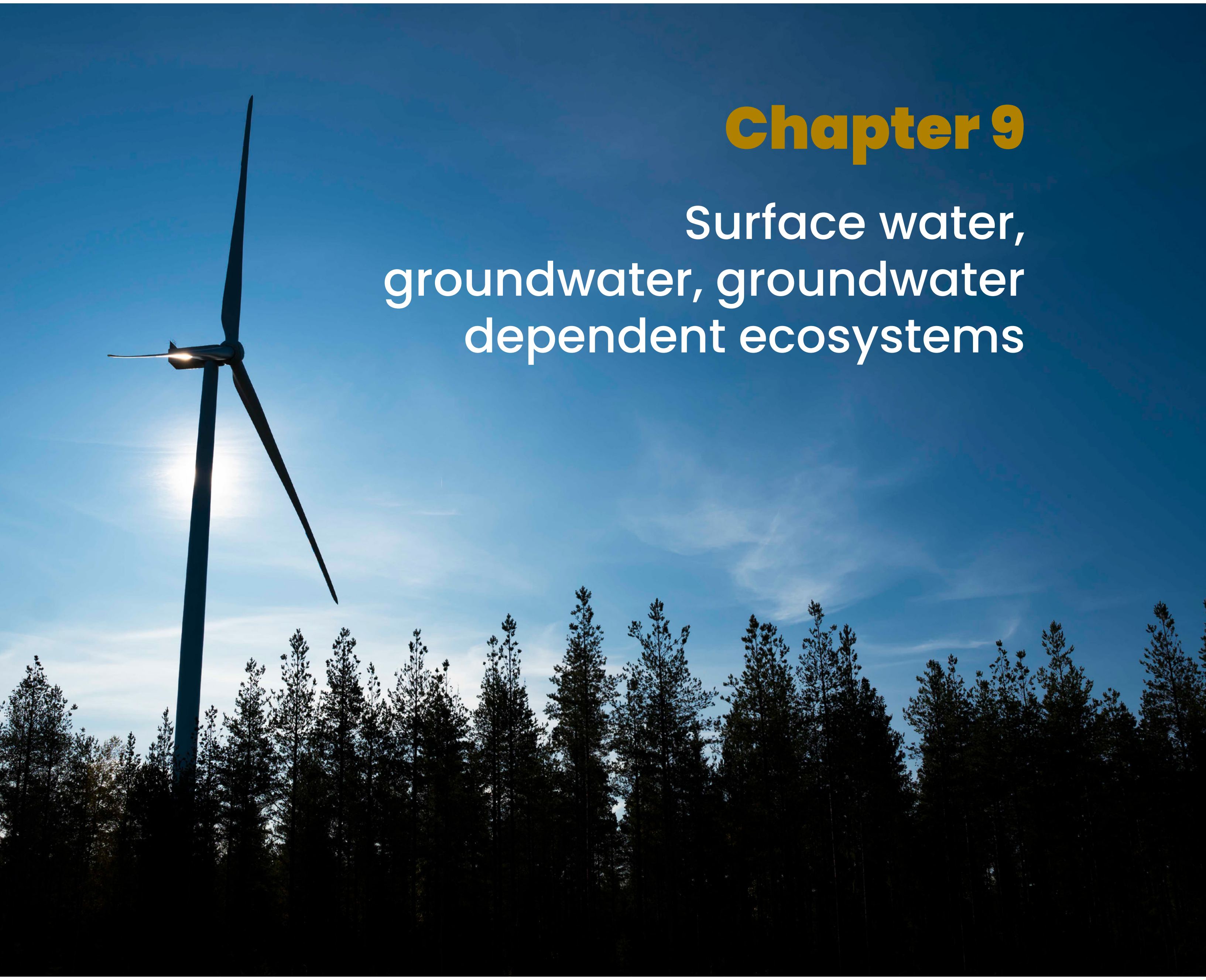
Chapter 9

Surface water, groundwater, groundwater dependent ecosystems



Acknowledgement of Country

Neoen Australia acknowledges the traditional custodians of the land in which we live, and pays its respects to their elders, past and present. The Gunditjmara are the original custodians of the Country on which the Project is located and we acknowledge them as the original custodians. We are committed to Aboriginal engagement and reconciliation and aim to bring Aboriginal and Torres Strait Islander people, local communities and the councils along for the journey to strengthen relationships and enhance local community outcomes.

9 Surface water, groundwater, and groundwater dependent ecosystems

This chapter describes the potential impacts on surface water, groundwater, and groundwater dependent ecosystems (GDEs) associated with construction and operation of the Project, as well as the mitigation measures proposed to minimise potential adverse impacts.

This chapter summarises the outcomes of the following impact assessments:

- Surface Water Impact Assessment (**Appendix F**)
- Groundwater Impact Assessment (**Appendix G**)
- Groundwater Dependent Ecosystem Impact Assessment (**Appendix H**).

9.1 Overview

Surface water

Surface water is any body of water which sits on the earth's surface, including lakes, rivers, streams, wetlands and the ocean. Natural surface waters can be perennial, where water is present throughout the year, or ephemeral, where water is only present for part of the year and usually following rain events. Surface water bodies can also be artificially constructed.

The greatest potential for impacts on surface water is through the Project's construction. There is potential for surface water quality to be impacted through dewatering of turbine foundations and trenches, which may result in increased sediments being discharged back to the environment, as well as stormwater run-off from disturbed areas containing sediments or other pollutants reaching receiving waterbodies. Further, there is potential for changes to surface water hydrology and flows, including altered flood risk and changes to low flow regimes. Industry standard mitigation measure such as treating collected trench water prior to discharging and installing sediment control devices will ensure potential residual impacts on surface water are minimised during construction of the Project. It is unlikely operation of the Project would impact on surface water.

Groundwater

Groundwater is water beneath the earth's surface that lies within cracks and pores in soil and rock. When stored in a body of rock and/or sediments, groundwater is said to travel through an aquifer. Aquifers are important resources for groundwater users, including people who extract groundwater from aquifers for residential or agricultural use, and GDEs.

There is very limited potential for groundwater to be intersected by the excavation of turbine foundation or transmission line trenching, as groundwater is predicted to be deeper than the excavation and trench depths. Groundwater extraction during construction is not expected to materially impact groundwater levels in existing groundwater bores.

Groundwater levels and flow are not expected to be impacted by the presence of turbine foundations or underground cabling during operation of the Project, with groundwater expected to readily flow around or beneath the turbines. Potential impacts associated with bores becoming damaged, destroyed or inaccessible during Project construction are unlikely to occur once the locations of all bores (registered and unregistered) have been confirmed and marked on construction plans.

Contaminated groundwater is not expected to be present within most of the study area. Concentrations of metals were found to be low and likely represent naturally occurring background levels. However, should any contaminated groundwater be encountered, appropriate management measures would be implemented to ensure soil and/or surface water quality is not impacted.

GDEs

GDEs are defined as "ecosystems that 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).

Extraction of groundwater for construction supply purposes could result in less groundwater being available for aquatic GDEs. However, groundwater extraction from deep aquifers during construction is not predicted to change groundwater levels in the shallow watertable, which support aquatic GDEs. However, a GDE monitoring and management plan will be implemented to ensure the hydraulic gradient to the Ramsar site is maintained throughout the groundwater extraction process during construction and for two years following construction works.

The release of drilling fluids or sediment during construction of the Surrey River horizontal directional drilling (HDD) 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. Any release of drilling fluids or sediment during construction is likely to be of very short duration (days), with any sediment released likely to be quickly diluted with very limited and short-lived impacts on aquatic vegetation and ecosystems.

No permanent or measurable impacts on GDEs are predicted to occur as a result of the Project.

9.2 EES evaluation objective

The specific environmental matters to be investigated and documented in this EES are set out in the *Scoping Requirements for Kentbruck Green Power Hub Environment Effects Statement* (Scoping Requirements). The Scoping Requirements provide evaluation objectives that describe the desired outcomes to be achieved for each of the matters being addressed in this EES.

The following draft evaluation objective is relevant for the surface water, groundwater and GDE impact assessments:

> ***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.*

As discussed in Section 1.5.2 in **Chapter 1 *Introduction***, the Scoping Requirements were issued when the superseded Environment Protection Act was in force (*Environment Protection Act 1970 (*Vic)). The term 'beneficial uses' was formerly described under the *State Environment Protection Policy (Waters)* which was subordinate to the Act, but has now been replaced with 'environmental values' as defined in the Environmental Reference Standard (ERS).

This chapter and the associated technical reports address the Project's specific surface water, groundwater and GDE matters in response to the Scoping Requirements, with environmental values now referenced instead of beneficial uses in accordance with the *Environment Protection Act 2017* (Vic) (EP Act) and ERS.

9.3 Assessment methodology

The following approach was undertaken for the surface water, groundwater and GDE impact assessments:

- Established the study areas and characterised the existing surface water and groundwater environment across the study areas, including waterways, wetlands, groundwater levels and flows and GDEs. As detailed in **Section 9.4**, these study areas comprise:
  - The surface water study area, which is limited to the Project Area.
  - The groundwater and GDE study area, comprising the Project Area with buffer zones divided into three sub-areas: the wind farm 'plantation sub-area', the wind farm 'north-eastern sub-area', and the transmission line sub-area.
- Desktop review of relevant baseline reports, publicly available information and databases including:
  - Victorian Government datasets for designated water supply catchments (PWSC100), state-wide watercourse network, and 1 in 100 year flood extent
  - Bureau of Meteorology (BoM) (2021) National GDE Atlas
  - Third Index of Stream Condition report for the Glenelg Hopkins region (DEPI, 2010)
  - National Surface Water Information (Geoscience Australia, 2023)
  - South West Victoria Groundwater Atlas (SRW, 2011)
  - South West Limestone Local Management Plan (SRW, 2023)
  - Glenelg Groundwater Catchment Statement (SRW, 2017)
  - Victorian Department of Energy, Environment and Climate Action (DEECA) Native Vegetation Information Management Tool and Nature Kit
  - DEECA Victorian Biodiversity Atlas (VBA)
  - Glenelg Estuary and Discovery Bay Ramsar Site (the Ramsar site) Ecological Character Description (DELWP, 2017 a) and Management Plan (DELWP, 2017 b).
- Consultation with relevant stakeholders including Glenelg Shire Council (GSC) and Southern Rural Water (SRW).
- A groundwater fieldwork program undertaken throughout 2021 and 2022 to characterise groundwater across the study area, including groundwater quality, depth to groundwater and hydraulic conductivity of underlying aquifers, which involved:
  - Installation of 12 new groundwater wells in the wind farm site, including:
    - Nine wells close to the southern boundary of the plantation sub-area, adjacent to a complex of swamps and wetlands (including the Ramsar site), at a depth of 4 to 10 metres below ground surface (mbgs).

    - Three wells in the north-eastern sub-area of the wind farm site at a depth of 6 mbgs, due to the presence of mapped potential GDEs at this location.
  - Gauging of the 12 newly installed groundwater wells and of seven existing groundwater wells (one State Observation Bore Network bore and six stock/domestic wells) to determine groundwater depth, in April 2021, October 2021 and March 2022.
  - Basic water sampling from the 12 newly installed groundwater wells. Groundwater sampling was conducted in April 2021 and tested for groundwater field chemistry, major ions and total dissolved solids (TDS).
  - More detailed water sampling for seven of the 12 newly installed bores. Detailed sampling was conducted in April 2021 and tested for contaminants of potential concern including total recoverable hydrocarbons (TRH); benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN); metals; herbicides; and pesticides.
  - Aquifer hydraulic testing (rising and falling head slug tests) for all 12 newly installed wells, in February 2020.
- A groundwater supply investigation was undertaken in February and March 2022 by AECOM, to assess the potential effect of groundwater extraction for water supply, which involved:
  - Installation of a test production bore (TB01) and monitoring bore (MB01) within the plantation sub-area.
  - Step and constant rate pumping tests at TB01.
- A subsequent 7-day constant rate pumping test was undertaken at TB01 in April 2023 by CDM Smith.
- Site walkovers by the surface water specialists (April 2023) and GDE specialists (October 2022) to verify database records and existing conditions and to inform identification of appropriate mitigation measures.
- Identification and assessment of potential impacts on surface water, groundwater and GDEs as a result of construction and operation of the Project, including groundwater drawdown modelling at turbine locations where groundwater would likely be intersected and require dewatering.
- Development of mitigation measures to avoid, minimise and manage potential impacts.
- Assessment of the residual impacts on surface water, groundwater and GDEs with the implementation of mitigation measures.

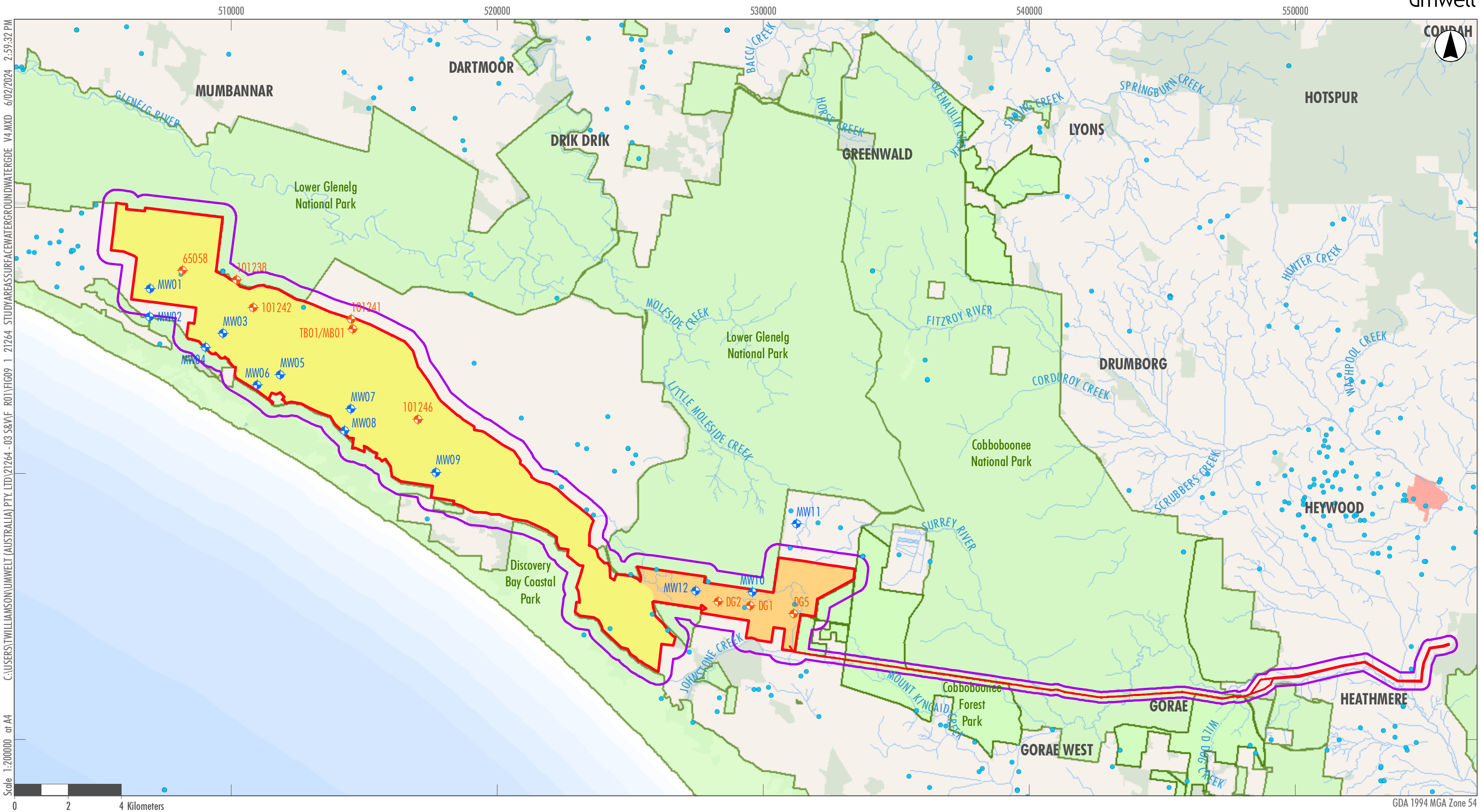
9.4 Study areas

The study area used in the Surface Water Impact Assessment was limited to the Project Area, which comprises the wind farm site and the transmission line corridor, and covers a total area of up to 8,350 ha (see **Figure 9.1**).

The groundwater and GDE study area comprises buffers around the wind farm site and transmission line corridor, with the wind farm site divided into two 'sub-areas', as described below and shown in **Figure 9.1**.

- Wind farm site with a 500 m buffer, divided into two sub-areas:
  - The 'plantation sub-area', comprising the land with pine plantation in the wind farm site.
  - The 'north-eastern sub-area', comprising the farmland in the wind farm site east of Portland-Nelson Road.
- Underground ransmission line corridor with a 200 m buffer.

These buffer widths were chosen as they were considered adequate to capture existing conditions (including groundwater users and GDEs) that may be affected by potential changes to groundwater levels and flow due to Project activities and infrastructure.



Legend

- Existing Groundwater Bores used for Monitoring
- New Groundwater Bores used for Monitoring
- Registered Bores
- Watercourses
- Proposed Transmission Line
- Wind Farm Site
- Study Area
- Parks and Reserves
- Windfarm Northeast Sub-area
- Windfarm Plantation Sub-area
- Built Up Areas

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FIGURE 9.1

Study Areas used in the Surface Water, Groundwater and GDE Impact Assessments

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

9.5 Regional existing conditions

This section provides an overview of the existing conditions within the region surrounding the Project Area that are relevant to the surface water, groundwater and GDE impact assessments. Existing conditions specific to each impact assessment are described in the relevant section (**Section 9.6** for surface water, **Section 9.7** for groundwater, and **Section 9.7.1** for GDEs).

9.5.1 Climate

The Project is in a region with a temperate climate of warm, dry summers and cool, wet winters. Based on the annual rainfall statistics recorded at the Nelson, Mount Richmond, and Cape Bridgewater weather stations, the average annual rainfall of the study area is around 800 millimetres (mm). Recharge of the aquifers across the study area is via direct rainfall infiltration.

Evaporation statistics from Mount Gambier in South Australia, located approximately 35 km north-west of the Project Area, were compared to the rainfall at Nelson (provided in the *Glenelg Estuary and Discovery Bay Ramsar Site: Ecological Character Description* (DELWP, 2017 a)). As indicated by **Plate 9.1**, groundwater recharge in the study area is winter dominated, with monthly rainfall typically exceeding evaporation between May and August. However, evaporation typically exceeds rainfall in the warmer months.

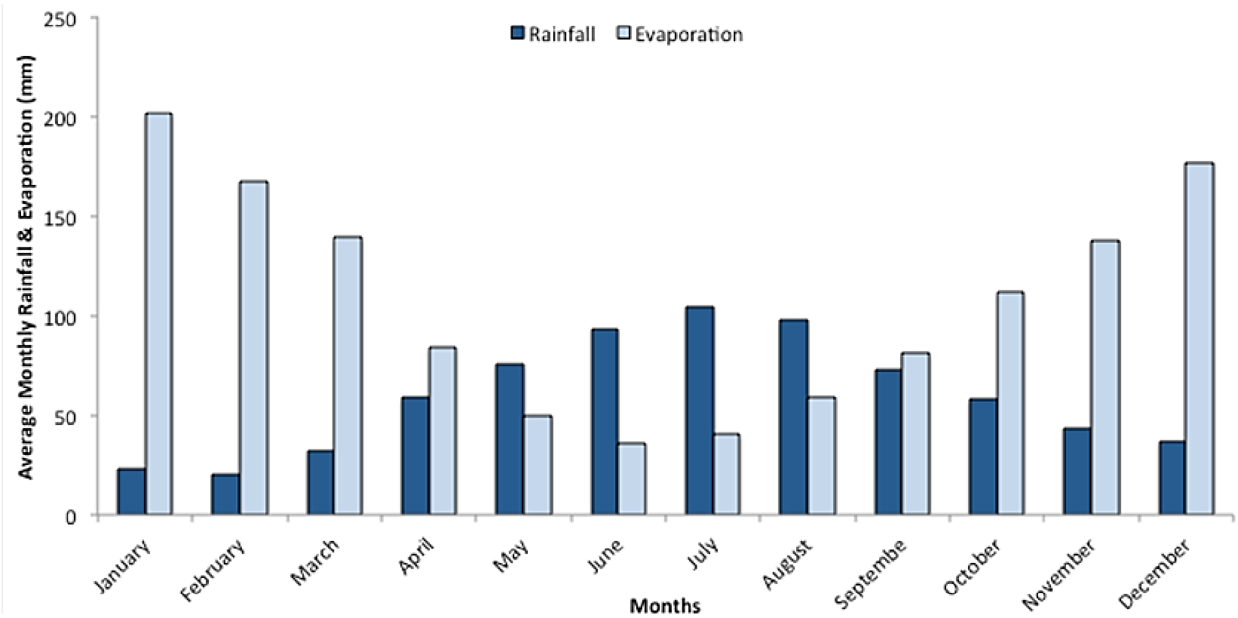
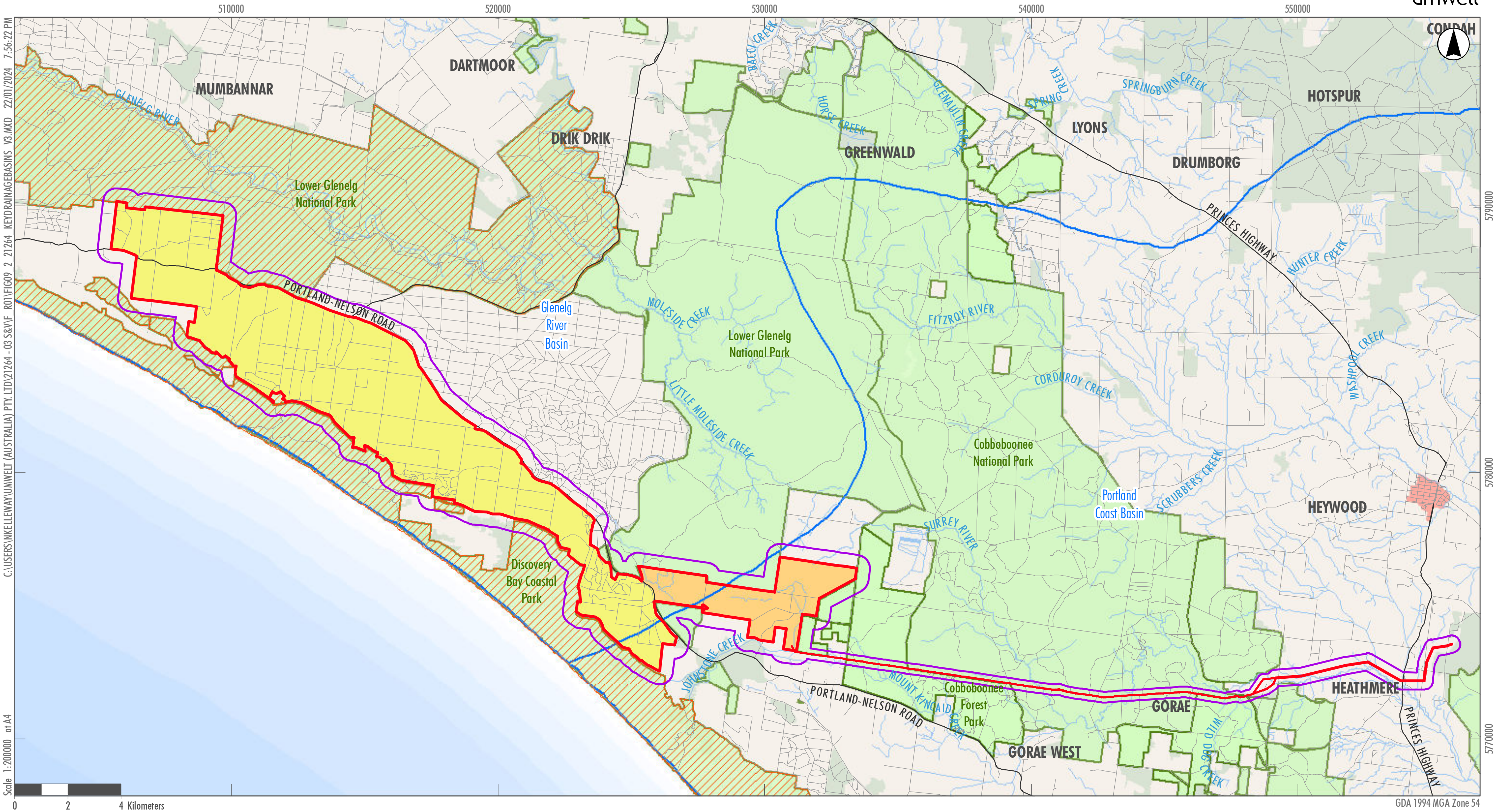


Plate 9.1: Mean monthly rainfall (Nelson) and evaporation (Mount Gambier) (1940-2014 BoM data) (DELWP, 2017 a)

9.5.2 Regional catchment overview

The Project is in the Glenelg Hopkins catchment, which has a drainage area of 29,910 km^2 (2.9 million ha). As shown in **Figure 9.2**, the catchment encompasses four river basins in Victoria and South Australia: Glenelg, Hopkins, Portland Coast and Millicent Coast. The Glenelg Hopkins Catchment Management Authority (GHCMA) is responsible for river health and accountable for regulation of works on waterways and floodplains, rural drainage and waterway and floodplain management in the catchment.

The Glenelg Hopkins catchment covers networks of rivers, streams and creeks, wetlands, mountain ranges, coastal areas, vast floodplains of agricultural land, and nature reserves and national parks with high conservation values such as Grampians National Park, Discovery Bay Coastal Park, and reserves in Port Fairy, Warrnambool and Yambuk. The largest watercourse within the Glenelg Hopkins Catchment is the Glenelg River, which rises in the Grampians National Park and flows west through Harrow and then south to Casterton and Dartmoor for around 500 km. A short stretch of the estuary winds through South Australia before returning to Victoria to enter the sea at Nelson. The Glenelg River is to the north and west of the wind farm site.



Legend

- Roads
- Watercourses
- Proposed Transmission Line
- Wind Farm Site
- Study Area
- Parks and Reserves
- Windfarm Northeast Sub-area
- Windfarm Plantation Sub-area
- Built Up Areas
- Glenelg Estuary and Discovery Bay Ramsar Site
- Key Catchment Basins

FIGURE 9.2

Key Drainage Basins

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

9.5.3 Topography

As shown in **Figure 9.3**, the wind farm site generally slopes towards the Ramsar site, with highpoints located across Portland-Nelson Road in the north of the Project Area. The ground surface elevation ranges from around 180 m above sea level (masl) near Mount Kincaid at the eastern boundary of the north-eastern sub-area, to 140 masl at the eastern boundary of the plantation sub-area, to 10 masl adjacent to Long Swamp and other wetlands areas in the Ramsar site.

Ground surface elevation within the plantation sub-area varies substantially, being characterised by ridges of sand dunes parallel to the coast separated by inter-dune swales and limestone depressions. The north-eastern sub-area is located at a topographical high point, with lower lying areas occurring adjacent to minor ephemeral waterways (see **Figure 9.3**).

Ground surface elevation decreases away from the wind farm site to the east. The underground section of the transmission line falls from a height of around 140 masl) in the wind farm site to the west, to around 40 masl in the east.

9.5.4 Glenelg Estuary and Discovery Bay Ramsar site

The Ramsar site was designated a Wetland of International Significance under the Ramsar Convention in 2018, primarily due to the site providing seasonal habitat for many migratory birds. It consists of estuaries, a beach and dune system, and freshwater wetlands. The Ramsar site covers an area of approximately 22,289 ha, including the western part of the Lower Glenelg National Park, most of the Discovery Bay Coastal Park and the Nelson Streamside Reserve (adjacent to the Glenelg River, north of Portland-Nelson Road in Nelson). As shown in **Figure 9.4**, the Ramsar site borders the southern and north-western boundaries of the wind farm site.

The Ramsar site's boundaries exclude the portions of the Glenelg Estuary that lie within South Australia as well as 600 m of the estuary channel adjacent to Nelson. This 600 m stretch of channel divides the Ramsar site into two portions:

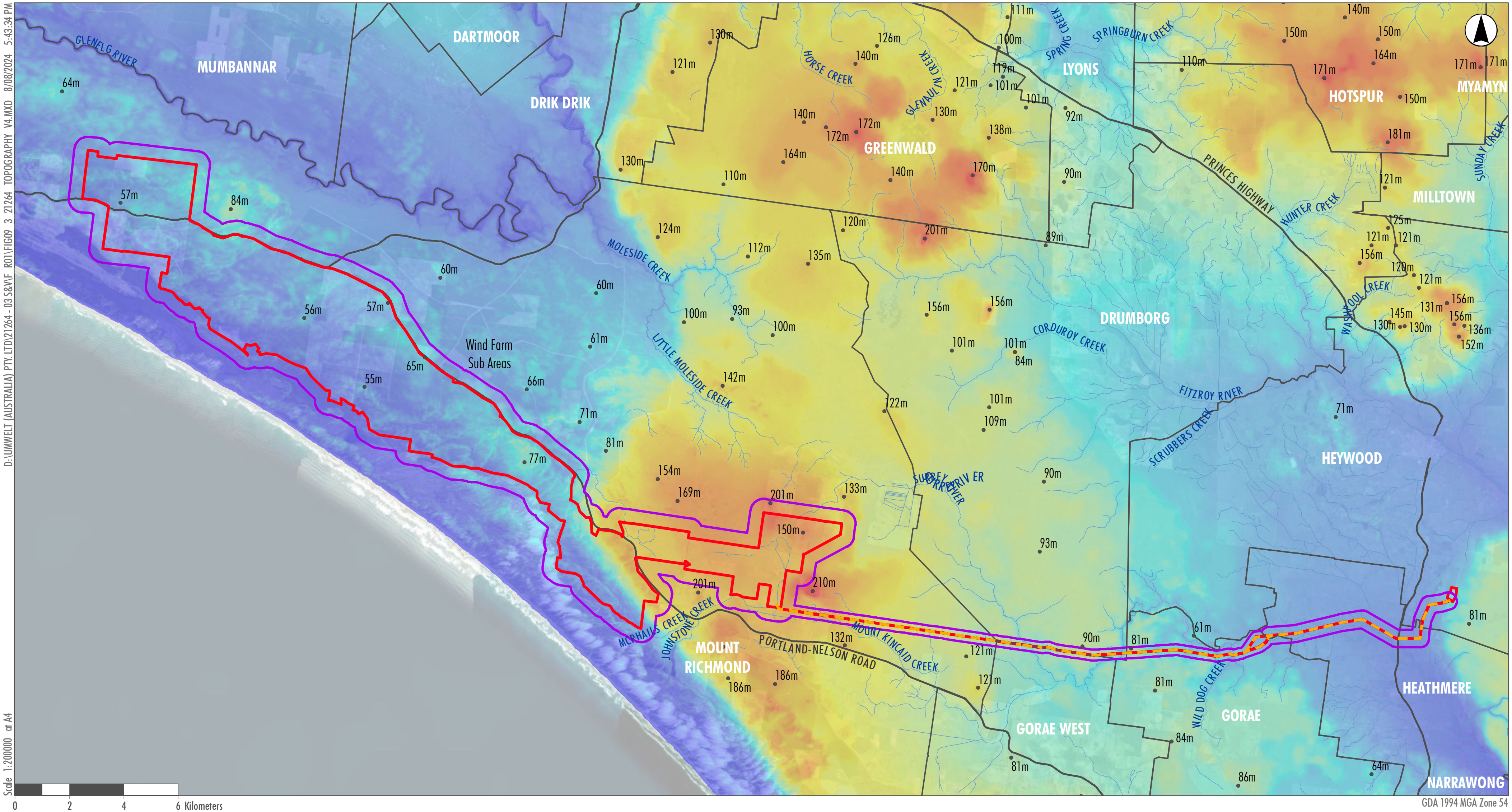
- A northern area encompassing the western part of the Lower Glenelg National Park. This area is to the north of Nelson and the north-western corner of the wind farm site.
- A southern area which includes Discovery Bay Coastal Park and the Nelson Streamside River Reserve. This area is to the south of the wind farm site.

The Glenelg River is the primary river which feeds into the northern portion of the Ramsar site from the east. Upstream from the Ramsar site boundary, the Glenelg River runs east-west roughly parallel to the northern boundary of the wind farm site (within approximately 2 km of the site boundary). Moleside Creek, a tributary of the Glenelg River, also occurs to the north of the wind farm site boundary. It is possible that the Glenelg River and Moleside Creek may receive some run-off from the wind farm site, although the high soil infiltration rates and vegetation within the wind farm site would limit the potential for run-off.

The southern area of the Ramsar site receives water from several watercourses, including the Glenelg River Estuary (on the far west of the Ramsar site) and Johnstone Creek (on the eastern border of the Ramsar site). The Johnstone Creek catchment (1,200 ha) intersects with the wind farm site and underground transmission line corridor before entering the Ramsar site. There are no mapped watercourses within the wind farm site, but surface water from the western and central areas of the site would generally drain towards Discovery Bay, although the total volume of run-off is low due to vegetation on site and high soil infiltration rates.

The Ramsar site comprises three broad systems that support different wetland types: The beach and dune systems of Discovery Bay, freshwater wetlands, and the Glenelg Estuary. These systems support a diversity of waterbird, fish and plant assemblages including a significant number of threatened species and ecological communities. The hydrological system includes a complex interaction of surface and groundwater flows and local rainfall run-off which is crucial to the function of the estuary and freshwater wetlands. Each wetland type is described below.

Increased stormwater and sediment entering the Ramsar site are identified as a key threat to the ecological character of the Ramsar site (Parks Victoria, 2015), (DELWP, 2017 b). An increase in sediments and nutrients from the catchment can result in increased algal growth and decreased dissolved oxygen levels, and subsequently impact fish diversity and aquatic vegetation used in fish reproduction and waterbird feeding. Increased stormwater run-off may also increase beach erosion.



Legend

- Study Area
- Project Area
- Underground Transmission Line
- Roads
- Watercourses

Elevation Surface (metres above sea level)

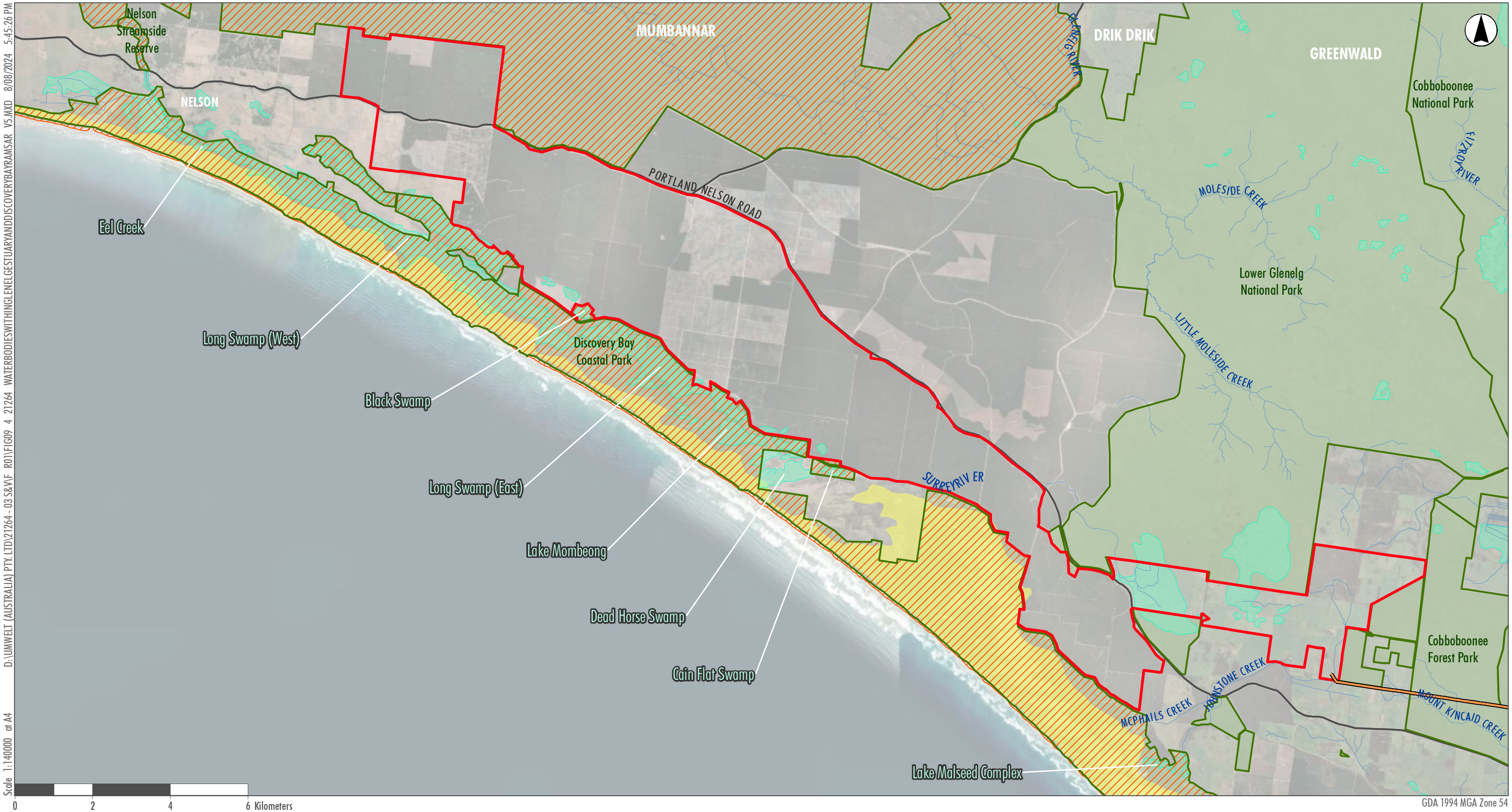
220m

0m

FIGURE 9.3

Topography of the Study Area

Image Source: ESRI Basemap (2021) Data source: DELWP (2021); Biosis (2022)



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Legend

- Project Area
- Underground Transmission Line
- Roads
- Watercourses
- Parks and Reserves
- Glenelg Estuary and Discovery Bay Ramsar Site
- Wetlands
- Discovery Bay Dune System

FIGURE 9.4

Waterbodies Within the Glenelg Estuary and Discovery Bay Ramsar Site

Image Source: ESRI Basemap (2021) Data source: DELWP (2021); Biosis (2022)

9.5.4.1 Discovery Bay beach and dune systems

The long sandy intertidal beach of Discovery Bay is formed by recently deposited, mobile sands and dunes that are sometimes broken by rocky limestone outcrops, such as Nobles Rocks.

The dune system includes humid dune slacks which are damp or wet depressions in the dune system. These dune slacks are maintained by groundwater and may be seasonally or permanently inundated depending on the water table elevation and fluctuation. The 'slack' water (still or slow moving water) may also include a component of seawater from high tides.

9.5.4.2 Freshwater wetlands

Freshwater wetlands in the Ramsar site consist of several different complexes located behind (inland of) the dune system:

- The Long Swamp complex runs adjacent to the southern boundary of the wind farm site and contains peatlands that support important fen wetlands (i.e. GDEs). The complex includes Sheepwash Lagoon, Cains Hut Swamp and several unnamed lagoons, Lake Mombeong, Black Swamp, McFarlanes Swamp and Eel Creek (connecting to Glenelg Estuary).
- The Lake Malseed complex is approximately 200 m from the groundwater/GDE study area at its nearest point, and comprises Malseed Lake, Swan Lake and Boomer Swamp.
- The Bridgewater Lakes are approximately 15 km south-east of the wind farm site and consist of a sequence of five freshwater lakes at the south-eastern end of the Ramsar site.

9.5.4.3 Glenelg Estuary

The Glenelg Estuary is a salt wedge estuary formed by stratification of freshwater overlying denser saline water. It covers a surface area of approximately 510 ha including the channel, Oxbow Lake, and a coastal lagoon extending from the channel (see **Plate 9.2**) and is linked to the Long Swamp complex via Eel Creek.

The estuary closes seasonally as sediment deposited by wave action cannot be displaced by the low summer flows of the Glenelg River. When closed, the estuary fills with freshwater until the mouth is breached by wave action or higher river flow in spring or winter. Periods of closure average 40 days, but can sometimes span a year.

Freshwater inflows to the Glenelg Estuary are from direct rainfall, river inflows and groundwater. Most of the freshwater inflow to the estuary occurs in late winter and early spring. A water balance study carried out when the estuary closed for extended periods, indicated that groundwater inflow may account for up to 45 % of total flows (DELWP, 2017 a). Marine water accounts for a large proportion of the total volume when the mouth of the estuary is open.

Plate 9.2: Glenelg Estuary

9.5.5 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 Threatened Ecological Community (TEC) was listed as endangered under the EPBC Act on 15 December 2020. The TEC is associated with a GDE and 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 (DAWE, 2020). Wetland dependent plants within the TEC 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.

Known occurrences of this TEC within the Investigation Area include Lake Mombeong (outside the Project Area), and two small wetlands north of Lake Mombeong (inside the Project Area). The small wetlands within the Project Area were identified as being potential examples of this TEC and did not contain areas of open water.

9.5.6 Environmental values

The ERS identifies environmental values that need to be achieved and maintained and provides a method to assess those environmental values in locations across Victoria. The ERS classifies surface water into segments based on geographic region and types of surface water (inland waters or marine and estuarine waters). Surface water in the study area is categorised as the Murray and Western Plains segment for inland waters, and the Otway and Estuaries segments for marine and estuarine waters. The surface water environmental values relevant to these segments are provided in **Table 9.1**.

Table 9.1: Surface water environmental values from the ERS

Inland waters	Marine and estuarine waters	
Rivers and streams – Murray and Western Plains Segment	**Open Coast – Otway**	**Estuaries**
• Water dependent ecosystems and species that are slightly to moderately modified • Agriculture and irrigation • Human consumption of aquatic foods • Industrial and commercial • Water based recreation (primary contact, secondary contact and aesthetic enjoyment) • Traditional Owner cultural values.	• Water dependent ecosystems and species that are largely unmodified • Human consumption of aquatic foods • Industrial and commercial • Water based recreation (primary contact, secondary contact and aesthetic enjoyment) • Traditional Owner cultural values • Navigation and shipping.	• Water dependent ecosystems and species that are slightly to moderately modified • Human consumption of aquatic foods • Industrial and commercial • Water based recreation (primary contact, secondary contact and aesthetic enjoyment) • Traditional Owner cultural values • Navigation and shipping.

The ERS divides groundwater across Victoria into seven 'segments', which are defined by the background water quality level of TDS), and identifies the environmental values to be achieved and maintained within each segment (or range of TDS).

Based on groundwater samples taken from the Project's monitoring bores and data from Victorian Department of Environment, Land, Water and Planning (DELWP) (Now split into DEECA and DTP (Victorian Department of Transport and Planning))'s Water Measurement Information System (WMIS), groundwater in the study area falls within the following segments:

- Segment A1 (0 – 600 mg/L TDS) in the north-eastern sub-area.
- Segment A2 (601 – 1,200 mg/L TDS) across the plantation sub-area and transmission line sub-area.

The same environmental values apply to both Segment A1 and A2:

- water dependent ecosystems and species
- potable water supply (desirable for segment A1 and acceptable for segment A2)
- potable mineral water supply
- agriculture and irrigation (irrigation and stock watering)

- industrial and commercial
- water-based recreation (primary contact recreation)
- Traditional Owner cultural values
- buildings and structures
- geothermal properties.

9.6 Surface water

9.6.1 Existing conditions

9.6.1.1 Hydrology

Surface water run-off from the western and central areas of the wind farm site generally flows towards the Ramsar site, however, the vegetated plantation and sandy soils ensure much of the rainfall occurring across these areas infiltrates into the ground.

Where run-off does occur, it is primarily conveyed through minor, ephemeral waterways and drainage pathways or as overland flow. The minor ephemeral waterways primarily cross the north-eastern sub-area and merge into Johnstone Creek and Mcphails Creek outside of the boundary of the Project Area (see **Figure 9.5** and **Figure 9.6**) eventually draining into the Ramsar site and Discovery Bay. There are also several farm dams in this area.

The wind farm site intersects with two minor, ephemeral waterways: one unnamed waterway and one unnamed tributary of Johnstone Creek (see **Figure 9.6).** Both waterways would be trenched where they intersect with access tracks and underground cabling within the wind farm site, as they are narrow waterways that can be reinstated quickly.

Seven DEECA current mapped wetlands are in the north-eastern sub area of the wind farm site (see **Figure 9.6**). The underground powerline and internal access track intersect with two of these wetlands (Wetland ID 20522 and 20532), along the northern wind farm site boundary. These wetlands are ephemeral and were observed to be largely dry with only small, isolated depressions containing surface water, which was following several months of higher-than-average rainfall (see **Plate 9.3** and **Plate 9.4**). The underground powerline and access track would also intersect a small number of additional wetlands mapped by Biosis as part of the Brolga Impact Assessment (see **Chapter 8** ***Brolga***).

Plate 9.3: Wetland ID 20532 located at the northern boundary of the wind farm site (AECOM, 2023)

Plate 9.4: Isolated depression with standing water in Wetland 20522, close to the underground cable alignment (AECOM, 2023)

The underground transmission line intersects waterways a total of 18 times (with some waterways intersected multiple times) (see **Figure 9.7)** and **Table 9.3**). Of these, 14 crossings are of minor waterways (including unnamed waterways and Wild Dog Creek), and four crossings are of a major waterway (the Surrey River). Surrey River has a large upstream catchment and is classified by DEECA as a non-ephemeral (perennial) waterway. However, no flow was observed in Surrey River, despite the region experiencing higher than average rainfall totals in the weeks prior to the visit (see **Plate 9.5**).

The Surrey River would be crossed with HDD at three locations due to its large upstream catchment and wide crossing over the Surrey River floodplain. Wild Dog Creek will also be crossed with HDD and other waterways would be trenched during dry weather as they are narrow, ephemeral waterways that can be reinstated quickly.

Plate 9.5: Dry riverbed in Surrey River at Boiler Swamp Road in April 2023 (AECOM, 2023)

9.6.1.2 Flooding

The wind farm site is not located within the 1 % Annual Exceedance Probability (1 % AEP) flood extent. However, parts of the wind farm site are known to be low-lying and subject to periodic inundation of waterlogging. These areas mostly encompass watercourses and wetlands located in the north-eastern sub-area (see **Figure 9.6**).

Parts of the transmission line intersect with the 1 % AEP flood extent of the Surrey River, as shown in **Figure 9.7.** The transmission line would be constructed via HDD through the crossing of Surrey River, and would be undertaken during low flow conditions (e.g. in summer).

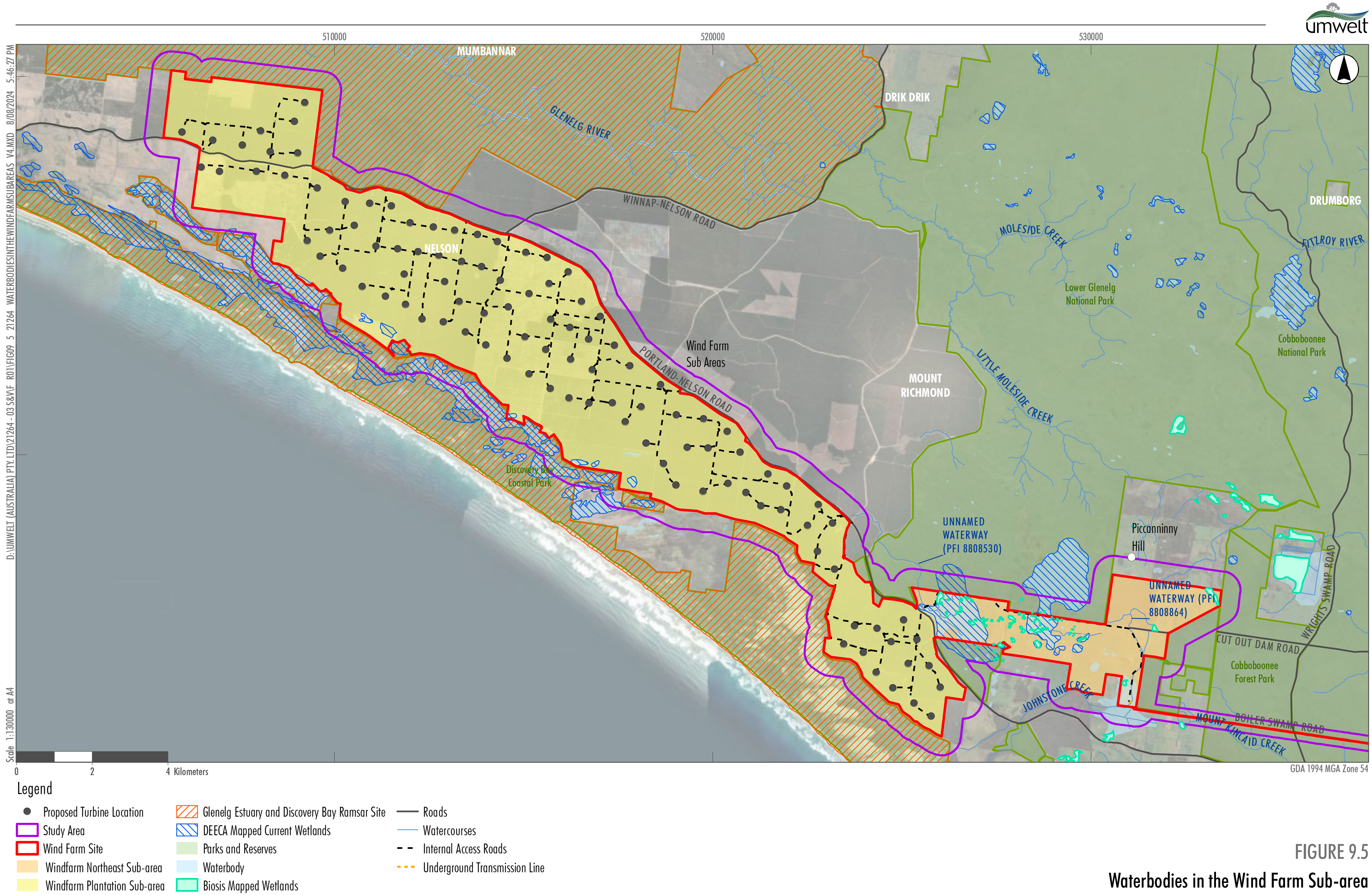

FIGURE 9.5

Waterbodies in the Wind Farm Sub-area

Image Source: ESRI Basemap (2022) Data source: DELWP (2021)

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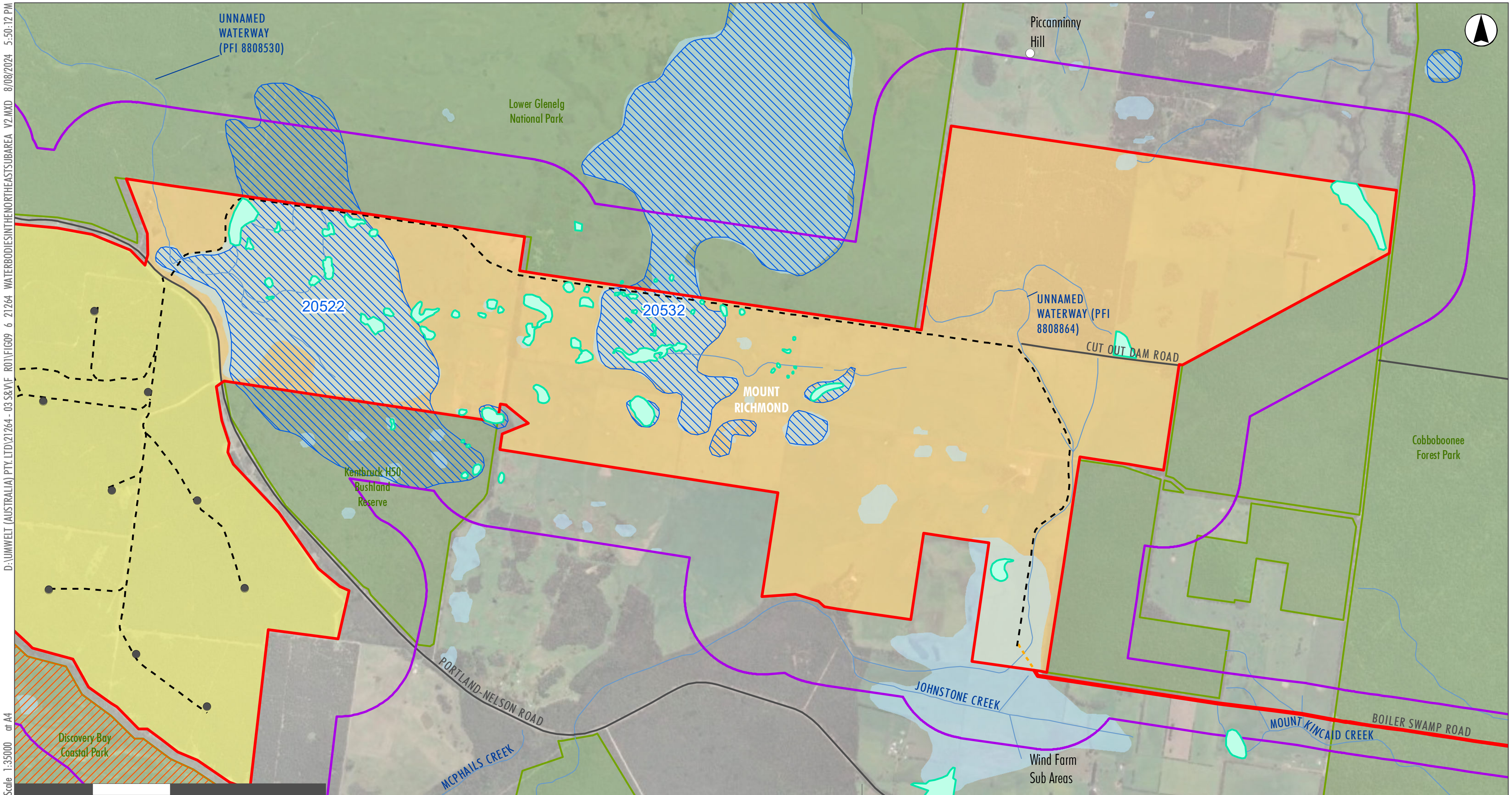

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GDA 1994 MGA Zone 54

Legend

- Proposed Turbine Location
- Study Area
- Wind Farm Site
- Windfarm Northeast Sub-area
- Windfarm Plantation Sub-area
- Glenelg Estuary and Discovery Bay Ramsar Site
- DEECA Mapped Current Wetlands
- Parks and Reserves
- Waterbody
- Biosis Mapped Wetlands
- Roads
- Watercourses
- Internal Access Roads
- Underground Transmission Line

FIGURE 9.6

Waterbodies in the Northeast Sub-area

Image Source: ESRI Basemap (2022) Data source: DELWP (2021)

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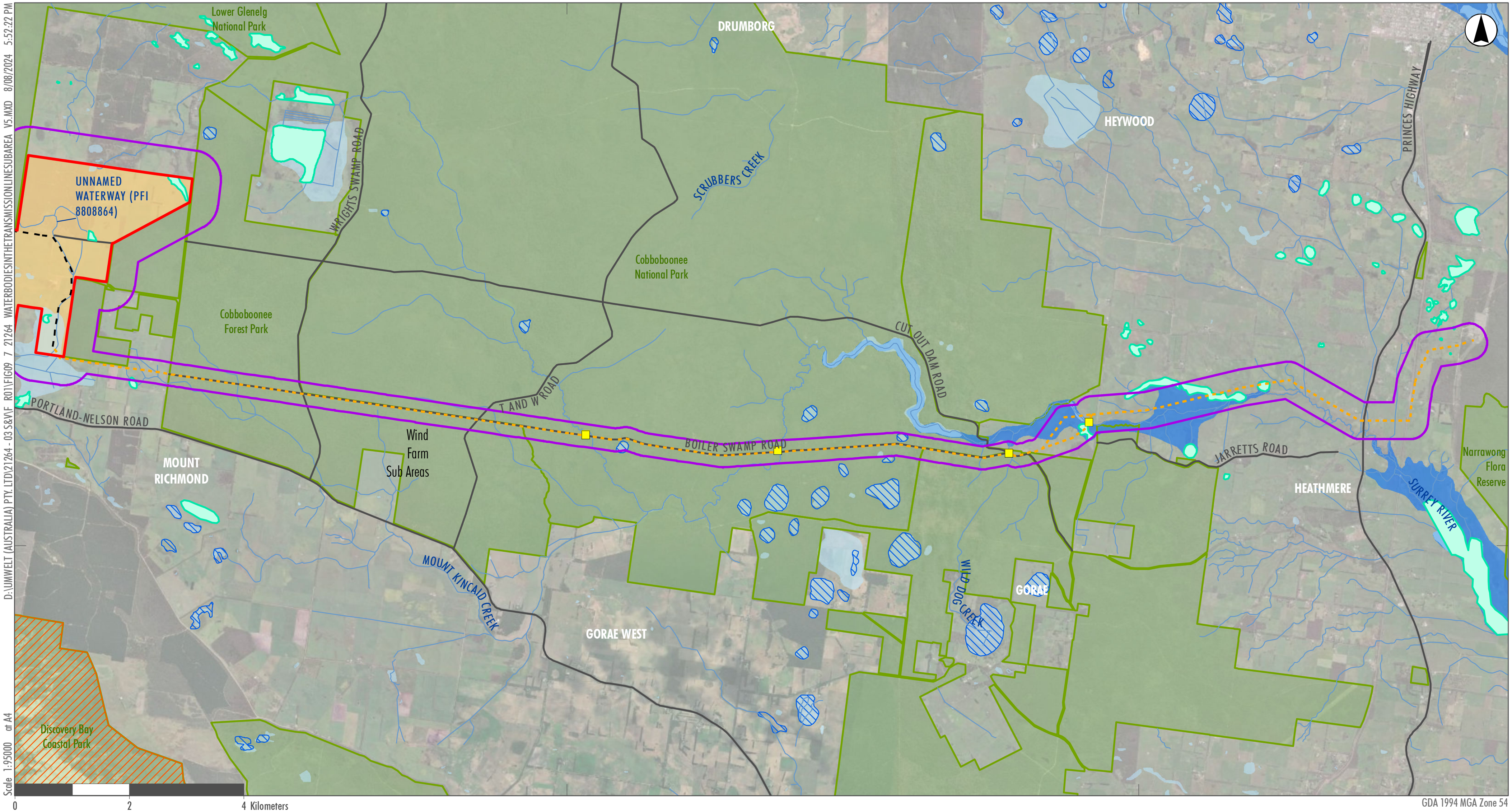

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Scale 1:95000 at A4

Legend

- Horizontal Drilling Locations
- Study Area
- Wind Farm Site
- Windfarm Northeast Sub-area
- Glenelg Estuary and Discovery Bay Ramsar Site
- DEECA Mapped Current Wetlands
- Parks and Reserves
- Waterbody
- Biosis Mapped Wetlands
- 1% AEP Flood Extent
- Roads
- Watercourses
- Internal Access Roads
- Underground Transmission Line

FIGURE 9.7

Waterbodies in the Transmission Line Sub-area

Image Source: ESRI Basemap (2022) Data source: DELWP (2021)

9.6.2 Construction impacts

9.6.2.1 Stormwater dewatering

Rain events occurring during construction may inundate turbine foundations and open trenches with surface water run-off. This water may contain sediments and other pollutants which, if not managed properly when being discharged from the construction site, could transport contaminants into nearby waterways such as Johnstone Creek and ultimately into sensitive environments such as the Ramsar site. This could result in increased sedimentation and turbidity within receiving waterbodies.

Sedimentation of these waterways occurs in the current context, both through naturally occurring processes and via land uses associated with adjacent areas, such as land clearing and grazing, which has the potential to exacerbate erosion and increase sediment loads. Increased sediment loads in waterways has the potential to alter the morphology and habitat of these waterways as well as potentially downstream receiving waterbodies. Sediments can also increase turbidity, which in turn can reduce the amount of light that is available to species and habitats within the waterway. There is also the potential for sediments to be bonded with particular contaminants which could harm waterway ecology, including increases nutrient loads and associated higher risk of potential algal blooms.

Industry standard sediment control measures will be implemented to manage the discharge of collected water so that no substantial increase in sedimentation or contamination is registered within neighbouring waterways. Dewatering will be managed through the Construction Environmental Management Plan (CEMP), which may include the development of a specific Dewatering Plan to manage impacts associated with dewatering from open excavations.

Measures to mitigate potential dewatering impacts on adjacent waterways include:

- Testing water resulting from dewatering for potential contaminants
- Treating water collected from excavated areas if turbidity exceeds requirements specified in EPA Publication 1834 *Civil Construction, Building and Demolition Guide* (EPA Publication 1834.*1)*, prior to discharging
- Ensuring water is discharged to low gradient areas to avoid soil erosion or sedimentation
- Discharging to land more than 50 m from any waterbodies.

Sediment control devices such as sediment fences and basins will be used where required to remove suspended soils and dissipate flow (see mitigation measure MM-SW01).

The separation distance from areas where dewatering is likely to be required and the flat to lightly undulating topography would assist in minimising potential dewatering impacts on nearby waterbodies. Coupled with the proposed mitigation measures discussed above and in **Section 9.9**, there is limited potential for residual impacts.

9.6.2.2 Run-off from disturbed areas

Surface water run-off from disturbed areas has the potential to increase sediment loads and turbidity in nearby receiving waterways. The possible effects of these run-off events are the same as those identified for stormwater dewatering in **Section 9.6.2.1**.

During construction, disturbed areas with the potential for run-off to be generated during rainfall events would include excavation of the turbine foundations, trenching of the transmission line, HDD sites, and temporary stockpiling of spoil material.

A Sediment, Erosion and Water Quality Management Plan (SEWQMP) will be implemented as part of the Project's CEMP to ensure surface water run-off is managed effectively and does not contaminate adjoining waterways. The SEWQMP will identify where sediment control devices such as bunding, silt fences and flow diversion banks would be used around disturbed areas and stockpiled material to minimise the risk of sediment transport into surrounding areas (see mitigation measure MM-SW02). The SEWQMP will also contain site specific surface water monitoring measures, such as daily monitoring of turbidity in surface water runoff, and background monitoring in the potential receiving environment, such as sampling upstream and downstream of an identified discharge point (see mitigation measure MM-SW09).

Stormwater run-off from construction sites and work activities can pollute receiving waterways and downstream environments. Whilst the release of contaminated surface water run-off from construction activities is considered possible, full implementation of the SEWQMP and identified mitigation measures would reduce the likelihood of waterway pollution to low and the consequence to minor, with localised, short-term impacts. The residual impact is therefore anticipated to be low and manageable with the mitigation proposed.

9.6.2.3 Changes to flood risk and flow regime

Project construction activities around waterways and on floodplains can increase flood risk across the Project Area and on neighbouring properties, such as the temporary placement of stockpiled materials near excavations for turbine foundations and trenches. The mechanisms for increased flood risk are varied and can include loss of flood storage and changes to flood flow characteristics brought about by changes to the surface of a floodplain or existing flow pathway.

The Project will implement a range of measures to ensure that spoil placed alongside excavations does not completely impede the flow of flood waters. Additionally, stockpiles will not be placed in flood prone areas and up-slope diversions will be used to convey flow around excavations (see mitigation measure MM-SW06).

Construction activities, including upgrades to or construction of new roads; site compounds and stockpiling can also change local drainage characteristics and flow pathways. These changes can impact existing uses such as agricultural water supplies or environmental flows to important areas of habitat.

To mitigate these impacts, all construction site infrastructure (e.g. compounds and laydown areas) and storage areas will be located outside of the floodplain or areas that are subject to inundation, where possible (see MM-SW06). Where this cannot be achieved, site activities and infrastructure will be set back from drainage pathways and the site layout optimised to reduce the amount of non-essential materials being stored on the floodplain (see mitigation measure MM-SW06).

While changes to the floodplain and flow regime from construction are considered possible, the residual impact would not be significant. Impacts would be localised and of a short term with the implementation of the above mitigation measures.

9.6.2.4 Spills

Spills of fuels and other liquid pollutants during the Project's construction phase have the potential to flow into local waterways and drainage lines. Fuels and other pollutants could contain harmful substances that reduce the water quality and impact aquatic fauna. Potential spills are most likely to be associated with vehicle refuelling and liquids used during the HDD drilling process.

Potential spills can be mitigated through industry standard practices such as minimal storage of chemicals at the work site and bunding of areas where storage is required. Chemicals will be stored away from waterways to ensure potential spills are localised and contained to the active work area. Spill kits will also be available at locations where machinery/plant are operating, at refuelling points, and at chemical storage locations (see mitigation measure MM-SW05). Refuelling of vehicles and machinery will not occur within 50 m of a watercourse and will only be undertaken in a designated refuelling area with appropriate measures to contain spills should they occur (see mitigation measure MM-SW05). The potential effects of spills that may occur during construction would be minor with the implementation of these mitigation measures, with the expectation that they would be managed locally without entering surface waterbodies.

9.6.2.5 Waterway crossings

Open-cut trenching

The waterway crossing methodology would involve standard open cut trenching; that is, in-stream excavation of a trench. For many waterways, open cut trenching is considered an appropriate crossing methodology due to a broad range of factors that can include ephemeral flow regime, small upstream catchments, poorly defined channels, lack of riparian vegetation or constructed channels.

Two unnamed waterways and two DEECA mapped wetlands would be intersected during construction of underground electrical cables and access tracks within the wind farm site (see **Table 9.2).** These have been identified as minor, ephemeral waterways and wetlands and as such, trenching has been identified as an appropriate crossing methodology. The works would be able to be done during dry periods and reinstatement would occur quickly, meaning residual effects of any significance are unlikely.

Table 9.2 Waterways and wetlands intersecting with the wind farm site

Name	Hierarchy (DEECA)	Ephemeral?	Natural / Constructed	Construction method
Unnamed Waterway	Minor	Yes	Constructed	Trench
Unnamed Tributary of Johnstone Creek	Minor	Yes	Constructed	Trench
DEECA wetland no. 20522	-	Yes	Natural	Trench / surface
DEECA wetland No. 20532	-	Yes	Natural	Trench / surface

The underground transmission line connecting the Project substation to the Heywood Terminal Station would intersect with several minor and major waterways, requiring careful consideration of crossing methodologies to ensure potential effects are managed appropriately (see **Table 9.3**). These waterway crossings are a combination of natural and constructed waterways (constructed waterways are predominantly culverts beneath Boiler Swamp Road).

Most of the minor waterways are ephemeral and trenching has been identified as the appropriate crossing construction methodology, subject to the implementation of appropriate mitigation measures including doing the works during dry or low-flow conditions, preparing any infrastructure such as cables ahead of time to ensure that cabling can be installed as soon as trenching is complete, and appropriately reinstating the trench including providing suitable compaction and revegetation (see MM-SW03 in **Table 9.9** for the full set of proposed mitigation measures for watercourse trenching). One crossing of an unnamed tributary of Surrey River that is classed as major and perennial would be trenched, as aerial imagery indicates this waterway is likely to be ephemeral at the crossing location meaning crossing and reinstatement works can be planned for dry weather and completed quickly.

Waterway crossings will also be constructed and managed in accordance with the relevant regulatory requirements and industry best practice guidelines. These include the *IECA Best Practice Erosion and Sediment Control Appendix P; Land Based Pipeline Construction Guidelines* and *EPA Publication 1896: Working within or adjacent to waterways*.

Mount Kincaid Creek flows into Cobboboonee Forest Park from farmland west of the Parks (east of the wind farm site). The underground transmission line would cross tributaries of Mount Kincaid Creek within the farmland. These waterways are currently proposed to be trenched as they are minor, ephemeral waterways with very small catchment areas, however investigations during detailed design will determine if HDD (see following section) may also be appropriate for these crossings.

Horizontal directional drilling

The most substantial waterway that the transmission line would cross is the Surrey River. The Surrey River is proposed to be crossed with HDD at three locations due to its large upstream catchment and wide crossing over the Surrey River floodplain (see **Table 9.3** and **Figure 9.7**). Wild Dog Creek would also be crossed using HDD due to potential constructability constraints. HDD avoids direct impacts on the waterway by drilling beneath the waterway, between an entry pit and an exit pit. The entry and exit pits would be installed within the Boiler Swamp Road roadway to avoid impacts on adjoining and riparian native vegetation, and at a setback distance that would ameliorate potential secondary effects on the waterway such as sedimentation (with the implementation of appropriate mitigation measures set out in mitigation measure MM-SW04 and implemented via the CEMP that would be prepared for the Project).

HDD can result in stormwater contamination and impacts on the receiving waterways. This can occur through the mobilisation of contaminants from drilling compounds (e.g. sediment from disturbed ground and excavations) or from drilling fluids returning to surface during the drilling operation, known as ‘frac-out’.

Frac-out generally happens when HDD pressure exceeds the overburden pressure, causing the drilling fluids to migrate through the overlying material and discharge to the surface. This can happen if the overlying material is shallow or made of loose material. In most instances of frac-out, drilling fluid can be recovered and managed to prevent it from entering the stormwater pathway. However, frac-out that occurs beneath a waterway channel may cause drilling fluids to discharge directly into water, causing downstream contamination.

Preventing frac-out can be achieved by undertaking site specific risk pressure calculations, adjustment of drilling profiles to suit existing conditions, appropriate drill configuration, and monitoring of drilling fluids during the HDD process. The HDD profile design and work method statement would be submitted to the GHCMA and approved prior to the commencement of works at the Surrey River crossings (see mitigation measure MM-SW04). With the implementation of mitigation measures, frac out from HDD is unlikely to occur, however impacts would be minor and localised if it did occur.

Table 9.3 Waterways intersecting the underground transmission line

Name	Hierarchy (DEECA)	Ephemeral?	Natural / Constructed	Construction method
Unnamed Tributary of Johnstone Creek	Minor	Yes	Natural	Trench
Unnamed Tributary of Mount Kincaid Creek	Minor	Yes	Natural	Trench
Unnamed Tributary of Mount Kincaid Creek	Minor		Natural	Trench
Unnamed Waterway	Minor	Yes	Natural	Trench
Unnamed Tributary of Mount Kincaid Creek	Minor	Yes	Natural	Trench
Surrey River	Major	No	Natural	HDD
Surrey River	Major	No	Natural	HDD
Unnamed Tributary of Surrey River	Minor	Yes	Natural	Trench
Wild Dog Creek	Minor	Yes	Natural	HDD
Surrey River	Major	No	Natural	HDD
Unnamed Tributary of Surrey River	Minor	Yes	Natural	Trench
Unnamed Tributary of Surrey River	Minor	Yes	Natural	Trench
Unnamed Tributary of Surrey River	Minor	Yes	Constructed	Trench
Unnamed Tributary of Surrey River	Minor	Yes	Constructed	Trench
Unnamed Tributary of Surrey River	Major	No	Constructed	Trench
Unnamed Tributary of Surrey River	Minor	Yes	Constructed	Trench
Unnamed Tributary of Surrey River	Minor	Yes	Constructed	Trench
Unnamed Tributary of Surrey River	Minor	Yes	Natural	Trench

9.6.3 Operation impacts

9.6.3.1 Changes to flood risk and flow regime

New above-ground infrastructure and buildings would be constructed including platforms and buildings for operation and maintenance, substations, met masts, and the formation of new road structures. This would increase the impervious area of the catchment which could change run-off characteristics and modify the existing flow regime within the catchment.

Increased run-off from the Project will be managed using standard design practices that include consideration of overland flow paths and discharge locations. Existing overland flow paths and potential localised flooding will be managed by ensuring appropriate siting and drainage provisions. Permanent surface structures will be designed to maintain existing overland flow paths and to not result in increased flood levels upstream of the sites (see mitigation measure MM-SW07). Flood and drainage infrastructure would be designed in a way to preserve the pre-development hydrology of the catchment.

Permanent infrastructure would also be designed and built above the predicted 1 % AEP flood level, with additional freeboard, as required by the Shire of Glenelg and the GHCMA. These predicted flood levels would include allowances for the impacts from climate change over the Project’s lifetime.

The pre-development landform would be restored and reinstated with groundcover vegetation following completion of the transmission line construction. The transmission line is therefore not expected to result in any permanent changes to the existing surface landform or create a permanent obstruction to overland flow or flow within waterways. Additionally, the Project would not permanently modify the existing cross section of waterways or alter existing levees or flood controls.

Overall, and with the implementation of mitigation measures, the likelihood and consequence of adverse impacts from flooding as a result of Project operation is considered to be low for the wind farm site and very low for the transmission line, and any impacts if they occurred would be minor.

9.6.3.2 Water quality impacts from stormwater run-off

The increase in impervious surfaces associated with permanent facilities and access roads has the potential to increase the volume of sediment and nutrients mobilised in stormwater run-off, which could flow into nearby waterways and impact on water quality. The potential impact is considered minor as the wind farm site and transmission line route will be designed to meet the pollutant reduction targets specified in the *Best Practice Environmental Management Guidelines* (CSIRO, 1999) and EPA Publication *1739.1: Urban Stormwater Management Guidance* and the Infrastructure Design Manual, as adopted by GSC.

Stormwater management measures will be designed to remove pollutants from stormwater, retain water on site and reduce the frequency of run-off discharging from the site during storm events (see mitigation measure MM-SW04). These measures will help ensure the Project achieves the water quality objectives as defined in the ERS (see **Section 9.5.4.1**). All stormwater management and treatment measures will be designed to allow for the projected impacts from climate change.

With the implementation of these stormwater management measures, the potential impacts from the Project on stormwater quality during operation are considered unlikely to occur and would have only minor, localised consequences if they did occur.

9.6.3.3 Spills

Spills of fuels and other hazardous substances during Project operation have the potential to contaminate local waterways if mobilised by stormwater. Spills would be most likely to occur during machinery refuelling or materials management. These types of spills are likely to be localised and managed within site boundaries.

Operational facilities will be designed in accordance with relevant Australian standards and regulatory requirements for the storage of chemicals and fuels to minimise the risk of this occurring, and any chemicals will be stored outside of overland flow paths (see mitigation measure MM-SW05).

Whilst a spill of fuel or chemicals is considered possible during operation of the Project, implementation of the above mitigation measures would reduce the consequence of waterway pollution to minor with localised, short-term impacts.

9.7 Groundwater

9.7.1 Existing conditions

9.7.1.1 Geological setting

The Project is situated within the Otway Basin, which consists mostly of Cretaceous and Cainozoic sedimentary and volcanic rocks (see **Figure 9.8**) and is around 3,000 m thick beneath the wind farm site. The geology of the wind farm and transmission line sub-areas is described below.

Geology of the wind farm sub-areas

The geology of the wind farm site comprises predominately aeolian, calcareous dunes and dune limestone (the Bridgewater formation) overlying upper mid-Tertiary limestone (Port Campbell Limestone). Some coastal dunes and minor swamp deposits are present directly to the south of the wind farm site. These form the beach and dune systems and the Long Swamp wetlands in the Ramsar site.

A generalised cross section showing the key landforms and geology of the wind farm site is provided in **Plate 9.6**.

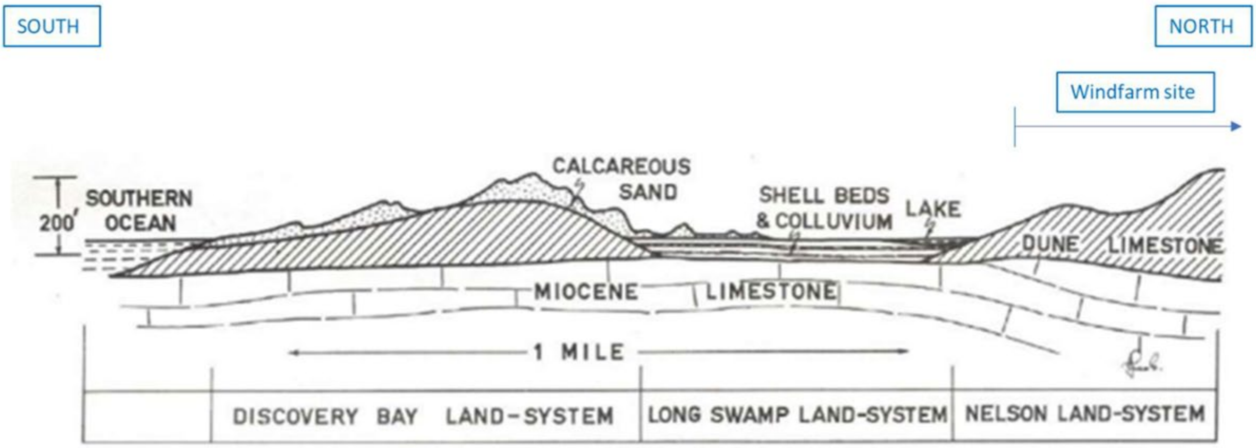


Plate 9.6: Generalised landform cross-section of the wind farm site (adapted from (AECOM, 2021a))

Geology of the transmission line sub-area

The underground section of the transmission line traverses the southern part of Cobboboonee National Park and Cobboboonee Forest Park (the Parks). Regional geological mapping indicates basalts of the Quaternary age Newer Volcanic to be at the surface along the underground transmission line route, with some minor swamp deposits along a small reach of the underground transmission line route east of Cobboboonee Forest Park (see **Figure 9.8**).

9.7.1.2 Key aquifers

An aquifer is an underground layer of rock that holds groundwater. It often consists of permeable or fractured rock, or unconsolidated sediments.

Key aquifers across the study area relevant to the Project are the Quaternary Aquifer (QA) and Upper Tertiary Basalt Aquifer (UTBA), which are part of the Upper Aquifer Group (SRW, 2011). These overlie the Upper-Mid Tertiary Aquifer (UMTA). A summary of the key aquifers of the study area is provided in **Table 9.4.**

The key aquifers relevant to the plantation sub-area are the QA and UMTA. The predominant QA unit is the Bridgewater formation which is present at the surface across the plantation sub-area. The unit varies in thickness from less than 5 m at the southern boundary to more than 30 m as the depth of QA cover increases to the north. Underlying the QA is the UMTA, which is thought to be near the surface at the southern boundary of the plantation sub-area, beneath a relatively thin sequence of QA.

The water table is hosted by the QA or the UMTA, depending on the top of the UMTA unit relative to the water table height. There is no significant aquitard between the QA and UMTA, so the QA and UMTA are considered to be in direct hydraulic connection and to essentially act as one hydrogeological unit.

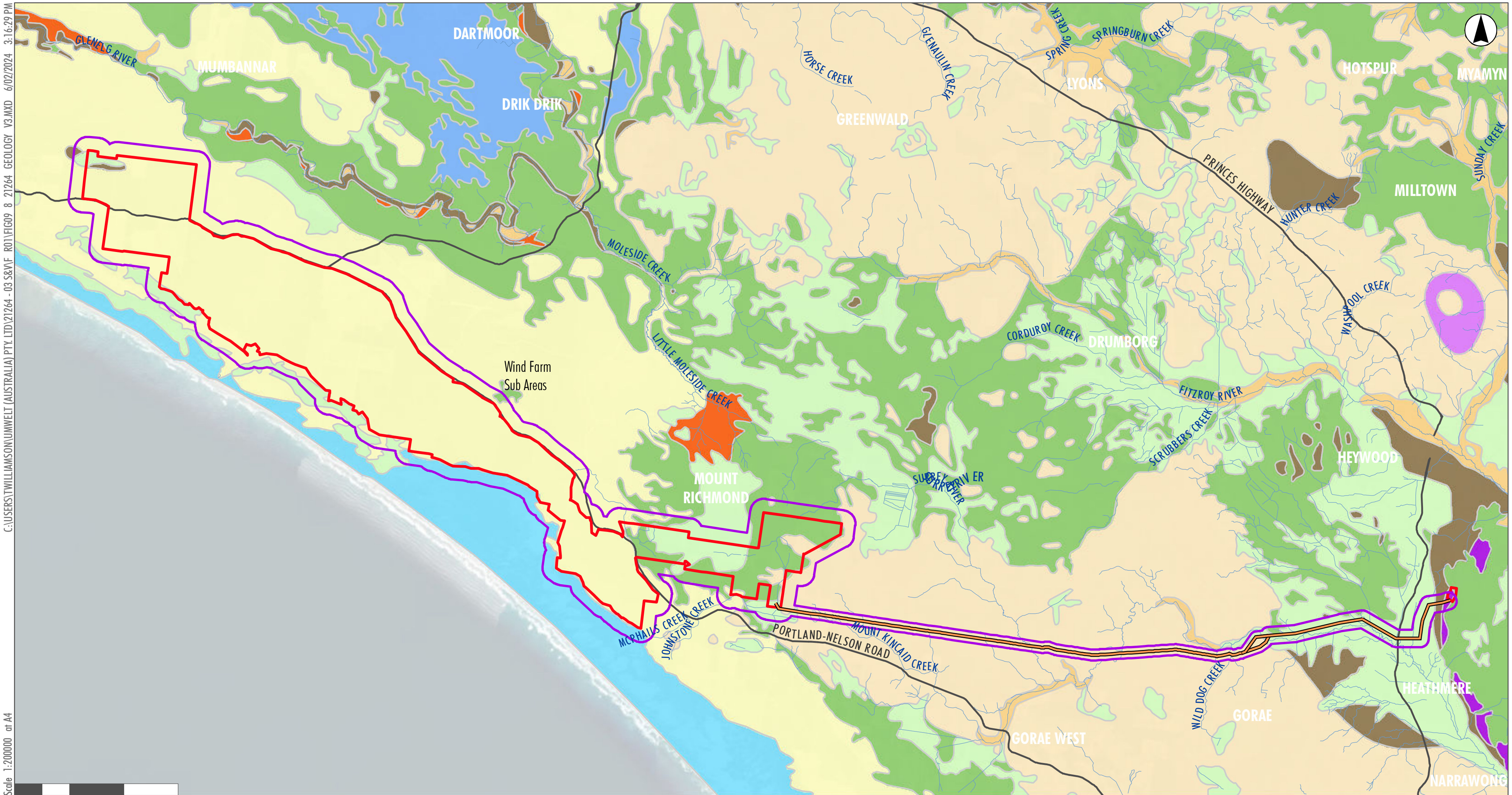
The key aquifer unit relevant to the north-eastern sub-area is the QA. Due to the variable thickness of the overlying QA, it is possible that the depth to the UTBA could be less than 6 m in places, particularly close to eruption points such as Piccaninny Hill (see **Figure 9.5).**

The key aquifer units relevant to the Heywood transmission line sub-area are the UTBA and QA.

Table 9.4: Aquifers of the study area

Study area zone	Aquifer	Hydrogeological groundwater unit	Depth (mbgs)*
Wind farm site	QA (Bridgewater formation)	Various aeolian deposits, fluvial, lacustrine, alluvial and colluvial sediments	0-30**
	UMTA	Port Campbell Limestone	30-250
Underground transmission line corridor	UTBA	Newer Volcanics	0-50
		Port Campbell limestones	5-200
	QA	Various aeolian deposits, fluvial, lacustrine, alluvial and colluvial sediments	0-5

* Approximate typical depths (metres below ground surface).
**The Bridgewater formation thickness reduces to around 10 m beneath the wind farm site at lower elevations (nearer the coast).



Legend

- Study Area
- Project Area
- Underground Transmission Line
- Roads
- Watercourses

Geology

- Ne: Holocene, Newer Volcanic Group
- Neo: Holocene, Newer Volcanic Group - basalt flows
- Nes: Holocene, Newer Volcanic Group - scoria deposits
- Nh: Miocene, Heytesbury Group
- Nxa: Pliocene, Whalers Bluff Formation
- Qa1: Holocene, alluvium
- Qdl1: Holocene, coastal dune deposits
- Qm1: Holocene, swamp and lake deposits
- Qxm: Holocene, Molineaux Sand
- Qxp: Pleistocene, Padthaway Formation
- Qxr: Pleistocene, Bridgewater Formation

FIGURE 9.8

Geology of the Study Area

Image Source: ESRI Basemap (2021) Data source: DELWP (2021); Biosis (2022)

9.7.1.3 Bore locations

As described in **Table 9.5** and shown in **Figure 9.1**, a total of 55 registered bores occur in the study area, 25 of which are located in the plantation sub-area, 14 in the north-eastern sub-area, and 16 within the transmission line sub-area. The bores have a range of purposes, including for consumptive use and monitoring, with the consumptive use bores accessing both shallow and deeper groundwater, between 4 and 122 mbgs. The deeper bores are located in the transmission line sub-area.

Table 9.5: Registered groundwater bores within the study area

Use	Plantation sub-area	North-eastern sub-area	Transmission line sub-area
Consumptive use	13 (depth range 4.5 – 54 mbgs)	8 (depth range 4 – 70 mbgs)	15 (depth range 6.1 – 122 mbgs)
Monitoring / observation	4	1	0
Unknown	8	5	1
Total	25	14	16

As outlined in **Section 9.3**, a fieldwork program was undertaken to understand groundwater characteristics within the study area. This involved testing of 12 existing groundwater bores and installation and testing of an additional 12 new groundwater bores. As shown in **Figure 9.1**, the existing bores are located throughout the wind farm site but are clustered along Portland-Nelson Road towards the western end of the plantation sub-area, and in the north-eastern sub-area. The new bores were installed along the southern boundary of the plantation sub-area to better understand groundwater characteristics close to the Ramsar site, and in the north-eastern sub-area where groundwater was likely to be near the surface (as informed through landowner consultation and indicated by the pooling of water on the surface, including in drier months).

9.7.1.4 Groundwater occurrence

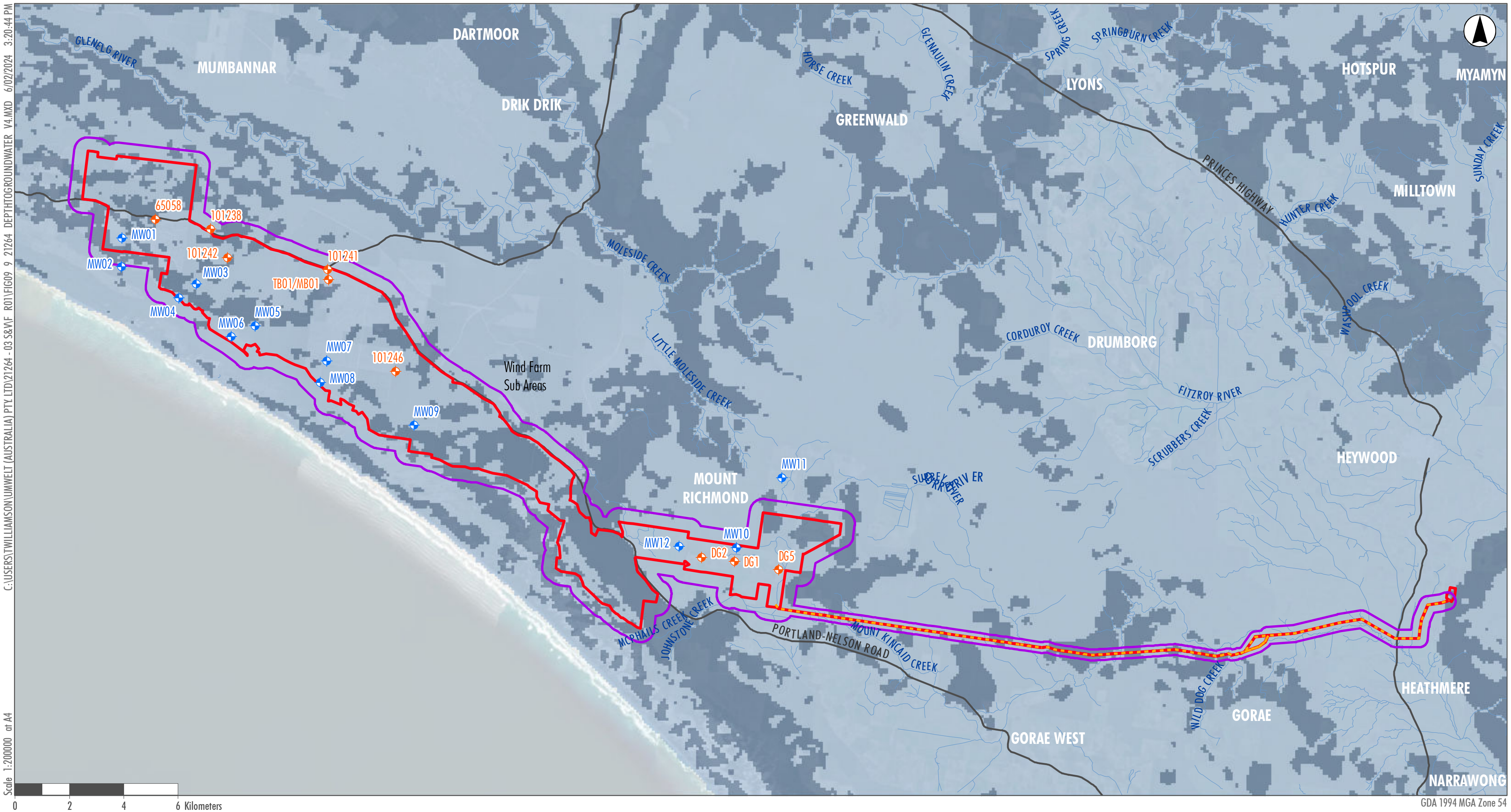
Broad-scale regional mapping indicates that groundwater level is more than 10 mbgs across much of the plantation sub-area but reduces to less than 10 mbgs in some areas, including immediately north of the Ramsar site (see **Figure 9.9**). The water table is less than 10 mbgs across much of the north-eastern sub-area, but is more than 10 mbgs in localised areas beneath higher topography such as Piccaninny Mountain. Groundwater levels are also less than 10 mbgs throughout most of the transmission line sub-area. The regional mapping was derived from publicly available sources including Visualising Victoria's Groundwater.

As discussed in **Section 9.7.1.3**, 12 monitoring bores were installed to gain a better understanding of groundwater occurrence across the wind farm site, with a focus on the lower lying areas near the southern boundary adjacent to the Ramsar site. The inferred depth to groundwater based on the data collected from these bores (see **Figure 9.10**) shows that there is considerable variation in groundwater levels across the plantation sub-area (from 1.8 to 40.9 mbgs), due to the flat water table and undulating ground surface which quickly increases in elevation to the north away from the southern site boundary. The depth to groundwater was shallowest adjacent to the Ramsar site, at less than 6 mbgs at some lower lying areas of the site.

Groundwater in the south eastern and north western of the plantation sub area were found to have depths to groundwater of more than 10m and further investigation in these areas for inferred groundwater levels was not considered warranted, as Project excavations are not required at these depths.

Depth to groundwater in the north-eastern sub-area was measured to be between 0.74 and 1.93 mbgs (see **Figure 9.11**). As per information from the landowner, groundwater levels are likely to be between 1 and 3 mbgs in summer and near surface in winter, depending on the local variation in ground surface elevations. Surface water elevation spot heights are at similar or slightly higher elevations than the measured groundwater elevations, indicating that the surface waterbodies are likely to be fed by groundwater. This is discussed further in **Section 9.7.1**.

The site-specific data are consistent with the water table being a subdued expression of topography, with the shape influenced by rainfall recharge, aquifer hydraulic characteristics (permeability and storage) and discharge mechanisms. The steeply increasing ground surface elevation away from the southern boundary of the wind farm site, compared to the relatively flat water table, leads to significant increases in depth to water immediately north of the southern site boundary. Overall, the site-specific groundwater data show limited potential for the 4 m deep turbine foundations to intersect groundwater across the wind farm. Water table data were not collected in the transmission line sub-area and are not available from DEECA's WMIS database for existing bores. Actual groundwater levels within the transmission line sub-area were therefore unable to be verified.



Legend

- Study Area
- Project Area
- Underground Transmission Line
- Roads
- Watercourses
- Existing Groundwater Bores used for Monitoring
- New Groundwater Bores used for Monitoring

Depth to Groundwater

- 0 - 9.99
- >10

FIGURE 9.9

Regional Depth to Groundwater Across the Study Area

Image Source: ESRI Basemap (2021) Data source: DELWP (2021); Biosis (2022)

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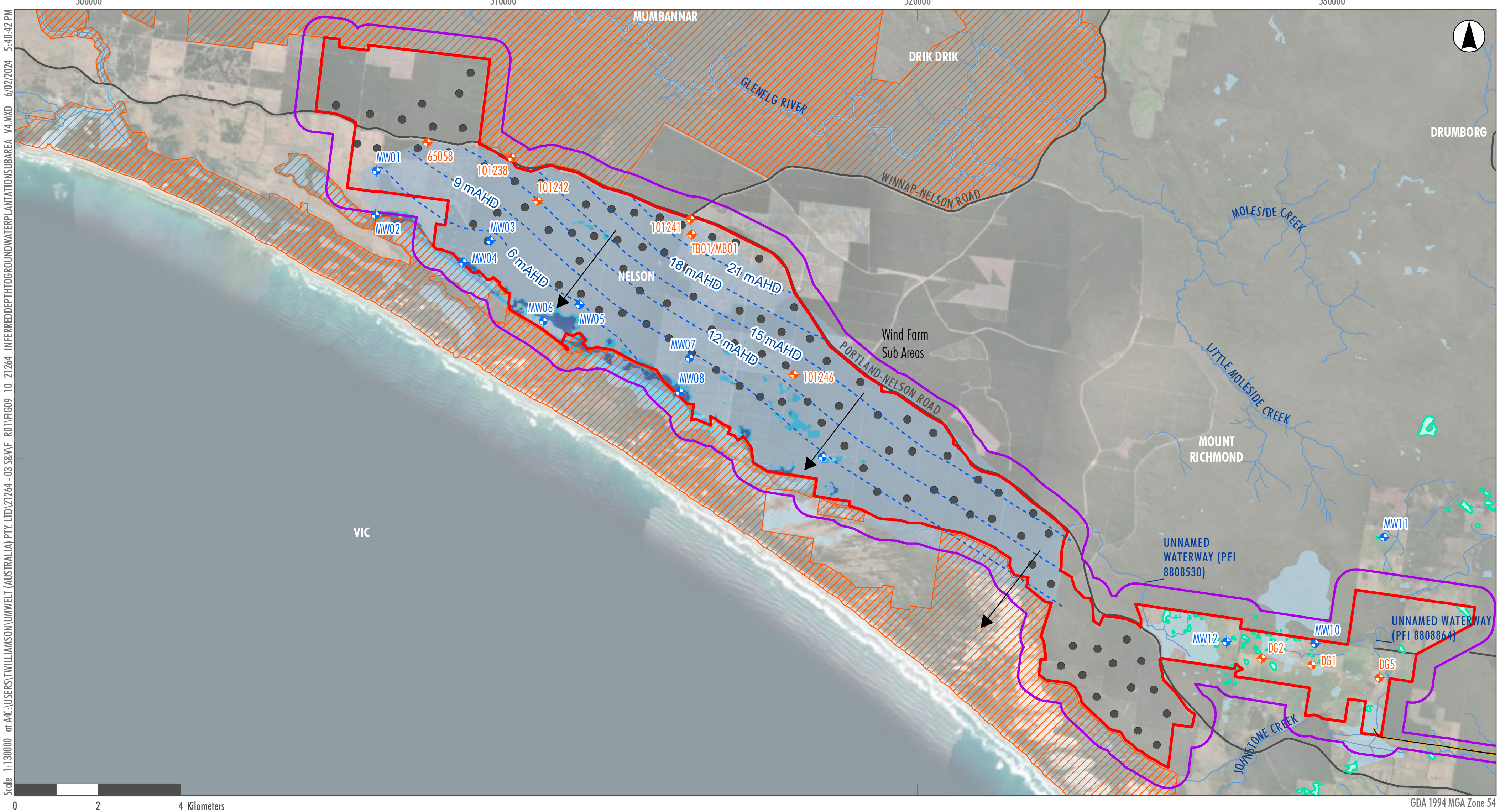


Legend

- Proposed Turbine Location
- Study Area
- Wind Farm Site
- Glenelg Estuary and Discovery Bay Ramsar Site
- Waterbody
- Biosis Mapped Wetlands
- Underground Transmission Line
- Roads
- Watercourses
- Inferred Groundwater Contours (mAHD)
- Inferred Groundwater Flow Direction
- Existing Groundwater Bores used for Monitoring
- New Groundwater Bores used for Monitoring

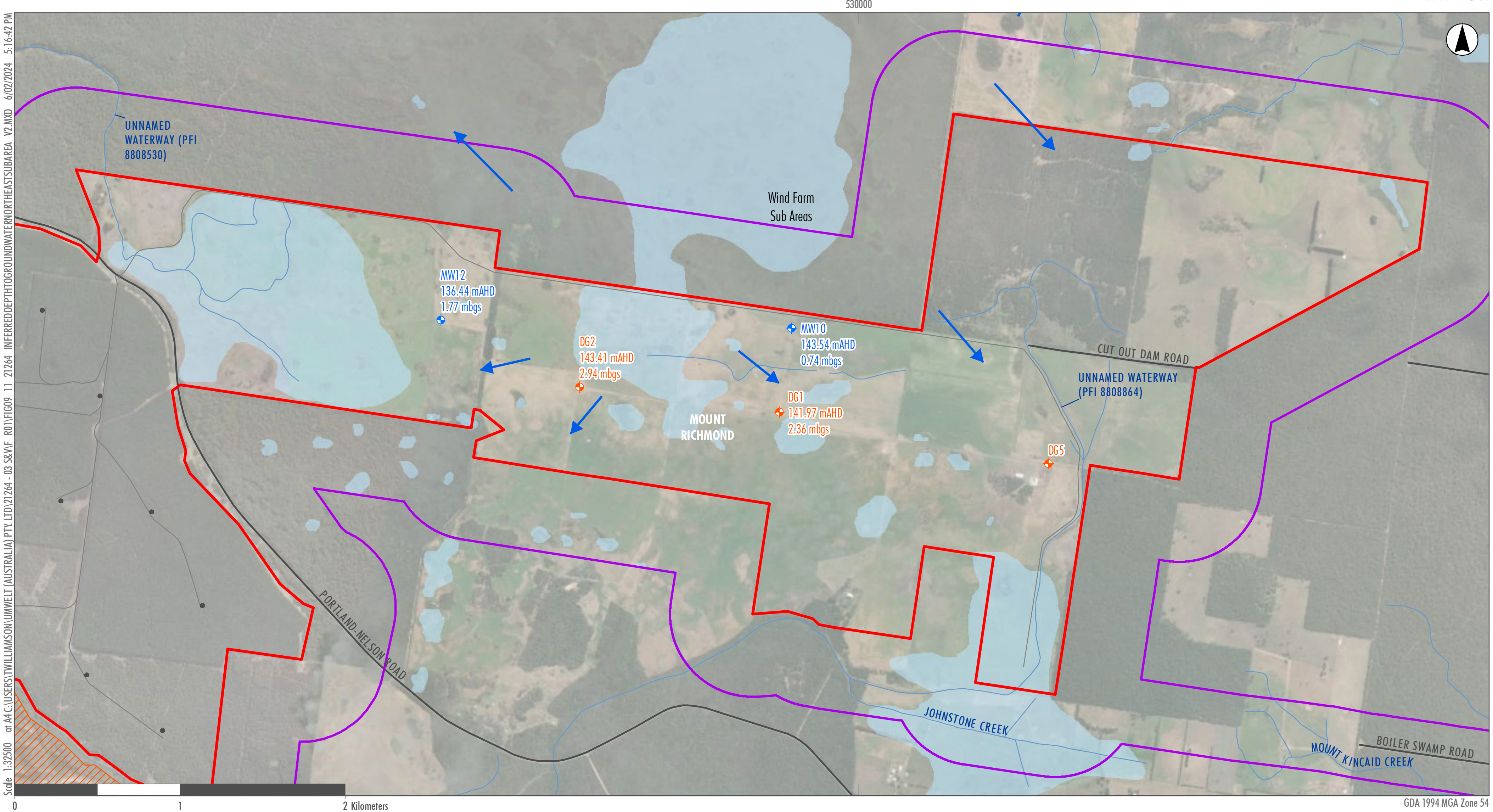
Inferred Depth to Groundwater

- < 4 mbgs
- 4 - 6 mbgs
- >6 mbgs

FIGURE 9.10

Inferred Depth to Groundwater in the Plantation Sub-area

Image Source: ESRI Basemap (2022) Data source: DELWP (2021)



Legend

- Study Area
- Wind Farm Site
- Proposed Wind Turbine Locations
- Glenelg Estuary and Discovery Bay Ramsar Site
- Waterbody
- Roads
- Watercourses
- Inferred Groundwater Flow Direction
- Existing Groundwater Bores used for Monitoring
- New Groundwater Bores used for Monitoring

FIGURE 9.11

Inferred Groundwater Flow Direction in the Northeast Sub-area

Image Source: ESRI Basemap (2022) Data source: DELWP (2021)

9.7.1.5 Groundwater flows and connectivity

Plantation sub-area

Soils in the plantation sub-area are typically free draining with no surface water features. Standing water is rarely seen and is temporary even following high intensity rainfall events (pers. comm. with landowner). Rainfall recharge is also affected by land use, with much of the wind farm site being forestry plantation that can intercept rainfall recharge and account for a large proportion of the water balance in some areas.

Groundwater data collected between April 2021 and June 2022 confirm that the hydraulic gradient is typically from north to south, towards the Ramsar site (see **Figure 9.10**). Shallow groundwater within the QA aquifer typically discharges across the southern wind farm site boundary to the swamps and wetlands in the Ramsar site. It is possible that localised and temporal reversal of shallow groundwater flow may occur at times (that is, from wetlands to the aquifer) in response to specific rainfall run-off events and/or tidal events. In addition, groundwater elevations close to the southern boundary are at, or higher, than surface water elevations at various swamps and wetlands. Shallow groundwater discharge to these waterbodies is therefore likely to be occurring.

North-eastern sub-area

Groundwater flow in the QA appears to be radial and away from the centre of the north-eastern sub-area towards the south-west and south-east based on the topography, groundwater elevations and surface water elevations (see **Figure 9.11**). There is also likely to be direct groundwater-surface water interaction, with waterbodies formed by shallow depressions intersecting the water table. It is anticipated that several dams within this sub-area 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.

Transmission line sub-area

The regional groundwater flow direction is unclear in the transmission line sub-area, but local scale shallow flow paths relevant to shallow trenching in this area may be influenced by discharge to gaining streams, GDEs and groundwater extraction where these are present.

Groundwater-surface water interaction would be limited to local interaction between shallow groundwater in watercourse sediments (e.g. associated with the Surrey River) and GDEs. Waterbodies mapped as potential aquatic GDEs in or close to the transmission line sub-area suggest the possibility of local surface water-groundwater interaction at these locations. This is discussed further in **Section 9.8.1**.

9.7.1.6 Groundwater management

The study area lies within several overlapping groundwater management precincts:

- South West Limestone Groundwater Management Area
- Glenelg Water Supply Protection Area
- South Australian-Victoria Border Groundwater Agreement.

Current water supply requirements for construction are estimated to be up to 250 megalitres (ML) over the construction period.

The extraction of groundwater for Project purposes would need to be made through temporary transfer of an existing licence allocation. All such applications will be in accordance with Section 40 of the *Water Act 1989* (Vic) and subject to the rules and limitations laid out in the relevant management plans. These may include restrictions on the siting of a new extraction bore (relative to existing users and GDEs) and the need to complete a detailed hydrogeological assessment. Appendix F of the **Groundwater Impact Assessment** (**Appendix G**) includes an initial groundwater supply assessment which would inform preparation of a take and use licence.

9.7.1.7 Groundwater quality

Data obtained from the 12 new groundwater monitoring wells indicate that pH in the area from MW01 to MW09 (plantation sub-area), is slightly acidic to neutral (pH 5.96-7.32), with no signs of impact associated with ASS. Groundwater pH from MW10 to MW12 (north-eastern sub-area) has a lower pH (pH 4-5) that may be representative of impacts associated with ASS. Groundwater from MW10 to MW12, has a low TDS compared to MW01 to MW09, which likely reflects the shallow depth to groundwater and rainwater infiltration source in the area.

Seven of the 12 new groundwater wells across the study area (MW02, MW04, MW06, MW08 and MW10-12) were gauged and analysed to determine the presence of contaminants within groundwater. No light non-aqueous phase liquid (LNAPL) was detected at any groundwater monitoring well, and no observations of detectable contamination such as odour or sheen were noted during any sampling. In general, metal concentrations were considered to be representative of natural occurrence, based on the absence of identified sources of contamination, absence of soil contamination and prevalence in regional geology.

Trace concentrations of organochlorine pesticides were detected in groundwater well MW04 (plantation sub-area, south-eastern end, adjacent to the Ramsar site boundary) but at levels orders of magnitude below drinking water criteria. Groundwater in pine plantations can become contaminated from organochlorine pesticides associated with the plantation uses. However, trace concentrations are considered unlikely to present a risk to human health or the environment, unless discharged directly to a waterway.

9.7.1.8 Groundwater and seawater interaction

In coastal areas, fresher (less saline) groundwater, sometimes known as the ‘freshwater lens’, sits on top of more saline groundwater. This saline groundwater beneath coastal areas is in connection with seawater and is sometimes called the ‘salt wedge’. 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.

The Ghyben-Herzberg relation states that for every metre of freshwater lens thickness above sea level, or approximately metres Australian Height Datum (mAHD), the freshwater lens extends 40 metres below sea level. This is due to the relative density of freshwater and seawater. The lowest recorded groundwater elevation was approximately 4.5 mAHD in MW06, located adjacent to Black Swamp (see **Figure 9.3**). This suggests a freshwater lens in the order of 180 metres below sea level (-180 mAHD) based on the simplified Ghyben-Herzberg approximation.

9.7.2 Construction impacts

9.7.2.1 Groundwater dewatering

Dewatering of turbine foundation or cable trench excavations would be required if groundwater is intersected during construction. Turbine foundations may require dewatering for up to one month while open during construction. Cable trench excavations would generally only be open for up to one day. When an excavation is dewatered a temporary, localised, ‘cone of depression’ (i.e. area of reduced groundwater levels) would be created radially away from the edge of the turbine foundation excavation. This has the potential to impact groundwater levels and groundwater flow to nearby receptors such as bores and GDEs, depending on the amount of groundwater ingress and associated dewatering, and the duration that the dewatering occurs.

Wind turbine foundations

The 4 m-deep turbine foundation excavations are not expected to intersect the water table where depths to groundwater are greater than 6 mbgs (2 m below the base of turbine foundations), which conservatively allows for seasonal variation against baseline conditions of April 2021 and any data inaccuracies. There are two areas of the wind farm site where the inferred depth to groundwater is less than 6 mbgs: along the southern boundary of the plantation sub-area, and in the north-east sub-area. Turbines have been sited to avoid areas where the inferred depth to groundwater is less than 6 mbgs. Potential for wind turbine foundations to require dewatering in these two areas is assessed in the following sections.

The number of concurrent wind turbine foundations in progress will be dependent on the final Project schedule but is anticipated to be up to 15 at any one time. The level of completion would range from just starting the excavation, to backfilling the earthworks after concrete curing. In this case, even if groundwater was encountered, dewatering would not be required at each foundation at the same time. If dewatering is required, it would occur at a limited number of locations at any given time.

Plantation sub-area

In the plantation sub-area, turbines have been sites to avoid areas where the inferred depth to groundwater is less than 6 mbgs (see **Figure 9.10**). Turbine micro-siting will avoid the areas where inferred groundwater depth is less than 6 mbgs (see mitigation measure MM-GW01).

To manage potential unforeseen issues relating to groundwater ingress during turbine foundation excavation, dewatering activities would be managed in accordance with a Dewatering Plan, which would be prepared as part of the CEMP (see mitigation measure MM-GW02). The measures would be developed specific to each turbine location where dewatering is required, and may include:

- Assessment of drawdown and dewatering volumes, based on site specific information including depth to water, hydraulic conductivity, base of foundation elevation relative to GDEs and/or consumptive use bore groundwater level, and distance to the GDE and/or consumptive use bore.
- Monitoring well installation and groundwater level monitoring to be based on drawdown estimates.
- Discharge of foundation dewatering to ground and down hydraulic gradient of the turbine to reduce drawdown and minimise loss of groundwater flow within the system (subject to groundwater quality and regulatory approvals) (see MM-GW05).
- Triggers and actions to be identified such as cessation of dewatering and/or make good arrangements.

Potential cumulative dewatering impacts associated with several turbine foundations being constructed at the same time are therefore also unlikely. The likelihood of substantial residual impacts on receiving environments is therefore low and the materiality of any residual impacts is likely to be negligible.

North-east sub-area

Earlier versions of the Project design had turbines in the north-east sub-area. Following investigations into several factors, all turbines from this sub-area have been removed (see **Chapter 8 *Brolga*** and **Chapter 4 *Project development***). There is no pathway where wind turbine foundations could intersect groundwater within this sub-area.

Underground cabling

Cables between turbines would be laid in trenches up to 1.2 m deep in 50 to 100 m sections. There is some potential for cable trenches to intersect groundwater in the north-east sub-area where groundwater is close to the surface in certain areas. If groundwater is intersected by the cable trenches during construction, groundwater would be removed prior to the cables being installed. The shallow trenching depth for the cabling limits the potential to penetrate a significant depth below the water table and any dewatering required would only be carried out for short periods of time (hours rather than days). Once the trenches are backfilled, there is no potential for dewatering to be required. Drawdown away from the trench section being dewatered would be negligible at distances beyond around 5 m and occur for less than a week. Impacts, if any, to nearby consumptive use bores would be negligible due to the shallow depth of trenching, limited extent and magnitude of drawdown away from trenches, and short duration of trench dewatering.

Transmission line

Trenching for the cables to be installed in for the underground transmission line would be to a depth of approximately 1.25 m. If groundwater is intersected by the trench it would be dewatered prior to the cables being installed. 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. Drawdown away from the trench section being dewatered would be negligible at distances beyond around 5 m and occur for less than a week.

Impacts, if any, to nearby consumptive use bores would be negligible due to the shallow depth of trenching, limited extent and magnitude of drawdown away from trenches, and short duration of trench dewatering.

9.7.2.2 Dewatering activities or groundwater supply extraction induces saline intrusion

In coastal areas, fresher (less saline) groundwater, sometimes known as the ‘freshwater lens’, sits on top of more saline groundwater. This saline groundwater beneath coastal areas is connected to seawater and is sometimes called the salt wedge. Pumping significant volumes of groundwater in coastal areas can cause reductions in groundwater levels in the freshwater lens, such that upward or lateral flow occurs from the salt wedge. This can increase salinity within the freshwater lens and may impact on groundwater bores and/or GDEs that utilise groundwater in the freshwater lens. The freshwater lens is estimated to be in the order of 180 m below sea level across the plantation sub-area.

In the unlikely event that groundwater is intersected within the plantation sub-area, lateral flow or upward leakage from the salt wedge is not expected to occur based on the distance of turbine locations from the coast (at least 2 km), thickness of freshwater lens (in the order of 180 m), depth of turbine foundations (4 m) and temporary nature of dewatering.

Groundwater extraction for construction supply would be from deeper portions of the UMTA and would occur around 5 to 6 km from the coast (nominally along the Portland-Nelson Road). Lateral flow or upward leakage from the salt wedge is unlikely to occur based on the depth of extraction, distance from the coast, the seawater and groundwater interaction model (see **Section 9.7.1.8**), and short-term, temporary extraction.

Saline intrusion due to dewatering activities or groundwater supply is therefore considered to be extremely unlikely and no mitigation measures are proposed. Any (unexpected) changes to groundwater quality due to saline intrusion would be localised, small in magnitude and temporary in nature, due to the hydrogeological setting, proposed locations and depths of excavations and production bores, and the limited duration of activities.

9.7.2.3 Groundwater supply extraction

A source of water would be required during Project construction for dust suppression, road-base construction, and to make concrete for turbine foundations and concrete slabs (e.g. at substations). Water supply requirements are estimated to be up to 250 ML over the Project's 24-month construction period, and would be met through the extraction of groundwater from several production wells across the plantation sub-area. Groundwater extraction has the potential to affect groundwater users by reducing groundwater levels at consumptive use bores and/or at GDEs.

A 24-hours pumping test was undertaken for a groundwater supply assessment as part of the **Groundwater Impact Assessment (Appendix G**). The test bore (TB01) and monitoring bore (MB01) used as part of the assessment intersected distinct fractures at depths <80 m, overlain by a low permeability limestone matrix. A subsequent 7-day pumping test was undertaken as part of the **GDE Impact Assessment** (**Appendix H**). The purpose of these tests was to assess the sustainable yield of TB01 and to estimate groundwater level drawdowns at various distances and pumping durations.

Aquifer testing showed that the limestone of the lower UMTA (targeted by TB01) behaves as a confined to semi-confined (leaky aquifer) system and is poorly connected to the overlying shallow groundwater systems (the upper UMTA and QA). Registered consumptive use bores within 5km of TB01 appear to target the upper groundwater system (QA and upper UMTA). The lower UMTA appears to be isolated from the shallow groundwater system used by these existing consumptive use bores. Therefore, groundwater extraction from the lower UMTA would not materially impact groundwater levels in existing groundwater bores.

Groundwater supply bore(s) for the Project would target lower portions of the UMTA to reduce the potential for interaction with the shallow groundwater system. Additional water supply investigations will be required in consultation with SRW prior to any groundwater take and use licence application (see mitigation measure MM-GW03). A groundwater level monitoring program would be implemented to identify and assess any potential effects on groundwater levels from groundwater supply extraction (see mitigation measure MM-GW06).

9.7.2.4 Quarry dewatering

The quarry would have a maximum extraction footprint of 9 ha and be up to 15 m deep, with actual dimensions to be determined following a comprehensive drilling, sampling and testing program during detailed design of the Project.

The existing GTFP quarry adjacent to the Project's quarry site has a depth of approximately 18 mbgs (the current base of the quarry is 35.97 mAHD) and has not had any groundwater ingress. This is consistent with the inferred groundwater elevation of approximately 18 mAHD which is 36 mbgs at the current quarry rim. Based on the conditions at the existing quarry, and the maximum depth of 15 mbgs at the Project quarry site, groundwater is not expected to be intersected by the Project's quarry and no dewatering impacts would occur. No mitigation measures have been proposed.

9.7.2.5 Existing bores become damaged, destroyed or inaccessible

Both registered and unregistered bores within, or near, the construction footprint of the wind farm and transmission line have the potential to be damaged, destroyed, or become inaccessible during construction. This has the potential to cause a temporary or permanent loss of access to groundwater for the affected bore owner/user.

There are 55 registered bores mapped within the groundwater study area (see **Figure 9.1**). However, many of these are located beyond the immediate footprint of turbines, access tracks and trenching locations where they could be directly impacted from construction activities.

Potential impacts on bores can be minimised and mitigated through detailed design stages, with the location of unregistered and registered bores to be visually confirmed on site relative to Project Infrastructure (such as turbines, access tracks and trenching). Prior to construction, the location of registered and unregistered bores will be visually confirmed and marked on construction plans. The potential for existing bores to be damaged or lost will be discussed with the landholder/bore owner, and compensation arrangements between Neoen Australia Pty Ltd (the Proponent) and the landholder/bore owner will be implemented if required (see mitigation measure MM-GW04). No residual impacts are anticipated to occur with the implementation of these mitigation measures.

9.7.2.7 Groundwater contamination

Existing groundwater contamination is not expected to be present within the majority of the study area. As discussed in **Section 9.7.2.6**, groundwater sampling undertaken for the Project identified that concentrations of metals were low and likely to represent naturally occurring background levels. Inappropriate management and disposal of contaminated groundwater extracted during Project construction has the potential to impact soil and/or surface water quality, and in turn groundwater quality, which could impact protected environmental values.

In the western end of the wind farm site (in the vicinity of TP05), there is potential for chemicals associated with the former sheep dip operation to be present in groundwater. If groundwater is extracted from this area during construction it will be tested prior to discharge to determine whether it must be remediated, sent offsite for disposal, or can be discharged to land (see mitigation measure MM-GW05).

Groundwater in the pine plantation may be contaminated by organochlorine pesticides associated with historical and current land uses, although it is noted that concentrations of pesticides were only observed above laboratory detection limits in groundwater from one of the four wells installed in pine plantation. Conservatively, all groundwater abstracted from properties associated with pine plantations will be managed to ensure that it is not discharged to a surface water body and is either discharged to land or taken offsite for disposal (see mitigation measure MM-GW05). The potential discharge of abstracted groundwater to land is not likely to result in an unacceptable ecological impact due to the low concentrations present in groundwater. Refer to **Section 9.7.1.4** for more information on groundwater occurrence and the likelihood of intersection in the plantation sub-area.

If there any are observations of odour, discolouration, sheen, or other signs of potential contamination in extracted groundwater, extraction will cease and only recommence following sampling and testing to confirm whether additional management measures and remediation are required (see mitigation measure MM-GW05).

9.7.1 Operation impacts

9.7.1.1 Turbine foundations impede groundwater affecting groundwater users

During operation of the Project there is potential for groundwater flow to be impeded by the turbine foundations, which could lead to changes in groundwater levels and flow direction. This could reduce groundwater availability at bores and GDEs that rely on that groundwater, or lead to salinity issues through raised groundwater levels up hydraulic gradient (‘up stream’) and evaporative effects.

It is unlikely that groundwater would be intersected by the 4 m-deep turbine foundations in the plantation sub-area, and therefore unlikely that groundwater flow would be impeded. In the unlikely event that this occurs it would be at a limited depth and be restricted to a small number of turbines. Impeded groundwater would readily flow around and beneath these foundations, and effects on groundwater levels would be negligible in magnitude and extent.

Overall, any impacts on groundwater users due to the presence of turbine foundations would be negligible.

9.7.1.2 Cable trenches impede groundwater affecting groundwater users

There is potential for shallow groundwater to be impeded by cable trenches once they have been backfilled with thermally stable backfill (if required) or the excavated spoil if thermally suitable, which is then compacted and followed by crushed rock to surface. Any impacts on shallow groundwater levels due to the trench acting as a barrier to groundwater flow are not expected to be material given the size and scale of the trench relative to the aquifer and regional context of groundwater flow. Potential impacts on cable trenches impeding groundwater and affecting groundwater users are therefore considered to be negligible.

9.8 Groundwater Dependent Ecosystems

9.8.1 Existing conditions

GDE environmental values have been identified within the study area, including stygofauna, terrestrial and aquatic GDEs. These environmental values and the likelihood of their occurrence within the study area are discussed in the following sections.

9.8.1.2 Terrestrial and aquatic GDEs

The GDE Atlas has identified potential terrestrial and aquatic GDEs that exist across the study area (BoM, 2021).

Aquatic GDEs are ecosystems that rely on the surface expression of groundwater. This includes surface water ecosystems which may have a groundwater component, such as rivers, wetlands, and springs. Terrestrial GDEs are ecosystems that rely on the subsurface presence of groundwater, which includes all vegetation ecosystems.

GDE 'potential' is generally rated on a scale of low, moderate, and high, and refers to the potential for that ecosystem to be interacting with groundwater. For example, a high potential GDE is considered to have a high potential to be interacting with groundwater.

Plantation sub-area

A total of 205 GDE features (> 0.1 ha in size) covering 2,293.4 ha are mapped within the plantation sub-area study area, dominated by terrestrial GDE types (see **Table 9.6**). Aquatic GDEs are mostly confined to the Long Swamp Complex and Beach/Dune system, however small portions are mapped within the plantations. These potential GDEs are shown in **Figure 9.12.** It should be noted that most of these GDEs do not occur within the wind farm site but are within the study area outside of wind farm site.

Table 9.6: Potential GDEs in the plantation sub-area

GDE type	Number of potential GDEs (Area of potential GDEs (ha))				
	High potential	Moderate potential	Low potential	Unclassified	Total
Aquatic	6 (798.1)	5 (76.2)	2 (7.3)	7 (28.0)	20 (909.6)
Terrestrial	88 (279.3)	3 (1.8)	94 (1,102.7)	0 (0)	185 (1,383.8)

The dependency (either permanent or intermittent) of terrestrial or aquatic systems on groundwater within the plantations and farmland is considered likely where groundwater is shallow. The dependency of terrestrial ecosystems on groundwater becomes less likely as the depth to groundwater increases. Groundwater depth in the north-western portion of the wind farm site (near the Lower Glenelg National Park) is between 18 – 21 mbgs. At this depth terrestrial vegetation is less likely to access groundwater on a permanent or intermittent basis.

Both aquatic and terrestrial GDEs are mapped within the Long Swamp Complex and Beach/Dune System. These terrestrial and aquatic GDEs support a diversity of species (including waterbird species) and associated habitats. The ecology of the Long Swamp Complex and Beach/Dune System is closely linked to the surface and groundwater flows through this area.

Vegetation mapping undertaken by Biosis (2021) also identified EVC 3 and EVC 858 within the plantation sub-area where it borders the Long Swamp Complex and Beach/Dune System. These vegetation communities are regarded as GDEs at this location as groundwater is close to the surface in this area, less than 4 m below surface, and groundwater is fed into the wetlands behind the dunes. The Long Swamp Complex and Beach/Dune System is known to regularly support several threatened flora and fauna species.

During the surveys undertaken by Biosis (2021) the karst springs and associated alkaline fens of the Naracoorte coastal plain bioregion TEC) was identified as occurring within the Ramsar site. This TEC is listed as endangered under the EPBC Act and has been identified as a type of permanent groundwater dependant wetland occurring on low lying areas in near-coastal zone between Millicent in South Australia and Portland in Victoria. 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.

This GDE was confirmed to be located at Lake Mombeong in the Ramsar site, which occurs more than 1,500m from the nearest wind farm infrastructure.

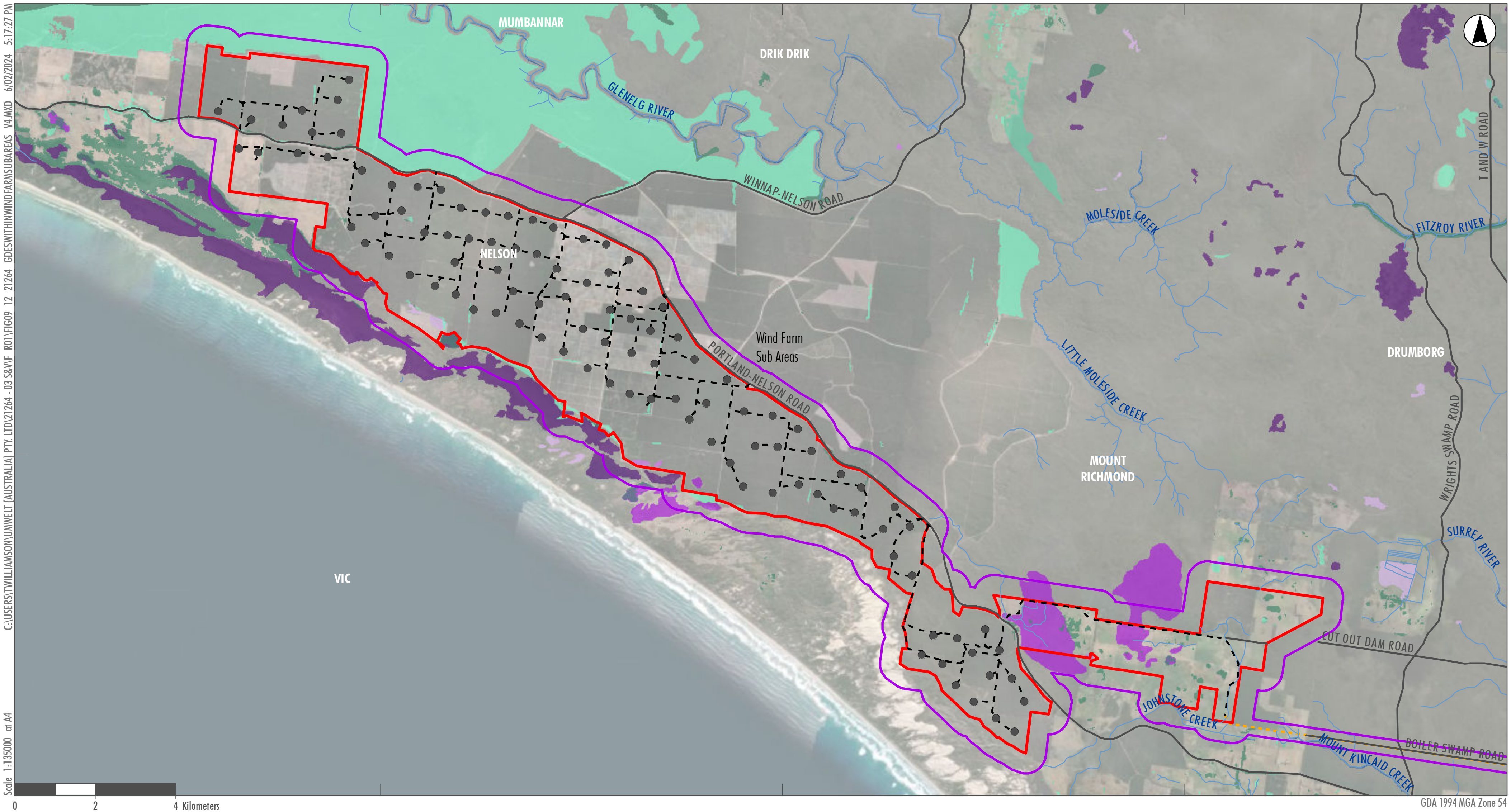
North-eastern sub-area

A total of 132 GDE features (> 0.1 ha in size) covering 553.5 ha are mapped within the north-eastern sub-area study area. These potential GDEs are shown in **Figure 9.12** and summarised in **Table 9.7**.

Table 9.7: Potential GDEs in the north-eastern sub-area

GDE type	Number of potential GDEs (Area of potential GDEs (ha))				
	High	Moderate	Low	Unclassified	Total
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 north-eastern sub-area are not directly associated with the Ramsar site but are associated with the Lower Glenelg National Park. Vegetation mapping undertaken by Biosis as part of the **Flora and Fauna Existing Conditions and Impact Assessment (Appendix C)** identified seven EVCs associated with GDEs in the north-eastern sub-area. Groundwater levels are close to the surface in this area, with waterbodies (mapped aquatic GDEs) anticipated to be reliant on groundwater, particularly during summer months. Given the shallow water table, terrestrial vegetation is likely to access groundwater on a permanent or intermittent basis in this sub-area. This is supported by terrestrial GDE mapping surrounding and in the immediate vicinity of mapped aquatic GDEs.



Legend

- Proposed Turbine Location
- Study Area
- Wind Farm Site
- Underground Transmission Line
- Internal Access Roads
- Roads
- Watercourses

Terrestrial GDE

- High potential GDE - from national assessment
- Low potential GDE - from national assessment
- Moderate potential GDE - from national assessment

Aquatic GDE

- High potential GDE - from national assessment
- Low potential GDE - from national assessment
- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies
- Unclassified potential GDE - from regional studies

FIGURE 9.12

GDEs Within the Wind Farm Sub-areas

Image Source: ESRI Basemap (2022) Data source: DELWP (2021)

Transmission line sub-area

A total of 231 GDE features (> 0.1 ha in size) covering 2,113 ha are mapped within the transmission line sub-area. These potential GDEs are shown in **Figure 9.13** and summarised in **Table 9.8**.

Table 9.8: Potential GDEs mapped in the transmission line corridor

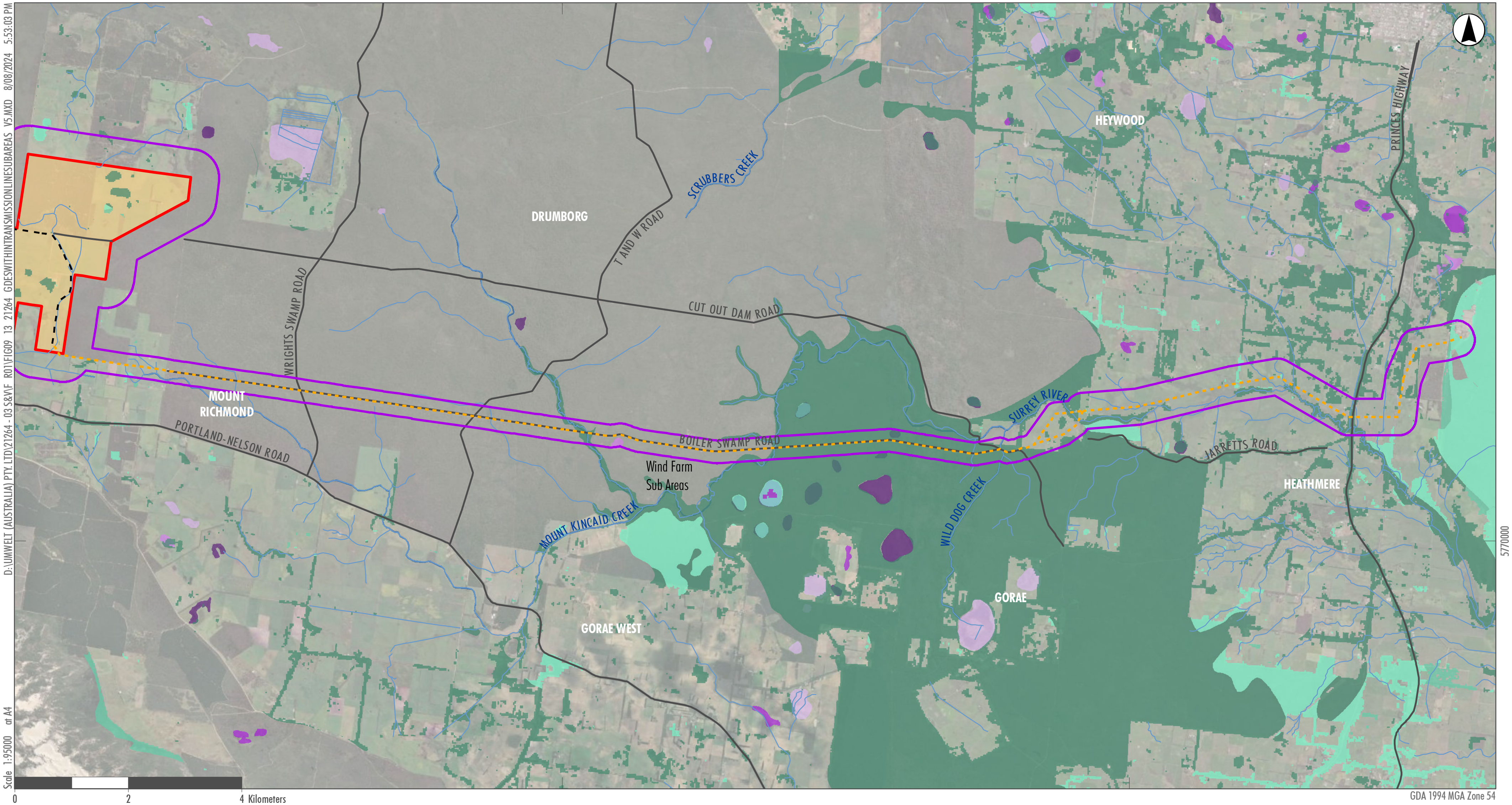
GDE type	Number of potential GDEs (Area of potential GDEs (ha))				
	High	Moderate	Low	Unclassified	Total
Aquatic	14 (87.5)	2 (14.7)	2 (11.8)	0 (0)	18 (114.0)
Terrestrial	171 (1,556.0)	38 (419.2)	4 (23.8)	0 (0)	213 (1,999.0)

Vegetation mapping undertaken by Biosis as part of the F**lora and Fauna Existing Conditions and Impact Assessment (Appendix C)** identified five EVCs associated with GDEs in the transmission line sub-area. High and moderate potential terrestrial and aquatic GDEs occur over relatively large areas in the transmission line sub-area. This mapping is supported by the relatively shallow predicted groundwater depth levels (less than 10 mbgs; see **Figure 9.9**). This suggests that ecosystems in these areas are likely to have some degree of reliance on groundwater, either on a permanent or intermittent basis.

9.8.1.3 Stygofauna

Stygofauna are animals that live permanently underground in water. In the Project region, stygofauna may live between grains of sand in the QA or in fractures and fissures in the UMTA. Sampling for stygofauna in the Project's wind farm site has previously been undertaken as part of the Victorian Gas Project ((Bold, Serov, Iverach, & Hocking, 2020), which sampled bores screened in unconfined aquifers across the Otway Basin (in which the Project is also located) to test for stygofauna presence. Two bores were located within the Project's wind farm site screened in the QA and UMTA. No stygofauna were identified in these bores during this sampling. The nearest bore with identified stygofauna is 20 km from the wind farm site and was screened in the QA.

Although no stygofauna have been identified in the study area, the geological setting of limestone and sand aquifers indicates that there may be suitable conditions for stygofauna and it is therefore assumed that stygofauna could be present in the study area.



Legend

- Study Area
- Wind Farm Site
- Windfarm Northeast Sub-area
- Internal Access Roads
- Underground Transmission Line
- Roads
- Watercourses

Terrestrial GDE
- High potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- Low potential GDE - from national assessment

Aquatic GDE
- High potential GDE - from national assessment
- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies
- Unclassified potential GDE - from regional studies

FIGURE 9.13

GDEs Within the Transmission Line Sub-areas

Image Source: ESRI Basemap (2022) Data source: DELWP (2021)

9.8.2 Construction impacts

Construction activities have potential to impact on GDEs by temporarily altering the hydrological settings. The GDE impact assessment therefore considered impacts on groundwater and surface water in the context of the ecological condition and function of GDEs.

The following construction activities have potential to impact on GDEs:

- Extraction of groundwater as a water source during construction.
- Trenching (and dewatering if required) and HDD for wind farm cabling and the transmission line.

These construction activities have potential to impact on groundwater in the following ways:

- Altered groundwater and surface water quality.
- Altered groundwater levels and groundwater flow.

Turbine dewatering was not considered to have a potential impact on GDEs as its unlikely for groundwater to be intersected during excavation of turbine foundations. See **Section 9.7.2.1.**

9.8.2.1 Groundwater supply extraction during construction

Extraction of groundwater for construction supply purposes during construction could result in less groundwater being available for aquatic GDEs.

As discussed in **Section 9.7.2.3**, aquifer testing showed that the lower UMTA (targeted by TB01) aquifer behaves as a confined to semi-confined (leaky aquifer) system and is poorly connected to the overlying watertable and shallow groundwater systems (the upper UMTA and QA).

Extraction of groundwater from the lower UMTA during construction is not predicted to result in a change in groundwater levels in the shallow aquifer (upper UMTA and QA). Therefore, the flow of groundwater to the aquatic GDE wetlands in the shallow UMTA and QA is predicted to be maintained throughout the pumping period.

However, as the lower UMTA is a semi-confined (leaky aquifer) system, there is potential for recharge into this aquifer (water recharges into the aquifer as groundwater is extracted) from the shallower overlying aquifers. A water balance assessment was undertaken by CDM Smith as part of the **GDE Impact Assessment** (**Appendix H**), which shows that leakage from the overlying shallow aquifer into the lower UMTA would have a negligible effect on the overlying aquifer groundwater balance and GDEs.

Groundwater extraction volumes from the lower UMTA are not large enough, or over a long enough timeframe, to cause a change in groundwater conditions in the watertable for aquatic GDEs.

The **GDE Impact Assessment** (**Appendix H**) did not identify potential for substantial effects on GDEs from extracting water during construction for groundwater supply purposes. A GDE monitoring and management plan will be implemented to ensure the hydraulic gradient to the Ramsar site is maintained throughout the groundwater extraction process during construction and for two years following construction works (see mitigation measure MM-GD01).

9.8.2.2 Transmission line trenchless creek crossings

The Surrey River is a high potential aquatic GDE (BoM, 2021), with vegetation observed to be typical of groundwater fed perennial systems (see **Plate 9.7**). It should be noted these observations by CDM Smith in October 2022 differ from the observations of Surrey River made in April 2023 as part of the **Surface Water Impact Assessment (Appendix F)**, that observed no flow in the Surrey River (see **Section 9.6.1.1**). As outlined in **Section 9.6.2.5**, HDD would occur at three transmission line crossings of the Surrey River to avoid interaction with the waterway or riparian zone.

The release of drilling fluids or sediment during construction of the Surrey River 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), with any sediment released to the river likely to be quickly diluted with very limited and short-lived impact on aquatic vegetation and ecosystems. See **Section 9.6.2.5** for further details on managing potential HDD impacts.

With the implementation of the suite of management measures developed to manage potential sedimentation and other secondary effects on waterways along the transmission line route, there is limited potential for material effects on GDEs to occur.

Plate 9.7: Ribbon grass in Surrey River indicative of perennial flow (CDM Smith, October 2022)

9.8.3 Operation impacts

No impacts on GDEs are expected to occur during operation of the Project.

9.9 Mitigation measures

Table 9.9 outlines the mitigation measures developed to avoid, minimise and manage impacts on surface water, groundwater and GDEs from construction, operation and decommissioning of the Project.

Table 9.9: Surface water, groundwater and GDE mitigation measures

MM ID	Mitigation measure	Relevant work area	Phase
Surface water			
MM-SW01	**Dewatering** • Water collected from excavated areas will be recycled and reused for construction activities such as dust suppression. • Dewatering activities will be managed in accordance with the Dewatering Plan in the Construction Environmental Management Plan (CEMP). The plan will 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 Environment Protection Authority (EPA) Victoria Publication: 1834: Civil Construction, Building and Demolition Guide (2020) will also be incorporated into the CEMP. • Water resulting from dewatering activities will be tested for potential contaminants. • Ponded stormwater and rainwater collected in excavations may be suitable for onsite treatment, reuse or discharge, subject to water quality testing results. • Water from excavated areas will not be discharged into or within 50 metres of a watercourse, drainage pathway or wetland without prior treatment. • Where deemed suitable, discharge of collected water to land will be to areas of low gradient to avoid soil erosion or sedimentation of land or water. Discharges to land will also avoid areas that are saturated or at risk of becoming inundated. • Sediment control devices will be used where required, to remove suspended soils and dissipate flow. These devices may include sediment fences or basins. • Groundwater that is contaminated by acid sulfate soils will be tested and discharged or disposed in accordance with protocols outlined in mitigation measure MM-CA03.	All areas	Construction
MM-SW02	**Surface water run-off** • A water quality monitoring and adaptive management program will be implemented to ensure the effectiveness of controls that are implemented to mitigate potential risks to surface waters, and detail additional and/or improved measures that would be implemented should those controls fail or are not effective to eliminate or minimise risks of harm to surface waters. • Monitoring of surface waters will be conducted upstream and downstream of works areas prior to construction, during construction and post-construction at the appropriate frequency (i.e., weekly during watercourse crossings works) to understand any changes to environmental values in line with EPA publication 1896: *Working within or adjacent to waterways.*	All areas	Construction

MM ID	Mitigation measure	Relevant work area	Phase

	• 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*, and EPA Publication 1895: *Managing stockpiles*.
	• A Project-wide Construction Environmental Management Plan 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.
	The SEWQMP will be developed in consultation with the Glenelg Hopkins Catchment Management Authority and Environment Protection Authority Victoria.		

MM-SW03	**Watercourse trenching** • 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 Glenelg Hopkins Catchment Management Authority. • 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.	All areas	Construction

MM ID	Mitigation measure	Relevant work area	Phase
	• Sediment control devices such as silt fences will be used to remove suspended solids and dissipate flow where required.		
MM-SW04	**HDD watercourse crossings** • The proposed HDD profile design and work method statement will be submitted to the Glenelg Hopkins Catchment Management Authority and approved prior to the commencement of works at the Surrey River crossings. • Risk of frac-out will be assessed in accordance with industry best practice guidelines to determine likelihood of occurrence (e.g. modelling). • Drilling profiles will be adjusted where the risk of frac-out is considered likely. • Drilling fluid properties will be monitored during horizontal directional drilling (HDD) operations to reduce the risk of frac-outs (e.g. mud weight, viscosity, pressure). • Drilling equipment and configuration will be appropriate for the proposed HDD operation to prevent frac-out. • Pollution prevention strategies will be in accordance with EPA Publications 1834 *Civil Construction, Building and Demolition Guide* and 1896 *Working within or adjacent to waterways*, and the IECA *Best Practice Erosion and Sediment Control Guidelines*. • Sediment control devices such as silt fences will be used to remove suspended solids from waterways and dissipate flow where required. • Earth bunds and/or drainage channels will be placed around the upper edges of drill sites and work areas to divert natural run-off around and away from the site and prevent mixing with drilling compound run-off. • Sump pits will be constructed at the bottom of the drill site. The sump pits will be positioned to capture run-off 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 will 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 will be bunded.	Transmission line	Construction
MM-SW05	**Fuel and chemical spills** • The storage of fuels and chemicals will comply with the requirements of the *Dangerous Goods (Storage and Handling) Regulations (2022), EPA Guideline 1698; Liquid Storage and Handling Guidelines and EPA Publication 1834; Civil Construction, Building and Demolition Guide.* • Fuels and chemicals stored on site will be minimised. • Fuels or other potentially contaminating material will not be stored in areas that are subject to inundation (e.g. floodplains), and at least 50 metres from sensitive receptors, such as waterways, wetlands and drainage pathways. • Fuel storage facilities will be bunded.	All areas	Construction and Operation

MM ID	Mitigation measure	Relevant work area	Phase
	• Spill kits will be available at locations where machinery/plant are operating and at refuelling points and fuel and chemical storage locations. • Spills of hazardous materials will be rendered safe and, where required, collected and transported by licenced contractors for disposal at appropriately licenced facilities, including cleaning materials, absorbents and contaminated soils. • Staff training will include spill management procedures. • Refuelling of vehicles, plant and equipment (excluding handheld machines) will be undertaken in a designated refuelling area with appropriate measures to contain spills. • Refuelling of vehicles, plant and equipment will not occur within 50 metres of a watercourse, drainage pathway or wetland. • Measures to manage fuel and chemical spills will be incorporated into the Hazardous Substance Management Plan, which will form part of the Construction Environmental Management Plan and Operation Environmental Management Plan.		
MM-SW06	**Changes to flow regime during construction** • A Project Construction Environmental Management Plan (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 flood risk management measures for each work area. • Construction compounds, drilling compounds, laydown areas and material storage areas will be located outside of floodplains and areas that are subject to inundation (outside the 1% AEP flood extent) , where it is practical given other Project commitments and constraints. Where this is not considered practical , site design optimisation will minimise the extent of works and storage in the floodplain / areas subject to inundation. • Excavation material, topsoil and trench spoil will not be stockpiled, stored or placed in areas that are flood prone or subject to inundation. • Site activities, facilities, infrastructure and materials will be set back from drainage pathways and waterways to the satisfaction of the Glenelg Hopkins Catchment Management Authority and, in the absence of regulatory requirements, in accordance with IECA Best Practice Erosion and Sediment Control guidelines.	All areas	Construction
MW-SW07	**Changes to flow regime during operation** • Proposed infrastructure will be designed to maintain existing levels of flood protection associated with overland flow paths (considering flood levels, flows and velocities) through compliance with Glenelg Hopkins Catchment Management Authority (GHCMA) requirements for flooding and overland flows. • Permanent surface structures will be designed to allow a set back from waterways and drainage pathways and to maintain existing flow regimes. • Modifications to existing flow pathways (e.g. drainage diversions) will be carried out to the satisfaction of the GHCMA and Glenelg Shire Council.	All areas	Pre-construction and Operation

MM ID	Mitigation measure	Relevant work area	Phase
MM-SW08	**Stormwater management at operational facilities and roads** • Stormwater produced at operation and maintenance facilities and on access tracks will be reused on site as much as possible. • A water collection and treatment system will be implemented to ensure that stormwater discharges comply with the Environment Reference Standard. • Stormwater treatments will be incorporated into the Project design for the operation and maintenance facilities and access tracks to capture surface run-off and reduce pollutants in accordance with the *Best Practice Environmental Management Guidelines* (CSIRO 1999). • Surface water discharges will be designed in consultation with Glenelg Hopkins Catchment Management Authority to ensure there is no adverse impact on the capacity, quality and integrity of the receiving waterway.	Wind farm site	Design Operation

MM-SW09	**Surface water monitoring and contingency plan**
	The Sediment, Erosion and Water Quality Management Plan will also outline the surface water monitoring and contingency measures for the construction phase, including a monitoring program (including, as a minimum, visual monitoring during construction activities and consideration of weather conditions) of sediment management measures, and a complaint investigation and response plan.
	This contingency plan will be aligned with industry best practice guidelines and will consider a broad range of measures that will be adopted during the event of an exceedance or failure of a mitigation measure. Aspects of the contingency plan would consider the following :
	• methods to prevent water entering excavations.
	• controls to be implemented when a storm event is forecast.
	• measures to ensure that waterways and floodplains retain sufficient flood detention capacity to moderate peak water flows.
	• a flood warning system.
	  ○ clean up procedures, including disposal of excess water.
	  ○ notification of relevant authorities if unplanned incidents occur that could pose a risk to the environment.
		All areas	Construction

Groundwater			
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.	Wind farm site	Design and Construction
MM-GW02	**Dewatering Plan** Dewatering activities will be managed in accordance with the Dewatering Plan in the Construction Environmental Management Plan. If groundwater is to be intersected at a turbine foundation location, the following hierarchy of contingency measures will be undertaken: • The turbine will be moved to higher ground to avoid groundwater intersection.	Wind farm site	Construction

MM ID	Mitigation measure	Relevant work area	Phase

	• A Dewatering Plan will be developed specific to each turbine location that could include but not be limited to:
	  ○ Assessment of drawdown and dewatering volumes, based on site specific information including depth to water, hydraulic conductivity, base of foundation elevation relative to Groundwater Dependent Ecosystems (GDEs) and/or consumptive use bore groundwater level, and distance to the GDE and/or consumptive use bore.
	  ○ Monitoring well installation and groundwater level monitoring to be based on drawdown estimates.
	  ○ Discharge of foundation dewatering to ground and down hydraulic gradient of the turbine to reduce drawdown and minimise loss of groundwater flow within the system (subject to groundwater quality and regulatory approvals) (see mitigation measure MM-GW05).
	  ○ Triggers and actions to be identified such as cessation of dewatering.		

MM-GW03	**Water supply investigations** 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).	Wind farm site	Construction
MM-GW04	**Registered bore locations** Visually confirm location of registered and unregistered bores. Prior to construction establish potential for damage or loss of access to existing bores in consultation with the landholder/bore owner. Agree to make good arrangements between the Proponent and the landholder/bore owner if required.	All areas	Construction and Operation
MM-GW05	**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 under the *Environment Protection Act 2017* (Vic),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 General Environmental Duty and regulatory approvals. Processes for groundwater management, including sampling and characterisation prior to disposal, will be set out in the Dewatering Plan (see mitigation measure MM-GW02).	Wind farm site	Construction and Decommissioning

MM ID	Mitigation measure	Relevant work area	Phase
	• 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 (see mitigation measure MM-CA03). • Specific measures to manage contaminated groundwater (if intersected) will be included in the Dewatering Plan in the Construction Environmental management Plan (see mitigation measure MM-GW02).		
MM-GW06	**Groundwater level monitoring plan** A groundwater level monitoring program will be developed and included in the CEMP to assess for effects on groundwater levels from foundation dewatering and groundwater supply extraction. This will be informed by baseline data results and include trigger levels and contingency measures. It would also be informed through consultation with Southern Rural Water (SRW) during groundwater take and use licence application and reflect conditions likely to be attached to any temporary licence agreed by SRW. A groundwater level monitoring program is to be developed generally in accordance with the indicative program provided the **Groundwater Impact Assessment (Appendix G)**. This will provide additional baseline (pre-construction) data and confirm 'natural' variations in groundwater levels. Baseline monitoring of groundwater levels will start 12 months prior to the commencement of water supply pumping and will include:: • Continuous groundwater level monitoring (e.g. hourly) via data loggers at monitoring wells MW01 to MW09 and MB01. • Monthly download of data logger and manual gauging at MB01. Quarterly downloading of data loggers and manual gauging of groundwater levels at all other monitoring wells. • Quarterly download of State Observation Bores 101246 & 65058 from WMIS website. • Quarterly collation of surface water/wetland data (available from Glenelg Hopkins Catchment Management Authority). • Monthly download of water extraction rates and volumes from production bore(s) and pump run hours. It is anticipated that monitoring during the Project's construction phase would be similar in scope to the baseline monitoring. Construction phase monitoring would be finalised based on consultation with SRW and other stakeholders during the groundwater take and use licence application process. Results of baseline and construction monitoring will inform the need for post-construction monitoring and the scope of any such monitoring, although no residual impacts were identified for the operational phase of the Project.	Wind farm site	Pre-Construction and Construction

MM ID	Mitigation measure	Relevant work area	Phase
	The groundwater level monitoring program will also consider any overlaps with surface water components. Liaison and sharing of groundwater level and surface water level between the Proponent and CMA will be undertaken.		
Groundwater Dependent Ecosystems (GDEs)			

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.
		Wind farm site	Construction

9.10 Conclusion

Construction and operation of the Project is considered unlikely to have significant adverse impacts on surface water, groundwater, and GDEs once the proposed mitigation and management measures have been implemented.

Surface water

Construction activities have the potential to impact local and downstream sensitive receiving waterbodies through the mobilisation of sediment and due to changes in water quality and stream hydrology/stability prior to the mitigation measures being applied. The Surrey River will be intersected three times by the transmission line and will be crossed using HDD. Rain events occurring during the construction phase have the potential to inundate open turbine foundations and cable trenches with stormwater, which may contain sediments and other pollutants, as well as result in increased surface water run-off over disturbed areas. Collected excavation water and stormwater run-off has potential to increase sediment loads and turbidity in nearby receiving waterways, including the Ramsar site. The implementation of industry standard mitigation measures such as treating collected trench water prior to discharging and installing sediment control devices will ensure potential residual impacts on surface water are managed during construction of the Project. It is unlikely operation of the Project would have surface water impacts on nearby sensitive receptors.

Groundwater

There is very limited potential for groundwater to be intersected by 4 m-deep turbine foundation excavations at the turbine locations, as groundwater is predicted to be more than 6 mbgs at all turbine locations. Groundwater is also not expected to be intersected by the shallow cable and transmission line trenches due to the deep groundwater levels. In the very unlikely event that groundwater is intersected by cable trenching, it would be localised and of limited depth, and dewatering durations would be hours rather than days. Any changes to groundwater levels and flow would be negligible in extent, magnitude, and duration.

Groundwater levels and flow are not expected to be impacted by the presence of turbine foundations or underground cabling during operation of the Project, with groundwater expected to readily flow around or beneath the turbines. Potential impacts associated with bores becoming damaged, destroyed or inaccessible during Project construction are unlikely to occur once the locations of all bores (registered and unregistered) have been confirmed and marked on construction plans.

Groundwater contamination is not expected to be present within the majority of the study area. Concentrations of metals were found to be low and likely represent naturally occurring background levels. However, inappropriate management and disposal of any contaminated groundwater during construction has the potential to impact soil and/or surface water quality, which could impact protected environmental values.

There is potential for treatment chemicals associated with the former sheep dip operation to be present in groundwater in the western end of the wind farm site. Groundwater in the pine plantation may be contaminated by organochlorine pesticides associated with historical land use, although it is noted that concentrations of pesticides were only observed above laboratory detection limits in groundwater from one of the four wells installed in the pine plantation. If groundwater is abstracted from these areas during construction, it will be tested prior to disposal, to determine whether it must be remediated, sent offsite for disposal, or can be discharged to land. No groundwater extracted from properties associated with pine plantations will be discharged to a surface water body.

GDEs

Extraction of groundwater for construction supply purposes could result in less groundwater being available for aquatic GDEs. However, groundwater extraction from the lower UMTA during construction is not predicted to result in a change in groundwater levels in the shallow aquifer (upper UMTA and QA). Therefore, the flow of groundwater to the aquatic GDE wetlands in the shallow UMTA and QA is predicted to be maintained throughout the pumping period.

Groundwater extraction volumes from the lower UMTA are not large enough, or over a long enough timeframe, to cause a change in groundwater conditions in the watertable for aquatic GDEs. However, a GDE monitoring and management plan will be implemented to ensure the hydraulic gradient to the Ramsar site is maintained throughout the groundwater extraction process during construction and for two years following construction works.

The release of drilling fluids or sediment during construction of the Surrey River HDD 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. Any release of drilling fluids during construction is likely to be of very short duration (days), with any sediment released likely to be quickly diluted with very limited and short-lived impact to aquatic vegetation and ecosystems.

Potential impacts on aquatic GDEs from groundwater/surface water contamination and surface water run-off are not anticipated to be significant with the implementation of standard sediment control and contamination management measures. It is therefore considered that the Project satisfies the relevant catchment values and hydrology objective specified in the Scoping Requirements, to avoid or minimise adverse effects on surface water, groundwater, GDEs and associated values.

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