EIS Volume 1 Chapter 10

Physical Environment

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10. Physical Environment

This chapter describes the existing physical environment of the Project and how construction and operation of the Project will affect soils, landform, surface water and groundwater.

10.1. Key Findings

- There is a low potential for soil erosion or sedimentation of surface waters which can be readily managed by infrastructure location and erosion and sedimentation controls.
- Soil compaction will be limited in extent and will be rehabilitated in areas of temporary disturbance following construction.
- Soil stockpiles will be appropriately managed to maintain soil viability and minimise loss of soil from wind and water erosion during construction.
- Acid sulfate soil is not expected to occur. If it is encountered, it will be appropriately managed and treated to prevent impacts to soil or water quality.
- Design and placement of infrastructure (including towers, access tracks and the Bundey substation) will avoid alteration of surface water flows.
- Groundwater abstraction (if required) will be assessed and managed so that it does not result in drawdown of aquifers and reduction in groundwater availability for flora, fauna and groundwater users.
- Wastewater disposal (e.g. temporary camp wastewater, washdown water) will be appropriately managed to avoid contamination of soil, surface water or groundwater.
- Groundwater will largely not be intersected by excavation and dewatering (if required) will be managed appropriately to ensure there are no impacts to soil and surface water quality.
- Existing contamination is not expected to be encountered or disturbed and procedures will be in place to prevent any additional contamination of soil, surface water or groundwater if it is encountered.
- Appropriate storage and handling of chemical and fuels will be undertaken and contamination of soil, surface water or groundwater is not expected occur as result of construction and operation.

10.2. Setting the Context

This section provides information to explain the context within which impact assessment is undertaken. It describes:

- the relevant EIS guidelines
- relevant requirements in legislation and other standards
- views of stakeholders and the environmental and social outcomes they would like the project to meet
- the assessment methodology used to identify baseline environmental values and to undertake the impact assessment.

10.2.1. EIS Guidelines

The EIS Guidelines require an assessment of the effect on the physical environment as set out in Table 10-1.

Table 10-1: EIS Guidelines addressed in the Physical Environment chapter

EIS Guidelines and Assessment Requirements	Assessment level
Effect on the Physical Environment *Assessment requirement 12:* The proposed development has the potential to disturb landforms and soils and to affect stormwater run-off	
• 12.1: Describe the nature and condition of the existing physical environment in the proposal's environs, including reference to geology, geomorphology, soils, hydrology and atmosphere	Medium
• 12.2: Identify any risks and implications of causing or exacerbating land degradation, especially soil erosion and the impacts of dust emissions during construction and ongoing maintenance	Medium
• 12.3: Identify the potential for pollution (including, but not limited to, sedimentation) of wetlands, watercourses, drainage channels and groundwater (especially at crossing points during construction), including the implications of this pollution	Medium
• 12.4: Describe potential changes to hydrology (e.g. drainage patterns or groundwater characteristics), including the implications of these changes	Medium
• 12.6: Outline mitigation measures and their likely effectiveness in minimising or avoiding disturbance to the physical environment (including surface and underground waters) during construction and maintenance	Medium
Construction, Operation and Maintenance Effects *Assessment Requirement 15*: The construction and operation of the proposal would require a range of impacts to be minimised, mitigated and monitored through an environmental management plan framework	
• 15.1: Describe construction techniques and the timing of construction, with reference to any climatic and temporal implications for the biophysical environment. This should include reference to potential land degradation, pollution and implications for the breeding seasons of native species	Standard
• 15.2: Outline the sources of waste and methods of disposing waste material, including reference to management of vegetation removed, indication of temporary and final locations for spoil and other waste and the possibilities for reuse or recycling of all waste streams. Provide details of a waste management plan.	Standard
• 15.4: Describe the location of surface water and groundwater infrastructure and the potential for groundwater interception when digging footings and how dewatering might be managed (if required)	Standard
• 15.6: Describe the impacts and proposed management of stormwater during construction and operation, including any opportunities for retention and reuse. Provide details of a soil erosion and drainage management plan	Standard
• 15.7: Identify the risks of contamination of surface and groundwater from spills of fuel (or other toxic substances). Describe measures for the prevention and containment of spills, describe the contingency plans to be implemented in the event of spills, and comment on their expected effectiveness	Standard
• 15.9: Outline the approximate size of the construction workforce including any need for any construction workers camps or accommodation. Describe the location and management of accommodation camps including sources of water and power, and the management of waste, wastewater and noise impacts.	Standard
• 15.11: Describe the location(s) where mobile concrete batching plants would be used and the management of wastewater, dust emissions and noise from such plant.	Standard
• 15.12: Describe the rehabilitation of the areas needed for construction including lay down, concrete batching and construction worker's accommodation areas.	Standard
Hazard Risk *Assessment Requirement 10:* The construction and operation of a high voltage powerline involves a range general and specific risks	
• 10.3: Describe any hazardous materials, with reference to storage, use, handling and disposal of these materials during construction and operation.	Medium
Specialist reports and details Details of any proposed wastewater management, including segregation, collection, treatment, storage, reuse and disposal of wastewater.	

Aspects of the assessment requirements identified in Table 10-1 which are not addressed in this chapter are listed in Table 10-2 together with the applicable chapter.

Table 10-2: Aspects of assessment requirements addressed in other chapters

Assessment requirement	Chapter
12.1 Nature and condition of the existing physical environment in reference to atmosphere	Chapter 14 Air Quality
12.2 Impacts of dust emissions during construction and ongoing maintenance	Chapter 14 Air Quality
12.2 Risks and implications of dust emissions on flora and fauna	Chapter 11 Flora and Fauna
15.1 Implications of construction for breeding seasons of native species	Chapter 11 Flora and Fauna
15.1 Describe construction techniques and the timing of construction	Chapter 7 Project Description
15.2 Management of removed vegetation , waste management	Chapter 7 Project Description
15.2 Outline the sources of waste and methods of disposing waste material	Chapter 19 Waste Management
15.9 Construction workforce size and location, and size of temporary construction camps	Chapter 7 Project Description
15.9 Noise impacts from construction camps	Chapter 15 Noise and Vibration
15.9 Size of the construction workforce and any need for any construction workers camps and accommodation	Chapter 17 Socio-Economic Environment
15.9 Waste from construction camps	Chapter 19 Waste Management
15.11 Location of concrete batching plants	Chapter 7 Project Description
15.11 Noise emissions from concrete batching plant	Chapter 15 Noise and Vibration
15.11 Dust emissions from concrete batching plant	Chapter 14 Air Quality
15.12 Rehabilitation of lay down, concrete batching and construction worker's accommodation areas	Chapter 7 Project Description
10.3 Storage, use, handling and disposal of hazardous materials during construction	Chapter 7 Project Description

10.2.2. Requirements in legislation and other standards

The *Landscape South Australia Act 2019* provides for the protection and management of the State's natural resources, including provisions relating to land management, water resource management and pest plant and animal control. Regional landscape plans and control policies are in force under the Act to guide management of water, soil and biological assets and define water affecting activities which require a permit. The western 20 km of the transmission line corridor is in the Northern and Yorke landscape management region, and the remainder is in the Murraylands and Riverland landscape management region.

The *Environment Protection Act 1993* creates a general environmental duty to take all reasonable and practical steps to prevent or minimise any resulting environmental harm. It outlines requirements and standards within Environment Protection Policies, including the *Environment Protection (Water Quality) Policy 2015* (Water Quality EPP), which provides the structure for regulation and management of surface water and groundwater quality and specifies relevant environmental values to be protected.

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC / ARMCANZ (2000) and revision (ANZG 2018)) are referenced by the Water Quality EPP and provide additional guidance on planning and managing water quality or sediment quality, including the derivation of guideline values.

The *National Environment Protection (Assessment of Site Contamination) Measure 1999* (as amended 2013) (NEPM), provides nationally consistent guidance on assessment and management of soil contamination

Other relevant legislation and guidelines that pertain to soil, landform and hydrology include:

- *River Murray Act 2003* and associated *River Murray Regulations 2017* establish broad management objectives and River Murray Protection Areas (RMPAs) which represent defined areas for regulating activities and policies.
- EPA SA guidelines including:
  - *Stormwater Pollution Prevention Code of Practice for the Building and Construction Industry (1999)*
  - *EPA 080/16 Bunding and spill management*
  - *EPA 517/16 Stormwater management for wash bays*
  - *EPA 1093/18 Environmental management of dewatering during construction activities*
  - *EPA 1095/19 Construction Environmental Management Plan (CEMP)*
- Australian Standard *AS 1940 The storage and handling of flammable combustible liquids*

10.2.3. Views of stakeholders

Consultation undertaken from December 2018 and ongoing through 2019 has highlighted the general position that the natural assets and ecosystem function of the area needs to be protected. There was a consistent view put forward by the majority of stakeholders that the proposed route should not traverse south of the Murray River for a variety of social, economic and environmental reasons (including number of landholders who would be impacted, number of productive agricultural and viticultural operations that would be impacted, potential impacts to tourism, proximity to the flood plains, and potential impacts to cultural heritage).

Details of community consultation are set out further in Chapter 6 Stakeholder Engagement.

10.2.4. Assessment method

The method of assessment has followed that set out in Chapter 8 Impact Assessment Methodology.

The description of the existing environment utilised publicly available information, supplemented by field observations and photographs undertaken by JBS&G and ElectraNet personnel between August 2018 and December 2020. Information sources are referenced in the text where relevant.

The assessment focussed on the 1 km wide transmission line corridor, with reference to the broader region where necessary. A 10 km wide corridor (5 km either side of the proposed alignment) has been used where appropriate (e.g. for mapping of features in and near the corridor and for assessment of aspects such as groundwater infrastructure).

Where there was uncertainty in the assessment of expected impacts, this was evaluated using risk assessment tools, as discussed in Chapter 8 Impact Assessment Methodology. This is discussed under each impact event where relevant. A summary of the evaluation of uncertainty for all impact events is contained in Appendix O.

10.3. Description of Existing Environment

10.3.1. Climate

The climate in the region traversed by the Project is broadly defined as temperate, characterised by warm to hot summers and mild, dry winters with cool to cold nights. Rainfall is variable throughout the region and rainfall frequency and intensity varies from year to year, with long periods of drought-like conditions evident in historical records. Rainfall exhibits seasonal variation with most rainfall occurring in winter and early spring. Average rainfall and the number of rainfall events in the region to the west of Morgan are typically higher than to the east.

Table 10-3 provides a summary of mean monthly temperatures and rainfall for five meteorological stations located in the region, from Eudunda near the western end of the transmission line to Renmark, near the eastern end.

Figure 10-1 shows the mean monthly rainfall data for these meteorological stations. The average annual number of rain days varies between 72 (Renmark) and 108 (Eudunda), although this can vary considerably from year-to-year.

Table 10-3: Summary of rainfall and temperature information

	Eudunda (#24511)	Robertstown* (#24528)	Gluepot (#20028)	Loxton (#24024)	Renmark Aero (#24048)
Annual mean min. – max. temperature (°C)	12.4 – 21.2	–	9.3 – 25.3	9.1 – 24.0	9.7 – 25.0
Highest mean monthly max. temperature (°C)	29.4	–	34.0	32.1	33.8
Lowest mean monthly min. temperature (°C)	5.1	–	3.6	3.9	3.8
Annual mean rainfall (mm)	446.0	338.0	263.9	256.0	232.9
Highest mean monthly rainfall (mm)	55.8	42.2	33.1	27.1	24.3
Lowest mean monthly rainfall (mm)	20.6	15.8	13.0	11.4	11.6

(Source: BoM 2020)
*Rainfall data only is available from Robertstown (Station 24528)

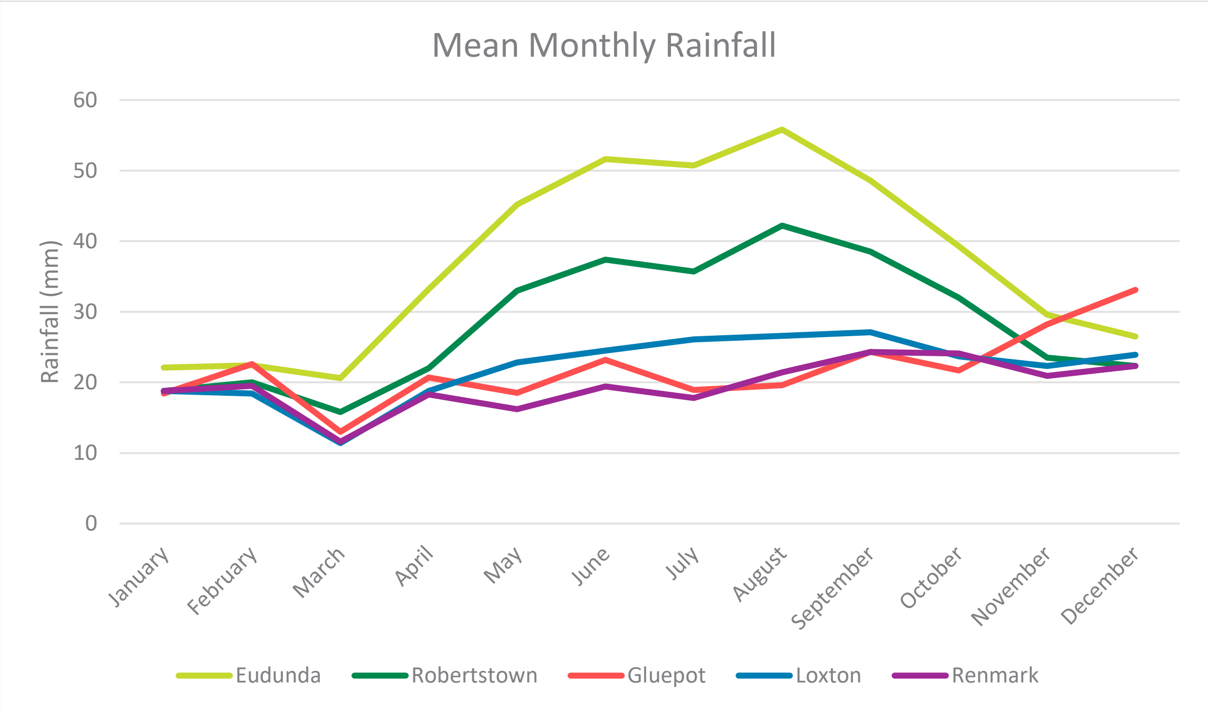


Figure 10-1: Mean monthly rainfall

The region is generally dominated by light to moderate southerly to westerly winds. Winds from the south and south east tend to dominate in summer and autumn, while in winter, westerly and northerly winds often prevail. The annual wind roses for the nearby meteorological stations are presented in Figure 10-2 and Figure 10-3.

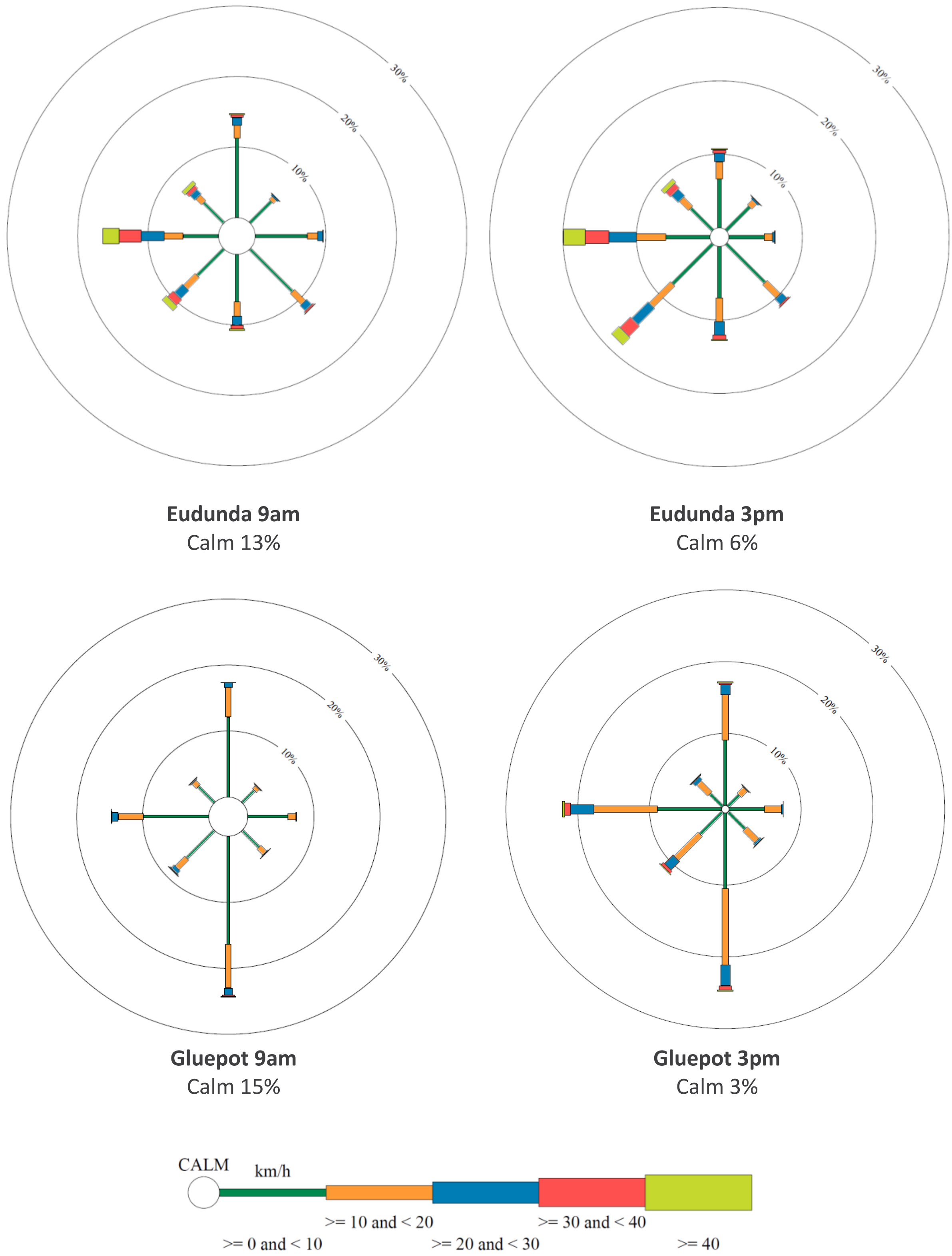
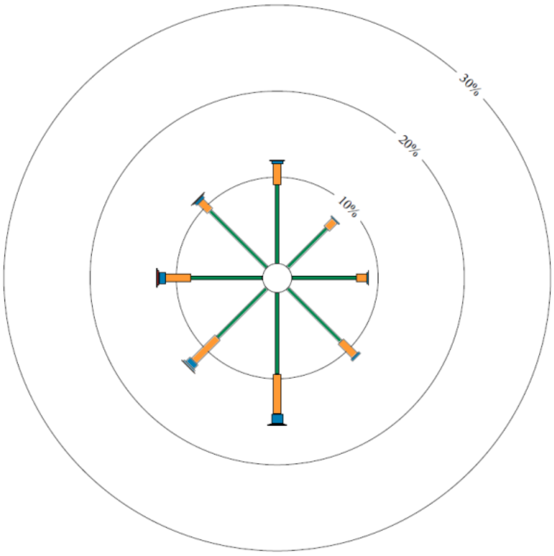
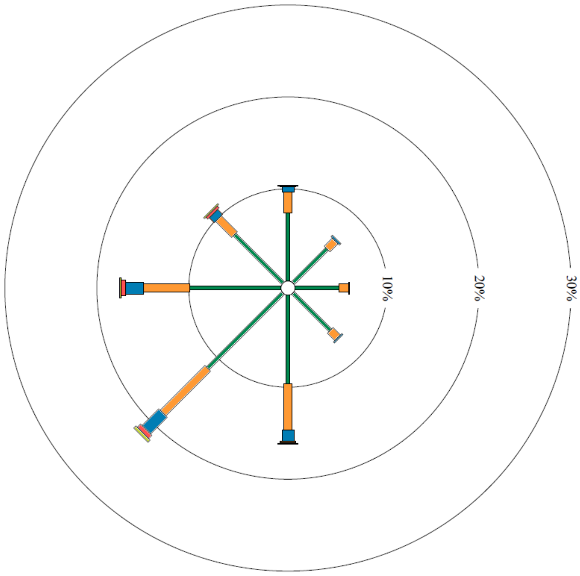


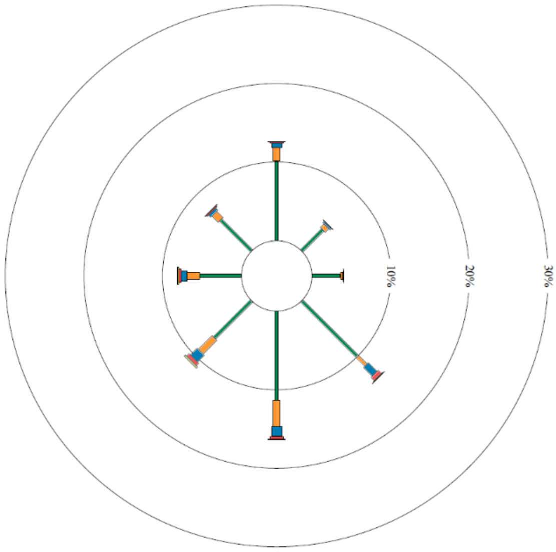
Figure 10-2: Wind roses for Eudunda and Gluepot meteorological stations

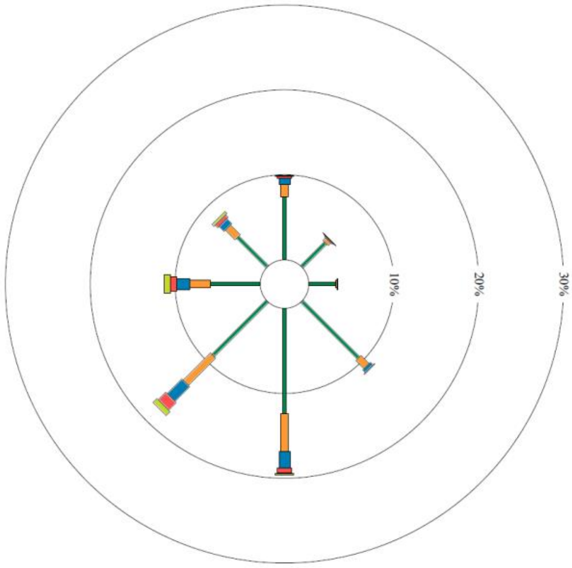




Loxton 9am
Calm 6%

Loxton 3pm
Calm 1%





Renmark 9am
Calm 4%

Renmark 3pm
Calm <0.5%

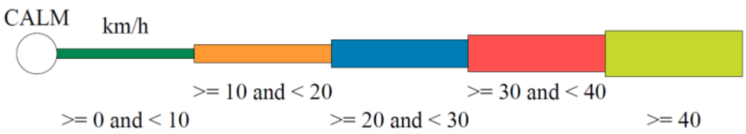


Figure 10-3: Wind roses Loxton and Renmark Aero meteorological stations

10.3.2. Soils and landform

Bioregions and landforms

Project EnergyConnect intersects three bioregions (as defined by the Interim Biogeographic Regionalisation for Australia (IBRA), which classifies Australia's landscapes into geographically distinct regions based on climate, geology, landform and vegetation): the Flinders Lofty Block, Riverina and Murray-Darling Depression bioregions.

Within these bioregions, the transmission line corridor crosses five IBRA subregions. The western extent of the corridor is located in the east of the Broughton subregion, then traversing eastwards, it crosses the Murray Mallee, Braemer and South Olary Plan subregions, then follows the edge of the Murray Scroll Belt subregion to the SA-NSW border.

The locations of IBRA regions and subregions in relation to the Project are shown in Figure 10-4 and descriptions of their landform, soils and vegetation are provided in Table 10-4. Further detail on the vegetation within each IBRA subregion is also provided in Chapter 11 Flora and Fauna.

Table 10-4: Landform, soils and vegetation in IBRA regions and subregions

IBRA Region	IBRA Subregion	Description
Flinders Lofty Block (FLB)	Broughton (FLB02)	**Landform:** Hills and valleys; alternating subparallel hilly ridges and valleys with a general N-S trend in north. In south, hilly dissected tableland. **Soils** are hard setting loams with red clayey subsoils, highly calcareous loamy earths, hard setting loams with mottled yellow clayey subsoil, coherent sandy soils, cracking clays. **Vegetation:** Native vegetation cover has been subject to widespread clearance for agriculture.
Murray-Darling Depression (MDD)	Murray Mallee (MDD02)	**Landform:** Very gently undulating, to flat aeolian sand covered depositional plain of the central-southern Murray Basin. **Soils** are brown calcareous earths, highly calcareous loamy earths, cracking clays, hard setting loamy soils with red clayey subsoils. **Vegetation** in the subregion consists of mallee heath and shrublands.
	Braemer (MDD07)	**Landform:** Plains with variable dune cover, from dune formations with relatively small plains between to plains with isolated tracts of dunes. Claypans, saline soils, swamps, and intermittent lakes in low-lying areas. **Soils** are brown calcareous earths, highly calcareous loamy earths, cracking clays, hard setting loamy soils with red clayey subsoils. **Vegetation** in the subregion consists of chenopod shrublands.
	South Olary Plain (MDD01)	**Landform:** Plains with variable dune cover, from dune formations with relatively small plains between to plains with isolated tracts of dunes. Claypans, saline soils, swamps, and intermittent lakes in low-lying areas. **Soils** are brown calcareous earths, highly calcareous loamy earths, cracking clays, hard setting loamy soils with red clayey subsoils. **Vegetation** in the subregion consists of mallee with and open shrubby understorey.
Riverina (RIV)	Murray Scroll Belt (RIV06)	**Landform:** An ancient riverine plain and alluvial fans composed of unconsolidated sediments with evidence of former stream channels. The Murray and Murrumbidgee Rivers and their major tributaries, the Lachlan and Goulburn Rivers flow westwards across this plain. **Soils** are cracking clays, brown sands. **Vegetation** in the subregion consist of eucalyptus woodlands with a shrubby understorey.

Plate 10-1 to Plate 10-5 provide examples of the landforms across the IBRA subregions. The plain and dune system of the South Olary Plain IBRA subregion is the dominant landform and comprises the majority of the central and eastern sections of the transmission line corridor.

The western extent of the transmission line corridor, on the eastern margin of the Mount Lofty Ranges, is dominated by a gentle easterly sloping landscape which mainly consists of outwash fans, with some defined creeks and other poorly defined drainage lines. Further to the east, the landform is characterised by an expansive, flat to gently undulating plain formed on Tertiary sediments of the central-southern Murray Basin and incised by the modern River Murray valley.

Gently undulating calcrete plains with stony rises and shallow depressions dominate the area to the west of Morgan while between Morgan and the State border, the calcrete plain tends to have a veneer of aeolian (wind-deposited) dunefields. Aeolian processes remain locally active within the region, and have been enhanced in some areas by land clearing since European settlement.

Elevation along the transmission line corridor varies from approximately 360 m in the western-most portion of the transmission line corridor to 20 – 80 m above sea level across the central and eastern portions of the proposed route. Elevation along the transmission line corridor is shown on Figure 10-5.

Plate 10-1: Undulating hills in the east of the Broughton subregion north of Robertstown substation looking north

Plate 10-2: Undulating plain in the Murray Mallee subregion

Plate 10-3: Plains in the Braemer subregion (Northwest Bend substation)

Plate 10-4: Plains and dunes in the South Olary Plan region

Plate 10-5: Riverine plain in the Murray Scroll Belt Subregion

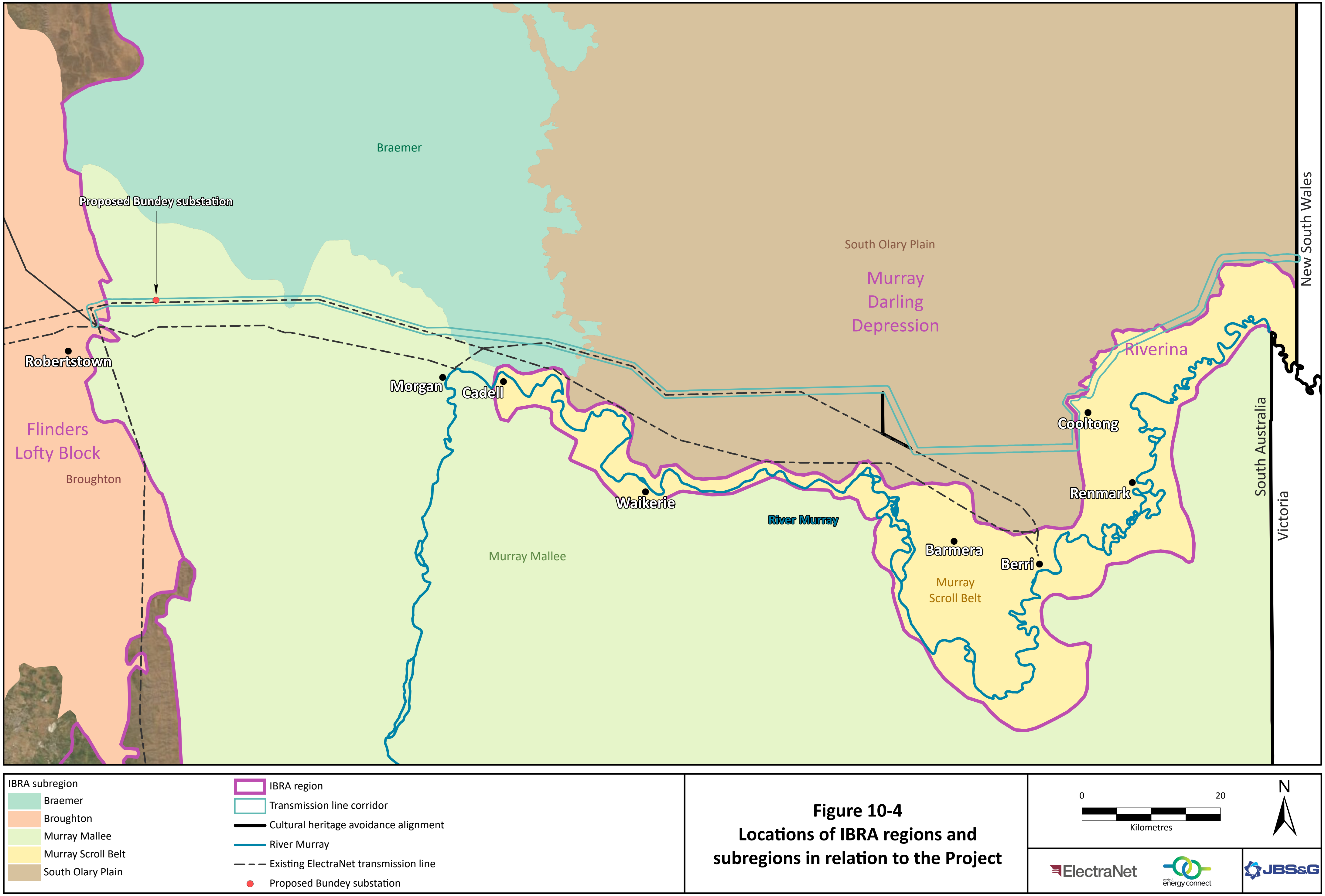
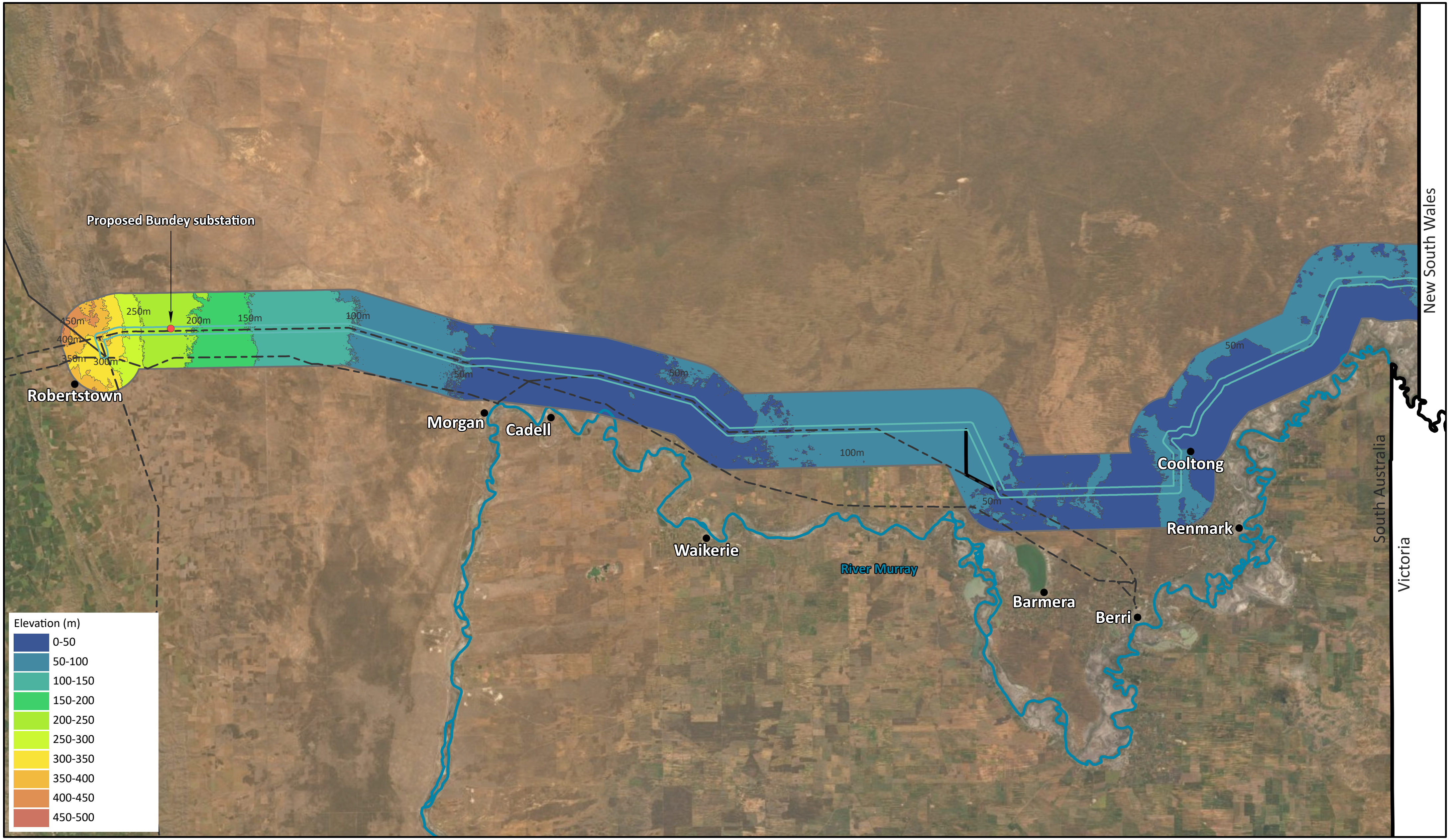


Figure 10-4
Locations of IBRA regions and subregions in relation to the Project



Transmission line corridor
Cultural heritage avoidance alignment
Contour
Existing ElectraNet transmission line
River Murray
Proposed Bundey substation

Figure 10-5
Elevation along the transmission line corridor

0 20
Kilometres
N

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Geology and soils

The Project is situated almost entirely within the Murray Basin portion of the Murray-Darling Basin, one of Australia's largest sedimentary basins. The Murray Basin covers an area of approximately 300,000 km^2. The basin is bordered to the east and south by the subdued mountain ranges of the Lachlan Fold Belt, to the west by the Kanmantoo and Adelaide Fold Belts, and to the northwest by the Broken Hill and Willyama Proterozoic basement blocks.

The Murray Basin is a widespread sequence of Cenozoic consolidated and unconsolidated sediments, the oldest of which were laid down between 60 and 30 million years ago in the Tertiary geologic period. The Cenozoic sequence is mostly underlain by the Cambrian Kanmantoo Group which form poorly defined infrabasins preserved in graben-like troughs and depressions (Brown & Stephenson 1991) which contain sedimentary rocks ranging in age from Silurian to Cretaceous. (Barnett 2015).

The Murray Basin sediments are overlain by a blanket of more recently deposited Quaternary sediments.

The western end of the transmission line corridor is on the eastern edge of the Adelaide Fold Belt, a belt of rock units which extends from south of Adelaide to the northern Flinders and Olary Ranges. These sediments were laid down over 500 million years ago and in this region are dominated by the Umberatana and Burra Groups, which consist mainly of siltstone, shale, slate, sandstone and quartzite.

The recent geological history has a strong influence over the surface geology and subsequent landscape characteristic of the region. Aeolian (wind deposited) and colluvial (deposited by debris flows, landslides and water) have dominated the region for the past 500,000 years or so (EDSCB 2002).

The surface geology of the transmission line corridor east of Cadell is dominated by the Woorinen Formation, which comprises red-brown silty siliceous sand, calcareous clay and sandy clays. West of Cadell, shallow calcareous loam over calcrete dominates, with interspersed areas of Quaternary alluvium and Blanchetown Clay. Calcareous loam over the older rocks of the Yudnamutana Subgroup and Burra Group are present on the slopes of the Mount Lofty Ranges at the western extent of the transmission line corridor.

Surface geology is shown in Figure 10-6 (based on Geoscience Australia 2012) and the main units present on or near the transmission line corridor (ordered from west to east) are described in Table 10-5.

Table 10-5: Surface geology

Name	Map unit	Description[1]
Yudnamutana Subgroup	Nsuu	Diamictite, siltstone, pebbly dolomite and orthoquartzite. Glaciomarine. Soils in the transmission line corridor predominantly calcareous loam on rock.
Burra Group	Nsbr	Siltstone, laminated; shale; sandstone, heavy mineral lamination, quartzose to feldspathic, cross bedding; dolomite, blue-grey to pale pink, lenticular. Soils in the transmission line corridor predominantly calcareous loam on rock.
Colluvium	Qrc	Colluvium and / or residual deposits, sheetwash, talus, scree; boulder, gravel, sand. May include minor alluvial or sand plain deposits, local calcrete and reworked laterite. Predominantly sandy loam at the surface in the transmission line corridor.
Alluvium	Qa	Channel and flood plain alluvium; gravel, sand, silt, clay. May be locally calcreted. Occurs predominantly in association with Burra Creek near Morgan and in the east of the Project region, where the coarse-grained fluvial and finer grained flood plain sediments of the Coonambidgal Formation comprise much of the present-day River Murray floodplain, along with more recent sediments associated with modern activity of the river.

Name	Map unit	Description[1]
Calcrete	Czk	Shallow calcareous loam on calcrete. Strongly cemented pale grey massive sheet calcrete, calcrete rubble, friable white and cream nodular calcrete; includes intraclasts of various lithologies set in calcrete matrix. Locally forms massive resistant sheets; elsewhere, calcrete rubble underlies much of the aeolian landscape in the west, and calcrete glaebules and rhizoliths occur in many soil profiles throughout the basin.
Pooraka Formation	Qrcp	Unconsolidated red-brown poorly-sorted clayey sand, gravel, conglomerate, breccia. Occurs as colluvial sheet wash, alluvial fan and residual lag. Forms extensive, coalesced, low-angle fans, high-angle talus cones and scree slopes.
Blanchetown Clay	Qtb	Consolidated to friable well laminated greenish-grey and red-brown clay; locally silty, sandy and calcareous and gypsiferous, minor quartz sand. Mainly concealed but is locally exposed in artificial excavations, river cliffs, gullies and lake margins.
Bungunnia Limestone	Qtbu	Well-cemented, flaggy, dolomitic limestone, thin-bedded, micritic. Lacustrine. Locally interfingers with underlying Blanchetown Clay. Locally developed calcrete cap, particularly north of North West Bend. Calcareous loams.
Woorinen Formation	Qdwr	Unconsolidated red-brown medium to fine silty sand, red calcareous silty clay, sandy clay, clay pellet aggregates. Forms extensive dune fields with subdued crests separated by swales and sand plains. The sands range in depths of between 1 – 3 m thickness in swales and up to 10 m at dune crests. In places, typically within gullies or in depressions, wind erosion has exposed the underlaying Blanchetown Clay.
Lake Deposits	Qt	Lake and swamp deposits; mud, silt, evaporites, limestone; minor sand, peat. Includes wetland lakes on the River Murray floodplain and salt lakes north of the floodplain where gypsiferous sediments of the Yamba Formation occur.
Lunette Dunes	Qdlu	Quartz and gypsum dunes and mounds (kopi); may include minor silt, sand, gravel, and clay flats adjacent to salt lakes; locally includes some playa sediments.
Parilla Sand	Czswp	Sand, fine to medium-grained, unfossiliferous, non-marine, clayey, quartz rich; sandy clay. Aeolian, lacustrine and fluvial deposits.

[1] Derived from Geoscience Australia (2012), DEM (2020), Brown and Stephenson (1991), SKM (2002), Barnett (2015), Geoscience Australia(2020), DEW (2009f).

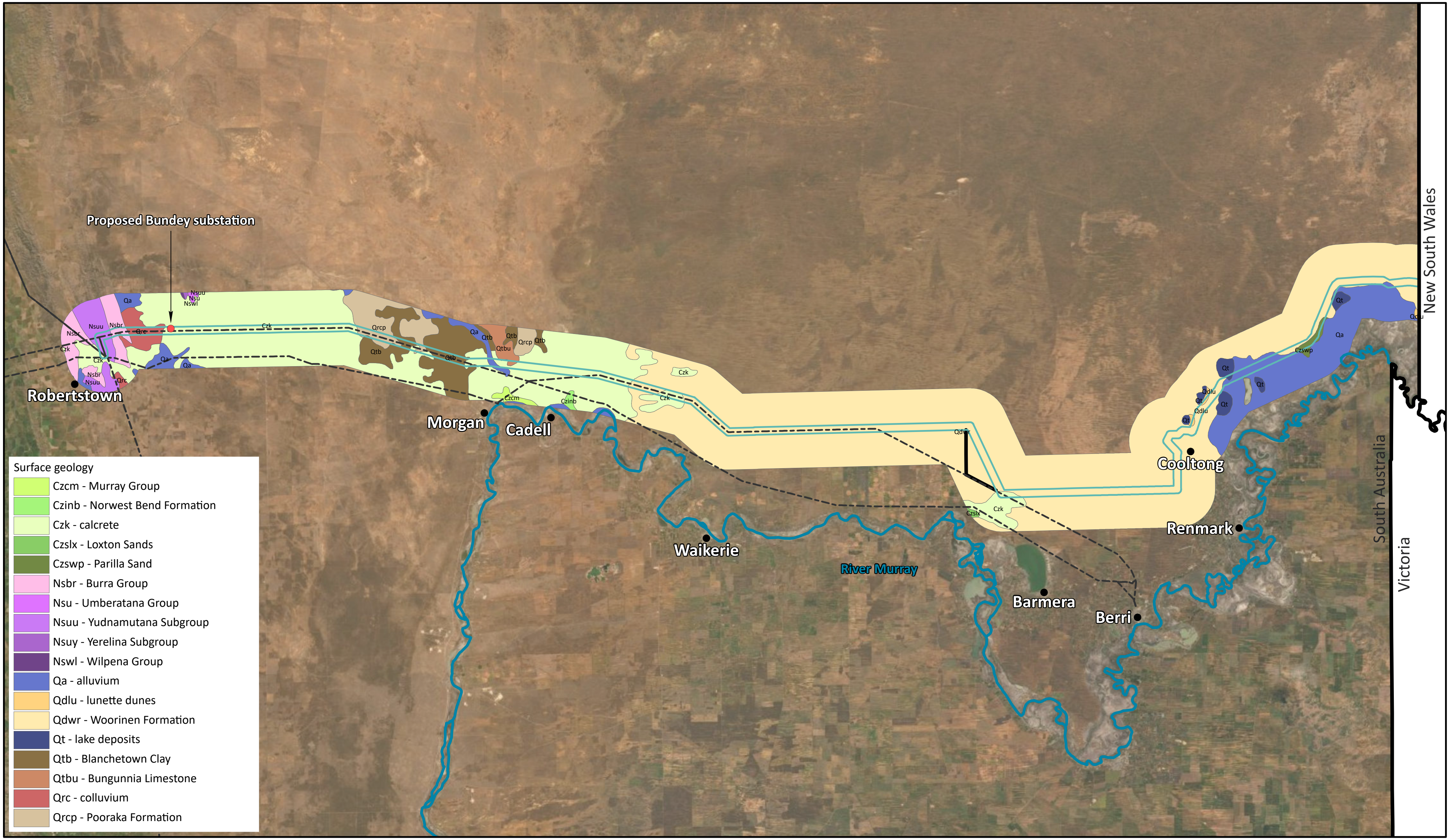

Figure 10-6
Surface geology in the region of the Project

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Soil characteristics

Water erosion potential

Water erosion potential mapping (DEW 2009a[1]) along the transmission line corridor indicates that water erosion potential is predominantly classified as low. This classification is based on inherent slope and soil erodibility characteristics and excludes the influence of vegetation and other protective cover (it assumes land is in a bare, cultivated state).

At the western end of the transmission line corridor, some areas of higher water erosion potential are present, as follows:

- for the most western 6 km of the transmission line corridor (in the slopes of the Mount Lofty Ranges), water erosion potential is classified by DEW mapping as moderate, with short sections of high erosion potential (approximately 1 km) on slopes south of Powerline Road
- for the next 6 km to the east, water erosion potential is classified as moderately low as the slopes transition to the plains
- between the eastern slopes of the Mount Lofty Ranges and the vicinity of Morgan near larger drainage lines (e.g. Burra Creek and Emu Gully), water erosion potential is classified as moderately low.

Some localised gullying is present in the immediate vicinity of Burra Creek (see Figure 10-6 in Section 10.1.1).

Wind erosion potential

Wind erosion potential (where wind erosion could be a problem under particular soil disturbance and weather conditions) has been classified as low to moderately low along the transmission line corridor to the west of Morgan (DEW 2009b).

The central portion of the transmission line corridor has been classified mostly as moderately high wind erosion potential, with some sections classified as moderately low. Within the moderately high areas, the mapping data generally indicates that there is a small proportion (less than 20%) of high wind erosion potential present. This higher wind erosion potential in this portion of the transmission line corridor is typically associated with the dune field and sand plains of the Woorinen Formation, which are inherently sensitive to wind erosion.

The eastern portion east of Renmark presents a low to moderately high potential for wind erosion.

Soil salinity

Soils within the proposed transmission corridor are characterised by low to moderate salinity and negligible acidity (DEW 2009e). However, the Yamba Formation salt lakes and the Blanchetown Clay can be hypersaline (more than 35,000 ppm) and saline (8,000 ppm) respectively.

Acid sulfate soils

Acid sulfate soils have elevated concentrations of metal sulfides and generate acidic conditions when exposed to oxygen. If incorrectly handled, these soils may potentially impact on human health and the environment, and may also result in damage to infrastructure constructed on acid sulfate soil material.

Acid sulfate soil mapping (DEW 2009c, CSIRO 2011) indicates that acid sulfate soil potential in the transmission line corridor is predominantly negligible (see Figure 10-7). Calcareous soils and limestone

[1] Water and wind erosion potential mapping (DEW 2009) covers approximately 75% of the length of the transmission line corridor. Landform and soil characteristics of sections of the alignment outside the limits of mapping (in the pastoral zone) have been used to interpret soil erosion potential for these areas, based on mapped soil erosion of adjacent areas with similar characteristics.

are common along the transmission line corridor and the alkalinity of soils present is reported as being alkaline to strongly alkaline (DEW 2009d).

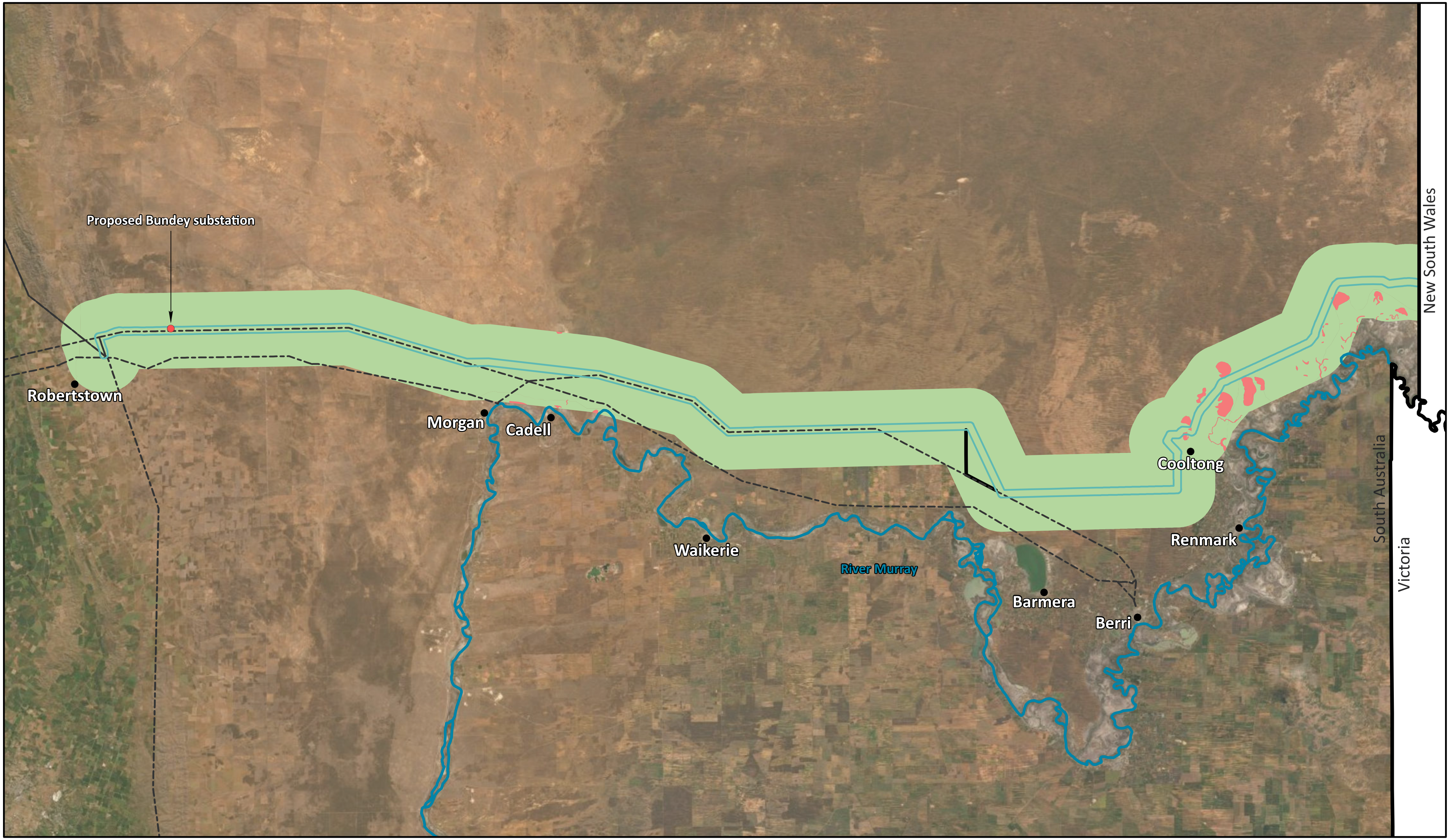
The ephemeral lakes in the Riverland Ramsar site (which are adjacent to the proposed alignment at its eastern end but are not intersected by it) are mapped as having a high probability of occurrence of acid sulfate soils (see Figure 10-7). Lake Woolpolool and Lake Merreti are characterised as having more than 60% of land susceptible to the development of acid sulfate soils (DEW 2009c) and other lakes in the Riverland Ramsar site (which are outside the limits of the DEW 2009c mapping) are also categorised as having a high probability of occurrence of acid sulfate soil (CSIRO 2011). The Riverland Ramsar site was assessed as medium acidification hazard (MDBA 2011).

Soil contamination

The South Australian EPA Public Register contains no records of environmental authorisations, orders and applications for the transmission line corridor, and are there also no notifications on the Site Contamination Index for the corridor. One parcel of land intersected by the transmission line corridor is listed on EPA Licence 2157, which covers scheduled activity 5(4) ‘Piggeries’. The piggery infrastructure is located approximately 4 km south of the proposed alignment on a separate land title.

The transmission line corridor traverses largely undeveloped land which has been used predominantly for agricultural and pastoral purposes (refer Chapter 9 Land Use and Tenure). Soil contamination is not considered likely to be present on the proposed alignment, however contaminants of potential concern which could possibly occur, based on these land uses, include:

- organochlorine and organophosphorus pesticides associated with agricultural chemicals
- nutrients (phosphorous and nitrogen) associated with fertiliser application
- heavy metals such as arsenic, associated with animal husbandry treatments
- hydrocarbons associated with farm refuelling and other activities.



Acid sulfate soil probability
- High probability of occurrence
- Low probability of occurrence
- Extremely low probability of occurrence
- Transmission line corridor
- Cultural heritage avoidance alignment
- Existing ElectraNet transmission line
- River Murray
- Proposed Bundey substation

0 20
Kilometres

N

Figure 10-7
Acid sulfate soil potential on the transmission line corridor

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10.3.3. Surface water

The Project is located within the Lower Murray catchment of the Murray-Darling Basin, which makes up approximately 95,300 km^2 (approximately 9%) of the total area (1.1 million km^2) of the Murray-Darling Basin (MDBA 2020).

Due to the semi-arid climate and generally sandy soils, there is limited development of surface water features in the region (apart from the River Murray).

The principal surface water features in the vicinity of the transmission line corridor are:

- the River Murray and its floodplain, which are located to the south of the corridor
- the small ephemeral watercourses in the western part of the corridor; these flow generally eastwards from the slopes of the Mount Lofty Ranges and only the largest of them (e.g. Burra Creek) reach the River Murray, with flow into the Murray occurring only in exceptionally wet years (Barnett 2015).

These features are discussed further below.

The transmission line corridor is not located in any surface water or water resource management prescribed areas under the *Landscape South Australia Act 2019* and does not cross any prescribed watercourses. The proposed alignment traverses outside the eastern edge of the River Murray Prescribed Watercourse Area (the boundary is Old Wentworth Road / Renmark-Wentworth Road).

Figure 10-8 shows the main surface water features in the vicinity of the transmission line corridor.

River Murray

The River Murray is the dominant surface water feature in the region. It flows in a generally westerly direction from the South Australia – New South Wales border to Morgan, where it turns southwards. Between Morgan and Overland Corner (located approximately 80 km upstream from Morgan), the river flows in a relatively narrow, steep sided gorge incised into the Murray Group limestones. Upstream of Overland Corner it forms a broad alluvial river valley about 10 km wide (Barnett 2015).

The River Murray is located to the south of the transmission line corridor. Between Morgan and Renmark the distance to the main channel varies from 5 km (near Morgan, Cadell and Overland Corner) to 10 – 15 km in other areas. North of Renmark, the transmission line corridor follows the edge of the floodplain, at distances of approximately 6 – 9 km from the main river channel. This eastern end of the transmission line corridor intersects the River Murray Floodplain Area defined under the River Murray Act (refer Chapter 5 Legislative and Planning Framework). This floodplain area is also listed under the Ramsar convention as the Riverland site as discussed further below.

The River Murray is subject to seasonal cycles of flooding, which have been significantly modified by water extraction and regulation of flows in the river by a system of storages, weirs and locks. In the southern part of the Basin, the majority of the floods occur in winter and spring, although there have been some large floods in summer and autumn (MDBA 2020). When river levels are high during periods of flood, the floodplain and associated creeks, channels, lagoons, billabongs, swamps and lakes become inundated.

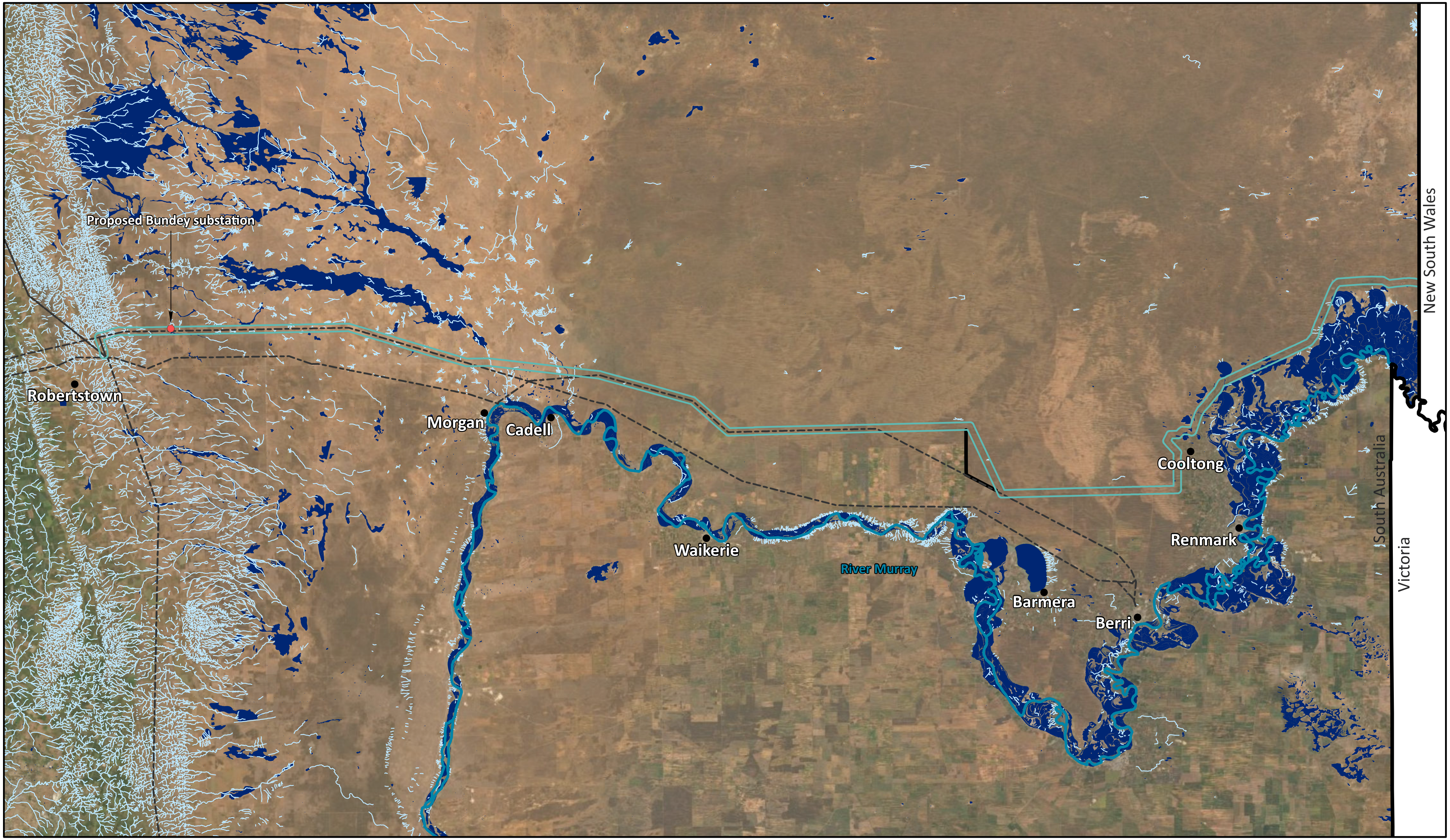
A South Australian River Murray flood is considered 'exceptional' when the water level is five or more metres above pool level (i.e. the regulated level weir pools in the river), which has occurred just four times (1931, 1956, 1973 and 1974) (WaterConnect 2019). The 1956 flood, which peaked at 341,000 ML/day, is the largest River Murray flood on record. Average daily flow to South Australia for the period 1968 – 2020 was 18,000 ML/day (MDBA 2021).

The floodplain of the River Murray along the 80 km section from the border to Renmark is listed under the Ramsar Convention as a wetland of international importance as the ‘Riverland’ Ramsar site (see

Chapter 9 Land Use and Tenure and Chapter 11 Flora and Fauna). This 30,600 ha site contains a series of creeks, channels, lagoons, billabongs, swamps and lakes which are subject to variable regimes of inundation. Wallace *et. al.* (2015) state that floodplain-river systems such as the Riverland Complex rely on frequent (sub-decadal scale) flooding to maintain their ecological function. However, changes in the hydrology of many wetlands since the 1920s and 1930s, as a result of weir installation along the river, has resulted in a transformation from seasonally variable water levels, to permanent inundation in a number of areas (DEW 2019b) and reduced flooding frequency in other areas.

Figure 10-9 shows areas of floodplain that are regularly subject to inundation in the eastern section of the transmission line corridor, as well as the 1956 flood level (which corresponds with the boundary of the Ramsar wetland site). The areas of inundation shown indicatively represent a 1 in 10 year scenario (based on comparison to Figure 3.17d of Newall *et al.* (2009)). Most of the wetlands in the vicinity of the transmission line corridor are subject to seasonal or intermittent freshwater inundation at varying frequencies, depending on river flows and managed inundation regimes. For example, Lake Merreti is permanently inundated with freshwater and Lake Woolpolool is a seasonal saline / brackish lake (Newall *et al.* (2009)).

The transmission line corridor passes predominantly north of the floodplain and the Ramsar site boundary, on higher ground on the northern side of the Old Wentworth Road / Renmark-Wentworth Road, for approximately 36 km. It does not cross any areas that are regularly inundated, and crosses three areas of upper floodplain (approximately 170 m, 480 m and 1.3 km in length) that were flooded in the 1956 flood and could be flooded in extreme flood events. A total of approximately 12.2 km of the proposed alignment is located within 1 km of lakes and swamps subject to reasonably frequent inundation (i.e. 1 in 10 (or less) years).



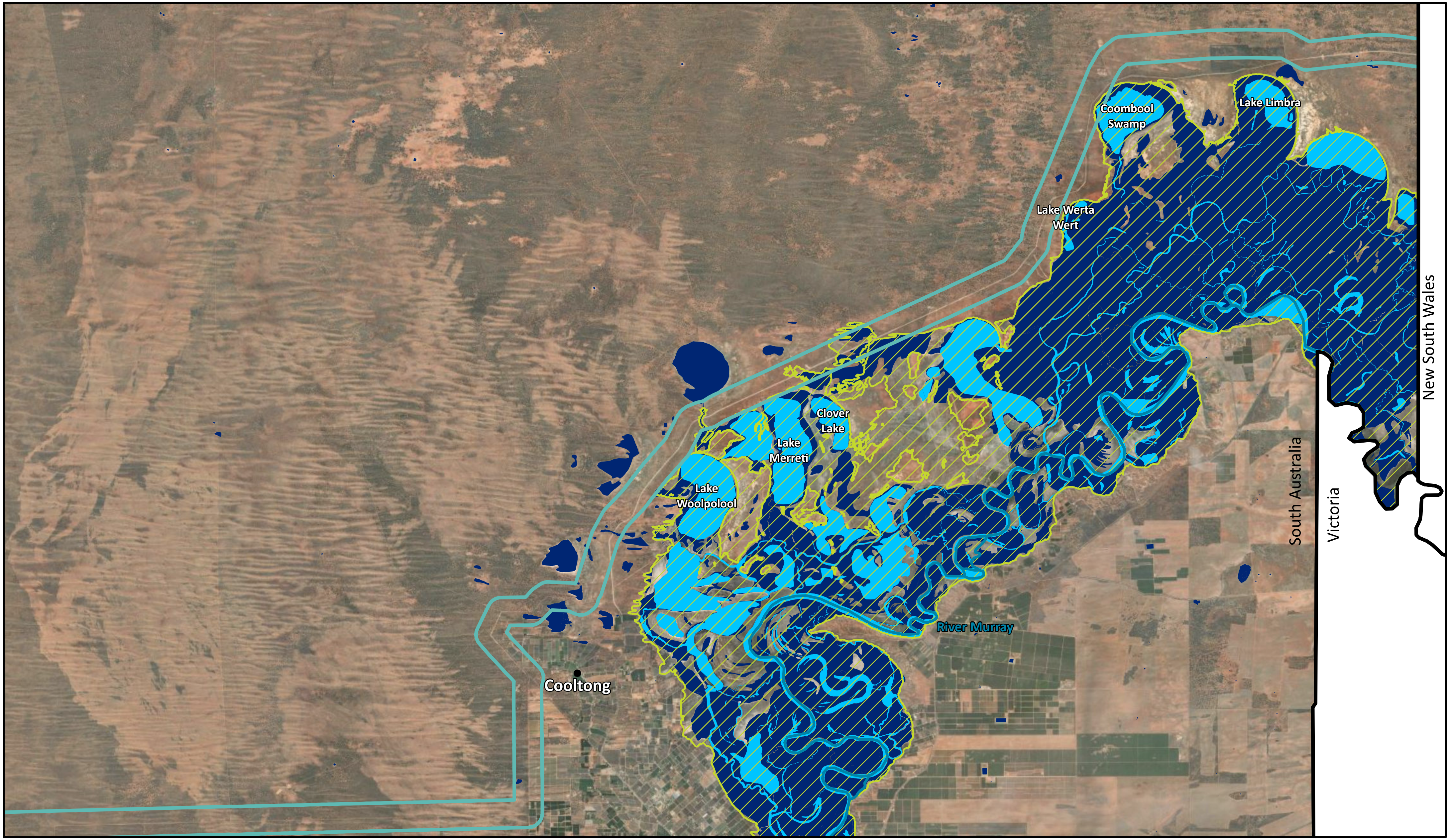
Water body*
Transmission line corridor
Cultural heritage avoidance alignment
Watercourse
Existing ElectraNet transmission line
River Murray
Proposed Bundey substation

Figure 10-8
Surface water features in the vicinity of the transmission line corridor

0 20
Kilometres
N

ElectraNet
project energy connect
JBS&G

*Includes Reservoirs, Dams, Lakes (permanent, intermittent and mainly dry), Land Subject to Inundation and Flooding



1956 flood extent
Regularly inundated area
Water body*
Transmission line corridor
Watercourse
River Murray

Figure 10-9
Historic flood levels and areas of regular inundation

0 5
Kilometres
N

ElectraNet
project energy connect
JBS&G

*Includes Reservoirs, Dams, Lakes (permanent, intermittent and mainly dry), Land Subject to Inundation and Flooding

Other watercourses

As noted above, surface water features in the region other than the River Murray are limited, due principally to the semi-arid climate, relatively flat topography and generally sandy soils.

The western end of the transmission line corridor traverses a number of small ephemeral creeks which arise in the slopes of the Mouth Lofty Ranges. These creeks flow out of the ranges usually only in very wet years and discharge onto the plains to the east for short distances before dissipating by evaporation or infiltration into permeable sediments (Barnett 2015).

Only the largest of these watercourses reach the River Murray in exceptionally wet years (if at all) (Barnett 2015). The transmission line corridor crosses two of these larger watercourses: Burra Creek (approximately 7 km north of Morgan) and a watercourse known in the vicinity of the river as Emu Gully (approximately 3 km north-east of Cadell). Burra Creek has an incised channel in the vicinity of the transmission line corridor (see Plate 10-6), while Emu Gully is very broad and shallow in profile with no incised channel.

The Burra Creek catchment is the only defined catchment boundary in the region (Penney 2016). Its headwaters commence just north of Mount Bryan (approximately 95 km north-west of Morgan) and flow in a southerly direction towards Worlds End (approximately 60 km west of Morgan), before changing direction to the east and flowing to its discharge point at the River Murray. Streamflow is generated from local rainfall events, generally between April and September, in the higher elevated parts of the Mount Lofty Ranges and Southern Flinders Ranges (Penney 2016). Flow from Burra Creek to the River Murray is rare, as the lower reaches are essentially flood-out plains and lack defined drainage (SAMDBNRMB 2009). The last time this occurred estimated to be around 1941 (Deane *et al.* 2006 cited in Penney 2016).

The catchment of Emu Gully extends approximately 80 km to the north-west and is characterised by discontinuous drainage lines with often broad and poorly defined channels, numerous depressions and swamps and an extensive network of farm dams along the major flow paths. Anecdotal evidence from the property manager indicates that the watercourse rarely flows across the entire catchment but can carry high volumes into the Murray River floodplain after extreme rainfall events (Lyon Solar 2017).

The other ephemeral watercourses that arise in the Mount Lofty Ranges south of Burra Creek (including those that are crossed by the far western end of the transmission line corridor) do not reach the River Murray because uplift along the Morgan Fault has created a barrier to eastward flow (Barnett 2015) and they terminate in permeable soils as they fan out onto the Murray Plains. The majority of the year these stream beds are dry (SAMDBNRMB 2009).

Watercourses at the western end of the transmission line corridor are shown in Figure 10-10.

Between Emu Gully and the River Murray floodplain near Renmark there are no defined watercourses or surface water features on or near the transmission line corridor, other than occasional dams which have been excavated to capture local runoff.

There are several very small drainage lines approximately 12 km long that cross the transmission line corridor and the Renmark-Wentworth Road near the eastern end of the corridor and carry localised runoff to the River Murray floodplain areas to the south.

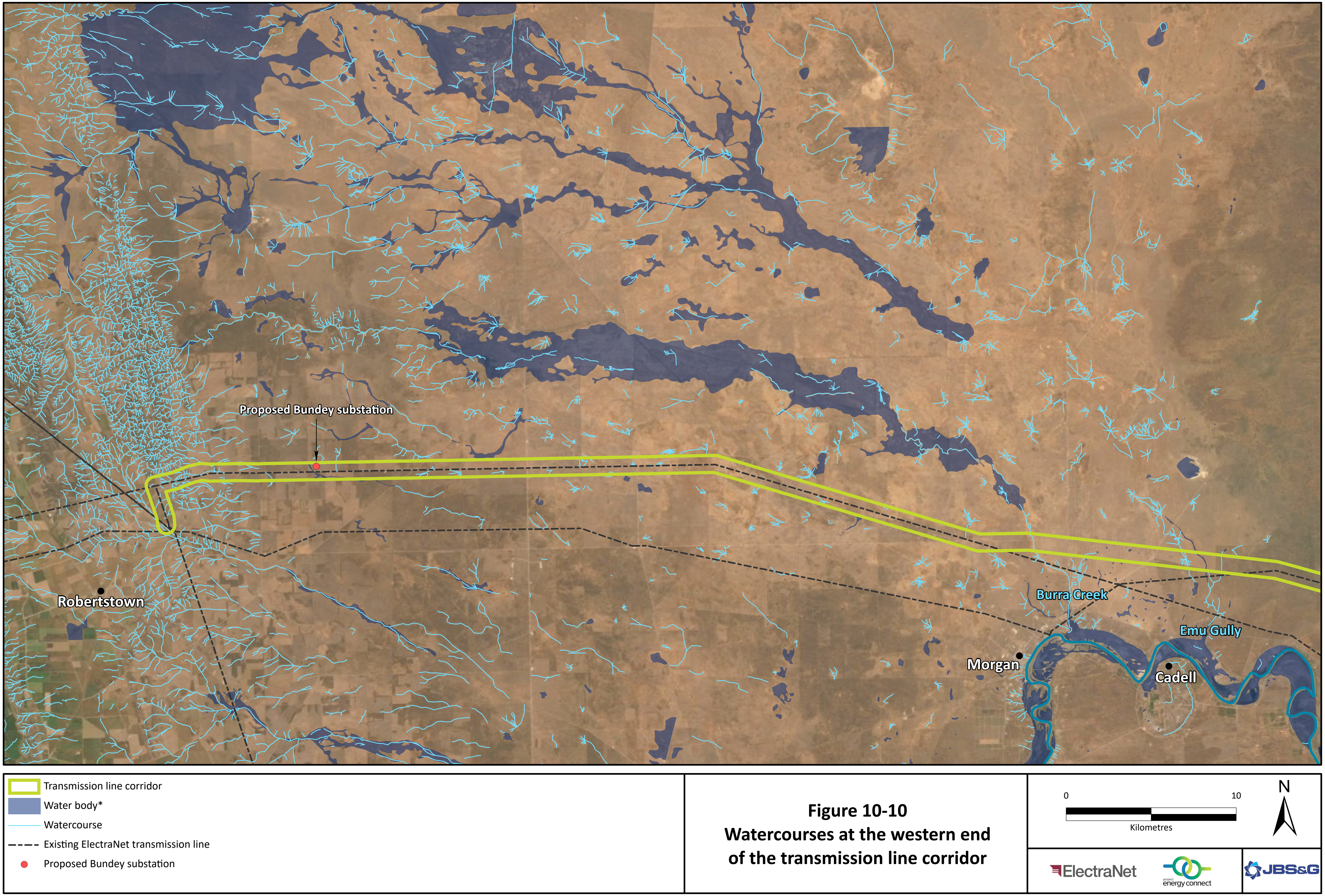


Figure 10-10
Watercourses at the western end of the transmission line corridor

*Includes Reservoirs, Dams, Lakes (permanent, intermittent and mainly dry), Land Subject to Inundation and Flooding

Plate 10-6: Burra Creek (approximately 1 km south of the proposed alignment)

The Bundey substation site is located on a flat calcareous loam plain. There are no defined drainage lines present. There are two shallow excavated dams on the western boundary and in the south western corner (see Plate 10-7) and mapping indicates a broad surface water flow path across the south-western part of the land parcel.

Plate 10-7: Panorama of proposed Bundey substation site from south-west corner

Water quality

The River Murray is a relatively turbid system, with elevated salinity and eutrophication reported as water quality issues (Newall *et al*. 2009, SAMDBNRMB 2015). Long term water quality monitoring data at Morgan (1978 – 2012 indicates a mean turbidity of 41 NTU (and a range of 0 to 410) and a mean salinity (electrical conductivity) of 522 µs/cm (range 166 – 32,100) (Henderson *et al.* 2013).

Turbidity and salinity in the wetlands of the Riverland Ramsar site are generally highly variable. Total dissolved solids in Clover Lake have been reported as ranging from 334 mg/L after flooding to 3,210 mg/L at the end of a long drying phase, with mean turbidity in Clover Lake of 110 NTU, during monitoring between 1990 and 1993 (Suter *et al*. 1993, cited in Newall *et al.* 2009). Turbidity is reported as ranging an order of magnitude from minimum to maximum readings in the wetlands (Suter *et al*. 1993, cited in Newall *et al.* 2009).

Significant quantities of salt (via saline groundwater) intrude into the River Murray in the Riverland region annually. Consequently, a number of salt interception schemes to operate in the region. There are no salt interception schemes in close proximity to the transmission line corridor, although several operate along the southern side of the River Murray (e.g. Waikerie, Woolpunda and Murtho).

Water quality in the ephemeral watercourses in the western extent of the transmission line corridor is expected to be variable. As these are predominantly dry and require large rainfall events to commence flowing (Penney 2016), high turbidity is likely to be common. EPA SA water quality sampling for nearby watercourses in 2010 (including Burra Creek near Burra) indicated that 71% of sites were assigned a 'Fair' condition rating and 29% of sites were 'Poor'; no sites were assessed to be 'Very Poor' condition, or in the 'Good' to 'Excellent' range (Penney 2016). Most streams showed evidence of considerable human disturbance including nutrient enrichment, sediment deposition and degraded riparian zone (Penney 2016).

Surface water use

The River Murray provides the water resources to support the domestic, industrial, livestock and irrigation demands of the region and other areas of the state. River Murray water also provides approximately 40 per cent of Adelaide's annual mains water needs increasing to 90 per cent if required during drought (SAMDBNRMB 2015).

In the western half of the transmission line corridor away from the River Murray, surface water stored in localised dams is the main source of water (EDSCB 2002). Numerous small dams are present across the landscape in drainage lines and depressions.

10.3.4. Groundwater

The majority of the transmission line corridor is situated within the Murray Basin, a low-lying sedimentary basin, containing a multi-layered regional groundwater system. Groundwater in the basin typically flows from the basin margins to the River Murray which acts as a drain for all aquifer systems in the Murray Basin and is the focus for groundwater discharge (Barnett 2015). These discharge rates are normally low due to the low hydraulic gradients from the distant recharge areas.

There are three main regional aquifers separated by confining layers in the Murray Basin in the vicinity of the transmission line corridor. In order of deepest to shallowest these are: the Renmark Group confined aquifer; the Murray Group limestone aquifer, which contains the watertable west of Overland Corner; and the Pliocene Sands aquifer, which contains the watertable aquifer to the east of Overland Corner but is elevated above the water table or absent to the west (Barnett 2015).

Within the River Murray valley, the more recently deposited (Quaternary) alluvial sediments of the Monoman Sands and the Coonambidgal Formation overly the regional aquifer units. The River Murray valley is incised into the Murray Group Limestone downstream of Overland Corner, whereas upstream the limestones are downwarped and the river valley and the Quaternary alluvial sediments overly the Pliocene Sands.

The characteristics of these hydrostratigraphic units are described in Table 10-6 in order of increasing age, which roughly corresponds to increasing depth below ground surface. Descriptions have been adapted from Barnett (2015) and RPS (2012).

Table 10-6: Hydrostratigraphic units in the Murray Basin and Quaternary alluvium

Hydrostratigraphic Unit	Extent	Comment
Coonambidgal Formation	River Murray valley	Alluvial sediment restricted to the River Murray valley. A discontinuous clay and coarse-grained layer up to 2 m thick which determines the semi-confined / unconfined nature and recharge to the underlying Monoman Formation.
Monoman Formation	River Murray valley	Alluvial sediment restricted to the River Murray valley. An unconfined to semi-confined aquifer consisting of relatively clean fine to coarse alluvial sands overlain by thin silts and clay. The Riverland Ramsar site generally occurs within the Monoman Formation or the overlying Coonambidgal Formation. The Monoman Formation is in direct hydraulic connection with the underlying semi-confined Lower Pliocene Sands, the laterally adjacent unconfined Upper Pliocene Sands and the River Murray. Salinity can reach over 35,000 mg/L in areas of the floodplain where evaporative discharge results in concentration.
Pliocene Sands aquifer	Regional (east of Overland Corner)	The Loxton-Parilla Sands unit comprises fine to coarse sands with silt and clay layers. It is saturated only in the eastern part of the Project region (east of Overland Corner) where it contains the water table aquifer. The groundwater flow is typically towards the Murray River under low gradients, except where irrigation operations adjacent to the river have generated water table mounds. The aquifer thickens to the east to a maximum of about 50 m. Salinity in the aquifer is generally over 20,000 mg/L.
Bookpurnong Formation (confining layer)	Regional	Located between the Pliocene Sands and underlying Murray Group Limestone in the east of the Project region, this formation acts as an aquitard. Comprised of plastic silts and shelly clays that confine the underlying limestone aquifer. Occurs only to the east of Overland Corner and attains maximum thickness of approximately 35 m at the border.
Murray Group Limestone aquifer	Regional	This regionally extensive comprises a consolidated, highly fossiliferous, fine to coarse limestone. It is unconfined west of Overland Corner. This aquifer has been developed for stock, domestic, irrigation and town water supplies in the broader Murray Basin because it contains low salinity groundwater over large areas. Recharge occurs from high rainfall areas around the basin margins such as the Mount Lofty Ranges to the west and in southwest Victoria to the southeast. Groundwater flows under low hydraulic gradients to the River Murray where it discharges and contributes to the increasing salinity of the river. Average thickness is about 100 m west of Overland Corner, but it thickens to the east to about 150 m at the State border where it is downwarped below ground level and confined by the Bookpurnong Formation. Salinities increase downgradient, from below 1,000 mg/L at the recharge areas to over 20,000 mg/L adjacent to the river.
Ettrick Formation (confining layer)	Regional	Consisting of glauconitic and fossiliferous marl, the low permeability layer sits between the Murray Group Limestone and the underlying Renmark Group aquifer. Thickness in the Project region varies from 12 to 75 m and it deepens to the east.
Renmark Group aquifer	Regional	A confined aquifer comprising unconsolidated carbonaceous sands, silt and clay. It is continuous over the Project region and deepens to the east to a maximum thickness of 300 m over the Renmark Trough. It has been developed for stock and domestic supplies only around the basin margins, where it is relatively shallow and contains groundwater that is usually of lower salinity than that within the overlying limestone aquifer which is sometimes saline. Groundwater flow is generally from the basin margins toward the river where discharge occurs to the overlying Murray Group Limestone aquifer by upward leakage. Salinities are in the range of 10,000 – 20,000 mg/L.

The western-most section of the transmission line corridor is located on the pre-Cambrian fractured rock aquifers of the Burra and Umberatana groups in the Adelaide Fold Belt. The aquifers outcrop and receive recharge in the Mount Lofty Ranges. They are predominantly comprised of sandstones and quartzites. Barnett (2015) reports that wells are mostly located in drainage lines yielding stock supplies only with salinities generally varying between 4,000 – 8,000 mg/L. To the east of the Mount Lofty Ranges these pre-Cambrian fractured rock aquifers underlie the Cainozoic sediments of the western margin of the Murray Basin.

The Quaternary sediments at the surface on the transmission line corridor are not considered to house any significant groundwater resources (SKM 2002). The Woorinen Formation is highly permeable and rainfall is rapidly absorbed and taken up by vegetation. It may form locally perched aquifers where underlain by Blanchetown Clay. The Quaternary sediments are underlain by the Tertiary aquifers of the Murray Basin described in Table 10-6 which form the water table in the region (i.e. the Murray Group Limestone aquifer to the west of Overland Corner and the Pliocene Sands aquifer to the east).

The transmission line corridor does not intersect any groundwater management prescribed areas under the *Landscape South Australia Act 2019*. The closest prescribed areas are the Barossa Prescribed Water Resources Area and the Mallee Prescribed Wells Area, which are both located over 50 km to the south.

Shallow groundwater depth and quality

Depth to shallow groundwater along the transmission line corridor is mapped as greater than 20 m for the western two-thirds of the corridor (DEW 2016a). It is mapped at shallower depths (5 – 10 m) in several areas near the eastern end of the transmission line (north of Barmera and adjacent to the Riverland Ramsar site) as shown in Figure 10-11.

Shallow groundwater salinity is mapped as between 14,000 and 35,000 mg/L along the majority of the transmission line corridor (DEW 2016b) as shown in Figure 10-12. Shallow groundwater salinity is lower west of Morgan (in the range 1,500 – 7,000 mg/L) and higher in several areas near the eastern end of the transmission line (north of Barmera, north of Renmark and near the state border) where it is greater than 35,000 mg/L. Shallow groundwater salinities of over 40,000 mg/L up to 85,000 mg/L have been recorded in wells in the Riverland Ramsar site (WaterConnect 2020).

Groundwater wells

There are 59 drillholes (wells) recorded in WaterConnect within the transmission line corridor, and 1,079 within 5 km of the proposed alignment, as shown in Figure 10-13 (WaterConnect 2020). Of these, only four wells within the transmission line corridor are listed as operational wells, with a further 34 not listed or unknown. Within 5 km of the proposed alignment, 86 wells are listed as operational with a further 679 not listed or unknown.

A large proportion of the wells within 5 km of the proposed alignment are used for observation and monitoring (WaterConnect 2020). As discussed above, groundwater in the region is used for stock watering where salinity is suitable. Most reported salinities for wells within 5 km of the proposed alignment are unsuitable for stock watering (of the 402 bores where salinity is reported, 106 have salinities less than 13,000 mg/L and only 11 of these have salinities less than 1,200 mg/L[2]).

Salinity values reported for these wells on the WaterConnect portal are highly variable. The minimum total dissolved salinity (TDS) value reported within 5 km of the proposed alignment is 200 mg/L (well number 7030-93 located in the Riverland Ramsar site at 15 m depth). The maximum recorded salinity is 85,850 mg/L (well number 7029-1628 located west of Lake Woolpolool in the Riverland Wetland, 1.5 m depth).

[2] These salinities correspond to the upper limits for environmental values in the *Environment Protection (Water Quality) Policy 2015* for 'Primary industries – livestock drinking water' (13,000 mg/L) and 'Drinking water for human consumption' (1,200 mg/L).

A summary of groundwater well data from the WaterConnect portal is provided in Table 10-7.

Table 10-7: Groundwater well data within 5 km of the proposed alignment

Location	Number of wells	Aquifers (number of wells)*	Average SWL** (m)	Average TDS (mg/L)	Average pH
Section 1: Robertstown to Goyder	53	Appila Tillite (2) Saddleworth Formation (1) Winnambool Formation (1)	36	8,258 (range 1,999 – 26,355)	7.9
Section 2: Goyder to Taylorville	52	Murray Group (11) Ettrick Formation Unit 1 (4) Coonambidgal Formation (2) Winnambool Formation (1)	32	10,660 (range 3,315 – 45,080)	7.9
Section 3: Taylorville to Wentworth-Renmark Rd	182	Loxton Sand (10) Murray Group (6) Monoman Formation (1) Bookpurnong Formation (1) Renmark Group (1) Warina Sand (1) Murray group (confined) (1)	26	23,160 (range 1,995 – 47,941)	6.1
Section 4: Wentworth-Renmark Rd to SA-NSW	792	Monoman Formation (334) Coonambidgal Formation (76) Loxton Sand (19) Murray group (confined) (7) Perched Woorinen Formation (1) Bookpurnong Formation (1) Warina Sand (1) Murray Group (1)	3.8	29,505 (range 200 – 85,850)	6.84

*Where reported (approximately 45% of wells had the aquifer reported)

**Standing water level (below ground surface)

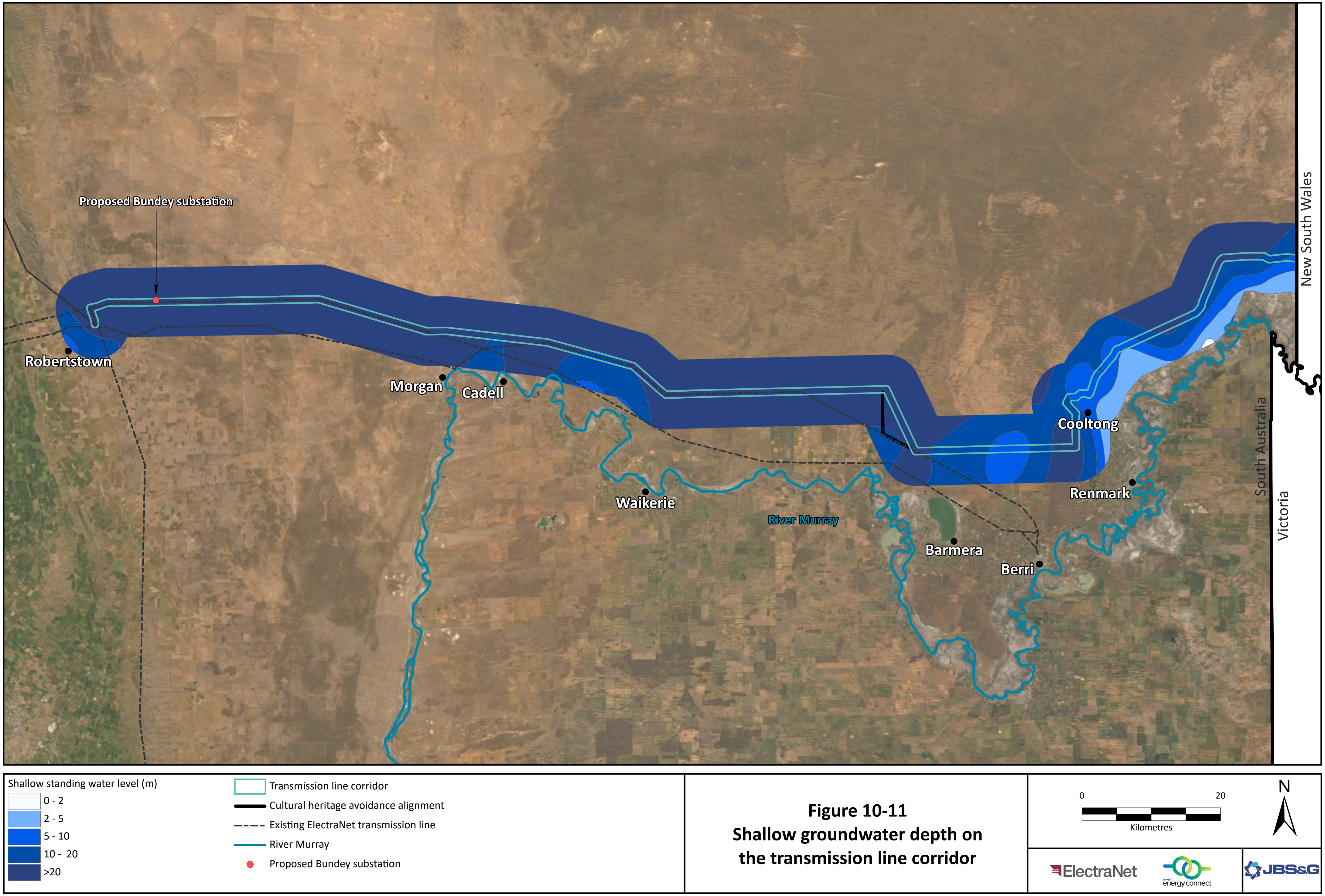
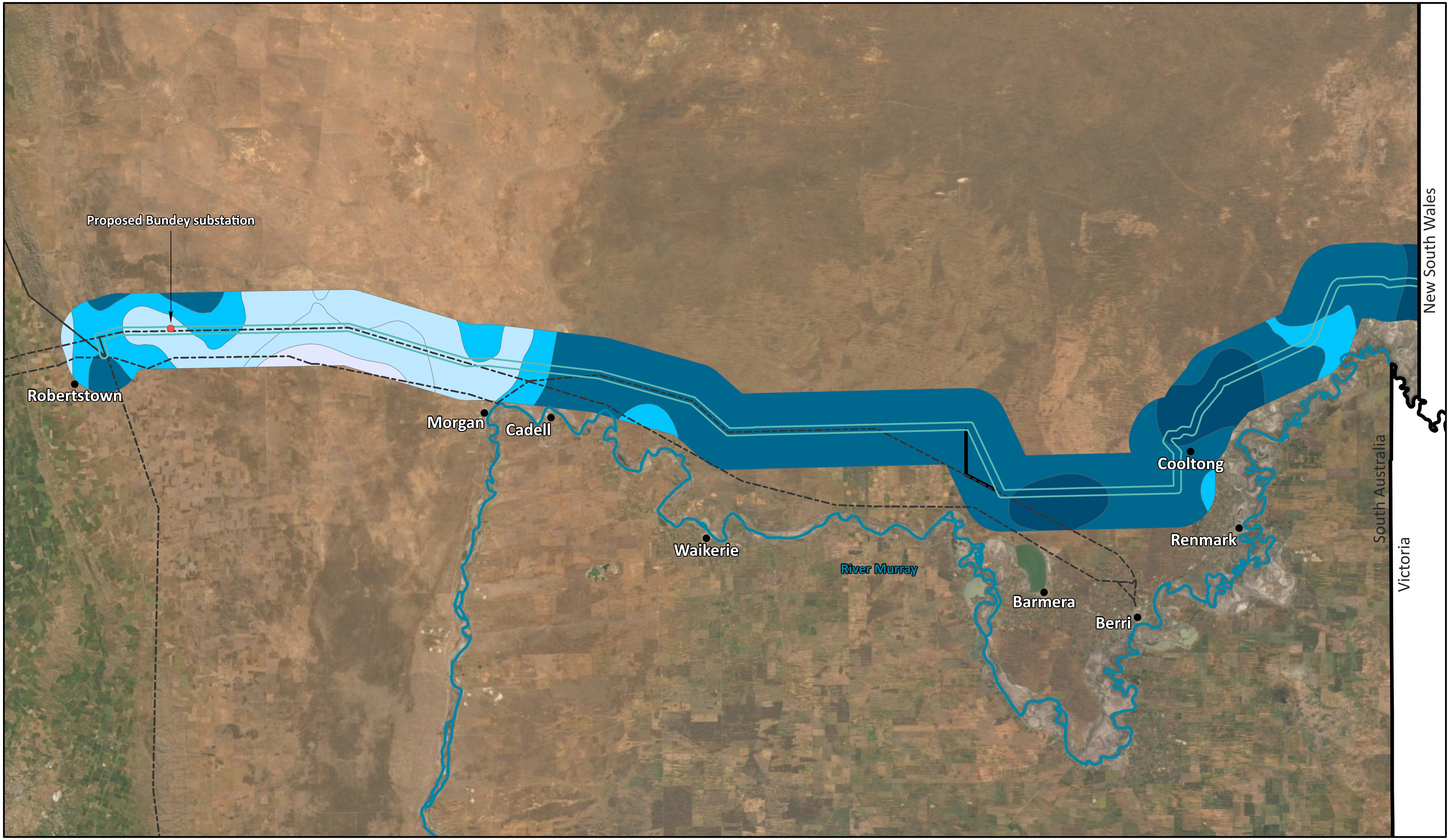


Figure 10-11
Shallow groundwater depth on the transmission line corridor



Total Dissolved Salinity (mg/L)
- 0 - 1,500
- 1,500 - 7,000
- 7,000 - 14,000
- 14,000 - 35,000
- >35,000

- Transmission line corridor
- Cultural heritage avoidance alignment
- Existing ElectraNet transmission line
- River Murray
- Proposed Bundey substation

Figure 10-12
Shallow groundwater salinity on the transmission line corridor

0 20
Kilometres

N

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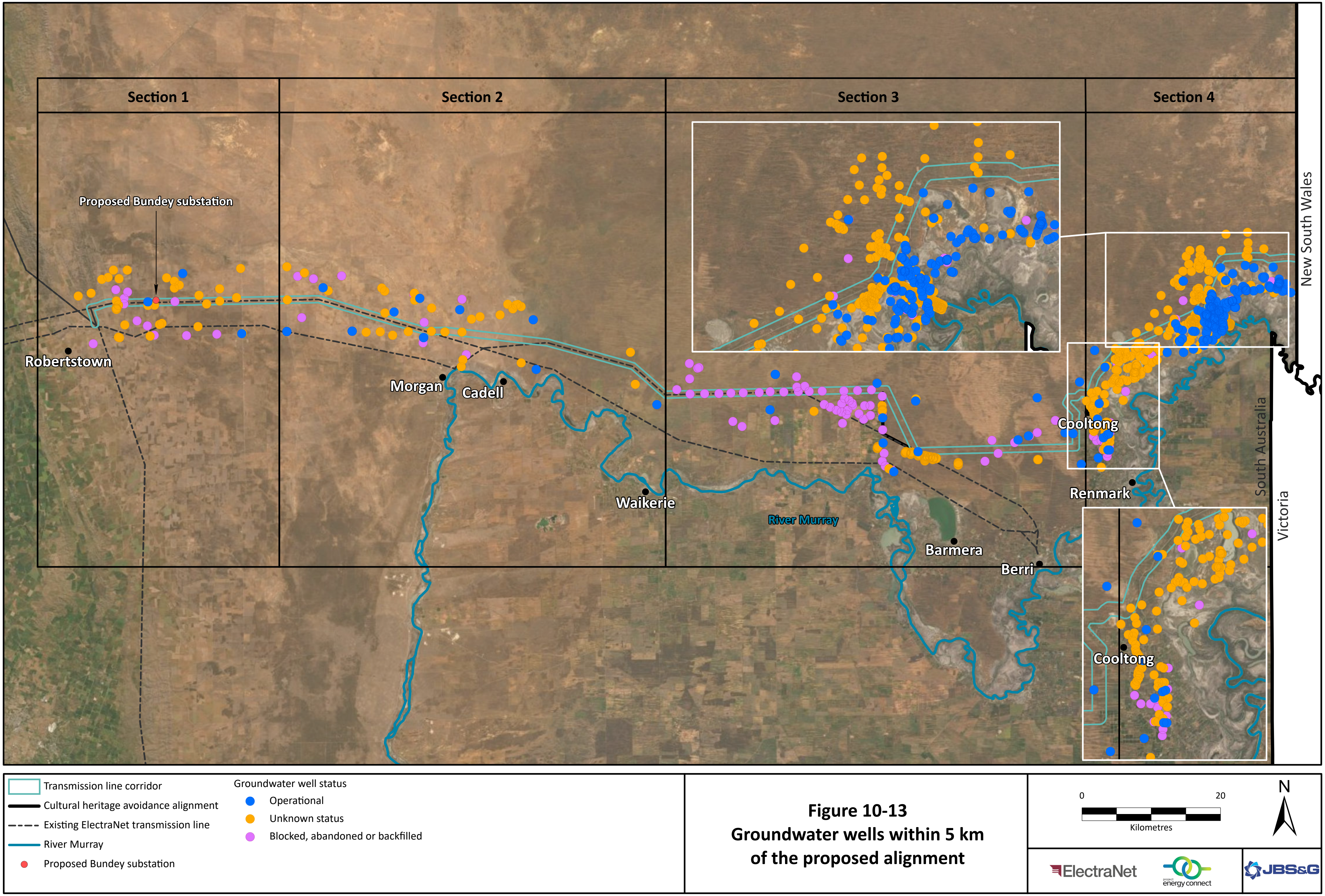

Figure 10-13
Groundwater wells within 5 km of the proposed alignment

10.4. Impact Assessment

The following Project aspects have been identified as sources of impacts to soils, landform, surface water and groundwater:

- land disturbance and vegetation clearance
- presence of permanent infrastructure (including substation, towers and access tracks)
- dewatering of excavations (if required)
- water sourcing for use in construction
- wastewater disposal
- use of chemicals and fuels.

The potential impact events resulting from these aspects of the Project are discussed below. Predicted impact categories and an evaluation of uncertainty are also discussed for each impact event.

10.4.1. Erosion and sedimentation

There is a low potential for soil erosion or sedimentation of surface waters which can be readily managed by infrastructure location and erosion and sedimentation controls

Vegetation clearance, excavation and earthworks will be required for the construction of towers, the Bundey substation, new access tracks and temporary facilities (e.g. temporary laydown areas / staging sites and worker construction camps). These activities have the potential to lead to soil erosion if stockpiles or disturbed areas are exposed to wind or water flows, and could result in subsequent transport of sediment to watercourses or surface water bodies. With the implementation of measures such as appropriate location of infrastructure and sediment and erosion controls, significant impacts are not expected. Rehabilitation of temporary disturbance areas and operational monitoring and remediation (if required) will prevent any ongoing impacts.

The areas of disturbance for towers along the proposed alignment have a relatively small and discrete footprint and are sparsely distributed. The area of disturbance for towers and other infrastructure will be minimised and groundcover will be retained where possible (e.g. for the stringing access corridor). The most continuous soil disturbance will be the access track along the transmission line which will traverse a limited number of areas more susceptible to erosion. Existing tracks will be utilised where possible and grading or other earthworks will be limited to what is required to provide safe access for construction.

As described in Section 10.3.2, the majority of the transmission line corridor traverses land with low water erosion potential, with limited areas where erosion potential is higher at the western end of the alignment and near Burra Creek. The Bundey substation site is in an area of low water erosion potential.

Infrastructure such as towers, tracks and temporary facilities will be located and constructed to minimise the possibility of erosion. Sites with steeper slopes or in close proximity to watercourse banks (e.g. Burra Creek) will be avoided. Geotechnical investigations, micro-siting and detailed design will be used to inform this process. Soil stockpiles will be appropriately located to minimise the potential for off-site impacts. Sediment and erosion control measures will also be installed where appropriate (e.g. where earthworks are being undertaken in areas of higher erosion risk or in close proximity to watercourses or the River Murray wetlands). Drainage features or structures will be installed on the access track where appropriate to prevent erosion during operations and remedial action will be implemented where required.

There is a limited number of receptors such as watercourses or waterbodies along the transmission line corridor and it is not in close proximity to the River Murray. The proposed alignment is separated from the wetlands of the Riverland Ramsar site by the Old Wentworth Road / Renmark-Wentworth

Road and distances of 250 m to 500 m or more. As described in Section 10.1.1, naturally high turbidity is expected to be common in the watercourses and surface water bodies in the region following flow events. Any effect of the Project on turbidity and sedimentation in watercourses, farm dams or River Murray wetlands, where inflows following rainfall are naturally turbid and where the transmission line corridor forms a small proportion of their catchment, would be small, localised and short term, particularly with appropriate infrastructure location and implementation of sediment and erosion controls. The Project will not result in a substantial and measurable change in the water quality of the Riverland Ramsar site.

Temporary facilities will typically be located in areas where the potential for erosion and sedimentation of surface waters is low, and they will be rehabilitated following construction which will further reduce the potential for erosion and sedimentation.

In areas of higher wind erosion potential such as the central portion of the transmission line corridor, micro-siting of towers and access tracks (e.g. to avoid traversing along dunes) and use of existing tracks will minimise the potential for wind erosion. Dust control measures during construction and rehabilitation of areas of temporary disturbance will also reduce this potential, as discussed in Chapter 14 Air Quality.

ElectraNet will develop and implement a soil erosion and drainage management plan as part of the Construction Environmental Management Plan (CEMP), which will detail the requirements for soil management and sediment and erosion control. Monitoring will be undertaken during and following construction to ensure that sediment and erosion control measures are effective and remediation will be undertaken if required.

The predicted impacts are in the **Negligible** to **Minor** category. Uncertainty in the predicted impact (based on uncertainty in the implementation of controls or rehabilitation measures and the potential for extreme weather events) has been evaluated in Appendix O and the level of risk is **Low**.

10.4.2. Soil compaction

Soil compaction will be limited in extent and will be rehabilitated in areas of temporary disturbance following construction

Soil compaction can occur in areas where there are vehicle movements and material storage, and soil may be deliberately be compacted at some sites (e.g. temporary worker camps and laydown areas) to stabilise the site. Soil compaction can result in a reduced water infiltration capacity, increased potential for runoff and erosion and reduced vegetation growth. Soil compaction will be limited to defined areas and will be rehabilitated where required to prevent ongoing impacts.

The level of soil compaction will vary along the alignment, depending on the frequency each area is traversed. Soil compaction is expected to be highest within laydown areas and the entrance / exit of access tracks where vehicle traffic is more frequent, whereas soil within the vicinity of the tower base will likely be utilised for a short period of time during construction, which will limit soil compaction. Most areas will only be used briefly and will have limited vehicle movement. Existing tracks will be used as far as possible and movement of vehicles and equipment will be limited to defined areas.

In areas of temporary disturbance (e.g. non-permanent access tracks or laydown areas), compacted soil will be rehabilitated if required by scarifying or ripping and replacing any previously stripped stockpiled topsoil and vegetation (or as agreed with relevant landholders).

The predicted impacts are in the **Negligible** category. Uncertainty in the predicted impact (based on uncertainty in the implementation of controls or rehabilitation measures and the potential for extreme weather events) has been evaluated in Appendix O and the level risk of is **Low**.

10.4.3. Soil stockpiling

Soil stockpiles will be appropriately managed to maintain soil viability and minimise loss of soil from wind and water erosion during construction

Topsoil will be removed and stockpiled during construction, predominantly at tower sites, prior to respreading during rehabilitation. Loss of topsoil as well as a decline of soil quality may result due to wind or water erosion or mixing with subsoil. Soil stockpiles during construction will be appropriately managed to maintain soil viability.

Disturbed topsoil will be stockpiled within designated storage areas at each site. Stockpiles would be kept below approximately 2 m height to reduce the potential for windblown erosion to occur, and to preserve soil structure. Stripped topsoil will be segregated from excavated subsoil. Sediment and erosion controls (e.g. sediment fences) would be installed where required (e.g. if there is a watercourse nearby). Following the completion of construction, topsoil and cleared vegetation will be respread in areas of the site that are to be rehabilitated. Any surplus soil material not required for rehabilitation purposes will be disposed of off site or placed in agreed locations with landowners.

Impacts on soil viability and quantity as a result of stockpiling will be very limited in extent.

The predicted impacts are in the **Negligible** category. Uncertainty in the predicted impact (based on uncertainty in the implementation of management measures) has been evaluated in Appendix O and the level of risk is **Low**.

10.4.4. Disturbance of acid sulfate soil

Acid sulfate soil is not expected to occur. If it is encountered, it will be appropriately managed and treated to prevent impacts to soil or water quality

Acid sulfate soil can generate acidic conditions when exposed to oxygen and if incorrectly handled, may potentially impact on human health and the environment, and may also result in damage to infrastructure constructed on acid sulfate soil material. Acid sulfate soil potential in the transmission line corridor is predominantly negligible, and the proposed alignment avoids the ephemeral lakes in the Riverland Ramsar site where there is a high probability of occurrence of acid sulfate soils. It is expected that towers will not be located where acid sulfate soils are present. In the unlikely scenario that tower locations cannot avoid acid sulfate soils, geotechnical investigations and detailed design would ensure that tower foundations are appropriately designed for soil conditions and that measures are in place to manage any excavated material and prevent any impacts (e.g. storage in a lined area, lime dosing and minimisation of exposure to oxygen). The CEMP will also contain standard management measures to address unexpected disturbance of acid sulfate soils.

The predicted impacts are in the **Negligible** category. Uncertainty in the predicted impact (based on uncertainty in data in the eastern end of the transmission line corridor) has been evaluated in Appendix O and the level of risk is **Low**.

10.4.5. Alteration of drainage patterns

Design and placement of infrastructure (including towers, access tracks and the Bundey substation) will avoid alteration of surface water flows

Activities involving earthworks and installation of infrastructure have the potential to alter surface water flows, which can impact vegetation, downstream water features and agricultural or pastoral operations that are reliant on surface water.

The Project will have a negligible effect on surface water flows. The natural topography of the transmission line corrdior will be maintained, and the presence of towers will not provide any significant impediment to surface water flows or alter catchment areas. Towers will not be located in in areas where they could alter surface water flows or be damaged by flooding (e.g. in close proximity to the Burra Creek channel). New or existing access tracks will be at the natural surface level and channel flows will be maintained at watercourse crossings (e.g. by construction at natural surface level or using pipes or culverts if required). Water affecting activity permits under the *Landscape South Australia Act 2019* will be obtained for watercourse crossings on the access track if required[3].

Construction of the Bundey substation may result in diversion of overland flows around the substation site. There is limited potential for scour to occur as slopes are low and flow paths in the vicinity of the site are broad and shallow. Siting and detailed design of the substation will ensure that there is no change to flow downstream of the substation and that scour or sedimentation do not occur.

There will not be a significant change in runoff in the transmission line corridor as impervious surfaces are not proposed to be introduced and the contribution from any less permeable areas (e.g. capped or compacted areas) will be negligible. Any effects on surface water flows during the construction period would be very minor, localised and short term. During construction, stockpiles will be managed to minimise impediment to flow, particularly near drainage lines.

The Project will not alter the hydrology of the Riverland Ramsar site.

The predicted impacts are in the **Negligible** category. Uncertainty in the predicted impact (based on uncertainty in placement of infrastructure or application of construction methodologies) has been evaluated in Appendix O and the level of risk is **Low**.

10.4.6. Groundwater use

Groundwater abstraction (if required) will be assessed and managed so that it does not result in drawdown of aquifers and reduction in groundwater availability for flora, fauna and groundwater users

Use of groundwater has the potential to result in drawdown of aquifers and reduction in groundwater availability for flora, fauna and groundwater users. However, as discussed below, the limited (if any) groundwater use for the project is not anticipated to have any significant impact.

Construction activities will require water for potable water supply (at temporary construction camps), concrete batching, dust suppression, and miscellaneous use such as wash bays. The water may be obtained from a range of sources, including existing licensed users (e.g. local landholders proximal to the route and local councils), the South Australian potable water network and potentially existing and new groundwater wells.

If groundwater is used (e.g. for dust suppression), the volumes used will be relatively low and extraction will be short term. If existing groundwater wells are used for water supply, the use of the wells and volume extracted will be in agreement with the landowner. Any new wells would be drilled in accordance with permit requirements and assessed to ensure that they will not impact any existing groundwater users. Groundwater use in the vicinity of the transmission line corridor is relatively limited.

The predicted impacts are in the **Negligible** category. Uncertainty in the predicted impact (based on uncertainty in the extent and location of possible groundwater use by the Project) has been evaluated in Appendix O and the level of risk is **Low**.

10.4.7. Soil or water contamination

Activities that could result in contamination or reduction in soil or water quality are assessed below. These include wastewater management, dewatering, use of saline water for dust suppression, disturbance of existing contamination and spills.

[3] Section 106 of the *Landscape South Australia Act 2019* outlines circumstances where a permit is not required, which may be relevant for the Project

Wastewater management

Wastewater disposal (e.g. temporary worker camp wastewater, washdown water) will be appropriately managed to avoid contamination of soil, surface water or groundwater

If an on-site wastewater treatment system is installed at camps, it would be designed and operated in accordance with the On-site Wastewater Systems Code and the *South Australian Public Health (Wastewater) Regulations 2013* to ensure that potential impacts are appropriately managed. Temporary washdowns would be operated in accordance with relevant EPA SA guidelines (e.g. EPA 517/16 *Stormwater management for wash bays*). Lined washout bays would be used to capture any hardened concrete, residual slurry or wastewater from washing of concrete trucks, prior to transport of waste off site once the wastewater has evaporated.

Wastewater management would also be undertaken in accordance with requirements of the Environment Protection (Water Quality) Policy and any wastewater disposal to land would not be in a location where it might enter any waters. Wastewater irrigation sites would be appropriately fenced and would also be located to avoid adverse impacts to native vegetation. Licensed contractors would be used where wastewater is removed for off-site treatment or disposal.

The predicted impacts are in the **Negligible** category. Uncertainty in the predicted impact (based on uncertainty in the locations for disposal or implementation of management measures) has been evaluated in Appendix O and the level of risk is **Low**.

Dewatering of excavations

Groundwater will largely not be intersected by excavation and dewatering (if required) will be managed appropriately to ensure there are no impacts to soil and surface water quality

Dewatering of excavations that encounter shallow groundwater or that collect rainwater or runoff can potentially result in soil erosion and soil and surface water quality impacts, if inappropriately managed.

The Project is not anticipated to intersect groundwater for the majority of the transmission line corridor as depth to groundwater is generally greater than 20 m. Shallower groundwater may occur within some areas (e.g. north of Cooltong, where it is mapped at 5 – 10 m depth). Footing excavations (which are typically 13 – 16 m in depth) may require dewatering (to adjacent land) during construction in these areas, or in other locations if excavations are open during significant rainfall events and collect runoff.

Dewatering would be undertaken in accordance with requirements of the Environment Protection (Water Quality) Policy and relevant guidelines e.g. EPA 1093/18 *Environmental management of dewatering during construction activities.*

If excavations require dewatering, water quality would be assessed to ensure that it is suitable for the disposal site with reference to relevant guidelines (e.g. EPA SA guidelines, ANZECC / ARMCANZ 2000 and ANZG 2018). Dewatering would be to land, in a location where it would not enter waters. It would be undertaken with landholder consent and sediment and erosion controls outlined in the CEMP would be in place. Alternatively, water may be treated or removed off-site for re-use or disposal.

Impacts of dewatering excavations on groundwater (e.g. drawdown) would be very localised and short term.

The predicted impacts are in the **Negligible** category. Uncertainty in the predicted impact (based on uncertainty in groundwater depths in the eastern end of the transmission line corridor and implementation of management measures) has been evaluated in Appendix O and the level of risk is **Low**.

Use of saline water for dust suppression

Use of saline water for dust suppression is expected to have a negligible impact

Saline water may be used for dust suppression on access tracks and stockpiles. Saline water may be extracted from groundwater wells or obtained from water treatment plant discharge and applied via water cart sprinklers and or hoses. There may be a minor and temporary increase in the salts in the soil or depositing on the leaf surface of plants in the immediate vicinity of areas where dust suppression undertaken as a result of the use of saline water in this application.

The impact of saline water use is expected to be confined to the disturbance footprint and even within the footprint, effects are likely to be very minor given the short-term nature of construction activities at any given location.

The predicted impacts are in the **Negligible** category. Uncertainty in the predicted impact (based on uncertainty in water salinity and extent of use) has been evaluated in Appendix O and the level of risk is **Low**.

Disturbance of existing contaminated soil

Existing contamination is not expected to be encountered or disturbed and procedures will be in place to prevent any additional contamination of soil, surface water or groundwater if it is encountered

While there is always potential for small-scale localised contamination in the transmission line corridor (e.g. if fuel or chemicals have been spilled or inappropriately disposed in the past), this is not considered likely. The detailed design process and geotechnical assessments will identify whether there are any potential site contamination issues at potential tower locations or specific management measures required. The CEMP will contain measures that would be implemented in the case of a discovery of potentially contaminated soil or groundwater, including measures to contain material and treat it on site or remove off-site for treatment or disposal at an appropriately licensed facility.

The predicted impacts are in the **Negligible** category. Uncertainty in the predicted impact (based on uncertainty in the potential for unexpected discovery or implementation of management measures) has been evaluated in Appendix O and the level of risk is **Low**.

Spills of chemicals or hydrocarbons

Appropriate storage and handling of chemical and fuels will be undertaken and contamination of soil, surface water or groundwater is not expected occur as result of construction and operation

There is no impact expected from the transport, storage and handling of hydrocarbons and chemicals, however accidental spills can lead to local contamination of soil, and potentially secondary impacts on surface water or groundwater.

In order to minimise the risk of soil or water contamination, fuel, oil and chemicals on site will be stored and handled in accordance with relevant standards and guidelines (e.g. AS 1940, EPA guideline 080/16 *Bunding and Spill Management* and the Australian Dangerous Goods Code). Fuel, oil and chemicals will be stored in their product containers with appropriate secondary containment (e.g. lined, bunded areas or on self-bunded pallets). Storage of fuel and chemicals will be restricted to designated areas at temporary facilities (e.g. construction camps and laydown areas). Waste chemicals, oils and other waste substances will be stored in designated waste storage areas for collection by an authorised contractor and disposed of off-site in accordance with EPA SA requirements.

Infield refuelling of vehicles would be undertaken within designated areas (e.g. cleared laydown areas) and is expected to be required infrequently. Permanent or transportable bunds and spill kits would be used for refuelling. All equipment will be subject to scheduled maintenance, to minimise the potential for oil leaks or broken hoses.

Runoff from hardstand areas at the Bundey substation will be directed to an oil water separator / containment tank which will reduce the risk of any spills resulting in contamination off-site.

If a spill occurs, it will be contained, reported and clean up actions initiated. Any contaminated soil resulting from a spill will either be treated in-situ or removed for treatment / disposal at an EPA SA approved facility. Assessment and remediation of spills would be consistent with the National Environment Protection (Assessment of Site Contamination) Measure and relevant EPA SA guidelines. A spill and emergency response plan will be developed to ensure mechanisms are in place to respond to any spill, leak, or unplanned emergency.

The measures that will be implemented for storage and handling of fuels and chemicals are well-established and widely used. They have been implemented successfully by ElectraNet on other transmission line construction projects and are known to be effective.

There are limited surface water receptors along the majority of the transmission line corridor and groundwater is predominantly at depths greater than 20 m, which limits the potential for secondary impacts of a spill to surface water or groundwater (if a spill occurs). As noted above, the transmission line corridor is not in close proximity to the River Murray and is the proposed alignment is separated from the wetlands of the Riverland Ramsar site by the Old Wentworth Road / Renmark-Wentworth Road and distances of 250 m to 500 m or more. Temporary facilities where fuel and chemicals are stored (e.g. camps) would not be established in areas where there is a risk of a spill entering the Riverland Ramsar site wetlands. Shallow groundwater use is also very low, further limiting the potential for secondary impacts of any spills on groundwater users.

There is no impact expected as a result of spills of chemicals or hydrocarbons. The level of risk associated with an unplanned event occurring has been assessed in Appendix O. The credible worst-case consequence would arise if a spill occurred near surface water, and is in the **Moderate** category, and this is considered **Unlikely**. The level of risk is **Low**.

10.4.8. Summary of key mitigation measures

Table 10-8: Key mitigation measures – physical environment

Mitigation measure	Construction	Operation
Restrict the area and duration of soil disturbance to the minimum necessary.	✓	✓
Retain groundcover where possible (e.g. for the stringing access corridor)	✓	
Incorporate existing tracks into the design as far as possible.	✓	
Locate and construct infrastructure such as towers, tracks and temporary facilities to minimise the potential for erosion and avoid alteration of surface water flows.	✓	✓
Install sediment and erosion controls (e.g. berms, drainage controls, sediment fencing) where necessary.	✓	✓
Implement measures to minimise wind erosion (e.g. watering or stabilisation) where required.	✓	
Ensure towers are not placed in watercourses, or on dune crests in areas of high erosion potential.	✓	✓
Undertake geotechnical investigations for detailed design.	✓	
Stockpile topsoil and cleared vegetation (separate from subsoil stockpiles) for re-spreading over areas of temporary disturbance.	✓	
Limit vehicle movements to defined tracks and work areas	✓	✓
Locate soil stockpiles to minimise the potential for off-site impacts (e.g. away from watercourses or potential flow paths.	✓	
Obtain water affecting activity permits for watercourse crossings where required.	✓	
Locate camps and temporary facilities away from watercourses and lakes.	✓	
Locate towers to avoid areas of potential acid sulfate soils as far as possible (e.g. near lakes at eastern end of transmission line corridor)	✓	✓
Develop a protocol for dealing with acid sulfate soils and potentially contaminated material if encountered during construction.	✓	

Mitigation measure	Construction	Operation
Manage any disturbed acid sulfate soil in accordance with industry standards (e.g. appropriate soil handling methods and lime dosing rates).	✓	
Implement appropriate measures for dewatering, such as disposal on site away from surface water features if it suitable for the disposal site (with reference to relevant guidelines).; water treatment; or removal off site for treatment or disposal. Any disposal on site must have landholder consent and be in a manner that minimises sedimentation and erosion.	✓	
Ensure that groundwater abstraction rates and volumes are within limits agreed with well owner.	✓	
Assess any new water supply wells to ensure they will not impact existing groundwater users.	✓	
Obtain appropriate permits for the construction of water supply wells where required.	✓	
Undertake hydrocarbon and chemical storage in accordance with Australian Standards and EPA SA bunding guidelines.	✓	
Undertake infield refuelling (where required) in designated areas with appropriate bunding and spill kits in place.	✓	✓
Avoid refuelling activities in close proximity to surface water features.	✓	✓
Manage camp wastewater in accordance with health regulations and *Environment Protection (Water Quality) Policy 2015.*	✓	
Maintain equipment to prevent spills or leaks.	✓	✓
Implement spill and emergency response procedures including containment, reporting and clean up.	✓	✓
Use licensed chemical and waste transporters.	✓	
Undertake progressive rehabilitation of temporary construction areas	✓	
Rehabilitate areas of temporary disturbance by scarifying or ripping to alleviate compaction and replacing any previously stripped stockpiled topsoil and vegetation (or as agreed with relevant landholders).	✓	
Undertake monitoring during and after construction to ensure that sediment and erosion control measures are effective and undertake remediation if required.	✓	✓
Monitor the easement and access tracks for evidence of erosion or sedimentation and undertake remediation where required.		✓

10.5. Conclusion

ElectraNet’s key finding is that Project construction or operational activities will not have a significant impact on the physical environment. Potential impacts (e.g. erosion and sedimentation, alteration of surface water flows or spills) can be readily managed with appropriate location of infrastructure and application of standard management measures.