APPENDICES

OVEN MOUNTAIN PUMPED HYDRO ENERGY STORAGE EIS

GDE assessment

OVEN MOUNTAIN PUMPED HYDRO STORAGE

EMM creating opportunities

Oven Mountain Pumped Hydro Energy Storage

Groundwater dependent ecosystem assessment

Prepared for OMPS Pty Ltd

March 2023

Oven Mountain Pumped Hydro Energy Storage

Groundwater dependent ecosystem assessment

OMPS Pty Ltd

J210465 OMPS EIS - Groundwater dependent ecosystem assessment

March 2023

Version	Date	Prepared by	Approved by	Comments
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Executive Summary

ES1 Introduction

OMPS Pty Ltd (OMPS) is proposing to develop the Oven Mountain Pumped Hydro Energy Storage Project (the Project), an off-river pumped hydro energy storage system located approximately half-way between Kempsey and Armidale adjacent to the Macleay River in northern NSW. The Project is located within the New England Renewable Energy Zone (REZ) and the Armidale Regional Local Government Area (LGA), proximate to its border with Kempsey Shire LGA.

At a basic level, the Project will consist of upper and lower dams and water reservoirs, an underground waterway connecting them, and a hydro-electric power station connected to the National Electricity Market (NEM).

The Project has been declared by the NSW Government to be critical State significant infrastructure (CSSI) under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). Infrastructure projects are declared to be CSSI if, in the opinion of the NSW Minister for Planning, they are essential to the State for economic, environmental, or social reasons. The Project will aid in the transition of the NEM towards cleaner, more reliable and affordable electricity by supporting new renewable energy projects. It will provide up to 900 megawatts (MW) of electricity generating capacity, and up to twelve hours of dispatchable energy at full generation to be stored and made available to the NEM through the New England REZ.

The expected operational lifespan of the Project is in excess of 100 years.

The purpose of this report is to provide an assessment of potential groundwater dependent ecosystems (GDEs) that may occur within the extent of the Projects groundwater model and assesses the impacts to these GDEs based on modelled groundwater drawdown.

ES2 Baseline monitoring program

A water monitoring network has been designed and implemented to establish pre-construction baseline data for the Project. The water monitoring network has been designed to ensure that the Project can be adequately assessed against the Aquifer Interference Policy (AIP) and has been designed and developed in accordance with the Guidelines for Groundwater Documentation for SSD/SSI Projects Technical Guideline (DPE Water 2022).

The groundwater monitoring network includes conventional groundwater monitoring bores, third-party landholder bores and groundwater springs. The network covers 35 locations across the Project area, many of which include dual installations. The surface water monitoring network includes one streamflow gauging location and eight surface water quality monitoring locations. Surface water monitoring targets areas upstream and downstream of the Project area in major creeks and rivers intercepted by the Project. Both the groundwater and surface water monitoring networks have been developed in consultation with NSW Department of Planning and Environment (DPE) Water hydrogeologists, hydrologists and assessment officers.

A diverse range of field investigations has been undertaken to develop the conceptual model understanding, including hydraulic testing, geochemical investigations, geophysical investigations, geomorphological studies and ecological studies.

The extent, duration and frequency of baseline monitoring on which this GDE assessment has been based on, is considered fit-for-purpose. Additional data will continue to be gathered at key locations to further understand and monitor potential Project impacts at a more local scale and verify model predictions and provide recalibration targets over time.

ES3 Assessment and findings

Numerical modelling has been used in this assessment to predict potential changes in groundwater and surface water resources. Groundwater flow into the key subsurface Project features (i.e. the power waterway, reservoirs access tunnels and the underground power station) is expected to occur primarily as a function of secondary porosity (i.e. via fractures and along bedding planes). The model assumed a bulk conservative hydraulic conductivity for each rock type and cannot simulate individual fractures because the locations and conductivity of individual fractures are not known until the tunnel intersects them. Attempts to 'constrain' the model to simulate unknown geological occurrences (i.e. fractures interspersed with low hydraulic conductivity zones) or design elements are not in-line with the Australian Groundwater Modelling Guidelines (Barnett et al 2012) and this has therefore not been undertaken.

The modelling results are therefore conservative for two reasons:

- Modelling does not consider actual design, management or mitigating activities (i.e. pre/post-grouting, concrete lining and steel lining). During construction the discrete fractures that yield excess water can be grouted, reducing the actual overall tunnel inflow volume.
- Hydraulic parameters within the numerical model for the Macleay River floodplain alluvials are conservative and assume significant permeability and flow. However, in reality, the entire unit may not behave like this, with some parts expected to be much less permeable with storage also expected to be constrained by thickness.

Therefore, the model predictions of inflow, baseflow reduction and watertable drawdown are likely to be overestimating Project impacts. The results of this conservative model approach need to be considered within this overall context to accurately assess the Project on its true merits.

Groundwater modelling predicts localised watertable drawdown in the vicinity of the Project throughout construction and operation. Watertable drawdown is predicted during construction and operation of the Project, with drawdown propagating up to approximately 1.7 km and 1.4 km north of the Project respectively.

This assessment found:

- There is no impact predicted to the Carrai Waterholes or obligate GDEs identified across the plateau and, additionally, there are no identified high priority GDEs within the study area.
- Water table drawdown is predicted at plant communities with a facultative/opportunistic dependence on groundwater, however this has been assessed as low risk due to the communities' reliance on surface water for sustainment.
- Aquatic ecosystems have been assessed as non-dependent on groundwater and are assessed as low risk for Project induced impacts.
- It is anticipated the impacts to subterranean ecosystems will be low.

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1 Introduction

1.1 The Project

OMPS Pty Ltd (OMPS) is proposing to develop the Oven Mountain Pumped Hydro Energy Storage Project (the Project), an off-river pumped hydro energy storage system (referred to as the 'pumped hydro system') located approximately half-way between Kempsey and Armidale, adjacent to the Macleay River in northern NSW. The Project is located within the New England Renewable Energy Zone (REZ) and the Armidale Regional Local Government Area (LGA), proximate to its border with Kempsey Shire LGA.

Figure 1.1 and Figure 1.2 provide the regional and local context of the Project respectively.

At a basic level, the Project will consist of upper and lower water reservoirs and an underground waterway connecting them via a hydro-electric power station.

The Project has been declared by the New South Wales (NSW) Government to be critical State significant infrastructure (CSSI) under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). Infrastructure projects are declared to be CSSI if, in the opinion of the NSW Minister for Planning, they are essential to the State for economic, environmental, or social reasons. The Project will aid in the transition of the National Electricity Market (NEM) towards cleaner, more reliable and affordable electricity by supporting new renewable energy projects. It will provide up to 900 megawatts (MW) of electricity generating capacity, and up to twelve hours of dispatchable energy at full generation to be stored and made available to the NEM through the New England REZ. The expected operational lifespan of the Project is in excess of 100 years.

The Project will utilise the highly favourable natural terrain of the site to allow electrical energy from the main grid to be stored by pumping water from the lower reservoir to the upper reservoir. Energy can then be generated when needed by allowing water to flow back down to the lower dam and reservoir via the hydro-electric power station, effectively enabling the Project to act as a large battery.

1.2 Proponent

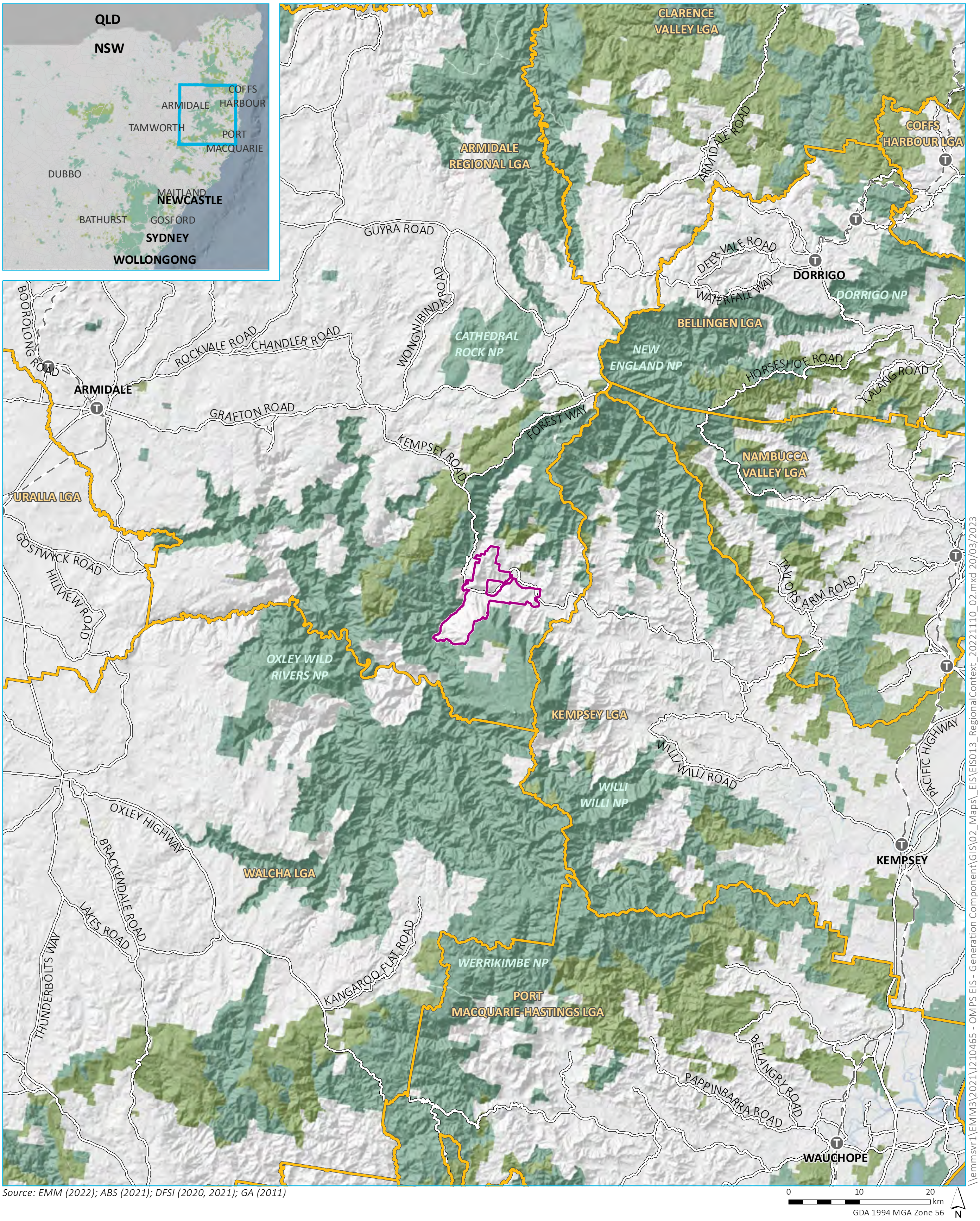
OMPS (ABN 22 160 259 174) is developing the Project and is located in Kempsey at 2/28 Clyde Street, Kempsey NSW 2440.

1.3 Purpose of this report

This report provides an assessment of potential groundwater dependent ecosystems (GDEs) that occur within the extent of the groundwater model and assesses the impacts to these GDEs based on modelled groundwater drawdown.

1.4 Assessment guidelines and requirements

This GDE assessment has also been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued by the former Department of Planning, Industry and Environment (DPIE) (now the NSW Department of Planning and Environment (DPE)) on 10 June 2022. To inform preparation of the SEARs, the Department invited relevant government agencies to advise on matters to be addressed in the EIS. These matters were taken into account by the Secretary for the Department when preparing the SEARs. Key matter raised in the SEARs include "An assessment of the biodiversity impacts of the Project on terrestrial, aquatic and groundwater-dependent ecosystems, including listed Commonwealth and State threatened species and communities and listed Commonwealth migratory species, and impacts on National Parks and Reserves and World Heritage Areas), and Attachment A of the SEARs".



Source: EMM (2022); ABS (2021); DFSI (2020, 2021); GA (2011)

KEY

- Project area
- Train station
- Rail line
- Major road
- Named waterbody
- Local government area
- NPWS reserve
- State forest

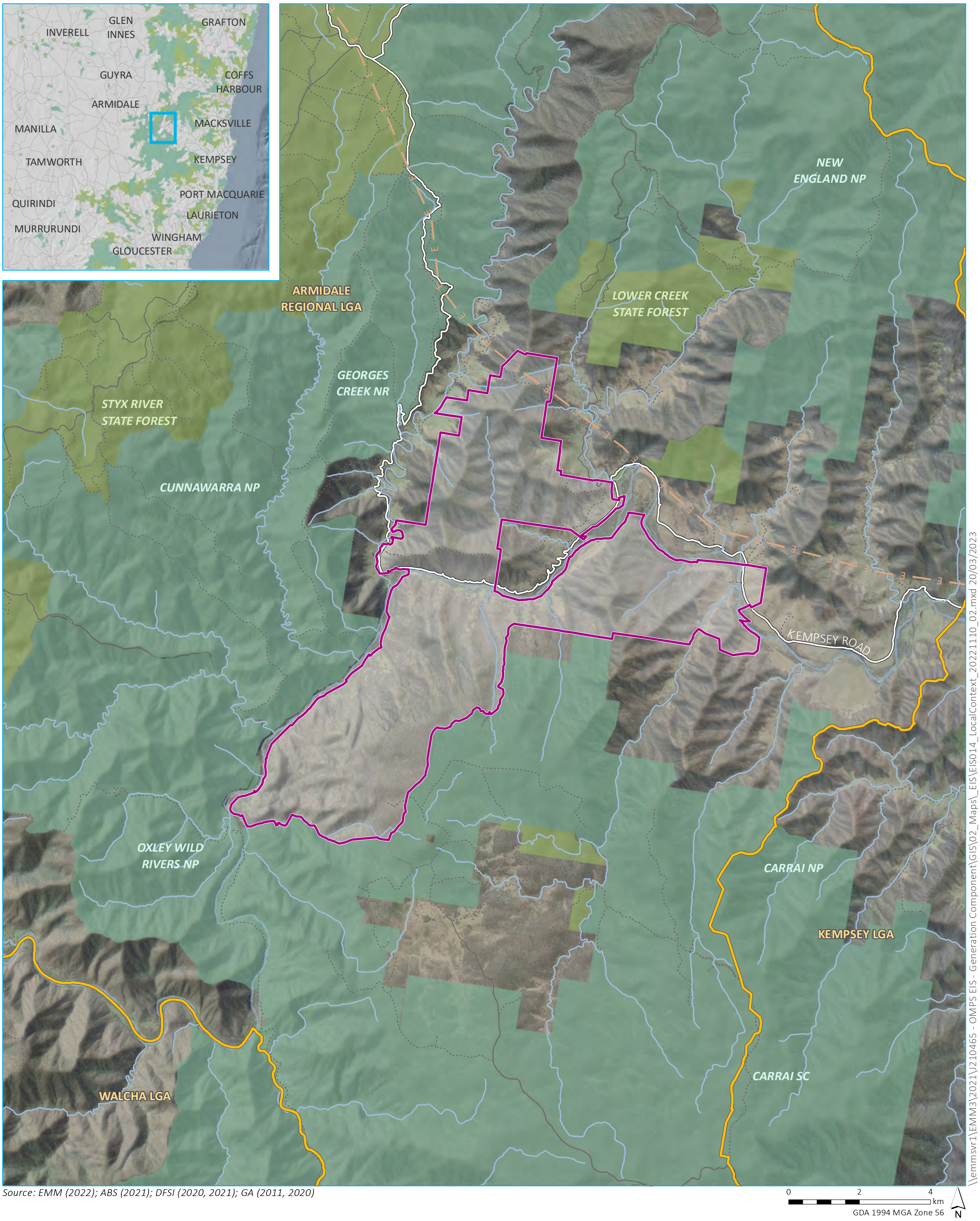
INSET KEY

- Major road
- NPWS reserve
- State forest

Regional setting

Oven Mountain Pumped Hydro Energy Storage Project
Groundwater dependent ecosystem assessment
OMPS Pty Ltd
Figure 1.1

creating opportunities



Source: EMM (2022); ABS (2021); DFSI (2020, 2021); GA (2011, 2020)

KEY

- Project area
- Existing transmission line
- Major road
- Minor road
- Vehicular track
- Named watercourse
- Named waterbody
- Local government area
- NPWS reserve
- State forest

INSET KEY

- Major road
- NPWS reserve
- State forest

The Project area - local context

Oven Mountain Pumped Hydro Energy Storage Project
Groundwater dependent ecosystem assessment
OMPS Pty Ltd
Figure 1.2

creating opportunities

2 The Project description

2.1 Project overview

The Project involves building two ‘off river’ water containment structures to create an upper and a lower reservoir (referred to as ‘the upper dam and reservoir’ and ‘the lower dam and reservoir’), on an ephemeral tributary of the Macleay River. An underground hydro-electric power station complex will be connected to the reservoirs by infrastructure including a power waterway and tunnels. During operation, the water will enable the generation of electricity as it passes through the underground power station while moving from the upper to the lower reservoir, from where it is pumped back up via the same waterway in a ‘closed-loop circuit’. The pumped hydro system will be connected to the existing transmission network via new overhead high voltage transmission lines.

A detailed description of the Project and its strategic context is provided in the Project’s EIS which should be read in conjunction with this report.

An overview of the key components and elements is provided below.

2.2 Key Project design elements

Broadly, the Project has been categorised into three key components, which are further broken down into the Project’s key elements in Table 2.1 and shown in Figure 2.1:

- pumped hydro-electric and generation works (PHGW) – including:
  - new upper and lower water storage dams and reservoirs
  - a new underground pumped hydro-electric power station and transformer hall
  - water tunnels, access tunnels, portals and adits
  - tailrace
  - intake and outlet structures
  - associated gates, shafts and screens
- transmission connection works – including:
  - new electricity transmission lines to connect the PHGW to the existing electricity transmission network (Line 965)
  - new electricity transmission infrastructure
  - a new substation
- ancillary development – including but not limited to:
  - access roads, tracks and bridge
  - on-site quarries and related infrastructure
  - utilities and communications infrastructure
  - construction pads containing assets such as workshops, concrete batching plants (CBPs), and offices

- laydown and storage areas
- construction accommodation
- pumping infrastructure
- operational facilities such as offices, and camps for staff
- construction and operational power supply.

Table 2.1 Key Project elements

Project element	Description
PHGW	
Underground power station complex	An underground pumped hydro-electric power station located below the upstream end of the pumped hydro system to optimise the hydraulic arrangement of the Project. The power station complex consists of: • two main caverns comprising – the machine hall – the transformer hall • interconnecting tunnels, the transformer hall tunnel and isolated phase busbar (IPB) tunnels.
Dams and reservoirs	Two concrete faced rockfill dams (CFRD) and reservoirs, referred to as the upper dam and reservoir and lower dam and reservoir, with the following specifications:
	Upper dam and reservoir: • CFRD approximately 70 metres (m) high and 780 m long • reservoir covering a total area of approximately 20 hectares (ha) and an inundation extent of approximately 16.7 ha • reservoir height of 881 m Australian Height Datum (AHD) at full supply level (FSL) and 830 m AHD at minimum operating level (MOL) • total reservoir storage capacity of around 5.1 gigalitres (GL) at FSL.
	Lower dam and reservoir: • CFRD approximately 70 m high and 280 m long • reservoir covering a total area of approximately 24.7 ha and an inundation extent of approximately 21.6 ha • reservoir height of 250 m AHD at FSL, 215 m at MOL and 205 m AHD at lowest operating level (LOL) • total reservoir storage capacity of around 6.5 GL at FSL.
Water intake structures	Two intake structures, one at each reservoir, including: • a morning glory, vertical-type intake structure situated at the upper dam and reservoir • a lateral intake structure, with head gates and stoplog slots, and an intake channel, at the lower dam and reservoir.
Spillway	Two concrete lined spillway chutes, one for each of the upper and lower dams and reservoirs. Both spillway crests will comprise of ungated ogee-shaped overflow weirs on the upstream ends of the spillway chutes.
Macleay River pump facility	A pump facility on the Macleay River, which will include duty and standby pumps for the first fill and for ongoing reservoir refills.

Table 2.1 Key Project elements

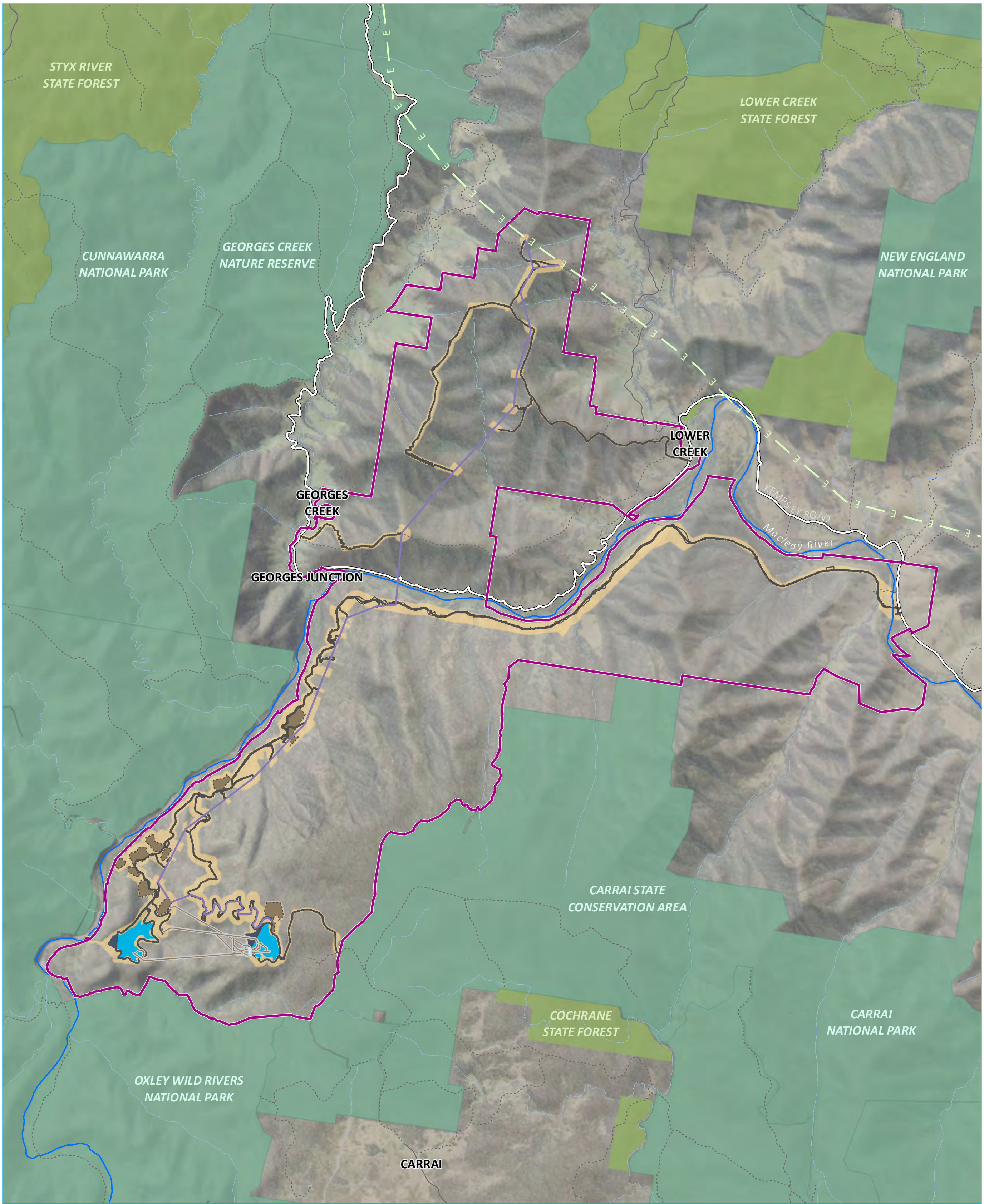
Project element	Description
Tunnels	Three main tunnels comprising of: • two main access tunnels (MAT1 and MAT2) • the emergency, cable, ventilation tunnel (ECVT). The MAT1 and MAT2 will provide loop access to the power station complex from the MAT portal. The ECVT will provide services access and egress between the switchyard portal and the transformer hall. The ECVT portal will contain the station switchyard, control rooms, ventilation and firefighting equipment, with blast walls separating important equipment.
Power waterway	The power waterway will consist of: • a 660 m deep, 5.1 m diameter vertical pressure shaft • 250 m concrete and steel lined high-pressure headrace tunnel • three or more 80 m long penstock tunnels • three or more 120 m long draft tube tunnels • an approximately 1,825 m long concrete lined tailrace tunnel.
Transmission connection works	
Connection works	The connection works will consist of: • An approximately 15 km long transmission alignment comprising, at a maximum, double circuit single tower 330 kV overhead infrastructure and single circuit single pole 132 kV overhead infrastructure connecting to TransGrid Line 965. • Up to 25 transmission tower sites (approximately 50 m x 50 m) containing the 132 kV and 330 kV infrastructure. • A transmission easement width of a maximum of approximately 105 m. Note: The upgrade of existing Line 965 will be the subject of a separate application.
Sub-station	Construction of a substation and associated connection infrastructure of up to 330 kV rating.
Switchyard	A high voltage connection linking the connection transmission lines to the cables exiting the underground power station complex. The outdoor air insulated switchyard will likely include: • switchgear and control room • cable potheads • disconnector/earth switches • capacitive voltage transformer (VT) • lightning protection • security fencing, lighting and surveillance • surge arrestor.
Ancillary development (construction and operation)	
Access roads, access tracks and bridge	A variety of road works to improve existing access, and construction of new permanent roads to enable construction access, temporary establishment and use of construction sites, and general access to the Project area including transmission line infrastructure.
	The proposed main access will be via the construction of a new unsealed two-lane access road located to the east of the site. The main access road will interface with the existing Kempsey Armidale Road and will require the construction of one new single or two lane low-level bridge crossing over the Macleay River. A temporary bridge may be utilised prior to the construction of the permanent bridge.

Table 2.1 Key Project elements

Project element	Description
	There will be approximately 40 km of permanent roads connecting the dams, surface works, portals, transmission assets and spoil sites. Some of these roads are existing roads, however approximately 25 km will be newly constructed roads. The key road components include: • Main Access Road (approximately 4.7 km) • Eastern Access Road (up to approximately 11. 4 km) • Lower Dam Access Road (approximately 3.6 km) • Upper Dam Access Road (approximately 7.1 km) • access to portals and underground works • Upper Dam Emergency Egress Road (approximately 2.2 km). Access to the transmission infrastructure north of the Macleay River will be via two roads accessed from the Kempsey Armidale Road. These two roads include the: • Northern Transmission Access Road (approximately 15 km) • Southern Transmission Access Road (approximately2.3 km). To support access along the transmission line easement south of the Macleay River and to each of the tower sites, a network of interconnecting access and maintenance tracks will be constructed, to a large extent utilising existing access tracks.
Surface works pads and facilities	There are four main construction pads in addition to surface portals which will be used temporarily during construction for different services (workers camp, construction site offices, workshop area, and laydown storage).
	Construction works will require the establishment of the following ancillary support infrastructure and areas: • main accommodation camp(s), which will temporarily accommodate the majority of workers as required workers as required throughout the construction period • temporary or fly camps, which will temporarily accommodate the majority of workers as required throughout the construction period • two works areas including Works Area 1 and Works Area 2, which will contain ancillary facilities such as CBPs, mechanical and electrical workshops, a laboratory and various water treatment and wash areas • spoil emplacement areas • staging area • stockpiling areas • temporary site offices to be used during construction.
Communications	Communication infrastructure such as fibre optic cables are required for the operation of the Project and will be located in a mix of: • on an overhead line linking the upper and lower dams and reservoirs (in conjunction with the electrical line) • buried in road corridors. The communication network will also include a communications tower near the upper dam and reservoir.
Utilities during construction	• Construction water will be supplied either via groundwater bores, or via pumping of water from the Macleay River to support camp operations, the CBP, dust suppressions and other activities across the site. • Construction power will be supplied primarily by use of portable diesel generators and supported where possible by leveraging off existing electricity distribution infrastructure running through the generation site.
Utilities for operation	Alignment and length of utilities (electricity, water, etc) will be combined into a single corridor (total length of about 5.4 km).

Table 2.1 Key Project elements

Project element	Description
Water diversion and water treatment facilities	• Site drainage will include a combination of cross drainage culverts, drainage pits and pipe, open channels/open drains (vegetated, rock-lined or concrete), levees/bunds, and detention basins. • Various water treatment plants will be used for construction drainage and water treatment facilities – for the main accommodation camp, temporary or fly camps, CBP, tunnel, etc. • Specific discharge locations are planned for stormwater and surface water runoff.
Laydown/stockpile areas	Temporary laydown/stockpile areas will be utilised across the Project area, with a total allocated stockpile area of around 114,000 m^2.
Spoil emplacement areas	To accommodate spoil generated through excavation of the underground caverns and tunnels, three permanent spoil placement locations have been identified with a capacity to store around 2 million cubic metres (Mm^3) of material. Dead storage space within the reservoirs will also be used for spoil placement, with a capacity to store approximately 300,000–400,000 m^3.
Ancillary operational facilities	Primary operation of the Project can be undertaken remotely and will require minimal onsite operational staff, other than for maintenance activities. Operational facilities include maintenance housing, work area, car parking, workshop and storage, control room and switchgear, water treatment plant, office area, heating, ventilation and air conditioning (HVAC), backup generators and Macleay River pump facility.
Other	
Construction	• Construction duration of around four to five years. • Construction workforce of over 600 workers at construction peak.
Rehabilitation	Rehabilitation of areas disturbed during pre-construction and construction will be undertaken progressively during all stages and phases of the Project. Progressive rehabilitation will occur over about 60 ha including spoil emplacement areas and areas used for construction ancillary facilities no longer needed during operation. At the end of the Project's life, 192 ha in total will be rehabilitated to native ecosystem (including native vegetation and rock landscape). Approximately 138 ha will be retained permanently for the water storages and access roads, subject to agreement with relevant landowners/land managers.
Operation	• The Project will provide up to 900 MW of electricity generating capacity and up to between eight and twelve hours of energy storage at full generating capacity. • Maintenance and operational activities will include power station operations, infrastructure inspections, maintenance to assets, vegetation management, auditing and compliance and other activities. • It is expected that the operation of the new power station will require around 30–50 full-time workers, as well as additional contractors for regular and ad hoc maintenance and repairs.
Hours of operation	• Construction of the Project will be 24/7 and 365 days per year. • Operation of the Project will be 24/7 and 365 days per year.
Project timeline	The Project will involve the construction and operational stages, and numerous phases which are outlined in the Project's EIS.
CIV	Estimated to be about $1.8 billion.



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Source: EMM (2022); DFSI (2020); GA (2011); SMEC (2022)

KEY

Project area
Construction envelope
Surface works
Project operational elements
Power station
Tunnels, portals, intakes, shafts
Transmission overhead lines
Permanent road
Dam wall
Reservoir
Existing environment
Macleay River
Watercourse/drainage line
Major road
Minor road
Vehicular track
Existing transmission line
NPWS reserve
State forest

Key Project elements

Oven Mountain Pumped Hydro Energy Storage Project
Groundwater dependent ecosystem assessment
OMPS Pty Ltd
Figure 2.1

EMM creating opportunities

2.3 Project area terminology

Approval for the Project is being sought based on feasibility and concept designs as is common for projects of this size and scale. To accommodate minor changes and amendments to the design as it progresses, a 'Project area', 'construction envelope', 'disturbance footprint' and 'operational footprint' approach is being adopted for the Project. This approach is aimed at ensuring environmental impacts are assessed as accurately as possible, whilst accounting for the current level of design and the likelihood of design refinements occurring as the Project progresses towards construction. The terms are explained below.

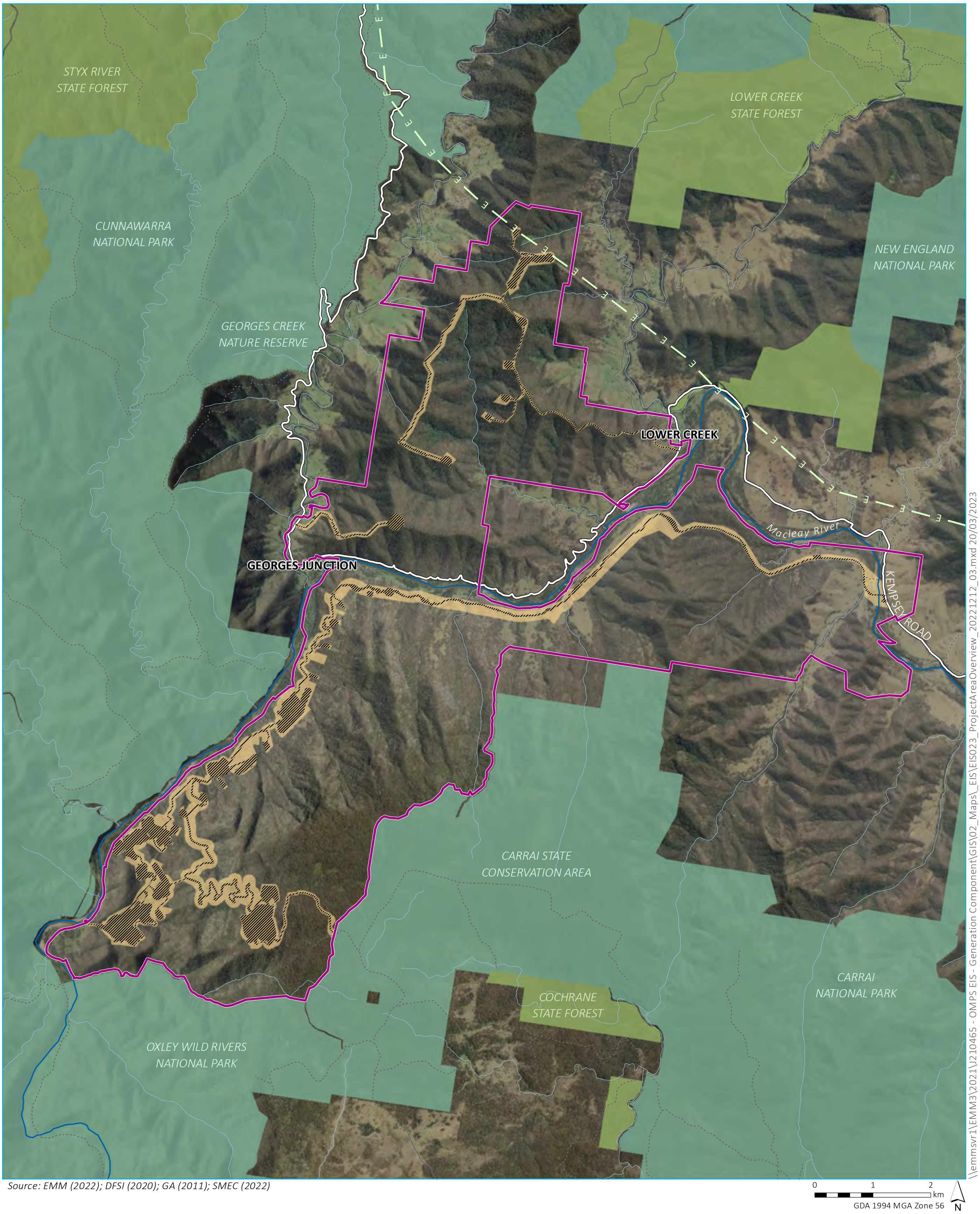
The *Project area* is the broader area within which the Project will be built and operated, and the extent within which direct impacts from the Project are anticipated. Importantly the Project area does not represent a footprint for the construction works, but rather indicates an area that was investigated during environmental assessments. The Project area has been further divided into different areas to facilitate the assessment of direct impacts from the Project.

The *construction envelope* represents the maximum extent of where disturbance may occur during the construction of the Project. In order to derive the construction envelope, buffers have been applied to the key Project elements and infrastructure. The buffers used to derive the final construction envelope area reflect the confidence around the current siting of the asset or infrastructure, and the likelihood that some amendments may be required prior to commencing the construction works as a result of the detailed design. The construction envelope for the Project covers an area of around 780 ha.

Located entirely within the bounds of the construction envelope sits the *disturbance footprint*, a smaller area that has been derived directly from the current level of design. The disturbance footprint represents the physical disturbance that can be expected as part of the construction works. As the design is refined, the final siting of the disturbance footprint can move within the construction envelope, subject to the recommended environmental management measures, and provided it does not exceed any limits as defined by the construction envelope. It is proposed that part of the disturbance footprint will be rehabilitated, and land formed at the completion of the Project. However, other parts will be retained after construction which is necessary for the ongoing operation and maintenance of the new power station (operational footprint). The disturbance footprint for the Project covers an area of around 330 ha.

Progressively and at the end of construction, temporary components that are required to support the construction of the Project will be rehabilitated and returned to a state representing their previous use. The exceptions to this are the areas required for the permanent operation of the Project, which would be retained (referred to as the *operational footprint*). The operational footprint of the Project covers an area of around 270 ha. Approximately 60 ha would be progressively rehabilitated during and following the completion of construction.

The Project area, construction envelope and disturbance footprint are shown in Figure 2.2.



Source: EMM (2022); DFSI (2020); GA (2011); SMEC (2022)

KEY

- Project area
- Disturbance footprint
- Construction envelope

Existing environment

- Macleay River
- Watercourse/drainage line
- Kempsey-Armidale Road
- Minor road
- Vehicular track
- Existing transmission line
- NPWS reserve
- State forest

Project areas overview

Oven Mountain Pumped Hydro Energy Storage Project
Groundwater dependent ecosystem assessment
OMPS Pty Ltd
Figure 2.2

3 Project setting

3.1 Overview

The study area relevant to this GDE assessment aligns with the numerical groundwater model boundary, as indicated in Figure 3.1. The study area, which is larger than the Project area (refer Section 1.1), encompasses the:

- Project related sub-surface excavations
- Project related water monitoring network
- nearby licensed groundwater bores
- nearby high potential groundwater dependent ecosystems (GDEs)
- identified sites of cultural significance.

As discussed in Section 2.2, proposed infrastructure beyond the study area comprises:

- power transmission lines and towers
- substation infrastructure
- access roads.

The aforementioned infrastructure will be designed to mitigate permanent interception of the regional groundwater table as much as possible. Temporary de-watering may be required for footing or trench excavations; however, potential impacts are considered minor and temporary and are not considered as part of the study area. Further discussion is provided in the Groundwater Impact Assessment (EMM, 2023).

The study area has been split into four focus areas, broadly constrained by topographic relief, comprising:

- the Carrai Plateau (the plateau), in the eastern portion of the study area
- the escarpment, extending west of the plateau
- the Macleay River floodplain, a relatively narrow area bordering the Macleay River
- the western catchment, on the western side of the Macleay River.

Focus areas are presented on Figure 3.1.

3.2 Topography and land use

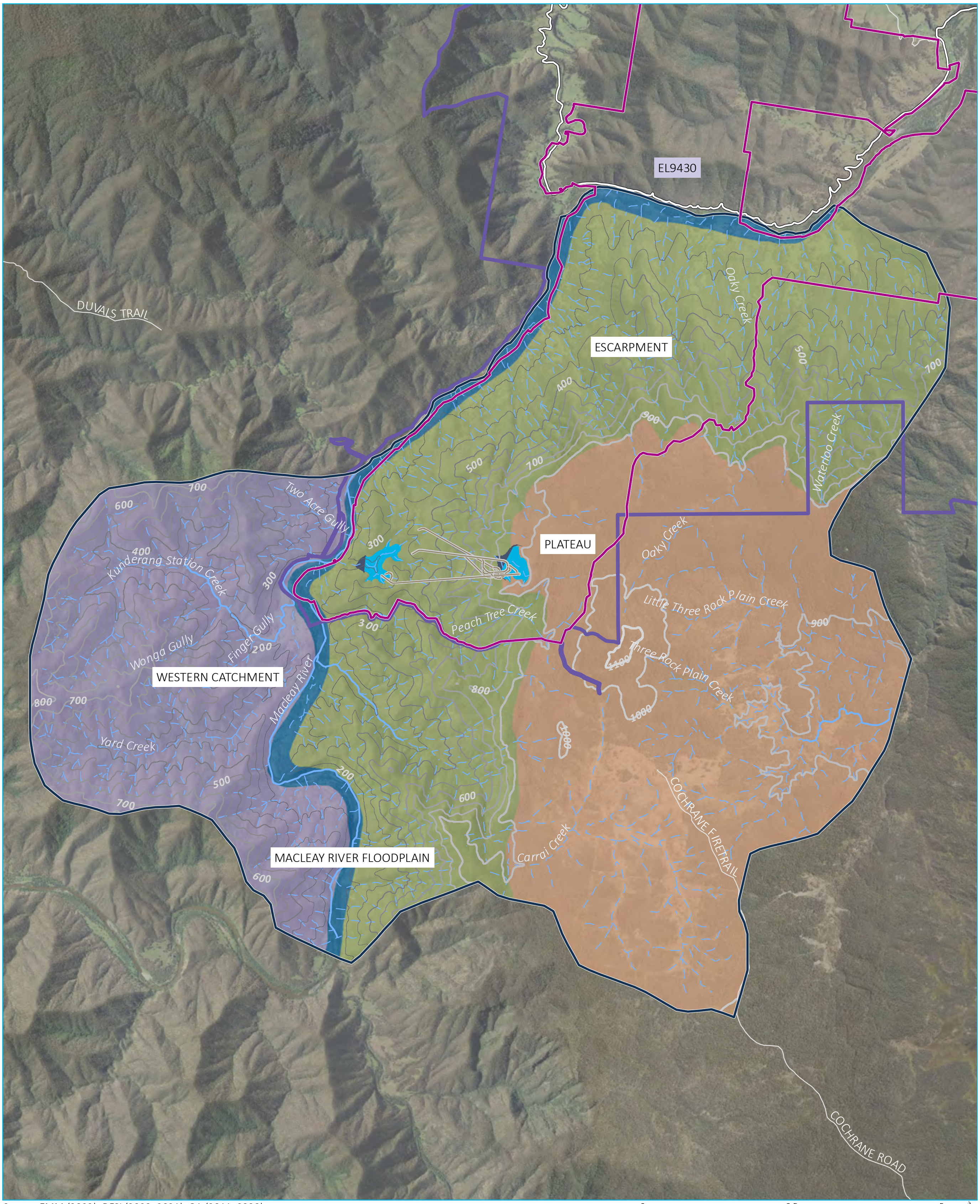
The topography of the plateau is relatively level at an average elevation of approximately 1,000 metres Australian Height Datum (mAHD). The escarpment dips down to the west and north-west from the plateau, where the relief levels out at an average elevation of 145 mAHD along the Macleay River floodplain.

The escarpment is dominated by a series of steep scarp slopes ranging between 20° and 30°. It is across this focus area where the majority of the power generation will occur, aided by an average grade of 25%. Incised valleys (generally orientated east-west) separate spurs, extending along the escarpment to the plain. The incised valleys support the majority of surface water relief, discharging via a series of first- and second-order watercourses to the Macleay River. Similar topography is mirrored by the Macleay River in the western catchment focus area, rising to approximately 760 mAHD, undulating over a series of north-south orientated ridgelines. Watercourses lie in the valley floors and discharge to the Macleay River.

Land use within the study area is predominantly agricultural, comprising agistment based cattle farming and logging on privately owned land. Based on the Geological Survey of NSW (GSNSW) mining tenements database (GSNSW, 2022), Pickands Mather & Co International and BHP Minerals Limited have undertaken mineral exploratory works in 1971 and 1974 respectively. Exploratory works were generally concentrated within exploration lease EL9430 (formerly named EL664), encompassing the northern escarpment and Macleay Valley floodplain (refer Figure 3.1). Exploratory sampling and geological works were undertaken to assess the prospectivity for:

- arsenic (As)
- tin (Sn)
- molybdenum (Mo)
- copper (Cu)
- gold (Au)
- tungsten (W).

The focus area and topography within the study area is illustrated in Figure 3.1.



Source: EMM (2022); DFSI (2020, 2021); GA (2011, 2020)

0 2.5 5 km
GDA 1994 MGA Zone 56
N

KEY

Project area
Study area
Exploration lease EL9430
Dam wall
Reservoir
Tunnels, portals, intakes, shafts

Focus area
Escarpment
Macleay River floodplain
Plateau
Western catchment

Existing environment
Major road
Minor road

Streams within study area
Perennial
Non-perennial

Topographic contour (100 m interval)
200
300
400
500
600
700
800
900
1000
1100

Focus areas and topography

Oven Mountain Pumped Hydro Energy Storage Project
Groundwater dependent ecosystem assessment
OMPS Pty Ltd
Figure 3.1

EMM creating opportunities

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3.3 Climate

3.3.1 Overview

The study area includes two climatic categories (Geiger, 1954), characterised as:

- humid-subtropical in the lower areas (near the Macleay River floodplain, lower escarpment and lower western catchment), with:
  - no dry months in summer
  - at least one-month's average temperature above 22°C
- temperate oceanic in the higher areas (near the plateau, upper escarpment and upper western catchment), with:
  - potential for dry months in summer
  - all months with average temperatures below 22°C.

3.3.2 Rainfall

Average rainfall is typically higher across the Macleay River floodplain, lower escarpment and lower western catchment, with 1,136 millimetres per year (mm/yr) average rainfall at Bellbrook (representative of the Macleay River floodplain, lower escarpment and lower western catchment) and 935 mm/yr at Jeogla Station (representative of the plateau, upper escarpment and upper western catchment). Rainfall occurs year-round in both areas, with slightly increased rainfall in summer months on average (compared to winter months).

There are several Bureau of Meteorology (BoM) operated rainfall gauges in the region that provide representative records for the study area. Key information and statistical data for five gauges near the study area are provided in Table 3.1. The rainfall gauges presented in Table 3.1 have been chosen based on their proximity, length and completeness of records.

Table 3.1 Annual rainfall statistics

Statistic	Units	Jeogla Station (BoM: 57011)[1]	Uralla (Blue Nobby) (BoM: 57091)[1]	Georges Creek (BoM: 57008)[1]	Lower Creek (Cedar Park) (BoM: 57052)[1]	Bellbrook (East Street) (BoM: 59000)[1]
Rainfall record	-	1907–present	1959–present	1918–1961	1961–2017	1889–2017
Record completeness	-	99%	97%	97%	89%	97%
Distance from study area	-	25 km north-west	33 km west	0 km	8 km north-east	30 km east
Elevation	(mAHD)[2]	950	1,067	166	130	95
Average annual rainfall	(mm/yr)[3]	935	933	912	1,069	1,136
Lowest annual rainfall	(mm/yr)	310	271	473	597	522
Highest rainfall	(mm/yr)	1,781	1,397	1,459	1,724	2,052

1. Source: BoM website (climate data online).
2. mAHD = metres Australian Height Datum.
3. mm/yr = millimetres per year.

The annual rainfall totals shown in Table 3.1 indicate that annual rainfall totals are similar for the two gauges (BoM: 57011, 57091) located on the elevated tablelands and west of the study area. Annual rainfall totals are observed to increase as elevation declines (approaching the coast), with the highest annual rainfall totals observed at the Bellbrook (East Street) gauge (BoM: 59000).

The Georges Creek (BoM: 57008) gauge, located immediately north of the Project area, has an average annual rainfall of 912 mm/yr, approximately 150 mm/yr less than the Lower Creek (BoM: 57052) gauge (1,069 mm/yr), located 8 km further northeast. It is considered that this is indicative of a relatively short rainfall record period during drought.

The Georges Creek and Lower Creek rainfall gauges are expected to be more representative of rainfall conditions for the Macleay River floodplain and lower escarpment/western catchment. The Jeogla Station (BoM: 57011) rainfall gauge is expected to provide more representative rainfall conditions near the plateau and upper escarpment/western catchment.

Inferred rainfall records accessed from the SILO database (DES, 2022) have been used to summarise historic rainfall trends for the study area. The deviation in the average annual rainfall total at the Project area since 1918 is shown in Figure 3.2, indicating that the study area has experienced long-term climate cycles with distinct wet and dry periods.

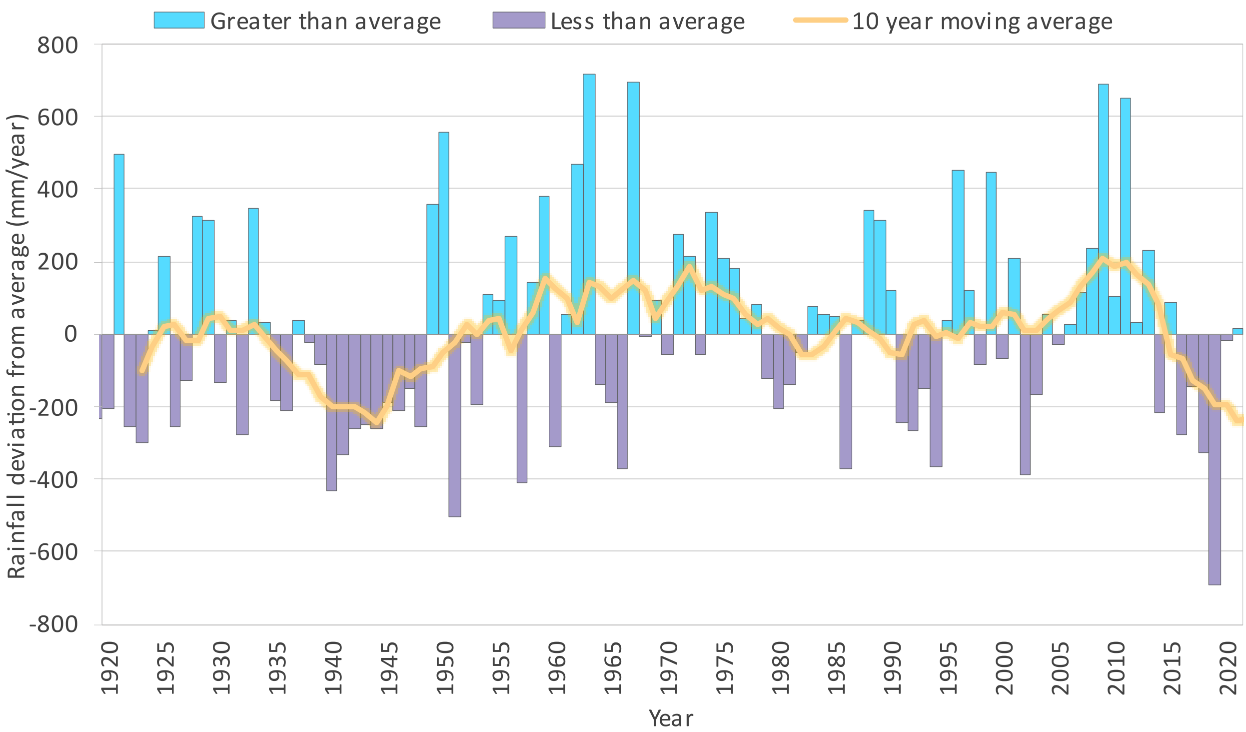


Figure 3.2 Historical rainfall trend at the Project area

3.3.3 Evaporation

The median yearly pan evaporation is approximately 1,345 mm/yr within the study area, as estimated using the SILO database (DES, 2022) at the nearby Georges Creek (BoM: 57008) station. Evaporation and rainfall data are provided in Figure 3.3, illustrating the lower than average rainfall proportional to the higher than average evaporation (drought period) until January 2020 and a distinct wetter period (higher than average rainfall and lower than average evaporation) since July 2021.

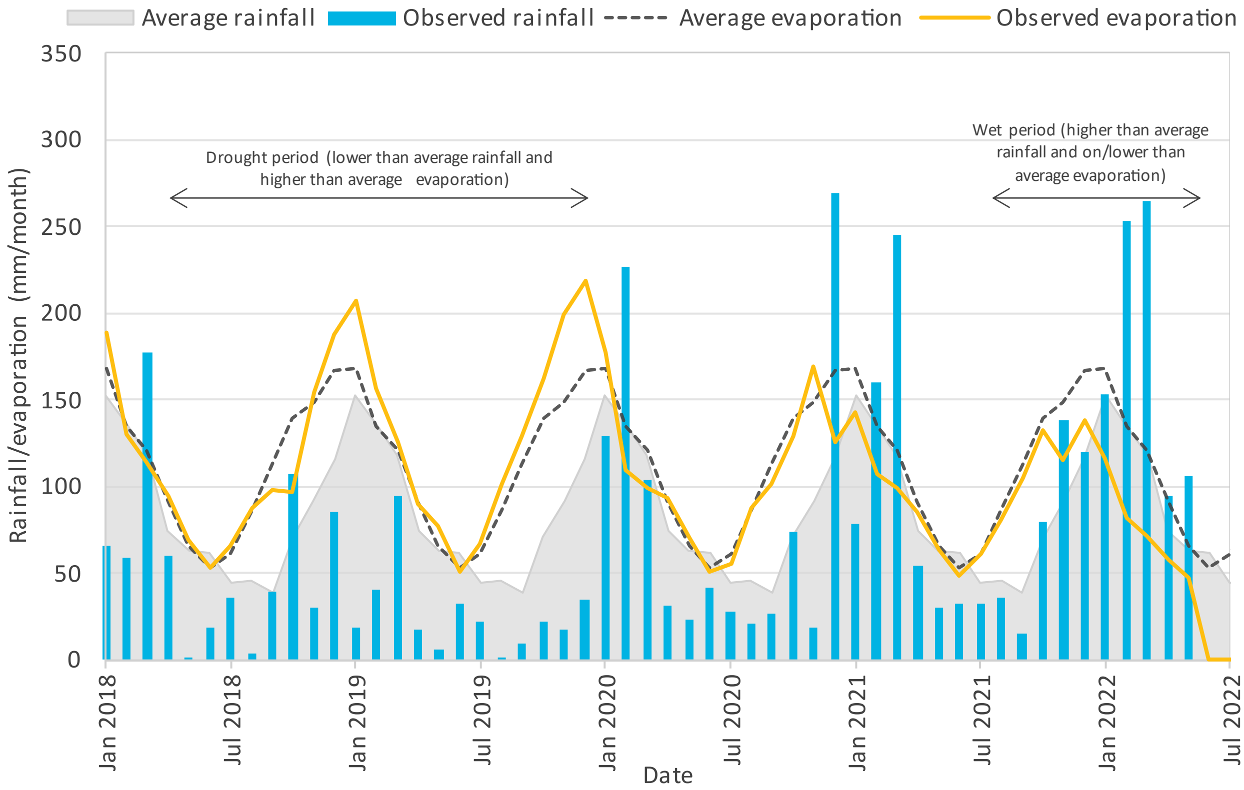


Figure 3.3 Monthly rainfall variability (Georges Creek SILO station) and mean monthly pan evaporation

3.4 Soils and geology

Based on publicly available Australian soil classification mapping data (DPIE 2021), the soil groups mapped within the study area include Kandosols, Tenosols and Rudosols (refer Figure 3.4). In general, these soil groups are observed (DJPR, 2020):

- to be relatively shallow, with rock close to surface
- comprising minimal clay content (≤15%)
- exhibiting poor water holding capability.

Soils within the Project area are predominantly residual, with their composition influenced by the properties of the underlying rock unit. In general, residual soil overlying the:

- granitic rock (granodiorite, adamellite and monzogranite) typically comprising of pale grey, medium grained sand with minor clay inclusions
- metamorphic rock (hornfels and metasediments) typically comprising of dark grey, medium–high plasticity clay.

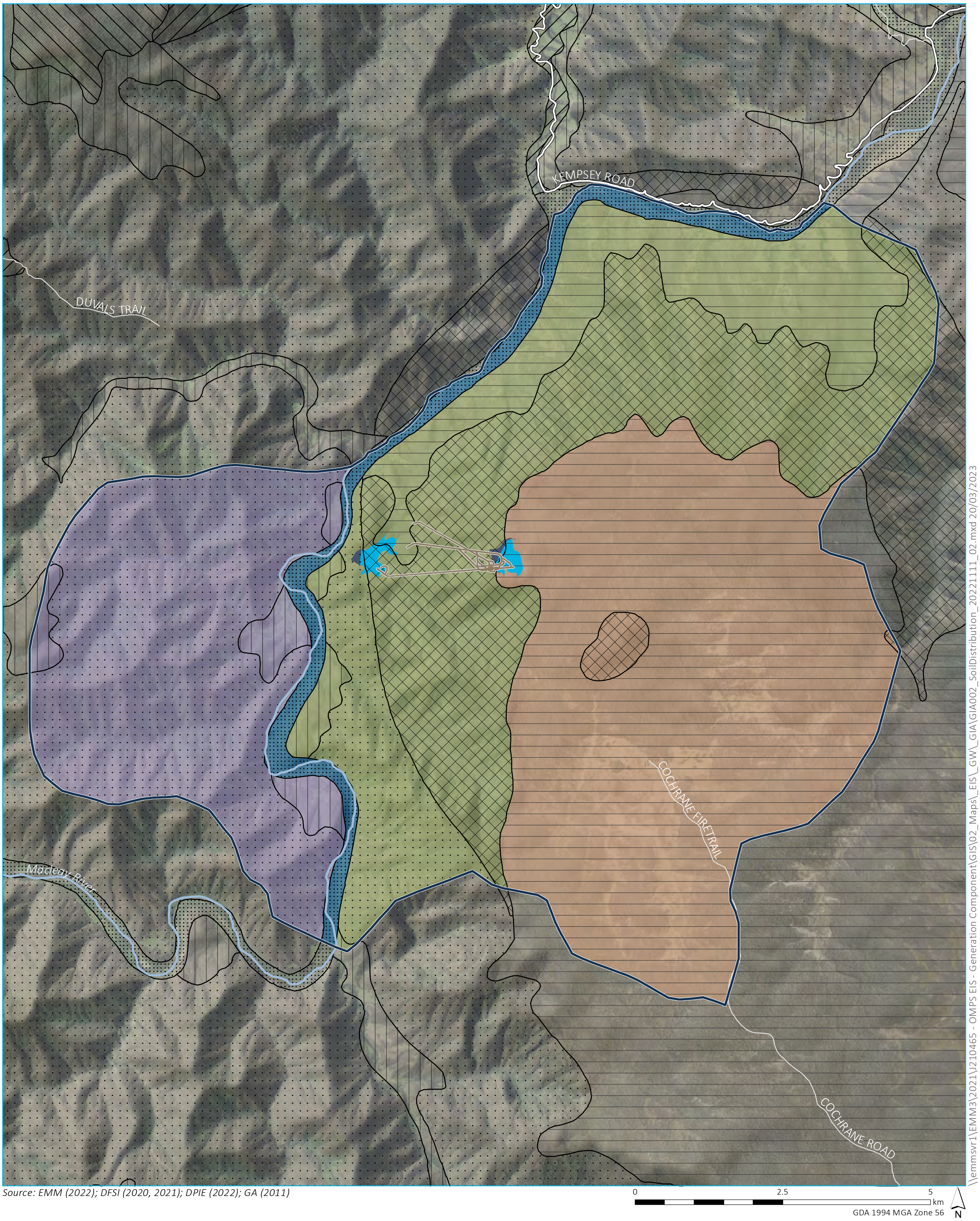
Deposits of alluvial and colluvial soils occupy the incised valleys which support the watercourses formed across the upper escarpment area (refer Section 3.2). The deposits become more substantial in the lower escarpment and plain area (further along the geomorphological profile of the streamline), reflecting the increased energy of the environment and wider catchment area, and generally comprise sub-rounded to rounded boulders, cobbles, gravel and sand. Further down the catchment, within the riparian corridor and along the fifth order Macleay River, the surficial geology is comprised of a relatively thin deposit of alluvium, comprising well rounded cobbles, gravel and sand.

The study area lies within the New England Orogen (NEO). The NEO extends approximately 2,000 km along the east coast of Australia from Townsville, QLD (north) to Newcastle, NSW (south), and is bordered by the Sydney-Gunnedah-Bowen Basin to the west (Jessop et al. 2019). Differing geodynamics in the early Permian to Triassic led to a series of linked pluton structures (known collectively as the New England Batholith) which intruded the sedimentary units of the Permian-aged Parrabel Beds and Carboniferous-aged Pee Dee Beds. The Triassic-aged Carrai Granodiorite, a plutonic structure outcropping over approximately 168 square kilometres (km^2), is the dominant geological unit occurring within the study area and a product of the New England Batholith.

A summary of the stratigraphy within the Project area is provided in Table 3.2. The distribution and extent of the relevant geological units to the study area are mapped and shown on Figure 3.5.

Table 3.2 Study area stratigraphy

Period	Formation	Typical description (Colquhoun et al. 2022)
Quaternary	Undifferentiated alluvial, colluvial sediments	Well sorted, coarse grained and oversized fractions at the base of the incised valleys and adjacent to the Macleay River. Generally, comprises localised deposits of cobbles and boulders at the base of the incised valleys, becoming more prevalent and continuous within the lower escarpment. Sands to cobbles more frequently observed within the Macleay Valley floodplain.
Triassic	Carrai Granodiorite	Coarse grained, felsic, crystalline igneous rocks including granodiorite, monzogranite and leucogranite. Relatively shallow weathering profile (≤9 m depth) and strength typically increasing with depth. Dominant geology underlying the study area.
Permian	Parrabel Beds	Fine to coarse grained sedimentary rocks including diamictite, conglomerate, sandstone, mudstone, limestone and tuff. Highly metamorphosed within the Project area by the Carrai Granodiorite intrusion, forming an aureole contact of hornfels and meta-sediments. Underlies the majority of the western catchment.
Permian	Pee Dee Beds	Fine to coarse grained sedimentary rocks including slaty siltstone, lithic sandstone and minor diamictite. Likely metamorphosed near the Project area by Carrai Granodiorite intrusion, forming an aureole contact of hornfels and meta-sediments. Underlies the northern portion of the western catchment and a small component of the Macleay River floodplain.



Source: EMM (2022); DFSI (2020, 2021); DPIE (2022); GA (2011)

KEY

Study area
Dam wall
Reservoir
Tunnels, portals, intakes, shafts
Existing environment
Major road
Minor road
Macleay River

Focus area
Escarpment
Macleay River floodplain
Plateau
Western catchment

Soil type (ASC)
Dermosols
Ferrosols
Kandosols
Kurosols
Rudosols
Rudosols (alluvial)
Tenosols

Soil distribution within the Carrai, NSW region

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Figure 3.4

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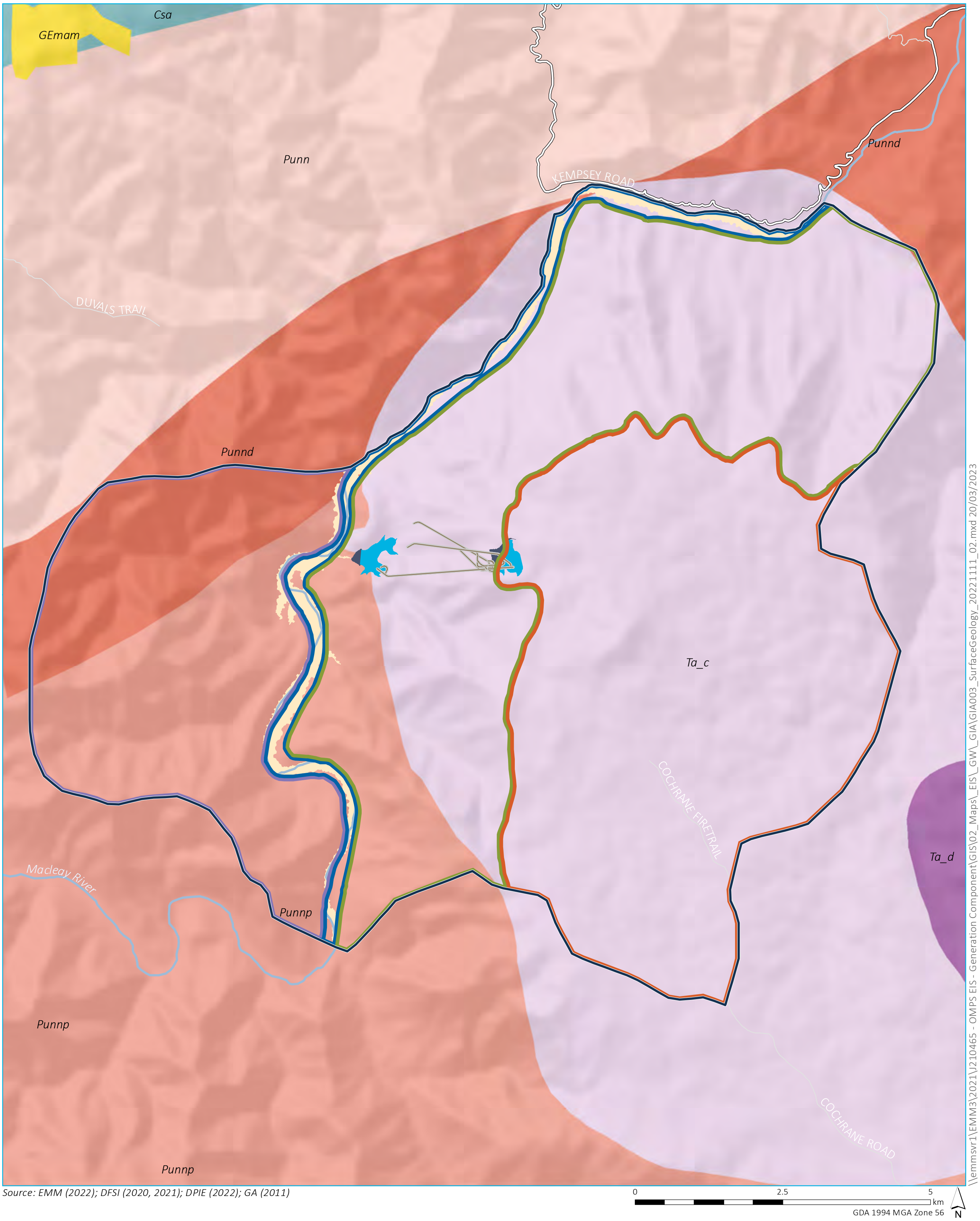

Source: EMM (2022); DFSI (2020, 2021); DPIE (2022); GA (2011)

KEY

- Study area
- Dam wall
- Reservoir
- Tunnels, portals, intakes, shafts
- Inferred alluvium

Existing environment

- Major road
- Minor road
- Macleay River

Focus area

- Escarpment
- Macleay River floodplain
- Plateau
- Western catchment

Surface geology (GSNSW)

Priabonian

- Maybole Volcanics (GEmam)

Late Triassic

- Carrai Granodiorite (Ta_c)
- Daisy Plains Leucosyenogranite (Ta_d)

Permian

- Nambucca beds (Punn)
- Parrabel beds (Punnp)
- Pee Dee beds (Punnd)

Carboniferous

- Sandon Association (Csa)

Surface geology within the Carrai, NSW region

Oven Mountain Pumped Hydro Energy Storage Project
Groundwater dependent ecosystem assessment
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Figure 3.5

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3.5 Surface water

The study area is located within the Macleay River catchment, covering approximately 11,400 km^2 from Armidale (on the Great Dividing Range of NSW) to Hat Head (on the east coast of NSW). The catchment generally comprises relatively impervious rock at the ground surface, leading to rapid water level and streamflow responses in the Macleay River following rainfall.

As described in Section 3.2, most of the surface water within the study area flows to the Macleay River (a ninth order, perennial watercourse) via a series of streamlines. Based on a search of the NSW Hydrography database (DCS, 2022), the following perennial watercourses also occur within the study area:

- Peach Tree Creek and Carrai Creek, originating in the upper escarpment and discharging to the Macleay River within the Macleay River floodplain.
- Kunderang Station Creek, originating in the upper western catchment and discharging to the Macleay River within the Macleay River floodplain.
- Three Rock Plain Creek and Little Three Rock Plain Creek, originating in the eastern plateau and discharging to the Macleay River outside (east) of the study area.

Ephemeral and intermittent streams discharge directly to the Macleay River or form upper tributaries to the perennial watercourses (refer Figure 3.1). The ephemeral streams typically flow for periods proportional to recent duration and magnitude of rainfall, with relatively high flow events evident from the transported boulders and vegetation. Intermittent streams flow for attenuated periods following rainfall, supported by groundwater discharge from localised groundwater systems across the plateau.

3.6 Groundwater

3.6.1 Hydrogeological setting

The study area largely comprises crystalline-igneous (Carrai Granodiorite) and metamorphic (metamorphosed Parrabel Beds/Pee Dee Beds) rocks associated with the NEO, forming a generally low permeability, fractured rock groundwater system, including a:

- shallow groundwater system, supporting:
  - vegetation (including eucalypts, grasses)
  - swamp areas (fens) and associated eco-systems
  - ephemeral streams, eventually discharging to the Macleay River
  - a small component of baseflow to the Macleay River
- deep groundwater system.

Localised groundwater systems are contained within the lower permeability soils associated with weathered rock across the plateau, and high permeability alluvium/colluvium within the lower escarpment, lower western catchment and Macleay River floodplain.

One groundwater bore (GW307320) is registered within the study area, located in the western catchment. The bore has intercepted a moderate yield (5 litres per second (L/s)) from within the shallow fractured rock groundwater system, providing typically fresh water for domestic use. Prospectivity for groundwater supply within the regional fracture rock groundwater system is typically low, with practical supply contingent on intercepting the infrequent fracture networks within the geology. No additional groundwater users are registered within 7 km of the study area (BoM, 2013).

3.6.2 Groundwater dependent ecosystems

Based on the Water Sharing Plan (WSP) for the North Coast Fractured and Porous Rock Groundwater Sources 2016 (Groundwater WSP) (DPI, 2016b), no high priority GDEs are mapped within 12 km of the study area.

Based on the relevant high ecological value aquatic ecosystem (HEVAE) database (DPE, 2022a) and the GDE atlas (BoM, 2017), GDEs were identified within the study area. A summary of the high potential and high category GDEs (as defined by the BoM and HEVAE databases respectively) is provided in Table 3.3 and outlined on Figure 3.6.

Table 3.3 Desktop summary of high potential and high category groundwater dependent ecosystems

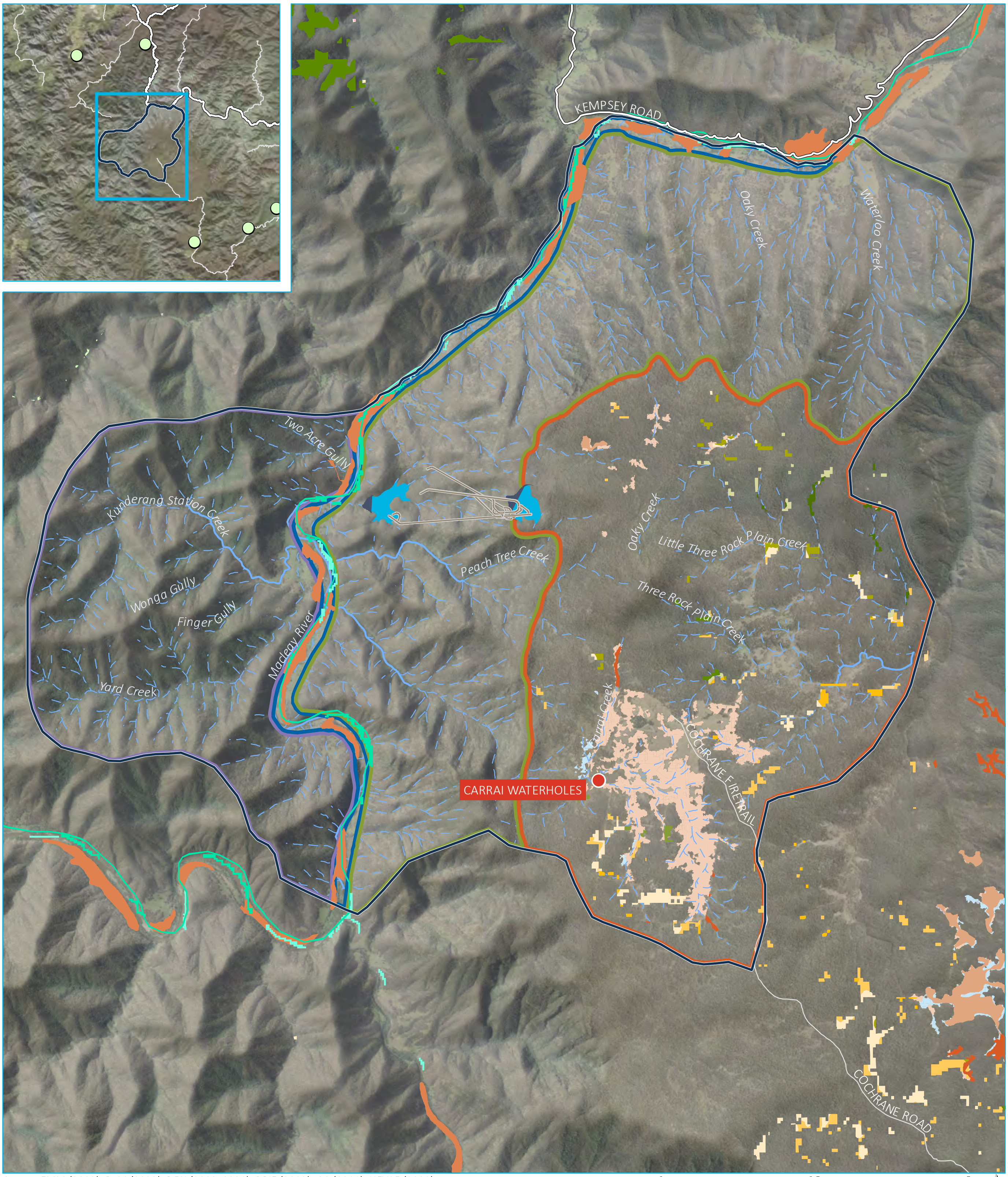
Category	Groundwater dependent ecosystem	Focus area	Source
Terrestrial	River Oak (PCT1106)	Macleay River floodplain	[1]BoM GDE atlas
	Freshwater Wetland	Plateau	[1]BoM GDE atlas
	Sedgeland/rushland	Plateau	[1]BoM GDE atlas
	New England Tableland Carex Fens (PCT3944)	Plateau	[2]HEVAE database
	Eastern New England Granites Wet Heath (PCT3934)	Plateau	[2]HEVAE database
Aquatic	Macleay River	Macleay River floodplain	[1]BoM GDE atlas
	Floodplain wetland	Macleay River floodplain	[1]BoM GDE atlas
Subterranean	[3]No ecosystem analysed		[1]BoM GDE atlas

Notes: 1. (BoM, 2017).
2. (DPE, 2022a).
3. Subterranean groundwater dependent ecosystem data not available within New South Wales (BoM, 2017).

Additional surveys were undertaken in the baseline monitoring program to further characterise GDEs within the study area, as discussed in Section 5.3.

3.6.3 Groundwater relevant cultural areas

Based on a search of the NSW state heritage inventory (DPE, 2022b), the 'Carrai Waterholes' were identified as a declared area of cultural significance, with a potential for groundwater interaction. The approximate location of the Carrai Waterholes is provided on Figure 3.6 and are not located within the Project area.



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Source: EMM (2022); BoM (2022); DFSI (2020, 2021); DPIE (2022); GA (2011); HEVAE (2022)

0 2.5 5 km
GDA 1994 MGA Zone 56
N

KEY

- Study area
- Dam wall
- Reservoir
- Tunnels, portals, intakes, shafts

Focus area
- Escarpment
- Macleay River floodplain
- Plateau
- Western catchment

Existing environment
- Major road
- Minor road

Streams within study area
- Perennial
- Non-perennial

- Carrai Waterholes (approximately)
- High priority GDE

GDE - Terrestrial (HEVAE)
- Central Eastern Ranges Riparian Dry Rainforest
- Eastern New England Granites Wet Heath
- Far North Escarpment Granitoid Wet Heath
- New England Tableland Carex Fens
- Northern Gorges Diverse Grassy Forest
- Northern Gorges River Oak Forest
- Northern Hinterland Red Gum Grassy Forest
- Northern Hinterland Shatterwood Dry Rainforest

GDE Aquatic (BoM)
- High potential GDE - Macleay River
- Moderate potential GDE - Macleay River

GDE Terrestrial (BoM)

Moderate potential GDE
- Alpine Gum
- Diehard Stringybark-New England Blackbutt
- Grassy New England Blackbutt-Tallowwood-Blue Gum
- Manna Gum
- Mid North Coast Wet Brushbox-Tallowwood-Blue Gum
- Moist Escarpment New England Blackbutt
- Snow Gum -Mountain/Manna Gum
- Sub-Tropical & Warm Temperate Rainforest
- Sub-Tropical Rainforest

High potential GDE
- Freshwater Wetland
- River Oak
- Sedgeland/Rushland

Groundwater dependent ecosystems and relevant cultural areas

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Figure 3.6

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3.7 Water management

3.7.1 Surface water management and use

Surface water within the study area is managed under the Water Sharing Plan for the Macleay Unregulated and Alluvial Water Sources 2016 (Macleay WSP). The Macleay WSP covers 33 surface water sources (with connected alluvial groundwater systems, refer Section 3.7.2) and one floodplain alluvial groundwater source (DPI, 2016a), between Armidale and Hat Head.

All streams within the Macleay WSP are classed as unregulated and users generally rely on natural flows for water supply, including Bellbrook and Willawarrin townships (located downstream of the Project).

Multiple weirs and small farm dams have been constructed throughout the Macleay WSP area including (Geoscience Australia, 2016):

- Steuart Mcintryre Dam, providing raw water supply for Kempsey, NSW
- Gara Dam, part of a former hydro-electric scheme operating 1895–1907 (Gojak, Giopoulos, & Dunnett, 1988)
- Oaky River Dam, part of a former hydro-electric scheme operating 1956–2013 (The Dam Zihni Built, 1998)
- Malpas Dam, providing raw water supply for Armidale, NSW
- Puddledock Creek Dam, providing raw water supply for Armidale, NSW.

The Project area straddles four water sources within the Macleay WSP (with further information provided in the Surface Water Impact Assessment (EMM, 2023a), comprising the:

- Macleay Gorges Water Source, including 2 unit shares (also straddled by the study area)
- Macleay Valley Water Source, including 3,432 unit shares (also straddled by the study area)
- Dyke River Water Source, without any unit shares
- Georges River Water Source, without any unit shares.

3.7.2 Groundwater management and use

Groundwater within the study area is managed under the Macleay WSP and the Groundwater WSP (DPI, 2016b).

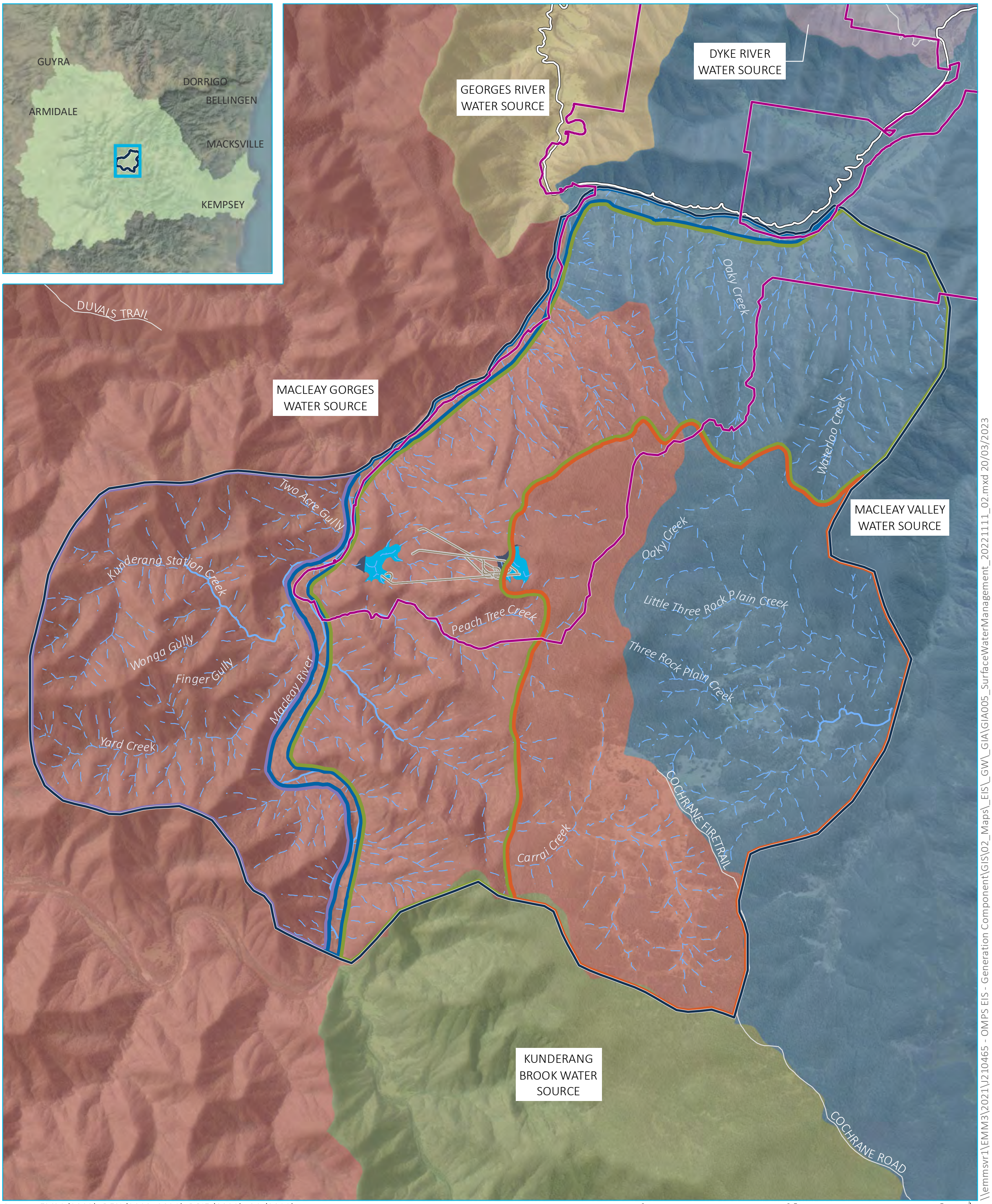
The Macleay WSP includes management measures for the water "contained within the alluvial sediments below the surface of the ground…" (DPI, 2016a), including the:

- Coastal Macleay Floodplain Alluvial Groundwater Source (135 ML of share components in the 2021/2022 water year)
- upriver alluvial sediments within the:
  - Macleay Valley Water Source (281 ML of share components in the 2021/2022 water year)
  - remaining water sources, within the Macleay WSP (0 ML of share components in the 2021/2022 water year).

Most groundwater extracted from the alluvial sediments is allocated for Kempsey Shire Council (KSC) town water supply. Groundwater is accessed via eight production bores within the Sherwood borefield, located approximately 11 km west of Kempsey, NSW (WaterNSW, 2022). Mapped upriver alluvial sediment boundaries are provided on Figure 3.7.

The Groundwater WSP covers 13 fractured and porous rock groundwater sources, located over approximately 69,400 km^2 between Gosford and the Queensland border. The study area is contained entirely within the New England Fold Belt Coast Groundwater Source (NEFB Coast Groundwater Source), with 15,899 ML of share components in the 2021/2022 water year.

The sub-surface Project infrastructure (tunnels, reservoirs, machine halls etc) will be entirely within the NEFB Coast Groundwater Source, as illustrated on Figure 3.8.



Source: EMM (2022); DFSI (2020, 2021); DPIE (2022); GA (2011)

0 2.5 5 km
GDA 1994 MGA Zone 56
N

KEY

- Project area
- Study area
- Dam wall
- Reservoir
- Tunnels, portals, intakes, shafts

Focus area

- Escarpment
- Macleay River floodplain
- Plateau
- Western catchment

Existing environment

- Major road
- Minor road

Streams within study area

- Perennial
- Non-perennial

- Macleay WSP (see inset)

Surface water sources (Macleay WSP)

- Dyke River Water Source
- Georges River Water Source
- Kunderang Brook Water Source
- Macleay Gorges Water Source
- Macleay Valley Water Source

Surface water management and sources

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Groundwater dependent ecosystem assessment
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Figure 3.7

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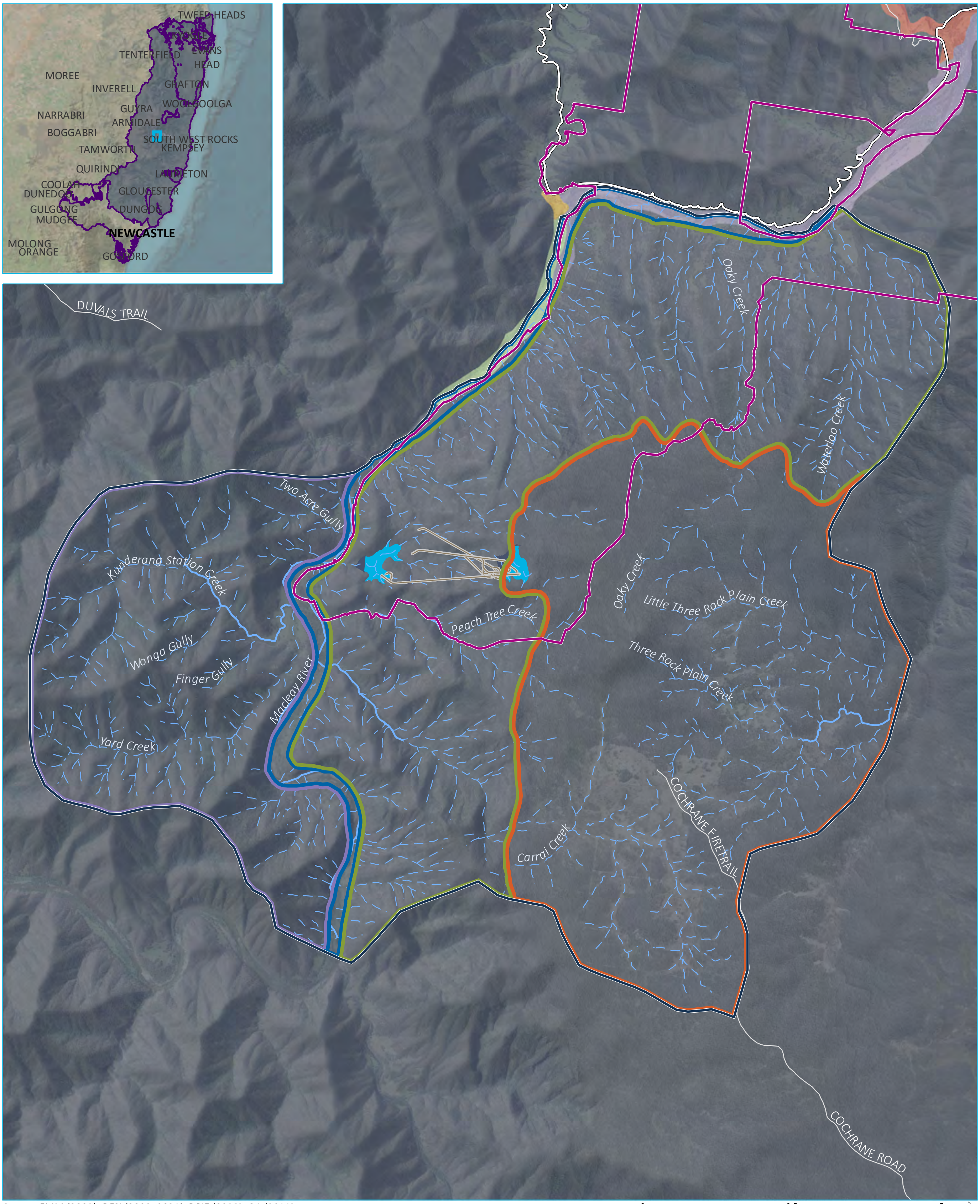

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Source: EMM (2022); DFSI (2020, 2021); DPIE (2022); GA (2011)

0 2.5 5 km
GDA 1994 MGA Zone 56
N

Project area
Study area
Dam
Tunnels, portals, intakes,
Focus area
Macleay River
Western

Existing
Major
Minor
Streams within study area
Non-

Groundwater
North Coast Fractured and Porous Rock

Groundwater source (groundwater
New England Fold Belt Coast Groundwater
Unnamed Upriver Alluvium in WSP in the Dyke
Unnamed Upriver Alluvium in WSP in the
Unnamed Upriver Alluvium in WSP in the
Unnamed Upriver Alluvium in WSP in the

Groundwater management and sources

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Figure 3.8

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4 Regulatory and policy context and assessment

The primary water related statutes that apply to the Project are the NSW *Water Management Act 2000* (WM Act), NSW *Water Act 1912* (Water Act), NSW *Protection of the Environment Operations Act 1997* (POEO Act), the NSW *Biodiversity Conservation Act 2016* (BC Act), the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and their attendant regulations (including water sharing plans (WSPs) under the WM Act). Projects that intercept groundwater also need to consider the AIP (DPI, 2012), which requires the Project to hold licences that account for the volume of water intercepted and consider changes in water quality and water levels at sensitive receptors in accordance with prescribed minimal impact criteria.

4.1 NSW Water Act 1912

The Water Act is gradually being repealed and replaced by the WM Act as WSPs are developed for water sources across NSW, and as new regulations are made. Some aspects of the Water Act are still operational across all of NSW, such as the requirement to hold a licence for all monitoring bores greater than 40 m depth. OMPS is exempt under the NSW *Water Management (General) Regulation 2018* as the Project is declared CSSI.

4.2 NSW Water Management Act 2000

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

The WM Act provides for water sharing between different water users, including environmental (such as GDEs), basic rights or existing water access licence (WAL) holders, and provides security for licence holders. The licensing provisions of the WM Act apply to those areas where a WSP has commenced.

4.3 Guidelines for Groundwater Documentation for SSD/SSI Projects

The Guidelines for Groundwater Documentation for SSD/SSI Projects (DPE, 2022) assists proponents to demonstrate if an activity [Project] can operate and be compliant with the principles and objects of the WM Act and the requirements described within the NSW groundwater policy documents.

The Guidelines for Groundwater Documentation for SSD/SSI Projects (DPE, 2022) has been considered throughout development of this GDE assessment (as an extension of considerations within the Groundwater Impact Assessment (EMM, 2023)).

4.4 Water sharing plans

WSPs are statutory documents 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, extractive, and other uses. WSPs also outline the water available for extractive uses within different categories (at the time the plan commenced), such as: local water utilities, domestic and stock, basic rights, and access licences. WSPs establish trading rules and mandatory licence conditions that apply to licence holders within each water source.

Planned environmental water is prescribed within a WSP to protect the aquifer and GDEs (planned environmental groundwater) or the river and streams systems and associated ecosystems (planned environmental surface water). For groundwater, environmental water is typically defined as 100% of the storage volume plus a proportion of the annual recharge volume.

Within the groundwater WSP, the proportion of annual recharge reserved for environmental water is categorised within (DPI, 2016b):

- 'High environmental value' areas as 100% of annual recharge (within the high environmental areas).
- 'Not high environmental value' areas as 96% of annual recharge (within the not high environmental areas).

The total volume of annual recharge reserved for environmental water as per the WSPs, is reported as 1,920,000 ML/yr for the NEFB Coast Groundwater Source (~97% of average annual recharge reserved).

The WSPs, associated water sources, available water, basic rights and licence shares as outlined in the WSPs applicable to the Project area are further discussed in the Groundwater Impact Assessment (EMM, 2023).

4.4.1 NSW Aquifer Interference Policy

DPE-Water provides indicative distributions of the highly productive and less productive groundwater sources in NSW (DPI-Water, 2013). The AIP further defines water sources by their general geological composition, being one of alluvium, coastal sand, porous rock, or fractured rock.

For each category of water source, the AIP identifies thresholds for minimal impact considerations. These thresholds relate to water table impacts, water pressure and water quality, and are ranked as being either 'level 1 minimal impact' or 'level 2 exceeding minimal impact'. The definition of 'minimal impact' is outlined in a series of tables which demonstrate how the criteria are applied for different types of water sources and for different sensitive receptors (i.e. other users and ecosystems).

Based on mapped areas of groundwater productivity in NSW (DPI-Water, 2013), the Project area is considered to be within a 'less productive' fractured rock source. The applicable minimal impact considerations are shown in Table 4.1.

If the impact of an activity is assessed as being 'Level 1: minimal impact', then the Project is considered to have impacts that are acceptable. Where the predicted impacts exceed the Level 1 thresholds by no more than the accuracy of the model, then this is considered as having impacts within the range of acceptability and extra monitoring or mitigation or remediation will be required during operations.

Where the predicted impact of an activity is assessed as being 'Level 2' or 'greater than minimal impact', additional studies are required to fully understand the predicted impacts. If the assessment shows that the predicted impacts, although greater than 'minimal', do not prevent the long-term viability of the relevant water-dependent asset, then the impacts will be considered to be acceptable.

Where impacts are predicted to be 'greater than minimal impact' and the long-term viability of the water-dependent asset is compromised, the impact is subject to make good provisions.

AIP Fact Sheet 4 (NOW 2013b) outlines how a minimal impact is to be considered. It describes how the minimal impact criteria are applied to both a water supply work and a GDE defined in a WSP. This fact sheet also defines the term 'make good provisions' as the requirement to ensure that third parties with water supply works have access to an equivalent supply of water through enhanced infrastructure or other means, for example deepening an existing bore, compensation for extra pumping costs or constructing a new pipeline or bore.

Table 4.1 Minimal impact criteria for 'less productive' porous and fractured rock water sources

Watertable	Water pressure	Water quality
1. Less than or equal to 10% cumulative variation in the watertable, allowing for typical climatic 'post-water sharing plan' variations, 40 m from any: a) high priority groundwater dependent ecosystem, or b) high priority culturally significant site. Listed in the schedule of the relevant water sharing plan. A maximum of a 2 m decline cumulatively at any water supply work.	1. A cumulative pressure head decline of not more than a 2 m decline, at any water supply work.	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.
2. If more than 10% cumulative variation in the watertable, allowing for typical climatic 'post-water sharing plan' variations, 40 m from any: a) high priority groundwater dependent ecosystem; or b) high priority culturally significant site. Listed in the schedule of the relevant water sharing plan if appropriate studies demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than a 2 m decline cumulatively at any water supply work then make good provisions should apply.	2. If the predicted pressure head decline is greater than requirement 1 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	2. If condition 1 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.

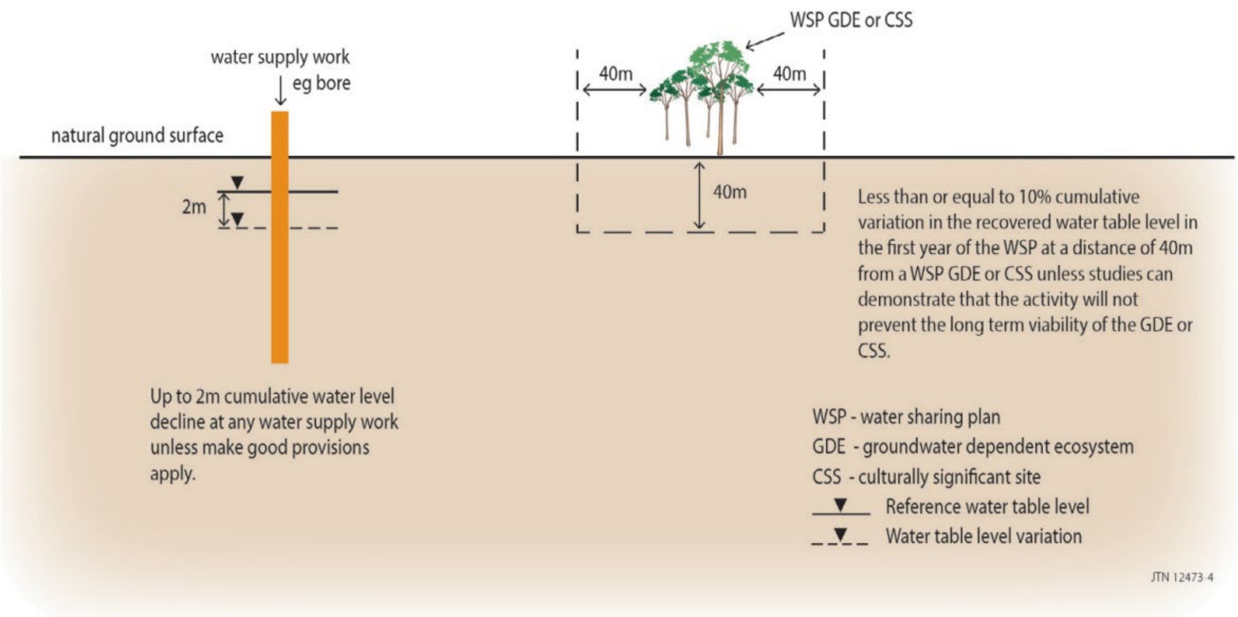


Figure 4.1 Fractured rock groundwater source minimal impact considerations

The AIP requires that two years of baseline groundwater data be collected and incorporated into an impact assessment before lodging an activity development application. An extensive groundwater monitoring network has been installed for the Project in consultation with DPE-Water, including:

- eight conventional groundwater monitoring bores
- three shallow fen monitoring bores

- one existing landholder bore
- seven boreholes
- eleven springs
- four surface water locations (within the Macleay River)
- one seep.

The baseline monitoring program commenced in August 2020 (over two years prior to the submission of the EIS) and is ongoing. Further discussion on the baseline monitoring program is provided in Chapter 5.

4.5 NSW Protection of the Environment Operations Act 1997

The Protection of the Environmental Operations (POEO) Act is the key piece of environment protection legislation administered by the NSW Environment Protection Authority (EPA). The POEO Act enables the government to set protection of the environment policies that provide environmental standards, goals, protocols, and guidelines. It also establishes a licensing regime for pollution generating activities in NSW. Under Sections 47 and 48 of the POEO Act, an environment protection licence (EPL) is required for 'scheduled development work' and 'scheduled activities', respectively, which include electricity generation and wastewater treatment. Accordingly, an EPL for the Project will be applied for.

In accordance with Section 5.24 of the EP&A Act, an EPL cannot be refused if it is necessary for carrying out approved SSI (and CSSI, by extension) and is to be consistent with the approval, should it be granted by the NSW Minister for Planning. The POEO Act also includes a duty to notify relevant authorities of pollution incidents where material harm to the environment is caused or threatened.

4.6 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The Environmental Protection and Biodiversity Conservation (EPBC) Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places, which are defined as matters of national environmental significance.

On 27 November 2020, OMPS submitted a referral for a proposed action to the Commonwealth Department of Agriculture, Water and the Environment (DAWE, now Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW)) under the EPBC Act for the Project (EPBC Ref: 2020/8850). This referral considered impacts to matters of national environmental significance (MNES) and the environment generally and detailed that the Project would potentially have a significant impact on MNES, including national heritage places, listed threatened species and ecological communities and listed migratory species. The referral also identified that the Project would have a potentially significant impact on the environment, as defined under the EPBC Act.

Due to the potential impacts of the Project on MNES and the environment, an accredited assessment process was sought under Section 87(4) of the EPBC Act, where the Commonwealth accredits the assessment process under Division 5.2 of the EP&A Act. On 1 February 2021, the DCCEEW Assistant Secretary provided notification of its referral decision and designated proponent, determining that the Project's action was a controlled action and is to be assessed by accredited assessment process under Part 5, Division 5.2 of the EP&A Act. An application to vary to the Project's action was approved on 23 December 2022 to include the transmission and EAR (which did not form part of the original referral).

As part of the accredited assessment process, DCCEEW assessment requirements have been included in the SEARs.

4.7 Relevant NSW plans, policies and guidelines

Several other guidelines and policies relevant to the water assessment are discussed in the following sections.

4.7.1 State Groundwater Policy Framework Document

The NSW State Groundwater Policy Framework Document (DLWC, 1997) aims to manage the groundwater resources of the state so they can sustain environmental, social, and economic outcomes for the people of NSW. The policy will be considered in resource management decisions made in NSW.

The document is a framework for the following three policies:

- NSW State Groundwater Quantity Management Policy (2001 (unpublished))
- NSW State Groundwater Quality Protection Policy (DLWC, 1998)
- NSW State Groundwater Dependent Ecosystem Policy (DLWC, 2002).

This policy establishes the overarching principles for the management of groundwater in NSW, which still remains valid more than twenty years after its inception. The principles of sustainability across the three environmental, social, and economic aspects are still referenced in modern water policies released by the NSW Government.

The Project and applied mitigation strategies will considerably minimise groundwater inflow and overall groundwater impacts (see the Groundwater Impact Assessment (EMM, 2023)). The design of the Project will closely follow the NSW State Groundwater Policy Framework Document objectives of achieving beneficial environmental, social, and economic outcomes for the state of NSW.

4.7.2 Risk assessment guidelines for groundwater dependent ecosystems

The Risk assessment guidelines for groundwater dependent ecosystems (Serov, Kuginis, & Williams, 2012) (GDE Risk Assessment Guidelines) are adopted by the DPE, establishing the requirements for assessment and management of GDEs under the WM Act. The dictionary to the Groundwater WSP provides that:

> groundwater dependent ecosystems include ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater.

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, i.e. seasonal or episodic (facultative), to total continual dependence (entire/obligate) (see Figure 4.2).

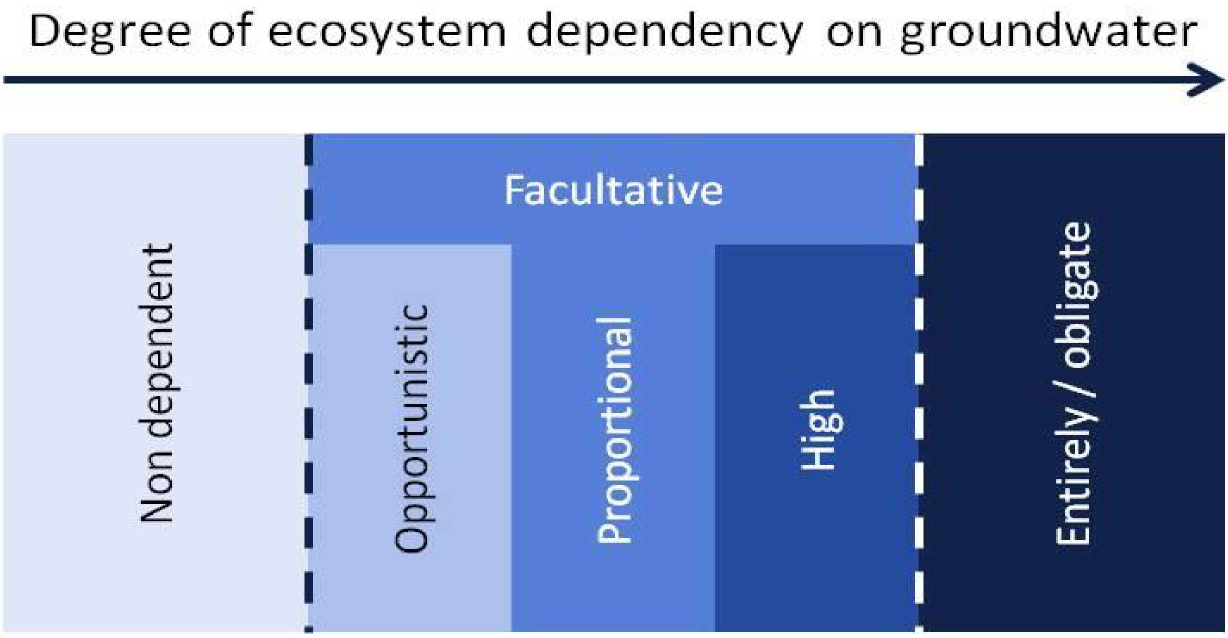


Figure 4.2 Ecosystem level of dependence on groundwater

A GDE risk assessment has been completed for the Project in accordance with the GDE Risk Assessment Guidelines. The assessment has been detailed in the Aquatic Ecology Impact Assessment (Stantec, 2023), and is summarised in the Project Groundwater Impact Assessment (EMM, 2023) and Biodiversity Development Assessment Report (EMM, 2023b).

The process for identification, assessment and risk mitigation (where required) has been documented in Figure 4.3.

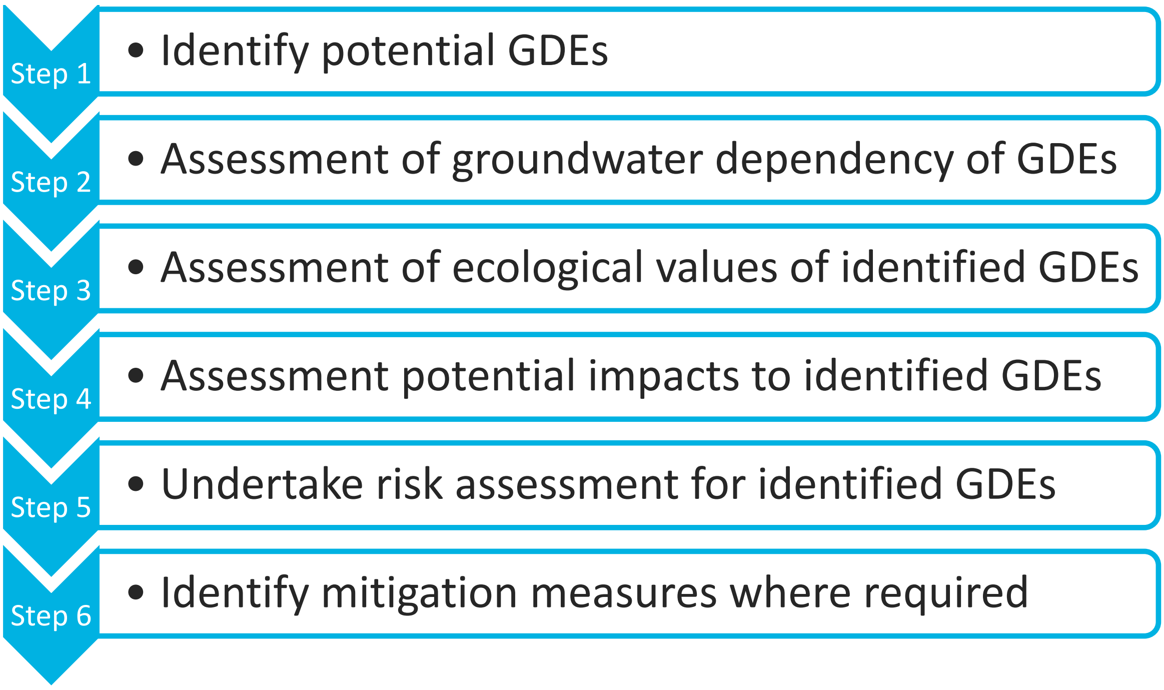


Figure 4.3 GDE risk assessment

Ecosystems that may rely on either the surface or subsurface expression of groundwater within or surrounding the Project area are those associated with:

- watercourses where groundwater is discharging and provides baseflow, including the Macleay River and ephemeral streams across the escarpment
- springs (providing flow to the ephemeral streams) across the escarpment, and/or
- terrestrial vegetation overlying shallow groundwater (within the vegetation root zone).

These ecosystems have been classified into three categories according to their dependence on groundwater:

- non-dependent
- facultative:
  - opportunistic
  - proportional
  - highly dependent
- entirely dependent/obligate.

Considerations in evaluating plant community types (PCT) and their potential dependency on groundwater included the:

- physiology of plant species that occur in the community and the likely dependence on groundwater availability
- location of PCTs in the landscape
- rooting depth of vegetation, further considering the potential for access to groundwater based on likely aquifer depth and soil characteristics.

Groundwater access is predominantly dependant on the depth to the watertable. As terrestrial vegetation communities are composed of a range of vegetation types with a range of rooting depths and strategies, there is generally a relationship between groundwater depth and the types and composition of the vegetation that is able to access it (Serov, Kuginis, & Williams, 2012).

4.7.3 NSW Wetlands Policy

The NSW Wetlands Policy (DECCW, 1996) provides for the protection, ecologically sustainable use and management of NSW wetlands.

A wetland is defined as areas of land that are wet by surface and/or groundwater for a sufficient period that plants and animals adapt to and depend on that moisture for at least part of their life cycle. Wetlands can be permanent or ephemeral. The policy contains 12 guiding principles focused on conservation, water and land management, sustainability, prioritisation of significant wetlands, recognition of wetlands’ cultural significance, climate change, protection, and reporting.

As discussed in the Aquatic Ecology Impact Assessment (Stantec, 2023) and in accordance with the NSW Wetlands Policy, no wetlands have been identified within the study area, as per the:

- Directory of Important Wetlands in Australia (Environment Australia, 2001)
- Australian Ramsar Wetlands database (DAWE, 2021).

4.8 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council (ANZECC & ARMCANZ) describe the water quality objectives for marine and freshwater environments, aquatic ecosystems, primary industries, and recreational water (ANZECC & ARMCANZ, 2000).

The guidelines should be considered when setting water quality objectives for natural and semi-natural water resources in Australia and New Zealand sustaining current or likely future environmental values/uses (EV), as required under Section 96(3A) of the POEO Act (OEH, 1997). The ANZECC guidelines also set out a framework for the application of water quality trigger levels, relevant to maintaining ecosystem condition.

The guidelines are a generic reference and should be used accordingly, i.e. only as a default reference. It is recommended to collect and use site-specific baseline data to establish baseline conditions and develop trigger levels. Project impacts should be assessed using site-specific baseline data and not the generic guidelines, where sufficient (typically >24 months) baseline data allows.

Further revisions to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality were made in 2018 with the release of a web-based guideline (ANZECC & ARMCANZ, 2018). The revised default guideline values for chemical contaminants/toxicants that are relevant to the Project area are consistent with levels presented in the earlier water quality objectives (ANZECC & ARMCANZ, 2000). Physical and chemical stressors have not yet been released for the ecoregion that contains the Project area.

Water quality objectives and EVs have been established in accordance with the ANZECC guidelines (ANZECC & ARMCANZ, 2000) for the Project (and in accordance with the Groundwater Impact Assessment (EMM, 2023)).

5 Baseline monitoring program

5.1 Summary

Baseline monitoring is an essential component in characterising the pre-existing groundwater conditions and ecosystem dependency on groundwater within the study area. Baseline water level and quality data obtained during the monitoring has facilitated the development and validation of a conceptual and numerical model, as well as supporting discussion on:

- water chemistry
- water flow mechanisms
- water recharge and discharge characteristics
- groundwater-surface water connectivity.

The water monitoring network (the network) was designed and monitored by EMM to establish a baseline dataset for the Project. The network was designed to capture data considering geological, spatial and temporal variations. The network was developed in consultation with DPE-Water, supporting a groundwater assessment in accordance with the AIP (DPI, 2012).

5.2 Water monitoring network

Groundwater and surface water monitoring commenced in August 2020 (and is currently ongoing), with increased monitoring as additional locations were identified or constructed. An overview of the baseline monitoring program is provided below:

The groundwater monitoring network included:

- eight conventional groundwater monitoring bores
- three shallow fen monitoring bores
- one existing landholder bore
- seven boreholes
- eleven springs
- four surface water locations (within the Macleay River)
- one seep.

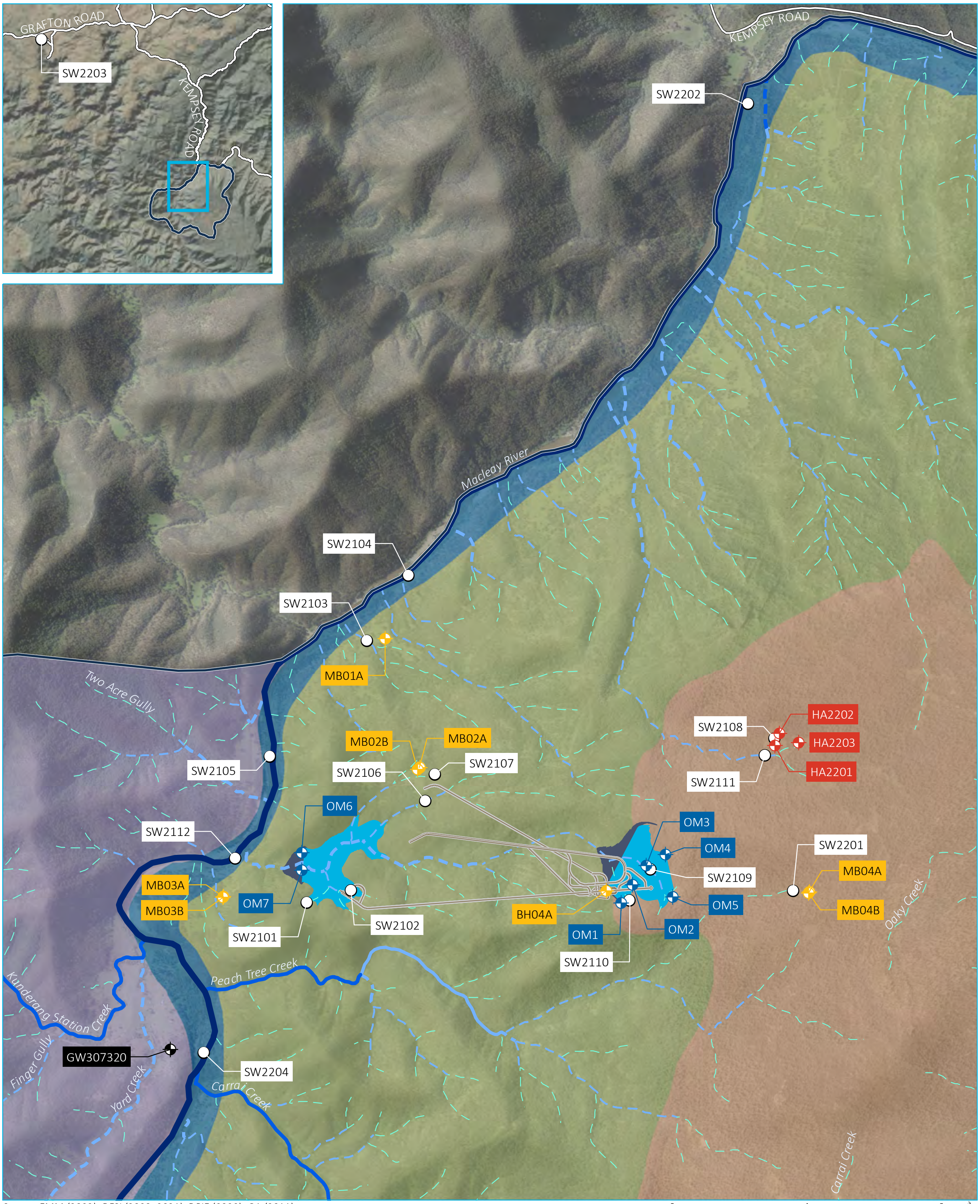
Monitoring sites were positioned to provide spatial coverage, investigate the dominant geologies and groundwater environments, and monitor potentially sensitive features. Specifically, the groundwater monitoring network was designed to:

- understand and monitor potential sensitive features, including surface watercourses and water levels in potential GDEs
- identify and characterise water bearing units in the study area, with focus on characterising groundwater flow and quality

- identify and characterise the different geological units in the study area, with a focus on characterising groundwater flow and quality
- establish baseline groundwater
- provide spatial representation and flux of pressure heads across the Project area to investigate potential vertical hydraulic gradients and connectivity between water bearing units
- investigate the potential for surface water–groundwater interaction.

The groundwater monitoring network includes both background (regional) monitoring locations and targeted monitoring locations along the alignment of the key Project infrastructure. The groundwater monitoring bore network was installed in a drilling campaign between September 2021 and July 2022.

Further information regarding the water monitoring network is provided in the Groundwater Impact Assessment (EMM, 2023). A summary of water monitoring locations is provided on Figure 5.1.



Source: EMM (2022); DFSI (2020, 2021); DPIE (2022); GA (2011)

0 1 2 km
GDA 1994 MGA Zone 56
N

KEY

- Study area
- Dam wall
- Reservoir
- Tunnels, portals, intakes, shafts

Focus area

- Escarpment
- Macleay River floodplain
- Plateau
- Western catchment

Existing environment

- Major road

Streams within study area

- 1st order (non-perennial)
- 2nd order (non-perennial)
- 3rd order (perennial)
- 3rd order (non-perennial)
- 4th order (perennial)
- 4th order (non-perennial)
- 9th order (perennial)

- Landholder bore
- Surface water sampling location

Groundwater monitoring network

- Borehole
- Fen monitoring bore
- Monitoring bore

Water monitoring locations

Oven Mountain Pumped Hydro Energy Storage Project
Groundwater dependent ecosystem assessment
OMPS Pty Ltd
Figure 5.1

\\emmsvr1\EMM3\2021\J210465 - OMPS EIS - Generation Component\GIS\02_Maps_EIS_GW_GIA\GIA007_WaterMonitoringLocations_20221111_02.mxd 20/03/2023

5.3 Ecological assessment

5.3.1 Aquatic ecology assessment

To aid in determining the ecological values of the Macleay River and associated waterways with the potential to be impacted by the Project, two field surveys were undertaken during March 2022 and June 2022. A total of 56 sites across 38 waterways were assessed upstream, within, and downstream of the Project (Table 5.1, Figure 5.2). Sampling sites were selected based on the potential degree of impact (e.g. reservoir, road, discharge point) and stream order (DFSI, 2023), with preference generally given to waterways 2nd order and above. The field surveys comprised undertaking sampling and assessment of a range of abiotic and biotic components, with biological sampling undertaken at waterways 4th order and above (Table 5.1, Figure 5.2), with the exception of:

- UW02-03 (2nd order) and UW02-04 (3rd order), which were located within the area proposed for the Lower Reservoir and will be directly impacted as a result of inundation. Both sites contained surface water during the March 2022 and June 2022 field surveys, due to preceding high rainfall events; therefore, they were included in biological monitoring.
- PC01 (4th order), an accessible reach of Peach Tree Creek which was located upstream of a waterfall which flows into the Macleay River. However, due to the significance of the waterfall as a fish passage barrier, the site was not included in biological sampling.

Habitat characterisation and key fish habitat was assessed at all 56 sites, while sampling of abiotic and biotic components was completed at a subset of 18 sites during the March 2022 and June 2022 field surveys. This was due to a number of factors including stream order classification, site accessibility, habitat characteristics and fish passage barriers.

Further information regarding the aquatic ecology assessment is provided in the Aquatic Ecology Impact Assessment (Stantec, 2023).

Table 5.1 Sampling site locations and components assessed during field surveys.

Project Area	Site	Latitude	Longitude	Potential Impact	Stream Order	Key Fish Habitat	Water Quality	Sediment Quality	eDNA	Aquatic Vertebrates	Macro-invertebrates
Macleay River	MR01	30.8091327	152.1418999	Reference site: no impact	9	June 2022	March 2022	March 2022	March 2022	June 2022	June 2022
	MR02	30.8000834	152.1530596	Pump station: water extraction	9	June 2022	-	-	-	June 2022	June 2022
	MR03	30.7870514	152.1644559	Downstream water extraction	9	June 2022	March 2022	March 2022	March 2022	June 2022	June 2022
	MR04	30.7790613	152.1757442	Water extraction	9	June 2022	March 2022	March 2022	March 2022	June 2022	June 2022
	MR05	30.7657944	152.1873576	Downstream water extraction/discharges	9	June 2022	March 2022	March 2022	March 2022	June 2022	June 2022
	MR06	30.7518159	152.1953029	Proposed bridge/road, downstream extraction/discharge	9	June 2022	-	-	March 2022	June 2022	June 2022
	MR07	30.7550662	152.2183669	Downstream of Project	9	June 2022	-	-	-	June 2022	-
	MR08	30.7315370	152.2693285	Proposed bridge/road, downstream of Project	9	June 2022	-	-	-	June 2022	June 2022
	MR09	30.7539758	152.2934717	Proposed bridge/road, downstream of Project	9	June 2022	-	-	-	June 2022	June 2022
Upper Reservoir	UW02-01	30.8089515	152.1837262	Within Upper Reservoir	2	March 2022	-	-	-	-	-
	UW02-02	30.8051412	152.1764285	Downstream of Upper Reservoir	2	March 2022	-	-	-	-	-
	UW06-01	30.8029227	152.1824165	Spoil storage	1	March 2022	-	-	-	-	-

Table 5.1 Sampling site locations and components assessed during field surveys.

Project Area	Site	Latitude	Longitude	Potential Impact	Stream Order	Key Fish Habitat	Water Quality	Sediment Quality	eDNA	Aquatic Vertebrates	Macro-invertebrates
Lower Reservoir and Access Road	PC01	30.8153752	152.1489948	Groundwater drawdown	4	June 2022	-	-	-	-	-
	UW01-01	30.8088373	152.1491195	Groundwater drawdown	2	June 2022	-	-	-	-	-
	UW02-03	30.7658803	152.1876897	Within Lower Reservoir	2	June 2022	March 2022	March 2022	March 2022	June 2022	June 2022
	UW02-04	30.8068975	152.1520653	Within Lower Reservoir	3	June 2022	March 2022	March 2022	March 2022	June 2022	-
	UW03-01	30.7945970	152.1591327	Excavation spoil storage	3	June 2022	-	-	-	-	-
	UW04-01	30.7923284	152.1611404	Construction pads	2	June 2022	-	-	-	-	-
	UW06-02	30.7951120	152.1692090	Road	2	June 2022	-	-	-	-	-
	UW06-03	30.7920800	152.1640280	Road, construction pads	2	June 2022	-	-	-	-	-
	UW07-01	30.7908860	152.1658550	Road, construction pads	2	June 2022	-	-	-	-	-
	UW08-01	30.7854510	152.1690040	Road crossing	2	June 2022	-	-	-	-	-
	UW09-01	30.7850390	152.1722890	Road crossing	2	June 2022	-	-	-	-	-
	UW10-01	30.7824580	152.1748210	Construction pad	2	June 2022	-	-	-	-	-
	UW11-01	30.7778040	152.1805610	Road crossing	3	June 2022	March 2022	March 2022	March 2022	June 2022	-
	UW12-01	30.7774888	152.1813488	Road crossing	3	June 2022	March 2022	March 2022	March 2022	June 2022	-
	UW13-01	30.7746721	152.1844309	Road crossing	3	June 2022	-	-	March 2022	-	-

Table 5.1 Sampling site locations and components assessed during field surveys.

Project Area	Site	Latitude	Longitude	Potential Impact	Stream Order	Key Fish Habitat	Water Quality	Sediment Quality	eDNA	Aquatic Vertebrates	Macro-invertebrates
	UW14-01	30.7698583	152.1881177	Road crossing	3	June 2022	-	-	March 2022	-	-
	UW15-01	30.7684301	152.1889016	Road crossing	3	June 2022	-	-	March 2022	-	-
	UW17-01	30.7661138	152.1902743	Road crossing	2	June 2022	-	-	-	-	-
	UW17-02	30.7649412	152.1917289	Road crossing	1	June 2022	-	-	-	-	-
	UW17-03	30.7619503	152.1923311	Road crossing	2	June 2022	-	-	-	-	-
	UW17-04	30.7583934	152.1935332	Road crossing	3	June 2022	-	-	-	-	-
	UW17-05	30.7563339	152.1920736	Road crossing	4	June 2022	-	-	March 2022	-	-
Eastern Access Road	CC01	30.7550909	152.2927429	Proposed bridge/road crossing	5	June 2022	-	-	-	June 2022	June 2022
	UW18-01	30.7546096	152.2001025	Road crossing/proposed transmission line	2	June 2022	-	-	-	-	-
	UW19-01	30.7540004	152.2046128	Road crossing/proposed transmission line	2	June 2022	-	-	-	-	-
	UW20_1-01	30.7558070	152.2093224	Road crossing/proposed transmission line	3	June 2022	-	-	-	-	-
	UW20-01	30.7570044	152.2168131	Road crossing/proposed transmission line	2	June 2022	-	-	-	-	-
	UW20-01	30.7558070	152.2093224	Road crossing/proposed transmission line	2	June 2022	-	-	-	-	-
	UW21-01	30.7573924	152.2196358	Road crossing/proposed transmission line	3	June 2022	-	-	-	-	-
	UW22-01	30.7582404	152.2252652	Road crossing/proposed transmission line	2	June 2022	-	-	-	-	-

Table 5.1 Sampling site locations and components assessed during field surveys.

Project Area	Site	Latitude	Longitude	Potential Impact	Stream Order	Key Fish Habitat	Water Quality	Sediment Quality	eDNA	Aquatic Vertebrates	Macro-invertebrates
	UW23-01	30.7592532	152.2286402	Road crossing/proposed transmission line	3	June 2022	-	-	-	-	-
	UW24-01	30.7596573	152.2328640	Road crossing/proposed transmission line	3	June 2022	-	-	-	-	-
	UW25-01	30.7558449	152.2376835	Road crossing/proposed transmission line	3	June 2022	-	-	-	-	-
	UW25-02	30.7565365	152.2381102	Road crossing/proposed transmission line	2	June 2022	-	-	-	-	-
	UW26-01	30.7545674	152.2402132	Road crossing/proposed transmission line	3	June 2022	-	-	-	-	-
	UW27-01	30.7535307	152.2417708	Road crossing/proposed transmission line	2	June 2022	-	-	-	-	-
	UW28-01	30.7520277	152.2440308	Road crossing/proposed transmission line	2	June 2022	-	-	-	-	-
	UW29-01	30.7465068	152.2515230	Road crossing/proposed transmission line	2	June 2022	-	-	-	-	-
	UW30-01	30.7379779	152.2624957	Road crossing/proposed transmission line	2	June 2022	-	-	-	-	-
	UW31-01	30.7488552	152.2698588	Road crossing/proposed transmission line	4	June 2022	-	-	-	-	-
	UW32-01	30.7524865	152.2728413	Road crossing/proposed transmission line	4	June 2022	-	-	-	-	-
	UW33-01	30.7532800	152.2743625	Road crossing/proposed transmission line	3	June 2022	-	-	-	-	-
	UW34-01	30.7528925	152.2755305	Road crossing/proposed transmission line	2	June 2022	-	-	-	-	-
	UW35-01	30.7515813	152.2788595	Road crossing/proposed transmission line	3	June 2022	-	-	-	-	-

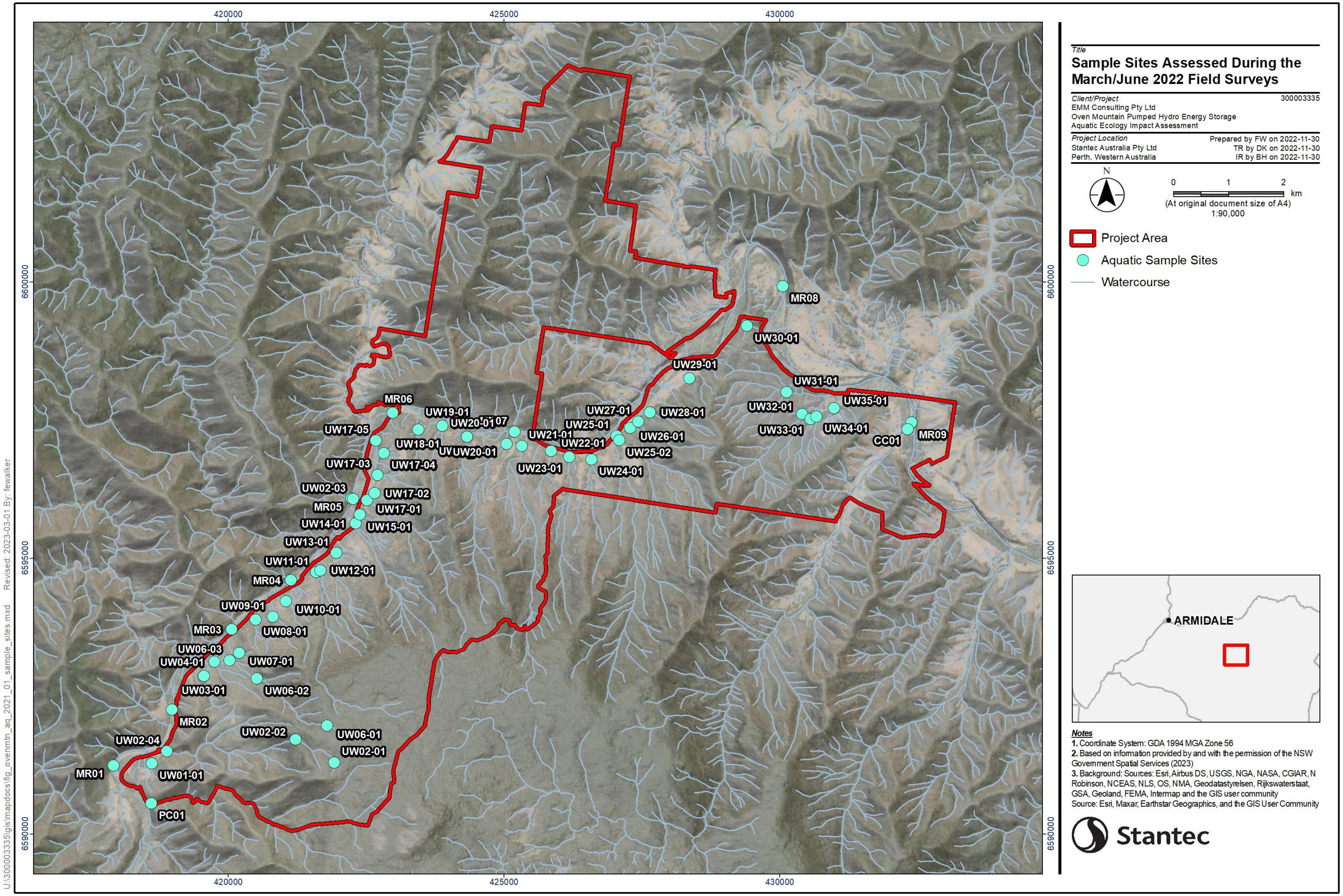


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Figure 5.2 Aquatic ecology - Location of sites assessed for groundwater dependence

5.3.2 Subterranean ecology assessment

A single pilot field survey was undertaken in March 2022 to assess stygofauna within groundwater of the Project area, as part of the assessment of GDEs. Four groundwater bores (Table 5.2,) were sampled within two geological formations; Carrai Granodiorite and Parrabel Beds (Table 5.2). Stygofauna were sampled using haul nets, which have been found to be the most efficient retrieval method (Allford, Cooper, Humphreys, & Austin, 2008). In the absence of any NSW sampling guidelines, sampling was undertaken in accordance with the Western Australian Technical guidance – Subterranean fauna surveys for environmental impact assessment (EPA, 2021).

Samples were collected using weighted haul nets fitted with a collection vial with a base mesh of 50 µm. The nets were lowered to near to the bottom of the bore hole and raised up and down to agitate the water column. The net was then slowly raised to the surface, the collection vial removed, the contents emptied into a polycarbonate vial, and preserved with 70% ethanol. This process was completed five times. All equipment was rinsed with Decon90 (2% to 5%) and rinsed with potable water after each sampling site. Samples were forwarded to Stantec for sorting and identification of specimens, based on available literature; however, no stygofauna specimens were present in the samples.

Table 5.2 Site locations of stygofauna samples collected.

Formation	Bore ID	Easting (GDA20)	Northing (GDA20)	Top Of Casing (m AHD)	Total Depth (m BGL)	Screened Lithology
Carrai Granodiorite	OM3	421793.20	6591463.00	846.10	50.30	Hornfels
	OM4	421936.00	6591542.30	899.70	49.67	Granite
Parrabel Beds	OM6	419231.90	6591557.20	213.00	50.00	Meta-sediment
	OM7	419232.80	6591427.10	209.20	50.10	Meta-sediment

5.3.3 Terrestrial ecology assessment

An assessment of the generation site was undertaken on 25 and 26 of February 2020 by NGH Pty Ltd (NGH). Survey methods included a site walkover supported by drone and helicopter surveys. Rapid vegetation assessments (RVAs) were collected, identifying the dominant plant species at each site. The site inspection focused on dominant canopy species and mid-storey when present; however, as the broader region had been subjected to impacts relating to bushfire of varying intensities, mid-storey and groundcover species were not readily identifiable.

Review of vegetation within the generation site was undertaken by EMM during the extensive surveys undertaken for the Project. Assessment of the access road and transmission line was undertaken between 8 and 10 March and 6 and 9 April 2022. Extrapolations were made based on the distribution of vegetation communities observed within accessible areas and from desktop assessment.

Further information regarding the terrestrial ecology assessment is provided in the Biodiversity Development Assessment Report (EMM, 2023b).

5.4 Groundwater and ecological assessment

To identify potential groundwater-dependency of a key PCT identified in the study area (PCT 1287, Upland heath swamps of the New England Tableland Bioregion), a preliminary assessment was undertaken by two EMM hydrogeologists and an EMM ecologist on 12 August 2021. This preliminary assessment included groundwater sampling, vegetation mapping and habitat assessments.

Where there is a reduction in depth to groundwater, or variability in climate, this may be reflected as a:

- substantial change in distribution and species composition for obligate GDE's (Serov, Kuginis, & Williams, 2012), or
- proportional change in ecosystem prevalence for facultative-opportunistic PCTs, but the ecosystem remains resilient in the absence of groundwater (Serov, Kuginis, & Williams, 2012).

Access to the groundwater is dependent on several factors with the core factor being the depth to the water table. As terrestrial vegetation communities are composed of a range of vegetation types, with a range of rooting depths and strategies, there is a relationship between groundwater depth and the types and composition of the vegetation that can access it (Serov, Kuginis, & Williams, 2012).

Considerations in evaluating surface ecosystems and their potential dependency on groundwater included:

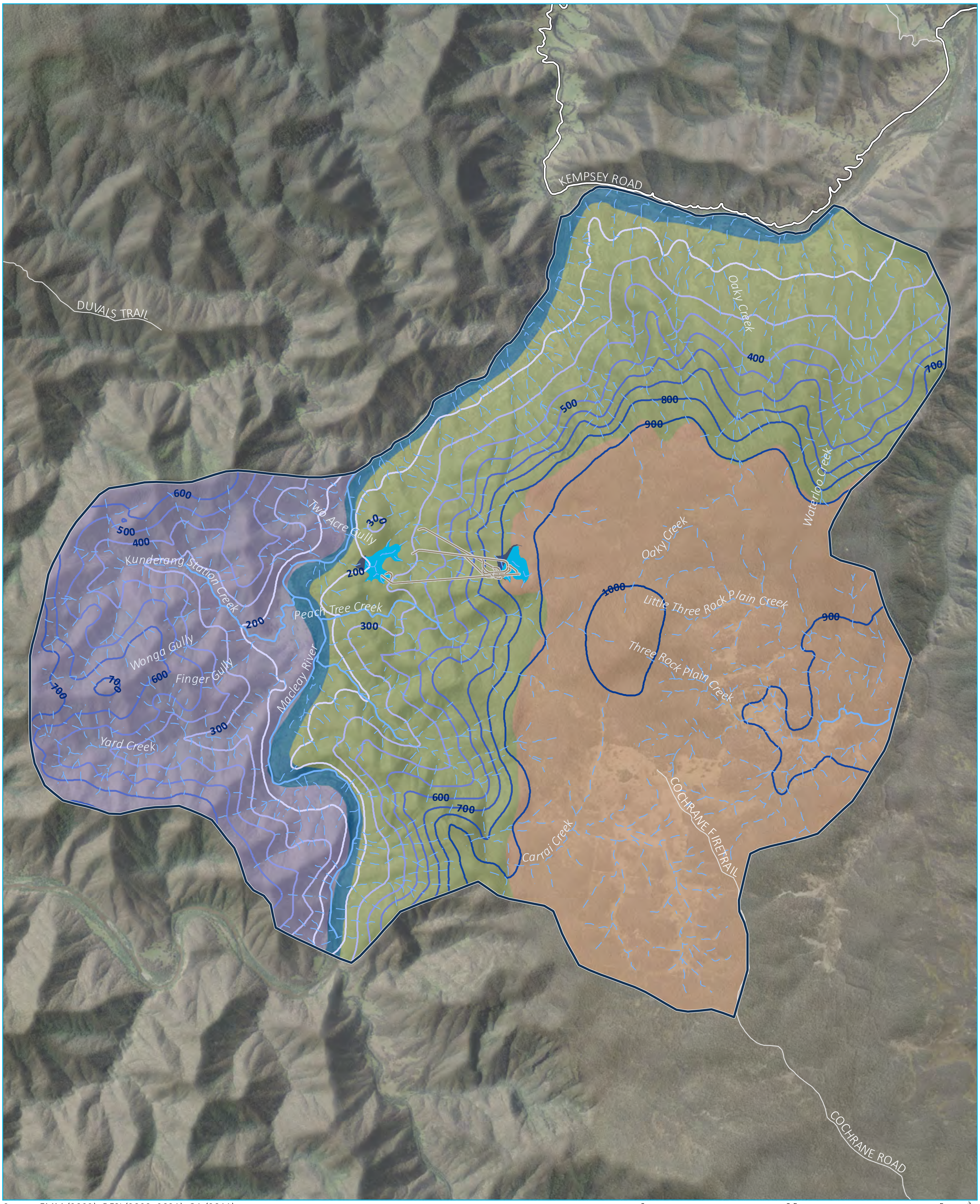
- association with groundwater levels across the region
- the physiology of plant species that occur in that community and their likely dependence on water availability
- a PCTs location in the landscape
- if the rooting depth of vegetation would be able to take up groundwater based on likely depth of the aquifer and soil characteristics.

To identify groundwater-dependent terrestrial ecosystems (phreatophytes), an analysis was undertaken documenting the association of the PCTs found within the Project area and the extent of the groundwater model domain with groundwater levels as modelled by the regional numerical groundwater model (EMM 2022b n.d.). Groundwater levels and groundwater depths across the Project area are shown in Figure 5.3 and Figure 5.4.

An intersection was undertaken in ArcGIS between PCTs mapped as a part of this assessment (wherever available) and within the regional mapping (DPE 2022, outside of mapped areas) against groundwater levels in the following categories:

- 0–0.5 mbgl
- 0.5–2 mbgl
- 2–5 mbgl
- 5–20 mbgl
- >20 mbgl.

The percentage of each PCT within these bands was determined, and the criteria listed in Table 5.3 was applied to provide an initial determination of the dependence of PCTs within the Project area on groundwater. Ecological knowledge of the PCTs, along with knowledge of the floristics of each PCT were applied to confirm the results of this initial analysis, with some PCTs amended based on this additional layer of assessment.



Source: EMM (2022); DFSI (2020, 2021); GA (2011)

0 2.5 5 km
GDA 1994 MGA Zone 56
N

KEY

Study area
Dam wall
Reservoir
Tunnels, portals, intakes, shafts

Focus area
Escarpment
Macleay River floodplain
Plateau
Western catchment

Existing environment
Major road
Minor road

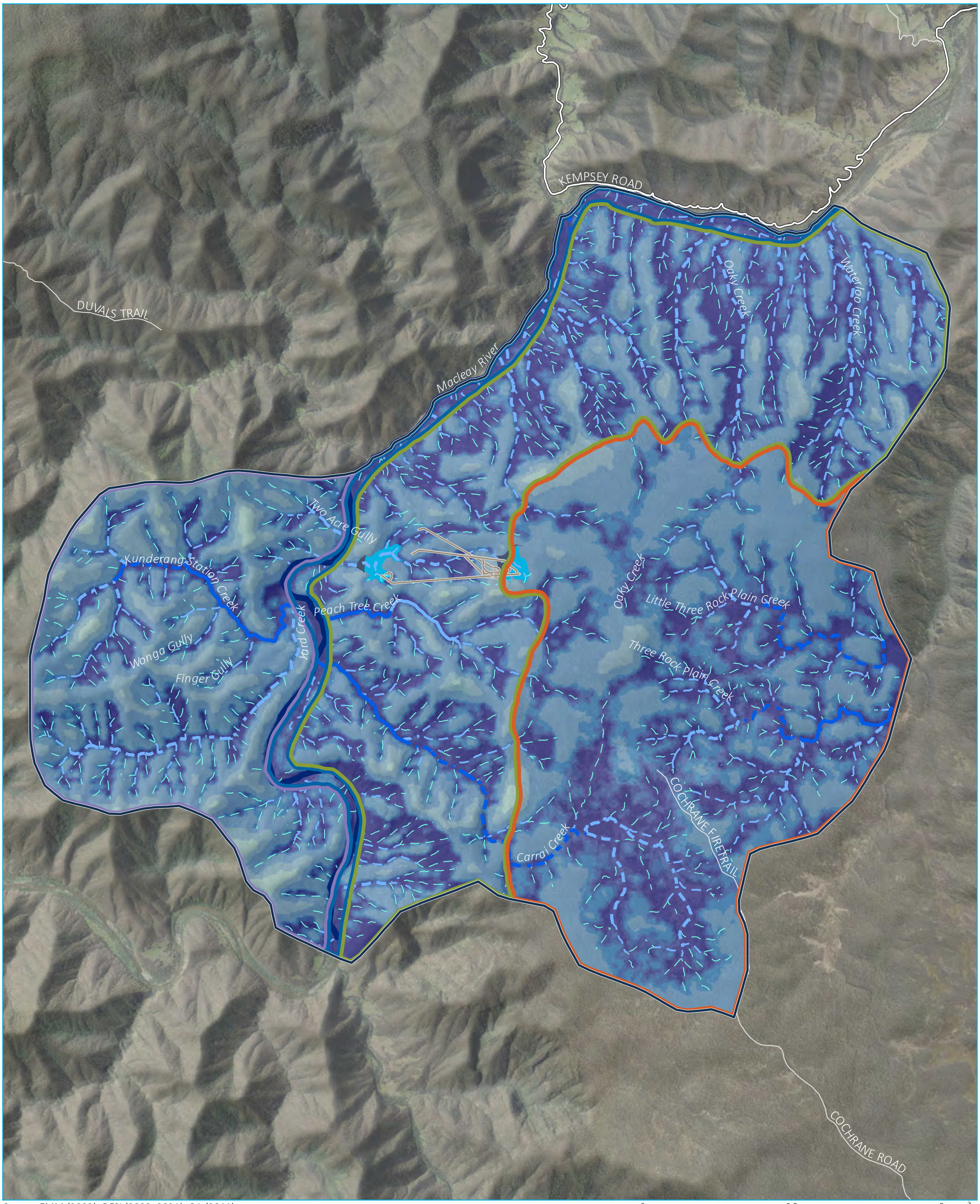
Streams within study area
Perennial
Non-perennial

Groundwater level contours (m AHD)
200
300
400
500
600
700
800
900
1000

Groundwater levels across the project area

Oven Mountain Pumped Hydro Energy Storage Project
Groundwater dependent ecosystem assessment
OMPS Pty Ltd
Figure 5.3

EMM
creating opportunities



Source: EMM (2022); DFSI (2020, 2021); GA (2011)

KEY

Study area
Dam wall
Reservoir
Tunnels, portals, intakes, shafts

Focus area
Escarpment
Macleay River floodplain
Plateau
Western catchment

Existing environment
Major road
Minor road

Streams within study area
1st order (non-perennial)
2nd order (non-perennial)
3rd order (perennial)
3rd order (non-perennial)
4th order (perennial)
4th order (non-perennial)
9th order (perennial)

Groundwater depth (m BGL)
> 100
50 - 100
10 - 50
5 - 10
2 - 5
0.3 - 2
< 0.3

Groundwater depth across the study area

Oven Mountain Pumped Hydro Energy Storage Project
Groundwater dependent ecosystem assessment
OMPS Pty Ltd
Figure 5.4

EMM creating opportunities

Table 5.3 Criteria used for determining surface groundwater dependence on PCTs

Dependence on groundwater	Criteria
Entirely/obligate	More than 50% of the PCT is mapped in areas with groundwater at 0.5 mbgl or less, or more than 75% of the PCT is mapped in areas with groundwater at 2 mbgl or less.
Facultative - high	More than 50% of the PCT is mapped in areas with groundwater at 2 mbgl or less, and more than 75% of the PCT is mapped in areas with groundwater at 5 mbgl or less.
Facultative - proportional	More than 75% of the PCT is mapped in areas with groundwater at 5 mbgl or less, but less than 50% of the PCT is mapped in areas with groundwater at 2 mbgl or less.
Facultative - opportunistic	More than 50% of the PCT is mapped in areas with groundwater at 5 mbgl or less, but less than 75% of the PCT is mapped in areas with groundwater at 5 mbgl and/or less than 50% of the PCT is mapped in areas with groundwater at 2 mbgl.
Non-dependent	Evenly distributed across groundwater levels, with generally less than 50% of the PCT mapped in areas with groundwater at 5 mbgl or less.

Groundwater dependent PCTs have been identified as being non-dependent, entirely/obligate or facultative/opportunistic type GDEs, intercepting shallow and/or regional groundwater systems. A summary is provided in Table 5.4.

Table 5.4 PCTs within the Project area, association with simulated groundwater levels and derived GW dependence

PCT ID	PCT Name	0–0.5 mbgl	0.5–2 mbgl	2–5 mbgl	5–20 mbgl	>20 mbgl	Total to 2 mbgl	Total to 5 mbgl	GW dependency
762	Cabbage Gum open forest or woodland on flats of the North Coast	1%	1%	22%	62%	13%	2%	25%	Facultative – opportunistic [1]
842	Forest Redgum – Broad-leaved Apple dry open forest of the gorges of NSW North Coast Bioregion	0%	1%	28%	16%	56%	1%	28%	Non-dependent
868	Grey gum – stringybark open forest of the gorges of the NSW North Coast Bioregion and New England Tableland Bioregion	0%	0%	7%	9%	84%	0%	8%	Non-dependent
983	New England Blackbutt – stringybark grassy forest the eastern New England Tableland Bioregion and NSW North Coast Bioregion	1%	2%	39%	12%	46%	3%	42%	Non-dependent
1106	River Oak riparian woodland of the NSW North Coast Bioregion and northern Sydney Basin Bioregion	4%	14%	63%	15%	4%	18%	81%	Facultative – opportunistic [1]
1287	Upland heath swamps of the New England Tableland Bioregion	6%	43%	51%	0%	0%	49%	100%	Entirely / obligate[1]
3019	Northern Hinterland Baloghia-Booyong Subtropical Rainforest	0%	0%	0%	0%	100%	0%	0%	Non-dependent
3031	Northern Escarpment Coachwood-Beech Rainforest	13%	22%	47%	10%	9%	35%	82%	Non-dependent[2]

Table 5.4 PCTs within the Project area, association with simulated groundwater levels and derived GW dependence

PCT ID	PCT Name	0–0.5 mbgl	0.5–2 mbgl	2–5 mbgl	5–20 mbgl	>20 mbgl	Total to 2 mbgl	Total to 5 mbgl	GW dependency
3033	Northern Escarpment Sassafras-Prickly Ash Rainforest	8%	16%	43%	13%	20%	24%	67%	Non-dependent[2]
3099	Northern Escarpment Shatterwood Dry Rainforest	3%	3%	18%	10%	67%	6%	24%	Non-dependent
3101	Northern Hinterland Shatterwood Dry Rainforest	1%	2%	6%	11%	79%	4%	10%	Non-dependent
3166	Northern Escarpment Brush Box-Tallowwood-Maple Wet Forest	0%	3%	53%	13%	31%	3%	56%	Non-dependent[2]
3203	Northern Escarpment New England Blackbutt Wet Forest	0%	0%	0%	0%	100%	0%	0%	Non-dependent
3205	Northern Escarpment New England Blackbutt-Tallowwood Wet Forest	0%	3%	42%	12%	43%	3%	45%	Non-dependent
3206	Northern Escarpment Corkwood-Brush Box Wet Forest	1%	6%	71%	5%	17%	8%	78%	Non-dependent[2]
3207	Northern Escarpment Layered Blackbutt Fern Forest	0%	2%	70%	17%	11%	2%	72%	Non-dependent[2]
3240	Lower North Escarpment Red Gum Grassy Forest	0%	0%	0%	0%	100%	0%	0%	Non-dependent
3251	Northern Gorges Diverse Grassy Forest	0%	4%	41%	9%	46%	4%	45%	Non-dependent
3254	Northern Hinterland Tallowwood-Forest Oak Grassy Forest	3%	1%	13%	8%	76%	4%	17%	Non-dependent
3277	Carrai Moist Grassy Forest	0%	2%	45%	9%	43%	2%	48%	Non-dependent
3286	Northern Escarpment Blackbutt Cool Moist Forest	0%	2%	13%	16%	70%	2%	15%	Non-dependent
3329	Northern Hinterland Valleys Red Gum Grassy Forest	0%	3%	31%	34%	31%	4%	35%	Non-dependent
3416	Southern Tableland Valley Flats Damp Grassland	4%	21%	73%	2%	0%	25%	98%	Facultative – opportunistic[1]
3427	Northern Hinterland Hills Bloodwood-Red Gum Grassy Forest	1%	1%	12%	11%	75%	2%	14%	Non-dependent
3461	Macleay Gorges Stringybark-Red Gum Grassy Forest	0%	0%	2%	6%	92%	0%	3%	Non-dependent
3462	Northern Gorges Blakes Wattle Rock Scrub	0%	0%	0%	0%	100%	0%	0%	Non-dependent
3464	Northern Gorges Grey Gum-Tallowwood Grassy Forest	0%	0%	0%	0%	100%	0%	0%	Non-dependent

Table 5.4 PCTs within the Project area, association with simulated groundwater levels and derived GW dependence

PCT ID	PCT Name	0–0.5 mbgl	0.5–2 mbgl	2–5 mbgl	5–20 mbgl	>20 mbgl	Total to 2 mbgl	Total to 5 mbgl	GW dependency
3501	Eastern New England Ranges Blackbutt Forest	89%	11%	0%	0%	0%	100%	100%	Facultative – opportunistic[1]
3819	Bellinger Escarpment Rockplate Mallee Heath	0%	0%	0%	0%	100%	0%	0%	Non-dependent
3822	Carrai Slopes Rocky Scrub	0%	0%	0%	0%	100%	0%	0%	Non-dependent
3825	Mid North Escarpment Rock Outcrop Scrub	0%	0%	4%	7%	89%	0%	4%	Non-dependent
3934	Eastern New England Granite Wet Heath	2%	37%	55%	5%	1%	39%	94%	Entirely/ obligate[1]
3937	Northern Escarpment Granitoid Wet Heath	6%	13%	81%	0%	0%	19%	100%	Entirely/ obligate[1]
3944	New England Tableland Carex Fens	15%	43%	41%	0%	0%	59%	100%	Entirely/ obligate[1]
3947	Northern Escarpment Montane Swamp Forest	2%	31%	67%	0%	0%	33%	100%	Facultative – high
4078	Northern Gorges River Oak Forest	6%	11%	68%	14%	1%	17%	85%	Facultative – opportunistic[1]
4079	Northern Hinterland Grassy River Oak Forest	13%	22%	55%	9%	1%	35%	90%	Facultative – opportunistic[1]
4111	Lower North Grey Myrtle Riparian Dry Rainforest	59%	20%	18%	3%	0%	79%	97%	Non-dependent[2]

Notes: 1. Groundwater dependency was increased based on landscape position and floristic composition described in the Vegetation Information System of BioNet and/or the known occurrence of the community within the Project area.

2. Groundwater dependence was reduced based on the relationship with groundwater being coincidental and derived by landscape position rather than being truly groundwater dependent.

The Groundwater Dependent Ecosystems Atlas (BoM, 2017) uses the new classification of PCTs for the eastern NSW that became live in early 2023 (DPE, 2022). PCT ID series for the new classification are numbered as 3000' and 4000'. PCTs mapped within the Project area using the current PCT ID at the time of assessment have been either split or recategorized into the new classification. In most cases these splits or recategorizations don't completely align with the new classification, with the PCTs having low, moderate or high relationship with each other. Therefore, the old PCTs may not have the same values as the new classification PCTs. The PCTs mapped within the Project area and their new classification equitant are as follows:

- PCT 765 has become PCT 3954 or PCT 3416
- PCT 822 has become PCT 3277
- PCT 842 has become PCT 3463
- PCT 868 has become PCT 3254
- PCT 1106 is split into PCT 4078 and PCT 4079
- PCT 1287 has become PCT 3934.

6 Results from baseline monitoring

6.1 Aquatic GDEs

The Macleay River and Floodplain Wetlands identified in Section 3.6.2 are considered to be predominantly supported by the Macleay River flow regimes and non-dependent on groundwater. Further discussion is provided in the Aquatic Ecology Impact Assessment (Stantec, 2023).

6.2 Subterranean GDEs

Noting that stygofauna were not detected during ecological field surveys (refer to Project Groundwater Dependent Ecosystem assessment (EMM, 2023)), existing stygofauna are assumed likely to exist within some parts of the groundwater system and are assumedly similar to those encountered in other fractured rock systems in NSW. Stygofauna are likely to be more common in bogs, hyporheic zones and shallow fractured rock groundwater systems due to the greater availability of dissolved oxygen and nutrients, further discussion is provided in the Aquatic Ecology Impact Assessment (Stantec, 2023).

6.3 Terrestrial GDEs

Four PCTs were identified as having an entirely/obligate dependence on groundwater, comprising:

- PCT 1287 – Upland heath swamps of the New England Tableland Bioregion
- PCT 3934 – Eastern New England Granite Wet Heath
- PCT 3937 – Northern Escarpment Granitoid Wet Heath
- PCT 3944 – New England Tableland Carex Fens.

These PCTs showed a moderate relationship with shallow groundwater (<2 mbgl); however, review of the PCT descriptions, location of PCT 1287 within the Project area and floristic composition showing a number of mesic and hydric species which are not found outside of these shallow groundwater systems indicates a strong reliance on shallow groundwater. It is likely that these PCTs occur as GDEs that are perched as well as fed by regional groundwater systems.

One PCT was identified as having a facultative – high dependence on groundwater:

- PCT 3947 – Northern Escarpment Montane Swamp Forest.

This PCT generally occurred in areas with a groundwater depth of 2–5 mbgl and proximal to ephemeral watercourses. It is likely that these PCTs are supported as GDEs via surface water and perched groundwater systems retaining available water for a period following streamflow.

Six PCTs were identified as having a facultative – opportunistic dependence on groundwater:

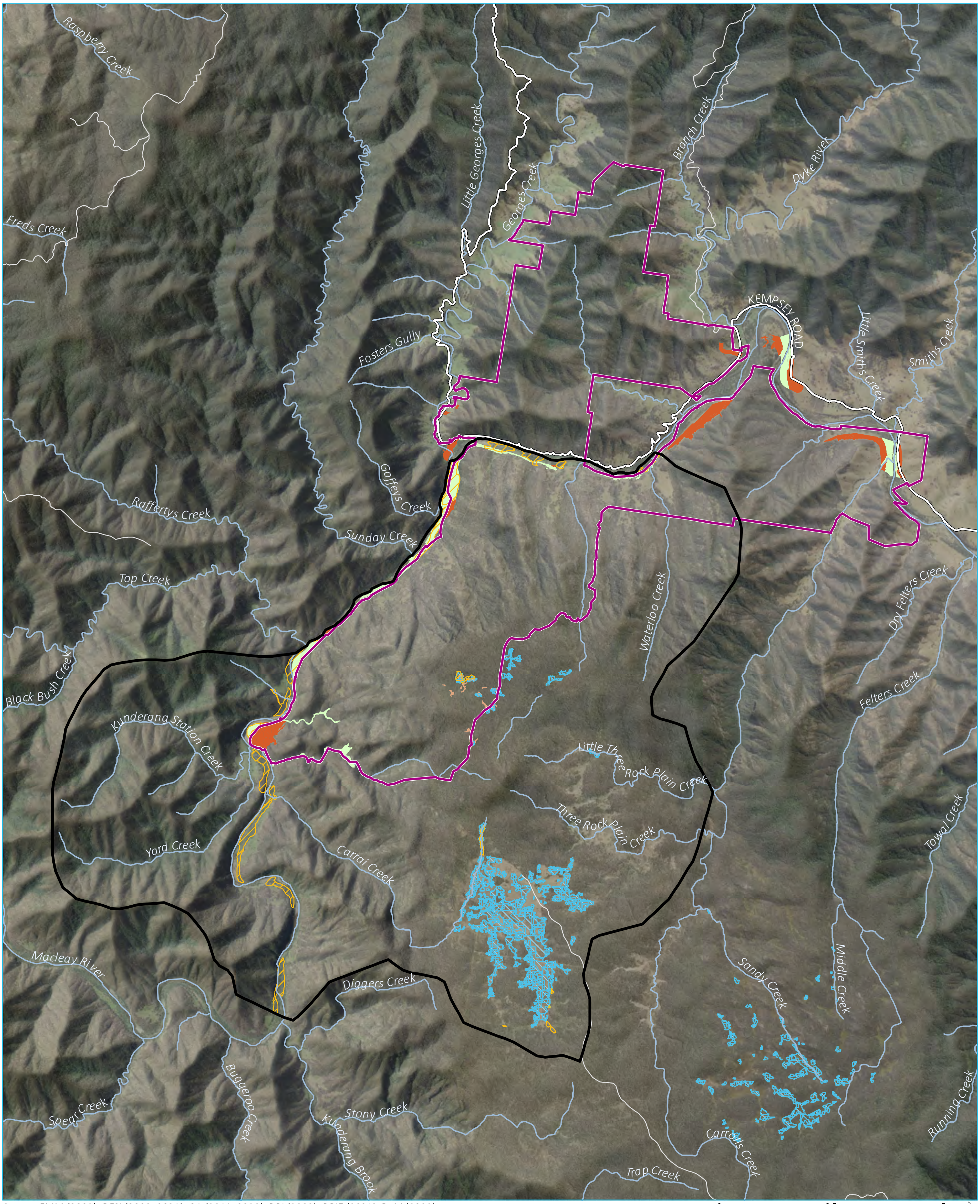
- PCT 762 – Cabbage Gum open forest or woodland on flats of the North Coast
- PCT 1106 – River Oak riparian woodland of the NSW North Coast Bioregion and northern Sydney Basin Bioregion
- PCT 3416 – Southern Tableland Valley Flats Damp Grassland
- PCT 3501 – Eastern New England Ranges Blackbutt Forest

- PCT 4078 – Northern Gorges River Oak Forest
- PCT 4079 – Northern Hinterland Grassy River Oak Forest.

These six PCTs generally occur in riparian zones and gullies where there is likely to be some near-surface expression of groundwater. The floristic composition of these communities supports a number of mesic species, as well as tree species that are likely to be accessing groundwater in unconsolidated alluvial and colluvial systems (when available as short-term bank storage, as further discussed in the Groundwater Impact Assessment (EMM, 2023)).

The remaining communities were considered non-dependent on groundwater.

Terrestrial GDEs are provided on Figure 6.1.



\\emmsvr1\EMM3\2021\J210465 - OMPS EIS - Generation Component\GIS\02_Maps_EIS_GW_Modelling\GW009_GDE_20221028_01.mxd 29/03/2023

Source: EMM (2022); DFSI (2020, 2021); GA (2011, 2020); DPI (2003); DPIE (2021); BoM (2022)

0 2.5 5 km

GDA 1994 MGA Zone 56

N

KEY

Project area

Model domain

Existing environment

Major road

Minor road

Named watercourse

Groundwater dependent ecosystems

High potential GDE - from regional studies

High ecological value aquatic ecosystem - GDE

GDEs - PCT mapping

1106

1287

762

Terrestrial ecology – Groundwater dependent ecosystems within the study area

Oven Mountain Pumped Hydro Energy Storage Project

Groundwater dependent ecosystem assessment

OMPS Pty Ltd

Figure 6.1

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7 Impact Assessment

7.1 Potential impacts on terrestrial GDE's

In accordance with the minimal impact criteria presented in the AIP (DPI, 2012), water table drawdown has been assessed within 40 m of the identified terrestrial GDEs. In summary:

- No obligate GDEs are predicted to be impacted within the study area during construction or operation.
- No facultative – high GDEs are predicted to be impacted within the study area during construction or operation.
- Water table drawdown is predicted during construction within 40 m of facultative/opportunistic GDEs, including:
  - 5–20 m of water table drawdown predicted within 40 m of facultative/opportunistic GDEs within the low-lying topography near Fingerboard Crossing Creek, comprising:
    - PCT 762 – Cabbage Gum open forest or woodland on flats of the North Coast.
    - PCT 1106 – River Oak riparian woodland of the NSW North Coast Bioregion and northern Sydney Basin Bioregion.
  - 0.5–2 m of water table drawdown predicted within 40 m of facultative/opportunistic GDEs within Peach Tree Creek, comprising:
    - PCT 1106 – River Oak riparian woodland of the NSW North Coast Bioregion and northern Sydney Basin Bioregion.
  - 2–5 m of water table drawdown predicted within 40 m of facultative/opportunistic GDEs between the lower reservoir and Macleay River, comprising:
    - PCT 762 – Cabbage Gum open forest or woodland on flats of the North Coast.
    - PCT 1106 – River Oak riparian woodland of the NSW North Coast Bioregion and northern Sydney Basin Bioregion.
- No water table drawdown is predicted during operation within 40 m of facultative/opportunistic GDEs.

Terrestrial GDEs with a facultative and opportunistic dependence on groundwater predominantly depend on rainfall infiltration and adjacent surface watercourses to meet their water requirements, accessing groundwater opportunistically and seasonally when the water table is sufficiently close to the rooting depth of the particular PCT. Given the flow in the respective adjacent watercourse is likely to be sustained by rainfall runoff and releases from the upper reservoir during construction and operation, facultative/opportunistic GDEs are at low risk of potential impacts. It is again noted that the drawdown predictions should be viewed as worst case based on conservative hydraulic conductivity values in the model and unmitigated tunnel and underground power station construction methods.

Extents of GDEs and water table drawdown are provided in Figure 7.1 and Figure 7.2, representing potential impacts during construction and operation respectively.

Table 7.1 Terrestrial GDEs and the area (ha) of each GDE subject to drawdown during construction

PCT ID	PCT Name	GW dependency	<0.5 m	0.5–2 m	2–5 m	5–20 m	>20 m	PCT area (ha)
1287	Upland heath swamps of the New England Tableland Bioregion	Entirely/obligate	0	0	0	0	0	15.88
3934	Eastern New England Granite Wet Heath	Entirely/obligate	0	0	0	0	0	216.26
3937	Northern Escarpment Granitoid Wet Heath	Entirely/obligate	0	0	0	0	0	26.61
3944	New England Tableland Carex Fens	Entirely/obligate	0	0	0	0	0	170.15
3947	Northern Escarpment Montane Swamp Forest	Facultative – high	0	0	0	0	0	4.90
762	Cabbage Gum open forest or woodland on flats of the North Coast	Facultative – opportunistic	25.95	8.75	0.12	0	0	34.82
1106	River Oak riparian woodland of the NSW North Coast Bioregion and northern Sydney Basin Bioregion	Facultative – opportunistic	107.94	3.89	0.72	4.06	1.02	117.62
3416	Southern Tableland Valley Flats Damp Grassland	Facultative – opportunistic	0	0	0	0	0	7.32
3501	Eastern New England Ranges Blackbutt Forest	Facultative – opportunistic	0	0	0	0	0	0.32
4078	Northern Gorges River Oak Forest	Facultative – opportunistic	0	0	0	0	0	122.21
4079	Northern Hinterland Grassy River Oak Forest	Facultative – opportunistic	0	0	0	0	0	51.01

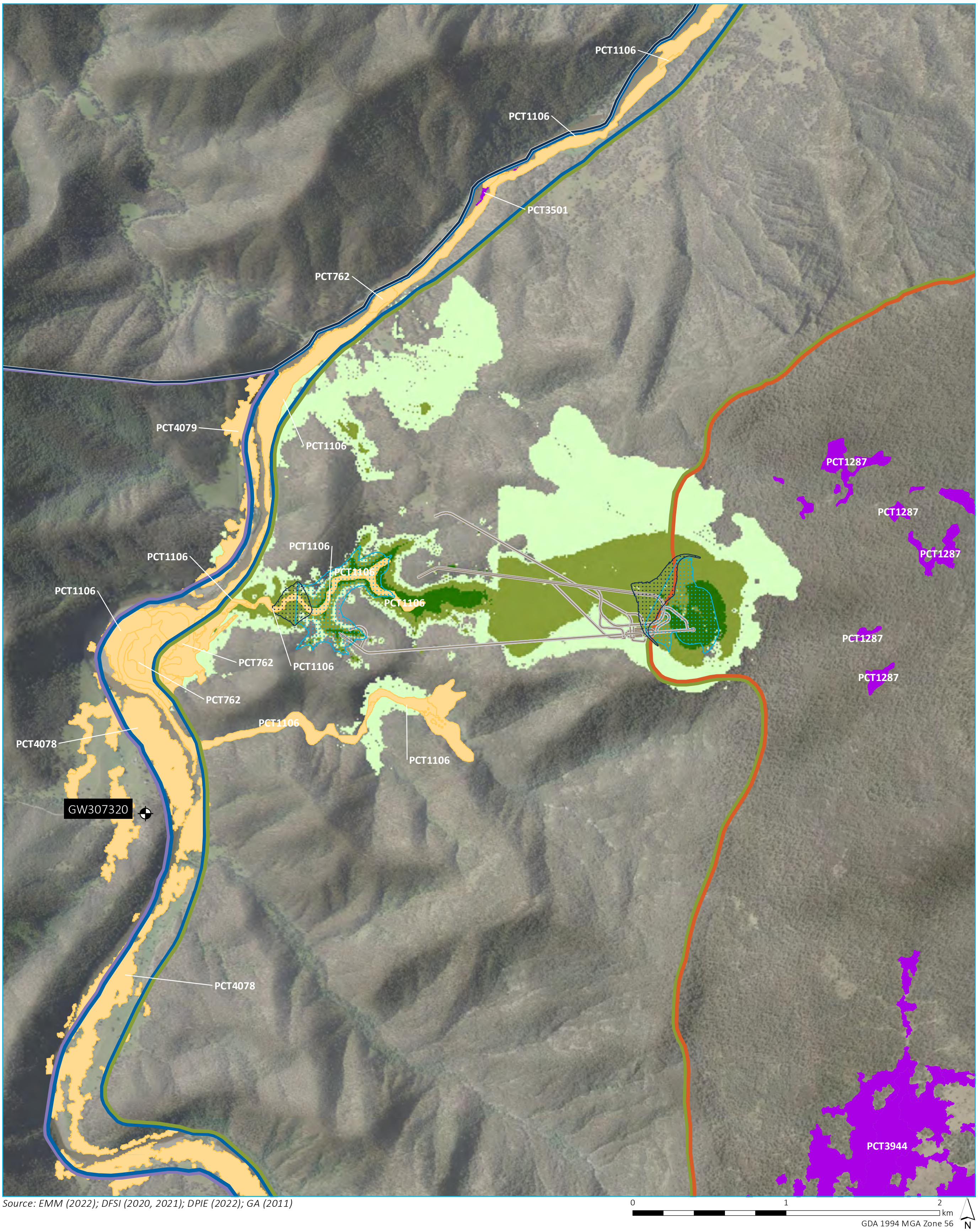
7.2 Potential impacts on aquatic GDE's

As discussed in Section 6.1, aquatic ecosystems have been assessed as non-dependent on groundwater and are assessed as low risk for Project induced impacts.

7.3 Potential impacts on subterranean ecosystems

The predicted drawdown will reduce the extent of habitat available to stygofauna. Drawdown of less than 20 m is considered unlikely to affect many stygofauna species given the ability of these species to relocate within the saturated zone as groundwater level declines; e.g. drawdown of 5 m would be unlikely to have any significant effect.

Stygofauna communities are considered to be at high risk (Serov, Kuginis, & Williams, 2012). However, only a small area (approximately 270 ha) of habitat is predicted to be affected by drawdown, and species of stygofauna have not been identified during site investigations (refer Section 6.2). Therefore, it is anticipated that impacts to stygofauna communities will be low. It is again noted that the drawdown predictions are worst case based on conservative hydraulic conductivity values in the model and un unmitigated tunnel construction methods.



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Source: EMM (2022); DFSI (2020, 2021); DPIE (2022); GA (2011)

KEY

- Study area
- Dam wall
- Reservoir
- Tunnels, portals, intakes, shafts

Focus area

- Escarpment
- Macleay River floodplain
- Plateau
- Western catchment

- Landholder bore

GDEs within study area

- Facultative – opportunistic
- Obligate

Construction probabalistic drawdown (m)

- < 0.2
- 0.2 - 2
- 2 - 10
- > 10

Groundwater drawdown during construction of the Project

Oven Mountain Pumped Hydro Energy Storage Project
Groundwater impact assessment
OMPS Pty Ltd
Figure 7.1

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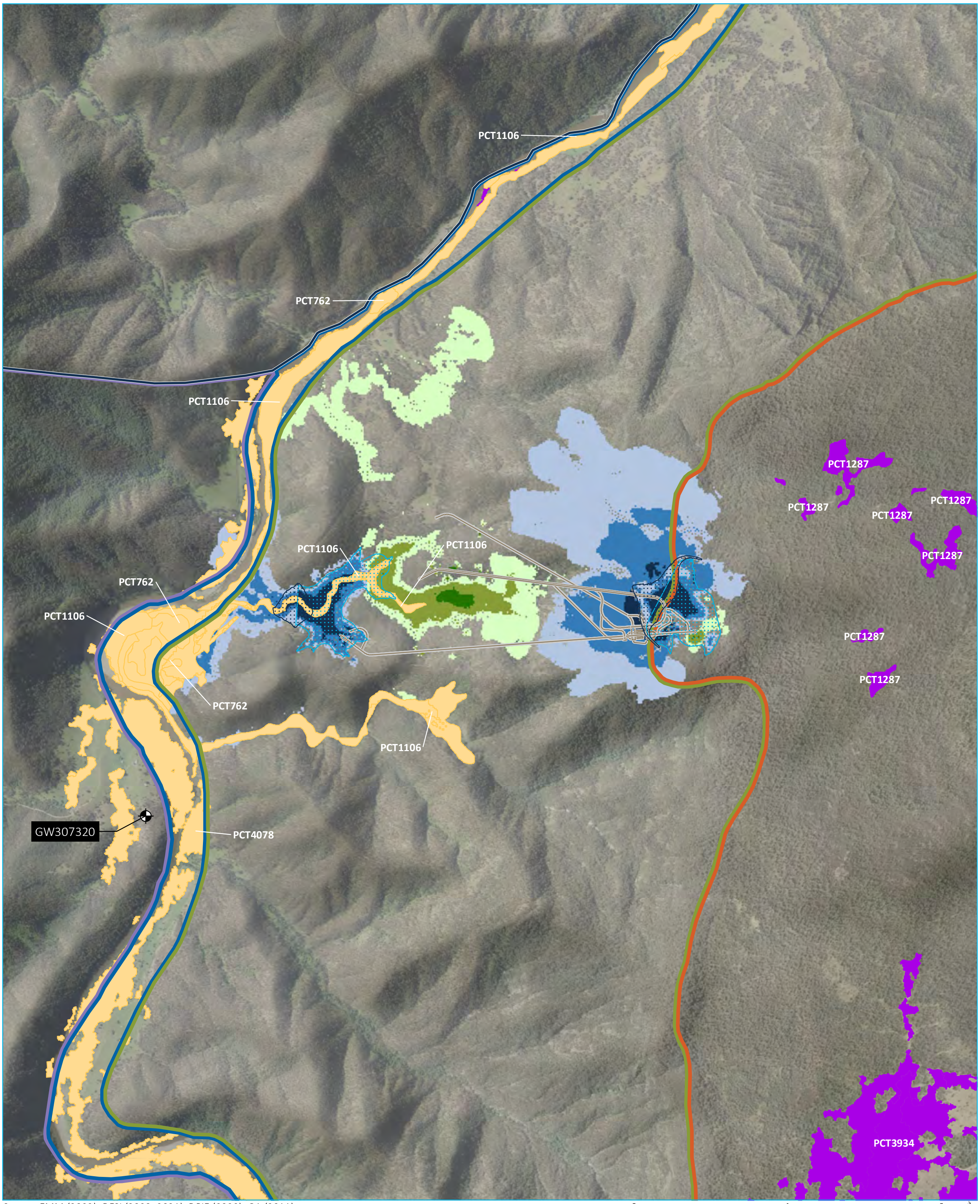

Source: EMM (2022); DFSI (2020, 2021); DPIE (2022); GA (2011)

0 1 2 km
GDA 1994 MGA Zone 56
N

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KEY

- Study area
- Dam wall
- Reservoir
- Tunnels, portals, intakes, shafts

Focus area

- Escarpment
- Macleay River floodplain
- Plateau
- Western catchment

- Landholder bore

GDEs within study area

- Facultative – opportunistic
- Obligate

Operation water table mounding (m)

- > 10
- 2 - 10
- 0.2 - 2
- < 0.2

Operation probabalistic drawdown (m)

- < 0.2
- 0.2 - 2
- 2 - 10
- > 10

Groundwater drawdown and mounding during operation of the Project

Oven Mountain Pumped Hydro Energy Storage Project
Groundwater dependent ecosystem
OMPS Pty Ltd
Figure 7.2

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8 Conclusion

This GDE assessment forms part of the EIS for the Project. It has been informed by the 15% feasibility design (SMEC, 2022) for the Project. The following aspects of the Project have been addressed in this report:

- Assessment of GDE's against the assessment requirements for Level 1 and Level 2 impacts of the AIP within the study area, including:
  - terrestrial GDEs
  - subterranean GDEs
  - aquatic GDEs.

Numerical groundwater modelling predicted groundwater drawdown within the study area during construction and operation of the Project. As discussed in the Groundwater Impact Assessment (EMM, 2023), the groundwater drawdown predictions provided by the numerical groundwater modelling are conservative for two reasons:

- Modelling does not consider actual design, management or mitigating activities (i.e. pre/post-grouting, concrete lining and steel lining). During construction the discrete fractures that yield excess water will be grouted during construction, reducing the actual overall tunnel inflow volume.
- Hydraulic parameters within the numerical model for the Carrai Granodiorite and Parrabel Beds are conservative and assume fracturing throughout the entire matrix however, in reality the entire unit may not behave like this, with some parts expected to be less permeable.

Therefore, the model predictions of water table drawdown are considered conservative and likely to be over estimating Project impacts.

Watertable drawdown is predicted during construction and operation of the Project, with drawdown propagating approximately 1.7 km and 1.4 km north of the Project respectively. There is no impact predicted to the Carrai Waterholes or obligate GDEs identified across the plateau and additionally there are no identified high priority GDEs within the study area. Water table drawdown is predicted at plant communities with a facultative/opportunistic dependence on groundwater however, this has been assessed as low risk due to the communities' reliance on surface water for sustainment.

The predicted drawdown will reduce the extent of habitat available to stygofauna. Drawdown of less than 20 m is considered unlikely to affect many stygofauna species given the ability of these species to relocate within the saturated zone as groundwater level declines; e.g. drawdown of 5 m would be unlikely to have any significant effect.

Only a small area (approximately 270 ha) of potential subterranean habitat is predicted to be affected by drawdown, and species of stygofauna have not been identified during site investigations (refer Section 6.2). It is anticipated that impacts to stygofauna communities will be low.

Management controls have been proposed to mitigate environmental impacts to water resources and GDEs. An overarching and adaptive WMP will be prepared for the Project in consultation with NSW government agencies.

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