 12 **TB01 and MB01 Babu-Dougherty solution fit (red line indicates equivalent Theis curve)**

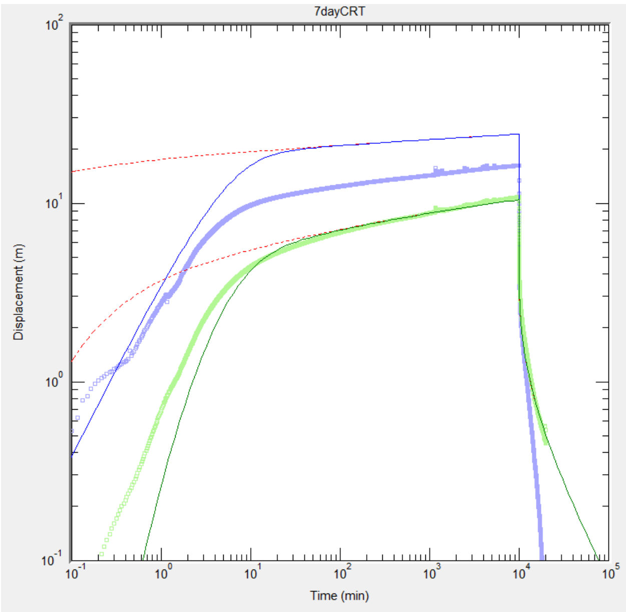


Figure 13 **TB01 and MB01 Babu-Dougherty solution with increase vertical to horizontal hydraulic conductivity ratio**

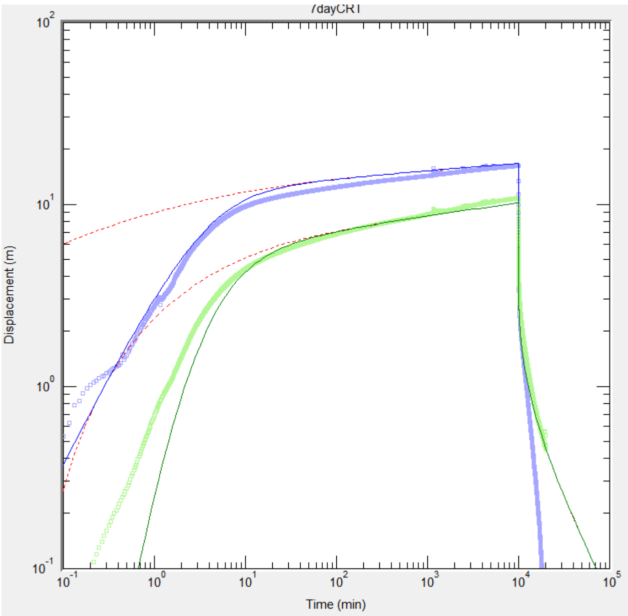


Figure 14 **TB01 and MB01 Babu-Dougherty solution with negative well skin**

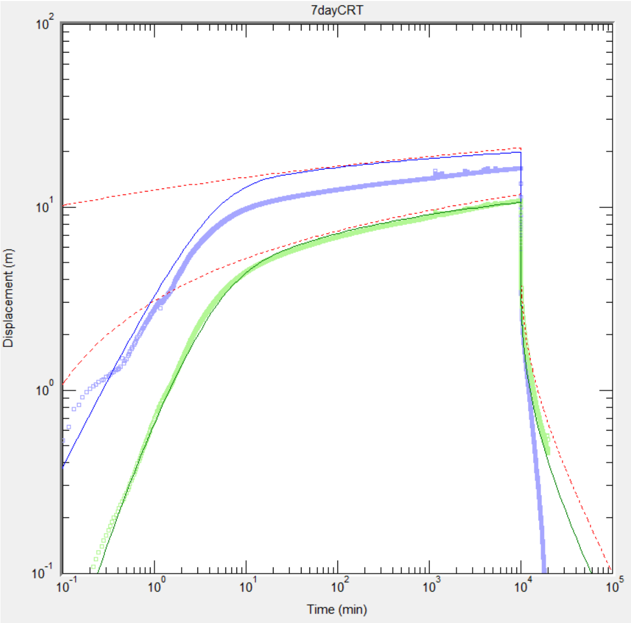


Figure 15 **TB01 and MB01 Moench solution**

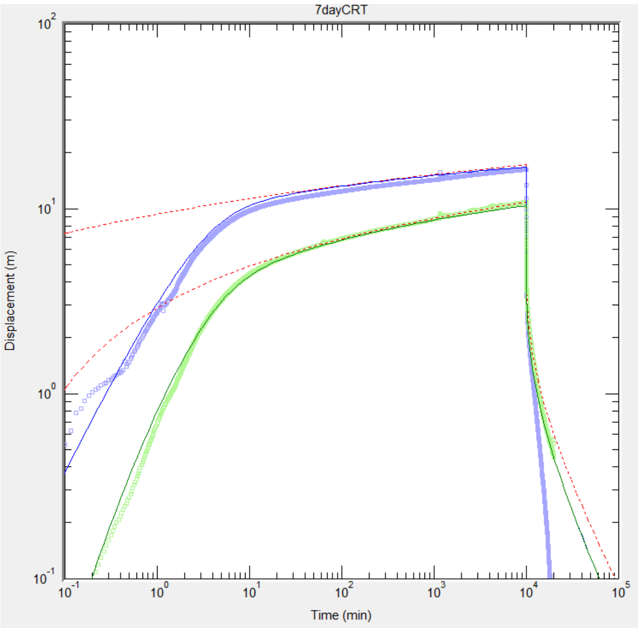


Figure 16 **TB01 and MB01 Moench solution with negative well skin**

Theis recovery

The residual drawdown data is plotted against log time since pumping began over time since pumping stopped and a straight line applied to the data. For TB01 the fit is reasonable although, as the residual drawdown equals zero before t/t' equals 1, this indicates a variation in storage or recharge occurring. For MB01 the fit is also good, with residual drawdown reaching zero close to t/t' equalling 1. The fit for MB01 gives a S/S' of 1.2, which means storativity during recovery is less than storativity during pumping, which can indicate a recharge effect.

The pump used in the pumping test is fitted with a non-return valve which should prevent water flowing from the lay flat hose into the bore. The recovery fit in the Moench solution charts indicates a relatively good fit for recovery in the pumping bore until the water level rises to within 1 m of the initial water level. It is possible that the difference in pressure between the hose and the well at this point is insufficient to maintain a solid seal on the non-return valve and that some leakage from the hose into the well occurred. Given the speed at which water level rise occurs in the latter parts of the recovery period, this is the most likely explanation.

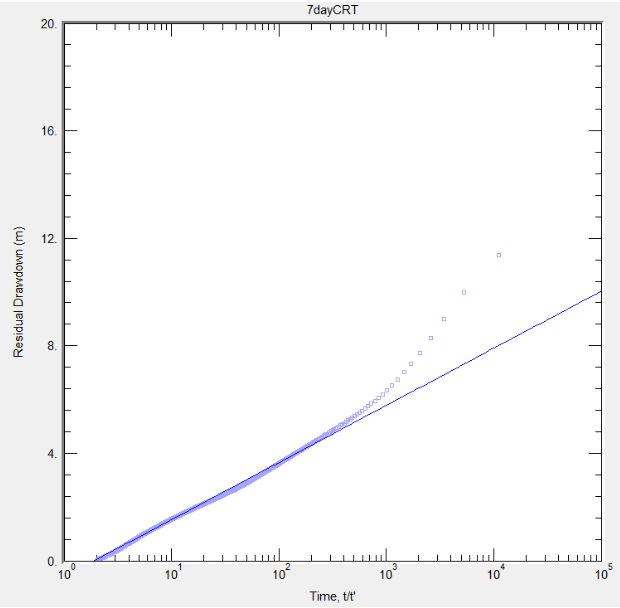


Figure 17 TB01 Theis recovery (residual drawdown) solution fit

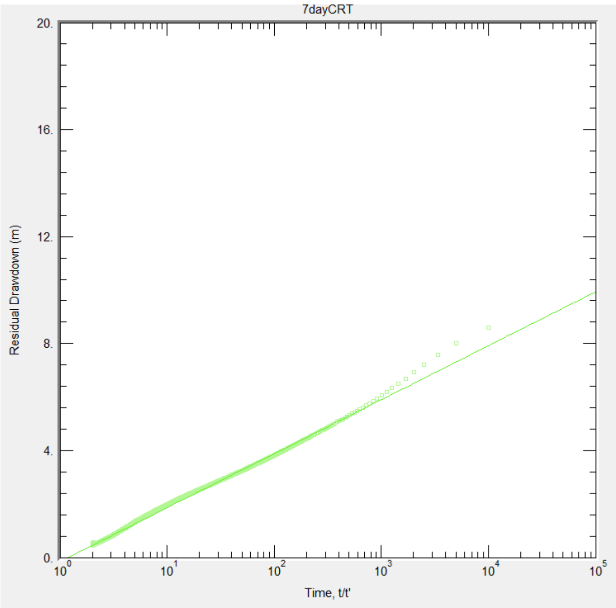


Figure 18 MB01 Theis recovery (residual drawdown) solution fit

Summary

The best fit analysis for drawdown and recovery for both bores is the Moench (1985) solution with a negative well skin applied to TB01. This indicates some degree of leakage (as would be expected in this aquifer setting) and a developed section of aquifer around the pumping bore. This solution also takes into account wellbore storage, which can be seen in the diagnostic plots.

The analysis indicates a transmissivity of between 15 and 26 m^2/day and a storativity of between $7x10^{-5}$ and $2x10^{-6}$. The vertical hydraulic conductivity of the aquitard is estimated to be between $5x10^{-7}$ and $7x10^{-6}$ m/day.

Table 3-2 Estimated aquifer parameters

Solution	Well response fit	Estimated transmissivity (m^2/d)	Estimated Storativity (-) *	Vertical hydraulic conductivity of aquitard (m/d)	Comments
Cooper Jacob	TB01	16	-	-	Derivative plot shows wellbore storage and therefore mid to late time data fitted to curve
	MB01	16	$5x10^{-6}$	-	
Theis	TB01	26	-	-	Early time water level and derivative data does not produce a good fit due to wellbore storage effects
	MB01	18	$7x10^{-5}$	-	
Papadopulos-Cooper	Both	17	$2x10^{-6}$	-	Good fit for MB01 (except recovery) but not as good for TB01 (drawdown less than expected)
Babu-Dougherty (-ve skin)	Both	21	$3x10^{-5}$	-	Reasonable fit for both bores and most of recovery but early time for MB01 shows delay not seen in observations.
Moench (no skin)	Both	15	$5x10^{-6}$	$7x10^{-6}$	Very good fit for MB01 but drawdown in TB01 less than expected
Moench (-ve skin)	Both	16	$5x10^{-6}$	$5x10^{-7}$	Excellent fit for drawdown and recovery for MB01 and most of drawdown for TB01.

Solution	Well response fit	Estimated transmissivity (m²/d)	Estimated Storativity (-) *	Vertical hydraulic conductivity of aquitard (m/d)	Comments
Theis recovery	TB01	15	-	-	Residual drawdown reaches zero before t/t' equals 1 potentially indicating a source of recharge
	MB01	16	1.2 (S/S')	-	

**Storativity can only be estimated from observation well data. Ratio of storativity during pumping (S) to storativity during recovery (S') is given for Theis recovery/residual drawdown solution.*

Section 4 Conclusions

A 7-day constant rate pumping test was completed in TB01 at 2 L/sec, with a 7-day recovery period. The results and analysis support the outcomes of the 24-hour test and develop the conceptualisation as follows:

- The UMTA appears to behave as a leaky confined aquifer at the depth across which it has been developed at TB01.
- The best fit solution indicates a leaky aquifer although with very low values of vertical hydraulic conductivity evident in the aquitard and therefore very slow leakage.
- It is recognised that groundwater flow in a fractured rock aquifer is more complex than can be represented using an aquifer analysis program such as Aqtesolv. However, given the degree of fit with the solutions presented, the analysis is considered suitable for the purpose of estimating bulk hydraulic parameters and estimating future drawdowns and impacts from the extraction bore (for a 2 year pumping period).
- Modelling of drawdown from this well based on a leaky confined response with a very low aquitard vertical hydraulic conductivity is reasonable for the purpose of predicting impacts to other groundwater users, given appropriate monitoring of the shallow aquifer is undertaken during the pumping period.

Section 5 References

AECOM (2022) Groundwater Impact Assessment Kentbruck Green Power Hub Project EES Technical Report, 25 August 2022

Cooper, H.H. and C.E. Jacob, 1946. A generalized graphical method for evaluating formation constants and summarizing well field history, Am. Geophys. Union Trans., vol. 27, pp. 526-534

Dougherty, D.E and D.K. Babu, 1984. Flow to a partially penetrating well in a double-porosity reservoir, Water Resources Research, vol. 20, no. 8, pp. 1116-1122.

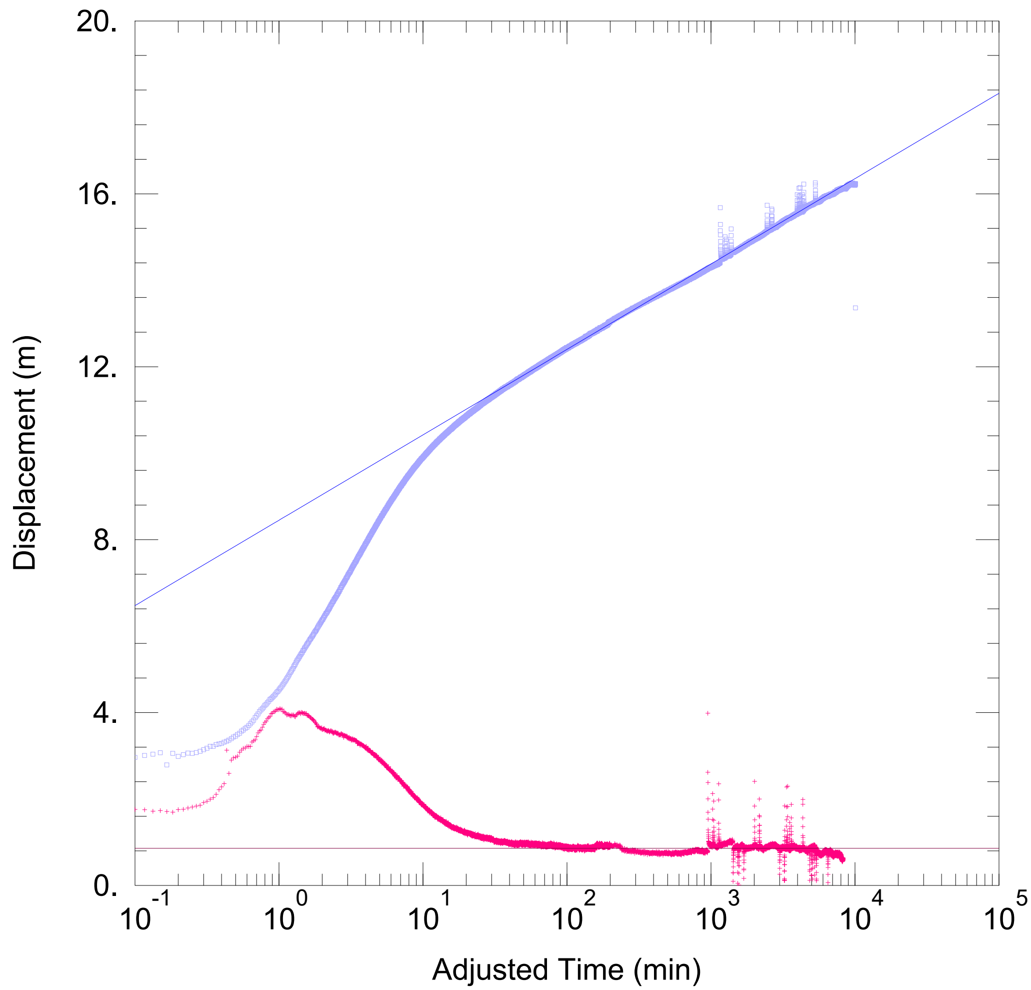
Moench, A.F., 1985. Transient flow to a large-diameter well in an aquifer with storative semiconfining layers, Water Resources Research, vol. 21, no. 8, pp. 1121-1131

Neuman, S.P. and P.A. Witherspoon, 1969. Theory of flow in a confined two aquifer system, Water Resources Research, vol. 5, no. 4, pp. 803-816

Papadopulos, I.S. and H.H. Cooper, 1967. Drawdown in a well of large diameter, Water Resources Research, vol. 3, no. 1, pp. 241-244.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

Appendix A Aqtesolv solution fitting



7DAYCRT

Data Set: \...\TB01-CJ.aqt
Date: 05/17/23 Time: 19:38:11

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

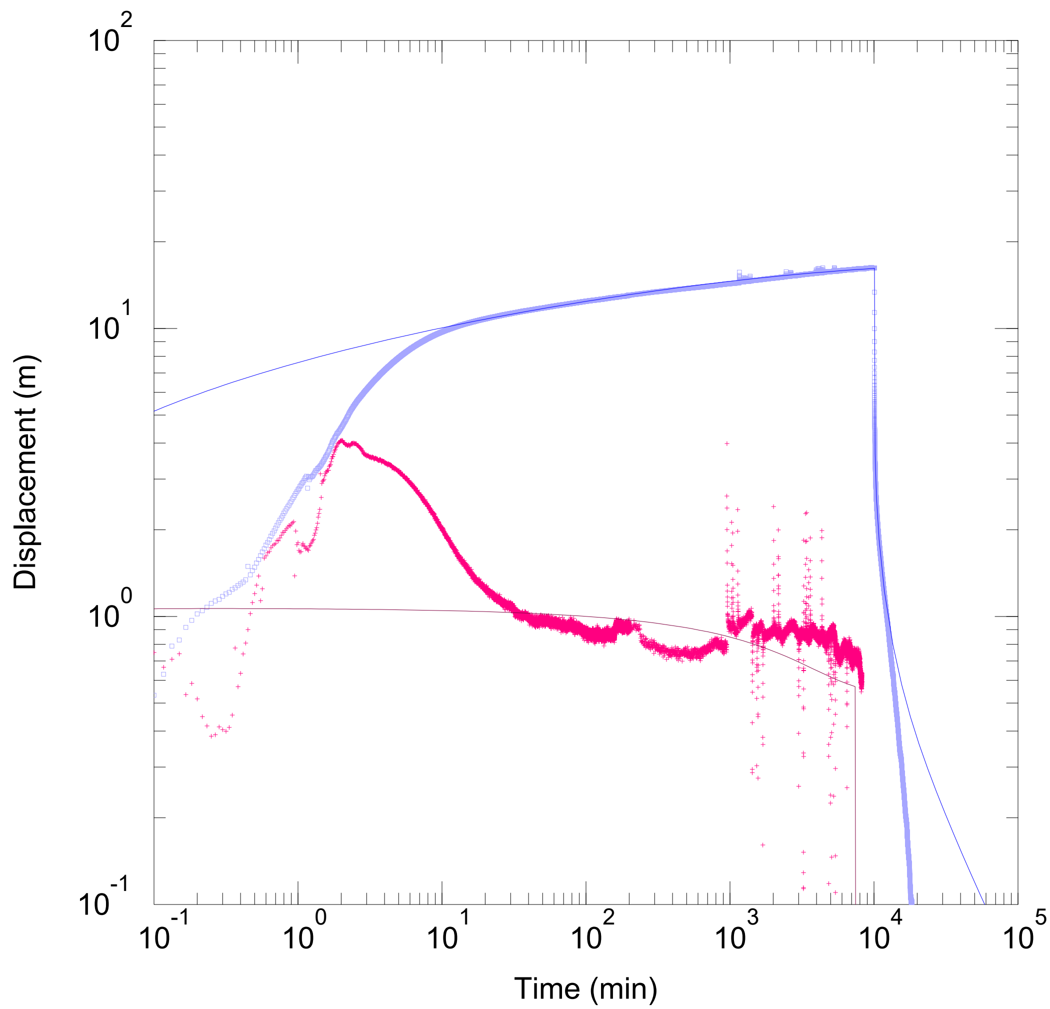
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 16.03 m^2/day S = 0.0001322



7DAYCRT

Data Set: \...\TB01-Theis.aqt
Date: 05/17/23 Time: 19:36:41

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

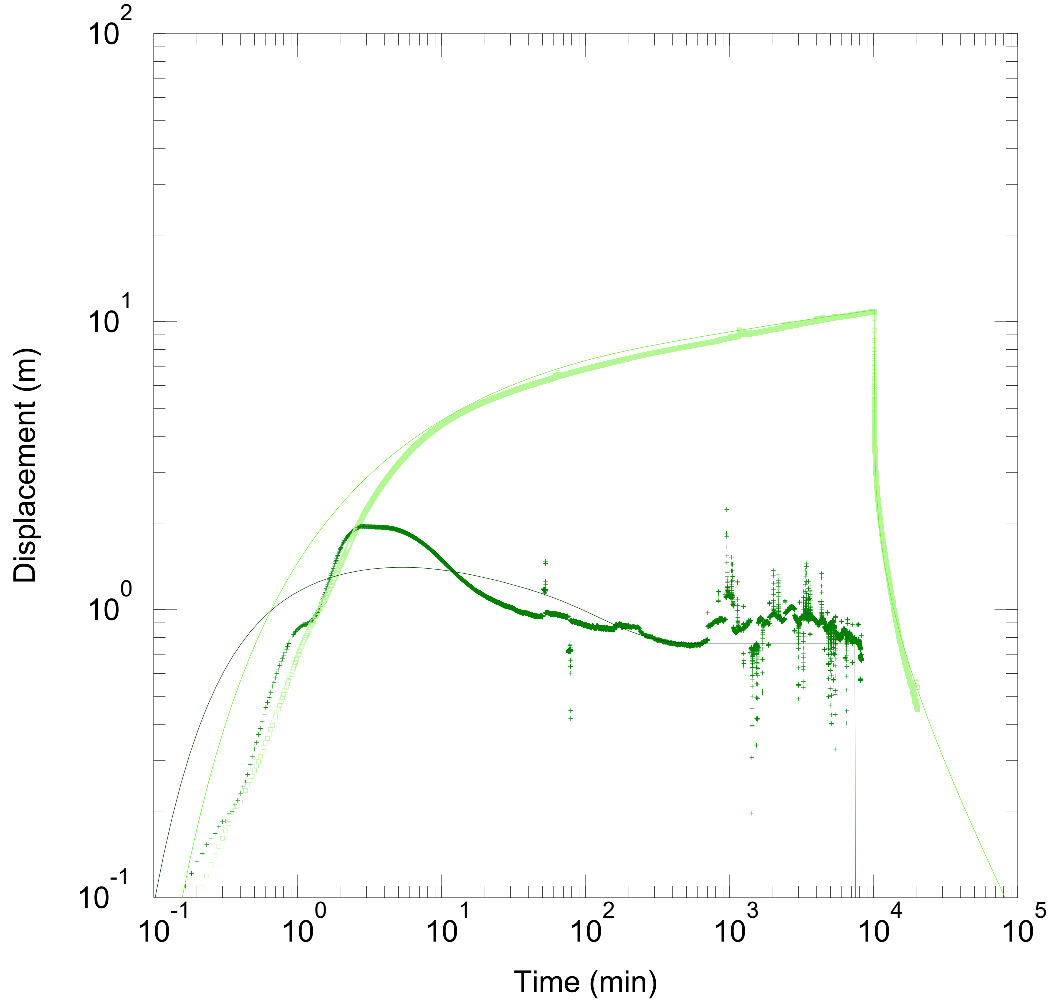
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 25.9 m^2/day
S = 0.003249
Kz/Kr = 0.1
b = 129. m



7DAYCRT

Data Set: \...\MB01-Theis.aqt
Date: 05/17/23 Time: 19:36:06

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

Observation Wells

Well Name	X (m)	Y (m)
MB01	13.87	0

SOLUTION

Aquifer Model: Confined

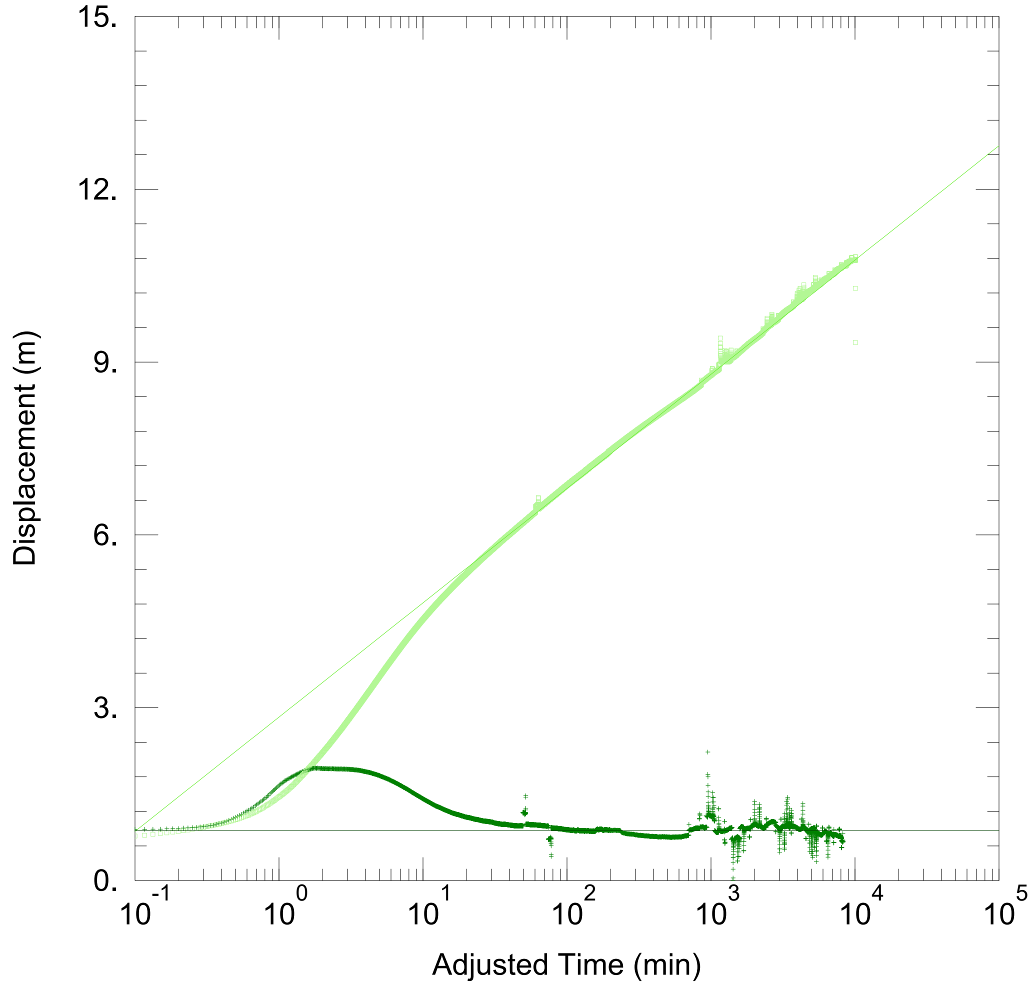
Solution Method: Theis

T = 18.07 m^2/day

S = 7.383E-5

Kz/Kr = 0.1

b = 129. m



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Data Set: \...\MB01-CJ.aqt
Date: 05/17/23 Time: 19:37:24

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

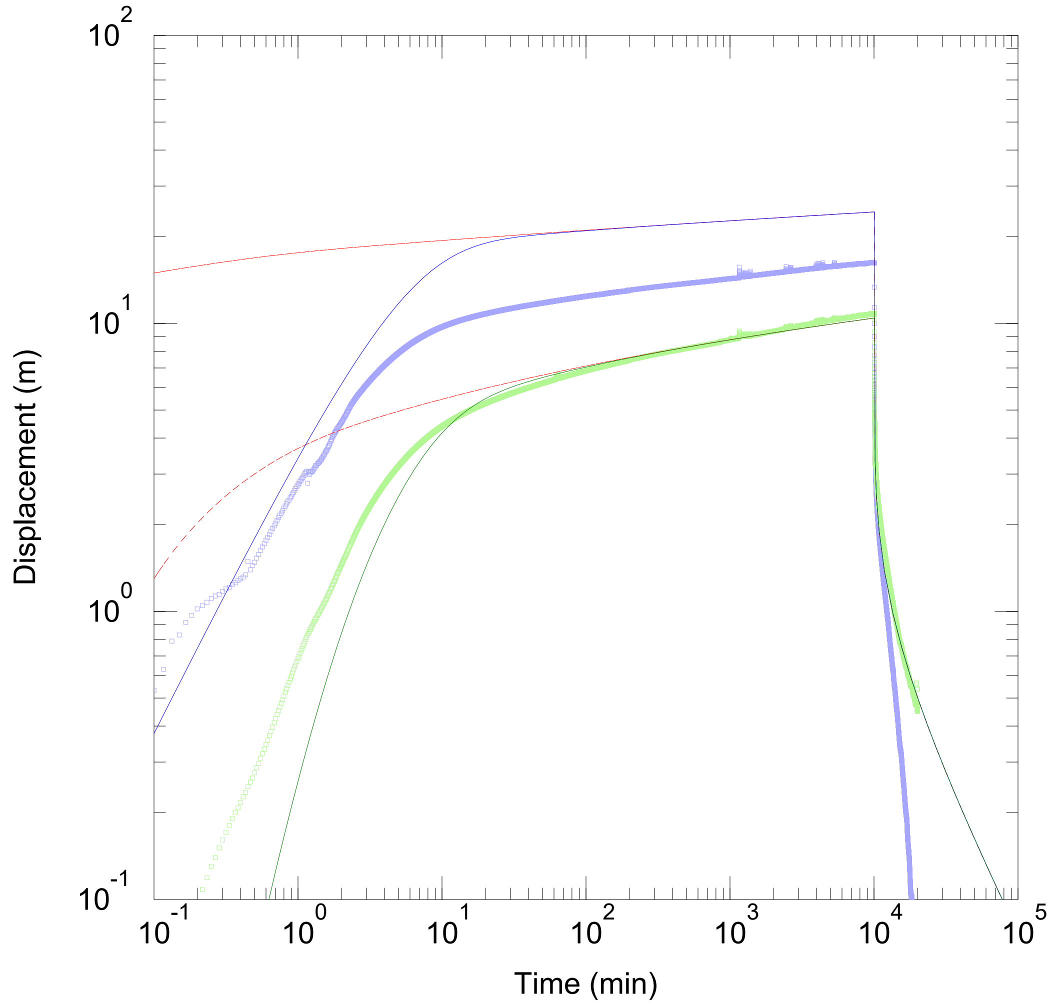
Observation Wells

Well Name	X (m)	Y (m)
MB01	13.87	0

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 15.96 m^2/day S = 4.82E-6



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PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

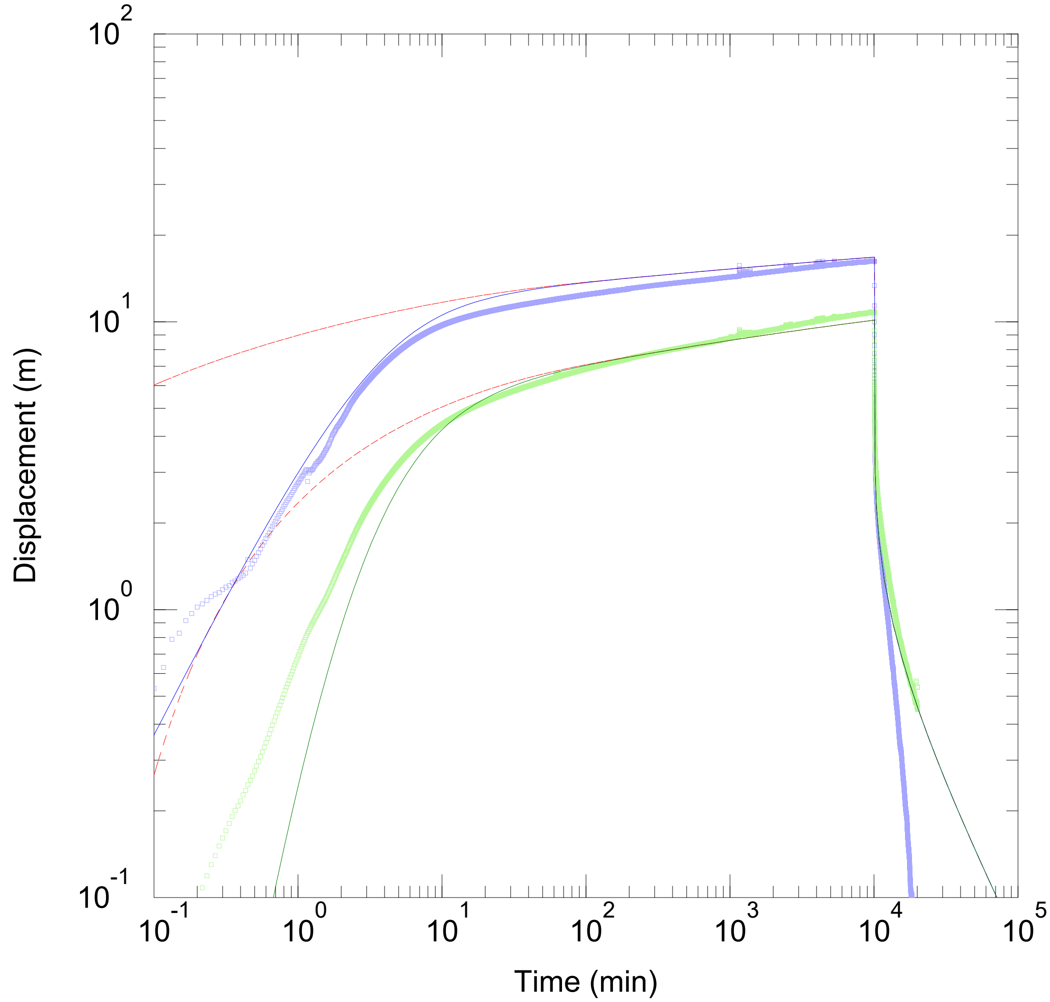
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Confined Solution Method: Dougherty-Babu

T = 19.06 m^2/day S = 8.069E-6
Kz/Kr = 1. Sw = 0.



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PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

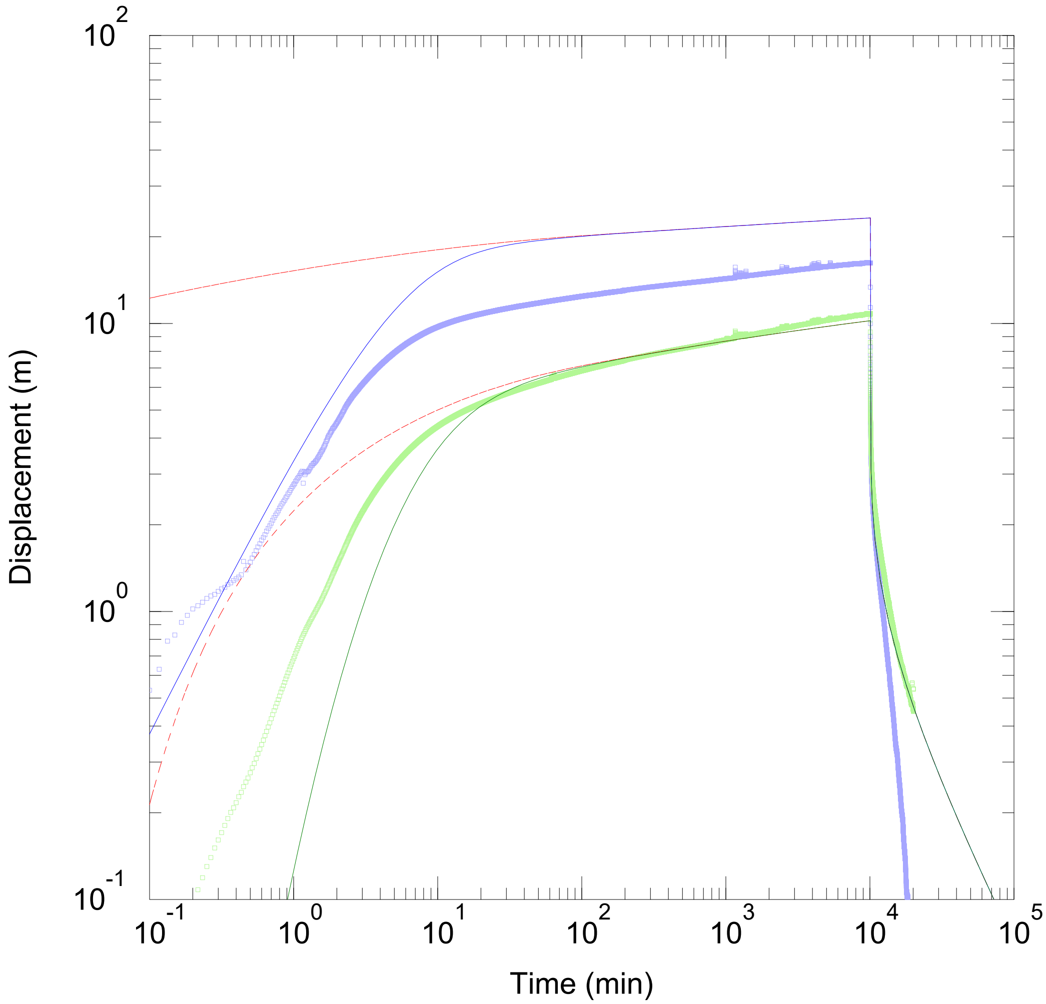
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Confined Solution Method: Dougherty-Babu

T = 20.9 m^2/day S = 3.186E-5
Kz/Kr = 0.1 Sw = -2.325



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PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

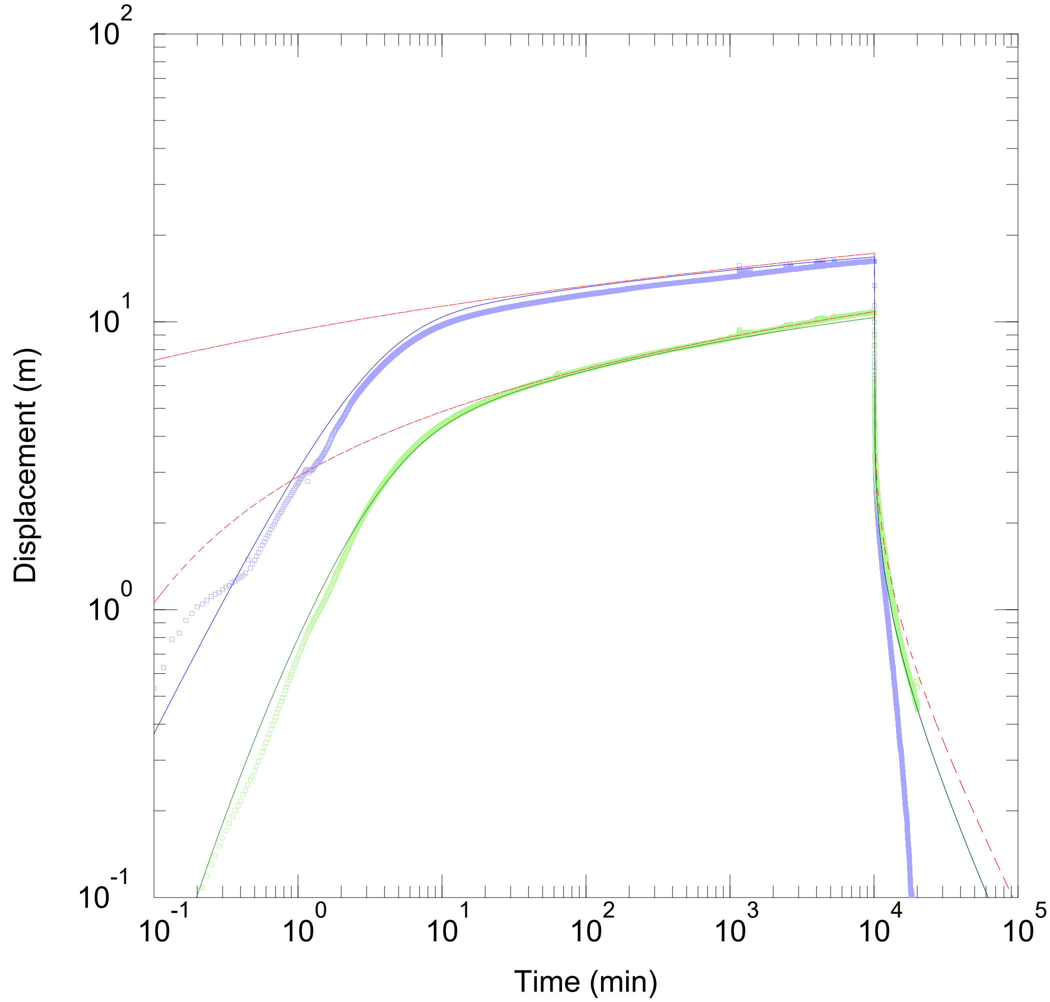
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Confined Solution Method: Dougherty-Babu

T = 20.54 m^2/day S = 3.563E-5
Kz/Kr = 0.1 Sw = 0.



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PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m
Anisotropy Ratio (Kz/Kr): 0.1
Aquitard Thickness (b'): 50. m
Aquitard Thickness (b"): 1. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

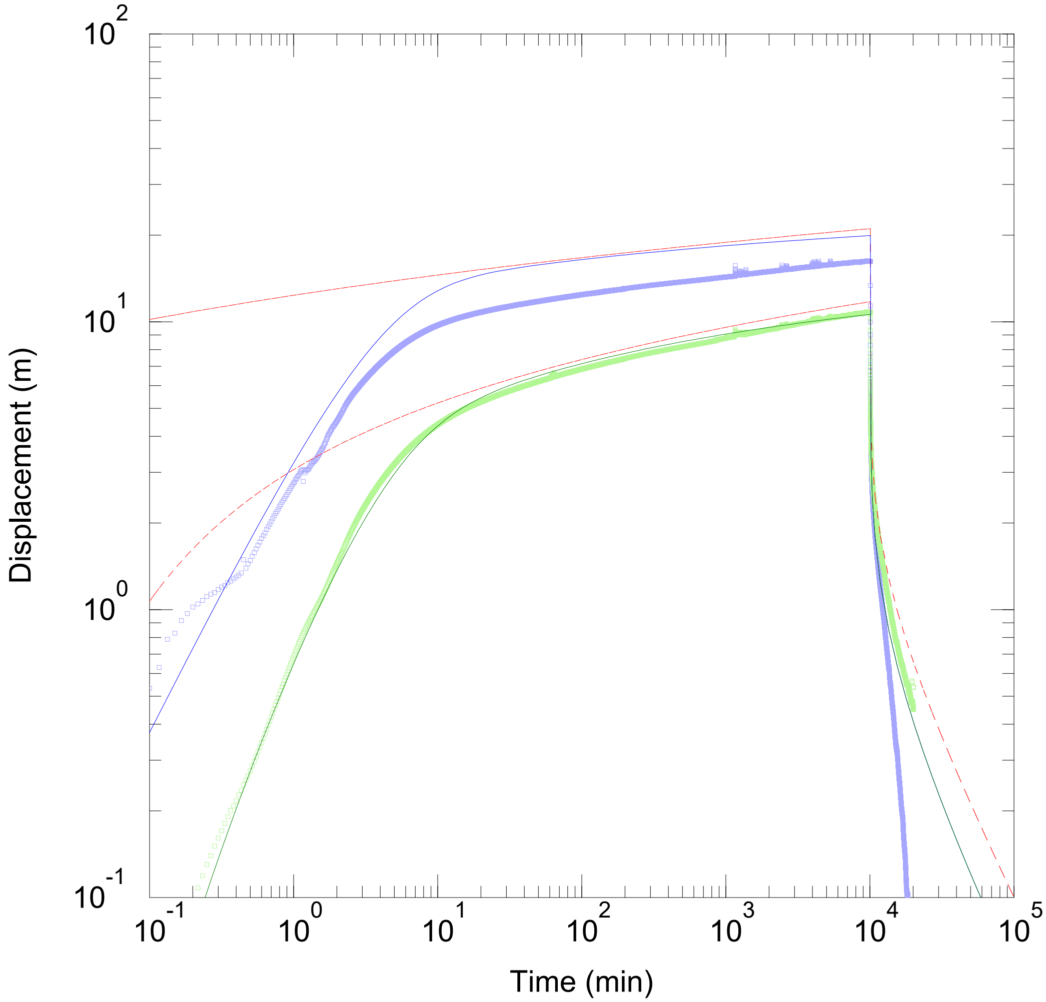
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Leaky
Solution Method: Moench (Case 1)

T = 15.91 m^2/day
S = 4.613E-6



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Data Set: \...\TB01 and MB01 Moench.aqt
Date: 05/17/23 Time: 19:42:37

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m
Aquitard Thickness (b'): 50. m
Anisotropy Ratio (Kz/Kr): 0.1
Aquitard Thickness (b"): 1. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

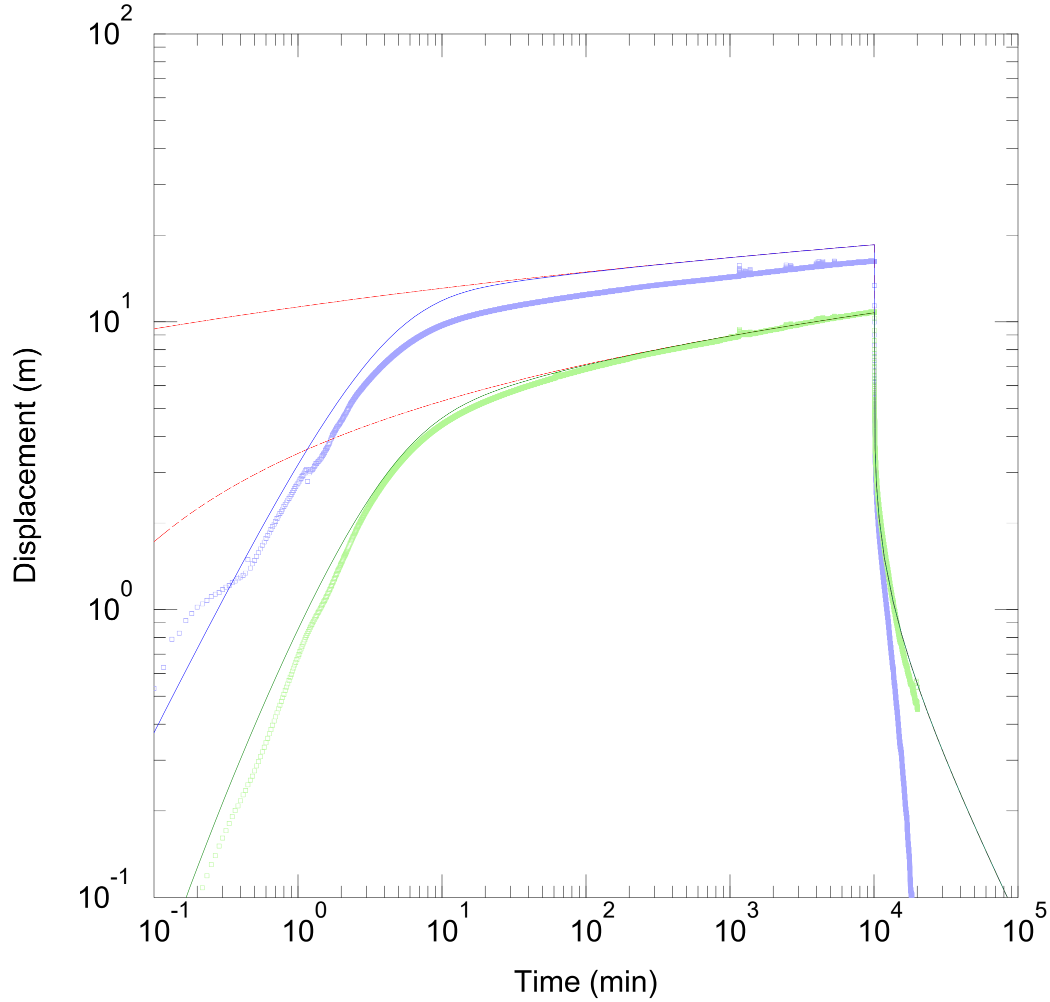
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Leaky
Solution Method: Moench (Case 1)

T = 14.57 m^2/day
S = 4.706E-6
1/B' = 0.0001 m^{-1}
β' = 0.0001 m^{-1}



7DAYCRT

Data Set: \...\TB01 and MB01 PC.aqt
Date: 05/17/23
Time: 19:43:10

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

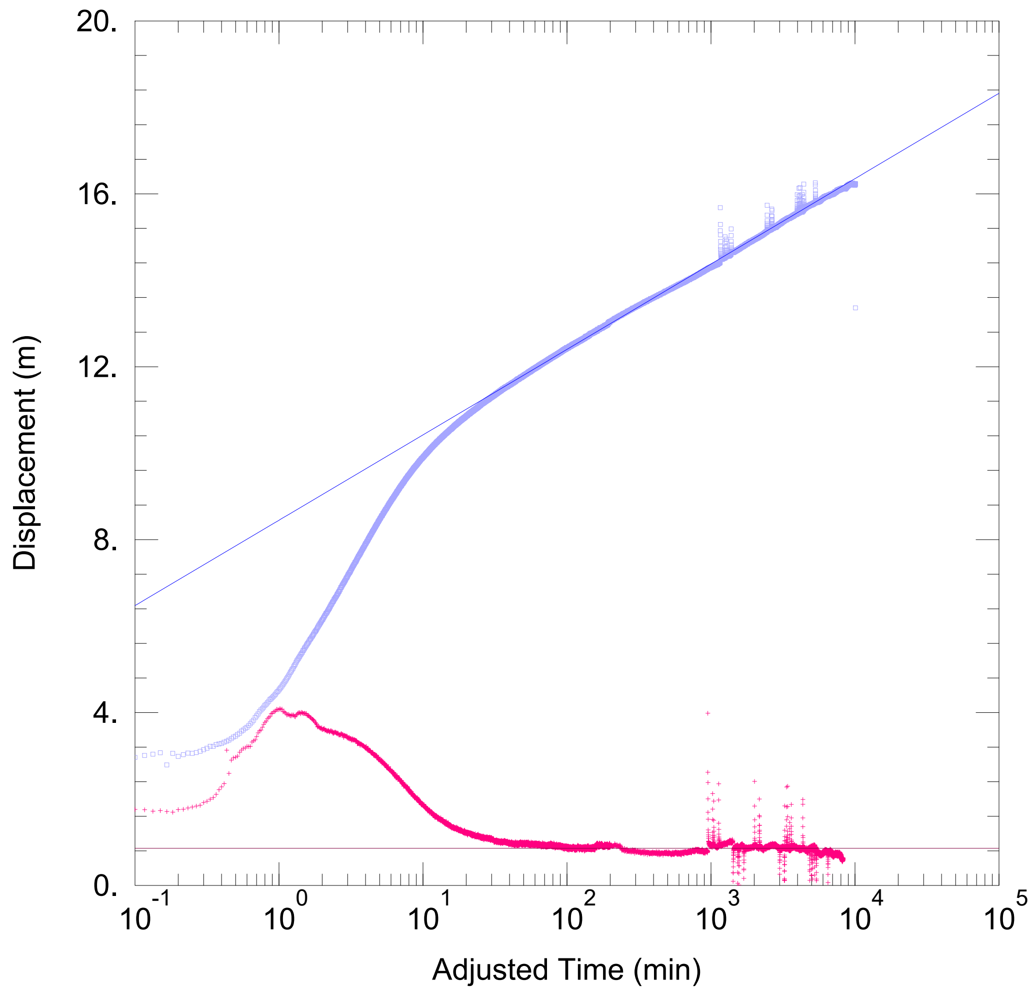
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Confined
Solution Method: Papadopulos-Cooper

T = 17.44 m^2/day
S = 1.708E-6
r(w) = 0.1 m
r(c) = 0.1 m



7DAYCRT

Data Set: \...\TB01-CJ.aqt
Date: 05/17/23
Time: 19:38:11

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

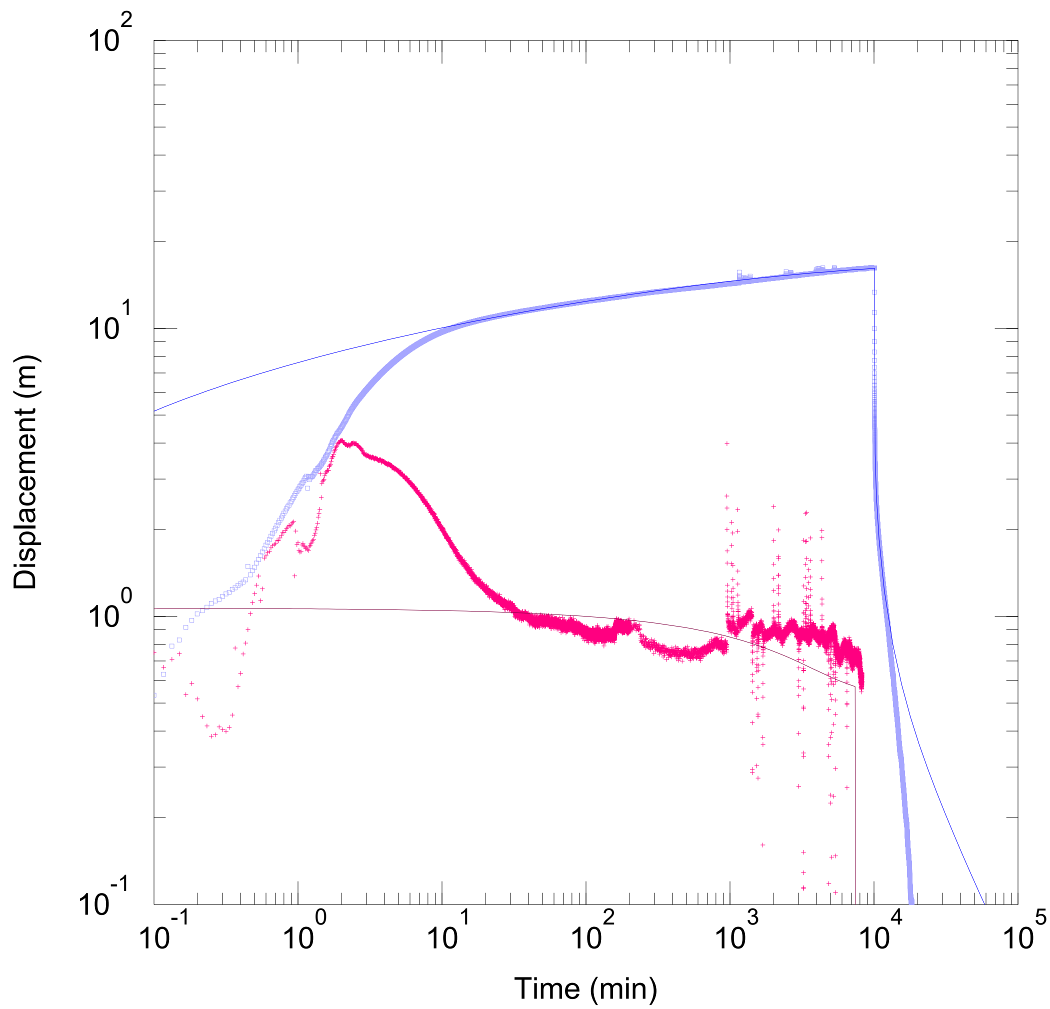
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Jacob

T = 16.03 m^2/day
S = 0.0001322



7DAYCRT

Data Set: \...\TB01-Theis.aqt
Date: 05/17/23 Time: 19:36:41

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

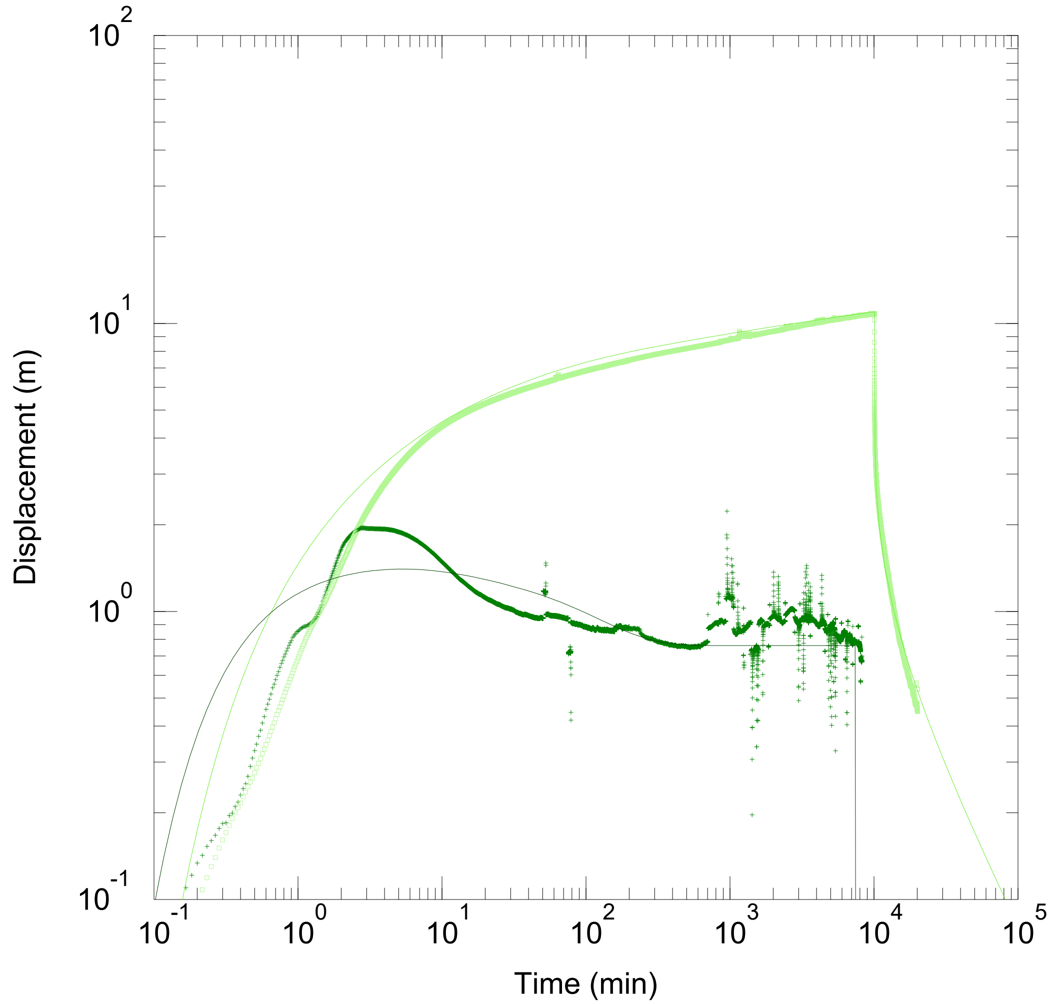
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 25.9 m^2/day
Kz/Kr = 0.1
S = 0.003249
b = 129. m



7DAYCRT

Data Set: \...\MB01-Theis.aqt
Date: 05/17/23 Time: 19:36:06

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

Observation Wells

Well Name	X (m)	Y (m)
MB01	13.87	0

SOLUTION

Aquifer Model: Confined

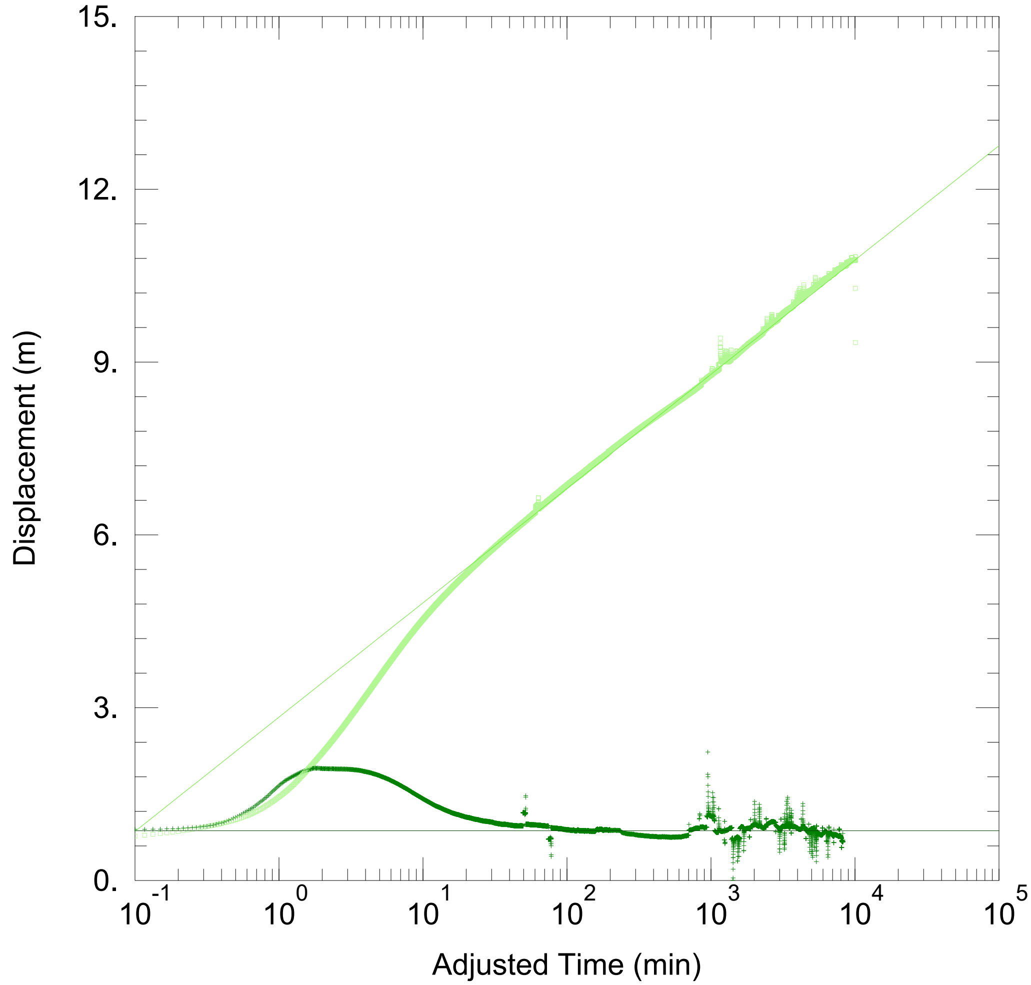
Solution Method: Theis

T = 18.07 m^2/day

S = 7.383E-5

Kz/Kr = 0.1

b = 129. m



7DAYCRT

Data Set: \...\MB01-CJ.aqt
Date: 05/17/23 Time: 19:37:24

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

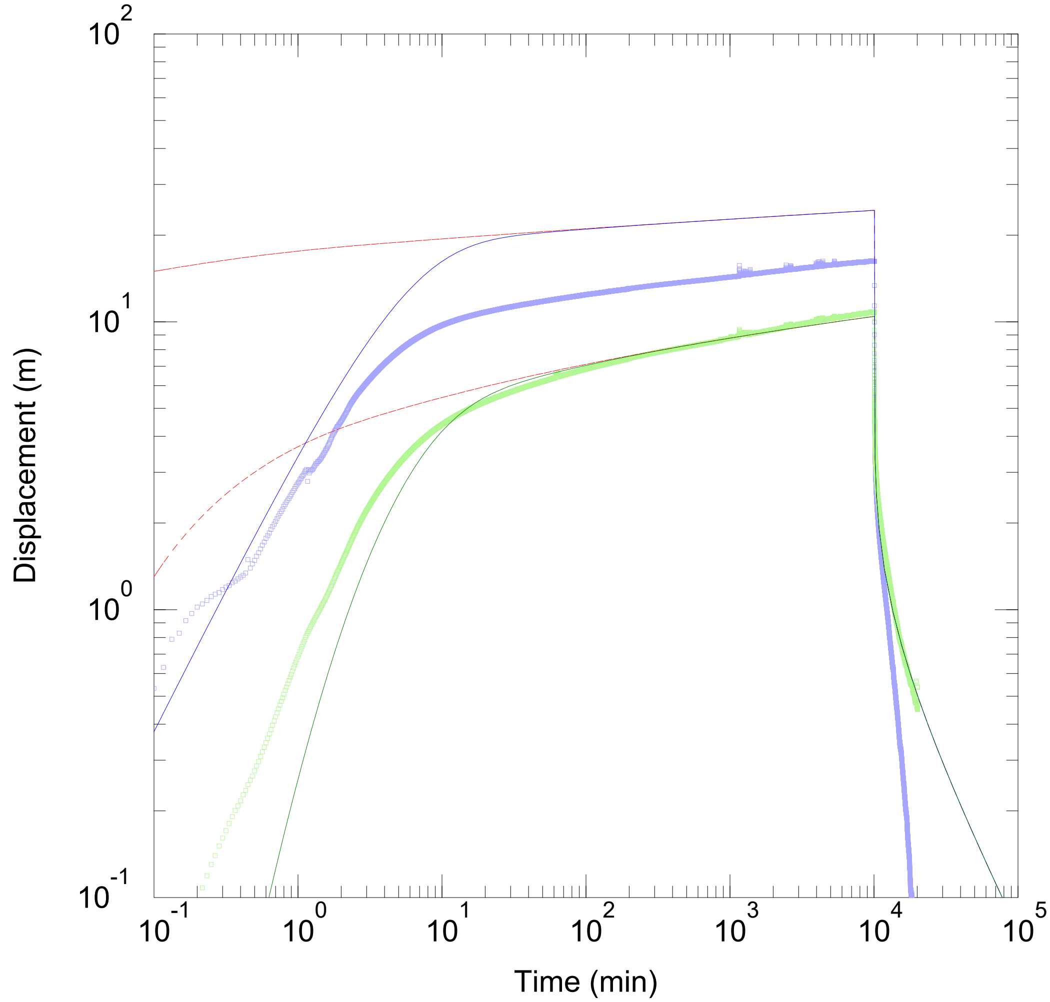
Observation Wells

Well Name	X (m)	Y (m)
MB01	13.87	0

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 15.96 m^2/day S = 4.82E-6



7DAYCRT

Data Set: \...\TB01 and MB01 DB with high kvkr.aqt
Date: 05/17/23 Time: 19:39:35

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

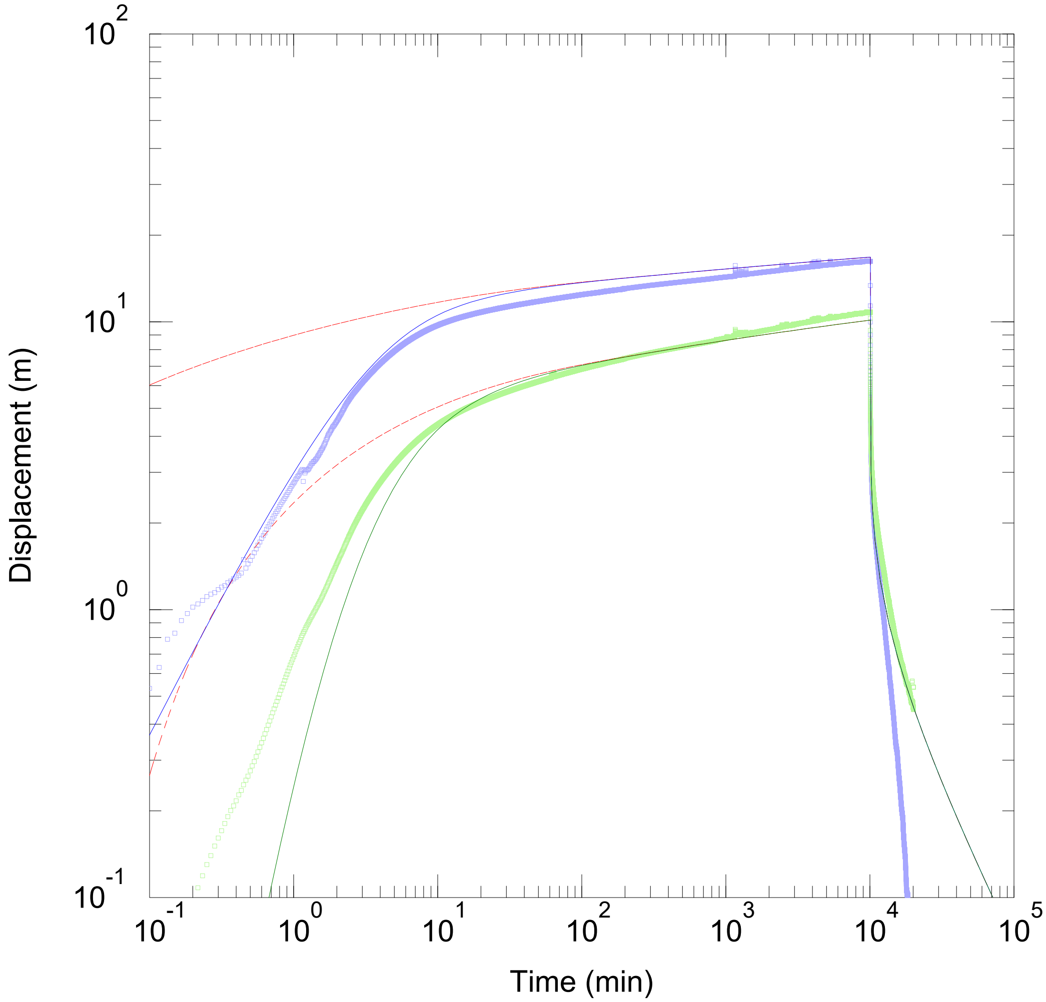
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Confined Solution Method: Dougherty-Babu

T = 19.06 m^2/day S = 8.069E-6
Kz/Kr = 1. Sw = 0.



7DAYCRT

Data Set: \...\TB01 and MB01 DB with high rw.aqt
Date: 05/17/23 Time: 19:40:07

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

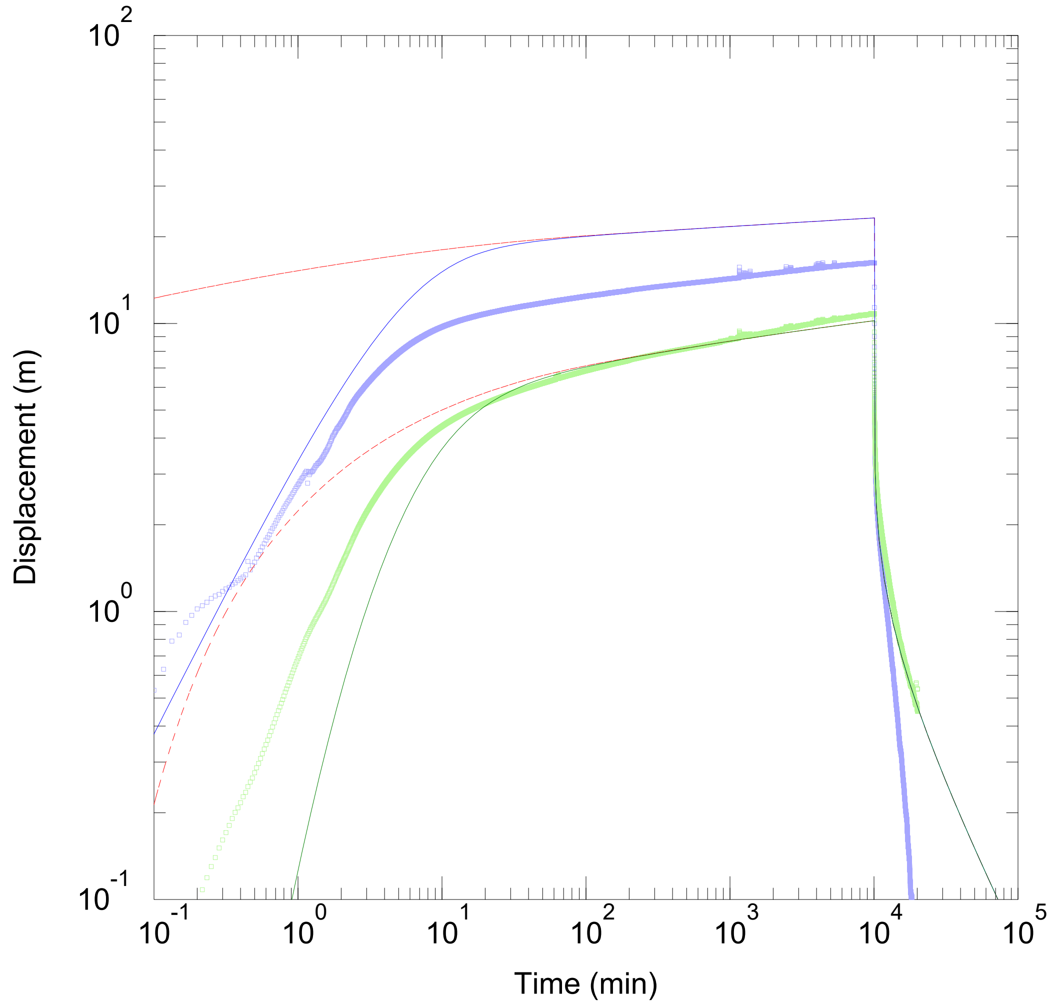
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Confined
Solution Method: Dougherty-Babu

T = 20.9 m^2/day
S = 3.186E-5
Kz/Kr = 0.1
Sw = -2.325



7DAYCRT

Data Set: \...\TB01 and MB01 DB.aqt
Date: 05/17/23 Time: 19:40:38

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

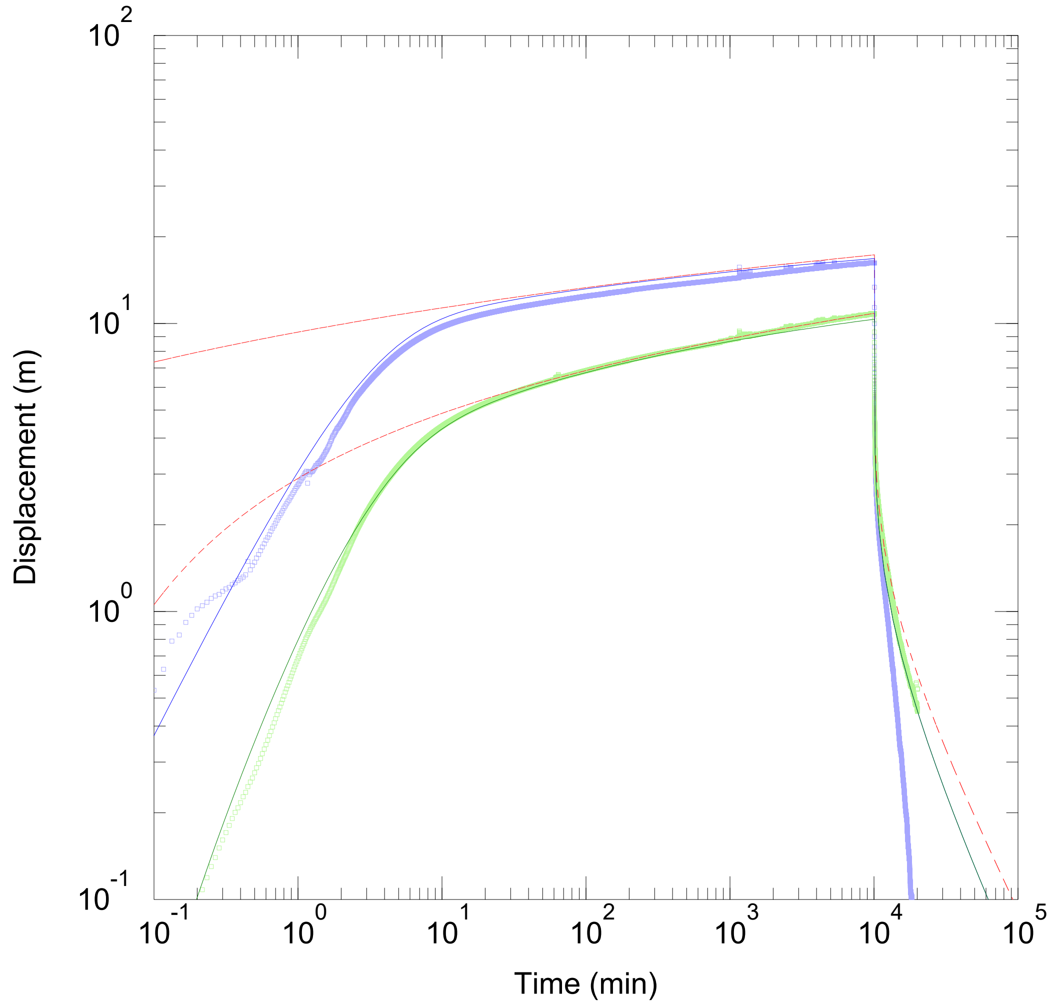
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Confined Solution Method: Dougherty-Babu

T = 20.54 m^2/day S = 3.563E-5
Kz/Kr = 0.1 Sw = 0.



7DAYCRT

Data Set: \...\TB01 and MB01 Moench w skin.aqt
Date: 05/17/23 Time: 19:41:58

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m
Anisotropy Ratio (Kz/Kr): 0.1
Aquitard Thickness (b'): 50. m
Aquitard Thickness (b"): 1. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

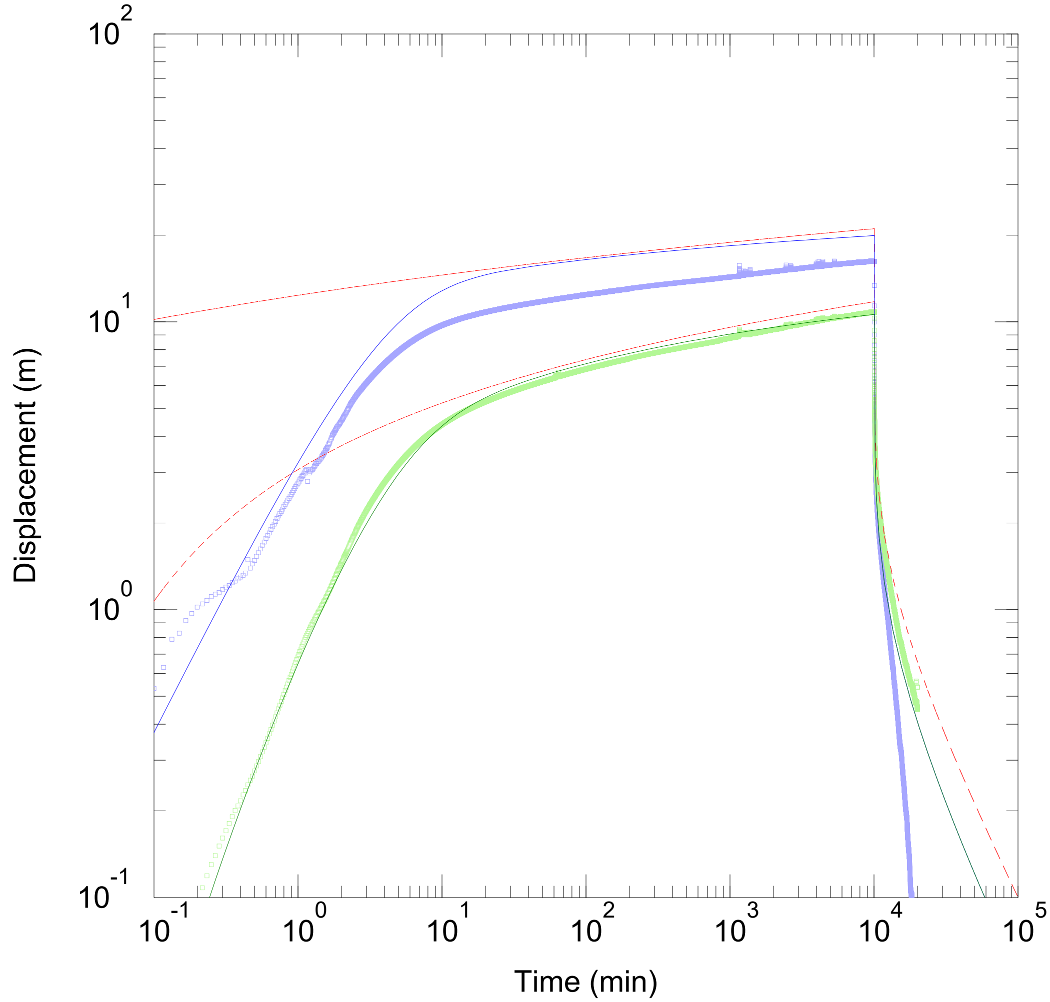
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Leaky
Solution Method: Moench (Case 1)

T = 15.91 m^2/day
S = 4.613E-6
1/B' = 2.513E-5 m^{-1}
β' = 0.0001128 m^{-1}



7DAYCRT

Data Set: \...\TB01 and MB01 Moench.aqt
Date: 05/17/23 Time: 19:42:37

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m
Anisotropy Ratio (Kz/Kr): 0.1
Aquitard Thickness (b'): 50. m
Aquitard Thickness (b"): 1. m

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

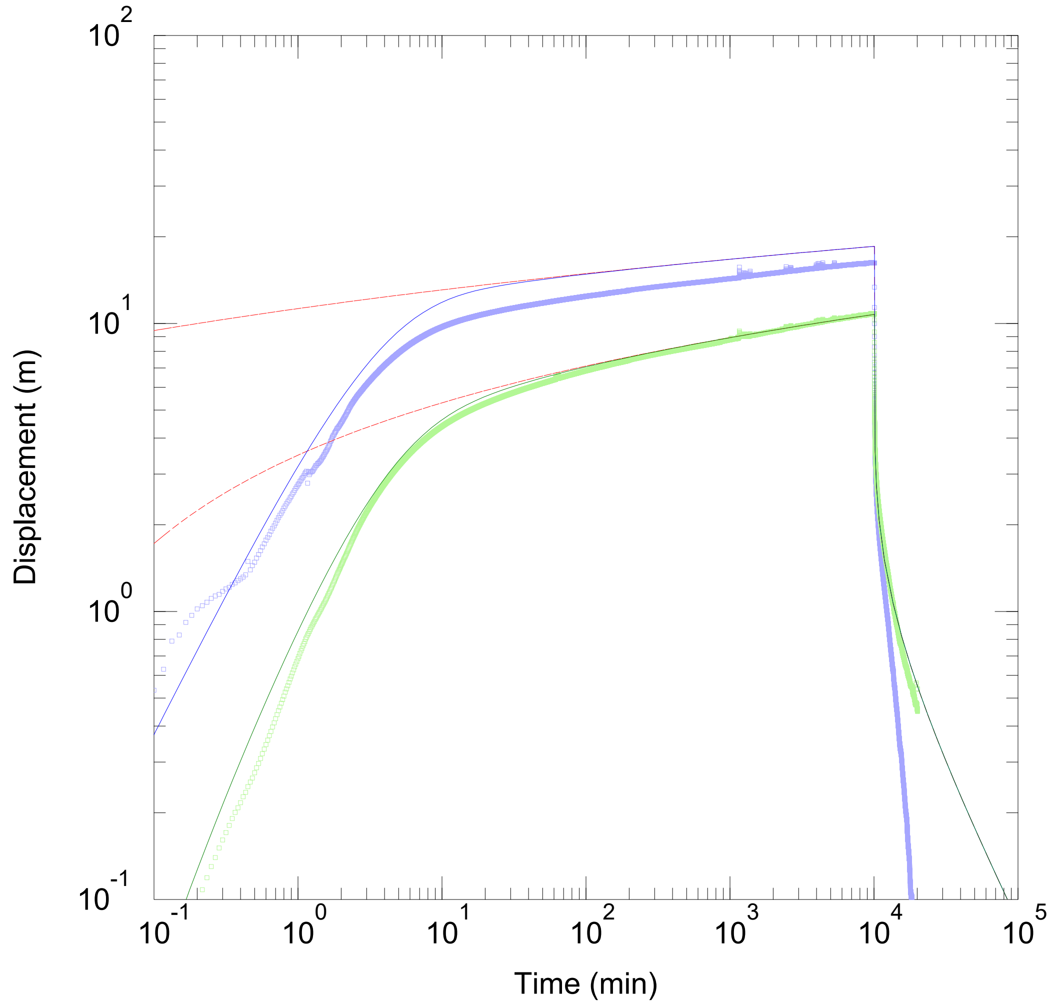
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Leaky
Solution Method: Moench (Case 1)

T = 14.57 m^2/day
S = 4.706E-6



7DAYCRT

Data Set: \...\TB01 and MB01 PC.aqt
Date: 05/17/23 Time: 19:43:10

PROJECT INFORMATION

Company: CDMS
Client: NEOEN
Project: 1001419
Location: Kentbruck
Test Well: TB01
Test Date: 17/04/2023

AQUIFER DATA

Saturated Thickness: 129. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Confined Solution Method: Papadopulos-Cooper

T = 17.44 m^2/day S = 1.708E-6
r(w) = 0.1 m r(c) = 0.1 m