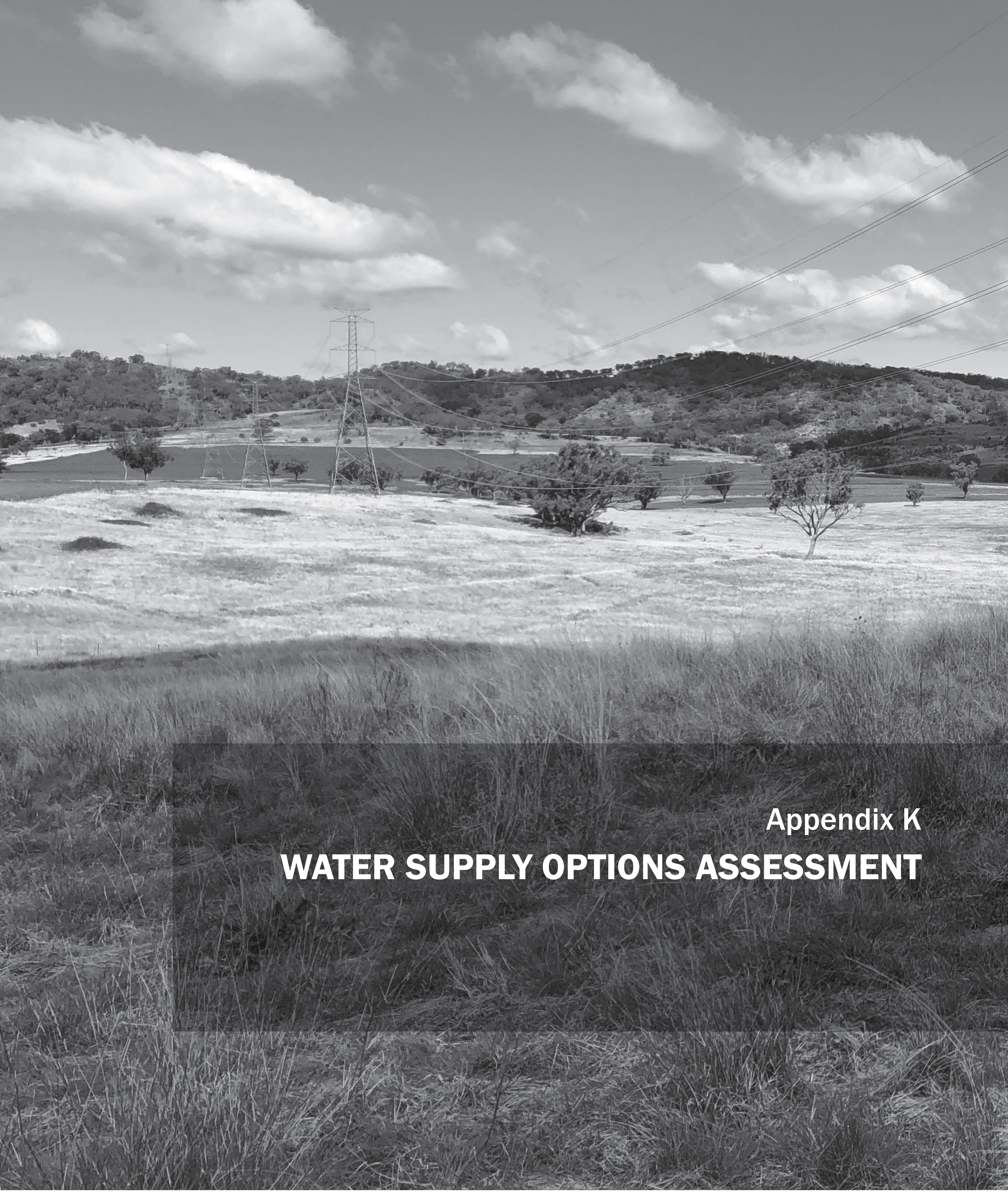

Appendix K

WATER SUPPLY OPTIONS ASSESSMENT

EMM
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Groundwater supply options and impact assessment

Sundown Solar Farm

Prepared for Sundown Solar Pty Ltd

January 2025

Groundwater supply options and impact assessment

Sundown Solar Farm

Sundown Solar Pty Ltd

E231160 RP#23

January 2025

Version	Date	Prepared by	Reviewed by	Comments
1	29 November 2023	Jonathon Tait	Nick Bartho	Draft
2	13 January 2025	Jonathon Tait	Nick Bartho	Figures updated to reflect the revised project layout. Final.

Approved by

Nick Bartho
Associate Director | Water Resources Engineer
13 January 2025

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Executive Summary

ES1 Introduction

Sundown Solar Pty Ltd proposes to develop the Sundown Solar Farm (the project), which is a large-scale solar photovoltaic (PV) electricity generation facility, BESS and associated infrastructure in Spring Mountain, NSW. The project will be assessed as a State significant development (SSD) and is located approximately 30 kilometres (km) east of Inverell in the New England Tablelands region of northern NSW.

A reliable water source is required for construction and operation of the project. Project demand is 75 megalitres (ML) over 21 months (i.e. 1.4 litres per second [L/s]) during construction, and up to 475 kilolitres per year (kL/year) during operation.

The Inverell Basalt and New England Fold Belt (NEFB) Groundwater Sources, managed under the *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2020* (MDBFRGS WSP), were identified as possible sources.

The assessment proposes two scenarios to meet supply demand. The preferred scenario is extracting from existing landholder bore GW971316 and two additional bores to meet construction and operational supply demand.

ES2 Site investigations

A site walk over was completed to inspect an existing landholder bore GW971316 located within the project area. Later, pumping testing was completed on GW971316 and found the bore could supply a long-term sustainable yield of 0.7 L/s, which could satisfy up to 50% of the construction water demand.

ES3 Sensitive receivers

Sensitive receivers in the vicinity of the project include high potential groundwater dependent ecosystems (GDEs) mapped by the Bureau of Metrology (BoM 2023) and landholder bores. Stock and domestic bore GW971316 is located within the project boundary. The second closest is a water supply bore GW067996 which is approximately 2 km north of the project boundary.

High potential GDEs along ephemeral tributaries were conceptualised to have a facultative (opportunistic) relationship with groundwater. High potential GDEs mapped along Kings Creek were conceptualised as having a facultative to obligate relationship with groundwater because of the more reliable flows in this watercourse.

No high priority GDEs, as listed in Schedule 2 of the MDBFRGS WSP, are within 25 km of the project.

ES4 Analytical modelling

Based on the *Minimum Groundwater Modelling Requirements for SSD/SSI Projects* (DPE Water 2022c), the environmental complexity and sensitivity was determined to be low therefore an analytical model (the model) used to predict potential impacts was built using MLU software (Hemker & Post 2008) to assess potential groundwater impacts on sensitive receivers. A one-layer model was created to replicate a confined aquifer system. The model assumes no recharge when pumping from a confined aquifer therefore drawdown is likely to overestimated.

Using aquifer parameters derived from aquifer testing, two scenarios were modelled and their impacts on sensitive receivers assessed. The first scenario involved pumping from GW971316 at 0.7 L/s and carting additional water to site. The second scenario involved abstracting a cumulative 1.4 L/s from GW971316 and two additional proposed bores. The two additional proposed bores were assumed to be located within existing highly disturbed areas (i.e. land that has been used for cropping) and within proposed project infrastructure placement areas. For the purposes of drawdown assessment the additional bores were also located near high potential GDEs as a conservative and worst-case scenario; in reality additional bores would be located as far as practical away from high potential GDEs to minimise potential impacts.

ES5 Performance criteria

Impact pathways to sensitive receivers were identified as unacceptable drawdown in water levels to high potential GDEs.

Proposed abstraction of groundwater for project water supply does not qualify as an aquifer interference activity under the NSW Aquifer Interference Policy (AIP) (DPI-W 2012). However, proposed water supply bores are likely to be conservatively assessed by Department of Environment and Planning – Water (DPE-W) against the minimal impact criteria outlined in the AIP.

ES6 Modelled impacts

In modelled scenario one, a maximum of 0.7 m of potential drawdown could occur in the Inverell Basalt at nearby high potential GDEs if they have access to groundwater.

In modelled scenario two, up to 0.6 m of potential drawdown could occur in the Inverell Basalt or NEFB aquifers at nearby high potential GDEs if they have access to groundwater.

However, the low volume and short duration of abstraction is unlikely to have long lasting impacts given high potential GDES are likely to have generally opportunistic relationships with groundwater. Negligible impact is expected during operation due to the low volumes of water required.

ES7 Mitigation and management

The following mitigation and management measures are proposed:

- Groundwater levels in pumping bores will be measured during operations to verify drawdown predictions.
- Pumping volumes will be measured and recorded to ensure compliance with licencing requirements.
- A monitoring bore should be installed near the closest high potential GDE to verify drawdown predictions.

ES8 Water licencing

The aquifer access licence available share component for the Inverell Basalt and NEFB MDB Groundwater Source is 1,073 and 14,520 unit shares, respectively. Securing shares in these groundwater sources is by purchasing water temporarily or permanently on the water market using a water broker.

ES9 Conclusions and recommendations

Due to the low volumes and short duration of groundwater abstraction, no long-lasting impacts are anticipated for high potential GDEs that have facultative or obligate access groundwater. No landholder bores will be impacted by abstraction due to their distance from the areas of groundwater extraction.

The report provides recommendations to progress a groundwater supply for the project.

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Photographs

1 Introduction

1.1 Background

Sundown Solar Pty Ltd (Sundown Solar) proposes to develop the Sundown Solar Farm (the project), which is a large-scale solar photovoltaic (PV) electricity generation facility, BESS and associated infrastructure in Spring Mountain, NSW. The project is located approximately 30 kilometres (km) east of Inverell in the New England Tablelands region of northern NSW (Figure 1.1).

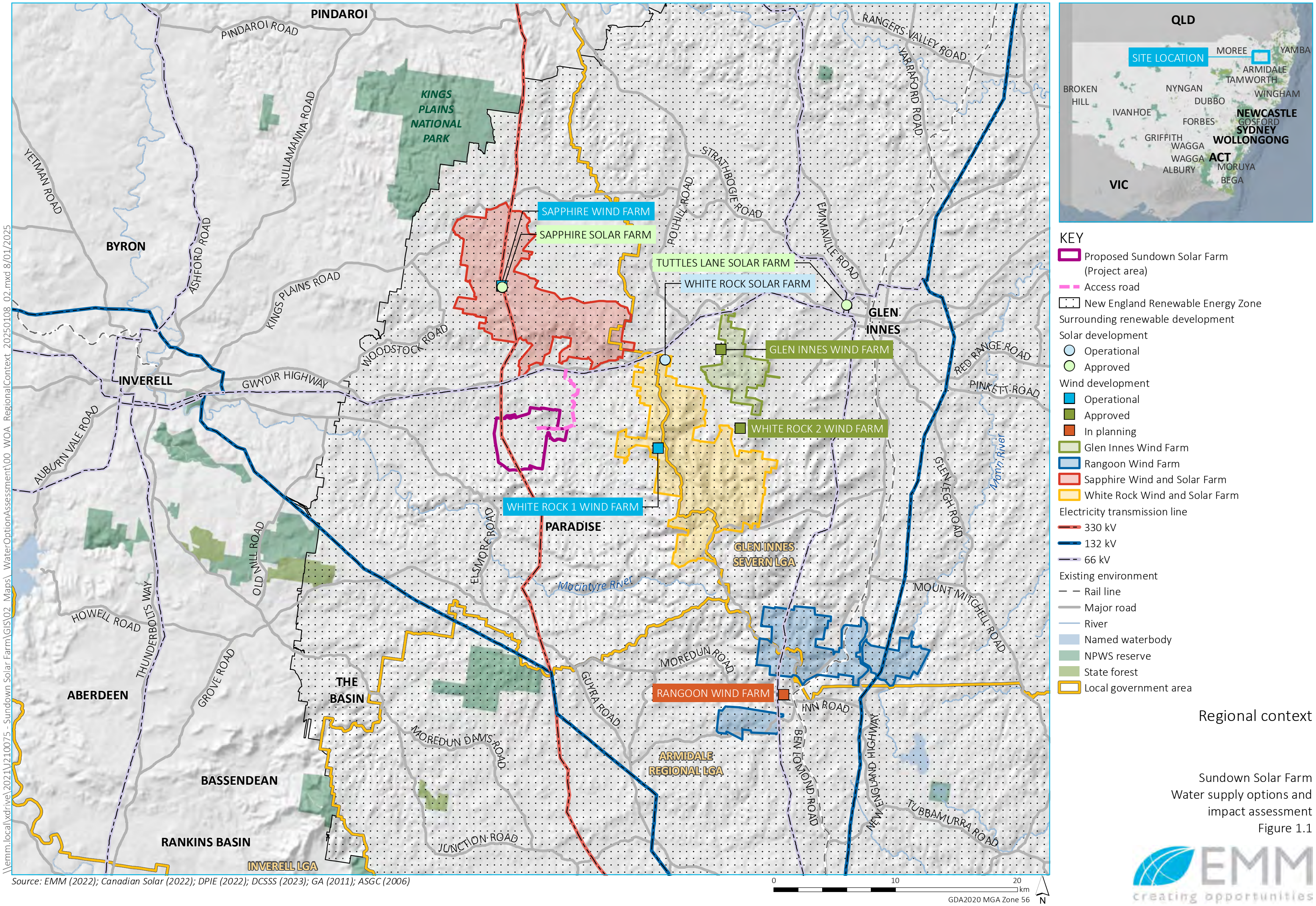
The project will be assessed as a State significant development (SSD) under State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP). Accordingly, an Environmental Impact Statement (EIS) for the project is required under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). Secretary's Environmental Assessment Requirements (SEARs) for the project were issued on 14 August 2020 (SSD-8911), and the supplementary SEARs received on 4 October 2022 as a result of the project being deemed a controlled action under the EPBC Act. On 15 February 2023 an addendum to the SEARs was received, requiring the EIS to be prepared in accordance with the *Large-scale Solar Energy Guideline* (2022, or the latest version) and supporting *Technical Supplement - Landscape and Visual Impact Assessment.*

Sundown Solar engaged EMM Consulting Pty Limited (EMM) to prepare the EIS, supporting technical assessments and the subsequent submissions report.

A Water Assessment was prepared by EMM (2023a) to support the EIS. This report provides additional technical groundwater investigation to support the proposed water supply strategy for the project.

1.2 Purpose of this report

Sundown Solar requires a reliable water source for the construction and operation of the Project. Groundwater has been identified as a possible source as described in the Water Assessment (EMM 2023a). This report investigates the local groundwater potential to support abstraction of 75 megalitres (ML) over a 21-month period for construction purposes, as well as minor ongoing operational purposes, and assesses any potential impacts to sensitive receivers such as groundwater dependent ecosystems (GDEs) and nearby landholder bores. The assessment also provides a regulatory pathway for securing the required water allocation from identified water sources.



Source: EMM (2022); Canadian Solar (2022); DPIE (2022); DCSSS (2023); GA (2011); ASGC (2006)

KEY

- Proposed Sundown Solar Farm (Project area)
- Access road
- New England Renewable Energy Zone

Surrounding renewable development

Solar development
- Operational
- Approved

Wind development
- Operational
- Approved
- In planning
- Glen Innes Wind Farm
- Rangoon Wind Farm
- Sapphire Wind and Solar Farm
- White Rock Wind and Solar Farm

Electricity transmission line
- 330 kV
- 132 kV
- 66 kV

Existing environment
- Rail line
- Major road
- River
- Named waterbody
- NPWS reserve
- State forest
- Local government area

Regional context

Sundown Solar Farm
Water supply options and impact assessment
Figure 1.1

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2 Project description

2.1 Overview

The project involves the development, construction and operation of a solar PV electricity generation facility, BESS and associated infrastructure.

Key infrastructure is shown in Figure 2.1 and comprises:

- a network of approximately 660,000 panels and associated mounting infrastructure
- a 150 megawatt (MW) BESS
- 330 kilovolt (kV) substation connected to the existing onsite 330 kV overhead powerline
- electrical collection and conversion systems, including inverter and transformer units, switchyard and control room
- underground and aboveground cables
- a management hub, including demountable offices and amenities and equipment sheds
- onsite creek crossings
- security fencing
- temporary laydown areas (during construction and decommissioning)
- parking and internal access roads
- lighting
- firefighting infrastructure.

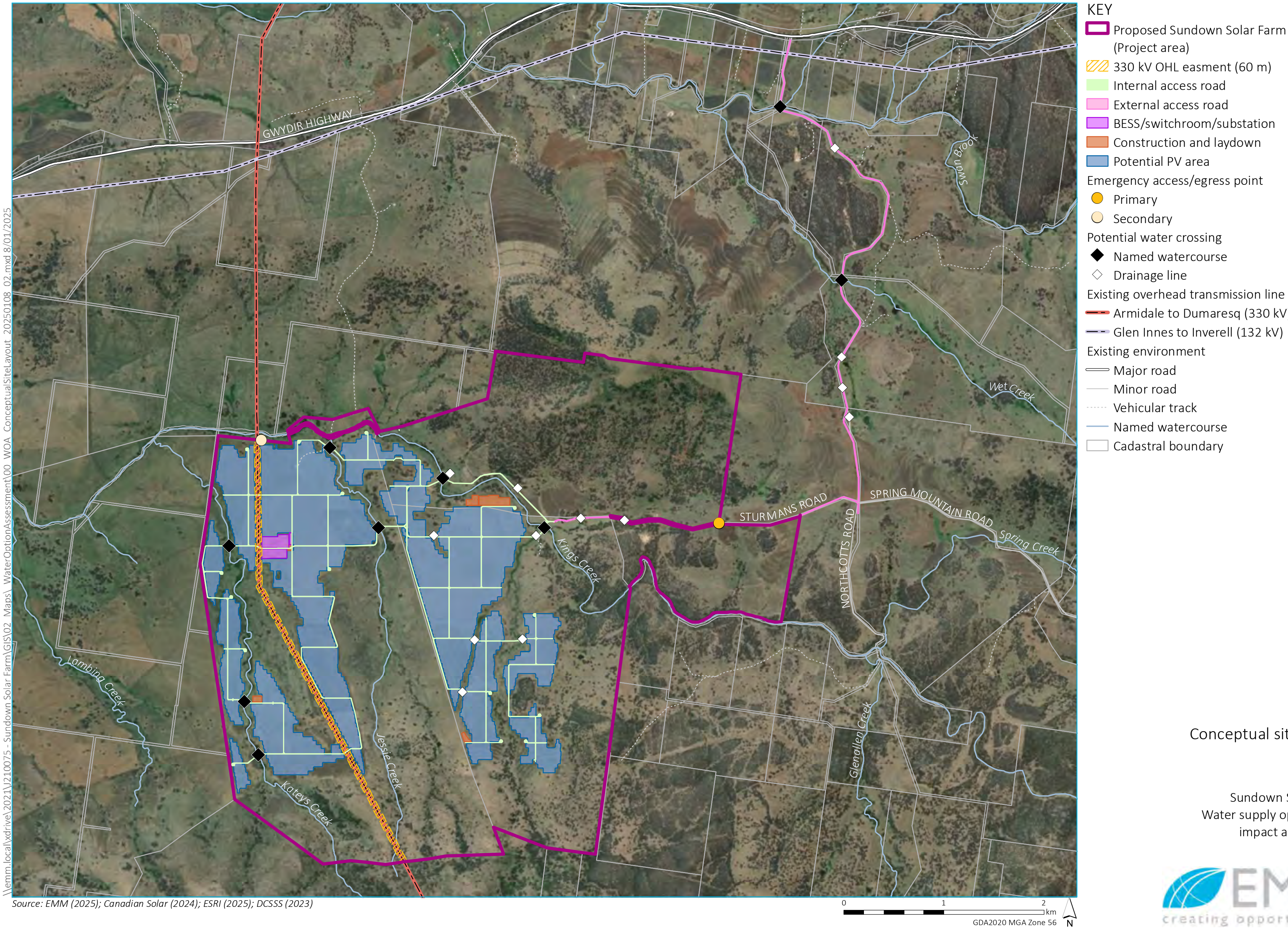
The project will also include the upgrade of the access road (Spring Mountain Road and Sturmans Road) and the Gwydir Highway/Spring Mountain Road intersection.

During the preparation of the EIS, the development footprint within the project boundary has been refined to consider any environmental constraints identified, outcomes of stakeholder engagement, community consultation and design of project infrastructure with the objective of developing an efficient project that avoids and minimises environmental impacts.

The project will have a targeted electricity generating capacity of up to 360 MW (AC) and up to 150 MW(AC) four-hour energy storage. The final number of PV modules will be dependent on detailed design, availability, and commercial considerations at the time of construction.

Electricity generated by the project will be injected into the grid via a new onsite substation connected to TransGrid's existing 330 kV transmission line that traverses the site.

The project life is estimated at 35 years.



Source: EMM (2025); Canadian Solar (2024); ESRI (2025); DCSSS (2023)

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Conceptual site layout

Sundown Solar Farm
Water supply options and
impact assessment
Figure 2.1

EMM
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2.2 Site description

The site is located on Sturmans Road, Spring Mountain, approximately 30 km east of Inverell in the New England Tablelands region of northern NSW. The site is also approximately 38 km west of Glen Innes.

The project will be developed within the Inverell Shire local government area (LGA) (Figure 1.1) and comprises three privately owned lots, namely Lot 148 in DP 753299, Lot 141 in DP 753305 and Lot 1 in DP 1064358. The entire site is zoned RU1 – Primary Production under the Inverell Local Environmental Plan 2012 (Inverell LEP) and is currently and has historically been used for farming (cropping and grazing) (Photograph 2.1 and Photograph 2.2). The surrounding land is used for farming.

Photograph 2.1 Grazing onsite

Photograph 2.2 Cropping onsite

There are three operational renewable energy farms within the broader region, namely White Rock Wind Farm, White Rock Solar Farm and Sapphire Wind Farm (Figure 1.1). There are a further three that have been approved but have not yet been developed, namely White Rock Wind Farm stage 2, Sapphire Solar Farm and Glen Innes Wind Farm.

Transgrid's 330 kV transmission line passes through the site (Figure 2.1). The site has good access to the Gwydir Highway and is accessed from Sturmans Road via Spring Mountain Road (Figure 2.1).

There is some Crown land within the study area, largely associated with road reserves.

The total project area and relationship to the proposed development and disturbance footprints is described in Table 2.1.

Table 2.1 Summary of project area, development and disturbance footprints

Terminology	Description
Project area	Comprises the three lots on which the project will be developed. The project area comprises the development footprint as well as the areas that will remain undeveloped. The project area comprises an area of approximately 2,097 hectares (ha).
Development footprint	The extent of surface area within the project area that will comprise project-related infrastructure (such as the PV panels, BESS, substation, switchroom, internal access roads etc). The development footprint comprises an area of approximately 651 ha.
Disturbance footprint	The extent of surface area within the project area that will be disturbed to facilitate the construction of the project plus the extent of surface area associated with the access road that will be disturbed to facilitate the construction of the access road and associated intersection. The disturbance footprint comprises an area of approximately 729 ha (including approximately 7.6 ha associated with the access road).

A detailed project description is provided in EMM (2023).

2.3 Water demands and source of supply

2.3.1 Construction phase

During the construction phase, the total water demand for the project is estimated to be approximately 75 ML over the 21-month construction period. Most of this water will be required for dust suppression, with other minor uses including site amenities, fire protection and washing of equipment and plant.

During construction, groundwater will be sourced from bores within the project area. Any short fall in supply will be trucked to site from a commercial water supply as the primary source.

Water for construction purposes will also be opportunistically sourced from the following to minimise the need for imported water:

- use from existing landholder dams where harvestable rights apply
- reuse from construction sediment basins
- reuse from rainwater tanks collecting runoff from building roofs.

Water licensing implications are described in Section 8.

2.3.2 Operational phase

The estimated ongoing operational water usage for the project is 475 kilolitres per year (kL/year), over 35 years. Most of this water will be required for washing of PV modules, with other minor uses including permanent site amenities, fire protection and washing of equipment and plant.

During the operational phase water will continue to be source from groundwater or trucked to site from a commercial water supply as the primary source.

Water will also be opportunistically sourced from rainwater tanks to minimise the need for imported water. Water may also be sourced opportunistically from existing landholder dams in accordance with harvestable rights.

Water licensing implications are described in Section 8.

3 Assessment requirements

3.1 Secretary’s Environmental Assessment Requirements (SEARs)

This report has been prepared to address the project SEARs, as well as relevant government assessment requirements, guidelines and policies. SEARs for the project were originally issued in 2017, and then re-issued in August 2020. On 15 February 2023 an addendum to the SEARs was received, requiring the EIS to be prepared in accordance with the *Large-scale Solar EnergyGuideline* (2022, or the latest version) and supporting *Technical Supplement - Landscape and Visual Impact Assessment.*

To inform preparation of the SEARs, the Department of Planning and Environment (DPE) invited relevant government agencies to advise on matters to be addressed in the EIS. These matters were taken into account by the Secretary for DPE when preparing the SEARs, which have been considered in the preparation of this report.

Table 3.1 lists the matters relating to ‘water’ relevant to this assessment and where they are addressed in this report.

Table 3.1 SEARs for the assessment of water

Requirement	Section addressed
An assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources (including wetlands, riparian land, 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.	Impacts to groundwater are described in Section 6. Proposed management and mitigation measures are detailed in Section 7.
Details of water requirements and supply arrangements for construction and operation.	Water requirements for construction and operation are detailed in Section 2.3. Supply arrangements and licencing implications are detailed in Section 8.

3.2 Regulatory context

3.2.1 NSW Water Management Act 2000

The *Water Management Act 2000* (the WMA) is based on the principles of ecologically sustainable development and the need to share and manage water resources for future generations. The WMA recognises that water management decisions must consider: economic, environmental, social, cultural and heritage factors. The WMA recognises that sustainable and efficient use of water delivers economic and social benefits to the state of NSW.

The WMA provides for water sharing between different water users, including environmental, basic landholder rights (BLR) or existing water access licence (WAL) holders, and provides security for licence holders. Trading of water is allowed between WAL holders within a water source and is usually restricted to management zones if they exist. The licensing provisions of the WMA apply to those areas where a Water Sharing Plan (WSP) has commenced.

3.2.2 Water Sharing Plans

WSPs are statutory plans that apply to one or more water sources. They contain the rules for sustainably sharing and managing water resources within water source areas. WSPs outline the vision, objectives and strategies for achieving sustainable water sharing, and describe the basis for water sharing. WSPs document the water available and how it is shared between environmental, consumptive, and other uses. WSPs also outline the water available for consumptive uses within different categories (at the time the plan commenced), such as: local water utilities

(LWUs), BLR, native title basic rights, and a variety of access licence types. WSPs establish trading rules and mandatory licence conditions that apply to licence holders within each water source.

The project area is located within the *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2020* (MDBFRGS WSP).

3.2.3 NSW Aquifer Interference Policy

Projects that intercept groundwater where that groundwater is not used for consumptive use need to consider the Aquifer Interference Policy (AIP), which requires projects to hold licences that account for the volume of water intercepted and consider changes in water level, water quality and pressure at sensitive receptors in accordance with prescribed minimal impact criteria (DPI-W 2012).

The AIP is the policy with respect to groundwater interference activities (DPI Water 2012). The WM Act (under Section 91) defines an 'aquifer interference activity' as an activity involving:

- penetration of an aquifer
- interference with water in an aquifer
- obstruction of the flow of water in an aquifer
- taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations
- disposal of water taken from an aquifer in the course of carrying out mining or any other activity prescribed in the regulations.

Groundwater 'take' for this project is **NOT** considered an aquifer interference activity.

3.2.4 Groundwater Assessment Toolbox for Major Projects in NSW

DPE Water has developed a *Groundwater Assessment Toolbox for Major Projects in NSW* (DPE Water 2022a), which aims to create a collaborative, transparent and enabling environment for the preparation and review of groundwater assessments for major projects in NSW. The documents provide a framework to investigate, assess the impacts on, manage and monitor groundwater resources and their interaction with surface water resources within the footprint of a major project.

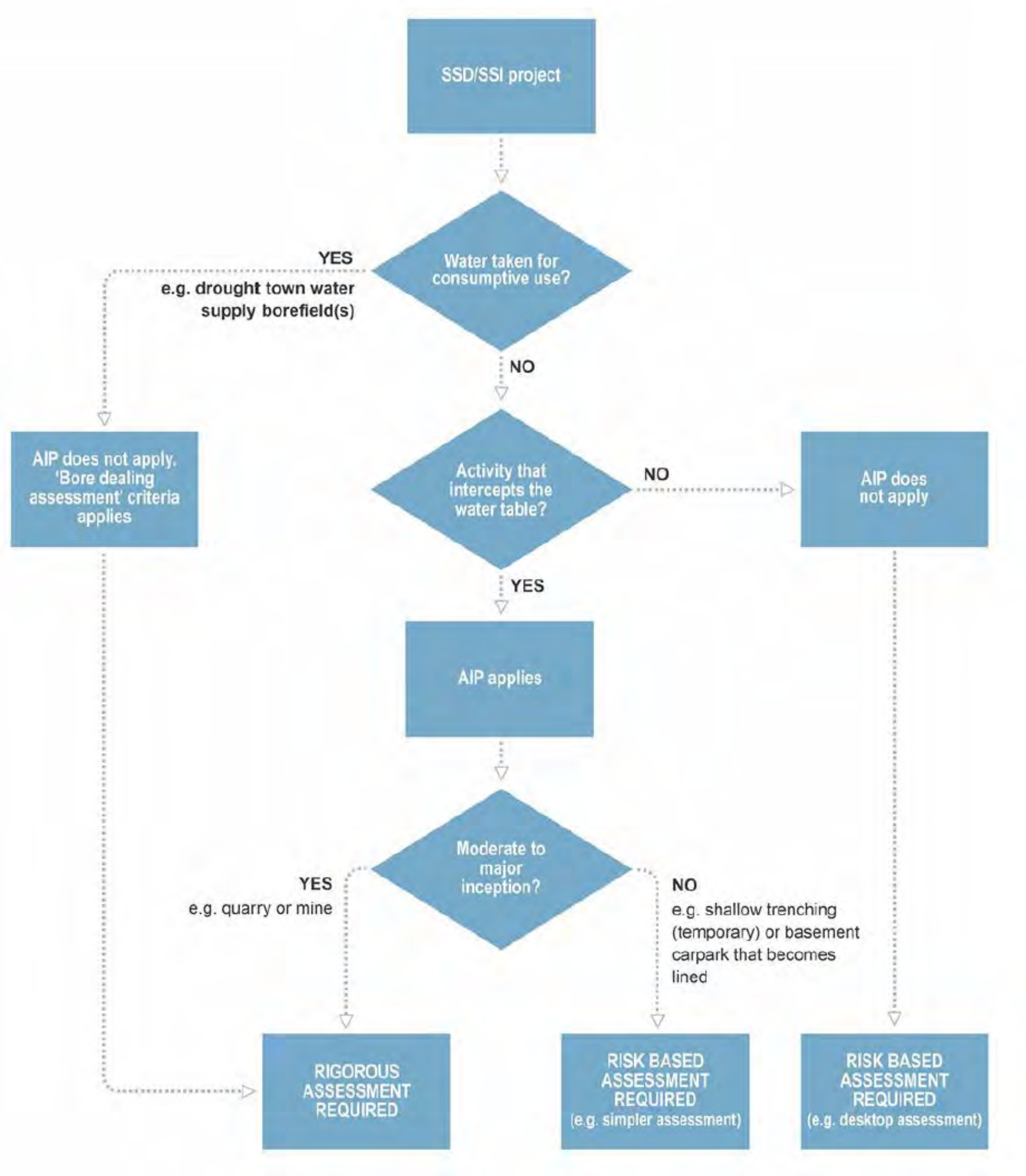
The Groundwater Assessment Toolbox is a complementary guidance document that comprises the following documents:

- *Guidelines for Groundwater Documentation for SSD/SSI projects* (DPE Water 2022b)
- *Minimum Groundwater Modelling Requirements for SSD/SSI Projects* (DPE Water 2022c)
- *Cumulative Groundwater Impact Assessment Approaches* (DPE Water 2022d).

These documents denote the role of the NSW Government in project assessment, and the continuation of guidance on and review of post-approvals monitoring and management plans, and compliance reporting.

The *Guidelines for Groundwater Documentation for SSD/SSI projects* (DPE Water 2022b) provides high-level guidance on the assessment considerations for SSD/SSI projects (Figure 3.1).

Based on Figure 3.1, and the interpretation that the construction and operation of the project does not constitute an aquifer interference activity, a desktop level risk-based assessment is appropriate for the project and is presented in Section 6.



Source: DPE 2022b

Figure 3.1 Groundwater assessment considerations for SSD/SSI projects

4 Existing environment

4.1 Climate

Climate and rainfall data was obtained from the long-term weather station operated by the Bureau of Meteorology (BoM) at Inverell Research Centre (BoM Station No. 056018) located approximately 30 km west of the site. Monitoring at this station commenced in 1949. An overview of key climate statistics is provided in Table 4.1 (BoM 2023a).

Table 4.1 Climate overview (BoM 056018, Inverell Research Centre)

Parameter	Range	Time period	Unit
Rainfall (mm)	Highest mean	January	98.2
	Mean	Annual	802.0
	Lowest mean	April	39.1

The climate of the region is temperate and is characterised by warm to hot summers and cold winters. Summers tend to be wetter with low autumn and winter rainfall. Evaporation data indicates a similar seasonal trend, with higher evaporation during summer and lower evaporation occurring during winter. Average annual rainfall of approximately 802 millimetres per year (mm/year) is far exceeded by average annual evaporation of approximately 1,600 mm/year (BoM 2023a). This generally results in low surface water availability and watercourse flow regimes that are typically ephemeral in nature.

4.2 Land use

The site and surrounding properties are currently, and have historically, been used for agricultural purposes; primarily cropping and grazing.

Whilst generally cleared of native woodland and forest, most of the site remains well vegetated with highly disturbed grassland. Some scattered trees remain in paddocks and in narrow, disconnected patches along creek lines. Existing vegetation is described in detail in the Biodiversity Development Assessment Report (EMM 2023b).

There are three operational renewable energy farms within the broader region, namely White Rock Wind Farm, White Rock Solar Farm and Sapphire Wind Farm (Figure 1.1).

4.3 Topography and landform

The local topography within the project development footprint is undulating and characterised by a series of ridgelines falling generally towards Kings Creek. Elevation across the development footprint varies from peaks around 900 m relative to Australian Height Datum (mAHD) along the ridgeline to the south of Kings Creek and 950 mAHD along the ridgeline to the north, falling to about 720 mAHD along Kings Creek at the western extent of the development footprint. Slopes are variable and whilst typically in the range of 3 to 10% reach up to maximum of about 15%.

Locally, the presence of low contour banks across much of the site to control local runoff, reduce overland flow velocities and minimise soil erosion is evidence of its past and current agricultural use.

4.4 Catchment and watercourses

The project is located in the southern headwaters of the Border Rivers catchment in northern NSW, which forms part of the greater Murray-Darling Basin.

Several ephemeral watercourses traverse the development footprint and drain generally from south to north. These include Kateys Creek (3rd order) and Jessie Creek (2nd order), as well as several unnamed 1st and 2nd order watercourses, all of which drain to Kings Creek. Kings Creek is a 4th order watercourse flowing generally to the west and joins the Macintyre River east of Inverell. The Macintyre River continues generally to the north-west beyond Inverell, ultimately forming part of the Barwon-Darling River system. Watercourses are shown on Figure 4.1.

Several small existing farm dams are located within the development footprint both on and adjacent to watercourses. These dams would have supported past agricultural use.

Surface water quality based on recent sampling in selected watercourses is described in Section 5.4.

4.5 Local geology

Local geology is based on a review of the Inverell 1:250 000 Geological Sheet (Chesnut and Cameron 1971). A summary of geological units within the project area is provided in Table 4.2. Surface geology and structural features within the project area are shown on Figure 4.1.

Palaeozoic igneous rocks of the Emmaville Volcanics and Cenozoic igneous rocks of the Maybole Volcanics geological units, including sparse outcroppings of alkali olivine and transit basalt flows and plugs, are the predominant outcropping units across the project area. Minor outcroppings of Palaeozoic low-grade metamorphic rocks of the Sandon beds are localised in the southern portion of the project area.

Outside, but in proximity of the project area footprint, Langari Hill Volcanics basalts overly the Maybole Volcanics and Emmaville Volcanics. The Cenozoic igneous basalts are collectively described as the Inverell Basalt and overly the Early Triassic-Permian granite and monzogranite (Table 4.2). Palaeozoic low-grade metamorphic rocks of the Texas beds are the oldest unit, outcropping nearby the project area and are localised east and northeast of the site.

Quaternary alluvial sediments, including terraced deposits, associated with Kings Creek and other tributaries, sparsely overly the older geological units.

Table 4.2 Geology of the Project Area

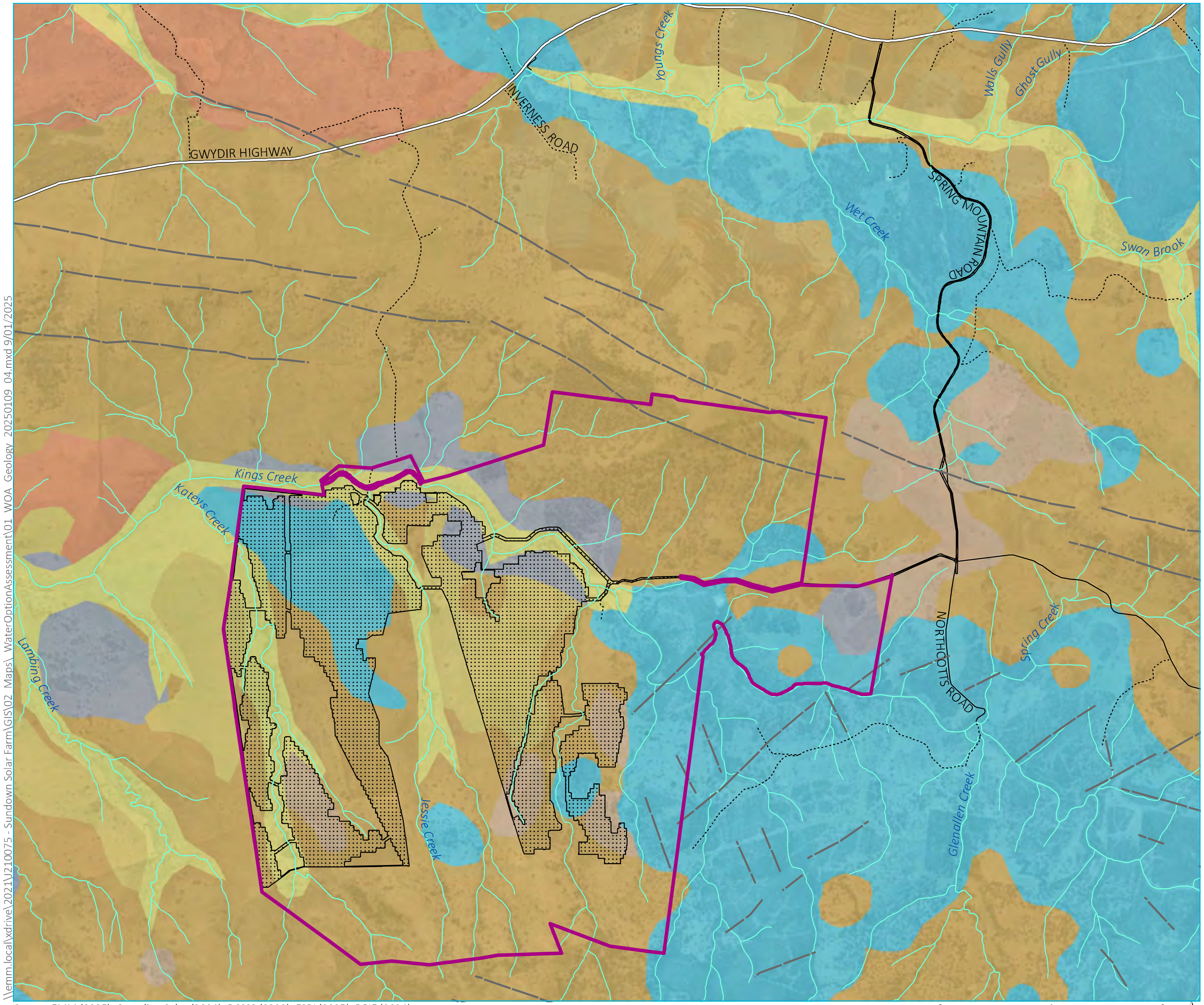
Period	Unit	Description
Quaternary (2.6-0.0 Ma)	Unconsolidated alluvial and colluvial sediments	Unconsolidated silty clay, silt, quartz-rich to quartz-lithic sand, polymictic pebble to cobble gravel (as sporadic lenses); sporadic paleosol horizons. Terraced fluvially deposited silt, clay, quartz-lithic sand, polymictic gravel.
Tertiary (68-2.6 Ma)	Langari Hill Volcanics	Olivine-bearing tholeiitic basalt with minor volcaniclastic rocks.
	Maybole Volcanics	Undersaturated to transitional alkali olivine basalts with minor lithic sapphire and corundum bearing volcaniclastic and epiclastic units. Rare plugs, dykes and sills. Some interbedded non-volcanogenic sediments.
Early Triassic (251.9-247.2 Ma)	Tingha Monzogranite	Biotite-hornblende-(pyroxene) monzogranite.

Period	Unit	Description
Permian (272.9 - 251.9 Ma)	Emmaville Volcanics	Felsic volcanic and volcaniclastic rock; ignimbritic rhyolite and rhyodacite (emplaced as a lava); minor dacite, andesite; porphyritic dacite, dacite & rhyolite (emplaced as ash flows); minor interbedded epiclastics (basal conglomerate, sandstone, shale).
Permian (Lopigian) (259.1-247.2 Ma)	Gilgai Leucogranite Elsmore Leucomonzogranite	Biotite- (hornblende) granite and monzogranite. Leucocratic monzogranite, in part extensively altered with common greisenisation and silicification.
Carboniferous (Mississippian) (382.7 - 323.2 Ma)	Sandon Beds	Low-grade, regionally metamorphosed, multiply deformed lithic wacke, paraconglomerate, siltstone, mudstone, minor chert, jasper, spilite.
Carboniferous (Middle Mississippian) (358.9 - 323.2 Ma)	Texas Beds	Greywacke, conglomerate, siltstone, mudstone, slate, local phyllite, chert, basalt limestone and rare tuff, low-grade regionally metamorphosed, variably deformed.

4.5.1 Geological structure

Geological structures such as faults, lineaments, synclines, anticlines and geological contacts (i.e. areas where geological units transition) can create deformation in local and regional geologies which can increase groundwater storage and permeability. In fractured rock groundwater systems, these structures can be targeted for potential groundwater supply.

No regional structures, such as major faults, have been mapped in the project area. Minor local structures (e.g. fracturing) are known to be present in all fractured rock geologies and generally constitute minor aquifers. Lithological transitions (i.e. between the Sandon Beds and Emmaville Volcanics), may present opportunities for deformation or structure that could be targeted.



KEY
- Proposed Sundown Solar Farm (Project area)
- Conceptual disturbance footprint
- Lineament

Rock unit
- Alluvial terrace deposits
- Alluvial valley deposits
- Langari Hill Volcanics
- Maybole Volcanics
- Maybole Volcanis - alkali basalt
- Maybole Volcanics - volcaniclastics
- Texas beds
- Sandon beds
- Emmaville Volcanics

Existing environment
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line

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Source: EMM (2025); Canadian Solar (2024); DCSSS (2023); ESRI (2025); DPIE (2024)

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Watercourses, local geology and structure

Sundown Solar Farm
Groundwater supply options and impact assessment
Figure 4.1

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5 Hydrogeology

5.1 Investigations

EMM completed hydrogeological investigations to help characterise the local groundwater systems. These investigations included the following:

- A site walkover, completed on the 13 April 2023, to inspect water bore GW971316 and potential spring features (Appendix A). Water samples were collected from GW971316, Kateys Creek, springs located on an unnamed minor tributaries and Kings Creek to determine water quality characteristics.

- Aquifer testing, completed from 11 July to 18 July 2023, to determine the prospectivity of GW971316 for water supply (see Section 5.8). The project's construction water supply demand is 75 ML over a 21 month period, or 1.4 L/s (see Section 2.3).

5.2 Regional groundwater systems

The following subsections detail the regional hydrostratigraphic units.

5.2.1 Unconsolidated sediments

Gravels, sand, silt and mud generally deposited by river systems (alluvial deposits) or as wash from hill slopes (colluvial deposits) constitute the Cenozoic unconsolidated sediments. Within the region they are found in terraces, valleys, alluvial fans and floodplains (DPIE 2019a). The unconsolidated sediments in the project area overlie the Palaeozoic New England Fold belt deposits (sedimentary, metamorphic and igneous rocks) and the more recent Cenozoic volcanic rocks (mostly Inverell Basalts) (DPIE 2019b).

Groundwater in the unconsolidated deposits can be characterised as either unconfined or semi-confined groundwater systems, and having a high degree of connectivity with surface water (i.e. streams and wetlands) and generally low to moderate connectivity with underlying fractured rock groundwater systems (Green et al. 2012). Water quality is good, typically fresh to marginally brackish and used for stock and domestic purposes.

5.2.2 Inverell Basalt

The Inverell Basalt is a fractured rock aquifer system consisting of a succession of Tertiary basalt flows as well as minor regolith and unconsolidated sediments (deep leads). The majority of the Inverell Basalt overlies the New England Fold Belt (NEFB).

Groundwater in the Inverell Basalt can be characterised as either a shallow unconfined or semi-confined aquifer that is typically weathered and fractured, making it conducive to higher aquifer recharge, or a deeper confined to semi-confined system connected through extensive vertical jointing and fracturing formed from cooling magma (DPIE 2019b, DPE 2022e).

Recharge to Inverell Basalt occurs primarily through infiltration from rainfall, runoff and surface water within the outcropping and sub-cropping areas. Groundwater may discharge naturally in localised areas as springs where there is a permeability change in the rock mass, at the break-of-slope or where there is a change in soil texture. Groundwater discharges may also contribute base flow to streams particularly in the high rainfall topographically dissected landscape of the tablelands and slopes (DPIE 2019b).

Water quality is typically fresh and used for stock and domestic purposes The median depth of bores is generally shallow with the large majority constructed to depths less than 60 m. Drilling construction information shows that most bores generally yield less than 1 L/s (Minview 2023).

5.2.3 New England Fold Belt

The New England Fold Belt (NEFB) is a fractured rock aquifer system that extends north from the Hunter Valley and into Queensland, comprising of an eroded mountain range bounded on the south and west by border thrust fault systems. The central zone consists of moderately to highly deformed Silurian to Permian rocks which increase in the degree of deformation from west to east (i.e. Great Dividing Range). The basement rocks include phyllites, cherts, jaspers and greywackes with interbedded basic volcanics.

Groundwater in the NEFB is characterised as either shallow, unconfined aquifers within weathered and fractured rock or deeper confined aquifers connected through jointing and fracturing (DPIE 2019). Groundwater in the NEFB is mostly used for stock and limited domestic use but is generally underutilised due to low bore yields (typically less than 0.5 L/s), variable groundwater quality (fresh to saline) and the availability of surface water sources where the NEFB occurs. A few towns and villages use groundwater as supplementary supply during periods of extreme drought (Minview2023, DPE 2022e).

Recharge to NEFB occurs primarily through infiltration from rainfall, runoff, and surface water within the outcropping and sub-cropping areas. Groundwater may discharge naturally in localised areas as springs where there is a permeability change in the rock mass, at the break-of-slope or where there is a change in soil texture. Groundwater discharges may also contribute base flows to streams where they intersect the water table.

Groundwater-surface water connection in the NEFB is variable and depends on the extent of fracturing between surface features and the underlying aquifers. But generally, the relatively low permeability of the NEFB means there is not likely to be significant connection between surface water and groundwater sources (DPIE 2019).

5.3 Local groundwater systems

Four potential local aquifers occur within the project area and these are summarised in Table 5.1 and detailed in the following subsections. Information was sourced from nearby landholder bores within a 10 km radius and publicly available literature. Figure 4.1 presents the local geology and structural features.

Table 5.1 Aquifer potential within 10 km of project area

Hydrostratigraphic unit	Geological unit	Bore depth (m)	Bore yields range [1](L/s)	Depth to water [2](mbgl)	Aquifer potential
Unconsolidated sediments	Quaternary deposits associated with Kings Creek and minor tributaries	2–10	Unknown	1.5	Low
Inverell Basalts	Maybole Volcanics	11–135	0.1–10	1.5–68	Low
New England Fold Belt	Emmaville Volcanics	21	0.1–1	3–30	Low
	Sandon beds	-	0.1–1	3–30	Low

Notes: 1. L/s: Litres per second.
2. mbgl: metres below ground level

i Unconsolidated sediments

Within the project area, the thickness of these deposits ranges from 2 to 10 m. Information on groundwater levels is limited, the only data available indicates depths shallower than 1.5 metres below ground level (mbgl). There are no yields reported but it is expected to be low, less than 1 L/s, due to the limited extent and depth of the alluvium. There is limited information on groundwater quality, but it is expected to be fresh due to short recharge pathways.

Due to the limited extent, thickness and continuity of potential water bearing sediments (i.e. gravels), the alluvial aquifer is not considered a viable source of water for the project.

ii Maybole Volcanics

The Maybole Volcanics is part of the Inverell Basalts. Nearby landholder bores range from 11 to 135 m depth and typically show yields of less than 2 L/s. A 48-hour constant rate pumping test was completed on a landholder bore (GW971316) within the project area and confirmed a sustainable yield of approximately 0.7 L/s (see Section 5.8). Higher yields (3 to 9 L/s) are present in bores where higher permeability alluvium has been buried by the basalt flows.

Groundwater levels range from 1.5 to 68 mbgl. Available water quality data indicates that salinity within the Maybole volcanics is fresh to marginally brackish.

The aquifer potential of the Maybole Volcanics depends on the degree of weathering and connectivity of fracturing. Where suitable yields for supply are intercepted, they can typically satisfy stock and domestic purposes.

Given the general low yields within existing landholder bores, several bores installed in the Maybole Volcanics may be required to meet project water supply demands.

iii Emmaville Volcanics

The Emmaville Volcanics is part of the NEFB. The unit is a fractured rock groundwater system with the same hydrogeological characteristics as the Maybole Volcanics. The Emmaville Volcanics outcrops to the east of the project. The extension of the unit is considerable, but yields are expected to be low (less than 1 L/s).

Like the Maybole Volcanics, the aquifer potential is dependent on the connectivity of fracturing which enables increased storage and potentially higher yields. Yields could increase if geological structures or lithological changes are targeted. There is limited information available on water quality, but it is expected to be fresh to brackish.

Given the general low yields, several bores installed in the Emmaville Volcanics could meet project water supply demands.

iv Sandon Beds

The Sandon beds is part of the NEFB. The unit is fractured rock groundwater system with the same hydrogeological controls as the Maybole and Emmaville Volcanics and is present to the north of the project area.

There are no groundwater bores drilled in this geological unit which are within 10 km of the project area. Like the Emmaville Volcanics, the aquifer potential is dependent on the connectivity of fracturing which enables increased storage and potentially high yields. Using landholder bores outside the project area, yields are expected to be low (less than 1 L/s) but could increase if geological structures or lithological changes are targeted. There is limited information available on water quality, but it is expected to be fresh to brackish.

Given the general low yields, several bores installed in the Sandon Beds could meet project water supply demands.

5.4 Water quality

A site walkover was completed on the 13 April 2023 to inspect GW971316 and potential spring features. During the site walkover, six water quality samples were collected to assist with understanding the relationship between surface water and groundwater:

- Two samples were collected from Kings Creek, upstream (SW2303) and downstream (SW2301).

- One sample was collected from a water trough sourced from GW971316. An additional sample was collected after 24 hours of constant rate pumping testing (CRT) at GW971316.
- One sample (SW2302) was collected from Kateys Creek, which is located about 250 m west of GW971316.
- Two samples were collected from an unnamed minor tributary east of Jessie Creek. Both locations (Spring Bore and Spring Bore Upstream) are believed to be dammed springs used for stock and domestic purposes.

The sampling locations are presented on Figure 5.2. Samples were submitted to a NATA accredited laboratory for testing of the analytes presented in Table 5.2. Notes from this site visit and comprehensive laboratory results are provided in Appendix A.

Table 5.2 Water chemistry testing summary

Category	Parameters
General water quality	Electrical conductivity (EC), Total dissolved solids (TDS) and pH
Hardness and alkalinity	Total hardness as $CaCO_3$, alkalinity (bicarbonate, carbonate, hydroxide, and total as $CaCO_3$)
Dissolved metals	Aluminium (Al), antimony (Sb), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), and zinc (Zn)
Major ions	Calcium (Ca), chloride (Cl), fluoride (Fl), sodium (Na), magnesium (Mg), potassium (K), sulfate (SO_4), and ionic balance

Table 5.3 provides a summary of the physicochemical analysis completed by laboratory ALS. The major ion characteristics of groundwater and surface water samples are shown in a piper diagram on Figure 5.1. Results show:

- electrical conductivity (EC) is fresh (<1,000 µS/cm) in surface water features and marginally brackish (1,000 to 1,500 µS/cm) at GW971316 and Spring Bore. Spring Bore Upstream shows a similar EC to surface water samples which likely indicates that it is charged by rainfall and surface runoff rather than deeper groundwater
- pH is alkaline at all sites due to alkaline basalts that dominate the surface geology of the area
- total dissolved solids (TDS) show similar trends to EC.

Table 5.3 Physicochemical quality results

Type	Site ID	Electrical conductivity (µs/cm)	Total Dissolved Solids (mg/L)	pH (units)
Groundwater	GW971316 Trough	661	430	8.34
	GW971316 CRT	1,170	760	7.97
Spring	Spring Bore	1,050	682	8.46
	Spring Bore Upstream	774	484	8.36
Surface water	SW2301 (Kings Creek Downstream)	948	616	8.21
	SW2302 (Kateys Creek)	896	582	8.21
	SW2303 (Kings Creek Upstream)	654	425	8.57

The piper plot (Figure 5.1) shows that all sites are magnesium bicarbonate type water which is due to the chemistry of alkaline basalts which dominate the surface geology of the area. Despite similar EC and TDS between Spring Bore and GW971316 CRT, there is a difference in cations with Spring Bore grouping more closely to surface water samples.

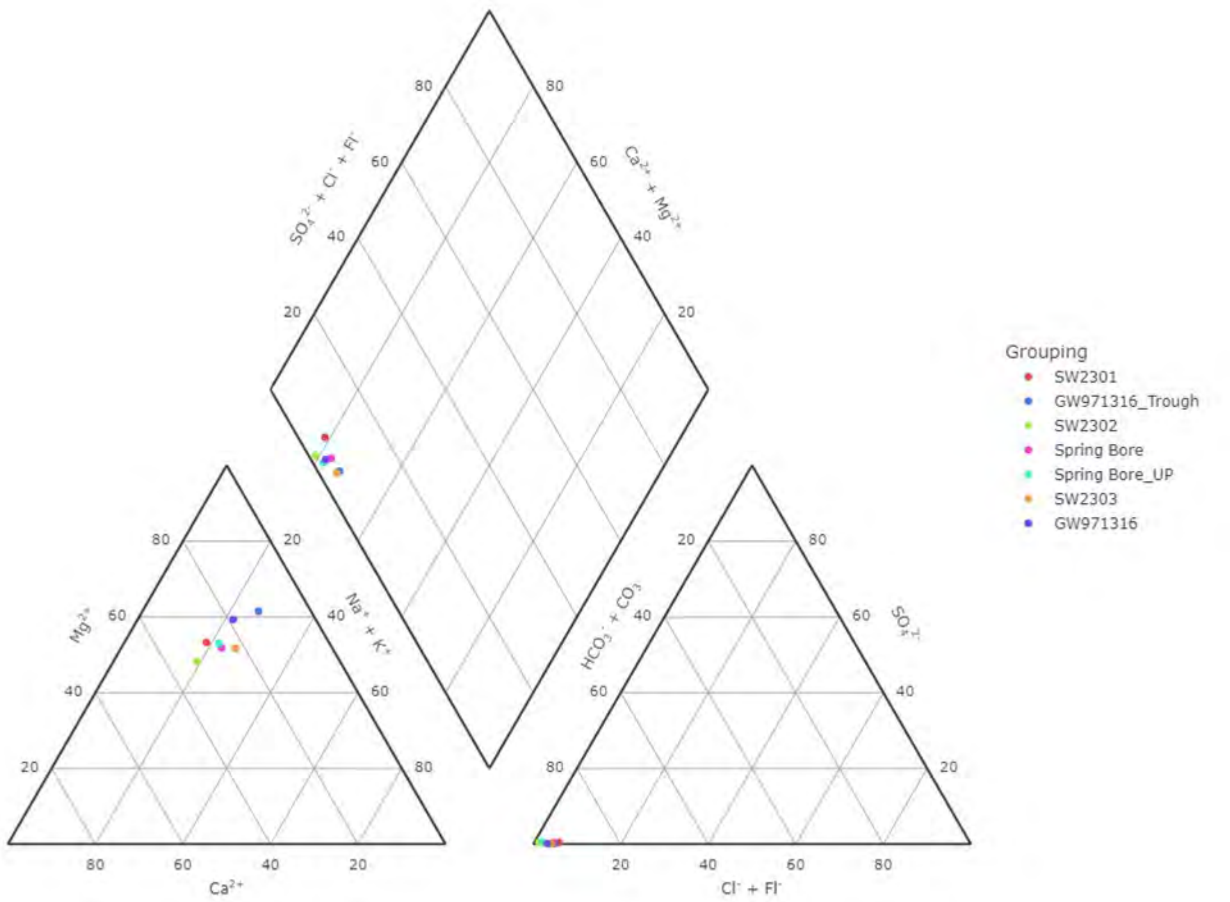
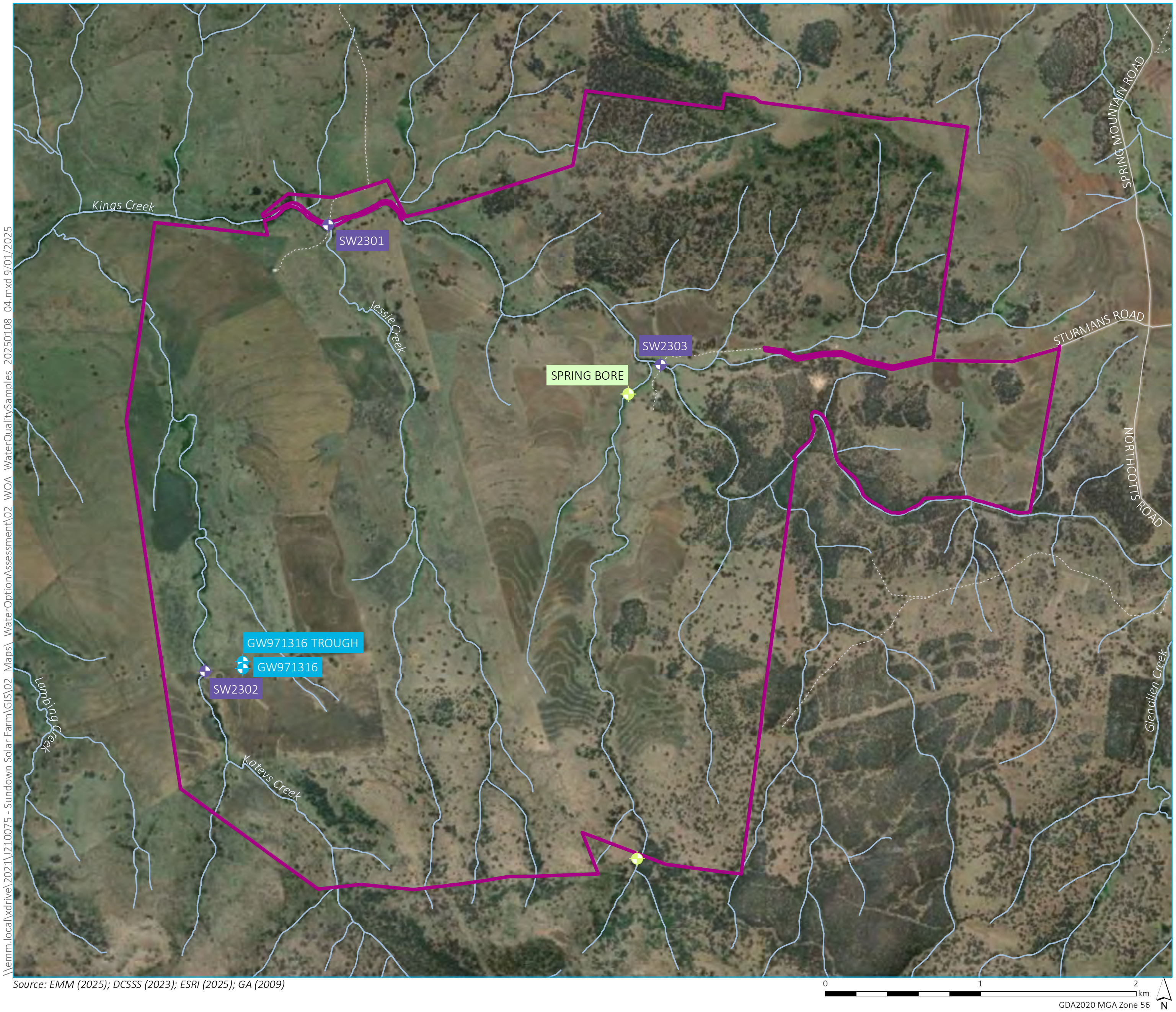


Figure 5.1 Piper plot for all groundwater and surface water monitoring sites



KEY

Proposed Sundown Solar Farm (Project area)

Sampling location

Groundwater

Spring

Surface water

Existing environment

Minor road

Vehicular track

Watercourse/drainage line

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Source: EMM (2025); DCSSS (2023); ESRI (2025); GA (2009)

Water quality sampling locations

Sundown Solar Farm
Groundwater supply options and impact assessment
Figure 5.2

EMM
creating opportunities

5.5 Groundwater level and flow

No recent groundwater level data or seasonal trends is available for the project area. The following understanding is based on other related hydrogeological systems and their common characteristics.

Groundwater flow within the Quaternary sediments is likely to be down gradient towards Kings Creek. Groundwater associated with the Kings Creek alluvium flows west towards Inverell. The seasonal nature of flows in Kings Creek and other minor tributaries means the groundwater storage in the alluvium is likely to be seasonal. The topography of the site descends south to north. Local groundwater flow in the Inverell Basalt and NEFB aquifers is to the north toward Kings Creek. Where the range peaks to the south, groundwater flows south towards Paradise Creek.

Due to the fractured rock nature of the aquifers, groundwater levels in the Inverell Basalt and NEFB would likely show delayed and subdued response to rainfall recharge with increases observed several weeks or months following extended rainfall events. Review of available data shows depth to groundwater in the Inverell basalt ranging from 1.5 to 68 mbgl (Minview 2023). Similar groundwater levels are expected in the NEFB. Depth to water is expected be shallower towards Kings Creek.

5.6 Surface and groundwater connectivity

High connectivity exists between the alluvium and surface water. Connectivity between the Inverell Basalt and surface water features is expected to be low (DPIE 2019b). Furthermore, all surface water channels cease to flow during dry conditions which indicates that groundwater discharge from springsis not a major contributor to surface water baseflow.

Groundwater-surface water connection in the NEFB is variable and depends on the extent of fracturing between surface features and the underlying aquifers. But generally, the relatively low permeability of the NEFB means there is not likely to be significant connection between surface water and groundwater sources (DPIE 2019b).

5.7 Sensitive receivers

The project area is sparsely populated with a limited number of sensitive receivers (Figure 5.4). Sensitive receivers in the vicinity of the project include potential groundwater dependent ecosystems (GDEs) and landholder bores.

5.7.1 Landholder bores

There are 49 registered bores within a 10 km radius of the project; 26 are registered as water supply bores, 17 for stock and domestic, 2 for irrigation and 2 for commercial purposes. Two bores are registered for unknown purposes.

Twenty-two bores are reported to be currently functioning; the status of the remaining boreholes is unknown. Bores are targeting the Maybole and Langari Hill Volcanics (i.e. Inverell Basalt), and unconsolidated sediments associated with alluvial terraces, creeks and rivers. Bore depths for the fractured rock bores range from 11 to 135 m.

One bore (GW971316) bore is located within the project area towards the south-western boundary of the footprint and is registered for stock and domestic purposes. Aquifer testing has been completed on GW971316 to determine if it is suitable for project water supply (see Section 5.8). The second closest bore is GW067996 which is located approximately 1.8 km north of the project boundary.

5.7.2 Groundwater dependent ecosystems

The risk assessment guidelines for GDEs (Serov et al 2012) (GDE Risk Assessment Guidelines) inform the assessment and management of GDEs under the *Water Management Act 2000* (WM Act) in NSW. The GDE Risk Assessment Guidelines provide that GDEs:

> Explicitly include any ecosystem that uses groundwater at any time or for any duration in order to maintain its composition and condition.

An ecosystem's dependence on groundwater can be variable, ranging from partial and infrequent dependence, that is, seasonal or episodic (facultative), to total continual dependence (entire/obligate) (refer Figure 5.3).

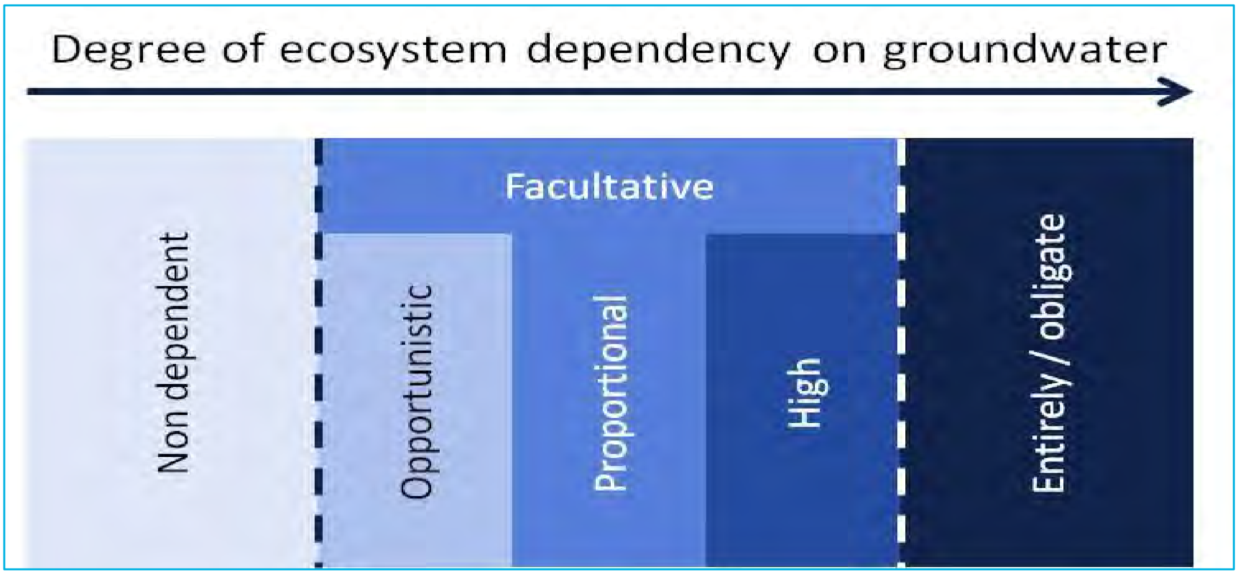


Figure 5.3 Ecosystem level of dependence on groundwater

A desktop assessment was completed to identify potential GDEs located within the vicinity of the project area. The desktop assessment involved a review of:

- the Bureau of Meteorology GDE Atlas for aquatic and terrestrial GDEs with low to high potential for groundwater interaction (BoM 2023b)
- MDBFRGS WSP for high priority GDEs listed in Schedule 2
- the Department of Planning and Environment (DPE) high ecological value aquatic ecosystem (HEVAE) mapping.

Any GDEs listed in the WSPs are high priority and, despite the project NOT qualifying as an aquifer interference activity, proposed water supply bores are likely to be conservatively assessed by Department of Planning and Environment – Water (DPE-W) against the minimal impact criteria outlined in the AIP.

The MDBFRGS WSP identifies high priority GDEs as those with both high probability of being groundwater-dependent and of either high or very high ecological value. Review of high priority GDE mapping and Schedule 2 of the MDBFRGS WSP identified two high-priority groundwater dependent ecosystems within the vicinity of the Project (Figure 5.4):

- Wyndhams Springs, about 25 km north of the Project area
- Deadbird Spring, about 30 km west of the Project area.

Both high priority GDEs will not be impacted due to their distance from the Project.

i High potential

The BoM groundwater Atlas (BoM 2023) was used to identify high potential aquatic and terrestrial GDEs. The review of the GDE Atlas found that:

- high to moderate potential terrestrial GDEs are localised along the waterways and their associated riparian corridors including Kateys Creek, Jessie Creek and Kings Creek. Associated plant communities could include River Oak, Roughed-Barked Apple, Blakeley's Red Gum and Yellow Box grassy woodland, and White Box grassy woodlands, the latter found mainly on Inverell basalts

- no high potential aquatic ecosystems are within 10 km from the project area. One moderate potential aquatic ecosystem was identified within 5 km from the project footprint on Macintyre River, to the southeast of the project

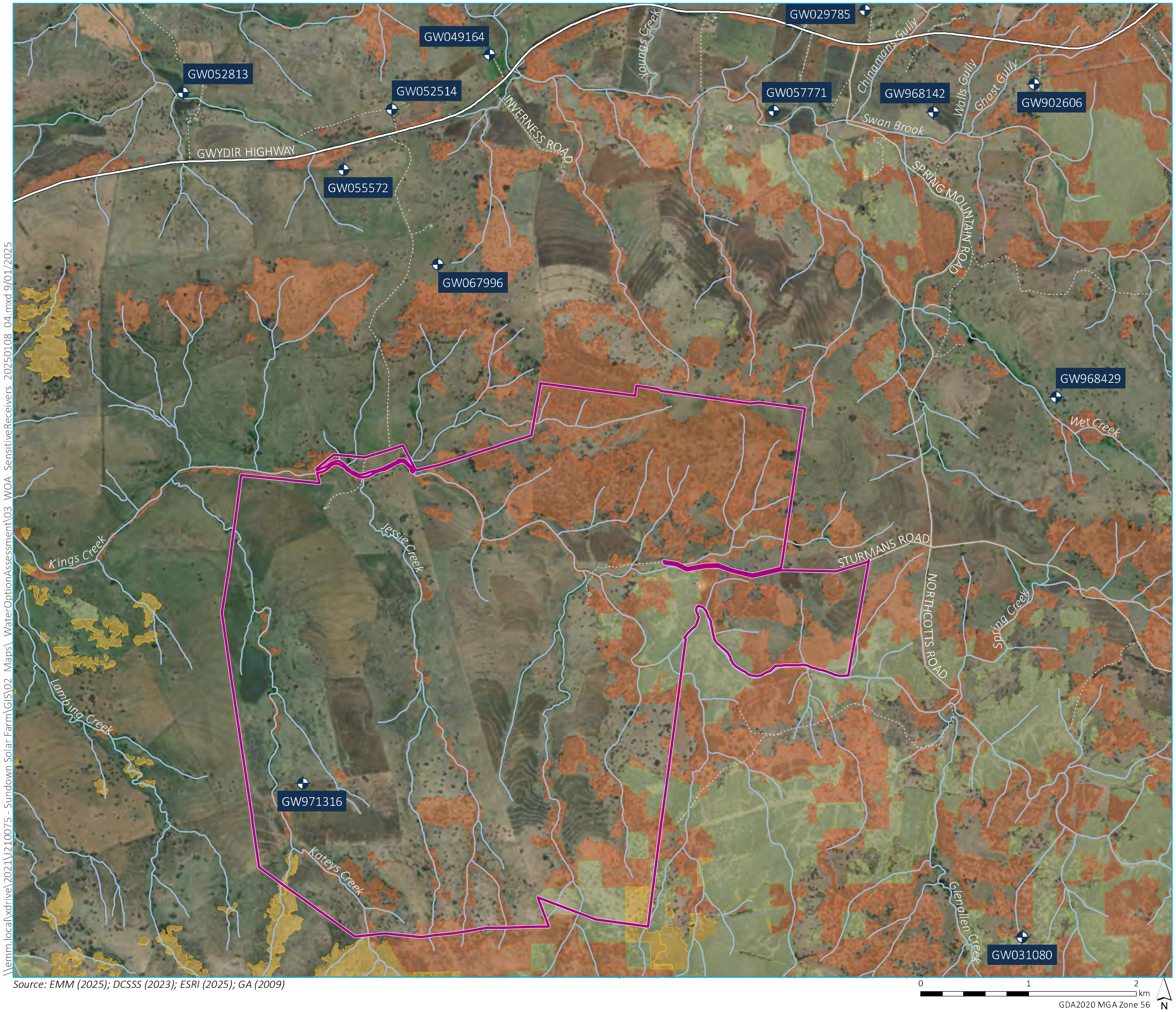
- no potential subterranean GDEs were identified.

Due to the ephemeral nature of tributaries within the project area (i.e. Kateys Creek, Jessie Creek and other unnamed ephemeral tributaries) any potential terrestrial GDEs along these tributaries is expected to have a facultative dependence on groundwater through potential shallow groundwater, throughflow and possibly the deeper water table where roots persist and can access water during extended dry periods. Along Kings Creek, potential GDEs could have an obligate to facultative relationship with groundwater because the flow is more reliable.

ii HEVAE

DPE's high ecological value aquatic ecosystem (HEVAE) framework was also reviewed to assign ecological value to GDEs. Data for four criteria (diversity, distinctiveness, naturalness, vital habitat) are weighted on a scale 1 to 4 (4 being the lowest) and combined to give the overall HEVAE instream score.

Based on GDE-HEVAE mapping available via the SEED portal (DPE Water 2022f) there are some selected areas of high and very potential GDEs. But generally, the HEVAE mapping is similar to the BoM groundwater atlas (BoM 2023) and generally highlights the same areas as potential GDEs.



Source: EMM (2025); DCSSS (2023); ESRI (2025); GA (2009)

KEY

Proposed Sundown Solar Farm (Project area)

Landholder bore location

Groundwater dependent ecosystem (GDE) – terrestrial

- High potential
- Moderate potential
- Low potential

Existing environment

- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line

Sensitive receivers

Sundown Solar Farm
Groundwater supply options and impact assessment
Figure 5.4

EMM creating opportunities

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5.8 Aquifer testing

Aquifer testing was completed at GW971316 to estimate the hydraulic properties of the Inverell Basalt and the supply potential of the bore. GW971316 is within the project area towards the south-western boundary of the project (Figure 5.4) and is used for stock and domestic purposes.

The bore work summary (Appendix A) show water bearing zones from 23 to 24 mbgl in weathered basalt and 30 to 32 mbgl in fractured basalt. Cumulative yield was reported to be 1.5 L/s during drilling. Lithology records show 1 m of topsoil overlying 17 m of clay, basalt to 34 m followed by clay to 38.6 m.

Table 5.4 GW191316 construction summary

Top of casing (m)	Total depth [1](mbgl)	Standing water level (mbtoc)	Pump inlet [2] (mbtoc)	Screened interval (mbgl)	Total depth (mbgl)	Water bearing zones (mbgl)
0.3	36	12.16	31.14	18 to 36	38.6	23 to 24 30 to 32

Notes: 1. Metres below ground level; 2. Metres below top of casing;

5.8.1 Methodology

Testing was designed in compliance with the *Minimum Requirements for Pumping Tests on Water Bores in New South Wales* (DPIE 2019c). Aquifer testing services were provided by Overall Drilling Pty Limited. Aquifer testing results were analysed using AQTESOLV (Duffield 2007).

The aquifer testing involved a step rate test (SRT) and a constant rate test (CRT):

- The SRT was undertaken to estimate bore efficiencies (aquifer and well losses) and inform the selection of an appropriate pumping rate for the CRT. The step test comprised five 60-minute steps of incrementally increasing flow rates.

- The CRT was designed to estimate aquifer properties at the pumped bore and identify the presence of any boundary conditions. A constant pumping rate was maintained for the duration of testing.

Groundwater level changes in the pumped bore were recorded with a down hole pressure transducer and manual measurements were also recorded using a water level meter. Groundwater pumped from the bore was discharged on a slight slope about 20 to 30 m down gradient of the bore.

5.8.2 Results

i SRT

Table 5.5 details the pumping rates, step durations and incremental drawdowns of the SRT conducted at GW971316.

Table 5.5 GW971316 SRT – step summary

Step number	Duration (min)	Flow rate (L/s)	Cumulative drawdown (m)
1	60	0.3	0.7
2	60	0.7	2.4
3	60	1.1	4.7

Step number	Duration (min)	Flow rate (L/s)	Cumulative drawdown (m)
4	60	2.0	10.4
5	60	2.5	14.1

Note: L/s: litres per second

The results of the SRT analysis are provided in Table 5.6 and discussed below.

Table 5.6 GW971316SRT – results

Step number	Flow rate [1] (L/s)	Incremental drawdown (m)	Linear aquifer-loss coefficient (B)(min/m^2)	Non-linear well-loss coefficient (C) (min^2/m^5)
1	0.3	0.7	5.5	2.9
2	0.7	1.7		
3	1.1	2.3		
4	2.0	5.7		
5	2.5	3.7		

Note: 1. L/s: litres per second

The calculated non-linear well-loss coefficient (2.9 min^2/m^5) suggests some degree of deterioration or clogging. Groundwater inflow is impeded by the slotted casing/bottom entry and suggests reduced connection with the surrounding aquifer/inflow zones.

Flow rates at step 4 and 5 dewatered the water bearing zone between 23 to 24 m which increased the amount and rate of drawdown indicating these flow rates are too high for long term pumping.

ii CRT

Based on the results of the SRT data analysis, the CRT was conducted at a rate of 1 L/s for 48 hours. Following pumping, the groundwater level recovery was then monitored for 12 hours.

On completion of pumping, the drawdown at GW971316 was 7.6 m, which translates to a groundwater level in the bore of 20.0 mbtoc (2 m below the top of the slotted casing but 3 m above the first inflow zone).

Table 5.7 summarises the pumping rate, duration and final drawdown of the CRT conducted at GW971316.

Table 5.7 GW971316 CRT pumping and recovery summary

	Duration (hr)	Flow rate [1](L/s)	Final drawdown (m)
Pumping	48	1	7.6
Recovery	12	0	0.1*

Note: 1. L/s: litres per second
* residual drawdown

Based on review of the driller's log and the local geology, the following assumptions have been made for the CRT analysis:

- The aquifer is semi-confined (leaky). The clay aquitard overlying the basalt aquifer acts as a constant head recharge (through downward leakage to the aquifer). This is evidenced by the analysis of the derivative of the CRT data (see Appendix A).
- The bore is fully penetrating.
- The aquifer thickness is 18 m.

Based on the above assumptions, the Moench (1984) solution for pumping in leaky aquifers has been selected as the most suitable model for the analysis. It assumes unsteady flow to a fully penetrating, finite-diameter well with wellbore storage and wellbore skin in a homogeneous, isotropic leaky confined aquifer.

Table 5.8 presents the results of the CRT analysis. The estimated horizontal hydraulic conductivity of the Inverell basalt aquifer at GW971316 is 7×10^{-2} m/day. This value is consistent with the textbook ranges for similar lithologies (Domenico and Schwartz 1990):

- Permeable basalt: 10^{-2} m/day to 10^{3} m/day.
- Fractured igneous rock: 10^{-3} m/day to 10^{2} m/day.

No monitoring well was available to derive storativity therefore textbook values were adopted. The storativity of 5×10^{-2} is typical of that of a semi-confined aquifer. The skin effect accounts for the head losses in the vicinity of a well. The negative skin factor indicates an area of enhanced permeability in the formation near the bore, typically because of drilling activities.

Table 5.8 GW971316 CRT analysis results – estimated hydraulic parameters

Solution	Transmissivity (m^2/day)	Hydraulic conductivity (K) (m/day)	Aquifer thickness (m)	Storativity (S) (-)	Skin factor (Sw) (-)
Moench (1985) – solution for pumping in leaky aquifers	1.3	7.2×10^{-2}	18	5.0×10^{-2}	- 0.4

Based on these pumping test results, the safe yield of the bore has been assessed. Details are provided in Section 6.6.

5.9 Hydrogeological conceptual model

Given limited sensitive receivers and aquifer simplicity within the project area, a simple hydrogeological conceptual model is presented to account for potential impact pathways (refer Section 5.10). A summary of the key hydrogeological mechanisms of relevance to the assessment is documented below:

- The Inverell Basalt and NEFB are considered the primary water source targets for the project. If explored, bores would target fracture systems yielding a minimum 0.5 L/s.
- The Inverell Basalt and NEFB are semi confined to confined. As indicated by pumping testing, the clay above the Inverell Basalt is a leaky aquitard and provides a constant head boundary (recharge) during short term pumping. However, during long-term pumping the aquitard could dewater due to limited storage and would reduce the aquifers supply capacity.
- Interflow (i.e. the horizontal flow of water through a soil profile) is likely to be a significant contributor to streamflow following extended rainfall events.

- Baseflows from the local Inverell Basalt aquifer could provide seasonal baseflow to ephemeral tributaries that intercept an elevated water table following extended wetting periods (i.e. La Niña). Minimal baseflows to local streams are expected during drier periods (i.e. El Nino).
- High potential GDEs along Katey Creek, Jessie Creek and other unnamed 1st and 2nd order tributaries are expected to have a facultative opportunistic reliance on groundwater due to their ephemeral or seasonal nature.
- High potential GDEs along Kings Creek could have a facultative to obligate relationship with groundwater due to the more permanent nature of surface water flows, and the likelihood of Kings Creek intercepting the regional water table which provides some baseflow along its length.
- The Inverell Basalt and NEFB aquifers are recharged by rainfall where the aquifer outcrops and minor leakage from the overlying alluvium (where present). Discharge in the Inverell Basalt occurs through pumping, evapotranspiration, leakage to the NEFB and diffuse seasonal spring discharge. Discharge in the NEFB occurs through pumping and discharge to tributaries where they intercept the water table.

5.10 Impact pathways

For an effect to occur to a sensitive groundwater receptor (i.e. either a landholder bore or a GDE), a pathway must exist between the pumping bore and the receptor. Risks are characterised by making an informed decision as to the potential for adverse effects to impact each groundwater receptor because of project-related activities. A summary of potential impact pathways to identified sensitive groundwater receptors is included in Table 5.9.

Table 5.9 Potential impact pathways

Receptor	Source	Potential impact	Comment
High Priority GDEs	Groundwater abstraction from the Inverell Basalt and/or New England Fold Belt (NEFB) fractured rock aquifers.	Groundwater drawdown due to groundwater abstraction limiting water availability.	No high priority GDEs under the current MDBFRGS WSP will be impacted. Wyndhams Springs is about 25 km north and Deadbird Spring is about 30 km west of the project area.
High potential GDEs		Induced leakage and loss of water from the alluvium/colluvium to the Inverell Basalt due to abstraction.	There are several high potential GDEs located within the Project area based on BoM (2023) mapping. Most are associated with Kings Creek, Jessie Creek, Katey Creek and unnamed 1st and 2nd order tributaries. High potential GDEs (remnant vegetation) have also been mapped to the south and northeast of the project area.
Landholder bores		Falling water levels and drawdown in landholder bores due to groundwater abstraction from the Inverell Basalt and/or NEFB fractured rock aquifer.	The closest landholder bore to the Project boundary is GW067996 which is approximately 1.8 km to the north of the Project boundary. GW971316 is the only bore within the project area and is planned to be used for construction and operational water supply.

6 Impact assessment

As detailed in Section 2.3, total water demand during construction is 75 ML over 21 months. During operation, this reduces to 475 kL/year, over 35 years. The bulk of this water demand is expected to be satisfied using groundwater.

The following sections detail the potential impacts from abstracting groundwater form local groundwater systems within the project boundary.

6.1 Water sharing plan rules

Relevant rules for the MDBFRGS WSP are detailed below. The rules apply to two groundwater sources which are present within the project area:

1. The Inverell Basalt Groundwater Source – basalt and sediment of Cenozoic (Tertiary) age (Maybole and Langari Hill Volcanics) as well as unconsolidated sediments (alluvial and colluvium).

2. The New England Fold Belt MDB Groundwater Source – Emmaville Volcanics and Sandon Beds.

WSP rules of relevance to the project when assessing potential impacts due to groundwater extraction include:

- Other groundwater users:

    - A water supply work must be greater than 200 m from any existing basic landholder rights water supply works (stock and domestic bore).

    - A water supply work must be greater than 400 m from any existing other supply works (water supply, commercial or irrigation bore).

    - A water supply work must be greater than 400 m from a government monitoring bore.

    - A water supply work must be greater than 500 m from a water utility licence (that is, a town water supply bore[s]).

Given no landholder bores are within the vicinity of the project, none of these rules are applicable.

- For high priority GDEs and groundwater dependent culturally significant sites:

    - a water supply work must be greater than 40 m from the top of the high bank of a river

    - a water supply work must be greater than 200 m from any high priority GDE listed in Table A, Schedule 2 of the WSP and groundwater dependent culturally significant sites

    - a water supply work must be greater than 200 m from any high priority GDE shown on the WSP high priority GDE map.

Given no high priority GDEs or culturally significant sites are within the vicinity of the project, none of these rules are applicable.

6.2 Obtaining a works and use approval

The NSW Department of Industry – Water (DPI-W 2018) prepared a fact sheet which details acceptable levels of impact when assessing water supply works (i.e. new water bores) applications. Given groundwater for the project will be abstracted from the Inverell Basalt Groundwater Source or the NEFB MDB Groundwater Source, impacts on groundwater pressure (confined/semi-confined aquifers) are applicable because aquifers within the project area have been conceptualised accordingly. The following are of note:

1. A cumulative drawdown of not more than 40% of the pre-development TAD (total available drawdown) at a distance of 200 m from any water supply works including pumping bores.

2. An additional drawdown of not more than 3 m at any water supply works (excluding those on the same property) subject to negotiation with impacted parties (i.e. make good arrangements may apply).

Without knowing the TAD at each landholder bore, 'additional drawdown of not more than 3 m at any water supply works' will be used to assess the project's impacts to other water supply works (i.e. neighbouring landholder bores). Should groundwater drawdown exceed this trigger, the project would need to 'make good' on any realised impacts to landholders.

There are no explicit assessment conditions for high priority or high potential groundwater dependent ecosystem for assessment criteria associated with confined/semi confined aquifers.

6.3 Risk assessment approach

A National Water Commission (NWC) risk framework (Moran 2010) has been adopted for the groundwater risk assessment. The framework uses a source-pathway-analysis that describes how water-affecting activities might impact on sensitive groundwater receptors.

For an effect to occur to a sensitive water receptor, a pathway must exist between a water-affecting activity and a receptor (see Section 5.10). Risks are characterised by making an informed decision as to the potential for adverse effects to impact sensitive groundwater receptors because of Project-related activities.

The impact assessment quantifies the risk from water-affecting activities and involves assessing the potential consequences arising from the water-affecting activities in terms of direct effects (i.e. altered water resource condition such as changes in groundwater pressure) and of possible indirect effects at identified receptors (i.e. landholder bores and GDEs).

The risk assessment also provides a basis for communicating risks and consequences and identifying the management approach that may be necessary to eliminate or reduce risk (Section 7). Monitoring data would be used to review the effectiveness of management measures over the construction of the Project.

6.4 Impact pathways

Primary impact is unacceptable drawdown in water levels to high potential GDEs (see Table 5.9). Because of the low volumes and duration of groundwater abstraction, no long-lasting impacts are anticipated for high potential GDEs that have facultative or obligate access groundwater. No landholder bores will be impacted by abstraction due to their distance from the project area.

6.5 Prediction modelling

Based on the *Minimum Groundwater Modelling Requirements for SSD/SSI Projects* (DPE Water 2022c), the environmental complexity and sensitivity was determined to be low therefore an analytical model (the model) used to predict potential impacts was built using MLU software (Hemker & Post 2008) to assess potential groundwater impacts on sensitive receivers. Results from MLU were verified against another analytical tool called AQTESOLV (Duffield 2007) and found to have similar results.

MLU programs are used to measure drawdown in confined single and multilayered aquifer systems and is commonly used to analyse aquifer test data and design water supply borefields. The model represents an infinite-extent approximation of drawdown responses for isotropic and homogenous confined aquifer conditions with no recharge.

6.6 GW971316 supply capacity

As detailed in Section 5.9, when GW971316 was pumping tested the Inverell Basalt was found to have a constant head boundary providing recharge from a leaky aquitard above the pumped aquifer. It is likely that the leaky aquitard has limited storage when pumped long term therefore a one-layer model was created to replicate a confined aquifer system. Therefore, the model assumes no recharge when pumping from a confined aquifer therefore drawdown is likely to overestimated.

The construction water demand is expected to be 75 ML over 21 months (i.e. about 1.4 L/s). The results of the pumping testing have been used to predict the long-term recommended pumping rate at existing bore GW971316.

The estimated hydraulic properties at GW971316 and conceptual understanding have been used to conduct forward modelling (a function in AQTESOLV [Duffield 2007]) and MLU (Hemker and Post 2008) to assist in assessing drawdown response to pumping at various rates over the 21-month construction period.

The assessment to identify a pumping rate for operation of bore GW971316 assumes:

- the aquifer has an infinite extent (i.e. no barrier boundaries are encountered)
- the maximum pumping groundwater level is set at 20 mbgl, i.e. 3 m above the first water cut (which is 23 mbgl as recorded by the driller’s log). With a pre-pumping static water level of 12 mbgl, the maximum available head (H) is therefore 8 m
- pumping is continuous for 21 months with no recovery periods.

Table 6.1 shows the calculated predicted drawdown at GW971316 after 21 months of continuous pumping at different flow rates. Based on the criteria and assumptions listed above, there is general agreeance between AQTESOLV and MLU software that the recommended long term pumping rate at GW971316 is 0.7 L/s.

Table 6.1 Predicted drawdown at GW971316 – continuous pumping over a 21-month period

Pumping rate (L/s)	Total drawdown (m)	Comparison with available head (H)
AQTESOLV (Theis 1935)		
0.6	6.8	< H
0.7	7.7	~ H
1.2	9.2	> H
1.4	10.7	> H

Pumping rate (L/s)	Total drawdown (m)	Comparison with available head (H)
MLU		
0.6	6.7	< H
0.7	7.8	~ H
0.8	8.9	> H
0.9	10.0	> H

Note: L/s: litres per second
H: maximum available drawdown (8 m)

With only one operational bore there is a predicted shortfall of 0.7 L/s (50%) to meet the total construction water demand of 1.4 L/s. Moreover, the predicted long-term pumping rate of GW971316 is based on assumptions on the aquifer extent and thickness. The actual pumping rate could be lower than predicted if boundaries (e.g. faults) that could not be observed during the constant rate test are present in the area. It is therefore recommended that additional production bores be installed, or water carted to site, to supplement the construction water supply. Additional bores could provide back-up pumping should the existing bore become unusable or if its long-term pumping rate is lower than predicted.

6.7 Drawdown prediction modelling

MLU was used to create drawdown contours to predict potential impacts to nearby high potential GDEs. To meet construction water supply demand, two scenarios have been modelled to determine potential drawdown impacts on high potential GDEs within the project area:

1. Pumping from GW971316 at a constant rate of 0.7 L/s. The shortfall in supply would be met by carting water to site.
2. Pumping from GW971316, and two other additional proposed bores, to achieve a cumulative yield of 1.4 L/s.

Both scenarios were modelled as confined aquifers and disregard any constant head boundaries, recharge or no flow boundaries (i.e. faults). However, it is known that the leaky aquitard above the Inverell Basalt and rainfall will provide some recharge during the proposed 21 months of abstraction and will buffer potential drawdown impacts. Furthermore, because the model assumes the aquifer is isotropic, drawdown is modelled evenly from the bore but in reality, is likely to be irregular and uneven depending on aquifer boundaries and fracture connectivity (e.g. drawdown may be greater in a north south direction because of fracture connectivity or geological boundaries meaning drawdown east and west of the bore is less). Nevertheless, the model shows an approximation of potential far reaching impacts caused by groundwater drawdown and is therefore conservative in nature.

6.7.1 Additional bore sites

Since additional proposed test production bore (TPB) locations have not been ground truthed, cultivated areas (shown hatched and labelled as areas of 'low ecological diversity' on Figure 6.2) area have been selected to install additional bores because they are already highly disturbed, and are located within the proposed project disturbance footprint. It is not expected that further assessment will be required when selecting additional bore sites in hatched areas because of their low ecological diversity and approved for disturbance under the project SSD.

When locating a suitable water supply within these areas it is recommended that several test bores are drilled to maximise the chance of intercepting a minimum of 0.5 L/s. Successful test bores would be converted to test production bores and pumping tested to confirm supply. Depending on where the yield is intercepted (i.e. Inverell Basalt or NEFB) will have licencing implications (see Section 8).

Bores should be installed a minimum 200 m away from high potential GDEs and minimum 500 m away from each other to reduce drawdown interference and maximise pumping potential. The recommended maximum depth of each of these new bores is 60 m. Drill pads will take up an area of approximately 40 × 40 m for the drill rig and ancillary equipment. The final bore site will take up an area of approximately 5 × 5 m.

6.7.2 Construction

i Scenario one

No landholder bores will be impacted by project related abstraction from the Inverell Basalt. The closest bore (GW067996) is approximately 5 km to the north of GW971316.

High potential GDEs have been mapped about 300 m to the south-west and 300 m east of GW971316. High potential GDEs to the southwest are associated with Kateys Creek with remnant woodland to the east (Figure 5.4).

After 21 months pumping at 0.7 L/s, MLU modelling predicts potential drawdown of the Inverell Basalt water table of 0.2 to 0.7 m at the location of the high potential GDEs near GW971316 (Figure 6.1). As mentioned in Section 6.6, modelled drawdown is likely overestimated under confined assumptions because it does not consider recharge or the constant head boundary from the leaky aquitard above the pumped aquifer nor does it consider the heterogenous nature of fractured rock aquifers. Given the short duration of pumping for construction and high potential GDEs along ephemeral tributaries conceptualised as having a facultative relationship with groundwater, impacts in this scenario are unlikely to cause long lasting negative impacts to high potential GDEs.

ii Scenario two

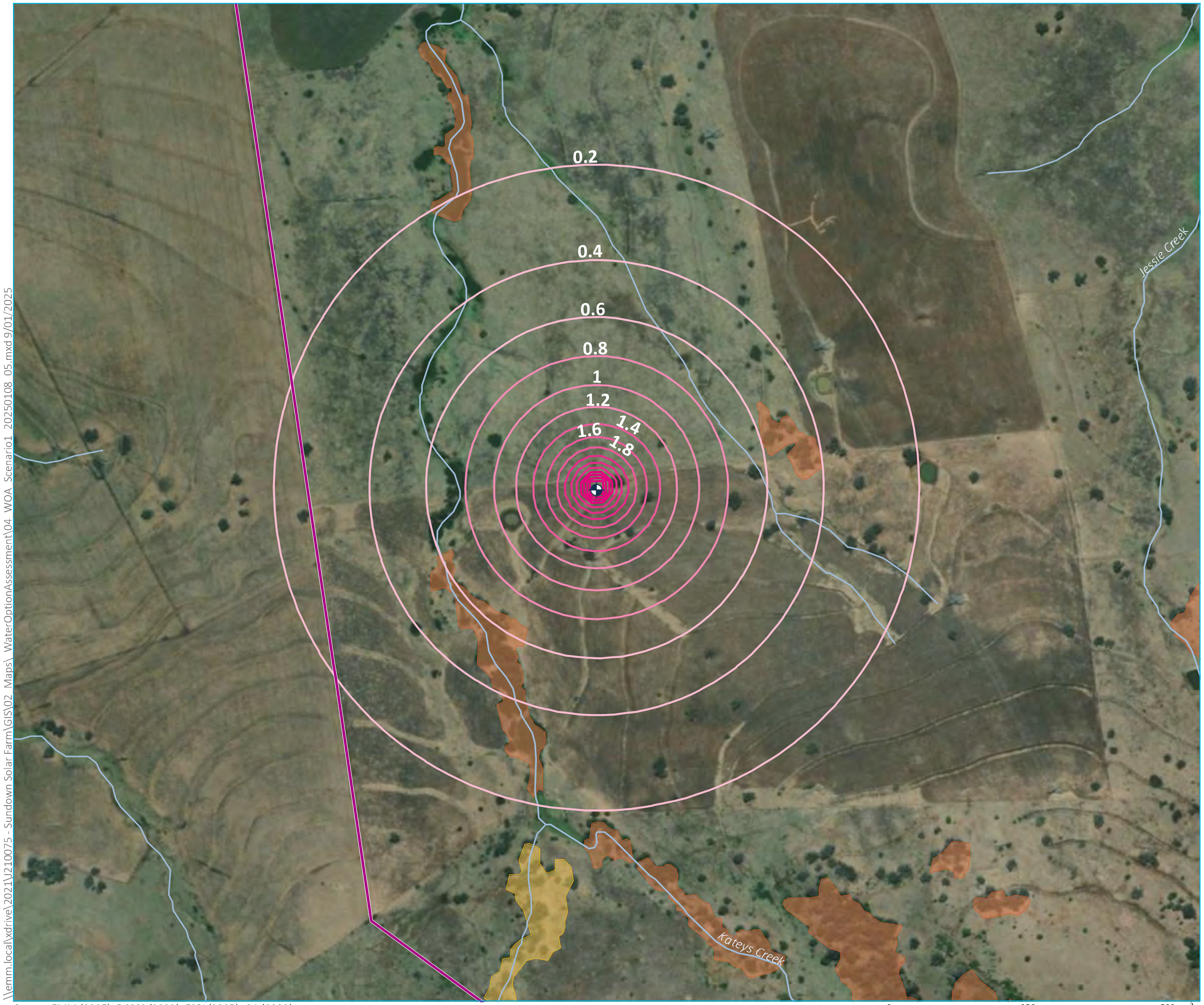
Potential drawdown from three bores (TPB1, TPB2 and GW971316) was assessed, pumping at 0.46 L/s over 21 months for a cumulative yield of 1.4 L/s. The two additional bores (TPB1 and TPB2) within the 'low ecological diversity' areas were located close to high potential GDEs on Kings Creek to assess scenario two as a worst-case. In reality, the final locations of test bores would be positioned to avoid high potential GDEs and tributaries therefore any potential impacts to high potential GDEs is unlikely.

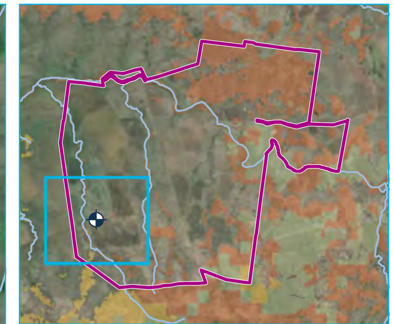
Under the worst-case scenario, no landholder bores will be impacted by project related abstraction from the Inverell Basalt or NEFB aquifers. The closest bore (GW067996) is approximately 2.5 and 2.8 km north of TPB1 and TPB2 respectively and modelled drawdown extends up to 650 m. When pumping at 0.46 L/s from GW971316, TPB1 and TPB2, potential drawdown at high potential GDEs could range from 0.1 to 0.6 m at over a 21-month period.

As mentioned in Section 6.6, modelled drawdown is likely overestimated under confined assumptions because it does not consider any recharge or potential constant head boundaries. Furthermore, the relationship between high potential GDEs and groundwater has been conceptualised as generally facultative (Section 5.9) and any short-term pumping is unlikely to cause long lasting impacts.

6.7.3 Operation

The estimated ongoing operational water usage for the project is 475 kL/year, over 35 years. It is expected that water requirements will be satisfied using bores and dams within the project boundary and rainwater tanks collecting runoff from building roofs. Any water extracted from bores will have negligible impact on sensitive receivers due to the low volumes required to maintain operations.





KEY

Proposed Sundown Solar Farm (Project area)

GW971316 bore

Drawdown contour (m)

- 0.20 - 0.60
- 0.60 - 1.20
- 1.20 - 1.80
- 1.80 - 2.40
- 2.40 - 3.20

Groundwater dependent ecosystem (GDE) – terrestrial

- High potential
- Moderate potential
- Low potential

Existing environment

- Watercourse/drainage line

Source: EMM (2025); DCSSS (2023); ESRI (2025); GA (2009)

0 250 500 m

GDA2020 MGA Zone 56

N

Scenario one - predicted drawdown from pumping GW971316 at 0.7 L/s

Sundown Solar Farm
Groundwater supply options and impact assessment
Figure 6.1

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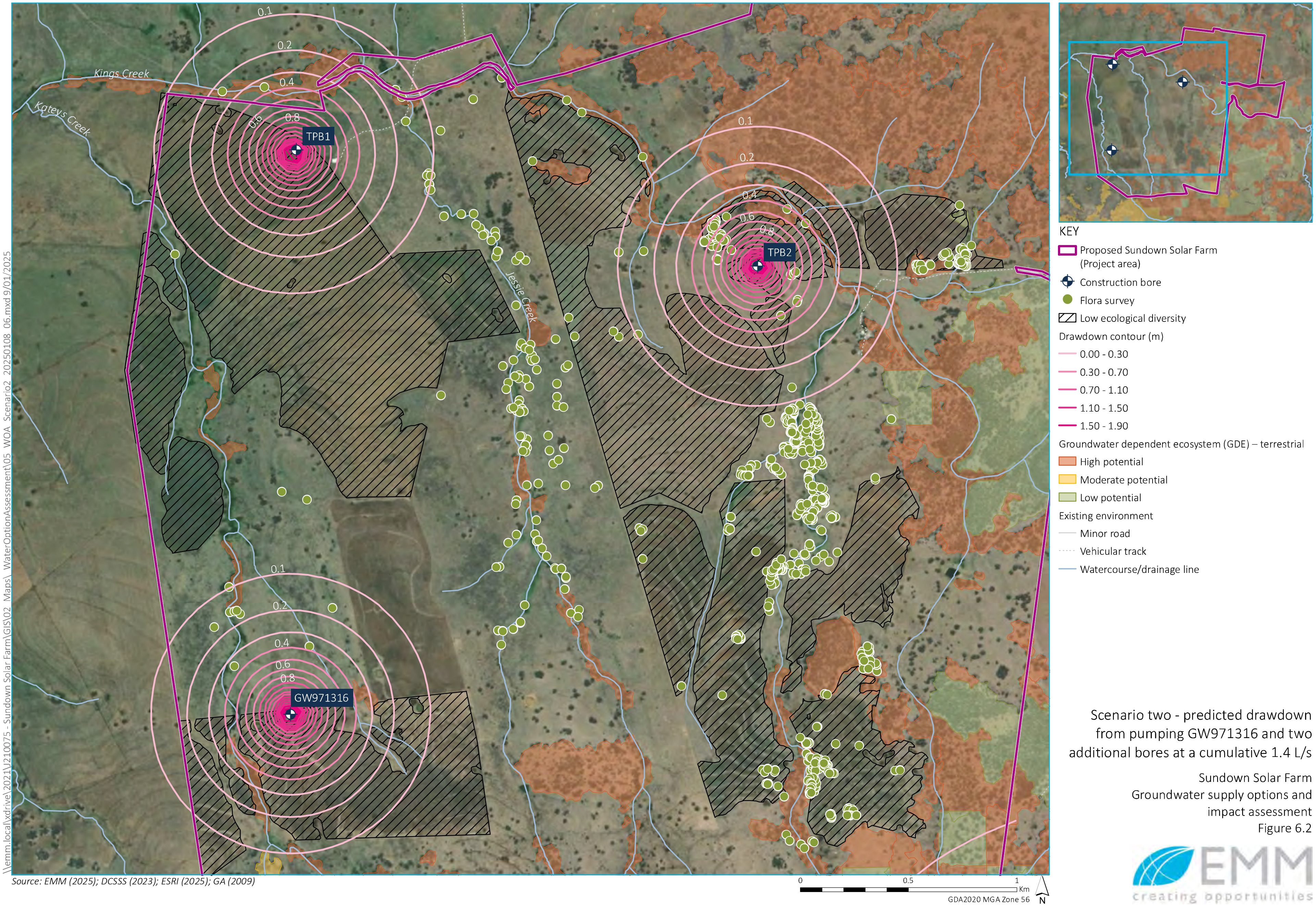

Source: EMM (2025); DCSSS (2023); ESRI (2025); GA (2009)

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Scenario two - predicted drawdown from pumping GW971316 and two additional bores at a cumulative 1.4 L/s

Sundown Solar Farm
Groundwater supply options and impact assessment
Figure 6.2

EMM
creating opportunities

7 Management and mitigation

The following management and mitigation measures are recommended.

Table 7.1 Groundwater supply mitigation measures

ID	Mitigation measure
GWS01	Monitoring of water levels in each of the pumping bores during the 21-month construction period to ensure optimal pumping rates and to verify predicted drawdown and potential impacts on any nearby high potential GDEs.
GWS02	Measurement and record of pumped volumes to comply with works and use approvals.
GWS03	Installation of one monitoring bore at location adjacent to closest terrestrial GDE area near GW971316. Monitoring bore should be monitored during the 21-month construction period to verify predicted drawdown and potential impacts on any nearby high potential GDEs. The monitoring bore will also help to confirm the facultative relationship high potential GDEs have with groundwater.

Although not anticipated because the closest water supply bore is 2 km north of project boundary, the recommended approach to mitigating any landholder bore impacts is through make good provisions as detailed in the MDBFRGS WSP. Make good provisions are a negotiation between parties to make good any realised impacts on water availability at landholder bores caused by project operations. Examples of make good provisions are deepening or installing a new water supply bore, lowering the pump intake, financial compensation, or alternate water supply.

8 Water licencing and approvals

The following section summarises the approvals required to legally take groundwater in NSW. The project is located within the Inverell Basalt Groundwater Source and NEFB MDB Groundwater Source which are managed by the MDBFRGS WSP*.*

The aquifer access licence available share component for the Inverell Basalt and NEFB MDB Groundwater Source is 1,073 and 14,520 unit shares, respectively.

8.1 Securing approval and licences

It should be noted that bores and pumps that extract water for stock and domestic purposes (Basic Landholder Rights) cannot be used to extract water for other purposes (such as water for construction and other commercial or industrial uses) without amendment of their water supply work and use approval. Similarly, basic landholder rights water entitlement cannot be traded or used for purposes outside that definition. For bores installed for the project, the water supply work and use approval would be registered for commercial usage.

8.1.1 Water access licence

Water access licences (WALs) entitle licence holders to specified shares (the share component) of water within a particular water source. Licences also specify general rules such as the timing, extraction rate or circumstances (the extraction component) in which water can be used. WAL holders can also trade share components, in the same water source, from one WAL holder to another.

The licensees or new users have three ways to secure water in NSW:

- Temporary trade – water allocation within the same water source or management area can be traded temporarily from one water account to another.
- Permanent trade – water entitlement within a water source or management area can be purchased in perpetuity from a WAL holder.
- Controlled allocation orders (CAOs) – allows any individual or company the right to apply for new WALs in water sources that are not fully committed. COAs are announced by DPE-W (approximately once a year) and water is sold by silent auction with floor prices set by DPE-W.

In fully committed water sources, WALs can only be obtained through the water market (i.e. temporary or permanent trade). The Inverell Basalt Groundwater Source is fully committed while the NEFB MDB Groundwater Source may have outstanding shares that could be purchased during a CAO, if and when declared.

8.1.2 Water supply works and use approval

To take water from a water source the user is required to hold a WAL which is linked to an approved water supply work (e.g. a bore, dam or river pump). Such approval authorises the holder to construct and use a specified water supply work at a specified location. If multiple bores are required, then multiple works and use approvals need to be obtained. These approvals often come with conditions to minimise adverse impacts to other users and the environment and cannot be traded from one property to another.

8.1.3 Miscellaneous works

A miscellaneous works can be applied for to cover all water related works assessed and approved under the project SSD, including the use of bores for production purposes. The miscellaneous works is intended to reduce the duplication of work because the assessment has already been approved under the project SSD.

A miscellaneous works reduces timeframes to secure a works approval. Only one miscellaneous works approval is needed to cover all water supply works assessed and approved under the SSD. Additional post approval water supply works are not covered under a miscellaneous works and would require individual water supply works and use approvals.

8.2 Controlled allocation order

The last CAO for the NEFB MDB Groundwater Source in 2022 made 679 unit shares available for purchase at a floor price of $750 per unit. During this allocation, 581 units were sold. Ninety-eight outstanding shares remain in the NEFB MDB Groundwater Source which could be purchased during the next CAO, which is yet to be announced. If water is required before the next CAO, it will need to be purchased on the water market via a water broker.

No COA for the Inverell Basalt Groundwater Source was made available in 2022 because the water source is fully allocated; water would need to be secured on the water market via temporary or permanent trades.

8.3 Process and timeframes

A miscellaneous works approval can be applied for following the approval of the project SSD. This will allow the project to begin installing test production bores to prove supply.

While bores are being installed and tested, a zero share WAL would also need to be applied for the targeted water source/s via DPI-W. The WAL would then need to be linked to the miscellaneous works. This linkage is undertaken by WaterNSW. The linkage then needs to be registered by the NSW Land Registry Services (LRS). Water can then be purchased within the Inverell Basalt and/or NEFB MDB Groundwater Sources either via trading or CAO (if made available).

Indicative processing timeframes (from the time an application is lodged) for water-related applications are as follows:

- Water Supply Work and Use Approval for a production bore (DPI-W) – 3 to 6 months
- Miscellaneous works (DPI-W) – 3 months.
- Zero Share WAL application (DPI-W) – 1 to 2 months.
- Link Water Supply Work and Use Approval or miscellaneous work with a WAL (WaterNSW) – 1 month.
- Register approval and WAL linkage (LRS) – 1 month.
- Purchase of water via temporary trade (via water broker) – 1 month.
- Purchase of water via permanent trade (via water broker) – as much as a year.
- Purchase of water via COA – as much as a year to process.

8.4 Utilising existing bores

To use GW971316 for the project, the following will need to be completed:

1. The works and use approval will need to be amended from stock and domestic purpose to commercial purpose (3 months).
2. Once converted, a zero share WAL will need to be secured and linked to the commercial works and use approval (1 to 2 months).

3. Using a water broker, shares within the Inverell Basalt Groundwater Source will need to be secured on a temporary or permanent basis and linked to the zero share WAL. Timing is dependent on the willingness of market participants to trade.

8.5 Utilising new bores

Given this assessment forms part of the EIS, two additional bores can be commissioned with the hatched area labelled ‘low ecological diversity’ (Figure 6.2) under a miscellaneous works. A zero share WAL and shares within relevant groundwater sources will need to be secured and linked to the miscellaneous works before additional bores can be pumped.

9 Conclusion

The water options assessment identified the Inverell Basalt and NEFB Groundwater Sources as possible sources for construction and operational water supply. Project demand is 75 ML over 21 months (i.e. 1.4 L/s) during construction, and up to 475 kL/year during operation. Water sources are managed under the MDBFRGS WSP.

To prove aquifer prospectivity, landholder bore GW971316, which extracts from the Inverell Basalt Groundwater Source, was pumping tested. The sustainable yield was found to be 0.7 L/s, which is about 50% of the water required during construction.

Using aquifer parameters derived from aquifer testing, two scenarios for sourcing the remining ~50% of the water were modelled and their impacts on sensitive receivers (i.e. landholder bores and GDEs) assessed. The first scenario involved pumping from GW971316 at 0.7 L/s and carting additional water to site. The second scenario involved abstracting a cumulative 1.4 L/s from GW971316 and two additional proposed bores. The two additional proposed bores were assumed to be located within existing highly disturbed areas (i.e. land that has been used for cropping) and within proposed project infrastructure placement areas. For the purposes of drawdown assessment, the additional bores were also located near high potential GDEs as a conservative and worst-case scenario; in reality additional bores would be located as far as practical away from high potential GDEs to minimise potential impacts.

Under both scenarios, no landholder bores will be impacted; the closest bore is about 2 km north of the project boundary and drawdown was modelled to propagate a maximum 650 m from each bore. Under both scenarios, high potential GDEs could be impacted during abstraction for construction:

- For scenario one, a maximum of 0.7 m of potential drawdown could occur in the Inverell Basalt at nearby high potential GDEs if they have access to groundwater.

- For scenario two, up to 0.6 m of potential drawdown could occur in the Inverell Basalt or NEFB aquifers (depending on which aquifer the test bores extract from) at nearby high potential GDEs if they have access to groundwater.

However, the low volume and short duration of abstraction is unlikely to have long lasting impacts given high potential GDES are likely have facultative relationships with groundwater. Negligible impact is expected during operation due to the low volumes of water required.

To utilise GW971316 as a water supply bore for the project, the water supply works and use approval will need to be amended from stock and domestic purposes to commercial usage. Water will also need to be secured for the Inverell Basalt Groundwater Source on the water market via temporary or permanent trades.

Additional bores would target the Inverell Basalt or NEFB Groundwater Sources. Under an SSD approval for the project, bores can be installed under a miscellaneous works. Water will need to be secured on the water market for groundwater sources they extract from.

9.1 Recommendations

The following recommendations are provided to progress a groundwater supply for the project:

- Two additional test bores should be planned to maximise the potential of intercepting a minimum 0.5 L/s at each bore within the proposed testing areas. If intercepted yields are satisfactory, the test bore should be converted to a production bore and aquifer tested to confirm supply potential.

- Up to 0.5 m of drawdown has been modelled to extend up to 230 m from bores. When positioning test/production bores, they should be located a minimum of 200 m away from high potential GDEs. It is also recommended that production bores are located a minimum of 500 m apart to minimise pumping interferences and maximise supply potential.

- To utilise GW971316, the existing works and use approval will need to be amended from stock and domestic purpose to commercial usage.
- Given this assessment is approved under SSD, additional bores can be drilled and tested under a miscellaneous works.
- Once a zero share WAL has been secured, water will need to be purchased permanently or temporarily on the water market via a water broker. For GW971316, water will be purchased from the Inverell Basalt Groundwater Source. The two additional bore sites will need to be drilled and tested to confirm the appropriate groundwater source and volumes required.
- Install one monitoring bore close to terrestrial vegetation near GW971316 that is mapped as a high potential GDE.

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Appendix A

Site walkover and water quality results

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	Bore: GW971316	Date: 14 April 2023
	Alternate name/s: Solar Bore, Turners Bore	**Project number:** J210075
	Project: Sundown Solar Farm	**Location:** ~30 km west of Glen Innes, NSW

Bore details

Note 1 indicates data that has been inferred from the relevant work summary

Landholder	John Rosberg	**Contact Number**	0408 667 638
Easting (GDA94, Z56)	~346784 mE	**Scale observed**	Yes, silica on receiving water tank
Northing (GDA94, Z56)	~6698871 mS	**Functionality**	Not tested, receiving tank and trough full
Elevation (mAHD)	~780	**Pump installed**	Yes
Total depth (mbgl)	36.0[1]	**Power source**	Solar electric
Screen (mbgl)	18.0–36.0[1]	**Yield (L/s)**	~1.0[1]
Water level (mbgl)	N/A (headworks obstructing)	**Purpose**	Stock watering, supplying to one tank and two troughs nearby
Construction material	Class 9 PVC[1] ~220 mm steel protection casing ~10 mm thick cast iron headplate	**Sample obtained**	Yes, proposed for major cation/anions and select dissolved metals

Notes

- Bore and infrastructure protected by steel fence panels.
- Bore supplies two troughs (~750 L each) and one tank (~30,000 L).
- Surface geology at bore comprises CLAY; high plasticity, dark brownish grey. Trace gravel, fine, angular to subrounded, basalt. Deep cracking profile near bore, likely vertosols of residual origin with colluvial gravels from the upslope hills to the south.
- Streamline ~150 m west of bore is non-perennial, largely occasional non-connected pools likely supported by discrete groundwater seeps. Deeply incised by ~4 m, with alluvial terraces at either edge.
- Headworks obstructed, could not access for water level dip or sample directly from bore. Sample obtained from trough ~40 m north of bore (and supplied by the bore).
- Landholder discussion highlighted:
    - Bore has never run dry
    - Windmill situated south, upstream along a non-perennial watercourse has dried up and is barely functioning
    - No issues noted with hardness, noting the water takes soap well and has never blocked pipes or damaged infrastructure
    - Potential to pumping test the bore, near the eastern trough and tank there is a headpipe that could be accessed for yield testing

Mud-map indicating bore and nearby infrastructure

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Mapping plate
Canadian Solar Pty Ltd
Sundown Solar Farm
Photograph 1

Bore GW971316 solar panels and protection infrastructure, facing west

EMM creating opportunities

Photographic plate
Canadian Solar Pty Ltd
Sundown Solar Farm
Photograph 2

Bore GW971316 headworks, facing down

Photographic plate
Canadian Solar Pty Ltd
Sundown Solar Farm
Photograph 3

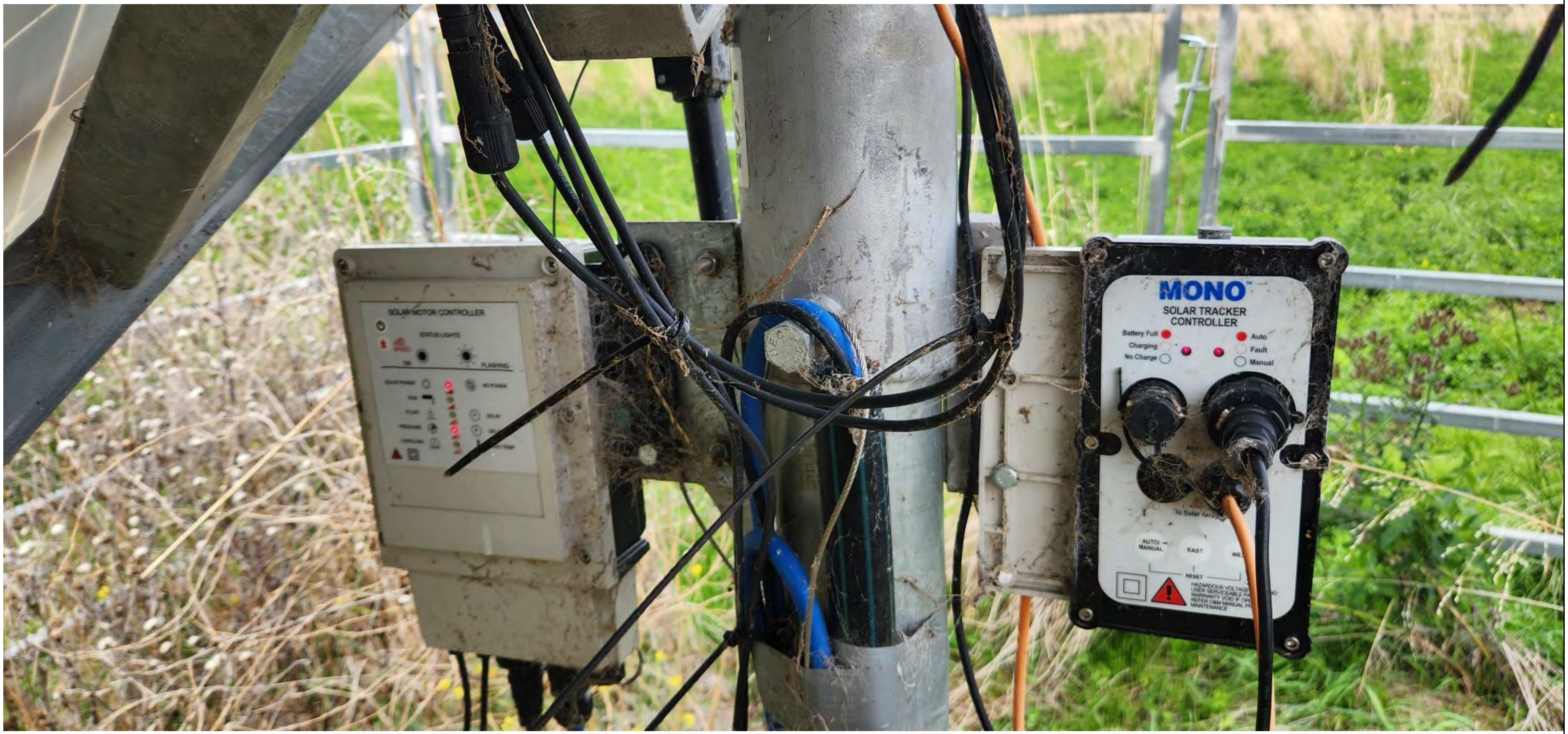
Trough looking towards bore GW971316, facing south

EMM
creating opportunities

Photographic plate
Canadian Solar Pty Ltd
Sundown Solar Farm
Photograph 4

Silica buildup on tank supplied by bore GW971316, facing south

Photographic plate
Canadian Solar Pty Ltd
Sundown Solar Farm
Photograph 5



Pump controllers on bore GW971316, facing south

WaterNSW
Work Summary

GW971316

Licence:

Licence Status:

Authorised Purpose(s):
Intended Purpose(s): STOCK

Work Type: Bore
Work Status: Supply Obtained
Construct.Method: Rotary Air
Owner Type: Private

Commenced Date:
Completion Date: 19/02/2015

Final Depth: 36.00 m
Drilled Depth: 36.00 m

Contractor Name: MANNION WATER DRILLING SERVICES
Driller: Jonathan Young
Assistant Driller:

Property:
GWMA:
GW Zone:

Standing Water Level (m): 19.000
Salinity Description:
Yield (L/s): 1.500

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	GOUGH	NEWSTEAD	1//1064358
Licensed:			

Region: 90 - Barwon
River Basin: 025 - MacIntyre
Area/District:

CMA Map: 9138-2N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown

Northing: 6698871.000
Easting: 346784.000

Latitude: 29°49'52.1"S
Longitude: 151°24'51.1"E

GS Map: -
MGA Zone: 56
Coordinate Source: GPS - Global

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	36.00	165			Rotary Air
1		Annulus	Cement	0.00	5.00	165	152		
1	1	Casing	Pvc Class 9	0.00	36.00	152	140		Seated on Bottom, Screwed and Glued
1	1	Opening	Slots - Horizontal	18.00	36.00	152		0	Mechanically Slotted, PVC Class 9, Screwed and Glued, SL: 10.0mm, A: 5.00mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
23.00	24.00	1.00	Unknown	19.00		0.50			
30.00	32.00	2.00	Unknown	19.00		1.00			

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.00	1.00	Topsoil	Topsoil	
1.00	17.00	16.00	Clay; brown	Clay	
17.00	23.00	6.00	Basalt; weathered	Basalt	
23.00	24.00	1.00	Basalt; weathered, water bearing	Basalt	
24.00	30.00	6.00	Basalt	Basalt	
30.00	32.00	2.00	Basalt; fractured, water bearing	Basalt	
32.00	34.00	2.00	Basalt	Basalt	
34.00	36.00	2.00	Clay; grey	Clay	

Remarks

19/02/2015: Form A Remarks:
Nat Carling, 23-Apr-2015; GPS provided on the Form-A.

***** End of GW971316 *****

	Bore: Unnamed spring excavations	Date: 14 April 2023
EMM creating opportunities	Alternate name/s: Spring bores	Project number: J210075
	Project: Sundown Solar Farm	Location: ~28 km west of Glen Innes, NSW

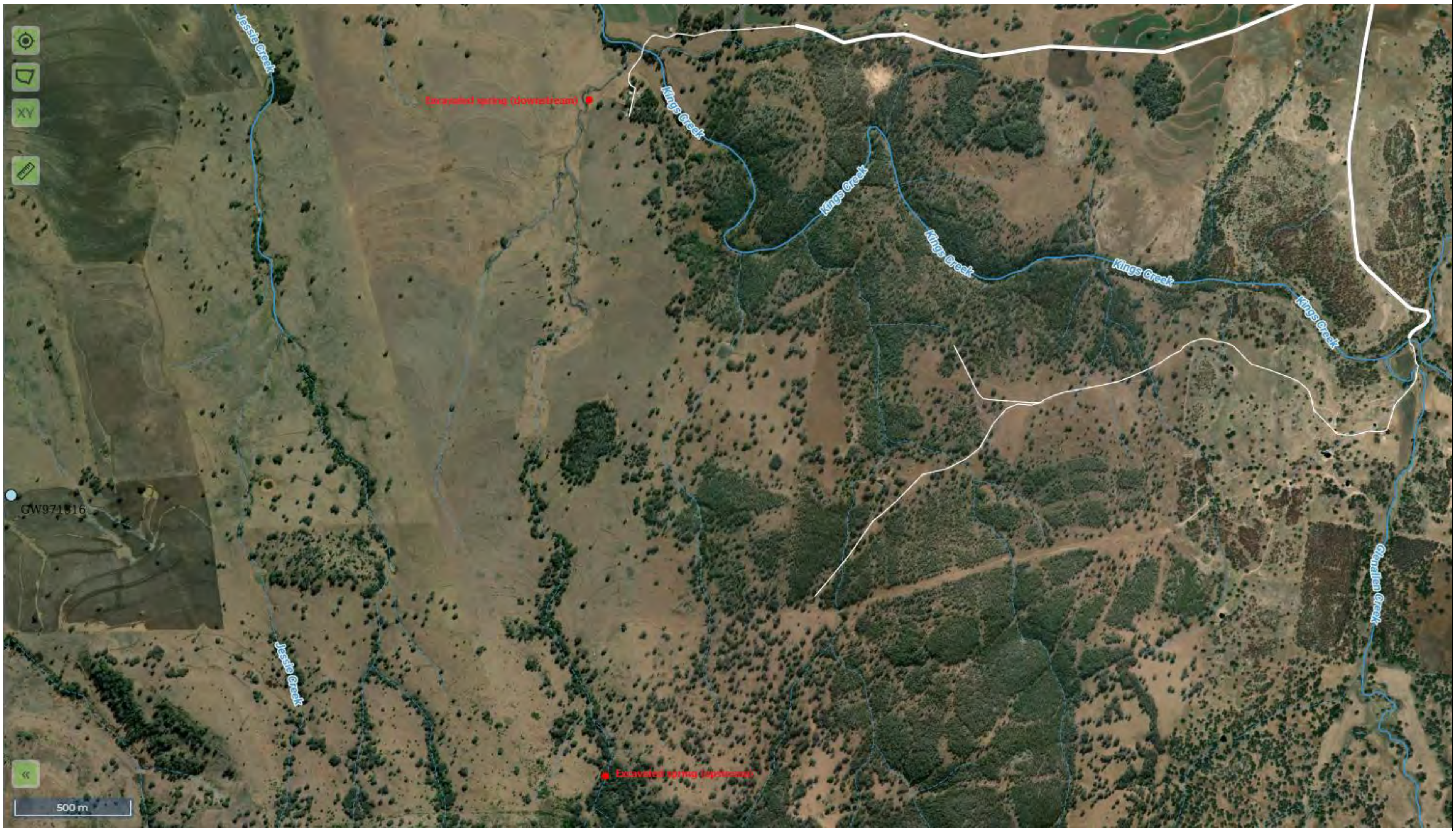
Bore details

Note 1 indicates data that has been inferred from the relevant work summary

Landholder	David Rose	**Contact Number**	0458 232 283
Easting (GDA94, Z56)	~349240 mE and ~349315 mE	**Scale observed**	No
Northing (GDA94, Z56)	~6700589 mS and ~6697648 mS	**Functionality**	Not tested
Elevation (mAHD)	~750 and ~875	**Pump installed**	Yes
Total depth (mbgl)	N/A	**Power source**	Electricity, 240 V and Diesel
Screen (mbgl)	N/A	**Yield (L/s)**	Unknown
Water level (mbgl)	0	**Purpose**	Stock and domestic water, supplying to troughs and house nearby
Construction material	Excavated springs in streamline	**Sample obtained**	Yes, proposed for major cation/anions and select dissolved metals

Notes

- Comprises two springs excavated in an ephemeral watercourse (upstream and downstream)
- Both excavations approximately 5 m in diameter
- Pumps in both springs, providing water to a nearby house (domestic) and troughs for stock watering
- Perennial stream (Kings Creek) at the end of ephemeral stream supporting spring excavations
- Based on surrounding spoil, excavations appear to have been through thin (~2 m) basalt cap and underlying alluvium (lithified by the basalt cap)
- Stream was running below downstream excavated spring, and occasional pockets of surface water above the downstream excavated spring
- Landholder discussion highlighted:
    - Landholder also hold 60 ML of entitlement from the Macintyre River
    - Excavations both approximately 20 feet deep (~6 m)
    - Downstream spring excavation has never run dry
    - Upstream spring excavation runs dry in prolonged dry periods
    - Water supply is dependent on intersecting water in the lithified alluvium



Mud-map indicating excavated spring locations

Mapping plate
Canadian Solar Pty Ltd
Sundown Solar Farm
Photograph 1

Excavated spring (downstream), facing west

Photographic plate
Canadian Solar Pty Ltd
Sundown Solar Farm
Photograph 2

Kings Creek downstream of both excavated springs, facing north-east

Photographic plate
Canadian Solar Pty Ltd
Sundown Solar Farm
Photograph 3

Excavated spring (upstream), facing north

Photographic plate
Canadian Solar Pty Ltd
Sundown Solar Farm
Photograph 4

Streamline between excavated springs, facing north

Photographic plate
Canadian Solar Pty Ltd
Sundown Solar Farm
Photograph 5

Lithified alluvium potentially providing groundwater to spring excavations, facing down

EMM creating opportunities

Photographic plate
Canadian Solar Pty Ltd
Sundown Solar Farm
Photograph 6

CERTIFICATE OF ANALYSIS

Work Order	: **ES2313318**	Page	: 1 of 6
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR JONATHON TAIT	Contact	: Customer Services ES
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: J210075 Sundown Solar farm	Date Samples Received	: 21-Apr-2023 15:06
Order number	: J210075	Date Analysis Commenced	: 22-Apr-2023
C-O-C number	: ----	Issue Date	: 01-May-2023 16:04
Sampler	: HENRY NOAKES		
Site	: ----		
Quote number	: EN/112/21		
No. of samples received	: 6		
No. of samples analysed	: 6		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED041G: LOR raised for Sulfate on sample 4 & 5 due to sample matrix.
- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- EG020A-F: Poor matrix spike recovery was obtained for some analytes on sample ES2313318-002. Confirmed by reanalysis.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW2301	GW971316_Trough	SW2302	Spring Bore	Spring Bore_UP
			Sampling date / time	13-Apr-2023 09:30	13-Apr-2023 10:00	13-Apr-2023 10:26	13-Apr-2023 14:00	13-Apr-2023 14:37
Compound	CAS Number	LOR	Unit	ES2313318-001	ES2313318-002	ES2313318-003	ES2313318-004	ES2313318-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.21**	**8.34**	**8.21**	**8.46**	**8.36**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**948**	**661**	**896**	**1050**	**744**
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	**616**	**430**	**582**	**682**	**484**
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**522**	**290**	**470**	**502**	**371**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	**14**	<1	**36**	**21**
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**504**	**340**	**543**	**563**	**421**
Total Alkalinity as CaCO3	----	1	mg/L	**504**	**354**	**543**	**599**	**442**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**5**	**1**	**5**	<10	<10
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**42**	**25**	**8**	**38**	**11**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**72**	**19**	**76**	**66**	**48**
Magnesium	7439-95-4	1	mg/L	**83**	**59**	**68**	**82**	**61**
Sodium	7440-23-5	1	mg/L	**53**	**47**	**49**	**67**	**45**
Potassium	7440-09-7	1	mg/L	**4**	**2**	**3**	**3**	**4**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.03**	**0.03**	<0.01	<0.01	**0.02**
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	**0.001**	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.066**	**0.039**	**0.377**	<0.001	**0.138**
Nickel	7440-02-0	0.001	mg/L	**0.003**	**0.003**	**0.007**	**0.003**	**0.003**
Zinc	7440-66-6	0.005	mg/L	**0.008**	**0.014**	<0.005	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	**0.12**	<0.05	<0.05	<0.05	<0.05

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW2301	GW971316_Trough	SW2302	Spring Bore	Spring Bore_UP
			Sampling date / time	13-Apr-2023 09:30	13-Apr-2023 10:00	13-Apr-2023 10:26	13-Apr-2023 14:00	13-Apr-2023 14:37
Compound	CAS Number	LOR	Unit	ES2313318-001	ES2313318-002	ES2313318-003	ES2313318-004	ES2313318-005
				Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	**0.2**	**0.2**	**0.3**	**0.2**
EN055: Ionic Balance								
ø **Total Anions**	----	0.01	meq/L	**11.4**	**7.80**	**11.2**	**13.0**	**9.14**
ø **Total Cations**	----	0.01	meq/L	**12.8**	**7.90**	**11.6**	**13.0**	**9.48**
ø **Ionic Balance**	----	0.01	%	**6.09**	**0.64**	**1.84**	**0.02**	**1.79**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW2303	----	----	----	----
			Sampling date / time	13-Apr-2023 14:15	----	----	----	----
Compound	CAS Number	LOR	Unit	ES2313318-006	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.57**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**654**	----	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	**425**	----	----	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**300**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	**36**	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**327**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**363**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**21**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**36**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**51**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**47**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**3**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.02**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.018**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.002**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW2303	----	----	----	----
			Sampling date / time	13-Apr-2023 14:15	----	----	----	----
Compound	CAS Number	LOR	Unit	ES2313318-006	--------	--------	--------	--------
				Result	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	----	----	----	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**7.84**	----	----	----	----
ø Total Cations	----	0.01	meq/L	**8.12**	----	----	----	----
ø Ionic Balance	----	0.01	%	**1.69**	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **ES2323504**	Page	: 1 of 4
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR JONATHON TAIT	Contact	: Sepan Mahamad
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61 2 8784 8555
Project	: J210075 Sundown Solar farm	Date Samples Received	: 14-Jul-2023 11:30
Order number	: ----	Date Analysis Commenced	: 17-Jul-2023
C-O-C number	: ----	Issue Date	: 20-Jul-2023 18:17
Sampler	: J DEBOER		
Site	: ----		
Quote number	: EN/112/21		
No. of samples received	: 1		
No. of samples analysed	: 1		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

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- Analytical Results

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Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Work Order : ES2323504
Client : EMM CONSULTING PTY LTD
Project : J210075 Sundown Solar farm

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	GW971316	----	----	----	----
			Sampling date / time	12-Jul-2023 17:00	----	----	----	----
Compound	CAS Number	LOR	Unit	ES2323504-001	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.97**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1170**	----	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	**760**	----	----	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**559**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**664**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**664**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**2**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**31**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**54**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**103**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**70**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**3**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.010**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.001**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.006**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----

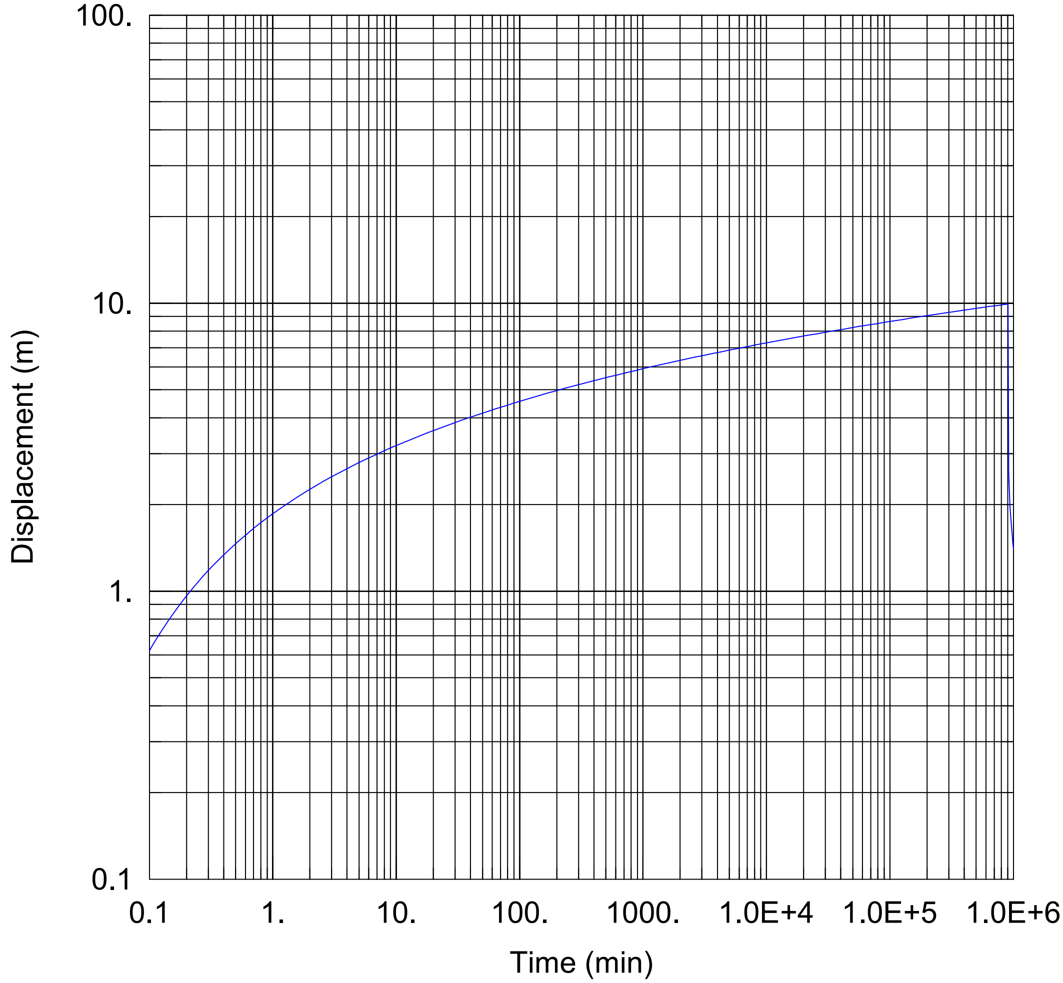
Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	GW971316	----	----	----	----
			Sampling date / time	12-Jul-2023 17:00	----	----	----	----
Compound	CAS Number	LOR	Unit	ES2323504-001	--------	--------	--------	--------
				Result	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	----	----	----	----
EN055: Ionic Balance								
ø **Total Anions**	----	0.01	meq/L	**14.2**	----	----	----	----
ø **Total Cations**	----	0.01	meq/L	**14.3**	----	----	----	----
ø **Ionic Balance**	----	0.01	%	**0.39**	----	----	----	----

Appendix B

GW971316 supply capacity forward predictions

creating opportunities



PROJECT INFORMATION

Company: EMM Consulting
Client: Sundown Solar Farm
Project: J210075
Location: ~346784 mE, ~6698871 mS
Test Well: GW971316

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
GW971316	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ GW971316	0	0

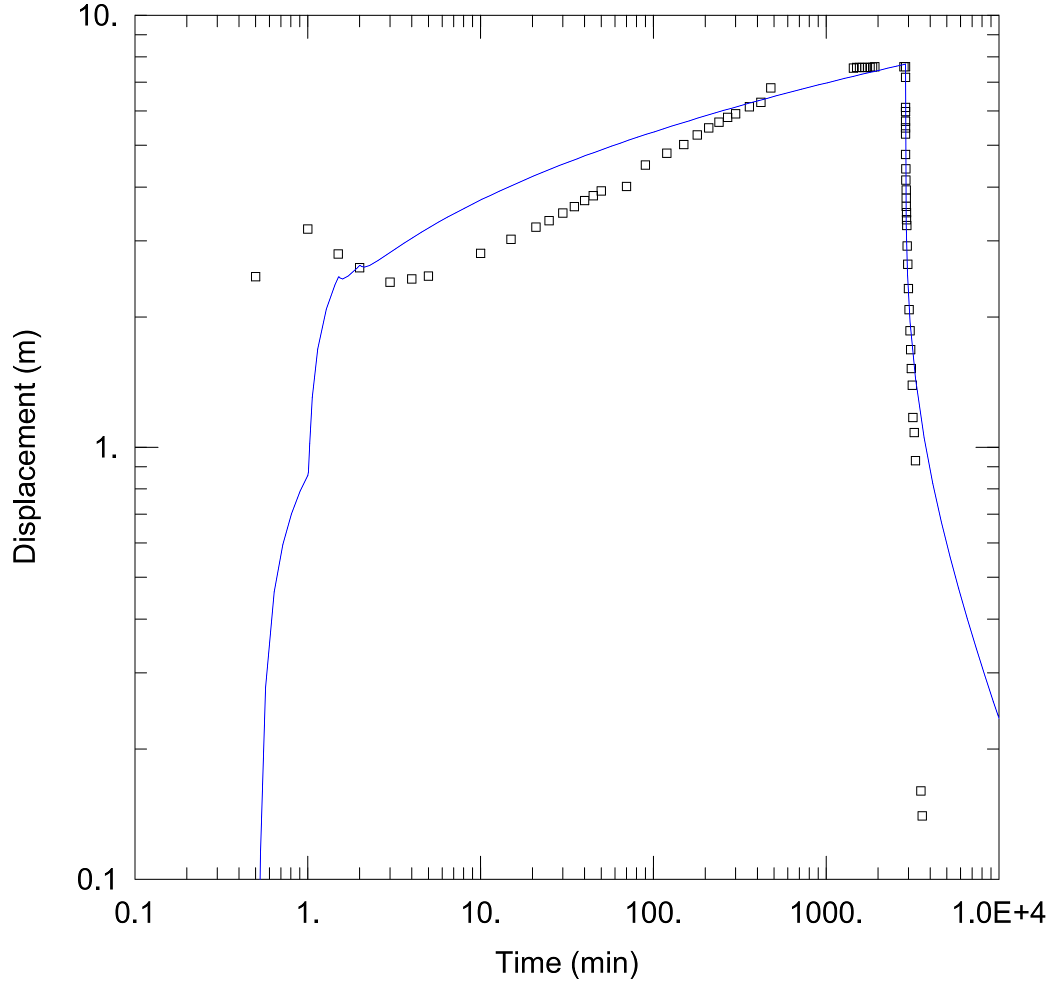
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 9.905 m^2/day
Kz/Kr = 1.

S = 0.1
b = 18. m



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Observation Wells

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SOLUTION

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b = 18. m

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