Appendix M Hydrogeological Assessment Report

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Hydrogeological Assessment Report

Daroobalgie Solar Farm

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Executive Summary

The Daroobalgie Solar Farm Project (the Project) is proposed to comprise the installation of approximately 420,000 solar photovoltaic (PV) panels, associated infrastructure, and an electricity transmission line (ETL) to connect the solar farm to an existing 132kV powerline west of Newell Highway. The Project will have an estimated capacity of approximately 100 megawatts (MW) and will provide enough electricity to power up to the equivalent of 34,000 homes each year.

The proposed Project comprises:

- A network of PV solar panel arrays and Power Conversion Units (PCUs) (DC-AC inverters)
- Battery energy storage system (BESS) with embedded storage of approximately 40MW/160MWh
- Electrical collection systems, substation and control room
- Temporary construction compound
- Operations and Maintenance (O&M) facility, including demountable offices, amenities, equipment sheds, storage and parking areas
- Internal access roads
- Perimeter security fencing
- An approximate 8.5 km long 132 kV transmission line
- A 132kV switchyard to connect to the existing 132 kV powerline (TransGrid infrastructure).

Assessment requirements

The Project's Secretary's Environmental Assessment Requirements (SEARs) was issued on 19 December 2019. The SEARs relating to hydrology and hydraulics were to prepare an assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources (including the unnamed water course traversing the solar farm site), drainage channels, wetlands, riparian land, farm dams, groundwater dependent ecosystems and acid sulfate soils), related infrastructure, adjacent licensed water users and basic landholder rights, and measures proposed to monitor, reduce and mitigate these impacts.

The assessment of the hydrogeology for the Project was undertaken using the following information or data sources:

- Daroobalgie Solar Farm Preliminary Geotechnical Report (Golder, 2019)
- Bureau of Meteorology:
  - National Groundwater Data base
  - GDE Mapping data base
  - Climate averages
- Parks 1:100,000 Geological Map Sheet 8531, 1st Ed 2000
- Department of Industry Office of Water 2012 Upper Lachlan groundwater flow model
- Department of Industry Office of Water 2010, Upper Lachlan Alluvium Groundwater Management Area 011 Groundwater Status Report – 2010

Existing environment

The Project is located on the western plains in central NSW approximately 11 kilometres (km) northeast of Forbes. The climate averages for the region within which the Project is located were obtained from the Forbes Airport AWS BOM station No 065103, located about seven kilometres west of Forbes. The climate is mild to warm with significant temperature variations between seasons as it is located on the transition region between the semi-arid climate to the west and humid subtropical climates to the east. Mean monthly rainfall is relatively consistent throughout the year with an annual average of approximately 480 mm. Average evapotranspiration exceeds rainfall annually, and in all months except June. The high evapotranspiration limits rainfall recharge to groundwater which is considered less than three percent of the annual rainfall (refer to Section 2 for more detail).

Project construction impacts and mitigation measures

The potential construction impacts to groundwater include:

- Water quality changes due to soil disturbance
- Contamination via chemical or hydrocarbon spills
- Recharge changes due to changes to surface covering and solar panels.

The maximum depth of solar panel footings is assumed to be less than two metres which is not anticipated to intercept the water table at the solar farm site. The maximum excavation depth for electricity transmission poles will be determined post detailed geotechnical studies however is expected to be less than four metres which is unlikely to intercept the top of the water table. Installation of driven piles for the solar panels and changes to the impervious areas are not anticipated to have an identifiable impact on groundwater levels or quality...

Construction water supplies will not be sourced from groundwater, therefore there are no anticipated impacts due to extraction.

The following construction phase mitigation measures will be employed:

- All fuel and chemicals used for the Project will be stored in designated bunded areas
- Refuelling activities to be undertaken in a bunded area or on hardstands where fuel spill kits are available
- Temporary Project offices and work spaces to have a portable above ground systems (i.e. above ground pump out septic systems)
- Construction water supplies to be trucked in.

Project operation impacts and mitigation measures

Potential operational impacts to groundwater may include:

- A reduction in evapotranspiration due to shading of the ground surface
- Contamination due to chemical and or fuel spills
- An increase in recharge across the solar farm site due to shading and point source recharge from panel runoff.

All potential impacts to groundwater are considered minor and are not anticipated to adversely impact groundwater resources.

The following operational phase mitigation measures will be employed:

- Bunding of fuels and chemicals storage areas
- Ongoing maintenance of plant and equipment to avoid / minimise chemical and or fuel spills
- Regular pumping out of septic systems.

The proposed development will not have direct interactions with groundwater. Any potential impacts are considered secondary, such as a fuel spill which reaches the water table before interception, and therefore able to be managed via standard mitigation measures common on operational industrial sites.

Conclusion

The following conclusions are drawn from the hydrogeological assessment:

- The proposed Project construction and operation are not anticipated to impact groundwater through direct interactions (excavations)
- There may be a low probability of the Project impacting groundwater though changes to recharge as a result of:
  - reduced evapotranspiration
  - increased point source recharge through runoff from panels
- Any changes to groundwater (levels and quality) as a result of the Project are likely to be minimal and not likely to be detectable

The risks of groundwater contamination (from spills) during construction and operation of the Project is considered low provided that appropriate mitigation measures are employed.

Terms and Definitions

Term	Meaning
EC	Electrical conductivity
ETL	Electricity transmission line
kV	Kilovolts
m	Metres
mAHD	Metres Australian height datum
mbgl	Metres below ground level
MW	Megawatts
Permeability	Measurement of the rate of water movement through a porous media (i.e. L/t)
PV	Solar photovoltaic
Solar farm site	The solar farm site is approximately 300 hectares on land legally described as Lot 77 in Deposited Plan 750183
Substation	This refers to the substation within the solar farm site
Switchyard site	This refers to the switchyard infrastructure at the point where the Project will connect into the Parkes-Forbes 132 kV line
SWL	Standing water level
TDS	Total dissolved solids
The Project	The Daroobalgie Solar Farm comprises of a solar farm site, the ETL and the switchyard site
µS/cm	Micro siemens per centimetre

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1 Introduction

1.1 Project description

1.1.1 Overview

The Daroobalgie Solar Farm (the Project) comprises the installation of approximately 420,000 solar photovoltaic (PV) panels, associated infrastructure (i.e., substation, Battery Energy Storage System, inverters, power cabling, Project offices, car parking, and new access tracks), an Electricity Transmission Line (ETL) and a switchyard site to connect the Project to the existing 132 KV powerline west of Newell Highway. The Project will have an estimated capacity of approximately 100 megawatts (MW) and will provide enough electricity to power up to the equivalent of 34,000 homes each year.

1.1.2 Site and Surrounds

The solar farm site is located approximately 11 kilometre (km) northeast of Forbes. The site is approximately 300 hectares (ha) on land legally described as Lot 77 in Deposited Plan 750183. The solar farm site will be accessed by Troubalgie Road to the north of the Project.

The ETL connects the solar farm site to the switchyard site located near the existing Forbes-Parkes 132 kilovolts (kV) transmission line. The ETL easement is approximately 8.5 km long and approximately 45 metre (m) wide. The easement traverses a number of private properties and road reserves.

The switchyard site is located approximately 5.5 km north of Forbes on Lot 14 in Deposited Plan 750158. The switchyard site is adjacent to the existing Forbes-Parkes 132 kV transmission line located approximately 500 m west of the Newell Highway. It will be accessed from Daroobalgie Road.

The solar farm site is shown on Figure 1-1 and the Project is shown at Figure 1.2.

1.1.3 Project Infrastructure

The proposed Project comprises:

- A network of PV solar panel arrays and Power Conversion Units (PCUs) (DC-AC inverters)
- Battery energy storage system (BESS) with embedded storage of approximately 40MW/160MWh
- Electrical collection systems, substation and control room
- Temporary construction compound
- Operations and Maintenance (O&M) facility, including demountable offices, amenities, equipment sheds, storage and parking areas
- Internal access roads
- Perimeter security fencing
- An approximate 8.5 km long 132kV transmission line
- A 132kV switchyard to connect to the existing 132kV powerline (TransGrid infrastructure).

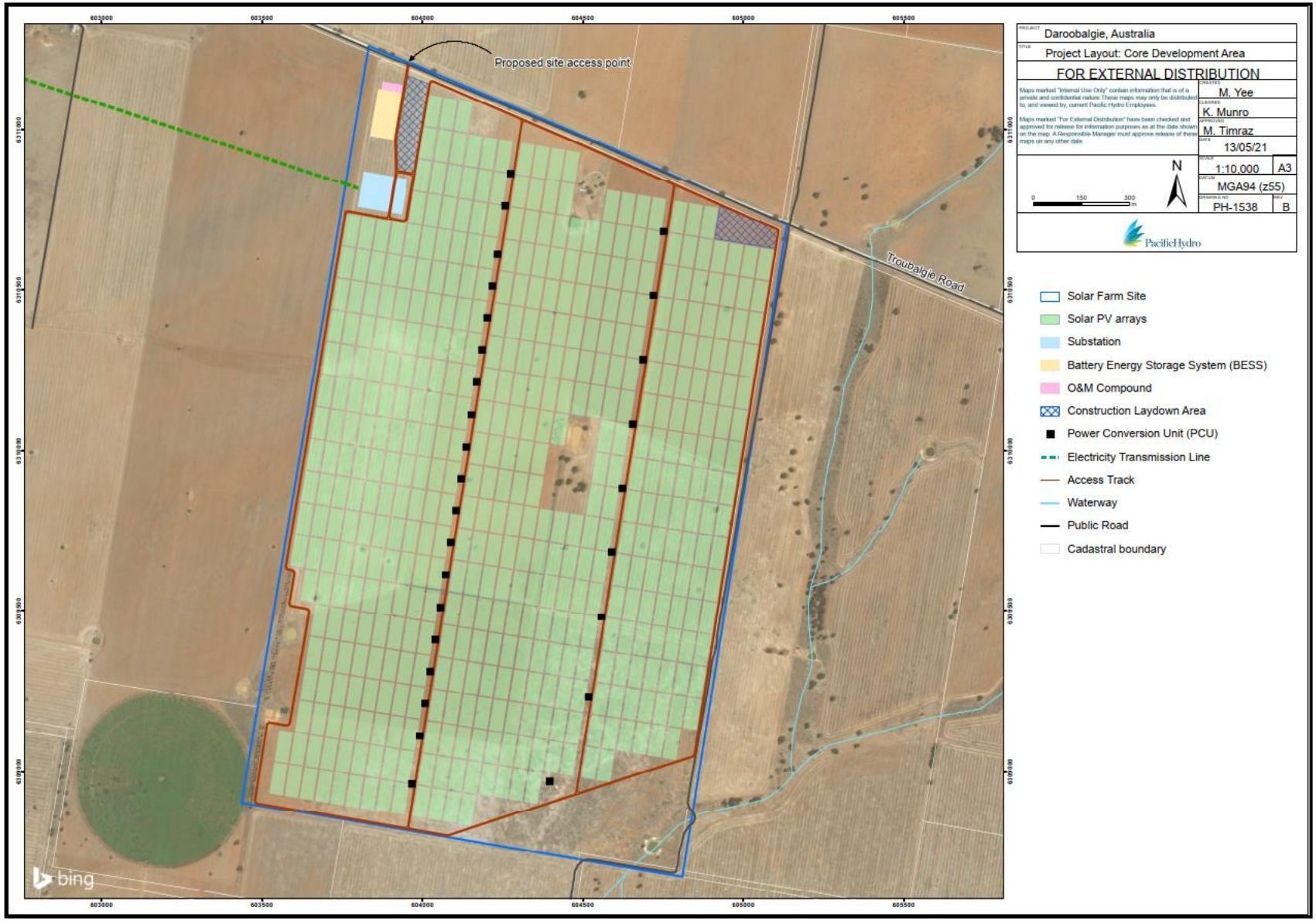

Figure 1.1 The solar farm site

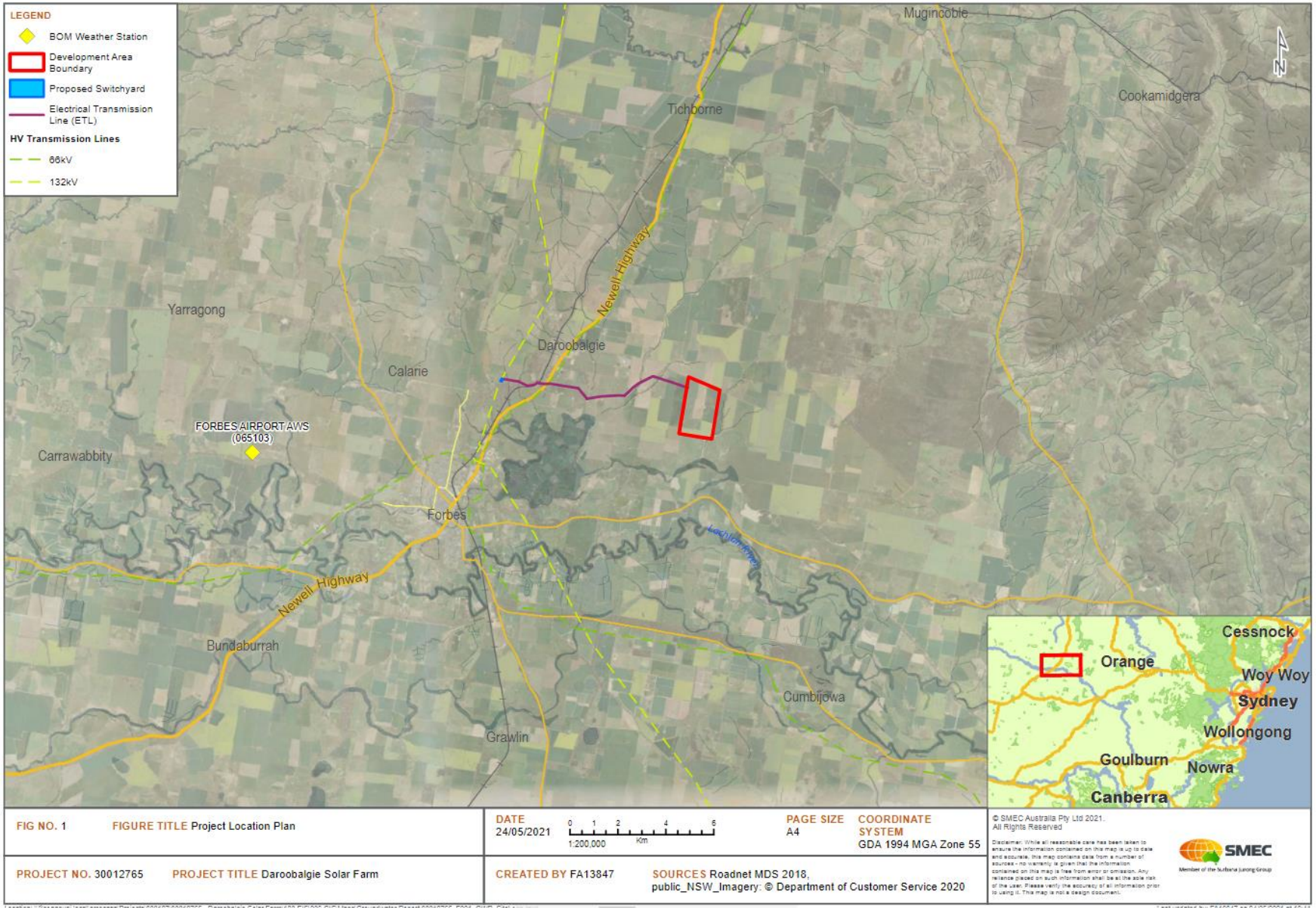

Figure 1.2: Project location showing the solar farm site, electricity transmission line and switchyard site

1.2 Approval and Assessment Requirements

1.2.1 Planning Secretary's Environmental Assessment Requirements (SEARs)

The Project SEARs were issued on 19 December 2019. The SEARs relating to hydrology and hydraulics are shown below in Table 1-1. The Project has been designated State Significant Development (SSD) in accordance with the provisions of Division 4.7 of the *Environmental Planning and Assessment Act 1979* (EP&A ACT).

Table 1-1: SEARs – Hydrology and hydraulics

Requirement	Where addressed in this report
an assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources (including the unnamed water course traversing the site), drainage channels, wetlands, riparian land, farm dams, groundwater dependent ecosystems and acid sulfate soils), related infrastructure, adjacent licensed water users and basic landholder rights, and measures proposed to monitor, reduce and mitigate these impacts;	Chapter 3, section 3.1 and 3.2 Chapter 4, Sections 4.1 and 4.2
details of water requirements and supply arrangements for construction and operation; and	Groundwater is not intended to be used for construction or operation of the Project

1.3 Legislation and Guidelines

The legislative and policy context relevant to groundwater are summarised in the following sections.

1.3.1 Water Act 1912 and Water Management Act 2000

Water resources in NSW are administered under the *Water Act 1912* and the *Water Management Act 2000* (WM Act) by the NSW Department of Planning, Industry and Environment. The WM Act governs the issue of water access licences and approvals for those water sources (rivers, lakes, estuaries and groundwater) in NSW where Water Sharing Plans (WSP) have commenced. The WSPs for the study area have commenced and water management for the Project is therefore generally governed under the WM Act. The exception is aquifer interference approvals, which are still governed under the *Water Act 1912*. The WSPs relevant to the proposal are described further in Section 1.3.2.

Ordinarily, if a Project extracts groundwater, whether directly due to pumping bores, or indirectly due to excavations beneath the water table intercepting groundwater seepage, the following approvals/licenses would typically be required:

- Water Use Approval under section 89 of the WM Act
- Water Supply Work Approval (falls under the umbrella of a water management work approval) under section 90 of the WM Act
- Water Access Licence (WAL) with sufficient entitlement volume in the relevant water source to account for the groundwater take.

Due to exemptions outlined in Division 4.7 of the EP&A Act, groundwater extraction activities that are assessed and approved as part of SSD Projects are exempt from water use approvals under section 89, water management work approvals under section 90, or an activity approval (other than an aquifer interference approval) under section 91 of the WM Act. The Project will not extract groundwater for construction or operational purposes, and it is not anticipated to intercept groundwater in excavations, trenches or pits.

1.3.2 Water Sharing Plan

Numerous Water Sharing Plans (WSPs) are established throughout NSW for the use of groundwater. The purpose of a WSP is to provide water users with a clear picture of when and how water will be available for extraction, protect the fundamental environmental health of the water source and ensure the water source is sustainable in the long-term. WSPs are sometimes subdivided into subset areas, referred to as 'sources', based on groundwater system characteristics. Multiple WSPs and sources can occur vertically on top of one another due to different hydrogeological systems. To determine WSPs/groundwater sources applicable to the proposal, the WSPs/groundwater sources were

visualised using the NSW Government Sharing and Enabling Environmental (SEED) Data Web Map Service (WMS), viewed within geographical information system (GIS) software.

The proposed Project has the potential to interact with the WSP outlined in Table 1-2.

Table 1-2 Potential interaction of the Project with WSPs

Proposal Feature	WSP	Groundwater Source
Project and ETL Construction Footprint	Lachlan Unregulated and Alluvial Water Sources – Upper Lachlan Alluvial	Murrumbidgee unregulated and alluvial water sources (Cowra Formation)
Project and ETL Construction Footprint	NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011	Lachlan Fold Belt MDB Groundwater Source

1.3.3 NSW Aquifer Interference Policy

The *NSW Aquifer Interference Policy* (AIP) (Department of Primary Industries, Office of Water, 2012) outlines minimal impact considerations for water table and groundwater pressure drawdown for high priority groundwater dependent ecosystems (GDEs) (as identified in the WSP), high priority culturally significant sites (as identified in the WSP) and existing groundwater supply bores. Water quality impact considerations are also outlined.

In the context of the AIP, the proposal is located in an alluvial / colluvial groundwater recharge source (Cowra Formation) and is considered to be underlain by highly productive groundwater sources. For adopting minimal impact consideration criteria from the AIP for groundwater impact assessment purposes, all groundwater systems applicable to the proposal were assumed to be 'highly productive'. 'Highly productive' groundwater sources are defined by the AIP to have total dissolved solids concentrations of less than 1,500 milligrams per litre and yields greater than five litres per second at bores. In accordance with the AIP, the minimal impact considerations outlined in Table 2.4 (of the AIP) apply and the term 'make good provisions' is used. Although not defined in the AIP, if make good provisions apply, a bore impacted due to drawdown requires replacement or some form of rectification. This could involve drilling of a replacement bore, possibly in a different location, or to a deeper depth to reinstate the pre-impacted groundwater level and bore yield.

The Project will not extract and is not anticipated to intercept groundwater, therefore 'make good provisions' are not anticipated to apply to this proposal.

1.3.4 Groundwater Dependent Ecosystems Policy

The *NSW State Groundwater Dependent Ecosystems (GDE) Policy* (Department of Land and Water Conservation, 2002) implements the WM Act by providing guidance on the protection and management of GDEs. It sets out management objectives and principles to:

- Ensure that the most vulnerable and valuable ecosystems are protected
- Manage groundwater extraction within defined limits thereby providing flow sufficient to sustain ecological processes and maintain biodiversity
- Ensure that sufficient groundwater of suitable quality is available to ecosystems when needed
- Ensure that the precautionary principle is applied to protect GDEs, particularly the dynamics of flow and availability and the species reliant on these attributes
- Ensure that land use activities aim to minimise adverse impacts on GDEs.

1.3.5 National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) is the adopted national approach to protecting and improving water quality in Australia. It consists of several guideline documents, of which certain documents relate to protection of surface water resources and others relate to the protection of groundwater resources. The primary document relevant to the assessment of groundwater risks for the proposal is the Guidelines for Groundwater Quality Protection in Australia (Department of Agriculture and Water Resources, 2013). This document sets out a high-level risk-based approach to protecting or improving groundwater quality for a range of groundwater beneficial uses (called 'environmental values'), including aquatic ecosystems, primary industries (including irrigation and general water users, stock drinking water, aquaculture and human consumption of aquatic foods), recreational and aesthetic values (e.g., swimming, boating and aesthetic appeal of water bodies), drinking water, industrial water and cultural values. For the

purpose of this assessment, 'environmental values' pertaining to drinking water, which is considered to have the highest 'environmental value', were considered applicable. The Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality (Australian Government, 2018) provide a framework for conserving ambient water quality in rivers, lakes, estuaries and marine waters and list a range of environmental values assigned to that waterbody. The ANZG (2018) recommended guideline values have been considered in assessment of existing groundwater quality.

1.4 Assessment Methodology

The assessment of the hydrogeology for the Project was undertaken using the following information or data sources:

- Daroobalgie Solar Farm Preliminary Geotechnical Report (Golder, 2019)
- Bureau of Meteorology:
  - National Groundwater Data base
  - GDE Mapping data base
  - Climate averages
- Parks 1:100,000 Geological Map Sheet 8531, 1st Ed 2000
- Department of Industry Office of Water 2012 Upper Lachlan groundwater flow model
- Department of Industry Office of Water 2010, Upper Lachlan Alluvium Groundwater Management Area 011 Groundwater Status Report – 2010

The available information was assessed and compared to the SEAR's requirements to provide an assessment of the potential Project construction and operation impacts on groundwater.

2 Existing Environment

2.1 Climate

2.1.1 Rainfall and Evaporation

The Project is located on the western plains in central NSW approximately 11 km northeast of Forbes. The climate averages for the region within which the Project is located within were obtained from the Forbes Airport AWS BOM station No 065103, located about seven kilometres west of Forbes (refer to Figure 1.2 above). The climate is mild to warm with significant temperature variations between seasons as it is located on the transition region between the semi-arid climate to the west (BSh) and humid subtropical climates (Cfa) to the east. Mean monthly rainfall is relatively consistent throughout the year with an annual average of approximately 480 millimetre (mm). Average evapotranspiration (ET) exceeds rainfall annually, and in all months except June. The high ET limits rainfall recharge to groundwater which is considered less than three percent of the annual rainfall. Figure 2.1 provides mean monthly rainfall, minimum temperature, maximum temperature, and average monthly evapotranspiration.

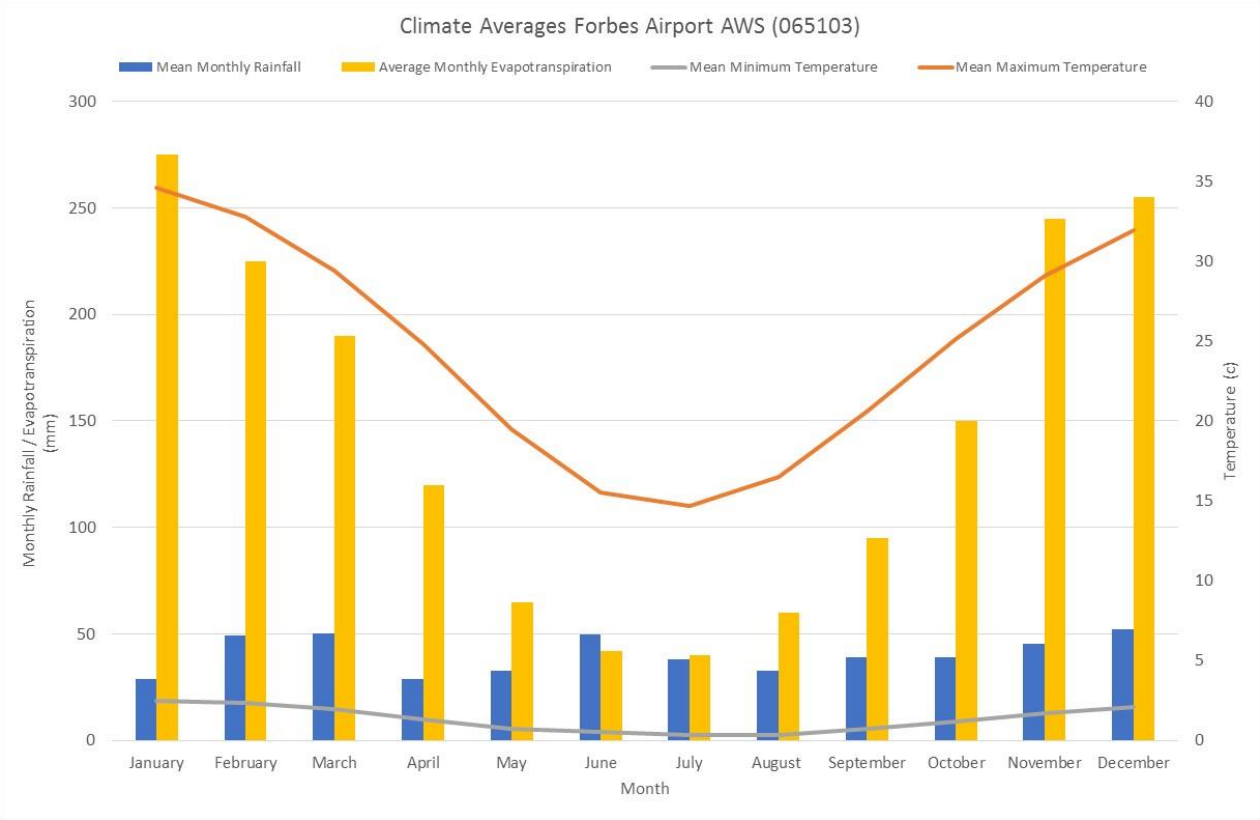

Figure 2.1: Climate averages for Forbes Airport AWS, BOM station 065103

2.2 Topography

The Project is located on land that is relatively flat. The solar farm site is located on land which gently slopes from north to south from around 250 m AHD at the northern boundary on Troubalgie Road to around 244 m AHD at the southern boundary. From the southern boundary the land generally slopes further to the south towards the Lachlan River located some 3.5 km away. The land around the switchyard site and the ETL is generally flat. The nearest elevated land is the Back Yamma State Forest at 340 mAHD approximately seven kilometres to the east-northeast of the Project.

2.3 Land Use

The predominant current land use in the Project area is broad acre cropping and grazing. There are currently four constructed dams within the proposed solar farm site. The southern portion of the solar farm site and some areas along the ETL are mapped as gilgai which is a hummocky natural land form formed by wetting and drying of shrink / swell clays. The land surface in the Project area has been cultivated through ploughing for at least the past 50 years

resulting in its current soil and structure and minor land form changes through levelling, building of dams and contour banks.

2.4 Surface Water

Surface water drainage is from the east-northeast to south-southwest towards the Lachlan River and associated flood channels. Apart from farm dams, the nearest permanent water course is the Lachlan River, 3.5 km to the south. During floods water tends to flow away from the Lachlan River when it overtops the natural river bank levees, filling the flood plain and entering ephemeral drainage channels where most groundwater recharge occurs.

2.5 Geology

The Project is predominately situated on recent Quaternary and Tertiary sediments consisting of gilgai and shallow slope colluvial plains and rises with some residual veneer interfingers with inactive alluvial plains (Parks 1:100,000 Geological Map Sheet 8531, 1st Ed 2000). The recent sediments overly Ordovician age metasediments of the Kirribilli Formation and Mugincobla Chert and intermediate - mafic volcanics, intrusives and associated volcaniclastic sediments and limestones. The north western corner of the solar farm site may overly the edge of the Silurian – Ordovician sedimentary Cotton Formation.

The Recent Quaternary and Tertiary sediments may be up to 100 m thick and are commonly known as the Cowra Formation. The Cowra Formation consists of a complex pile of interbedded generally fine grained clays, silts and sands with lesser course sand and gravel palaeo channels.

The solar farm site, the majority of the ETL and the switchyard site are located on CZ_a - Alluvium and Q_ca - Mixed colluvial, alluvial and aeolian deposits. A small portion of the ETL does cross over Q_afs - Alluvial floodplain deposits - swamp facies and Q_ca - Mixed colluvial, alluvial and aeolian deposits. The geology underlying the project is shown in Figure 2.2.

2.6 Hydrogeology

Immediately underlying the Project are the upper Quaternary and Tertiary alluvial unconsolidated sediment sequence is divided into two major aquifer formations, the Cowra Formation and the deeper Lachlan Formation. The Cowra Formation unconformably overlies the Lachlan Formation and basement rocks. It is generally 30-50 m thick in most areas. The Cowra Formation forms an important stock, domestic and irrigation water supply in the Forbes area. Coarse sand and gravel palaeo channels and outwash beds within the formation form an unconfined to semi confined upper and semi confined to confined lower laterally discontinuous aquifer system of low to high yield. Registered bores within approximately seven kilometres of the solar farm site are indicated on Figure 2.3.

The Lachlan Formation occurs in the deep incised palaeo channel of the Lachlan River and the maximum thickness is around 90 m. This Formation consists of subrounded to rounded, grey to off white sand and gravel with larger amounts of interbedded brown to yellow to grey clay. The Lachlan Formation is not present under the Project.

2.6.1 Water Table Depth

A search of the Bureau of Meteorology National Groundwater Explorer indicates 51 registered bores within approximately seven kilometres of the Project (refer to Figure 2.3). The nearest borehole with groundwater level information is GW022640 located 3.7 km northeast of the site (refer to Figure 2.4) and shows a range between 59.4 m and 65.9 m below ground level (refer to Table 2-1). There are a number of monitoring bores located south of the Project which indicate a depth to groundwater ranging from around 1.3 m to 34 m. The shallower readings are from bores constructed in the Cowra Formation, while the deeper readings are generally from bores constructed in the lower Cowra, Lachlan Formation gravels or fractured rock underlying the Cowra Formation. The two shallow bores are both located south of the solar farm site, down gradient and reflect water levels closer to the natural discharge along the Lachlan River. The monitoring bore water level information is likely impacted by groundwater pumping and long-term climatic trends as evidenced by the large variation in levels.

The depth to groundwater within the solar farm site was assessed during the preliminary geotechnical investigation conducted by Golder (2019) which included six auger holes and six test pits to a maximum depth of 7.5 m. Groundwater was not encountered in any of the investigation holes or pits. Although, it should be noted the work was undertaken during a period of drought and groundwater levels may have been depressed.

Bore hydrographs for GW030495 pipe 1.1 and GW036502 pipe 1.1 screened in the Cowra Formation indicate the depth to groundwater in the upper portion of the Cowra Formation is moderately linked to the prevailing climatic

conditions with recharge to the water table during wetter periods, especially flood events. The spike in the water level in 1990 – 91 is related to the 1990 flood event.

The depth to water on the solar farm site is likely to vary over time depending on the climate, especially with flooding events. Some bores in the vicinity of the site (Table 2-2) are only 12 m deep suggesting the depth to water may be less than this. Bore logs indicate the depth to the first water strike can be highly variable reflecting the depositional environment of confined alluvial out wash plains and discontinuous palaeo channels infilled with sands and gravels.

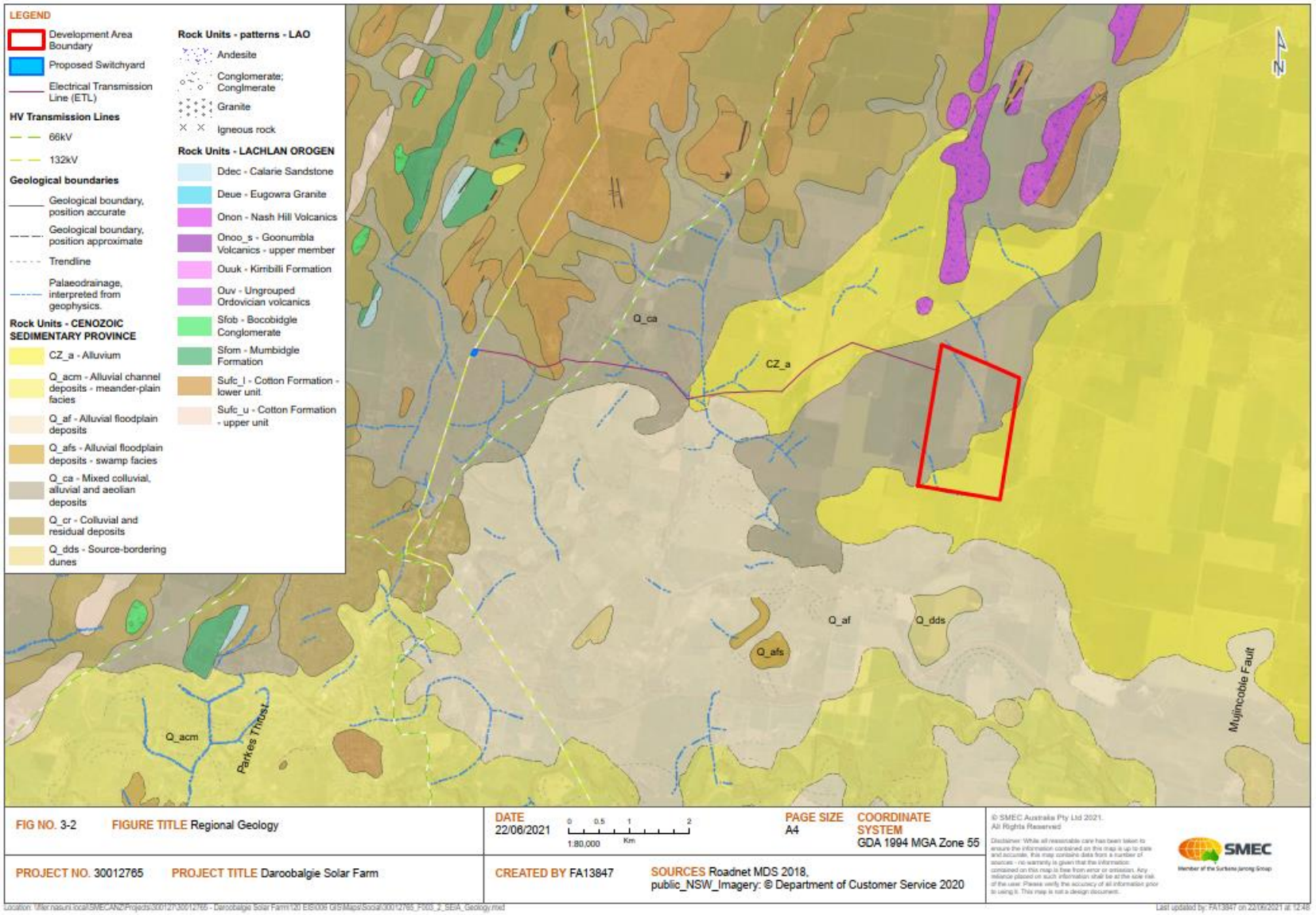

Figure 2.2:Regional geology map

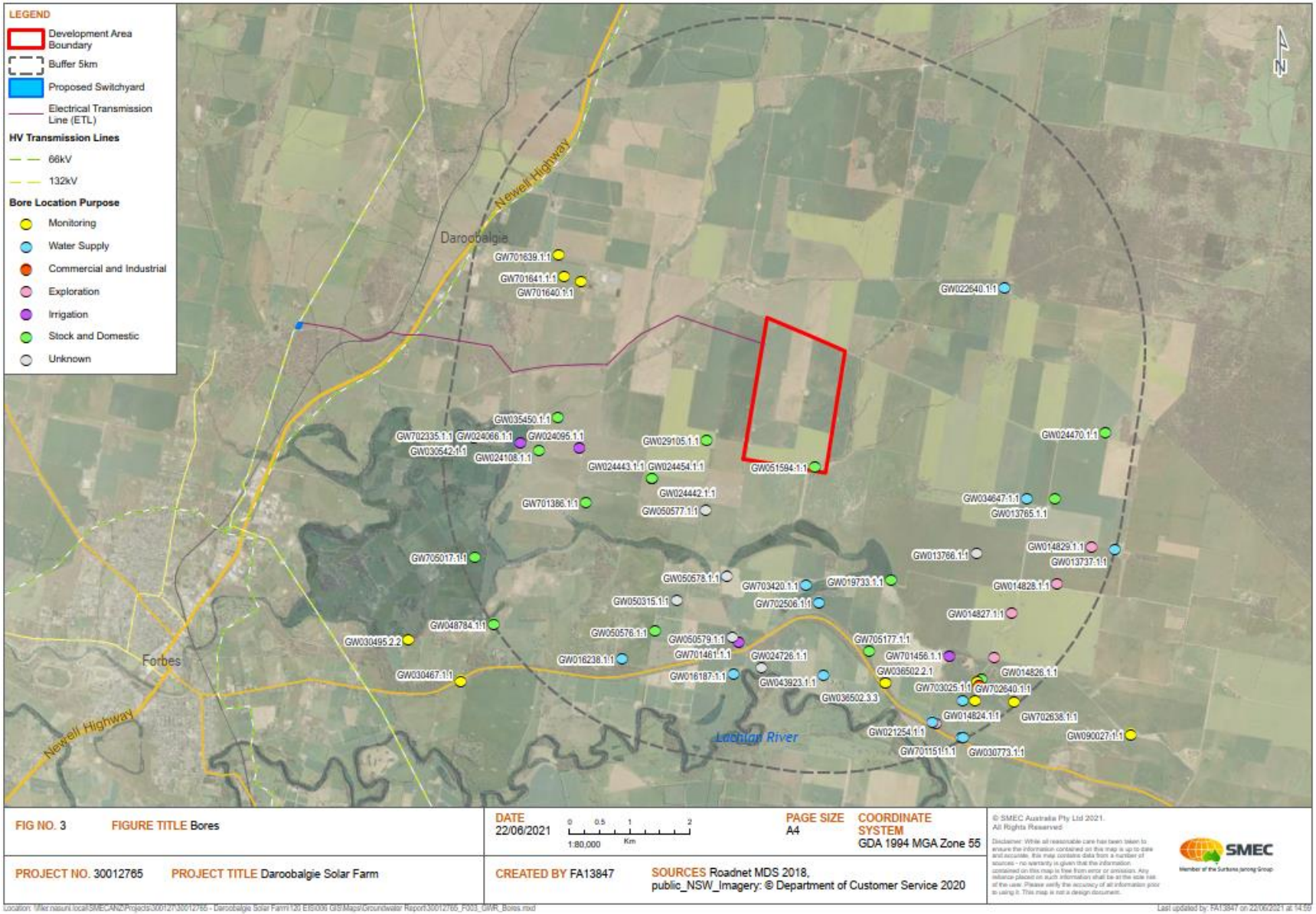

Figure 2.3: Registered bores within 7km of the Project (BOM National Groundwater Explorer)

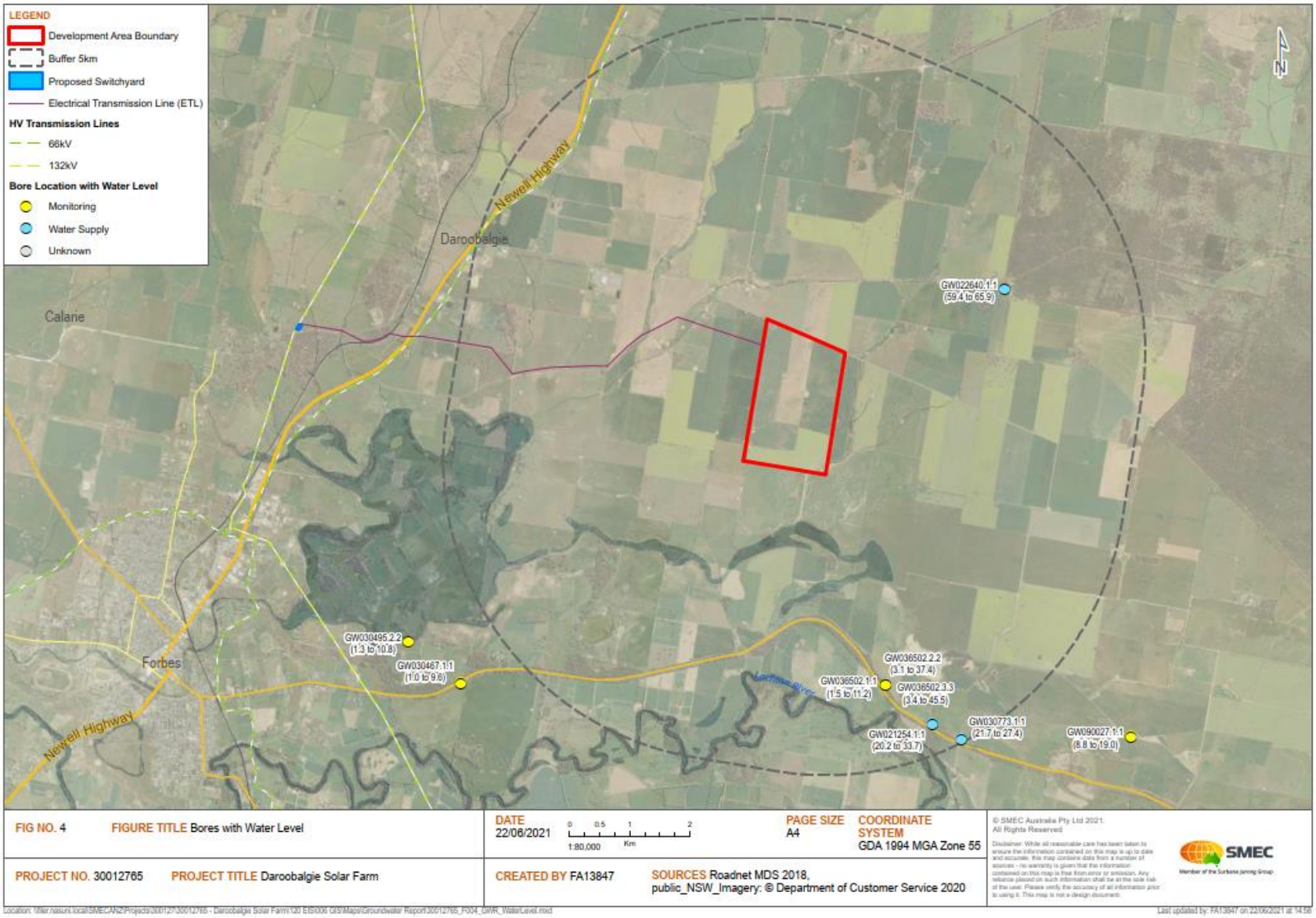

Figure 2.4: Registered bores with water level information (BOM National Groundwater Explorer)

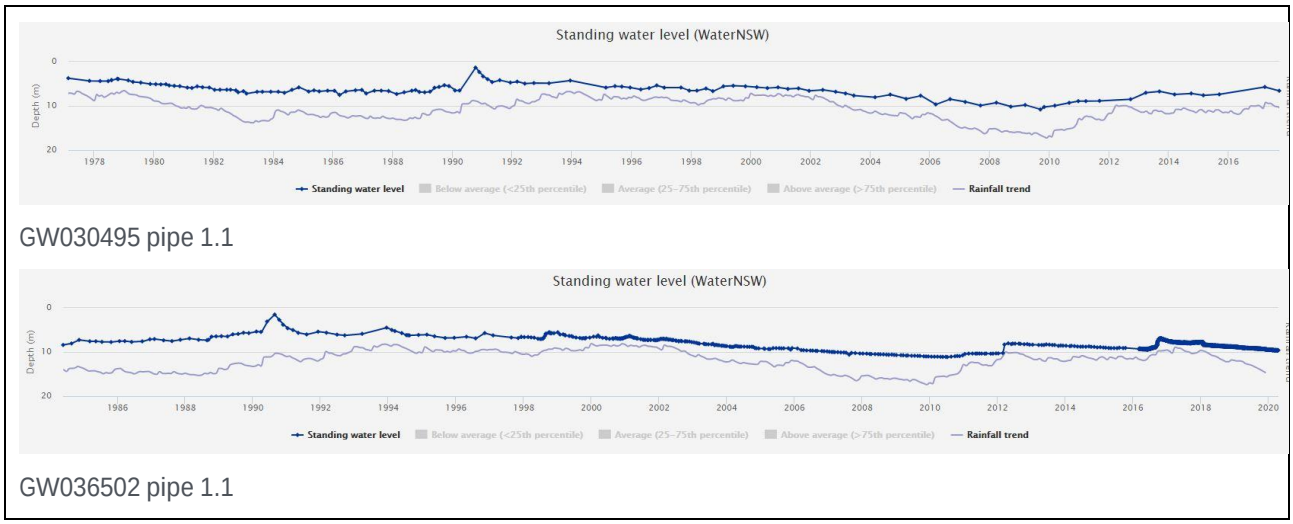

Figure 2.5: Hydrographs for two shallow Cowra Formation bores (BOM National Groundwater Explorer, Water NSW data)

Table 2-1: Summary of bores with water level and salinity information

Bore ID	Bore Depth (mbgl)	Purpose	Formation	Standing Water Level range (mbgl)	Salinity
GW036502.1.1	NA	Unknown	Cowra Formation	1.5 to 11.2	
GW036502.2.2	NA	Unknown	Cowra Formation	3.1 to 37.4	
GW036502.3.3	108	Monitoring	Unknown	3.4 to 45.5	
GW022640.1.1	80	Water Supply	Unknown	59.4 to 65.9	
GW702335.1.1	14	Water Supply	Cowra Formation	NA	1200 (TDS)
GW701151.1.2	125	Water Supply	Unknown	NA	358 (TDS)
GW024726.1.1	14	Unknown	Cowra Formation	NA	392 (µS/cm)
GW701639.1.1	37	Monitoring	Unknown (CF ?)	NA	28 (TDS)
GW030773.1.1	124	Water Supply	Unknown	21.7 to 27.4	335 - 970 (µS/cm)
GW021254.1.1	114	Water Supply	Unknown	20.2 to 33.7	610 - 929 (µS/cm)
GW030495	NA	Monitoring	Cowra Formation	1.3 to 10.8	-
GW030467	NA	Monitoring	Cowra Formation	1.0 to 9.6	-

ID – (Bore) Identification, mbgl – metres below ground level, NA – Not Available, µS/cm – Micro Siemens per centimetre, TDS – Total Dissolved Solids (1 µS/cm is equivalent to approximately 0.7 to 0.8 mg/L TDS)

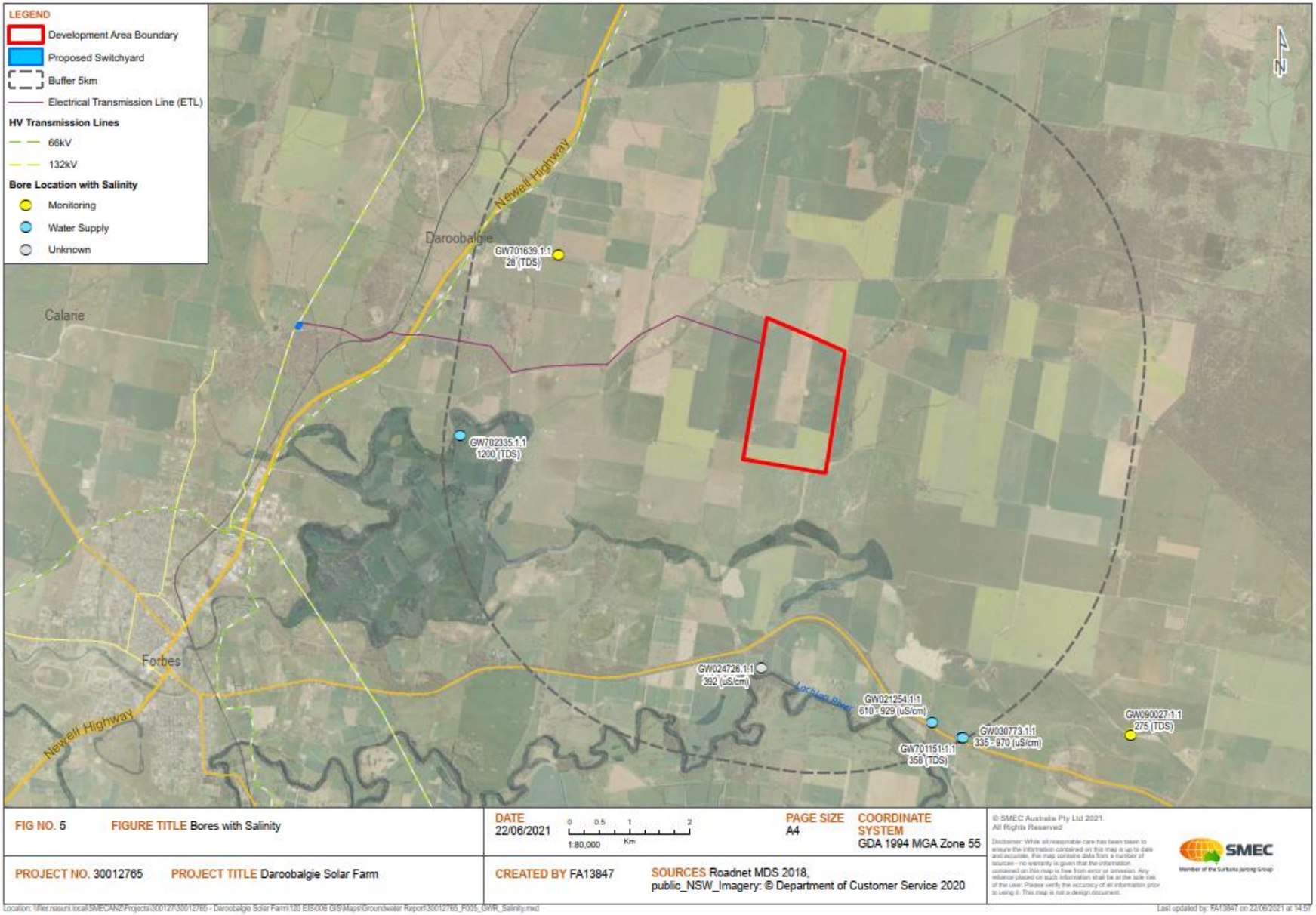

Figure 2.6: Registered bores with groundwater salinity information

2.6.2 Recharge

Groundwater recharge to the upper aquifer is via direct rainfall and flood water infiltration in areas of inundation. Recharge to the underlying meta sediments is via vertical leakage from the overlying sediments or infiltration through exposed bedrock along the contact between overlying Quaternary and Tertiary sediments and bedrock.

2.6.3 Discharge

Discharge from the upper aquifers is via evapotranspiration, discharge as base flow to the down gradient Lachlan River and pumping. Discharge from the bedrock is thought to be via up flow to the Lachlan Gravels and Cowra Formation in low lying areas and pumping. The main discharge mechanism is now thought to be pumping for stock and domestic and irrigation purposes.

2.6.4 Groundwater Flow and Gradient

The regional groundwater flow direction is towards the Lachlan River to the south of the Project. The water table is thought to be a subdued version of topography with a gradient in the order of 0.002 metres over a metre. On a local scale the gradient and flow direction are likely influenced by pumping. In the vicinity of the project there are limited groundwater bores, therefore the flow direction and gradient are assumed to reflect the regional flow towards the Lachlan River.

2.6.5 Groundwater Quality

Groundwater quality (i.e. salinity) for the Cowra Formation ranges from around 28 mg/L to 1200 mg/L Total Dissolved Solids (Figure 2.6) and Table 2-1. The high variability in the salinity reflects the depositional environment and confined discontinuous nature of aquifers within the Cowra Formation. OOW (2012) indicates groundwater salinity generally increases with distance from the Lachlan River.

2.6.6 Beneficial Use

A search of the National Groundwater Explorer data base (Figure 2.3) indicates there are 60 registered bores within approximately 7 km of the Project. The bore details are summarised in Table 2-2 and indicate the following purpose, 17 Stock and Domestic, 13 Water Supply, 10 Monitoring, five Exploration, four Irrigation and 10 Unknown. Bore depths are also highly variable ranging from 9 m to 125 m reflecting the depositional variability of the Cowra Formation and likely variable depth to groundwater and yields.

The shallowest bore GW048784 is located 5 km southwest of the Project and is 9 m deep, while 2 km southwest of the Project GW024454 is 14 m deep and GW019733 2 km southeast is 13 m deep suggesting groundwater is shallower than 13 m within the upper Cowra Formation.

Table 2-2: Summary of registered bores details and purpose within seven kilometres of the Project

Bore ID	Bore Depth (m)	Drilled Date	Purpose	Status	Screened Geology
GW050315.1.1	18		Unknown	Functioning	Cowra Formation
GW701640.1.1	20	10/04/2003	Monitoring	Functioning	Cowra Formation
GW030773.1.1	124	1/06/1980	Water Supply	Unknown	Unknown
GW034647.1.1	36	1/06/1972	Water Supply	Unknown	Unknown
GW048784.1.1	9	1/01/1978	Stock and Domestic	Unknown	Cowra Formation
GW702506.1.1	39	25/01/2005	Water Supply	Functioning	Unknown
GW701641.1.1	27	11/04/2003	Monitoring	Functioning	Unknown (CF ?)
GW024454.1.1	14	1/06/1965	Stock and Domestic	Unknown	Unknown (CF ?)
GW026143.1.1	15	1/03/1966	Stock and Domestic	Unknown	Unknown (CF ?)
GW050576.1.1	18	1/03/1980	Stock and Domestic	Unknown	Unknown (CF ?)

Bore ID	Bore Depth (m)	Drilled Date	Purpose	Status	Screened Geology
GW016238.1.1	15	1/01/1961	Water Supply	Unknown	Cowra Formation
GW019733.1.1	13	1/11/1962	Stock and Domestic	Unknown	Cowra Formation
GW024442.1.1	44	1/06/1964	Stock and Domestic	Unknown	Unknown
GW013766.1.1	16	1/01/1944	Unknown	Unknown	Unknown (CF ?)
GW702639.1.1	119	27/10/2005	Monitoring	Proposed	Unknown
GW036502.3.1	0		Unknown	Unknown	Unknown
GW701461.1.1	64	15/05/2002	Irrigation	Functioning	Unknown
GW051594.1.1	36	1/08/1980	Stock and Domestic	Unknown	Unknown
GW036502.1.1	0	1/03/1984	Unknown	Unknown	Cowra Formation
GW024066.1.1	24	1/01/1966	Irrigation	Proposed	Unknown (CF ?)
GW036502.2.2	0	1/03/1984	Unknown	Unknown	Unknown
GW030542.1.1	30	1/09/1970	Stock and Domestic	Unknown	Unknown (CF ?)
GW014825.1.1	26	1/11/1963	Water Supply	Proposed	Unknown (CF ?)
GW024108.1.1	11	1/02/1966	Stock and Domestic	Functioning	Unknown (CF ?)
GW014827.1.1	117	1/07/1963	Exploration	Abandoned	Unknown
GW703420.1.1	0	17/02/2009	Water Supply	Functioning	Unknown
GW016187.1.1	14	1/08/1960	Water Supply	Unknown	Cowra Formation
GW043923.1.1	91	1/04/1975	Water Supply	Unknown	Unknown
GW014828.1.1	80	1/06/1963	Exploration	Proposed	Unknown
GW701456.1.1	100	30/10/1996	Irrigation	Unknown	Unknown
GW705177.1.1	108	6/09/2018	Stock and Domestic	Proposed	Unknown
GW014829.1.1	90	1/06/1963	Exploration	Proposed	Unknown
GW050578.1.1	18		Unknown	Functioning	Unknown (CF ?)
GW702335.1.1	14	12/12/2004	Water Supply	Functioning	Unknown (CF ?)
GW013765.1.1	35	1/01/1938	Stock and Domestic	Unknown	Unknown
GW029105.1.1	24	1/12/1966	Stock and Domestic	Unknown	Unknown (CF ?)
GW701386.1.1	0	21/11/2001	Stock and Domestic	Functioning	Unknown
GW702638.1.1	113	28/10/2005	Monitoring	Proposed	Unknown
GW050577.1.1	18		Unknown	Functioning	Unknown (CF ?)
GW702640.1.1	119	26/10/2005	Monitoring	Removed	Unknown
GW013737.1.1	28	1/01/1938	Water Supply	Unknown	Unknown (CF ?)

Bore ID	Bore Depth (m)	Drilled Date	Purpose	Status	Screened Geology
GW014826.1.1	113	1/11/1963	Exploration	Abandoned	Unknown
GW024470.1.1	72	1/11/1965	Stock and Domestic	Unknown	Unknown
GW024095.1.1	24	1/02/1966	Irrigation	Proposed	Unknown (CF ?)
GW701151.1.1	125	13/04/1995	Water Supply	Functioning	Unknown
GW014824.1.1	119	1/07/1963	Exploration	Abandoned	Unknown
GW024726.1.1	14	1/01/1976	Unknown	Unknown	Unknown (CF ?)
GW036502.2.1	0		Unknown	Unknown	Unknown
GW705017.1.1	15	23/07/2017	Stock and Domestic	Functioning	Cowra Formation
GW701639.1.1	37	10/04/2003	Monitoring	Functioning	Unknown
GW050579.1.1	18		Unknown	Functioning	Cowra Formation
GW036502.3.3	108	1/03/1984	Monitoring	Unknown	Unknown
GW024443.1.1	25	1/06/1965	Stock and Domestic	Unknown	Unknown (CF ?)
GW022640.1.1	80	1/04/1965	Water Supply	Unknown	Unknown
GW021254.1.1	114	1/11/1966	Water Supply	Unknown	Unknown
GW703025.1.1	109	29/06/2007	Commercial and Industrial	Functioning	Unknown
GW035450.1.1	20		Stock and Domestic	Unknown	Cowra Formation
GW090027.1.1	42	15/06/2000	Monitoring	Unknown	Cowra Formation
GW030467.1.1	24	1/12/1973	Monitoring	Unknown	Cowra Formation
GW030495.2.2	42	1/03/1974	Monitoring	Unknown	Unknown

CF ? - Likely Cowra Formation

2.7 Groundwater Dependant Ecosystems (GDE's)

The majority of the Project is currently used for grazing with no mapped Groundwater Dependent Ecosystems located at the solar farm site and switchyard site. The ETL will cross an unnamed stream/drainage line with the instream habitat category of very low. The Project is not anticipated to impact groundwater therefore there are no anticipated impacts to GDE's.

3 Project Impacts

The potential impacts to groundwater from the construction and operational phases of the Project are described in the following sections.

3.1 Construction Impacts

Construction of the solar farm includes:

- A network of PV solar panel arrays and Power Conversion Units (PCUs) (DC-AC inverters)
- Battery energy storage system (BESS) with embedded storage of approximately 40 MW/160 MWh
- Electrical collection systems, substation and control room
- Temporary construction compound
- Operations and Maintenance (O&M) facility, including demountable offices, amenities, equipment sheds, storage and parking areas
- Internal access roads
- Electricity Transmission Line infrastructure
- Switchyard to connect to an existing 132kV powerline (TransGrid infrastructure)
- Perimeter security fencing.

The potential impacts to groundwater include:

- Water quality changes due to soil disturbance
- Contamination via chemical or hydrocarbon spills
- Recharge changes due to changes to surface covering and solar panel runoff

The maximum depth for solar panel footings is assumed to be less than two metres which is not anticipated to intercept the water table at the solar farm site. The maximum excavation depth for electricity transmission poles is expected to be less than four metres which is unlikely to intercept the top of the water table. Installation of driven piles for the solar panels and changes to the impervious areas are not anticipated to have an identifiable impact on groundwater levels or quality.

Construction water supplies will not be sourced from groundwater, therefore there are no anticipated impacts due to extraction.

3.2 Operational Impacts

Potential operational impacts to groundwater include:

- A reduction in evapotranspiration due to shading of the ground surface
- Contamination due to chemical and or fuel spills
- An increase in recharge across the Project due to shading and point source recharge from panel runoff.

All potential impacts to groundwater are considered minor and are not anticipated to adversely impact groundwater resources. Increased recharge due to point source runoff and reduced evapotranspiration may have a small but positive recharge effect.

4 Mitigation Measures

The following mitigation measures will minimise the potential for impacts to groundwater.

4.1.1 Construction

The following construction phase mitigation measures will be employed:

- All fuel and chemicals stored for the Project should be in approved bunded areas
- Refuelling activities will be undertaken in a bunded area or on hardstands where fuel spill kits are available
- Temporary Project offices and work spaces to have a portable above ground systems (i.e. above ground pump out septic systems)
- Construction water supplies to be trucked in.

4.1.2 Operational

The following operational phase mitigation measures will be employed:

- Bunding of fuels and chemicals storage areas
- Ongoing maintenance of plant and equipment to minimise chemical and or fuel spills
- Regular pumping out of septic systems.

The proposed development will not have direct interactions with groundwater. Any potential impacts are considered secondary, for example as a result of a fuel spill which reaches the water table before interception, and therefore able to be managed via standard mitigation measures common to operational industrial sites.

5 Conclusion

The following conclusions are drawn from the hydrogeological assessment:

- The proposed Project construction and operation are not anticipated to impact groundwater through direct interactions (excavations)
- There is a low probability of the Project impacting groundwater though changes to recharge as a result of:
  - reduced evapotranspiration
  - increased point source recharge through runoff from panels
- Any changes to groundwater (levels and quality) as a result of the Project are likely to be minimal and unlikely to be detectable
- The risks of groundwater contamination (from spills) during construction and operation of the Project is considered low provided that appropriate mitigation measures are employed.

6 References

Australian Government. Guideline for Fresh and Marine Water Quality, 2018

Department of Agriculture and Water Resources. Guidelines for Groundwater Quality Protection in Australia, 2013

Department of Land and Water Conservation. The NSW State Groundwater Dependent Ecosystems Policy, 2002

Department of Primary Industries, Office of Water. NSW Government policy for the licensing and assessing of aquifer interference activities, September 2012

Department of Primary Industries, Office of Water. Upper Lachlan Alluvium Groundwater Management Area 011 Groundwater Status Report, 2010

Department of Primary Industries, Office of Water. Upper Lachlan Groundwater Flow Model, February 2012

Parks 1:100,000 Geological Map Sheet 8531, 1st Ed 2000

Water Management Act 2000, NSW Government, viewed 21 June 2021, www.legislation.nsw.gov.au/view/html/inforce/current/act-2000-092

Water Act 1912 No 44, NSW Government, viewed 21 June 2021 www.legislation.nsw.gov.au/view/html/inforce/current/act-1912-044

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