



Appendix J

Groundwater Dependent Ecosystem Assessment

Mount Pleasant Operation Modification 8 – Groundwater Dependent Ecosystem Assessment

1. Introduction

1.1. Background

The Mount Pleasant Operation is an open cut coal mine and associated rail spur and product coal loading infrastructure, located approximately 3 kilometres north-west of Muswellbrook in the Upper Hunter Valley of New South Wales (Figures 1 and 2).

The Mount Pleasant Operation Development Consent DA 92/97 was granted on 22 December 1999. The Mount Pleasant Operation was also approved under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in 2012 (EPBC 2011/5795).

MACH Energy Australia Pty Ltd (MACH Energy) acquired the Mount Pleasant Operation from Coal and Allied Operations Pty Ltd on 4 August 2016. MACH Energy commenced construction activities at the Mount Pleasant Operation in November 2016 and commenced mining operations in October 2017, in accordance with Development Consent DA 92/97 and EPBC 2011/5795.

MACH Mount Pleasant Operations Pty Ltd manages the Mount Pleasant Operation as agent for and on behalf of the unincorporated Mount Pleasant Joint Venture between MACH Energy (95% owner) and J.C.D. Australia Pty Ltd (5% owner)¹.

Under Development Consent 92/97, the Mount Pleasant Operation is approved to produce up to 10.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. Thermal coal products from the Mount Pleasant Operation are transported by rail to the Port of Newcastle for export, or to domestic customers for use in electricity generation.

MACH is proposing an extension of life to the existing mining operations approved under Development Consent DA 92/97 to create greater certainty for the Mount Pleasant Operation and an increase in extraction rate due to operational efficiencies identified (the Modification).

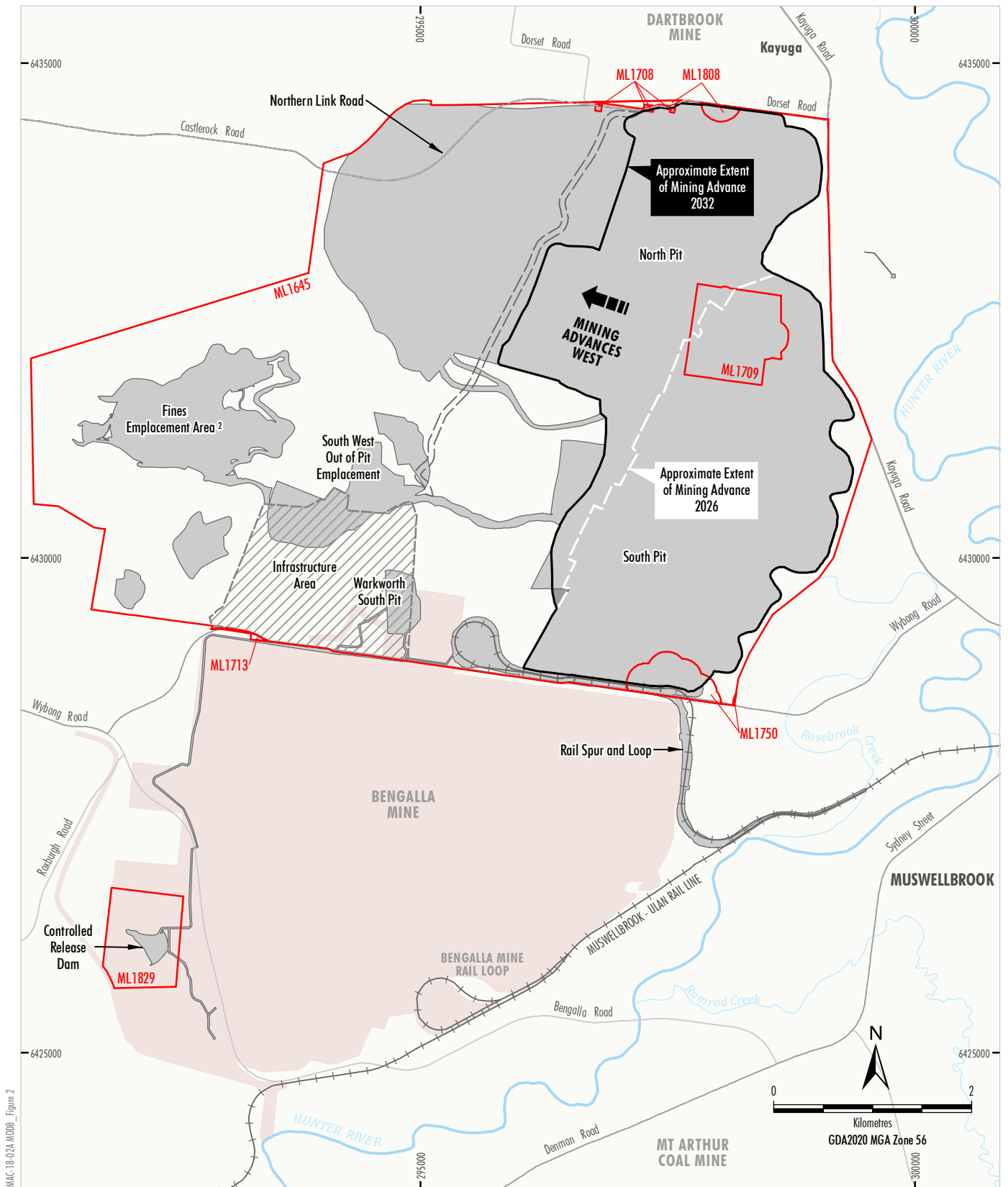
This report provides an assessment of groundwater dependent ecosystems (GDEs) for the Modification.

1.2. Overview of the Modification

The Modification would include the following key changes to the Mount Pleasant Operation approved under Development Consent DA 92/97:

- a six year extension of permitted (ROM coal) mining operations to 31 December 2032; and
- an increase in the approved ROM coal extraction rate from 10.5 Mtpa to 12.5 Mtpa.

¹ MACH Mount Pleasant Operations Pty Ltd and the unincorporated Mount Pleasant Joint Venture are herein referred to as MACH.



LEGEND

- Mining Lease Boundary (Mount Pleasant Operation)
- Approved Surface Disturbance Plan - DA 92/97 ¹
- Services Corridor Being Developed Under SSD-10418 to be Used Under the Modification
- Extension of Open Cut Mining and Emplacement Area (Land Lawfully Disturbed under SSD-10418)
- Revised Infrastructure Area Envelope
- Bengalla Mine Approved Disturbance Boundary (SSD-5170)

¹ Excludes some incidental Project components such as water management infrastructure, access tracks, topsoil stockpiles, power supply, temporary offices, other ancillary works and construction disturbance.

² The general arrangement of the Fines Emplacement Area has been amended from the area shown in DA 92/97 to reflect as-built structures.

Source: MACH (2025); NSW Spatial Services (2025); Department of Planning and Environment (2016)

MACHEnergy
MOUNT PLEASANT OPERATION
Overview of the Modification

Figure 2



The Modification would involve no material changes to existing:

- mining tenements;
- mining methods;
- primary site access;
- electricity supply and distribution;
- Mine Infrastructure Area;
- Coal Handling and Preparation Plant, coal stockpile and rail loading facilities;
- rehabilitation objectives and methods; and
- the existing hours of operation and key on-site activities.

2. Native Vegetation

The land across the Mount Pleasant Operation area has been used for grazing of cattle and sheep for over 100 years, and as a result, the Pleasant Operation area is a mosaic of majority cleared grassland with patches of woodland.

Seven Plant Community Types have been mapped across a study area encompassing the majority of the Mount Pleasant Operation by Hunter Eco (2024). Several of these communities were present in both remnant vegetation form and derived native grassland form.

Mapped Plant Community Types are shown on Figure 3.

3. Groundwater Dependent Ecosystems

GDEs are ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis (Richardson *et al.* 2011).

There are two types of terrestrial GDEs: those that are dependent in whole or in part on water reserves held in the ground; and those dependent on the surface expression of groundwater. Water reserves held in the ground form the saturated part of the aquifer soil matrix that sits below the 'water table' or 'phreatic surface', and are differentiated from water bound in the soil matrix in the unsaturated zone above the water table.

Water in the soil aquifers originates from all or any of: rainfall directly on the aquifer surface; runoff from areas immediately adjacent to the aquifer; or sub-surface inflow. The quantity of rainfall that stays in the unsaturated zone and the quantity that makes it into the water reserves is a function of unsaturated zone soil moisture dynamics.

The structure of these water reserves or aquifers is significant for plant use of the available water. For root access to water, the aquifer needs to be unconstrained by any impenetrable rock layers. Unconstrained aquifers consist of a lower saturated zone above which lies an unsaturated zone, referred to as the capillary fringe or vadose zone. The surface of the saturated zone where water pressure equals atmospheric pressure is the phreatic zone (from the Greek 'phrear' meaning spring or well).

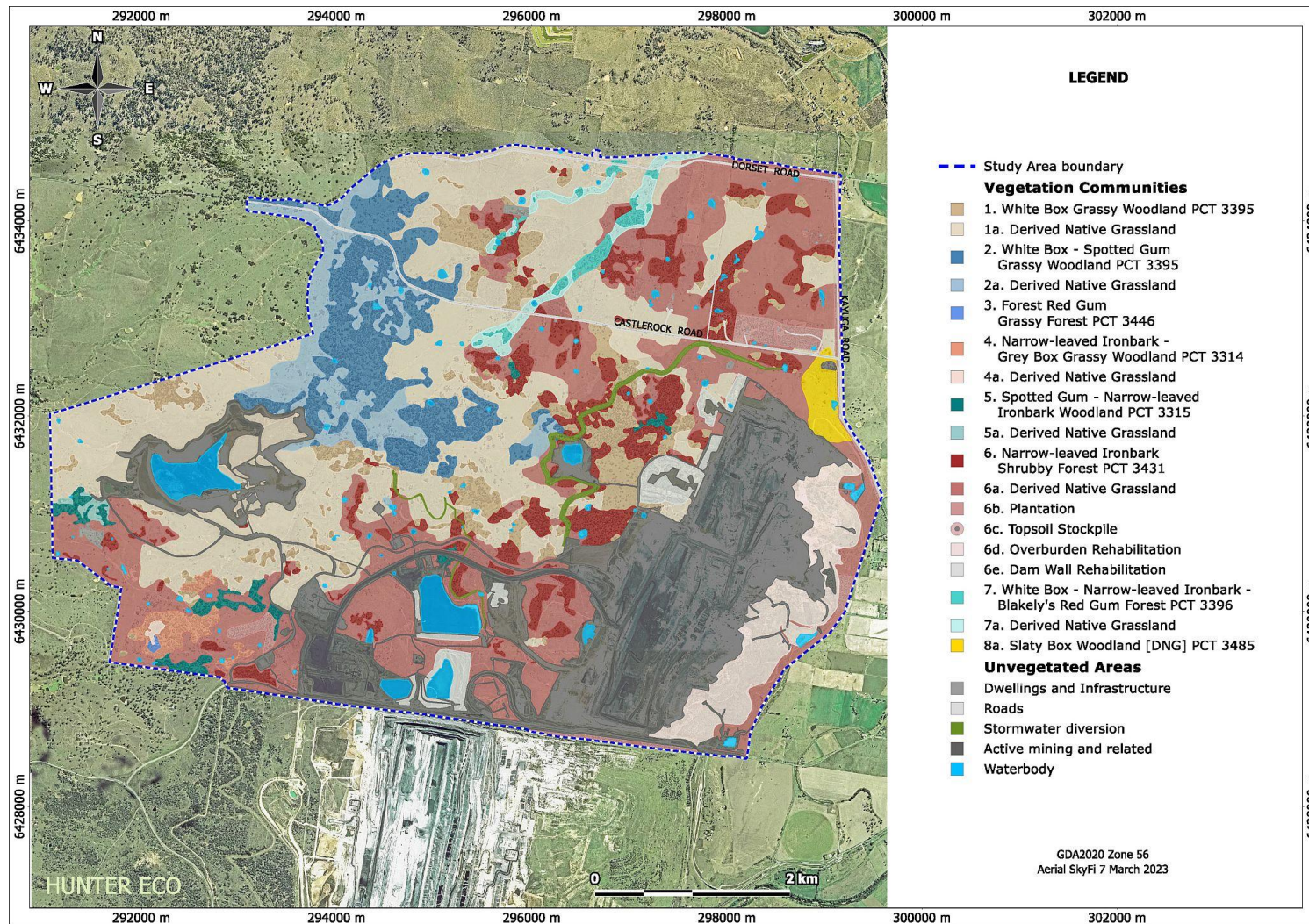


Figure 3: Local Vegetation Communities Mapped Across the Study Area



Vegetation making up a GDE, termed phreatophytic and consisting of phreatophytes, can have varying degrees of dependency on the groundwater. Obligate GDEs are made up of species that depend entirely on the groundwater, and are capable of living with their roots continually wet or at least for seasonal periods of inundation. Facultative GDEs contain species that access the groundwater via the capillary fringe and also take up water from within the soil matrix above this area (Hatton and Evans 1998). These plants cannot cope with having their roots inundated with water.

Depth to water is an important consideration for identifying potential GDEs, and in this context plant rooting depth is relevant. While some plants are capable of sending roots tens of metres (m) into the soil, generally the plants in dry sclerophyll woodland, including trees, would have maximum root depth of approximately 5 m (Canadell *et al.* 1996).

The time scale of availability of water to GDEs also needs to be considered and this has been shown to vary from annual seasonal to as infrequently as 6 months in 10 – 20 years (Eamus *et al.* 2006) with facultative vegetation tolerant of this variability. Thus, GDEs may be present at times when groundwater investigations do not detect any or few aquifers.

A GDE can also be in a perched system where the soil matrix holds water and prevents this water from penetrating the deeper soil layers. In these perched systems, the vegetation will consist of species that are dependent on a generally permanently wet environment. There can be a link between perched GDEs and an underlying aquifer where the replenishing of the water in the perched system occurs when, as a result of sufficient rainfall, the ground water overflows into the perched system.

The *Groundwater Dependent Ecosystems Atlas* (GDE Atlas) (Bureau of Meteorology [BoM] 2025) provides a model of potential GDEs across Australia based on a national-scale analysis or regional studies. Several terrestrial systems within the vicinity of the Modification are mapped in the GDE Atlas (BoM 2025) as low, moderate and high potential for groundwater interaction. The majority of remnant terrestrial vegetation in the vicinity of the Modification is mapped as having low potential for groundwater interaction. A final determination of GDE presence is based on an assessment of whether species within each mapped vegetation community are known to be typically groundwater dependent, as well as a heuristic assessment of where accessible groundwater might occur.

To assist with the assessment a Topographic Wetness Index model (Conrad *et al.* 2015) was prepared (Figure 4) that simulates increasing soil moisture as a result of downslope flow from rainfall.

3.1. Groundwater Dependent Ecosystems in the Modification Area

The potential for remnant terrestrial vegetation in the vicinity of the Modification to be groundwater dependent was assessed based on desktop analysis and site-specific surveys.

The Topographic Wetness model shown in Figure 4 indicated there are moist areas with potential for GDEs. These occur along drainage lines flowing north-east. The GDE Atlas includes these areas but also includes areas along dry ridges, unlikely to support groundwater dependent vegetation.

It was determined that some small patches of the *White Box-Narrow-leaved Ironbark-Blakley's Red Gum* vegetation community (Plant Community Type [PCT] 3396) could potentially be a facultative GDE (Attachment 1, Plates 1 and 2). Considering that this community is restricted to drainage lines suggests that they favour areas of higher moisture content. While the streamlines are ephemeral, erosion and the incised stream beds indicate that there are periods of significant stormwater flow that could recharge transient aquifers.

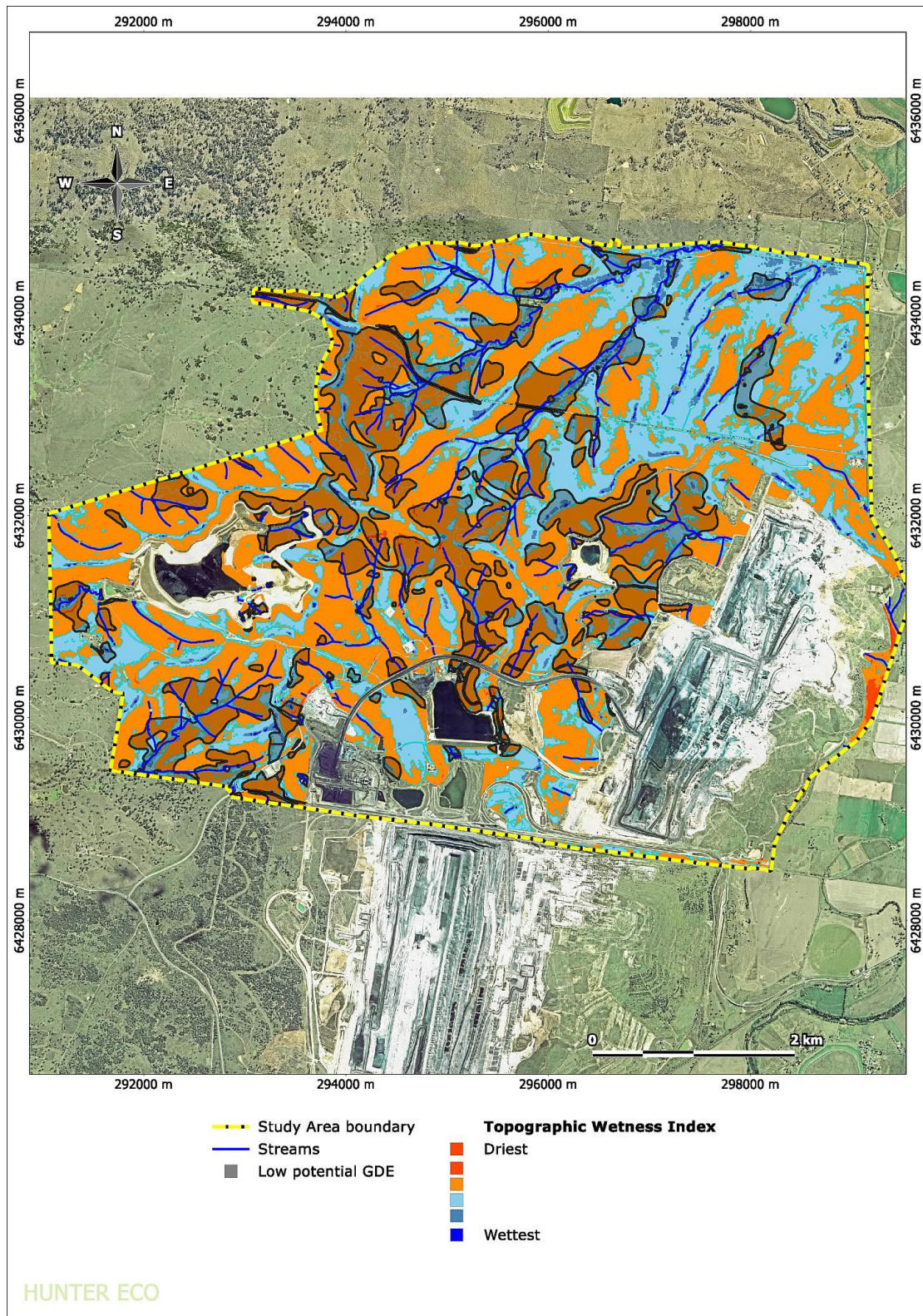


Figure 4: GDE Atlas Low Probability Terrestrial GDEs and Topographic Wetness Index Model Output



The tree species in this community (Forest Red Gum [*Eucalyptus tereticornis*], Yellow Box [*Eucalyptus melliodora*] and White Box [*Eucalyptus albens*]) do not require access to groundwater on a permanent (obligate) basis. These trees have a dimorphic root structure (Doody et al 2015; Fan et al 2017) with spreading subsurface roots accessing soil moisture from precipitation, and sinker roots capable of accessing deeper aquifer/ground water. In this specific location groundwater is approximately 5 m below ground level (Australian Groundwater and Environmental Consultants [AGE] 2025). At this depth, it is possible that the trees use groundwater to meet some of their water requirements.

There are no indications of other potential GDE elsewhere across the Study Area.

3.2. Far-field Effects – Sandy Creek

Sandy Creek lies to the west of the mining area and flows north-south into the Hunter River. An inspection showed that there was a narrow strip of riparian vegetation along the creek, extending in places into small side reaches. The surrounding area consisted of scattered paddock trees in cleared grassland being actively grazed. The dominant riparian canopy species were *Casuarina glauca* (Swamp Oak), *Angophora floribunda* (Rough-barked Apple) and *Eucalyptus blakelyi* (Blakely's Red Gum). A shrub layer was dominated by the high threat weed *Lycium ferocissimum* (African Boxthorn). The creek bed contained ponded water with patches of native reeds *Typha orientalis* (Broadleaf Cumbungi), as well as patches of another high threat weed *Arundo donax* (Giant Reed).

The riparian vegetation resembled PCT 4015 *Central Hunter Riparian Forest* although significantly degraded by the dense African Blackthorn and Giant Reed (Attachment 1, Plates 3 to 6). This riparian vegetation was clearly groundwater dependent both on surface water (aquatic GDE in the case of Broadleaf Cumbungi and associated sedges) and likely alluvial aquifer in the case of the canopy trees (terrestrial GDE).

The overall catchment for Sandy Creek is approximately 9,100 hectares (ha) which would contribute significant rainfall and stormwater flow into the creek over and above any aquifer and baseflow reductions due to the adjacent mining.

3.3. Potential Impacts of the Modification to Groundwater Dependent Ecosystems

The Groundwater Assessment for the Modification (AGE 2025) assessed the groundwater impacts from mining up to 2032. No drawdown is predicted to occur for the Modification (or cumulatively) during mining or post-mining at any high priority GDEs (AGE 2025). Therefore, the Modification is not anticipated to impact the condition of the vegetation community any of these mapped high priority GDEs

The patches of *White Box-Narrow-leaved Ironbark-Blakley's Red Gum* vegetation community (PCT 3396) that could potentially be a facultative GDE are located within the approved surface disturbance area, but are not planned for mining disturbance prior to 31 December 2032

Notwithstanding, negligible groundwater impacts (e.g. drawdown) are predicted to occur in the vicinity of the *White Box-Narrow-leaved Ironbark-Blakley's Red Gum* vegetation community (PCT 3396) from mining up to 2032 and post-mining as provided in the Groundwater Assessment for the Modification (AGE 2025).

Therefore, the Modification is not anticipated to impact the condition of the vegetation community on the basis that the community only accesses groundwater on a facultative basis and is predicted to experience negligible drawdown.



4. Conclusion

Site-specific investigations confirmed that while small patches of the *White Box-Narrow-leaved Ironbark-Blakely's Red Gum woodland* (PCT 3396) within drainage lines may function as facultative GDEs, these areas are limited in extent and the vegetation communities are primarily reliant on soil moisture from rainfall and episodic surface flows rather than groundwater on a permanent basis.

Groundwater modelling (AGE, 2025) indicates that groundwater levels in these areas are typically greater than 5 m below ground level, with negligible predicted drawdown attributable to the Modification. Accordingly, any potential change in soil moisture availability or groundwater access for facultative GDEs is expected to be minor and well within the range of natural variability.

Riparian vegetation along Sandy Creek (PCT 4015 Central Hunter Riparian Forest) is also recognised as groundwater dependent to varying degrees. However, given the substantial catchment area (approximately 9,100 ha), the dominance of surface water contributions, and the limited predicted influence of mining-induced drawdown on the alluvial aquifer, no material impacts to riparian or aquatic GDE function are anticipated.

Overall, it is considered unlikely that the Modification would have any measurable impact on GDEs.



References

- Australasian Groundwater and Environmental Consultants (2025) *Mount Pleasant Operation Modification 8 – Groundwater Assessment*. Prepared for MACH Energy Australia Pty Ltd.
- Bureau of Meteorology (2025) *Groundwater Dependent Ecosystems Atlas*. Website: <http://www.bom.gov.au/water/groundwater/gde/>.
- Canadell, J., Jackson, R. B., Ehleringer, J. B., Mooney, H. A., Sala, O. E., & Schulze, E.-D. (1996) Maximum rooting depth of vegetation types at the global scale. *Oecologia*, 108(4): 583–595. <http://doi.org/10.1007/BF00329030>
- Conrad, O., Bechtel, B., Bock, M., Dietrich, H., Fischer, E., Gerlitz, L., Wehberg, J., Wichmann, V., and Böhner, J. (2015) System for Automated Geoscientific Analyses (SAGA) v. 2.1.4, *Geosci. Model Dev.*, 8, 1991–2007, doi:10.5194/gmd-8-1991-2015.
- Doody, T. M., Colloff, M. J., Davies, M., Koul, V., Benyon, R. G., & Nagler, P. L. (2015) Quantifying water requirements of riparian river red gum (*Eucalyptus camaldulensis*) in the Murray–Darling Basin, Australia—implications for the management of environmental flows. *Ecohydrology*, 8(8), 1471–1487.
- Eamus, D., Froend, R., Loomes, R., Hosea, G., & Murray, B. (2006) A functional methodology for determining the groundwater regime needed to maintain the health of groundwater-dependent vegetation. *Australian Journal of Botany*, 54, 97–114.
- Fan, Y., Miguez-Macho, G., Jobbágy, E. G., Jackson, R. B., & Otero-Casal, C. (2017) Hydrologic regulation of plant rooting depth. *Proceedings of the National Academy of Sciences*, 114(40), 10572–10577.
- Hatton, T., Evans, R., (1998) *Dependence of ecosystems on groundwater and its significance to Australia*. Occasional paper no 12/98. Land and Water Resources Research and Development Corporation. August 1998.
- Hunter Eco (2024) *Mount Pleasant Operation – Baseline Flora Report*. Prepared for MACH Energy Australia Pty Ltd.
- Richardson, S., Irvine, E., Froend, R., Boon, P., Barber, S. and Bonneville, B. (2011) *Australian groundwater-dependent ecosystems toolbox part 1: assessment framework*. Waterlines report, National Water Commission, Canberra.



ATTACHMENT 1
EPHEMERAL DRAINAGE LINE AND SANDY CREEK PHOTOGRAPHS



Plate 1: Red Gums (PCT 3396) along the ephemeral drainage line



Plate 2: Red Gums (PCT 3396) along the ephemeral drainage line



Plate 3: Sandy Creek Swamp Oak, Blackthorn and Broadleaf Cumbungi



Plate 4: Sandy Creek Blakely's Red Gum, Rough-barked Apple, Swamp Oak and Blackthorn



Plate 5: Sandy Creek Ponded Water with Broadleaf Cumbungi, Native Grasses, Swamp Oak and Blackthorn



Plate 6: Ponded water fringed with Swamp Oak, Cumbungi reeds and Blackthorn